DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

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This letter is a condensation of recent newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific newsletters should be directed to the author. A list of recent DATAQUEST Research Newsletters appears at the end of this letter.

SEMICONDUCTORS

Some good news and a little bad news this month.

Business is still good and we think that the trend will continue. Naturally, there is concern about the impact of large amounts of capacity increases on pricing next year, particularly key product areas like 16K RAMS where there are numerous suppliers. DATAQUEST has done a detailed analysis of supply and demand for 16K RAMS for next year. We project supply to increase to about 140 million parts in 1980, up from 68 million parts this year. We believe that real demand next year could exceed 155 million devices. In other words, the business should be basically sold-out next year and price declines should be orderly. The big risk, of course, is that demand is based on shipment expectations by the computer industry. If computer/mini-computer/peripheral demand holds up reasonably well in 1980, as we at DATAQUEST believe it will, then we believe that our semiconductor forecast will be accurate.

Now for a little bad news—the Japanese are back. We understand that, in the European market, some Japanese suppliers are quoting prices more than 20 percent below equivalent U.S. prices on computer memory for mid-1980 delivery. It is an attempt by the Japanese to expand their position in Europe, where they have made very little penetration to date. We do not believe that the price cutting will necessarily spread to other products or other markets, but it is worth noting, once again, this longer term risk to the U.S. industry's longer term profitability.

COMPUTERS

It appears that Digital Equipment may be delaying several new commercial data processing products. The widely anticipated "COMET" (a lower end version of the VAX 11/780) was expected this fall, but may be delayed until March 1980, we understand. Furthermore, a new version of the PDP-11/34 with a commercial instruction set may be delayed six months, and a commercial version of the PDP-11/70 may be delayed indefinitely.

There are several ways of interpreting the DEC decisions. One possibility is that the company may be rethinking its whole approach to the commercial data processing market. More probably, the company is holding off on new product announcements because of very strong demand for existing products and a disinclination to build backlogs or beef up production schedules beyond targeted levels.

With delivery dates starting to stretch out at the company, strong earnings gains in the June 1980 year seem almost assured. We are using $5.20 per share for fiscal 1980 versus $4.10 per share in fiscal 1979. Any disappointments that may occur over the next nine months would likely be in orders, since the general purpose minicomputer market may soften in early 1980. Introducing new commercial products next spring rather than this fall may prove to be very good timing for DEC, giving the company's product line a boost when it may need it more than it does now.

IBM's Data Products Division (DPD) recently announced two low-cost terminals. The products are interesting, but the pricing on the products is more worthy of note. DPD is offering discounts of up to 20 percent on purchases over 100 units. This is the first time DPD has ever offered a volume discount. This offer reinforces our earlier stated beliefs that discounts at IBM may spread throughout its product line to meet selective competitive threats.

PAPER AND FOREST PRODUCTS

Industry order rates remained strong in almost all grades through the end of the third quarter with only spotty areas of weakness.

Prices on almost all products were increased to offset the impact of higher oil prices, but because of backlogs, the impact of higher paper prices will not be felt until the fourth quarter. Therefore, while industry earnings in the third quarter should be roughly comparable to the second, there may be some uneveness in various company reports. Results from companies that use a lot of oil in their manufacturing process (International Paper, Great Northern Nekoosa, for example) may be somewhat disappointing.

It appears that the industry will enter 1980 with higher prices than we had anticipated. Offsetting this is the fact that costs are escalating more rapidly than we had expected. Netting these two factors out, our forecast remains unchanged for 1980—a 10 percent decline in industry operating earnings from pulp and paper.

CAPITAL EQUIPMENT

Evidence continues to point to the fact that the high end of the construction machinery market remains severely depressed.

It is DATAQUEST's estimate that Caterpillar Tractor has shipped 225 of its D-10 crawler tractors (sold almost exclusively to the mining industry) since August 1978. However, we believe that only 65-75 of the units have been sold to customers. Some of the balance have been rented—the majority is in the hands of CAT dealers. In a recent trip to the large tractor plant in East Peoria, Illinois, we found 30 D-10's sitting on the factory grounds. All of which indicates that some cutback in work schedules at East Peoria could be forthcoming.

In general, we believe that CAT has used the large number of machines still on allocation as a means of building inventory in anticipation of a strike. Once the strike is ended, the number of machines on allocation could start coming down pretty rapidly. We are using $7.00 per share this year for CAT and $6.75-$7.00 per share in 1980.

Confirming the weak order trend from mining markets, Fiat-Allis's large crawler tractor plant in Springfield, Illinois, is suffering from weak demand (industry factory shipments of large crawler tractors down 30-40 percent year-to-year), high dealer inventories, and strong competition from the D-10. We believe that a temporary plant shutdown may be needed.

INSTRUMENTATION

As might be expected in a year when semiconductor demand is booming, sales of Automated Test Equipment (ATE) are meeting or exceeding our projections.

We have recently completed an update of the circuit board testing segment of the ATE market and now believe that revenues will total $188 million in 1979, a 39 percent gain over last year (versus our $178 million mid-year forecast). GenRad should maintain or slightly improve its dominant market share, and major gains in share should be made by Teradyne, Hewlett-Packard, and the Zehntel Division of Plantronics. A preliminary look at the semiconductor tester segment of ATE indicates that our 25 percent growth forecast, to about $240 million, is still reasonable.

In total, the ATE market should grow by 31 percent in 1979 to $460 million. More importantly, the 1980 outlook appears reasonably solid. The board testing segment has not traditionally been highly cyclical and we believe that it can grow 20 percent in 1980 to $225 million. Traditionally, semiconductor testing has been very cyclical, but we believe things are changing somewhat. Faced with incredible pressure to increase capacity, semiconductor companies are not likely to curtail buying drastically to the degree they have in the past. We project 13 percent growth in semiconductor testing equipment next year, assuming some slowdown in semiconductor demand, indicating total ATE revenue of $532 million in 1980, up 16 percent.

The two "pure plays" in ATE, GenRad and Teradyne should have an excellent second half of 1979 and relatively strong comparisons next year. We expect GenRad to do $2.90 per share this year and $3.40 per share next year. Teradyne could do $2.30 per share in 1979. There is room for volatility in Teradyne's earnings next year in both directions because of product mix and possible margin expansion. Our present forecast is $2.80 per share in 1980.

COPY AND DUPLICATING

Expect competition to remain fierce in the low end of the copier market in 1980. Two very strong new products are coming from Japan—the Minolta 310 and the Canon NP200J. Both are dry toner machines. The key advantage of the 310 is superior copy quality. Major advantages of the NP200J are very small size, high speed (20 cpm), 11" x 17" copying capability, and fiber optics. Because of high demand, Minolta is chartering cargo jets in order to begin shipments in the United States this month. We expect the Canon unit to be introduced to the U.S. by the third quarter of 1980. With a world-wide recession next year a possibility, the low end could get even more competitive.

Xerox's low-end products, the 2300 and 2600 are receiving good response. Interestingly, however, the company has allowed delivery times to remain abnormally high for these kinds of copiers. We have no hard evidence of plans for a new low end product, but as mentioned in the past, Xerox's 2300 and 2600 do not compare favorably with the Japanese competition. A new low end product from Xerox would be a major plus. A recent new product introduction, the 3300, is also designed for low-end applications. Xerox is saying that the 3300 has a new copying engine, but to us it looks like an evolutionary enhancement of the old 3100; we do not expect the 3300 to be a significant new product.

Elsewhere in the copier business, Eastman Kodak placements are doing better than DATAQUEST had projected, and we have revised our 1978 placement number upward as well. Nothing new from IBM, almost making one wonder whether IBM has given up on its conventional copier business beyond the Copier III, concentrating instead on intelligent copiers. Nashua's placements should reach 45,000 in 1979, up from 39,000 last year, but maintaining that level in 1980 may prove difficult.

Michael R. Weisberg

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GOVERNMENT ISSUES AFFECTING THE SEMICONDUCTOR INDUSTRY

SUMMARY

This report provides a brief analysis of some of the current issues having an impact on the U.S. semiconductor industry. Some of these issues have been reported upon before in earlier DATAQUEST newsletters, and we will be following them in the coming months.

- International Trade Commission (ITC) plans to formally review staff study on the competitiveness of U.S. semiconductor industry in September.
- House Ways and Means and Senate Finance Committees tell Executive Branch to pay attention to "threat of injury" for high technology industries.
- Government organization to enforce recently approved Multilateral Trade Negotiations (MTN) agreements is a key question on Capitol Hill.
- Legislation to substantially amend the Export Administration Act of 1969 has passed the Senate and will be voted on by the House at any time.
- Legislation to reinstate stock options and to eliminate the restricted stock option as an item of tax preference is likely to gain strong Congressional backing.
- Support for Export Trade Associations, through modification of Webb-Pomerene Act, grows on Capitol Hill.
- Very High Speed IC (VHSIC) program not funded.

ITC STUDY OF COMPETITIVENESS OF U.S. SEMICONDUCTOR INDUSTRY PROCEEDS APACE

The staff of the International Trade Commission expects to complete an initial draft of its report on the competitive posture of the U.S. semiconductor industry this month. The draft will be circulated internally within the ITC and is expected to be reviewed by the Commission itself in a public meeting at the end of September. The Commission has until the end of October to make its final report to Congress. Once in the hands of Congress, the ITC report can be expected to stimulate Congressional hearings, especially in the Senate Commerce and Banking Committees.

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Commission staffers working on the report have been hampered by the lack of specific responses by U.S. manufacturers on the question of impediments to U.S. exporters and by the late arrival of foreign manufacturers' export-import data.

PAY ATTENTION TO "THREAT OF INJURY" FOR HIGH TECHNOLOGY INDUSTRIES CONGRESS TELLS EXECUTIVE BRANCH

In their separate reports telling the Administration how Congress intends that U.S. anti-dumping and countervailing duty laws are to be enforced, both the House Ways and Means and the Senate Finance Committees have specifically instructed the Executive Branch to take the "threat of injury" into account in making countervailing duty or anti-dumping cases in the face of unfair foreign competition. Both committees acted in response to pleas from the U. S. semiconductor industry, which has argued that it is being hurt by subsidies and price cutting by Japanese manufacturers; however, it cannot successfully proceed with countervailing duty or anti-dumping claims because by, traditional standards, the industry appears healthy.

The House Ways and Means Committee, in its Report on the trade bill, told the Executive Branch:

> "An increase in market penetration may be an early warning signal of injury. Indicia of the threat of material injury will vary from industry to industry. The ITC should place emphasis on the rate of increase in market penetration, particularly if market penetration is achieved by prices which are below U.S. price levels, but which are not maintained in the home market. Under certain circumstances, increases in market penetration should be examined over a short time period—such as the change from quarter to quarter within a calendar year."

The Senate Finance Committee was more explicit in its instructions:

> "Economic factors which may indicate that a threat of material injury is present will vary from case to case and industry to industry. The ITC will continue to focus on conditions of trade and competition and the nature of a particular industry in each case. For example, in some cases, e.g., an industry producing a product which has a relatively short market life and significant research and development costs associated with it, a rapid increase in market penetration could quickly result in material injury to that industry. The existence of such increases in market penetration may be a particularly appropriate early warning signal of material injury in such cases."

Sources close to the Senate Finance and House Ways and Means Committees and at the ITC all agree that this language in the committee reports would make it easier for the U.S. semiconductor industry to successfully file countervailing duty or anti-dumping charges against the Japanese before any economic downturn.

TRADE REORGANIZATION NOW THE KEY QUESTION ON CAPITOL HILL

With the President's signing of legislation implementing the Multilateral Trade Negotiations, Congressional attention has turned to how the results of these negotiations will be monitored and enforced. Under pressure from the Senate Finance

Committee, the Administration announced a proposed plan to reorganize the federal government's international trade functions in an attempt to meet criticism from many in Congress and some from industry groups, which claimed that the present structure would not permit effective response to violations of the MTN.

Under the Administration's plan, the Office of the Special Trade Representative would be renamed the Office of the U.S. Trade Representative. The Trade Representative would retain Cabinet rank, and the Office would assume the following functions:

- Trade Policy Coordination. Currently the Office's responsibilities are limited primarily to trade negotiations.

- Lead Responsibility for Trade Negotiations. In addition to multilateral and bilateral negotiations now assigned to the Trade Representative, the Office would be assigned the responsibility for: (1) commodity negotiations; (2) East-West trade; (3) all negotiations relating to the MTN, including representation to the General Agreement on Tariffs and Trade.

The Office of the United States Trade Representative would retain the lead policy role with respect to discretionary trade remedy functions, including escape clause, Section 301, and market disruption cases.

The Department of Commerce would also assume a greater role and would become responsible for implementing nonagricultural trade policy generally. The Department would be renamed the Department of Trade and Commerce and, under the reorganization, would be assigned:

- Anti-dumping, countervailing duties, embargoes, national security trade investigations, all of which are now the responsibility of the Department of the Treasury

- Responsibilities with regard to unfair import practices under Section 337 of the Tariff Act of 1930, which come under the International Trade Commission

The Department would also be responsible for providing staffing for Section 301 cases that involve unfair trade practices in nonagricultural matters. Finally, the Department would be specifically assigned the job of providing support for the implementation of the MTN agreements, and its sectorial analysis would be upgraded.

Senate hearings on the Administration's reorganizational proposal have begun, and the House is expected to schedule hearings shortly. Thus far, the reaction on Capitol Hill to the Administration's proposal has been lukewarm at best. Overall concern among the members has centered around the fact that the Administration's recommendations do not show a real commitment to improve U.S. trade policy. Some Senators have indicated that the proposal is not the real shakeup that is needed. Senators have also asked for clarification of the anti-dumping and countervailing duty roles of the Commerce Department and the U.S. Trade Representative, although many are happy that the Treasury Department is no longer involved.

The Administration will try to work with Congress to get an agreement on reorganization after hearings in both Houses. The compromise on which Congress and the Administration finally agree could be submitted as a reorganization plan. Such a plan would not require legislation, and would go into effect unless disapproved by Congress.

EXPORT CONTROL BILL PASSED BY THE SENATE

By an overwhelming majority (73-4), the Senate has approved a bill (S. 737) to amend and extend the Export Administration Act of 1969. The House is expected to vote on a similar bill at any time. This bill, which would clarify many export trade issues, will be discussed in detail in the next DATAQUEST Government Issues newsletter.

EMPLOYEE STOCK OPTION PLANS

Several key Senators and Congressmen plan to introduce legislation to amend Sections 57 and 424 of the Internal Revenue Code of 1954 to reinstate restricted stock options and to eliminate the restricted stock option as an item of tax preference in the near future.

Sponsored by the National Venture Capital Association and the American Electronics Association, the legislation would enable corporations to provide their employees with meaningful incentives to achieve business growth and increased productivity, thus creating new jobs and stimulating the economy.

Judging by the number of influential legislators who are anxious to cosponsor this proposed legislation, the proposal could build up support similar to that which ensured the passage of the reduction in capital gains tax rates last year.

SUPPORT FOR EXPORT TRADE ASSOCIATIONS GROWS IN CONGRESS

Renewed interest in the use of U.S. export trade associations has begun to surface in both the House and Senate, as members of Congress seek ways to stimulate U.S. exports. In both houses legislation has been introduced that would encourage greater use of these organizations through modifications of the Webb-Pomerene Act, the 1918 statute that permitted their creation.

The bill that has attracted the most attention is the "Export Trade Association Act of 1979" (S. 864), introduced by Senator John Danforth (R-Miss.), a member of the Senate Finance Committee.

The existing Webb-Pomerene Act permits American companies to join together in developing foreign sales while enjoying immunity from U.S. antitrust laws. Over the years, there has been much disagreement as to the extent of that immunity—so much so that the role of Webb-Pomerene associations has changed significantly over the years. At their high-water mark, between 1930 and 1935, Webb associations accounted for about 19 percent of total U.S. exports. Today, their share has slipped to less than 2 percent.

The legislation sponsored by Senator Danforth attempts to expand and clarify the Webb-Pomerene Act's antitrust immunity as well as to make its provisions applicable to the export of services. Senator Danforth has also proposed some organizational changes in the administration and policy review aspects of the law intended to promote its more active use. One provision would transfer the administration of the law from the Federal Trade Commission to the Department of Commerce. Another would create within the Commerce Department an office to promote the formation of export trade associations. Still another would create a task force to evaluate the effectiveness of the Act in increasing U.S. exports and to make recommendations regarding its future to the President.

S. 864 would change both the chartering and complaint procedures to clarify antitrust immunity. Companies seeking certification in a Webb trade association would be required to disclose specific information on the products being exported, the countries that will be receiving the exports, and the method of export. In addition, the association would have to disclose any information required by the Secretary of Commerce concerning "operation, management, or finances."

Complaints brought against Webb associations on antitrust grounds would be limited to federal agencies, with private parties enjoying only the right to petition the Secretary of Commerce to investigate an association's actions. If an export association were found to be violating the new Act, the Commerce Department could take one of the following remedial actions:

1. Require that the association submit an amendment to its original charter

2. Force the association to modify its procedures

3. Revoke the association's charter

4. Recommend to the Justice Department that legal action be undertaken

One of the principal reasons for the use of Webb-Pomerene trade associations is the increasing involvement of foreign governments in foreign trade; it is felt that U.S. firms are at a disadvantage in such markets.

VHSIC PROGRAM DIES IN COMMITTEE

After lining up several company teams and individual companies interested in participating in the Defense Department's Very High Speed IC program, House and Senate conferees failed to appropriate funds for the program for the fiscal year beginning October 1, 1979. While the program is officially dead for the coming fiscal year, it could be revived as a rider to a supplemental military appropriations bill.

The VHSIC program was first announced in September 1978, to be funded by the Department of Defense for approximately $150-200 million to be spread over the four- to six-year lifetime of the program.

Semiconductor firms that have submitted proposals to the Department of Defense Development and Engineering were teams from Rockwell International-Sanders Associates; General Instrument-Boeing Aerospace; TRW-Motorola-Univac-GCA; Westinghouse-National Semiconductor; Hughes Aircraft-Signetics; Raytheon-Fairchild Camera and Instrument-Extrion (Varian); and individual companies——General Electric, IBM, RCA, Texas Instruments, and Western Electric.

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ADVANCED SCHOTTKY TTL

SUMMARY

Advanced Schottky TTL, an iteration of Super Schottky, is now being offered by Fairchild, Raytheon, and Texas Instruments. It offers improved speed/power characteristics over conventional Schottky. Fairchild has placed its emphasis on lower power while Raytheon and Texas Instruments have emphasized higher speeds. We expect that the higher speeds of Advanced Schottky will cause significant usage problems—especially at wire wraps and connectors. Interest in the new families is high, but no significant market has yet developed due to the newness of the product lines and the lack of alternate sources.

BACKGROUND

Advanced Schottky (AS) and Advanced Low Power Schottky (ALS) have been announced recently. These families originated from Super Schottky development programs sponsored by IBM's Federal Systems Division, but they are now pursuing different directions. The divergent directions, uncertainty about the future, and lack of alternate sources is causing confusion in the marketplace. Two of the AS product families (Fairchild and Raytheon) are intended to be direct retrofits for Schottky (S), but some questions about full compatibility do exist. Texas Instruments AS family is implemented with new circuits in new packages; hence, it is definitely intended for new designs and not for retrofitting. Texas Instruments ALS family should be pin-compatible with the existing low-power Schottky (LS) family, but will be faster and should consume less power. Key parameters for the Schottky families are shown in Table 1.

Advanced Schottky takes advantage of modern oxide-isolated processing to offer the user a significantly improved speed/power product. Thus, we expect that major extensions of Schottky will soon be effected with oxide isolation only.

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Table 1

TYPICAL VALUES FOR KEY PARAMETERS OF TTL LOGIC FAMILIES

	Logic Family							
Parameter	TTL	H-TTL	S-TTL	FCI AS	RAY AS	TI AS	LS	TI ALS
Average Switching Delay (ns)	9	6	3	2.65	1.5	1.5	5.0	4.0
Waveform Rise Time (ns)	6-9	4-6	1.8-2.8	2.5	2.1	2.3	9.5	5.0
Waveform Fall Time (ns)	4-6	2-3	1.6-2.6	2.5	1.9	1.8	6.0	5.0
Power Consumption (mW per gate)	10	22.5	20	4	20	20	2	1
Speed-Power (pJ)	90	135	60	11	30	30	10	4
Oxide Isolated ?	No	No	No	Yes	No	Yes	No	Yes

Source: DATAQUEST, Inc.
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MANUFACTURERS

Fairchild

Fairchild's FAST (Fairchild Advanced Schottky TTL) employs Isoplanar processing and was the first of the new families to be introduced. Fairchild's product is well specified and nine SSI and MSI devices are available. Fairchild's strategy was to introduce a retrofitable family with slightly improved performance and greatly reduced power consumption. Although Fairchild claims that significant usage problems are not expected to result from retrofitting existing S designs, we advise potential users to proceed with caution; history has shown us that retrofitting contains many unexpected problems. We expect FAST to be performance-competitive in MSI devices, since it appears to be the interface design that limits the speed in SSI devices.

Raytheon

Raytheon's AS family offers no improvement in power consumption, but is about twice as fast as conventional Schottky. To facilitate driving transmission lines and large capacitances, Raytheon has increased I_{os} (output short-circuit current) to a minimum of 125 mA. This tripling of the output current capability will result in very sharp edge speeds under light load conditions. Furthermore, Raytheon sacrificed some noise margin by lowering the input low-threshold voltage to 0.7 volts. Raytheon's AS is fabricated with a high-performance, junction-isolation process.

Raytheon promotes its family as being fully compatible with existing S devices and offers it in the same packages as S. Data sheets are available, but we understand that device samples are still in short supply.

Texas Instruments

Texas Instruments approach to this emerging market is more radical; it chose to serve the extremes of high speed and low power and to offer the high-performance family in new packages. It uses an oxide-isolated process for both the AS and the ALS products. Its AS line is twice as fast as its S family and it is making no claims about retrofitability; the new family is offered in new circuit functions and in new package configurations and retrofitting is impossible. AS is to be the vehicle for introducing new complex functions, which will be offered in three output configurations as appropriate. These are: 50-ohm line drivers, buffers for lines to 100 ohms, and S configurations.

Texas Instruments philosophy on ALS is to double the AC performance over comparable devices in LS while saving about one-half of the power and retaining the same design rules. With a doubling of the AC performance, TI expects that many existing S designs will be converted to ALS. In this case, some consideration must also be given DC loading rules. Note that DATAQUEST is skeptical about direct replacement of any devices by faster devices. Data sheets and samples are available on some SSI devices. TI expects initial availability of MSI specifications and product in October.

Other Manufacturers

No other manufacturer has yet announced an Advanced Schottky family. National has recently upgraded its LS family to match the performance of Fairchild's and Motorola's LS with the noise margin offered by Signetics' LS. AMD expects to use an oxide-isolated process for higher performance MSI/LSI in the future, but does not intend to enter the Advanced Schottky marketplace per se. Signetics' position is similar to that of AMD in that it sees no need for either a new family or an oxide-isolated process at this time. It expects to make additions and selective replacements to its LS line with advanced junction-isolated processes.

Motorola states that it too is watching the market and that it intends to follow the approach that is best accepted by the marketplace. It intends to announce a decision in 1979. Motorola is one of IBM's suppliers; therefore, it has the technology to supply AS product.

USAGE PROBLEMS

A prominent problem in the use of high-speed logic forms is reflections on the signal lines. Reflections are generated in improperly terminated lines; they become more persistent as the propagation delay and the signal rise time approach the same magnitude. Especially in the case of the Raytheon AS, we would expect that careful termination would be required for all signal paths longer than a couple of inches.

Reflections are aggravated by the discontinuities associated with wire-wrapped open wiring and connectors. Circuit malfunctions result if the reflections cause false or delayed crossings of the logic thresholds; therefore, noise margins are of vital concern. With these considerations, there is concern that AS may require more costly interconnection techniques, such as twisted pairs or strip lines on mother boards.

MARKET

Table 2 presents DATAQUEST's estimates of worldwide TTL logic consumption. TTL logic is segmented into standard TTL logic and Schottky logic; Schottky logic is further segmented into Standard Schottky and low-power Schottky. As indicated in Table 2, low-power Schottky is expected to have the highest growth of the various segments, reaching almost $1.2 billion by 1983. The AS and ALS markets will eventually be segments of the low-power Schottky market but it is still premature to forecast markets for these emerging product lines.

Table 2

ESTIMATED WORLDWIDE TTL LOGIC CONSUMPTION

(Millions of Dollars)

	1978	1979	1980	1981	1982	1983
Standard TTL Logic	$485	$ 540	$ 550	$ 535	$ 510	$ 490
Schottky TTL Logic	363	585	730	975	1,265	1,585
Standard Schottky	214	290	310	345	375	405
Low-Power Schottky	149	295	420	630	890	1,180
Total TTL Logic	$848	$1,125	$1,280	$1,510	$1,775	$2,075

Source: DATAQUEST, Inc.
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DATAQUEST found the greatest user interest in AS and ALS to be with manufacturers of minicomputers and military equipment. Competitive minicomputers must have very fast logic in their data paths to effect the required throughput. The power consumption of conventional high-speed logic results in troublesome power-density problems and the associated problems of power distribution and heat removal. Military equipment manufacturers are vitally concerned with the size and weight of power supplies and with the effects of internally generated heat in high ambient temperature environments. Speed/power improvements thus typically result in large cost savings in these, and other, systems.

Thus, we expect AS to be especially popular in applications that demand maximum performance, and ALS and FAST to be especially popular in military systems and in minicomputer peripheral circuits. Many users are concerned that the present movements will cause existing product lines to become obsolete. For example, Texas Instruments has commented that it will produce no new circuit designs in conventional LS; some systems manufacturers project that some existing LS may be discontinued. It certainly follows that new designs must use the new technology if the manufacturer is to remain competitive in its market.

Prices of Advanced Schottky devices are expected to be 20-30 percent higher than their conventional equivalents. Although we found significant interest and awareness of the new families, we found no committed designs. We expect that there will be few commitments until at least one of the major TTL manufacturers decides to become an alternate source.

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PRELIMINARY MARKET SHARE ESTIMATES OF U.S. AND EUROPEAN MERCHANT SEMICONDUCTOR SUPPLIERS

Summary

DATAQUEST's preliminary 1979 estimates of semiconductor shipments by the 22 leading U.S. and European semiconductor suppliers (shown in Table 1) reveal a 33.6 percent growth over estimated shipments for 1978. Estimates of Japanese companies' shipments are not yet available, and are not included in this table. The 18 U.S. semiconductor companies accounted for 85.1 percent of the total U.S. semiconductor shipments in both 1977 and 1978 and are estimated to have shipped a comparable percentage in 1979.

Preliminary estimates for the 13 leading IC and discrete suppliers in 1979 demonstrate a 39.7 percent and a 16.0 percent increase, respectively, over the value of 1978 shipments. DATAQUEST's 1978 IC shipment estimates show the 11 leading U.S. IC suppliers to have 81.9 percent of the worldwide IC shipments by all U.S. IC suppliers, up from a 78.2 percent market share in 1977. Although the number of total 1979 shipments is not yet available, we estimate that these 11 companies have shipped about four-fifths of the total IC's shipped by U.S. companies. The 10 leading U.S discrete suppliers are estimated to have shipped 79.8 percent of the 1978 worldwide shipments by all U.S. discrete suppliers, up from 78.5 percent in 1977. Note that discrete devices here include optoelectronics.

Preliminary revenue estimates of the top 14 U.S. MOS suppliers in 1979 exhibit a 51.5 percent growth in MOS shipments over 1978 estimates. Again, the MOS market segment showed the highest growth in the semiconductor marketplace. In 1978, the 14 U.S. MOS market leaders shipped 92.7 percent of the worldwide shipments by all U.S. MOS suppliers, up from an 84.2 percent market share in 1977. Their collective market share for 1979 is expected to grow slightly over their 1978 market share. At this time, we have no preliminary MOS revenue estimates for the European companies. However, the final version of Appendix B will have a more complete breakdown for European IC suppliers.

Semiconductor Suppliers

Table 1 presents the preliminary ranking of the 22 leading U.S. and European semiconductor suppliers broken down into ICs, Discretes, and Other. Please note that Table 1 includes Optoelectronics under Discretes, unlike the DATAQUEST Appendix B Market Share Estimates notebook section which separates the two. The "Other" category consists primarily of modules and hybrids.

DATAQUEST's Preliminary Appendix B, which is scheduled for a January publication, will include preliminary shipment estimates by product type for all products for all companies covered in our annual Appendix B - Market Share Estimate Worksheets. The final revision of Appendix B is scheduled for publication in May.

It is significant to note that in the preliminary ranking, two of the top seven semiconductor suppliers are European companies, namely, Philips and Siemens. (In Japan, Hitachi and NEC are of comparable size.)

IC Suppliers

The preliminary DATAQUEST estimates for the 1979 leading U.S. and European IC suppliers are shown in Table 2. It is obvious in the 39.7 percent market share increase of the top U.S. And European IC suppliers' revenues that 1979 was a good year for IC growth. Texas Instruments was the leading merchant IC manufacturer, shipping an estimated $925 million in 1979. Motorola, National and Philips are in close rank for second place among IC suppliers at about $500 million each. However, one should note that in Table 2 the IC estimates for National and Motorola do not include estimates for hybrids and modules, which are $40 million and $10 million respectively.

Table 2 demonstrates remarkable growth in the IC marketplace for all the listed companies. However, AMD, Mostek, and Motorola, in particular, stand out as having annual growths above 50 percent. Mostek's outstanding 68.0 percent growth has placed it eighth among U.S. IC suppliers with AMD not far behind with its 57.6 percent growth in ICs. Also, Motorola's 50.8 percent growth has moved it into a tight third place ranking behind Texas Instruments and National.

Discrete Suppliers

Table 3 shows the preliminary estimates for the 13 leading U.S. and European discrete suppliers in 1979. Overall growth in the 1979 discrete marketplace is reflected in the 16.0 percent growth in shipments of the 13 leading U.S. and European discrete suppliers. For General Instrument, this includes revenues of the optoelectronics division acquired in 1979 from Monsanto for both 1978 and 1979 ($27 million and $33 million, respectively). General Instrument and National both exhibited a healthy 30 percent growth in discretes.

MOS Suppliers

Preliminary estimates for the 1979 leading U.S. MOS suppliers are shown in Table 4. The high demand for MOS devices in 1979 is reflected in the 51.5 percent over 1978 MOS shipments by the 14 leading U.S. MOS suppliers. Clearly, this growth marks the MOS market segment once again as the fastest growth segment in the semiconductor marketplace.

AMD, Fairchild, Mostek, Motorola, National, and Synertek all exhibit 1979 preliminary MOS revenue estimates that are up at least 51.0 percent over 1978 levels. Motorola and National stand out with their remarkable 88.1 percent and 84.6 percent growths, respectively. Mostek grew next fastest at 68.0 percent. Fairchild has moved into a tie with RCA for tenth place among U.S. MOS suppliers due to its healthy 56.9 percent increase in MOS revenues in 1979. It is also significant to note that Synertek has joined the leading 12 U.S. MOS suppliers with a 51.5 percent MOS growth.

Mary Ellen Hrouda
James F. Riley
Daniel L. Klesken

Table 1

PRELIMINARY ESTIMATES
1979 WORLDWIDE SHIPMENTS BY LEADING U.S. AND EUROPEAN SEMICONDUCTOR SUPPLIERS
(Millions of Dollars)

	ICs	Discretes[1]	Other[2]	Total
Texas Instruments	$925	$285	-	$1,210
Motorola	$496	$424	$10	$ 920
Philips (including Signetics)	$490	$290	-	$ 780
National	$515	$ 65	$40	$ 620
Fairchild	$330	$120	$20	$ 470
Intel	$430	-	-	$ 430
Siemens	$150	$260	-	$ 410
RCA	$155	$115	-	$ 270
Signetics	$250	-	-	$ 250
Mostek	$210	-	-	$ 210
AMD	$208	-	-	$ 208
General Instrument[3]	$ 90	$100	$ 6	$ 196
ITT	$ 85	$100	-	$ 185
Sescosem	$ 40	$120	-	$ 160
General Electric	$ 3	$126	-	$ 129
AEG-Telefunken	$ 40	$ 85	-	$ 125
Harris	$115	-	-	$ 115
AMI	$ 95	-	-	$ 95
Intersil	$ 85	$ 7	-	$ 92
Hewlett-Packard	See Note 4	$ 85	-	$ 85
International Rectifier	-	$ 78	-	$ 78
Rockwell	$ 70	-	-	$ 70

[1] Includes Optoelectronics

[2] Consists primarily of hybrids and modules

[3] Includes Optoelectronics Division, formerly Monsanto, having estimated 1979 revenues of $33 million

[4] For Hewlett-Packard, captive IC production is not counted

Source: DATAQUEST, Inc.
December 1979

Table 2

PRELIMINARY ESTIMATES
WORLDWIDE SHIPMENTS BY LEADING U.S. AND EUROPEAN IC SUPPLIERS

(Millions of Dollars)

	1978	1979	Annual Growth Percent
Texas Instruments	$ 669	$ 925	38.3%
National	370	515	39.2
Motorola	329	496	50.8
Philips (including Signetics)	375	490	30.7
Intel	300	430	43.3
Fairchild	255	330	29.4
Signetics	205	250	22.0
Mostek	125	210	68.0
AMD	132	208	57.6
RCA	127	155	22.0
Siemens	108	150	38.9
Harris	85	115	35.3
General Instrument	75	96	28.0
Total IC Shipments of 13 Leading Companies	$2,950	$4,120	39.7%

Source: DATAQUEST, Inc.
December 1979

Table 3

PRELIMINARY ESTIMATES
1979 WORLDWIDE SHIPMENTS BY LEADING U.S. AND EUROPEAN DISCRETE SUPPLIERS[1]
(Millions of Dollars)

	1978	1979	Annual Growth Percent
Motorola	$ 351	$ 427	21.7%
Philips	266	290	9.0
Texas Instruments	254	285	12.2
Siemens[2]	208	260	25.0
Fairchild	125	140	12.0
General Electric	111	126	13.5
Sescosem	100	120	20.0
RCA	113	115	1.8
ITT	95	100	5.3
General Instrument[3]	77	100	29.9
Hewlett-Packard	69	85	23.2
International Rectifier	70	78	11.4
National Semiconductor	50	65	30.0
Total Discretes Shipments of 13 Leading Companies	$1,889	$2,191	16.0%

[1]Figures Include Optoelectronics

[2]Includes Litronix revenues of $21 million for 1978 and $36 million for 1979

[3]Monsanto Optoelectronics, purchased by General Instrument in June 1979, is now included for both 1978 and 1979. Estimated revenues for Optoelectronics were $27 million and $33 million for those years.

Source: DATAQUEST, Inc.
December 1979

Table 4

PRELIMINARY ESTIMATES
1979 WORLDWIDE SHIPMENTS BY LEADING U.S. MOS SUPPLIERS

(Millions of Dollars)

	1978	1979	Annual Growth Percent
Intel	$ 283	$ 408	44.2%
Texas Instruments	238	340	42.9
Motorola	143	269	88.1
National	130	240	84.6
Mostek	125	210	68.0
AMD	71	110	54.9
AMI	71	95	33.8
General Instrument	68	90	32.4
Fairchild	51	80	56.9
RCA	69	80	15.9
Rockwell	52	70	34.6
Synertek	33	50	51.5
Intersil	35	45	28.6
Signetics	32	35	9.4
Total MOS Shipments of Above Companies	$1,401	$2,122	51.5%

Source: DATAQUEST, Inc.
December 1979

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GENERAL INDUSTRY UPDATE

SUMMARY

DATAQUEST expects U. S. semiconductor consumption for 1980 to show moderate growth of more than 13 percent over 1979 levels despite a poor outlook for the overall U.S. economy. Our estimate of the growth of the U.S. market in 1979 still continues to rise. DATAQUEST currently expects U.S. semiconductor consumption for 1979 to be approximately 31 percent over 1978.

Behind this tremendous growth in the semiconductor industry, however, lies a national economy which has performed in a varied and inconsistent manner throughout 1979 and now appears to be sliding into a downturn. An essentially flat economy in 1979, the energy problems, and the extremely high interest rates all promise a recessionary economy for the first half of 1980 although a deep recession is not generally expected. Special factors mitigate the effect on the semiconductor industry and should cause the industry to outperform the economy as a whole by a considerable margin. Nevertheless, considerable caution is called for. A temporary demand slowdown (not a downturn) is expected to result in inventory and price adjustments, flush out double orders and reduce backlogs and lead times.

Table 1

ESTIMATED U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1978	1979	Percent Increase 1978-79	1980	Percent Increase 1979-80
Discrete Devices	$1,019	$1,218	19.5%	$1,252	2.8%
Integrated Circuits	2,304	3,137	36.2%	3,695	17.8%
Total	$3,323	$4,355	31.1%	$4,947	13.6%

Source: DATAQUEST, Inc.
December 1979

Recent Economic Trends

The U.S. economy declined in the second quarter of 1979 and then had revitalized growth during the third quarter. This growth, in turn, has been reversed by energy problems and movements by the Federal Reserve to tighten the money supply and raise interest rates. These movements have not yet had the extremely deleterious effect on the economy that many expected. However, a prolonged downturn is currently considered likely, beginning in the fourth quarter and extending through the first half of 1980. Obviously, with the current energy problems and high inflation rate, the world economic situation is very tentative. The U.S. economy itself appears to be very sensitive to both further oil price and supply manipulation by OPEC or policy actions by the (U.S.) Federal Government. A deeper recession is not likely, but economic developments should be closely watched. Already, higher energy prices have markedly impacted the economic outlook for Europe and Japan.

The following recent economic developments are noteworthy:

- The Gross National Product grew at an annual rate of about 3.1 percent in real terms in the third quarter of 1979, following a slow first quarter and a drop in the second quarter of 1979.
- Most economic forecasters expect the real GNP to remain about level in the fourth quarter and to move down during the first half of 1980, followed by a period of slow recovery.
- Inflation continues to be both pernicious and persistent, with prices rising at levels significantly above 10 percent annually. The differential effects of this inflation on various sectors of the economy are not well understood, making all forecasting doubly difficult.
- Currently, the economic slowdown is highly skewed. Industries such as automotive and housing that are affected directly by inflation, high interest rates, and the high cost of energy are in definite recessions, or soon will be. Other industries, which have not had rapidly increasing prices, have been less affected and show continued growth.
- Industrial production has remained essentially level throughout 1979.
- The Index of Leading Indicators continues to decline at a moderate pace. This pattern indicates the current and expected economic slowdown, but not a major downturn.
- Money supply has recently grown very slowly due to the actions by the Federal Reserve.
- Economic growth in Europe and Japan will certainly be slower than anticipated because of higher oil prices and actions taken to reduce inflation.
- Capital expenditures for business equipment remain relatively strong.

The slowdown of the economy is definitely here. The recession will likely be somewhat longer than previously anticipated: time is needed to effectively combat the problems of energy, high inflation, and the weak dollar. As the downturn persists, more and more sectors of the economy will be affected.

SEMICONDUCTOR INDUSTRY TRENDS

Significantly, the U.S. semiconductor consumption has risen dramatically despite the lackluster overall economic performance in 1979. U.S. semiconductor demand in the third quarter of 1979 continued to be extremely strong. Book-to-bill ratios have remained in the range significantly above 1.1 to 1. Indications are that bookings through November have remained strong except in specific areas of devices for consumer products, and in discrete devices generally. Nevertheless, production has been increasing faster than bookings, and book-to-bill ratios are declining.

Semiconductor shipments and consumption in the third quarter were up significantly over the second quarter of 1979. DATAQUEST estimates that U.S. consumption was about 4.5 percent above that of the second quarter. For the third quarter, with its seasonal weakness, this is an extremely strong performance. One probable factor in the increased value of shipments is that of product pricing, which has remained stable throughout the year.

At this point, the semiconductor industry and most industries from which its demand derives are clearly outperforming the economy as a whole, which has been essentially flat all year. This discrepancy is without historical precedent, but DATAQUEST feels that it is not without explanation.

Semiconductors are one of the few products that continue to decline in price. It is our feeling that inflation has indirectly been a terrific engine of demand for semiconductors. The price of almost everything has gone up while the price of semiconductors has fallen continuously. The rising price of alternative solutions not only adds to the relative cost effectiveness of semiconductors in many applications, but sensitizes managers to the problems of inflation. This awareness is very evident today in business capital expenditures. Even though general business expenditures are not particularly strong, expenditures for electronics have greatly outpaced other areas. We feel this situation will continue. The cumulative effects of inflation are a very positive aspect of semiconductor demand, and are without historical precedent.

Next year, strong demand is expected from other special areas—increased purchases by the captive manufacturers, particularly IBM and Western Electric, and the opening of some very large new markets, including the automotive market, the telecommunications market, and areas related to the microprocessor revolution. These new markets are appearing at an unprecedented rate. Recently, the military government and aerospace markets for semiconductors have been experiencing excellent growth and that growth is expected to continue.

Overseas purchases of semiconductors from U.S. manufacturers have increased rapidly due to the devaluation of the dollar, revitalized foreign economies, and other factors. Bookings and shipments to areas outside the United States have grown at a rate significantly greater than have those to the U.S. market in general. If the non-U.S. economies continue to perform better than the domestic economy in the near future, foreign markets will be a stimulus to the U.S. semiconductor industry. Currently, the world economies are not in the lock step that they were in 1974.

These special demand factors are strong, positive influences both in 1979 and 1980: inflation, new markets, captive purchases, the military market, and non-U.S.

sales. Significantly, most of these demand factors are not directly affected by the U.S. economy, and they are also outside the historical relationship of the semiconductor industry to the overall economy.

With a slowdown in demand expected in a weak economy, it is instructive to look at the similarities and differences between 1974 and 1979. As in 1974, the semiconductor industry is currently experiencing labor shortages, device shortages, a strong surge in bookings, and higher prices. Labor shortages are especially acute now, whereas in 1974 device shortages were more critical. At this time, the imbalance between demand and supply appears to be moderating, although still in existence.

Pricing is a more critical problem. Prices are not declining at the usual rates for some products, including memory. Prices for many products have not declined at all in 1979, and prices for some products have actually increased, such as for certain microprocessors and for some TTL products. While some of this price strength is healthy for the industry, in that the semiconductor industry needs higher margins to finance future growth, some aspects of it are unhealthy and could be a problem when demand slows.

There are two aspects of the present price/cost situation which deserve attention. Both of these factors indicate that prices will drop in a softer market, although less severely than in 1974. The first factor is that price strength throughout 1979, caused by demand/supply imbalance, has allowed many manufacturers to achieve net profit margins above their historical levels of profitability. During the second quarter this year, there was a 12 percent increase in value of shipments over the first quarter; a significant portion of this increase was due to price increases alone, rather than capacity increases. This situation has persisted until today. In the event of a shift from a sellers' to a buyers' market, there would be pressure for more price competition and reduced prices, profit margins, and industry revenues.

Second, the heavy output increases in 1979 have had a deleterious effect on yields for many manufacturers, and costs have not dropped as fast as production increases would have dictated under less trying circumstances. A slackening in 1980 would also afford manufacturers the opportunity to improve yields, i.e., reduce costs.

There are some major differences from the earlier downturn. In 1974, inventories of semiconductors, or end products made from semiconductors, were not well controlled. At this time, DATAQUEST believes that inventory is much less of a problem primarily because of the increased caution and improved computerized inventory control. 1974 was a time of inventory build up in the economy with very little real demand; currently, inventory in the economy is moderate, the demand for semiconductors is believed to have a sound basis, and this demand is complemented by the large new markets opening up. Most important, the general caution throughout 1979 by semiconductor manufacturers and users of semiconductors has provided a healthy limitation to business excesses. Additionally, the difficulty of increasing capacity for LSI devices has precluded the buildup of potential excess industry capacity. Most companies are operating in excess of comfortable manufacturing capacity.

SEMICONDUCTOR INDUSTRY FORECAST

This forecast reflects the consequences of two powerful forces—the effects of the slow economy and the many current special engines of semiconductor demand. The slowness of the economy assures that heavy demand will not overheat the industry in 1980. On the other hand, those factors also ensure that a moderate (and somewhat skewed) recession will not cause an undue decline in semiconductor revenues. The ability of the semiconductor industry to significantly outperform the economy in 1979 should continue for the foreseeable future. Thus, a limited recession will slow the increase in semiconductor consumption but will not cause the significant decline in semiconductor demand which the industry saw in 1964, 1967, 1970, and 1975. The flatness of the industry shipments in early 1980 is expected to be caused primarily by adjustments in price, inventory, and double order cancellations.

Table 1 gives our estimate for U.S. semiconductor consumption in dollars. We believe that semiconductor consumption in 1979 will show an increase of about 31 percent over 1978. The resistance of the U.S. economy to sliding into a deeper recession, and the continued strength of the electronics industry, has led to greater demand in the second half of 1979 than expected. Thus, our forecasts for 1979 have continued to move gradually higher. In 1980, DATAQUEST expects industry growth of about 13.6 percent over 1979.

Our current estimates for U.S. semiconductor consumption by calendar quarter are shown in Table 2. We expect significantly slower growth in 1980 than in 1979. Essentially, very small industry growth is expected in the first half of 1980 with a resumption of growth in the third and fourth quarters. Current problems caused by higher prices, shortages, double ordering, inventory buildup, and other imbalances from two years of rapid growth are expected to dissipate extremely rapidly, and the basic engines now driving the semiconductor industry should reassert themselves in late 1980.

The long term secular demand factors in the industry are extremely positive. DATAQUEST expects current supply-demand imbalance to moderate temporarily, but to become more pronounced when the world economy improves. The industry is expected to be hard pressed to meet the heavy demands of increased capacity required for the rapid future growth of LSI and VLSI devices. The high cost of wafer fabrication for these products, the high technical content, and shortages of labor and financing are expected to be limiting factors to meeting future demand.

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Lane Mason

Table 2

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1979				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$ 281	$ 315	$ 310	$ 312	$1,218
Integrated Circuits	680	761	814	882	3,137
Total	$ 961	$1,076	$1,124	$1,194	$4,355
Percent Change From Previous Quarter	3.4%	12.0%	4.5%	6.2%	
Percent Change From Previous Year	30.7%	30.9%	34.3%	28.5%	31.1%

	1980				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$ 304	$ 307	$ 315	$ 326	$1,252
Integrated Circuits	874	890	921	1,010	3,695
Total	$1,178	$1,197	$1,236	$1,336	$4,947
Percent Change From Previous Quarter	(1.3%)	1.6%	3.3%	8.1%	
Percent Change From Previous Year	22.6%	11.2%	10.0%	11.9%	13.6%

Source: DATAQUEST, Inc.
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MAJOR SEMICONDUCTOR USERS

In January 1980, DATAQUEST will publish a new Notebook Service Section entitled "Estimated Merchant Market Semiconductor Purchases by Major Users." Identified as Appendix C, it will provide estimates of merchant market purchases by about 50 major users of semiconductors worldwide, broken into categories of integrated circuits and discrete devices. Appendix C will include estimates of historical semiconductor usage as well as forecasts of future consumption to 1984. There will also be an analysis of trends apparent in the purchasing pattern of these companies.

This newsletter summarizes some important results of the research to be published in Appendix C.

Table 1, Estimated Merchant Market Purchases by Major Semiconductor Users, presents estimates of merchant market semiconductor purchases by 23 major users all of whom consumed more than $50 million worth of components in 1979. Purchase estimates for some major users, notably Nippon Telephone and Telegraph and Mitsubishi, are not available at this time but will be added when they become available. In 1979, these 23 major users consumed an estimated $2.11 billion worth of semiconductors which represented 19 percent of worldwide semiconductor consumption. In 1984, these same major users are expected to consume an estimated $5.28 billion worth of semiconductors.

The increasing number of major semiconductor users is having a major impact on the semiconductor manufacturers and users as well as the distributors and suppliers to the industry. Basically, smaller users are forced to compete for limited resources from suppliers while the suppliers direct their main thrust at serving the major users. This situation is forcing major changes in the procurement and supply of semiconductors and will be a significant topic for the 1980s.

Based on the historical trends of semiconductor purchases by individual companies and a consideration of expected market factors, DATAQUEST has forecast estimated semiconductor purchases in 1984 for each of these companies. These forecasts, of course, depend critically on the users' "make or buy" decisions in the intervening years. DATAQUEST estimates of future consumption in Table 1 are based primarily on the expected growth of the market into which these semiconductor purchasers sell their product.

DATAQUEST expects that semiconductor purchases by firms whose principal business is computer manufacturering will grow at approximately 16 percent per year; purchases by firms selling industrial equipment and consumer products should grow at a slightly slower rate. Merchant semiconductor sales to equipment manufacturers selling into the government and military segments are expected to grow at about 8 percent per year for the next five years.

DATAQUEST has identified seven companies that annually purchase more than $100 million in semiconductors each from the merchant market. The list now includes DEC, General Motors, IBM, Northern Telecom, N. V. Philips, Siemens and Western Electric. In 1980, Ford, General Electric, Hewlett-Packard, NCR, and Texas Instruments are expected to join this rapidly growing list of purchasers of over $100 million of semiconductors. By 1984, the list is expected to include more than 30 companies.

An estimated 21 percent of the dollar value of the semiconductor purchases by these major users is discrete and optoelectronic components, much lower than the estimated 36 percent of total merchant semiconductor sales worldwide which are discrete and optoelectronic. An estimated 79 percent of the dollar value of semiconductor purchases by these major users is integrated circuits, much higher than the estimated 64 percent of total 1979 merchant semiconductor value which are integrated circuits.

These important differences are a result of the large number of LSI and VLSI circuits consumed by these major users. If the value of custom chips were subtracted from these totals, the major users' IC/discrete mix would probably be more representative of the overall industry mix.

Finally, of the 23 major users of semiconductors listed, 22 have a captive source of supply: either wholly captive (e.g., IBM), or selling also on the merchant market (e.g., Hitachi).

Daniel L. Klesken
Lane Mason
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Table 1

ESTIMATED MERCHANT MARKET PURCHASES BY MAJOR SEMICONDUCTOR USERS

(Millions of Dollars)

Company	1979	1984
Burroughs	$ 72	$195
Control Data	$ 54	$150
Digital Equipment	$143	$355
Ford Motor	$ 66	$250
General Motors	$140	$455
General Electric	$ 85	$200
General Telephone and Electric	$ 65	$180
Hewlett-Packard	$ 80	$275
Hitachi	$ 75	$190
Honeywell	$ 80	$200
IBM	$175	$400
ITT	$ 65	$155
Motorola	$ 70	$145
NCR	$ 90	$210
Northern Telecom	$129	$320
N.V. Philips	$135	$285
Olivetti	$ 62	$150
Rockwell	$ 60	$130
Siemens	$130	$270
Sperry Univac	$ 75	$165
Texas Instruments	$ 90	$185
Western Electric	$110	$255
Xerox	$ 60	$155

Source: DATAQUEST, Inc.
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MOS MICROPROCESSOR SHIPMENTS

SUMMARY

Worldwide shipments of MOS microprocessors in the third quarter of 1979 were an estimated 20.9 million units, up about 36 percent over estimated second quarter 1979 shipments, and up about 182 percent over the third quarter of 1978. Four-bit microprocessors represented about 66 percent of the total with estimated shipments of 13.8 million units, up about 39 percent over the second quarter of 1979. Eight-bit microprocessors represented about 33 percent of the total with estimated shipments of 7.0 million units, up about 53 percent over the second quarter. Sixteen-bit products represented about 1 percent of the third quarter 1979 shipments with an estimated 160,000 units, up about 14 percent over estimated second quarter shipments.

Figure 1 shows the dramatic growth in quarterly microprocessor shipments. The quarterly shipments growth has exceeded 20 percent in each of the last seven quarters except the fourth quarter of 1978. The figure also shows the significant growth of 8-bit single-chip microcomputer shipments from a small start in early 1978 to an estimated 2.8 million units in the third quarter of 1979.

Four-bit and 8-bit single-chip microcomputer shipments were an estimated 16.5 million units in the third quarter of 1979, representing about 79 percent of the total third quarter shipments, up from 76 percent of the total in the second quarter of 1979. Almost all single-chip microcomputer families have lead times of 20 to 40 weeks as demand continues to be extremely strong.

QUARTERLY MICROPROCESSOR SHIPMENTS

Table 1 presents DATAQUEST's estimates of worldwide microprocessor CPU shipments for the third quarter of 1979. Our estimated shipments refer to microprocessor CPU chips only and do not include I/O or peripheral chips. Estimated total microprocessor shipments in the third quarter of 1979 were 20.9 million units, up 36 percent over the second quarter of 1979, and up 182 percent over the third quarter of 1978.

Table 2 presents DATAQUEST's estimates of worldwide shipments of single-chip microcomputers. Estimated third quarter 1979 shipments of single-chip microcomputers were 16.5 million units, up about 39 percent over estimated second quarter 1979 shipments of 11.8 million units, and up about 208 percent over estimated third quarter 1978 shipments of 5.4 million units.

Worldwide demand for single-chip microcomputers is extremely strong with a number of user companies publicly stating that they are now limited by their inability to procure sufficient quantities of microcomputers. The game and toy manufacturers are particularly hard hit because they require millions of units. Most of the single-chip microcomputers have lead times of 20 to 40 weeks. Since these are mask ROM products, there is usually a minimum lead time of eight to twelve weeks for the mask turn around. The additional lead time is waiting time in the queue as a result of the high demand.

Although some EPROM versions, such as the 8748, do exist in the single-chip families, their higher cost precludes their being used in high volumes. Instead, they are useful for prototyping and small production runs.

Prices for single-chip microcomputers are still within the $8 to $10 range for deliveries in the fourth quarter 1979 and into early 1980. Some prices for very high quantities (100,000 to 250,000) of these products, however, do range between $5 to $8.

4-BIT MICROPROCESSORS

Table 3 presents DATAQUEST's estimates of worldwide shipments of 4-bit microprocessors. Shipments of these products in the third quarter of 1979 are estimated at 13.8 million units, up about 39 percent over estimated second quarter 1979 shipments and up about 170 percent over the third quarter of 1978.

Prices of the 4-bit products generally remain firm in the $1.50 to $3.50 range for large volume purchases. Some CMOS products, as well as new product introductions, reflect prices two to three times those mentioned above. We expect CMOS microcomputer chips to continue to command this premium because of their low power consumption.

8-BIT MICROPROCESSORS

Worldwide shipments of 8-bit microprocessors in the third quarter of 1979 were an estimated 7.0 million units, up about 30 percent over estimated second quarter 1979 shipments and up about 213 percent over estimated third quarter 1978 shipments (see Table 4). Single-chip microcomputers continue to play an increasing role in the 8-bit market segment; in the third quarter of 1979, they represented about 40 percent of the total 8-bit microprocessor shipments, up from 36 percent of the total in the second quarter of 1979.

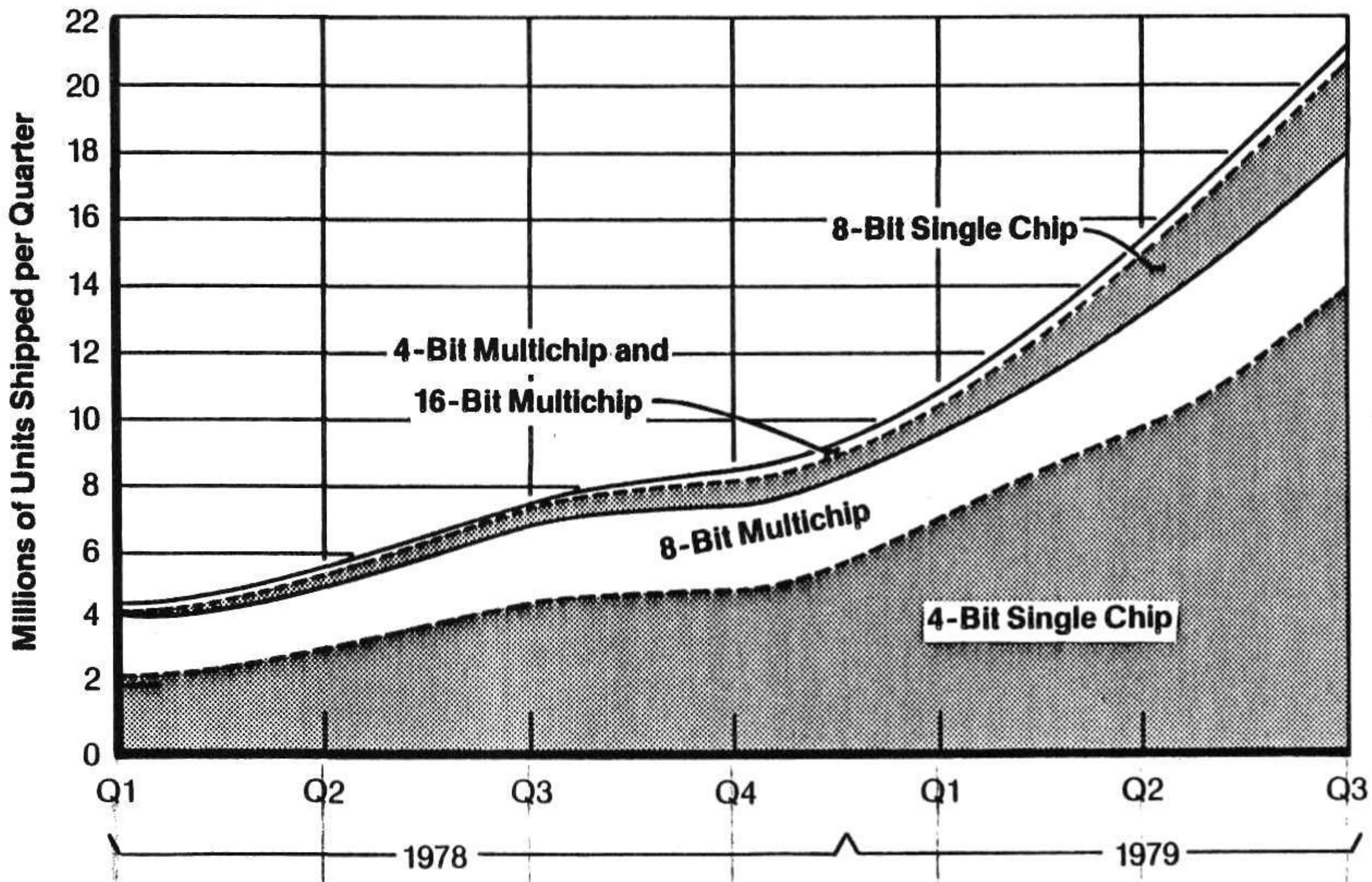
Prices for most of the mature 8-bit microprocessor products for delivery in late 1979 or early 1980 remain in the $4 to $8 range. Prices have been relatively stable since early 1979 and are expected to remain so into 1980. Lead times on the 8-bit microprocessor families range from 10 to 30 weeks depending upon the specific family. The only exception is the 8-bit single-chip microcomputers which have considerably longer lead times, somewhat a result of the ROM programming required for these products.

12-AND 16-BIT MICROPROCESSORS

Table 5 presents estimates of worldwide shipments of 12- and 16-bit microprocessors. Shipments of 12-bit microprocessors were an estimated 13,000 units in the third quarter, up about 18 percent from an estimated 11,000 units in the second quarter of 1979. This market segment has not moved significantly for the last year,

Figure 1

ESTIMATED WORLDWIDE MICROPROCESSOR SHIPMENTS



Source: DATAQUEST, Inc.

but two suppliers are still actively pursuing business. Note that these shipment estimates for the 12-bit products have been restated since the last newsletter.

Worldwide shipments of 16-bit microprocessors in the third quarter of 1979 were an estimated 160,000 units, up about 14 percent over estimated second quarter 1979 shipments and up about 63 percent over estimated third quarter 1978 shipments. 1979 and 1980 will still be design-in years for most of the new 16-bit products; therefore, large quantity increments in microprocessor shipments are not expected for another year or so.

Prices on the 16-bit microprocessors remain firm in the third and fourth quarter of 1979. The more mature TMS-9900 family is available for about $12 for the TMS-9980 model and about $25 for the 9900. Most of the newer 16-bit products command prices in the $70 to $100 range. Some of the very new products, such as the Z8000 and the 68000 are priced in the $150 to $250 range because of the very limited quantities available.

Daniel L. Klesken
Lane Mason

Table 1

ESTIMATED WORLDWIDE SHIPMENTS OF MOS MICROPROCESSORS
(Thousands of Units)

Company	MPU Products	Bits	MOS Process	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.
AMD	8080A	8	N	115	125	435	135	325	335
	8085	8	N	S[1]	5	5	15	40	75
	8048	8	N	0	0	0	S	S	3
	Z8000	16	N	0	0	0	0	S	S
AMI	S2000	4	N	8	12	29	38 50	~~330~~ 367	~~550~~ 731 683K
	6800	8	N	30	35	130	38	30	30
	6802/6808	8	N	0	0	0	S	10	10
EFCIS[2]	6800	8	N	0	0	0	8	10	12
Fairchild	F8	8	N	190	200	630	150	200	275
	3870	8	N	5	10	23	40	50	120
	6800	8	N	80	90	270	155	155	155 Says MPU + periph.
	6802/6808	8	N	0	S	S	20	45	100
General Instrument	PIC-1650	8	N	105	175	450	300	950	1,250
	CP-1600	16	N	15	15	60	15	20	20
Harris	6100	12	C	5	7	22	7	7	8
Hitachi	HMCS-40	4	P&C	110	120	410	130	150	175
	6800	8	N	20	25	70	50	100	125
Hughes	1802	8	C	10	12	35	12	14	15
Intel	4004	4	P	40	35	159	35	32	28
	8008	8	P	25	22	103	20	18	16
	8080A	8	N	180	190	705	190	200	210
	8048/8021	8	N	150	170	480	210	300	375
	8748	8	N	5	25	30	50	75	75
	8085	8	N	95	125	350	175	260	325
	8086	16	N	10	13	24	13	15	19
Intersil	6100	12	C	4	4	15	4	4	5
Matsushita (Panasonic)	MN1400	4	N,P&C	N/A[3]	N/A	N/A	500	800	1,000
MOS Technology	6500	8	N	60	60	225	65	70	80
Mostek	F8	8	N	35	45	160	90	125	125
	Z80	8	N	60	80	260	100	120	125
	3870	8	N	75	205	350	260	300	425
Motorola	141000	4	C	5	15	20	30	75	90
	6800	8	N	150	160	570	165	175	215
	6801/6803	8	N	0	0	0	0	S	3
	6802/6808	8	N	65	90	180	150	240	275
	6805	8	N	0	0	0	0	0	S
	6809	8	N	0	0	0	S	2	8
	3870	8	N	15	40	70	80	125	125
	68000	16	N	0	0	0	0	0	S
National	COPS	4	N&C	675	650	2,325	900	1,100	1,500
	4004	4	P	35	30	130	30	26	20
	IMP	4	P	20	20	80	18	15	10
	8080A	8	N	100	100	375	150	175	200
	8049	8	N	0	0	0	0	0	S
	SC/MP	8	P	100	100	335	100	140	160
	PACE	16	P	25	25	86	25	25	25
NEC	COM-4	4	N,P&C	525	600	1,500	1,100	1,300	2,300
	8080A	8	N	90	60	305	65	90	106
	8048/8049	8	N	S	15	15	25	160	350
	8085	8	N	5	25	30	55	75	120
	Z80	8	N	5	25	30	60	60	60
	768	16	N	0	0	0	S	S	S
RCA	1802	8	C	85	90	325	115	115	125
Rockwell	PPS-4	4	P	675	650	2,275	600	1,100	1,100
	6500	8	N	75	60	595	50	60	60
	6500/1	8	N	0	0	0	S	S	3
Sescosem[4]	6800	8	N	6	7	25	0	0	0
Siemens	8080A	8	N	0	0	0	S	3	10
	8085	8	N	0	0	0	0	S	2
Signetics	2650	8	N	35	45	125	45	90	110
	8048	8	N	S	S	S	15	30	60
Solid State Scientific	1802	8	C	0	10	22	10	11	12
Synertek	6500	8	N	60	70	680	100	120	280
Texas Instruments	TMS 1000	4	P&C	3,000	3,200	9,400	3,700	5,000	7,000
	TMS 8080A	8	N	40	35	136	32	25	16
	TMS 9900	16	N	48	53	185	50	60	92
Zilog	Z8	8	N	0	0	0	0	S	S
	Z80	8	N	150	210	550	195	250	425
	Z8000	16	N	0	0	0	0	1	4
Total Microprocessors				7,429	8,390	25,798	10,720	15,443	20,932
Percent change from previous quarter				36.4%	12.9%		27.7%	44.1%	35.5%

[1] S = Sampling

[2] EFCIS, a joint venture between Sescosem and the French AEC, now handles the MOS MPUs formerly handled by Sescosem, a Division of Thompson-CSF

[3] N/A = Not Available

[4] Sescosem is no longer shipping MOS MPUs since these are now handled by EFCIS

Source: DATAQUEST, Inc.
November 1979

Table 2

ESTIMATED WORLDWIDE SHIPMENTS OF SINGLE-CHIP MICROCOMPUTERS

(Thousands of Units)

		1978			1979		
Company	MPU Products	3rd Qtr.	4th Qtr.	1978 Total	1st Qtr.	2nd Qtr.	3rd Qtr.
AMD	8048	0	0	0	S[1]	S	3
AMI	S2000	8	12	29	30	330	550
Fairchild	3870	5	10	23	40	50	120
General Instrument	PIC-1650	105	175	450	300	950	1,250
Hitachi	HMCS-40	110	120	410	130	150	175
Intel	8048/8021	150	170	480	210	300	375
	8748	5	25	30	50	75	75
Matshushita	MN1400	N/A[2]	N/A	N/A	500	800	1,000
Mostek	3870	75	205	350	260	300	425
Motorola	141000	5	15	20	30	75	90
	6801	0	0	0	0	S	3
	6805	0	0	0	0	0	S
	3870	15	40	70	80	125	125
National	COPS	675	850	2,325	900	1,100	1,500
	8049	0	0	0	0	0	S
NEC	COM-4	525	600	1,500	1,100	1,300	2,300
	8048/8049	S	15	15	25	160	350
Rockwell	PPS-4	675	650	2,275	600	1,100	1,100
	6500/1	0	0	0	S	S	3
Signetics	8048	S	S	S	15	30	60
Texas Instruments	TMS 1000	3,000	3,200	9,400	3,700	5,000	7,000
Zilog	Z8	0	0	0	0	S	S
Total		5,353	6,087	17,377	7,970	11,845	16,504
Percent change from previous quarter		55.7%	13.7%		30.9%	48.6%	39.3%

[1]S = Sampling

[2]N/A = Not Available

Source: DATAQUEST, Inc.
November 1979

Table 3

ESTIMATED WORLDWIDE SHIPMENTS OF 4-BIT MICROPROCESSORS

(Thousands of Units)

		1978			1979		
Company	MPU Products	3rd Qtr.	4th Qtr.	1978 Total	1st Qtr.	2nd Qtr.	3rd Qtr.
AMI	S2000	8	12	29	30	330	550
Hitachi	HMCS-40	110	120	410	130	150	175
Intel	4004	40	35	159	35	32	28
Matshushita	MN1400	N/A[1]	N/A	N/A	500	800	1,000
Motorola	141000	5	15	20	30	75	90
National	COPS	675	850	2,325	900	1,100	1,500
	4004	35	30	130	30	26	20
	IMP	20	20	80	18	15	10
NEC	COM-4	525	600	1,500	1,100	1,300	2,300
Rockwell	PPS-4	675	650	2,275	600	1,100	1,100
Texas Instruments	TMS 1000	3,000	3,200	9,400	3,700	5,000	7,000
Total		5,093	5,532	16,328	7,073	9,928	13,773
Percent change from previous quarter		55.5%	8.6%		27.9%	40.4%	38.7%

[1] N/A = Not Available

Source: DATAQUEST, Inc.
November 1979

Table 4

ESTIMATED WORLDWIDE SHIPMENTS OF 8-Bit MICROPROCESSORS

(Thousands of Units)

Company	MPU Products	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.
AMD	8080A	115	125	435	135	325	335
	8085	S[1]	5	5	15	40	75
	8048	0	0	0	S	S	3
AMI	6800	30	35	130	38	30	30
	6802/6808	0	0	0	S	10	10
EFCIS	6800	0	0	0	8	10	12
Fairchild	F8	190	200	630	150	200	275
	3870	5	10	23	40	50	120
	6800	90	90	270	155	155	155
	6802/6808	0	S	S	20	45	100
General Instrument	PIC-1650	105	175	450	300	950	1,250
Hitachi	6800	20	25	70	50	100	125
Hughes	1802	10	12	35	12	14	15
Intel	8008	25	22	103	20	18	15
	8080A	180	190	705	190	200	210
	8048/8021	150	170	480	210	300	375
	8748	5	25	30	50	75	75
	8085	95	125	350	175	260	325
MOS Technology	6500	60	80	225	65	70	80
Mostek	F8	35	45	160	90	125	125
	Z80	80	80	260	100	120	125
	3870	75	205	350	260	300	425
Motorola	6800	150	160	570	165	175	215
	6801/6803	0	0	0	0	S	3
	6802/6808	65	90	180	150	240	275
	6805	0	0	0	0	0	S
	6809	0	0	0	S	2	8
	3870	15	40	70	80	125	125
National	8080A	100	100	375	150	175	200
	8049	0	0	0	0	0	S
	SC/MP	100	100	335	100	140	160
NEC	8080A	90	60	305	65	90	105
	8048/8049	S	15	15	25	160	350
	8085	5	25	30	55	75	120
	Z80	5	25	30	80	80	60
RCA	1802	85	90	325	115	115	125
Rockwell	6500	75	60	595	50	60	60
	6500/1	0	0	0	0	S	3
Sescosem	6800	6	7	25	0	0	0
Siemens	8080A	0	0	0	S	3	10
	8085	0	0	0	0	S	2
Signetics	2650	35	45	125	45	90	110
	8048	S	S	S	15	30	60
Solid State Scientific	1802	8	10	22	10	11	12
Synertek	6500	60	70	680	100	120	260
Texas Instruments	TMS 8080A	40	35	135	32	25	18
Zilog	Z8	0	0	0	0	S	S
	Z80	150	210	550	195	250	425
Total		2,229	2,741	9,078	3,515	5,363	6,986
Percent change from previous quarter		7.5%	23.0%		28.2%	52.6%	30.3%

[1] S = Sampling

Source: DATAQUEST, Inc.
November 1979

Table 5

ESTIMATED WORLDWIDE SHIPMENTS OF 12-BIT AND 16-BIT MICROPROCESSORS

(Thousands of Units)

12-Bit Products		1978			1979		
Company	MPU Products	3rd Qtr.	4th Qtr.	1978 Qtr.	1st Total	2nd Qtr.	3rd Qtr.
Harris	6100	5	7	22	7	7	8
Intersil	6100	4	4	15	4	4	5
Total		9	11	37	11	11	13
Percent change from previous quarter		12.5%	22.2%		0%	0%	18.2%
16-Bit Products							
AMD	Z8000	0	0	0	0	S[1]	S
General Instrument	CP-1600	15	15	60	15	20	20
Intel	8086	10	13	24	13	15	19
Motorola	68000	0	0	0	0	0	S
National	PACE	25	25	86	25	25	25
NEC	768	0	0	0	S	S	S
Texas Instruments	TMS 9900	48	53	185	68	80	92
Zilog	Z8000	0	0	0	0	1	4
Total		98	106	355	121	141	160
Percent change from previous quarter		22.1%	8.2%		14.2%	16.5%	13.5%

[1]S = Sampling

Source: DATAQUEST, Inc.
November 1979

DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

Vol. I - No. 7 November 28, 1979

This letter is a condensation of recent newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific newletters should be directed to the author. A list of recent DATAQUEST Research Newletters appears at the end of this letter.

COPYING & DUPLICATING

"The most significant development in copying at Xerox since the 914." That's how Dave Jorgensen, our resident expert on such matters, described the recent new product announcements from Xerox. We will attempt to tell you why in half a page.

On two of the new products, the Models 8200 and 9500, Xerox has made a breakthrough in imaging that has dramatically improved the quality of the copy. Furthermore, this was accomplished without introducing a new engine, which means that startup problems with the new machines should be minimal.

We at DATAQUEST divide the copy and duplicating market into six segments (Segment 1 the very low end, Segment 6 the high end). In Segment 5, Eastman Kodak has had, up to now, the only product entry. The prime selling points of the Ektaprint line have been copy quality and, because of the document feeder and finisher, high productivity . The 8200 appears equal to the Ektaprint 150 in price, better in productivity, and, based on initial copies from the 8200, its copy quality is actually superior. The 8200 should allow Xerox to make serious inroads into Kodak's dominance of Segment 5 in North America; moreover, the fact that Kodak has not yet introduced its copiers abroad may now be an error without remedy.

In Segment 6, the high end, the competition is offset presses. One of the prime limitations to the penetration of the Xerox 9400 has been the superior copy quality of offset. The 9500, which will obsolete the 9400, offers equivalent or even superior copy quality to offset. Therefore, it may speed the displacement of offset presses and thus expand the growth of Xerox's copier business.

The net results are first that the probability of our 12 percent growth forecast in Xerox's copy and duplicating revenues and earnings over the next four years being low rather than high has increased materially, and second that the strength of Kodak and IBM as competitors has diminished significantly.

It is still essential that Xerox make some material progress in word processing/office of the future markets. Nevertheless, the risk/reward potential in Xerox, in our opinion, has been materially upgraded as a result of the new product announcements.

PAPER & FOREST PRODUCTS

We will comment on two relevant issues this month—industry profitability in 1980 and our longer term thesis on brown paper.

We have seen some scare stories in the press about sharp drops in profitability of the paper industry in 1980. We don't agree. We think that people will be surprised at the strength of overall paper demand next year relative to the decline in GNP. By our reading, user inventories are low and liquidation should not contribute to softening demand. Finally, prices have risen so dramatically in 1979 that even with some declines next year, average pricing should still be solidly above average 1979 levels.

In linerboard, for example, we are assuming a 7 percent average gain in price realization in 1980, 9-10 percent cost increases and a 1-2 percent decline in shipments, which should result in a 5-10 percent drop in operating profits. In general, we continue to forecast only a 10 percent decline in industry profits in 1980.

We have stated in the past that the brown paper sector of the industry appears to have excellent potential over the next 3-4 years because of tight supply/demand relationships. In part, our projections were based on some expected plant closings, and recent announcements by International Paper lend considerable support to our thesis. I.P. has indicated that in the next three years, it may close or redeploy three southern mills that together account for 3.5 percent of linerboard capacity and 4.5 percent of semi-chemical capacity.

Taking that much capacity off stream can turn a soft operating environment into a tight one all by itself. So, let us reiterate—if you want to play the papers, you should look first at companies with a strong brown paper exposure. Among the larger companies, this means (in descending order of exposure to brown paper) Union Camp, Great Northern, Nekoosa, St. Regis, and Westvaco. Among smaller companies with very high brown paper exposure are Longview Fibre, Stone Container, and Southwest Forest.

INSTRUMENTATION

Some impressions and comments after our first Instrumentation Industry Conference:

DATAQUEST estimates test and measurement (ex ATE) industry growth to be 19 percent in 1979, slowing to 12 percent next year. On a five-year basis, we are looking for 15 percent revenue growth. There is a potential problem here in terms of investor attitudes. One must recognize that the rate of growth in individual company results will vary around a 15 percent target in the future instead of the 20-25 percent target of the past. Business is still strong for the individual companies, but order gains are beginning to moderate somewhat and published numbers should soon start to reflect our reduced growth expectations for 1980 and beyond, as evidenced by the recently reported fourth quarter at Hewlett-Packard.

Automatic test equipment (ATE) is having another booming year—industry sales are estimated to rise 37 percent to $615 million this year. Once again we expect moderation in 1980, to 16 percent total ATE growth. Two factors make this sector very different than the test and measurement market. First, there is absolutely no evidence of any moderation in order trends. Second, the potential variation from our growth forecast to 1980 is large in both directions.

We came away from the conference with the impression that while the 1980 outlook for ATE may be subject to debate because of the economy, the five-year picture seems really clearcut: the use of electronics will proliferate, the need to test integrated circuits and boards will remain, and the alternatives to automatic testing will rapidly become obsolete. The 20 percent plus growth we forecast between 1979-1984 seems a very solid estimate to us.

At the company presentations, Tektronix indicated that second quarter (November) orders may come close to a 20 percent year-to-year rate of gain (lower in instruments, higher in displays), but sales may fall below target because of an inability to catch up to past shipment shortfalls in graphic displays. None of the projections causes us to change our \$5.00 per share forecast for final 1980. Teradyne had a surprisingly strong third quarter and a \$3.25 per share estimate in 1980 now seems very attainable (versus \$2.45 per share in 1979). GenRad is progressing pretty much on target, with 19 percent growth likely in 1980 earnings (to \$3.45 per share vs. \$2.85 per share) on top of 34 percent gains this year.

COMPUTERS

Now that the furor over the down quarter at Data General has subsided, one can properly talk about the longer term implications for both the company and the industry.

We are witnessing the evolution of the small computer industry away from the traditional markets (R&D, process control, product OEM) to the broadly defined commercial market. This does not mean that the traditional sectors will not grow, but rather that the peak rates of growth here have probably already been realized and that the growth opportunities in the commercial area are greater.

The commercial market necessitates a different type of product (greater software and service support instead of maximum hardware price/performance) and a different type of sell (mainframe-type salesman selling to an executive rather than engineer selling to engineer). Data General and to a lesser extent Digital Equipment have oriented their products to the traditional markets and now must redeploy their assets to capitalize on the opportunities in commercial fields. One of the means to this end is increase the level of field service support and the unusually high (42 percent year-to-year) gain in field service people was perhaps the major contributing factor to the poor quarter at Data General.

The transition of the small computer market is most obvious among the smaller participants. Those companies with a strong commercial data processing orientation (Datapoint, Four Phase, Prime, Wang) are flourishing. Those with more traditional product lines (General Automation, Computer Automation, SEL, Modcomp) are having degrees of difficulty.

Among the giants, Hewlett-Packard sacrificed market share during the mid-1970s to position itself squarely in commercial markets and is reaping the benefits—orders and revenues will be up over 50 percent in 1979. We believe the transitions that DEC and Data General are making is the correct one for each and short-term disappointments that may occur should be viewed within this proper longer-term course.

WORD PROCESSING

IBM has finally announced its entry into the shared resource segment of the word processing market, presently dominated by Wang Laboratories. Initial orders for the product, called the 5520 Administrative System, are strong, but the real test of its capabilities will not come for a year.

The strength of the product is its communications capability. It will have the ablity to send messages to IBM's intelligent copier, its ink jet printer, and most of its other word processing products. However, this communication package will not be ready until November 1980. The word processing features of the 5520 are fairly standard, with no special features and a price-per-workstation about 30 percent above that of Wang.

Because the 5520 will be marketed by IBM's GSD, there will be a natural inclination to offer it to data processing managers. We view the product more as a D.P. than a W.P. oriented sell, since communications are its strongest feature. Our initial reaction (we have not yet seen the product) is that it presents no major threat to Wang. The fact that communications on the 5520 is a year away gives Wang an additional advantage.

Orders, revenues, and earnings momentum at Wang remain very strong. The most impressive aspect of business thus far in fiscal 1980 is that we sense that orders for Wang's small business computers have slowed quite a bit; yet overall orders are running over 80 per cent ahead of those a year ago, as the VS-100 line of larger minicomputers is enjoying outstanding success and is, along with word processing, taking up any slack. This situation is very important in assessing Wang's outlook over the next year. Small business computers orders usually slow in a recession (and apparently are slowing already), while the VS-100 type of product should be relatively unaffected, so the company is reducing the cyclical exposure of its computer line. We believe that earnings at Wang can approach $2.00 per share in fiscal 1980, versus $1.17 per share in fiscal 1979.

CAPITAL EQUIPMENT

A check with construction equipment dealers around the country indicates that demand is still good for middle-sized products, typically sold to commercial contractors and large home builders. The small end of the market is starting to weaken, reflecting residential housing trends, and the high end remains soft.

Interestingly, some dealers in the Kentucky area indicate that after having waited quite a while, some large coal operators have finally been issued permits to mine coal and that they are starting to buy some equipment. At present, the large supply of used or repossessed machinery available is soaking up any demand. The dealers also indicate that high interest rates have not deterred people from buying equipment—they are apparently passing on the costs to their customers.

We are not as negative as some about the timing of a resurgence in coal equipment demand. Coal demand should increase about 12 percent in 1979 and another 4 percent in 1980, and this should allow a lot of excess coal supplies to be worked off. We believe that demand for mid-sized equipment from coal operators could turn up as early as third quarter 1980, while demand for larger equipment (draglines, etc.) might start improving in early 1981. In our view, the best way of participating in a resurgence in coal equipment demand is via Caterpillar, because of its exposure to the mid-range equipment area.

The strike presently affecting Caterpillar could turn out to have some real benefits for the company. Its dealers are starting to swap among each other for badly needed machines and CAT should be running near capacity for at least part of 1980 to catch up with dealer needs. We are estimating $6.50 per share fully diluted at Caterpillar for both 1979 and 1980 and if the strike extends into January, additional earnings will be shifted into 1980. While it is very early to forecast, 1981 shapes up as a potentially excellent year for CAT; earnings of over $8.00 per share seem attainable. International Harvestor is also being struck, but the disadvantages seem to outweigh the benefits in this case. Harvestor needs to gain market share to capitalize on its potential and being shut down while Deere is operating can only hurt IH in both the construction and farm markets.

SEMICONDUCTORS

Bookings remain strong through October. The current slowdown in some sectors of the economy is having no negative impact on the semiconductor industry.

Our forecast for 1980 U. S. semiconductor consumption, as presented at our recent conference, is for a 13 percent gain, with integrated circuits growing 16.5 per cent and discretes gaining 4 per cent. We should caution that our forecast implies only a moderate recession in the first half of 1980 and if economic conditions worsen, then the gains should be less.

In support of our positive forecast, we should note three factors not highly related to the economy that should bolster demand next year: the electronic engine control demand from the auto companies, greatly increased buying in the merchant market by IBM, and a memory market that we believe will be sold out next year.

Apart from memory, the one other area of extreme tightness at present is low-powered Schottky. Recently, we have noted some shortening in lead times and some moderation in demand, although business remains basically strong. Customers do not seem as desperate for products as they once were, perhaps because National Semiconductor has increased its LS product offerings. We are not as sanguine about low-powered Schottky prices and demand next year as we are about memory.

Michael R. Weisberg

RECENT NEWSLETTERS OF NOTE

Copying & Duplicating		
1.	Xerox Introduces Three Major New Products to Its Copier/Duplicator Line	11/14/79
2.	Canon Introduces the NP-3 in Japan	10/31/79
3.	Eastman Kodak Announces New Accessories for Its Ektaprint Line	10/31/79
4.	Xerox Reasserts Leadership Role with Three Powerful New Copiers Xerox Announces the Models 5600, 8200, and 9500	10/31/79
Paper & Forest Products		
1.	Unbleached Grades: From Rags To Riches?	11/09/79
Instrumentation		
1.	Microprocessor Development Systems	10/10/79
2.	Analytical Instrumentation Market	10/09/79
Computers		
1.	Data General Announces Word Processing Software and X.25-Based Network System	11/09/79
2.	Four-Phase Systems Financial Analysts' Meetings October 26, 1979	10/30/79
3.	Burroughs Announces B-90 Small Business Computer with New High Density Floppy Disc	10/17/79
4.	8-Inch Two-Sided Floppy Market Struggling with Uncertainty Volume I	10/09/79
Word Processing		
1.	Burroughs Introduces Competitive Half-Page Display Stand Alones and On-Line OCR	11/13/79
2.	Lanier Unbundles Software Costs and Significantly Lowers Stand Alone Prices	11/02/79
3.	CPT Announcements	11/02/79
4.	IBM's General Systems Division Introduces Multistation Word Processing—The 5520 Administrative System	11/02/79
5.	QYX Announcement	11/02/79
6.	Olivetti Introduces Communications For Its Electronic Typewriters	11/02/79
7.	Wang Lowers OIS/Basic Fees	11/02/79
8.	IBM: Further Comment On The IBM Models 75 and 175	10/12/79
9.	NBI Lowers Prices	10/12/79
Capital Equipment		
1.	The Mini Motor Grader Market Reemerges as Small Manufacturers Seek to Fill Void	10/26/79
2.	Latest Crawler Loader Forecast Model Shows Downturn Underway with Recovery in UnitShipments Starting Late 1980	11/15/79
Semiconductors		
1.	Dynamic and Static MOS RAM and EPROM Shipments	11/16/79

DATAQUEST RESEARCH NEWSLETTER
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DISTRIBUTION IN THE 1980s

DATAQUEST's Semiconductor Industry Service has just published a comprehensive report on distribution in the 1980s. This report analyzes the current trend toward distribution of subsystem components and gives market data from 1974 to 1979, projected to 1984. An historic analysis of geographic market share is also given. Subscribers will find a detailed analysis in SIS Volume II, Sections 7.8 through 7.9.

Overview

Distributors' share of semiconductor consumption has remained relatively constant over time, as shown in Table 1, except for the recession year of 1975. In this year, many electronic equipment manufacturers cut back their commitments with their semiconductor vendors, and were later forced to make up these deficiencies with purchases through distributors. Once distributors gained this portion of the semiconductor market, the gain was permanent.

In spite of the data mentioned above, most distributors feel that distribution is increasing its share of market year-by-year. An explanation for this belief can be found in these facts:

- Semiconductors represent an increasing share of the total components. We estimate this share will increase from 33 percent in 1974 to 41 percent in 1984.

- As a result, semiconductors will represent an increasing share of distributor sales, from an estimated 28 percent in 1974 to 31 percent in 1984.

In other words, semiconductors are becoming increasingly important to distributors, but distributors, since the recession of 1975, have not significantly increased their share of semiconductor sales.

Manufacturers of non-semiconductor components seem to be increasingly turning to distribution. We estimate that distributors' share of total components distribution will increase from 26 percent in 1974 to 30 percent in 1984. As in the case of subsystem components, it appears that distributors are able to find customers that are otherwise not available to components manufacturers. These customers are also buyers of other components like resistors and capacitors and, obviously, are currently customers of industrial electronic component distributors. Moreover, some of these customers buy subsystem components from systems distributors as well. A system

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distributor sells systems and subsystems but does not sell components. Table 2 shows how this market is segmented and how it is projected to grow. Systems distributors normally sell systems to end users and subsystems components to systems integrators. However, as shown in the table, it is estimated that they sold $20 million of subsystem components to manufacturers in 1979.

The advantage of the industrial subsystem components market is that the buyers of these units generally expect only a minimum of software and service support from their distributors. Since these units are reincorporated into some larger piece of "hardware" and then resold, the equipment manufacturer, himself, generally develops the software and service capability needed to support his product. Distributor overhead is reduced because these customers do not demand extensive software and service support. One successful distributor made quite a point of his belief that profits in this business could be higher than profits in components distribution. This situation is possible because the cost to process a line item tends to be independent of the price of the line item. Since subsystem components have higher line item prices than components, profits improve.

Market Statistics

Market statistics are presented here. Table 3 indicates semiconductor resales by technology. Table 4 gives the ratio of these sales to the total North American market as given in Appendix A. These figures overstate the distributor share on a unit basis since resales are at distributor selling prices. Note that only 19.9 percent of MOS sales passed through distribution in 1978. This figure reflects that ROMs and custom LSI constitute a large fraction of MOS sales; since the customization of these products requires direct customer-to-vendor contact, there is no reason for manufacturers to use distributors.

Howard Z. Bogert
Mary Ellen Hrouda

Table 1

ESTIMATED DISTRIBUTOR SEMICONDUCTOR RESALES
AS A PERCENTAGE OF NORTH AMERICAN SEMICONDUCTOR CONSUMPTION

	1974	1975	1976	1977	1978	1979
Distributor Sales	22.6%	26.1%	25.0%	24.5%	26.8%	27.0%
Growth (shrinkage) in North American Semiconductor Consumption	15.6%	(20.1%)	30.0%	15.2%	22.6%	30.1%

Source: DATAQUEST, Inc.
November 1979

Table 2

ESTIMATED NORTH AMERICAN INDUSTRIAL AND SYSTEMS DISTRIBUTORS
SUBSYSTEM COMPONENTS RESALES TO MANUFACTURERS

(Millions of Dollars)

	1978	1979	1984
Industrial Electronic Distributor Sales			
Semiconductor Company Products	$110	$150	$460
Non-Semiconductor Company Products	15	40	275
System Distributor Sales			
Non-Semiconductor Company Products	10	20	50
Total	$135	$210	$785

Source: DATAQUEST, Inc.
November 1979

Table 3

ESTIMATED NORTH AMERICAN INDUSTRIAL ELECTRONIC
DISTRIBUTOR SEMICONDUCTOR RESALES

(Millions of Dollars)

	1974	1975	1976	1977	1978	1979	1984
Total Semiconductor	$512.0	$472.0	$589.0	$664.0	$875.0	$1,120	$2,218
Integrated Circuits	288.3	255.7	359.0	417.0	591.7	N/A[1]	N/A
Bipolar Digital	139.6	98.6	133.2	150.9	223.7	N/A	N/A
MOS	72.2	80.7	134.1	152.3	229.1	N/A	N/A
Linear	76.5	76.4	91.7	113.8	138.9	N/A	N/A
Discrete	206.7	193.2	202.7	215.2	244.2	N/A	N/A
Optoelectronic	17.0	23.1	27.3	31.8	39.1	N/A	N/A

[1]Not Available

Source: DATAQUEST, Inc.
November 1979

Table 4

ESTIMATED NORTH AMERICAN INDUSTRIAL ELECTRONIC
DISTRIBUTOR RESALES AS A PERCENTAGE OF NORTH AMERICAN CONSUMPTION

	1974	1975	1976	1977	1978	1979	1984
Total Semiconductor	22.6%	26.1%	25.0%	24.5%	26.3%	26.3%	27.0%
Integrated Circuits	22.9%	25.1%	25.3%	23.3%	25.7%	N/A[1]	N/A
Bipolar Digital	24.4%	27.2%	27.3%	25.8%	31.1%	N/A	N/A
MOS	16.3%	18.7%	20.3%	18.0%	19.9%	N/A	N/A
Linear	31.3%	34.1%	34.0%	32.1%	31.9%	N/A	N/A
Discrete	23.7%	29.1%	25.6%	26.2%	27.9%	N/A	N/A
Optoelectronic	13.9%	18.0%	19.0%	30.3%	26.8%	N/A	N/A

[1]Not Available

Source: DATAQUEST, Inc.
November 1979

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GOVERNMENT ISSUES AFFECTING THE SEMICONDUCTOR INDUSTRY

SUMMARY

This report provides a brief analysis of some of the current government issues which have an impact on the U.S. semiconductor industry. Some of these issues have been reported in earlier DATAQUEST newsletters; we will be following all of them in the coming months.

- President Carter has signed a new export control law which could (1) reduce the scope of controls over the export of certain high technology items; (2) ensure that export license applications are processed in a timely manner; and (3) require the U.S. government to take foreign availability into account when imposing export controls or processing export license applications.

- Congressman Charles Vanik (D-OH) has introduced legislation to provide tax incentives for corporate contributions to stimulate basic research.

- The Commerce Department seeks legislation to protect confidential business information submitted to the government by U.S. exporters.

- The VHSIC (Very High Speed Integrated Circuit) Program has been authorized by both the full House and Senate. Appropriation of funds for the program must wait for passage of the Defense Appropriation Bill, which is now being heard by the Joint House Senate Committee.

EXPORT CONTROL LEGISLATION BECOMES LAW

On September 29, 1979, President Carter signed into law S. 737, a bill to amend and extend the Export Administration Act of 1969 for four years.

As finally approved by the Congress and signed by the President, S. 737 represents a generally positive step for high technology exporters. Over the past several years, exporters have been complaining that overly restrictive export controls and delays in the processing of export licenses have put them at a competitive disadvantage against their foreign competitors in the emerging markets of the People's Republic of China, the U.S.S.R., and the other socialist countries of eastern Europe. In this connection, the legislation would:

- Reduce the scope of controls over the export of certain high technology products

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- Ensure that export license applications are processed in a timely and expeditious manner

- Require the U.S. Government to take into account the question of foreign availability when imposing export controls or when processing an export license application.

High technology companies must be relieved that the final version of the legislation did not contain amendments sought by conservative members in both the House and the Senate. Those amendments would have given the Department of Defense virtual control over which technologies and products could be exported to both Communist and free world destinations.

It is generally recognized that the sweeping changes made in the Export Administration Act this year by the Congress were essentially in response to the bad management and poor implementation of earlier law by the Department of Commerce and other Federal agencies involved in the export licensing process. S. 737, necessarily, gives the Executive Branch a great deal of flexibility in determining how the general guidelines established by the Congress will be implemented. It can decide such matters as what constitutes a "militarily" critical technology or product; how foreign availability is to be established, and what items should be decontrolled. The direction of Federal rulemaking in these and other areas will not be evident for several months; however, these decisions will indicate how much progress the exporters of high technology products have made in the two-year effort to modernize and streamline U.S. export control procedures.

One positive change that should emerge is that the export licensing process will become more open to all exporters. The new law contains numerous requirements for the government to inform the exporters of the status of his export license application, and provides the exporter with legal rights to ensure that the Federal licensing agencies meet their obligations in the handling of export license applications.

Following is a summary of the major provisions of the Export Administration Act. DATAQUEST has prepared this summary to assist companies in understanding the changes made to the Export Administration Act by S. 737.

Summary of the Major Provisions of S. 737 Affecting U. S. High Technology Exporters

Congressional Findings

The bill S.737:

- Recognizes that the ability of U.S. citizens to engage in international commerce is a fundamental concern of U.S. policy

- Declares that uncertainty of export control policy can curtail the efforts of American business to the detriment of the overall attempt to improve the trade balance of the United States

- Specifies that for the sake of U.S. national security, export controls must be applied to the export of goods and technologies which could significantly aid a potentially threatening foreign military power

Congressional Policy Statements

It is the Congressional intent that the U.S. policy minimize uncertainties in its export control policy, and encourage trade with all countries.

It is the policy of the United States to use export controls only after full consideration of the impact on the U.S. economy and only to the extent necessary:

- To restrict the export of goods and technology which would significantly contribute to the military potential of any country which would prove detrimental to the national security interests of the United States
- To further fundamental national security or foreign policy objectives when such export controls will clearly aid these objectives, and when they are properly administered

General Provisions

The bill establishes the following three types of export licenses:

- A validated license
- A qualified general license
- A general license

(Note: The new qualified general license is established for exports which are not subject to multilateral, i.e., COCOM (NATO countries minus Switzerland, plus Japan) control, but which are nevertheless subject to U.S. national security controls. The new license is intended to form a "precedent"—subject to appropriate end use controls—for the licensing of high technology products which are available from foreign sources.)

Also expressed is the intent of Congress that qualified general licenses be used to the maximum extent possible. Validated licenses shall be used for those items monopolized by the United States or applied to items for which the U.S. is seeking comparable controls by other countries.

The President may not delegate any authority to any department or agency unless the Senate has confirmed its head.

(Note: This provision is expressly intended to prevent the National Security Council from getting involved in decisions on export license applications.)

National Security Controls

Whenever the Secretary of Commerce makes any revision regarding any goods or technologies, or revisions involving any countries or destinations affected by export controls imposed for national security purposes, such changes must be published in the Federal Register.

The Secretary of Commerce will establish and maintain a list of all goods and technologies subject to export controls for national security purposes. The Secretary of Defense and other agencies will assist the Secretary of Commerce in identifying those items which are to be included on the control list, and the Secretary of Defense must concur on these items. If the Secretary of Defense and the Secretary of Commerce fail to agree on an item(s) or technology(ies) to be included on the control list, the matter is to be referred to the President for resolution.

The Secretary of Commerce is required to issue regulations providing for the review of the list of items controlled by multinational agreement not less frequently than every three years, and annually in the case of all other controls. The regulations are to provide interested parties with an opportunity to submit written data, views or arguments. The regulations also must require that an assessment be made of the availability of goods or technologies from sources outside the U.S. which are controlled for national security purposes.

(Note: In requiring an annual review for U.S. unilateral export controls, the Congress expressed the hope and expectation that this would ensure more frequent review of the U.S. unilateral control list than is now provided despite the fact that the Administration argued that it was "continuously" reviewing the control list.)

The Secretary of Commerce, in consultation with the Secretary of Defense, is directed to ensure that export controls imposed for national security are limited to militarily critical goods and technologies.

Critical Technologies List

The Secretary of Defense bears the primary responsibility for developing a list of militarily critical goods and technologies with primary emphasis given to:

- Arrays of design and manufacturing know-how

- Keystone manufacturing, inspection and test equipment

- Goods accompanied by sophisticated operation, application or maintenance know-how

The initial version of this list is to be published in the Federal Register by October 1, 1980.

(Note: In its Conference Report, the Congress indicated that the inclusion of this provision was intended to clarify the respective roles of the Secretary of Commerce and the Secretary of Defense in the control list maintenance and review process, but not to change fundamentally the current sharing of responsibilities of these two officials and their respective departments. The Secretary of Commerce will retain the responsibility for maintaining the export control list; it is made clear that it is the responsibility of the Secretary of Defense to identify critical goods and technologies for possible inclusion on the control list.)

Foreign Availability

The Secretary of Commerce will establish within the Commerce Department a capability to monitor and gather information on foreign availability.

The Secretary of Commerce is directed to review, on a continuing basis, the availability of items and technologies from sources outside the U.S. which are controlled by the United States. If the Secretary properly determines that any such goods or technologies are available to controlled (i.e., Communist) destinations to sufficiently make U.S. requirements for validated licenses ineffective, he may not impose validated licensing requirements on those items unless the President determines it to be a case of national security. When the President makes such a determination, the Secretary of Commerce must publish both the basis of the determination and the estimated economic consequences of the President's decision.

Any determination of foreign availability is to be made in writing and supported by reliable evidence such as:

- Scientific or physical examination
- Expert opinion based on adequate factual information
- Intelligence information

Uncorroborated representations by applications will not be sufficient evidence of foreign availability.

Indexing

The use of an indexing system permits the Secretary of Commerce, whenever appropriate, to provide for annual increases in the performance levels of goods or technologies subject to national security licensing requirements. The Secretary may remove any goods or technology from the control list whenever they no longer meet the performance levels established by such reviews.

(Note: In authorizing the creation of an indexing system, Congress intends to assure that goods and technologies actually are obsolete before they are decontrolled. Even though an item may be obsolete by U.S. standards, it may make a significant contribution to the military potential of the Soviet Union or other adversary nation.)

COCOM

The President will enter into negotiations with COCOM countries with the following objectives:

- Establish an agreement to publish a list of items controlled for export by COCOM.

- Provide for periodic meetings with high-level representatives of COCOM member governments for the purpose of issuing policy guidance to COCOM countries.

- Reduce the scope of the export controls imposed by COCOM to a level acceptable and enforceable by all COCOM governments.

- Develop more effective procedures for enforcement of export controls which are agreed to by participating countries.

Foreign Policy Controls

Export controls maintained for foreign policy purposes expire on December 31, 1979, or one year after their imposition, whichever is the later, unless extended by the President. Any extension or expansion cannot exceed a period of more than one year.

When imposing, extending, or expanding export controls for foreign policy purposes, the President must consider:

- The probability that the imposition of such controls will achieve their intended foreign policy objective
- The compatibility of the proposed controls with the foreign policy objectives of the United States
- The reaction of other countries to the imposition or expansion of such export controls
- The likely effects of the imposition of such controls on the export performance of the U.S., on the competitive position of the U.S. in the international economy, on the reputation of the U.S. as a supplier of goods and technology, and on individual U.S. companies and their employees and communities, including the effects of such controls on existing contracts

The Secretary of Commerce will consult with affected U.S. industries before imposing controls for foreign policy purposes.

The President will consult with the Congress before imposing any export controls for foreign policy purposes.

Procedures for Processing Export License Applications

Whenever possible, the Secretary of Commerce will make a determination regarding an export license application without referring it to other government agencies.

Within 10 days after receipt of any export license, the Secretary of Commerce will:

- Send the applicant an acknowledgement of the receipt of the application and the date of receipt
- Submit to the applicant a written description of the procedures required for the processing of the application
- Return the application without action if it is incomplete or improperly completed, together with sufficient information to permit the applicant to properly fill out and resubmit the application
- Determine whether it is necessary to refer the application to any other department or agency and, if so, to inform the applicant to whom the application will be referred
- Determine whether it is necessary to refer the application to COCOM and, if so, inform the applicant of this requirement

If the application does not need to be referred to other agencies for review, the Secretary of Commerce will formally issue or deny an application within 90 days.

Within 30 days of receipt of an application which requires review by other agencies, the Secretary of Commerce shall:

- Refer the application, together with all necessary analysis and recommendations of the Department of Commerce, concurrently to all agencies which the Secretary deems appropriate

- If the applicant requests, provide the applicant with an opportunity to review for accuracy the documentation to be referred to other agencies to determine whether the documentation accurately describes the proposed export

All agencies to which an application is referred must submit to the Secretary of Commerce their recommendations on the application within 30 days unless the head of an agency informs the Secretary before the end of the 30-day period that more time will be necessary to review the application. When notification is provided, that agency has an additional 30 days to submit its recommendations to the Secretary of Commerce.

The Secretary of Commerce, within 90 days after receipt of the recommendations from the other agencies, formally issues or denies the license. In cases where the Secretary receives conflicting recommendations from other government agencies, he is directed to take any action necessary to resolve these differences within this 90-day period.

When the Secretary of Commerce receives questions or negative recommendations from other agencies (consistent with national security and foreign policy objectives of the U.S.), the applicant must be informed of the specific questions raised and/or the negative recommendations made. The applicant must be accorded the opportunity to respond in writing to such questions or recommendations before a final decision on the application is made.

The applicant must be informed within five days of a decision to deny an application.

Whenever he denies an application for national security or foreign policy purposes, the Secretary of Commerce will notify the applicant of the denial and explain what, if any, modifications or restrictions on the goods or technologies could be made to allow the application to be approved. Alternatively, the Secretary may indicate in the denial notice which licensing officers in the Department of Commerce are most familiar with the case. These licensing officers are to be made reasonably available to the applicant for consultation with regard to any modifications or restrictions which might lead to the approval of the license application.

The Secretary of Commerce may extend the time periods described above if he determines that a particular application or set of applications is of sufficiently exceptional importance or complexity that additional time is required to review the application. If the Secretary makes such a determination, he is required to notify both the applicant and the Congress.

Special Role for the Secretary of Defense

The Secretary of Defense may review the proposed export of any goods or technologies which are controlled for national security purposes. He is directed to confirm in writing to the Secretary of Commerce the types of transactions he wishes to review.

The Secretary of Defense must carefully consider any application referred to him by the Secretary of Commerce and, within 30 days:

- Recommend to the President that he disapprove the proposed export, or
- Recommend to the Secretary of Commerce that the export be approved subject to specified conditions, or
- Recommend to the Secretary of Commerce that the application be approved

The President may overrule any recommendation of the Secretary of Defense, but in those instances, the President must inform the Congress of his decision.

COCOM Review of U.S. Export License Applications

When applications are subject to COCOM review, the Secretary of Commerce will notify the applicant of U.S. approval of the application and the date of such approval, although a license may not be issued until COCOM approval is secured. If COCOM does not reach a determination on the application within 60 days after it is approved by the U.S. Government, the Secretary of Commerce is directed to issue the license unless he determines that such action would prove detrimental to U.S. national security interests. If the Secretary makes such a determination, he is required to notify the applicant and the Congress of his decision, the reasons for it, the reasons the COCOM review could not be completed within the 60-day period, and the actions being taken by the U.S. Government to secure conclusion of COCOM review. These 60-day extensions may be repeated, but in each instance the Secretary is required to inform both the applicant and the Congress of all the factors listed in the initial extension.

Legal Rights of an Applicant

Whenever any action is not taken on a license application within the time periods specified (except in those cases involving applications of exceptional importance or complexity where the applicant is notified), the applicant may file a petition with the Secretary of Commerce requesting compliance with the law. If, after 30 days, the processing of an application has not been brought into conformity with the provisions of the law, or if the application has been brought into conformity but the Secretary has not so notified the applicant, the applicant may bring an action in the appropriate U.S. District Court to require compliance with the law's requirements.

Effective Dates

- By October 1, 1980, the bill also requires the Department of Defense to publish an initial critical technologies list.
- By July 1, 1980, the bill requires the Secretary of Commerce to establish procedures for handling of export license applications.
- The bill extends the Export Administration Act, as amended, until September 30, 1983.

LEGISLATION TO STIMULATE BASIC RESEARCH INTRODUCTION IN THE HOUSE

Legislation has been introduced in the House by Rep. Charles Vanik (D-OH) to enable companies to obtain tax credits and deductions for corporate or business expenditures, for directed basic research, or for exploratory research conducted by universities.

The legislation, entitled the "Basic Research Revitalization Act of 1979," permits companies to establish segregrated Research Resources Funds (entities similar to Domestic International Sales Corporations) to receive, accumulate, and distribute funds to qualified grantees.

Research Resources Funds would be tax exempt and could accumulate funds for up to four years before disbursement.

Under the terms of the legislation, companies would qualify for a 25 percent tax credit in the year in which funds are placed into the Research Resources Fund. In addition to the credits, the legislation would permit tax deductions on a dollar-for-dollar basis in the year in which funds are placed in the Fund.

The combination of tax credits and deductions should provide the investor with a tax write-off amounting to about 70 percent of every dollar put into a Research Resources Development Fund.

The legislation was introduced just a week after L. J. Sevin, Chairman of the Board of Mostek Corporation, recommended to the Joint Economic Committee that Congress provide for tax credits for corporate contributions to universities to stimulate industrial innovation.

CONFIDENTIALITY OF SHIPPERS' EXPORT DECLARATIONS BEING THREATENED

Confidential reports, containing 20 items of detailed information on every U.S. export transaction are in danger of public disclosure, unless corrective legislation is passed before June 30, 1980. These reports, known as Shippers' Export Declarations, must be filed by U.S. exporters for each shipment of merchandise valued at $251.00 or more exported from the U.S. They are the basis for compilation of official U.S. export statistics.

Twin Coast Newspapers, Inc., publisher of the "Journal of Commerce" has filed suit in the U.S. District Court to compel the U.S. Department of Commerce to release Shippers' Export Declarations under the provisions of the Freedom of Information Act.

In an amendment to the Export Administration Act, recently signed into law by President Carter, the Congress provided that information obtained under the Act's authority, including Shippers' Export Declarations, on or before June 30, 1980, shall be deemed to be confidential and exempt from disclosure.

If legislation is not passed to permanently exempt Shippers' Export Declarations before June 30, 1980, and if the courts rule in favor of Twin Coast Newspapers, the government will have to reveal the following types of information on individual export transactions:

Mode of Transportation
Exporter
Ultimate Consignee
Description of the Commodity
Net Quantity
Value of the Shipment
Date of Exportation

The Department of Commerce has had legislation introduced in the House to clarify its authority to maintain the confidentiality of Shippers' Export Declarations permanently. Hearings on this legislation are expected later this month.

VHSIC PROGRAM AUTHORIZED, AWAITS APPROPRIATIONS

In our last DATAQUEST Newsletter, we published erroneous information as to the status of the VHSIC program. Presently, the VHSIC program has been authorized by both the Senate and House. The VHSIC program legislation is a part of the Defense Appropriations bill presently being heard by the joint House-Senate Appropriations Committee. Since Senate and House versions were almost identical as authorized, it is expected that the monies will be appropriated as written, with $30 million for Fiscal Year 1980. If the Appropriations bill is passed as expected, awards to participating companies would follow after January 1, 1980.

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Lane Mason

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DYNAMIC AND STATIC MOS RAM AND EPROM SHIPMENTS

SUMMARY

Worldwide shipments of 16K dynamic MOS RAMs increased to an estimated 18.7 million units in the third quarter of 1979, up about 29 percent over an estimated 14.5 million units shipped in the second quarter of 1979. Demand continues to be extremely strong such that prices that had been flat are now increasing slightly. Prices are in the $5.50 range for plastic packages and in the $6.50 range for hermetic packages. Most major suppliers of 16K RAMs are fully committed through mid-1980.

Worldwide shipments of 4K dynamic MOS RAMs continued to decline slowly in the third quarter of 1979, falling to an estimated 17.2 million units, down about 7 percent from estimated second quarter shipments. Prices remain firm in the $2 range and lead times are in the 15 to 25 week range as the unavailability of the 16K dynamic RAMs makes the 4K dynamic RAMs still desirable.

Estimated third quarter shipments of slow 4K NMOS static RAMs reached an estimated 10.4 million units up about 22 percent over second quarter shipments. The 2147 type fast static RAM shipments were an estimated 965,000 units, down from estimated second quarter shipments of 1.3 million units. CMOS 4K static RAMs continue to increase dramatically in the third quarter, reaching an estimated 1.9 million units, up about 51 percent from 1.2 million units shipped in the second quarter of 1979.

Worldwide shipments of 8K EPROMs in the third quarter were up slightly to an estimated 5.3 million units. This level is up about 9 percent over the second quarter shipments and prices remain in the $6 to $7 range. Shipments of 16K EPROMs continue to increase to an estimated 3.3 million units, up about 36 percent over estimated second quarter shipments of 2.5 million units. Prices had been in the mid-$20 range for most of the third quarter, but recently some softness has occurred with price quotes reaching $18 to $20 range for plastic parts. The two quantity suppliers of 32K EPROMs shipped an estimated 110,000 units in the third quarter. Hitachi has now begun sampling this part, also.

DYNAMIC MOS RAMS

16K RAMs

DATAQUEST estimates of worldwide 16K dynamic MOS RAM shipments are presented in Table 1. We estimate that the current suppliers of this device shipped an estimated 18.7 million units in the third quarter of 1979 an increase of about 29 percent over estimated second quarter of 14.5 million units. Our estimates include 16K chips shipped in 2-chip hybrid packages as 32K dynamic RAMs.

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The demand for 16K dynamic RAMs appears to be increasing almost weekly as more users are committing their design to this product. Purchasing agents of major corporations are coming back into the market for increased quantities as new programs are being added to the list of 16K RAM users or as existing programs expand their usage. IBM's requirements appear to be increasing as well, and their actual demand may be as high as 12 to 14 million 32K RAMs in 1980, thereby putting increased pressures on this market.

Most major suppliers are committed through the second quarter of 1980 and some as far as the third and fourth quarter of 1980. Most price quotations for first half delivery of high volume and high quality plastic parts are in the $5.50 to $5.80 range with prices for the second half of the year still remaining in the same range. There is some uncertainty about the second half of 1980 as suppliers are trying to evaluate the effect of higher interest rates and tighter money on the computer and industrial segments. If demand from this sector should soften, prices could fall in the second half of 1980. However, the present outlook is that prices will remain relatively firm into the second half of 1980 and perhaps even increase.

Currently there is a very active spot market for 16K dynamic RAMs for those suppliers who have some additional supply. The spot market prices range from $1 to $3 above the long term contract pricing depending upon quantity and specifications.

About 50 percent of the 16K RAMs shipped in the third quarter were in plastic packages. Some manufacturers are shipping as much as 75 percent of their product in the plastic packages, but others who have not been manufacturing the product for quite so long currently have only about a third of their product in plastic. As the prices decline over the next couples of years, there will be an increased incentive for pressure on the suppliers to switch to plastic packages in order to maintain margins.

4K RAMs

DATAQUEST estimates of 4K dynamic MOS RAM shipments are presented in Table 2. Quarterly shipments continued to decline in the third quarter of 1979 to an estimated 17.2 million units, down about 7 percent from estimated second quarter shipments. Although many suppliers are now de-emphasizing this product as they continue to shift capacity toward the 16K dynamic RAMs and other products, demand remains quite strong. Some products that had been scheduled for conversion to 16K dynamic RAMs are being forced to stay with the 4K dynamic because of the tight supply of 16K RAMs. Lead times remain in the 15 to 25 week range with prices in the $2 range for plastic and $2.50 range for CERDIP.

32K RAMs

Mostek is the only supplier that is currently marketing a 32K dynamic MOS RAM into the merchant market. They shipped an estimated 30,000 units in the third quarter with prices still in the $17 to $20 range. The estimated shipments of 32K dynamic RAMs by Intel, Mostek, Motorola, and TI to IBM are included as 16K equivalents in Table 1.

64K RAMs

In the third quarter of 1979, there were still only three suppliers sampling 64K RAMs: Fujitsu, Motorola, and Texas Instruments. We estimate that Motorola shipped about 3,000 samples in the quarter whereas Fujitsu and TI each shipped an estimated 1,000 units in the third quarter. We are still expecting additional suppliers to begin sampling before the end of 1979, but the extreme difficulty in making this device has slowed introductions.

STATIC MOS RAMS

4K RAMs

The growing importance of fast static NMOS RAMs and CMOS static RAMs has resulted in our splitting static MOS RAMs into three separate tables: slow NMOS statics, fast NMOS statics, and CMOS statics. Table 3 presents our estimates of slow 4K NMOS static RAM shipments in the third quarter of 1979. The industry shipped an estimated 10.4 million units on a worldwide basis. This is up about 22 percent over an estimated 8.5 million units shipped in the second quarter. The split between the 1Kx4 and the 4Kx1 architecture is indicated in the table. In the third quarter, the 1Kx4 architecture represented 82 percent of the total as opposed to 73 percent in the second quarter and 67 percent in the first quarter. We expect the percentage of 1Kx4 devices to level off at about 85 to 90 percent of the total. Lead times for slow static RAMs remain in the 15 to 20 week range with pricing in the $3.50 to $4.50 range for the 2114-type device in plastic.

Table 4 presents DATAQUEST's estimates of worldwide shipments of fast 2147 (4Kx1) static RAMs. Third quarter shipments of 965,000 units were down from estimated shipments of 1.3 million units in the second quarter. Note that Intel shipments in the third quarter included an estimated 25,000 of the 2148 (1Kx4) fast static RAM. All other shipments in Table 4 are of the 2147-type. Two years after the introduction of the 2147, Intel is still by far the leading producer of the product. However, four other companies are shipping the device now and several others are sampling. Prices for the 2147 are in the $18.00 to $21.00 range with lead times of 12 to 18 weeks.

Table 5 presents our estimates of 4K CMOS static RAM shipments. Third quarter shipments were an estimated 1.9 million units, up about 51 percent from the estimated 1.2 million units shipped in the second quarter. Lead times on the devices are in the range of 12 to 16 weeks and prices are running from $10.00 to $13.00 for shipments in the fourth quarter of 1979. The split between the 1Kx4 and 4Kx1 device is in favor of the 1Kx4 architecture which has 63 percent of the total units in the third quarter.

8K RAMs

Mostek shipped an estimated 50,000 1Kx8 slow static NMOS RAMs in the third quarter of 1979 and an estimated 5,000 8Kx1 fast static in the same quarter. In the meantime, EMM continued to sample its 1Kx8 static RAM. Prices for these devices are in the $13.00 to $15.00 range. Other suppliers are expected to sample 8K as well as 16K statics in the coming quarters.

EPROMs

8K EPROMs

Table 6 presents DATAQUEST's estimated worldwide shipments of 8K EPROMs. In the third quarter of 1979 an estimated 5.3 million units were shipped, up about 9 percent from second quarter shipments. Prices are remaining firm in the $6.00 to $7.00 range with some lower quantities $1.00 to $2.00 higher. Lead times are in the 12 to 16 week range.

16K EPROMs

Table 7 presents our estimates of worldwide shipments of 16K EPROMs. In the third quarter, an estimated 3.3 million units were shipped, up from an estimated 2.4 million units in the second quarter and up very dramatically from 465,000 units in the third quarter of 1978. During most of the third quarter, prices remained relatively firm in the mid-$20.00 range. However, toward the end of the third quarter and in the early fourth quarter, prices dropped to the $18.00 to $22.00 range as more supply has become available. Lead times have shortened to off-the-shelf delivery up to 12 weeks.

32K EPROMs

Table 8 presents our estimates of worldwide shipments of 32K EPROMs. Third quarter shipments of 110,000 units are up from an estimated 65,000 units in the second quarter. Prices are still in the $50.00 to $80.00 range for the limited quantities being shipped. Additional suppliers should be entering this market within the next two or three quarters.

Daniel L. Klesken
Lane Mason

Table 1

ESTIMATED WORLDWIDE SHIPMENTS OF 16K DYNAMIC MOS RAMS[1]

(Thousands of Units)

	1978			1979		
Company	3rd Qtr.	4th Qtr.	Year	1st Qtr.	2nd Qtr.	3rd Qtr.
AMD	0	S[2]	S	S	5	10
Fairchild	200	200	465	300	400	500
Fujitsu	500	900	2,000	1,100	1,300	1,600
Hitachi	350	500	1,210	800	1,400	2,200
Intel	600	900	2,400	600	700	950[3]
Intersil	0	S	S	S	5	5
ITT	75	100	203	200	300	600
Matsushita	0	0	0	0	0	S
Mostek	1,400	1,800	4,900	2,400	3,600	4,600
Motorola	550	500	1,750	700	1,200	1,000
National	75	150	287	~~700~~ 250	~~1,200~~ 450	1,000
NEC	1,100	1,300	3,850	1,700	2,200	3,200
Siemens	25	40	85	65	100	250
Signetics	30	80	140	75	40	50
Texas Instruments	950	1,400	3,150	~~1,8900~~ 1800	2,200	1,800
Toshiba	80	150	285	225	550	900
Zilog	15	20	60	20	50	50
Total	5,950	8,040	20,785	10,235	14,500	18,715
Percent Change From Previous Quarter	45.1%	35.1%		27.3%	41.7%	29.1%

[1] Includes merchant market and internal shipments

[2] Indicates sampling

[3] Includes an estimated 50,000 5-volt only parts

Source: DATAQUEST, Inc.
November 1979

Table 2

ESTIMATED WORLDWIDE SHIPMENTS OF 4K DYNAMIC MOS RAMS[1]

(Thousands of Units)

Company	1978 3rd Qtr.	1978 4th Qtr.	1978 Year	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.
AMD	1,800	2,200	6,600	2,600	3,000	~~280~~ 3,000
Fairchild	0	0	900	0	0	0
Fujitsu	400	300	~~9,900~~ 1,900	200	200	200
Hitachi	500	450	1,780	350	200	200
Intel	2,700	2,300	11,000	1,700	1,700	1,500
Intersil	100	100	450	100	50	50
ITT	300	800	1,600	1,100	1,300	1,300
Mostek	4,800	4,200	17,000	3,800	3,300	3,400
Motorola	1,500	1,900	5,700	1,500	1,150	1,800
National	1,500	1,700	5,600	2,000	2,400	2,000
NEC	1,600	1,350	6,150	1,350	1,900	1,300
Signetics	300	300	1,150	300	100	50
Texas Instruments	4,000	3,800	16,700	3,600	3,200	2,700
Total	19,500	19,400	76,530	18,600	18,500	17,~~200~~ 500
Percent Change From Previous Quarter	0.0%	(0.5%)		(4.1%)	(0.5%)	~~(7.0%)~~ (5.4%)

[1]Includes merchant market and internal shipments

Source: DATAQUEST, Inc.
November 1979

Table 3

ESTIMATED 1979 WORLDWIDE SHIPMENTS OF SLOW 4K NMOS STATIC RAMS

(Thousands of Units)

	1st Quarter		2nd Quarter		3rd Quarter	
	1Kx4	4Kx1	1Kx4	4Kx1	1Kx4	4Kx1
AMD	150	30	275	75	330	140
AMI	50	0	55	0	95	0
EMM	600	500	600	600	700	650
Fairchild	50	0	100	0	300	0
Fujitsu	80	0	150	0	250	0
Hitachi	450	0	450	0	450	0
Intel	400	400	600	600	850	100
Intersil	200	100	230	130	250	150
Maruman	0	0	10	0	20	0
Matsushita	0	0	20	0	50	0
Mostek	450	0	600	0	900	S
Motorola	270	30	320	20	450	30
National	530	120	900	190	900	200
NEC	400	600	600	60	1,200	0
Synertek	560	0	600	0	900	0
Texas Instruments	500	500	500	500	550	450
Toshiba	150	0	210	0	300	0
Zilog	0	110	0	110	0	150
Total	4,840	2,390	6,190	2,285	8,495	1,870
Percent Change From Previous Quarter			27.9%	(4.4%)	37.2%	(18.2%)

Source: DATAQUEST, Inc.
November 1979

Table 4

ESTIMATED 1979 WORLDWIDE SHIPMENTS OF FAST 4K NMOS STATIC RAMS

(Thousands of Units)

	1st Qtr.	2nd Qtr.	3rd Qtr.
AMI	5	10	5
Fujitsu	0	S[1]	15
Hitachi	0	0	S
Intel	800	1,200	650[2]
Motorola	S	10	20
National	0	10	25
NEC	25	70	250
Toshiba	0	0	S
Total	830	1,300	965
Change From Previous Quarter		56.6%	(25.8%)

[1]Indicates Sampling

[2]Includes 25,000 2148 (1Kx4) Devices

Source: DATAQUEST, Inc.
November 1979

Table 5

ESTIMATED 1979 WORLDWIDE SHIPMENTS OF 4K CMOS STATIC RAMS

(Thousands of Units)

	1st Quarter		2nd Quarter		3rd Quarter	
	1Kx4	4Kx1	1Kx4	4Kx1	1Kx4	4Kx1
Harris	25	15	40	30	100	100
Hitachi[1]	0	150	0	325	0	500
Motorola	0	0	0	0	S[2]	0
National	0	0	0	0	S	S
NEC	100	0	270	0	450	0
RCA	50	0	80	0	125	0
Toshiba	175	25	450	50	500	100
Total	350	190	840	405	1,175	700
Change From Previous Quarter			140%	113.1%	39.9%	72.8%

[1]Includes 25,000 6147 Fast CMOS Static RAMs in 2nd Quarter and 100,000 in 3rd Quarter

[2]Indicates sampling

Source: DATAQUEST, Inc.
November 1979

Table 6

ESTIMATED WORLDWIDE SHIPMENTS OF 8K EPROMS[1]

(Thousands of Units)

Company	1978 3rd Qtr.	1978 4th Qtr.	1978 Year	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.
AMD	80	340	485	600	700	700
Electronic Arrays	60	60	200	75	100	125
Fairchild	60	120	280	160	200	350
Fujitsu	70	70	280	70	50	50
Intel	800	1,000	3,400	1,100	1,400	1,400
Motorola	300	400	1,020	700	750	1,000
National	300	500	1,250	600	800	800
Signetics	80	50	280	0	0	0
Texas Instruments	400	800	2,100	800	800	800
Toshiba	10	30	40	50	100	100
Total	2,160	3,370	9,335	4,155	4,900	5,325
Percent Change from Previous Quarter	(5.9%)	56.0%		23.3%	17.9%	8.7%

[1]Includes merchant market and internal shipments

Source: DATAQUEST, Inc.
November 1979

Table 7

ESTIMATED WORLDWIDE SHIPMENTS OF 16K EPROMS[1]

(Thousands of Units)

	1978			1979		
Company	3rd Qtr.	4th Qtr.	Year	1st Qtr.	2nd Qtr.	3rd Qtr.
AMD	0	0	0	0	0	5
Fairchild	0	0	0	S[2]	S	S
Fujitsu	0	5	5	70	200	300
Hitachi	5	30	35	125	200	350
Intel	250	450	1,350	550	750	1,000
Mostek	S	25	25	90	150	250
Motorola	10	90	100	160	150	160[3]
National	S	S	S	5	50	80
Texas Instruments	200	300	850	400	900	1,100[4]
Toshiba	S	5	5	25	50	90
Total	465	905	2,370	1,425	2,450	3,335
Percent Change from Previous Quarter	(28.5%)	94.6%		57.5%	71.9%	36.1%

[1] Includes merchant market and internal shipments

[2] Indicates sampling

[3] About 10 percent represent parts having a 5 volt only power supply

[4] About 40 percent represent parts having a 5 volt only power supply

Source: DATAQUEST, Inc.
November 1979

Table 8

ESTIMATED WORLDWIDE SHIPMENTS OF 32K EPROMS
(Thousands of Units)

Company	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.
Hitachi	0	0	S[1]
Intel	5	30	50
Texas Instruments	10	35	60
Total	15	65	110

[1]Indicates Sampling

Source: DATAQUEST, Inc.
November 1979

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

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MICROPROCESSOR DEVELOPMENT SYSTEMS

DATAQUEST's Test Instrument Industry Service will soon publish a report on Microprocessor Development Systems (MDS) for subscribers to the Service. This study will provide an in-depth analysis of this market.

MARKET STATUS

Since the introduction of the first microprocessors in 1971, the microprocessor market has experienced rapid growth. The complexity of such devices demands the use of development tools, and the widely expanding use of microprocessors by industry has created a growing market for these development aids. The major development aid is the stand-alone development system; DATAQUEST estimates its 1978 worldwide sales to have reached $143 million, as shown in Table 1.

Semiconductor manufacturers, serving as either the original or secondary source, supply dedicated (single-vendor) development systems to support the devices they manufacture. The majority of the development systems continues to be supplied by semiconductor manufacturers; however, beginning in 1977, Tektronix became the first large manufacturer of test instruments to provide universal (multi-vendor) development systems, providing in-circuit emulation (ICE) for devices produced by multiple semiconductor manufacturers. Two additional large manufacturers of test instruments have since entered the MDS market in 1979: GenRad, through the acquisition of Futuredata (former independent MDS supplier) and Hewlett-Packard. The entry of Tektronix has contributed to the growth of the non-semiconductor segment of the MDS market in 1978; and this market is expected to increase in market share through 1983, as GenRad, Hewlett-Packard, and other test instrument companies augment this market segment.

MARKET FORECAST

The microprocessor development system (MDS) market is expected to increase from an estimated $143 million in 1978 to an estimated $520 million in 1983, a compound annual growth rate of approximately 30 percent, as shown in Figure 1. Table 2 presents DATAQUEST's estimated sales by supplier type through 1983.

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Table 1

ESTIMATED WORLDWIDE SALES OF MICROPROCESSOR DEVELOPMENT SYSTEMS, 1976-1978
(Millions of Dollars)

Supplier	1976	1977	1978	Compound Annual Growth Rate 1976-1978
Semiconductor Manufacturer (Single-vendor)	$46.0	$82.0	$127.0	66.2%
Test Instrument Manufacturers and Others (Multi-vendor)	2.0	8.0	16.0	182.8%
Total	$48.0	$90.0	$143.0	72.6%

Source: DATAQUEST, Inc.

Sales of development systems have grown rapidly during the past three years and are expected to continue to have good growth, although at a slower rate. The following factors should contribute to the MDS market growth through 1983:

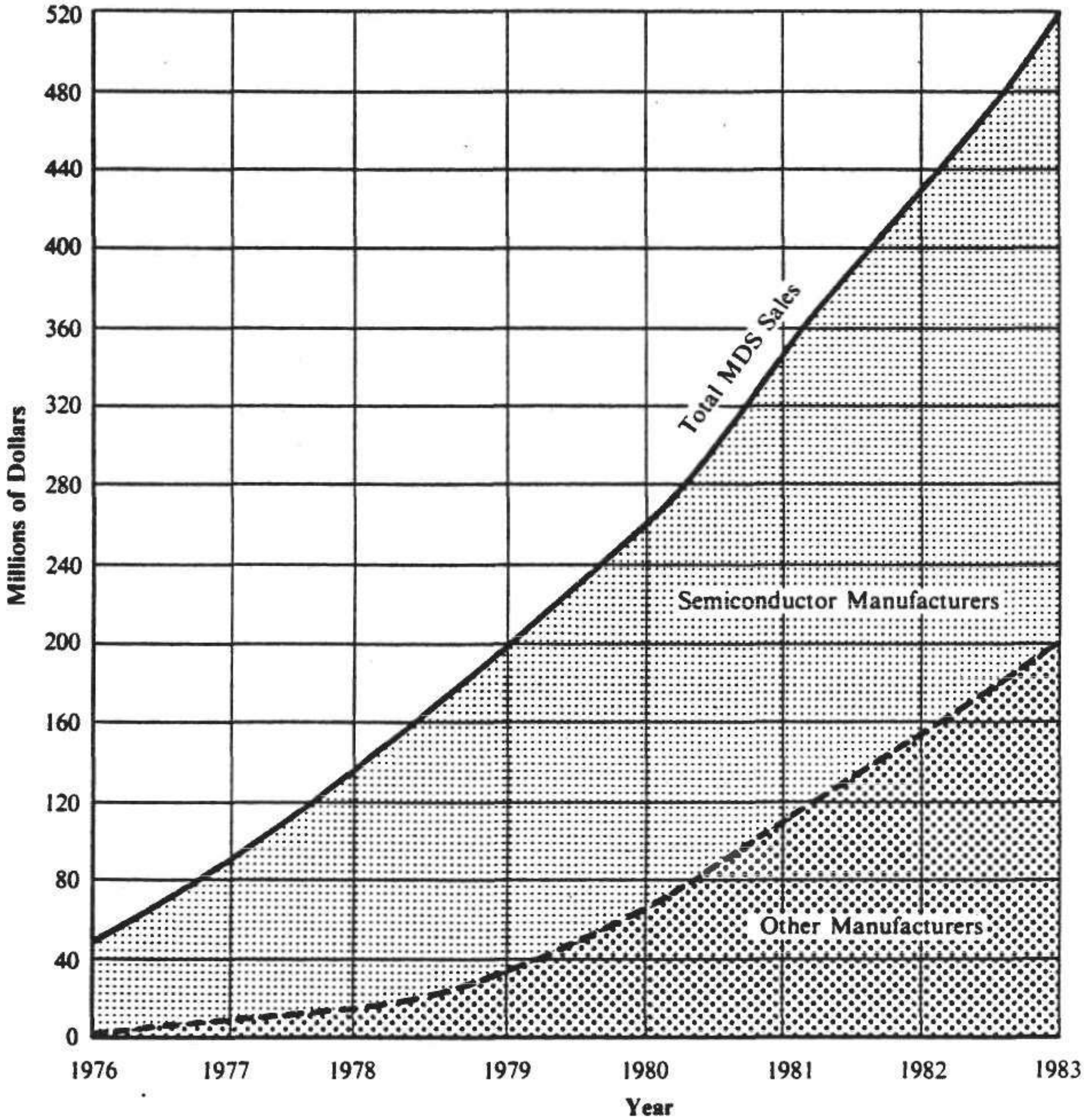
- Expanding electronics sales
- Penetration of microprocessors into new products
- Increasing complexity of new microprocessor devices
- Replacement and/or upgrading of installed base

However, there are other factors which may cause the growth of this market to be moderate. These factors are:

- Multi-user systems are expected to lower per-terminal cost.
- Universal systems (multi-vendor) sales are expected to grow at a faster rate than dedicated (single-vendor) systems, thus reducing total capital output for development systems.
- Stand-alone in-circuit emulators (ICE) are expected to increase in usage, allowing an increase in the down-loading from existing MDSs to these units.
- There is a vast installed base of development systems.

FIGURE 1

ESTIMATED WORLDWIDE SALES OF MICROPROCESSOR DEVELOPMENT SYSTEMS, 1976-1983



Source: DATAQUEST, Inc.

Table 2

ESTIMATED WORLDWIDE SALES OF MICROPROCESSOR DEVELOPMENT SYSTEMS BY SUPPLIER, 1978-1983
(Millions of Dollars)

Supplier	1978	1979	1980	1981	1982	1983	Compound Annual Growth Rate 1978-1983
Semiconductor Manufacturer (Single-vendor)	$127.0	$165.0	$195.0	$235.0	$275.0	$320.0	20.3%
Test Instrument Manufacturers and Others (Multi-vendor)	16.0	35.0	65.0	110.0	155.0	200.0	65.7%
Total	$143.0	$200.0	$260.0	$345.0	$430.0	$520.0	29.5%

Source: DATAQUEST, Inc.

Factors causing the non-semiconductor segment to grow to an expected 38 percent in market share by 1983 are:

- Test instrument manufacturers are currently prominent in research and development (R&D) labs in which microprocessors are being designed into new products; thus, engineers are familiar with the major companies, their equipment, and their service.

- Test instrument manufacturers sell primarily through their own direct sales force and sales representatives; typically, both segments have personnel with technical backgrounds. This combined sales force penetrates the total engineering community, including the R&D labs.

- Test instrument manufacturers provide a variety of emulators for the popular microprocessors. This availability gives the user flexibility in the choice of microprocessors to be used in new applications without purchasing additional stand-alone systems.

The forecast for the next five years is based upon the assumption that each semiconductor manufacturer will continue to provide emulation only for those devices that it manufactures, either as the original or a second source.

TRENDS

There are trends in the microprocessor market that affect the MDS market and there are trends within the development systems market itself. The major trends that influence the market are:

Limited Number of Microprocessor Families

DATAQUEST expects the number of distinct microprocessor families (multi and single chip) to grow at a moderate rate because of the large cost and time involved in bringing out a new family. However, within a product family, we expect a proliferation of microprocessor and peripheral chips.

Increasing Demand for Microprocessors

DATAQUEST estimates the market for microprocessors will increase at a compound annual growth rate of 63 percent for the next 5 years, reaching a consumption level in 1983 which is expected to be 11.5 times as large as that of 1978.

Increasing Complexity of Microprocessor Devices

With the arrival of the 16-bit microprocessors, designers are experiencing, first hand, the complexity of these higher-end microprocessors.

Multiple Microprocessors in Applications

The increased application of multiple microprocessors on a board is expected to force suppliers of development systems to support this type of microprocessor application.

Multi-User System Configuration

Another trend in program development systems is toward multi-terminal or multi-station systems. Such systems are similar to time-sharing, except that they are dedicated to microprocessor program development.

Increased Software Orientation

The trend is expected to continue toward high-level languages, particularly PASCAL. The use of hard disc storage is expected to be on the incline.

Distributed Terminals

DATAQUEST expects an increasing number of manufacturers to provide development systems with terminals dedicated to the integration of hardware and software (in-circuit emulation) and terminals dedicated to software development (text editing and assembly).

COMPETITION

The competitors of the 1978 MDS market were primarily semiconductor manufacturers, representing an estimated 89 percent of the market. Intel was by far the dominant force in this market with an estimated 47 percent in market share. The combination of Intel, Motorola, and National Semiconductor accounted for approximately 69 percent of the 1978 market, as shown in Table 3.

The non-semiconductor MDS manufacturers are primarily Tektronix and GenRad/Futuredata which represent approximately 9 percent of the 1978 market. Tektronix is the leader in this market segment. With the entry of Hewlett-Packard and other test instrument manufacturers in the MDS market, this segment is expected to reach an estimated 38 percent in market share in 1983.

Kenneth N. Neff
Galen W. Wampler

Table 3

ESTIMATED WORLDWIDE SALES OF
MICROPROCESSOR DEVELOPMENT SYSTEMS BY MANUFACTURER
(Millions of Dollars)

	1976	1977	1978	1979
Intel	$20.0	$35.0	$ 57.0	74
Motorola	6.0	12.0	19.0	28
Tektronix	0	4.0	10.0	20
National Semiconductor	4.4	5.0	7.5	13.5
Zilog	1.2	3.0	5.0	[illegible].8
Texas Instruments	0.9	3.0	5.0	
AMD	0	1.5	4.5	
Mostek	0.8	1.5	2.8	1
GenRad/Futuredata	0	1.0	2.5	
Rockwell	0.8	2.0	2.0	
Fairchild	1.0	1.0	1.0	
Signetics	1.0	1.5	1.0	
AMI	1.2	1.7	0.5	
Others	3.7	5.3	6.2	7
Subtotal	$41.0	$77.5	$124.0	
Distributor's Mark-Up	7.0	12.5	19.0	
Total	$48.0	$90.0	$143.0	400 760

Source: DATAQUEST, Inc.

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Vol. I, 4.12

ADVANCED SCHOTTKY TTL

SUMMARY

Advanced Schottky TTL, an iteration of Super Schottky, is now being offered by Fairchild, Raytheon, and Texas Instruments. It offers improved speed/power characteristics over conventional Schottky. Fairchild has placed its emphasis on lower power while Raytheon and Texas Instruments have emphasized higher speeds. We expect that the higher speeds of Advanced Schottky will cause significant usage problems—especially at wire wraps and connectors. Interest in the new families is high, but no significant market has yet developed due to the newness of the product lines and the lack of alternate sources.

BACKGROUND

Advanced Schottky (AS) and Advanced Low Power Schottky (ALS) have been announced recently. These families originated from Super Schottky development programs sponsored by IBM's Federal Systems Division, but they are now pursuing different directions. The divergent directions, uncertainty about the future, and lack of alternate sources is causing confusion in the marketplace. Two of the AS product families (Fairchild and Raytheon) are intended to be direct retrofits for Schottky (S), but some questions about full compatibility do exist. Texas Instruments AS family is implemented with new circuits in new packages; hence, it is definitely intended for new designs and not for retrofitting. Texas Instruments ALS family should be pin-compatible with the existing low-power Schottky (LS) family, but will be faster and should consume less power. Key parameters for the Schottky families are shown in Table 1.

Advanced Schottky takes advantage of modern oxide-isolated processing to offer the user a significantly improved speed/power product. Thus, we expect that major extensions of Schottky will soon be effected with oxide isolation only.

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Table 1

TYPICAL VALUES FOR KEY PARAMETERS OF TTL LOGIC FAMILIES

Parameter	Logic Family							
	TTL	H-TTL	S-TTL	FCI AS	RAY AS	TI AS	LS	TI ALS
Average Switching Delay (ns)	9	6	3	2.65	1.5	1.5	5.0	4.0
Waveform Rise Time (ns)	6-9	4-6	1.8-2.8	2.5	2.1	2.3	9.5	5.0
Waveform Fall Time (ns)	4-6	2-3	1.6-2.6	2.5	1.9	1.8	6.0	5.0
Power Consumption (mW per gate)	10	22.5	20	4	20	20	2	1
Speed-Power (pJ)	90	135	60	11	30	30	10	4
Oxide Isolated ?	No	No	No	Yes	No	Yes	No	Yes

Source: DATAQUEST, Inc.
September 1979

MANUFACTURERS

Fairchild

Fairchild's FAST (Fairchild Advanced Schottky TTL) employs Isoplanar processing and was the first of the new families to be introduced. Fairchild's product is well specified and nine SSI and MSI devices are available. Fairchild's strategy was to introduce a retrofitable family with slightly improved performance and greatly reduced power consumption. Although Fairchild claims that significant usage problems are not expected to result from retrofitting existing S designs, we advise potential users to proceed with caution; history has shown us that retrofitting contains many unexpected problems. We expect FAST to be performance-competitive in MSI devices, since it appears to be the interface design that limits the speed in SSI devices.

Raytheon

Raytheon's AS family offers no improvement in power consumption, but is about twice as fast as conventional Schottky. To facilitate driving transmission lines and large capacitances, Raytheon has increased I_{OS} (output short-circuit current) to a minimum of 125 mA. This tripling of the output current capability will result in very sharp edge speeds under light load conditions. Furthermore, Raytheon sacrificed some noise margin by lowering the input low-threshold voltage to 0.7 volts. Raytheon's AS is fabricated with a high-performance, junction-isolation process.

Raytheon promotes its family as being fully compatible with existing S devices and offers it in the same packages as S. Data sheets are available, but we understand that device samples are still in short supply.

Texas Instruments

Texas Instruments approach to this emerging market is more radical; it chose to serve the extremes of high speed and low power and to offer the high-performance family in new packages. It uses an oxide-isolated process for both the AS and the ALS products. Its AS line is twice as fast as its S family and it is making no claims about retrofitability; the new family is offered in new circuit functions and in new package configurations and retrofitting is impossible. AS is to be the vehicle for introducing new complex functions, which will be offered in three output configurations as appropriate. These are: 50-ohm line drivers, buffers for lines to 100 ohms, and S configurations.

Texas Instruments philosophy on ALS is to double the AC performance over comparable devices in LS while saving about one-half of the power and retaining the same design rules. With a doubling of the AC performance, TI expects that many existing S designs will be converted to ALS. In this case, some consideration must also be given DC loading rules. Note that DATAQUEST is skeptical about direct replacement of any devices by faster devices. Data sheets and samples are available on some SSI devices. TI expects initial availability of MSI specifications and product in October.

Other Manufacturers

No other manufacturer has yet announced an Advanced Schottky family. National has recently upgraded its LS family to match the performance of Fairchild's and Motorola's LS with the noise margin offered by Signetics' LS. AMD expects to use an oxide-isolated process for higher performance MSI/LSI in the future, but does not intend to enter the Advanced Schottky marketplace per se. Signetics' position is similar to that of AMD in that it sees no need for either a new family or an oxide-isolated process at this time. It expects to make additions and selective replacements to its LS line with advanced junction-isolated processes.

Motorola states that it too is watching the market and that it intends to follow the approach that is best accepted by the marketplace. It intends to announce a decision in 1979. Motorola is one of IBM's suppliers; therefore, it has the technology to supply AS product.

USAGE PROBLEMS

A prominent problem in the use of high-speed logic forms is reflections on the signal lines. Reflections are generated in improperly terminated lines; they become more persistent as the propagation delay and the signal rise time approach the same magnitude. Especially in the case of the Raytheon AS, we would expect that careful termination would be required for all signal paths longer than a couple of inches.

Reflections are aggravated by the discontinuities associated with wire-wrapped open wiring and connectors. Circuit malfunctions result if the reflections cause false or delayed crossings of the logic thresholds; therefore, noise margins are of vital concern. With these considerations, there is concern that AS may require more costly interconnection techniques, such as twisted pairs or strip lines on mother boards.

MARKET

Table 2 presents DATAQUEST's estimates of worldwide TTL logic consumption. TTL logic is segmented into standard TTL logic and Schottky logic; Schottky logic is further segmented into Standard Schottky and low-power Schottky. As indicated in Table 2, low-power Schottky is expected to have the highest growth of the various segments, reaching almost $1.2 billion by 1983. The AS and ALS markets will eventually be segments of the low-power Schottky market but it is still premature to forecast markets for these emerging product lines.

Table 2

ESTIMATED WORLDWIDE TTL LOGIC CONSUMPTION

(Millions of Dollars)

	1978	1979	1980	1981	1982	1983
Standard TTL Logic	$485	$ 540	$ 550	$ 535	$ 510	$ 490
Schottky TTL Logic	363	585	730	975	1,265	1,585
Standard Schottky	214	290	310	345	375	405
Low-Power Schottky	149	295	420	630	890	1,180
Total TTL Logic	$848	$1,125	$1,280	$1,510	$1,775	$2,075

Source: DATAQUEST, Inc.
September 1979

DATAQUEST found the greatest user interest in AS and ALS to be with manufacturers of minicomputers and military equipment. Competitive minicomputers must have very fast logic in their data paths to effect the required throughput. The power consumption of conventional high-speed logic results in troublesome power-density problems and the associated problems of power distribution and heat removal. Military equipment manufacturers are vitally concerned with the size and weight of power supplies and with the effects of internally generated heat in high ambient temperature environments. Speed/power improvements thus typically result in large cost savings in these, and other, systems.

Thus, we expect AS to be especially popular in applications that demand maximum performance, and ALS and FAST to be especially popular in military systems and in minicomputer peripheral circuits. Many users are concerned that the present movements will cause existing product lines to become obsolete. For example, Texas Instruments has commented that it will produce no new circuit designs in conventional LS; some systems manufacturers project that some existing LS may be discontinued. It certainly follows that new designs must use the new technology if the manufacturer is to remain competitive in its market.

Prices of Advanced Schottky devices are expected to be 20-30 percent higher than their conventional equivalents. Although we found significant interest and awareness of the new families, we found no committed designs. We expect that there will be few commitments until at least one of the major TTL manufacturers decides to become an alternate source.

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Frederick L. Zieber

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MOS MICROPROCESSOR SHIPMENTS

SUMMARY

Worldwide shipments of MOS microprocessors in the second quarter of 1979 were an estimated 15.4 million units, up about 44 percent over estimated first quarter shipments and up about 184 percent over the second quarter of 1978. Shipments of 4-bit microprocessors were an estimated 9.9 million units, up about 40 percent over estimated first quarter shipments and represented about 64 percent of the total; shipments of 8-bit microprocessors were an estimated 5.4 million units, up about 53 percent over estimated first quarter shipments and represented about 35 percent of the total. The 16-bit products represented about 1 percent of second quarter 1979 total shipments, with an estimated 141,000 units which is up about 17 percent over estimated first quarter shipments. During the second quarter, two new 16-bit microprocessors, the 432 and the Z8000, were sampled in limited quantities. Early in the third quarter a limited number of the 68000 microprocessor were sampled.

Single-chip microcomputer shipments in the second quarter of 1979 were an estimated 11.8 million units, representing about 76 percent of the total second quarter microprocessor shipments. Demand for single-chip microcomputers continues to be extremely strong and greatly exceeds available supply. Lead times range from 15 to 30 weeks, and prices have increased 40 to 60 percent on selected products during the last six months.

QUARTERLY MICROPROCESSOR SHIPMENTS

Table 1 presents DATAQUEST's estimate of worldwide microprocessor CPU shipments for the second quarter of 1979. As always, our estimated shipments refer to microprocessor CPU chips only and do not include I/O and peripheral chips. Estimated microprocessor shipments in the second quarter of 1979 were 15.4 million units, up about 44 percent over the first quarter of 1979, and up about 184 percent over the second quarter of 1978. This quarter-to-quarter percent increase in shipments is the largest percent increase since the third quarter of 1977.

Table 2 presents DATAQUEST's estimates of worldwide shipments of single-chip microcomputers. Estimated second quarter 1979 shipments of microcomputers were 11.8 million units, up about 48 percent over estimated first quarter 1979 shipments of 8.0 million units, and up about 243 percent over estimated second quarter 1978 shipments of 3.4 million units.

Demand for single-chip microcomputers appears to be growing each quarter and now greatly exceeds available supply. Lead times for most of the single-chip

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microcomputers are in the 15 to 30 week range, depending upon the particular product and quantities required. Prices for these products have firmed in the second and third quarters of 1979, and some products, such as the 8048 and 3870, have seen price increases from the $5-$6 range in December 1978 to the $8-$10 range for third quarter 1979 deliveries. These price increases reflect the strong demand for the devices as well as some value-added pricing.

4-Bit Microprocessors

Table 3 presents DATAQUEST's estimates of worldwide shipments of 4-bit microprocessors. Shipments of 4-bit microprocessors in the second quarter of 1979 are estimated at 9.9 million units, up about 40 percent over estimated first quarter 1979 shipments, and up about 203 percent over the second quarter of 1978. The large shipment increases for devices in this product segment reflect their popularity and cost-effectiveness in a wide range of consumer, industrial, and computer applications.

Prices for these 4-bit products are generally in the $1.50-$3.50 range for volume purchases of about 100,000 units. Lower volume purchases, as well as some of the newer product introductions, reflect prices of $5.00 or more. The CMOS products are commanding premiums that are double or triple the price of the equivalent PMOS product. The new 141000 CMOS device from Motorola is priced in the $8-$10 range at the smaller quantities now being shipped.

8-Bit Microprocessors

Worldwide shipments of 8-bit microprocessors in the second quarter of 1979 were an estimated 5.4 million units, up about 53 percent over estimated first quarter 1979 shipments, and up about 159 percent over estimated second quarter 1978 shipments (see Table 4). Single-chip microcomputers continue to represent an increasing percentage of the total 8-bit market segment; in the second quarter of 1979, they represented about 36 percent of the total 8-bit microprocessor shipments.

Prices for most 8-bit microprocessors for delivery in the third and fourth quarters of 1979 are in the $4-$8 range and have been relatively stable since the first of the year. The only exception has been the price increases on selected 8-bit microcomputers as mentioned earlier. We expect relatively stable pricing on most of these microprocessor products through year-end because of the strong demand and capacity limitations.

12-Bit and 16-Bit Microprocessors

Table 5 presents estimates of worldwide shipments of 12-bit and 16-bit microprocessors. Shipments of 12-bit microprocessors were an estimated 19,000 units in the second quarter, up about 6 percent from an estimated 18,000 units in the first quarter of 1979 and up 27 percent from an estimated 15,000 units in the second quarter of 1978. The 12-bit microprocessor market seems unlikely to be a significant market, as is evidenced by the presence of two suppliers and one product.

Worldwide shipments of 16-bit microprocessors in the second quarter of 1979 were an estimated 141,000 units, up about 17 percent over estimated first quarter 1979 shipments and up about 70 percent over estimated second quarter 1978 shipments. The largest portion of the gain in the second quarter of 1979 comes from the TMS 9900 products, as many of these are now used in production runs. The newer 8086 is still in the design-in phase, but will nevertheless be appearing in limited production runs in the coming quarters. In the second quarter of 1979, samples of the 432 and the Z8000 became available. Early in the third quarter, the first samples of the 68000 were seen by selected customers. In the coming quarters, these products will participate in design-ins before eventually appearing in production runs.

Prices on 16-bit microprocessors are basically unchanged since the last issue of this newsletter, with the TMS 9980 being available for $10-$15 in 1,000 unit quantities, whereas the 8086 is commanding prices in the $70-$100 range, depending upon quantity.

Daniel L. Klesken
Lane Mason

Table 1

ESTIMATED WORLDWIDE SHIPMENTS OF MOS MICROPROCESSORS

(Thousands of Units)

Company	MPU Products	Bits	MOS Process	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.	1979 2nd Qtr.
AMD	8080A	8	N	105	115	125	435	135	325
	8085	8	N	0	S[1]	5	5	15	40
	8048	8	N	0	0	0	0	S	S
	Z-8000	16	N	0	0	0	0	0	S
AMI	S2000	4	N	9	8	12	29	30	330
	6800	8	N	30	30	35	130	38	30
	6802/6808	8	N	0	0	0	0	S	10
EFCIS[2]	6800	8	N	0	0	0	0	8	10
Fairchild	F8	8	N	130	190	200	630	150	200
	3870	8	N	5	5	10	23	40	50
	6800	8	N	45	80	90	270	155	155
	6802/6808	8	N	0	0	S	S	20	45
General Instrument	PIC-1650	8	N	95	105	175	450	300	950
	CP-1600	16	N	20	15	15	60	15	20
Harris	6100	12	C	5	5	7	22	8	9
Hitachi	HMCS-40	4	P&C	95	110	120	410	130	150
	6800	8	N	15	20	25	70	50	100
Hughes	1802	8	C	8	10	12	35	12	14
Intel	4004	4	P	42	40	35	159	35	32
	8008	8	P	28	25	22	103	20	18
	8080A	8	N	170	180	190	705	190	200
	8048/8021	8	N	100	150	170	480	210	300
	8748	8	N	0	5	25	30	50	75
	8085	8	N	80	95	125	350	175	260
	8086	16	N	1	10	13	24	13	15
Intersil	6100	12	C	10	10	10	38	10	10
Matsushita (Panasonic)	MN1400	4	N,P&C	N/A[3]	N/A	N/A	N/A	500	800
MOS Technology	6500	8	N	55	60	60	225	65	70
Mostek	F8	8	N	30	35	45	160	90	150
	Z80	8	N	50	60	80	260	100	120
	3870	8	N	50	75	205	350	260	300
Motorola	141000	4	C	0	5	15	20	30	75
	6800	8	N	140	150	160	570	165	175
	6802/6808	8	N	20	65	90	180	150	240
	6809	8	N	0	0	0	0	S	2
	3870	8	N	10	15	40	70	80	100
National	COPS	4	N&C	500	675	850	2,325	900	1,100
	4004	4	P	35	35	30	130	30	26
	IMP	4	P	20	20	20	80	18	15
	8080A	8	N	90	100	100	375	150	175
	SC/MP	8	P	70	100	100	335	100	140
	PACE	16	P	18	25	25	86	25	25
NEC	COM-4	4	N	225	525	600	1,500	1,100	1,300
	8080A	8	N	85	90	60	305	65	90
	8048/8049	8	N	0	S	15	15	25	160
	8085	8	N	0	5	25	30	55	75
	Z80	8	N	0	5	25	30	60	80
	432	16	N	0	0	0	0	S	S
RCA	1802	8	C	75	85	90	325	115	115
Rockwell	PPS-4	4	P	550	675	650	2,275	600	1,100
	6500	8	N	200	75	60	595	50	60
	6500/1	8	N	0	0	0	0	S	S
Sescosem[4]	6800	8	N	6	7	7	25	0	0
Signetics	2650	8	N	25	35	45	125	45	90
	8048	8	N	0	S	S	S	15	30
Solid State Scientific	1802	8	C	0	0	0	0	2	8
Synertek	6500	8	N	225	60	70	680	100	120
Texas Instruments	TMS 1000	4	P&C	1,800	3,000	3,200	9,400	3,700	5,000
	TMS 8080A	8	N	30	40	35	135	32	25
	TMS 9900	16	N	44	48	53	185	68	80
Zilog	Z80	8	N	100	150	210	550	195	250
	Z8000	16	N	0	0	0	0	0	1
Total Microprocessors				5,446	7,433	8,386	25,799	10,719	15,446
Percent change from previous quarter				20.4%	36.5%	12.8%		27.8%	44.1%

[1] S = Sampling

[2] EFCIS, a joint venture between Sescosem and the French AEC, now handles the MOS MPUs formerly handled by Sescosem, a Division of Thomson-CSF

[3] N/A = Not Available

[4] Sescosem is no longer shipping MOS MPUs since these are now handled by EFCIS

Source: DATAQUEST, Inc.
September 1979

Table 2

ESTIMATED WORLDWIDE SHIPMENTS OF SINGLE-CHIP MICROCOMPUTERS

(Thousands of Units)

Company	MPU Products	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.	1979 2nd Qtr.
AMD	8048	0	0	0	0	S[1]	S
AMI	S2000	9	8	12	29	30	330
Fairchild	3870	5	5	10	23	40	50
General Instrument	PIC-1650	95	105	175	450	300	950
Hitachi	HMCS-40	95	110	120	410	130	150
Intel	8048/8021	100	150	170	480	210	300
	8748	0	5	25	30	50	75
Matsushita	MN1400	N/A[2]	N/A	N/A	N/A	500	800
Mostek	3870	50	75	205	350	260	300
Motorola	141000	0	5	15	20	30	75
	6801/6803	0	0	0	0	0	1
	3870	10	15	40	70	80	100
National	COPS	500	675	850	2,325	900	1,100
NEC	COM-4	225	525	600	1,500	1,100	1,300
	8048/8049	0	S	15	15	25	160
Rockwell	PPS-4	550	675	650	2,275	600	1,100
	6500/1	0	0	0	0	S	S
Texas Instruments	TMS 1000	1,800	3,000	3,200	9,400	3,700	5,000
Total		3,439	5,353	6,087	17,377	7,955	11,791
Percent change from previous quarter		37.4%	55.7%	13.7%		30.7%	48.2%

[1] S = Sampling

Source: DATAQUEST, Inc.
September 1979

Table 3

ESTIMATED WORLDWIDE SHIPMENTS OF 4-BIT MICROPROCESSORS

(Thousands of Units)

		1978				1979	
Company	MPU Products	2nd Qtr.	3rd Qtr.	4th Qtr.	Total	1st Qtr.	2nd Qtr.
AMI	S2000	9	8	12	29	30	330
Hitachi	HMCS-40	95	110	120	410	130	150
Intel	4004	42	40	35	159	35	32
Matsushita	MN1400	N/A[1]	N/A	N/A	N/A	500	800
Motorola	141000	0	5	15	20	30	75
National	COPS	500	675	850	2,325	900	1,100
	4004	35	35	30	130	30	26
	IMP	20	20	20	80	18	15
NEC	COM-4	225	525	600	1,500	1,100	1,300
Rockwell	PPS-4	550	675	650	2,275	600	1,100
Texas Instruments	TMS 1000	1,800	3,000	3,200	9,400	3,700	5,000
Total		3,276	5,093	5,532	16,328	7,073	9,928
Percent change from previous quarter		34.9%	55.5%	8.6%		27.9%	40.4%

[1]N/A = Not Available

Source: DATAQUEST, Inc.
September 1979

Table 4

ESTIMATED WORLDWIDE SHIPMENTS OF 8-BIT MICROPROCESSORS

(Thousands of Units)

Company	MPU Products	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.	1979 2nd Qtr.
AMD	8080A	105	115	125	435	135	325
	8085	0	S[1]	5	5	15	40
	8048	0	0	0	0	S	S
AMI	6800	30	30	35	130	38	30
	6802/6808	0	0	0	0	S	10
EFCIS	6800	0	0	0	0	8	10
Fairchild	F8	130	190	200	630	150	200
	3870	5	5	10	23	40	50
	6800	45	80	90	270	155	155
	6802/6808	0	0	S	S	20	45
General Instrument	PIC-1650	95	105	175	450	300	950
Hitachi	6800	15	20	25	70	50	100
Hughes	1802	8	10	12	35	12	14
Intel	8008	28	25	22	103	20	18
	8080A	170	180	190	705	190	200
	8048/8021	100	150	170	480	210	300
	8748	0	5	25	30	50	75
	8085	80	95	125	350	175	260
MOS Technology	6500	55	60	60	225	65	70
Mostek	F8	30	35	45	160	90	150
	Z80	50	60	80	260	100	120
	3870	50	75	205	350	260	300
Motorola	6800	140	150	160	570	165	175
	6801/6803	0	0	0	0	0	1
	6802/6808	20	65	90	180	150	240
	6809	0	0	0	0	S	2
	3870	10	15	40	70	80	100
National	8080A	90	100	100	375	150	175
	SC/MP	70	100	100	335	100	140
NEC	8080A	85	90	60	305	65	90
	8048/8049	0	S	15	15	25	160
	8085	0	5	25	30	55	75
	Z80	0	5	25	30	80	80
RCA	1802	75	85	90	325	115	115
Rockwell	6500	200	75	60	595	50	60
	6500/1	0	0	0	0	S	S
Sescosem	6800	6	7	7	25	0	0
Signetics	2650	25	35	45	125	45	90
	8048	0	S	S	S	15	30
Solid State Scientific	1802	0	0	0	0	2	8
Synertek	6500	225	60	70	680	100	120
Texas Instruments	TMS 8080A	30	40	35	135	32	25
Zilog	Z80	100	150	210	550	195	250
Total		2,072	2,227	2,731	9,056	3,507	5,358
Percent change from previous quarter		2.2%	7.5%	22.6%		28.4%	52.8%

[1]S = Sampling

Source: DATAQUEST, Inc.
September 1979

Table 5

ESTIMATED WORLDWIDE SHIPMENTS OF 12-BIT AND 16-BIT MICROPROCESSORS

(Thousands of Units)

12-Bit Products		1978				1979	
Company	MPU Products	2nd Qtr.	3rd Qtr.	4th Qtr.	Total	1st Qtr.	2nd Qtr.
Harris	6100	5	5	7	22	8	9
Intersil	6100	10	10	10	38	10	10
Total		15	15	17	60	18	19
Percent change from previous quarter		15.4%	0%	13.3%		5.9%	5.6%
16-Bit Products							
AMD	Z8000	0	0	0	0	0	S[1]
General Instrument	CP-1600	20	15	15	60	15	20
Intel	8086	1	10	13	24	13	15
National	PACE	18	25	25	86	25	25
NEC	432	0	0	0	0	S	S
Texas Instruments	TMS 9900	44	48	53	185	68	80
Zilog	Z8000	0	0	0	0	0	1
Total		83	98	106	355	121	141
Percent change from previous quarter		22.1%	18.1%	8.2%		14.2%	16.5%

[1] S = Sampling

Source: DATAQUEST, Inc.
September 1979

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DYNAMIC AND STATIC MOS RAM AND EPROM SHIPMENTS

Summary

Worldwide shipments of 16K dynamic MOS RAMs increased to an estimated 14.4 million units in the second quarter of 1979, up about 41 percent over an estimated 10.2 million units in the first quarter of 1979. Demand for the 16K RAM continues to be extremely strong, and DATAQUEST expects this trend to continue through 1980. Lead times are in the 25 to 40 week range, and prices have risen slightly to the $6.00 to $7.00 range.

Worldwide shipments of 4K dynamic MOS RAMs in the second quarter of 1979 were an estimated 18.5 million units, down about 0.5 percent from an estimated 18.6 million units in the first quarter of 1979. Prices have increased to about $2.00 as some users are staying with the 4K RAM in light of the 16K RAM shortages.

We estimate that 11.2 million 4K static MOS RAMs were shipped in the second quarter of 1979. This total includes an estimated 1.4 million CMOS static RAMs and 1.2 million 2147 fast 4K statics.

Second quarter shipments of 8K EPROMs were an estimated 4.9 million units, up about 18 percent over the first quarter. Prices have increased slightly to about $6.00. Shipments of 16K EPROMs were an estimated 2.5 million units, up by 72 percent over the previous quarter. Prices remain firm in the $20.00 to $24.00 range with lead times generally in excess of 20 weeks. An estimated 65,000 32K EPROMs were shipped in the second quarter by two suppliers.

Dynamic MOS RAMs

16K RAMs

DATAQUEST estimates of worldwide 16K dynamic MOS RAM shipments are presented in Table 1. We estimate that worldwide shipments in the second quarter of 1979 were 14.4 million units, an increase of 41 percent over estimated first quarter shipments of 10.2 million units. Our estimates include the total shipments by each company, including any shipments to other divisions of the same company. We are also including estimates of 16K chips shipped in two-chip hybrid packages as 32K dynamic RAMs.

Lead times are in the range of 25 to 40 weeks and generally increasing. Most suppliers are fully booked for 1979 shipments and are now booking first and second quarter 1980 business. The suppliers are each using some type of allocation to assure that their major long-term customers receive an adequate supply of devices. Texas Instruments has had 16K dynamic MOS RAMs on a 16-week allocation system

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since early 1979. Mostek and Intel now have instituted their own forms of allocation to assure proper handling of their top customers, and other suppliers have followed suit. DATAQUEST expects these long lead times to continue through 1980 before easing.

The strong demand comes from the computer and industrial market segments with mainframes and minicomputers being the primary source of demand. Of course, the presence of IBM in the market is having an important effect. This will be even more pronounced in 1980 as DATAQUEST estimates that IBM demand in 1980 for the two-chip 32K dynamic RAM will be in the range of 10 to 12 million units. This level of demand from IBM is expected to grow in 1981 and peak in late 1982 or 1983.

The extreme demand has resulted in third quarter pricing that is essentially flat with prices in the second quarter. Plastic parts are in the $5.50 to $6.50 range, whereas ceramic parts are selling for $6.50 to $7.25, depending upon specifications. Although list prices have not actually increased, marketing managers have had the flexibility to bid prices in the high end of their bidding range and get the order if they can commit to a delivery schedule. On some 16K RAMs, this practice has, in effect, led to higher prices than were being quoted in the first quarter of 1979. Prices on spot contracts are $1.00 to $2.00 higher than deliveries being made under long-term agreements made in 1978.

4K RAMs

DATAQUEST estimates of worldwide 4K dynamic MOS RAM shipments in the second quarter of 1979 are presented in Table 2. We estimate that about 18.5 million units were shipped in the second quarter of 1979, down about 0.5 percent from an estimated 18.6 million units in the first quarter. Quarterly shipments of 4K RAMs are declining on a quarterly basis as many suppliers have elected to de-emphasize 4K dynamic RAMs and reallocate their capacity to the 16K RAM or other products. However, demand remains very strong as users unable to obtain 16K dynamic RAMs are continuing production runs on older products with the 4K dynamic RAM.

The shortage of 16K RAMs has resulted in lead times for 4K dynamic RAMs moving from 15 weeks out to the range of 25 weeks. Prices have increased from a low of $1.35 in plastic up to about $2.00 in plastic, about $2.50 for CERDIP, and in the $3.00 to $4.00 range for high performance ceramic devices.

32K RAMs

Mostek continues to be the only supplier actively marketing a 32K dynamic RAM. We estimate that Mostek shipped 35,000 units, in the second quarter, up from an estimated 30,000 in the first quarter of 1979. Prices are still in the $17.00 to $20.00 range. A limited number of 32K RAMs shipped by Intel and TI to IBM are included as part of the overall estimate for 16K dynamic RAMs.

64K RAMs

Fujitsu, Motorola, and Texas Instruments continue to sample their 64K RAMs. We estimate that Motorola shipped about 1,000 sample devices whereas Fujitsu and TI shipped about 400 units by the end of 1979. We expect another two or three suppliers to be sampling their devices by the end of 1979.

STATIC MOS RAMS

4K RAMs

Table 3 presents DATAQUEST's estimates of 4K static MOS RAMs shipped in the second quarter of 1979. An estimated 11.2 million 4K RAMs were shipped in the second quarter, up about 30 percent over estimated first quarter shipments. For the first time, we have tried to estimate static RAM shipments as 4Kx1 NMOS, 1Kx4 NMOS, and CMOS devices. CMOS RAMs represent an estimated 1.4 million units, or 12 percent of the 4K MOS static RAM total. Units shipped are up 157 percent from an estimated 540,000 CMOS static RAMs shipped in the first quarter. The 1Kx4 architecture for NMOS static RAMS is the more popular of the two and represented about 6.2 million units shipped. The 4Kx1 architecture represented about 3.6 million units or 36.8 percent of the NMOS total. Included in the 4Kx1 devices, we estimate that 1.2 million units were of the 2147 fast static RAM variety.

Lead times for most 4K static RAMs remain in the 15-week range with pricing remaining flat in the $3.75 to $4.75 range for the 2114-type in plastic. Ceramic packages command a premium of about $1.00. CMOS RAMs are still going for prices in the $15.00 to $20.00 range. These prices are expected to drop dramatically as shipment volumes increase over the next few quarters. Prices for the 2147 devices remain strong in the low $20.00 range, but should decline as more suppliers emerge.

Intel is still the only high-volume producer of the 2147 fast 4K static RAM. It shipped an estimated 1.2 million 2147s in the second quarter. We estimate that Motorola shipped about 10,000 2147s of the 70ns variety and that National shipped 10,000 2147s, including some at 55ns. Late in the second quarter, Hitachi began sampling its CMOS version of the 2147. This device uses CMOS and bipolar technology for the peripheral circuitry and NMOS for the memory array.

8K RAMs

Mostek shipped an estimated 50,000 1Kx8 static RAMs in the second quarter of 1979 while EMM continued to sample its 1Kx8 RAM. Other suppliers are soon expected to enter this market as well as the 16K static RAM market. Prices on the 8K static are in the $12.00 to $15.00 range.

EPROMS

8K EPROMs

Table 4 represents DATAQUEST's estimates of worldwide shipments of 8K EPROMs. We estimate that worldwide shipments in the second quarter of 1979 were 4.9 million units, up about 17.9 percent from first quarter shipments. Prices for 8K EPROMs have firmed and actually risen with much of the business in the $6.00 to $7.00 range and a few as high as $7.00 to $8.00. This is up substantially from the $4.00 to $6.00 range of the first and second quarters of 1979.

16K EPROMs

Table 5 represents our estimates of worldwide shipments of 16K EPROMs. It shows that an estimated 2.5 million units were shipped in the second quarter of 1979, up about 72 percent over estimated first quarter shipments. Pricing for third and fourth quarter delivery is in the $18.00 to $22.00 range. This should hold relatively firm until later this year when more suppliers enter the market. Lead times are generally in the 15 to 25 week range.

32K EPROMs

Table 6 represents our estimates of worldwide shipments of 32K EPROMs. Currently, only Intel and Texas Instruments are shipping the devices, but several other suppliers are expected to introduce this product shortly. Prices in these limited quantities are still in the $50.00 to $80.00 range.

Daniel L. Klesken
Lane Mason

Table 1

ESTIMATED WORLDWIDE SHIPMENTS OF 16K DYNAMIC MOS RAMS[1]

(Thousands of Units)

	1978			1979	
Company	3rd Qtr.	4th Qtr.	Total	1st Qtr.	2nd Qtr.
AMD	0	S[2]	S	S	10
Fairchild	200	200	465	300	400
Fujitsu	500	900	2,000	1,100	1,300
Hitachi	350	500	1,210	800	1,400
Intel	600	900	2,400	600	700
Intersil	0	S	S	S	5
ITT	75	100	203	200	300
Mostek	1,400	1,800	4,900	2,400	3,600
Motorola	550	500	1,750	700	1,200
National	75	150	287	250	450
NEC	1,100	1,300	3,850	1,700	2,200
Siemens	25	40	85	65	80
Signetics	30	80	140	75	40
Texas Instruments	950	1,400	3,150	1,800	2,200
Toshiba	80	150	285	225	450
Zilog	15	20	60	20	50
Total	5,950	8,040	20,785	10,235	14,385
Percent Change From Previous Quarter	45.1%	35.1%		27.3%	40.5%

[1] Includes merchant market and internal shipments

[2] Indicates sampling

Source: DATAQUEST, Inc.
August 1979

Table 2

ESTIMATED WORLDWIDE SHIPMENTS OF 4K DYNAMIC MOS RAMS[1]

(Thousands of Units)

Company	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.	1979 2nd Qtr.
AMD	1,800	2,200	6,600	2,600	3,000
Fairchild	0	0	900	0	0
Fujitsu	400	300	1,900	200	200
Hitachi	500	450	1,780	350	200
Intel	2,700	2,300	11,000	1,700	1,700
Intersil	100	100	450	100	50
ITT	300	800	1,600	1,100	1,300
Mostek	4,800	4,200	17,000	3,800	3,300
Motorola	1,500	1,900	5,700	1,500	1,150
National	1,500	1,700	5,600	2,000	2,400
NEC	1,600	1,350	6,150	1,350	1,900
Signetics	300	300	1,150	300	100
Texas Instruments	4,000	3,800	16,700	3,600	3,200
Total	19,500	19,400	76,530	18,600	18,500
Percent Change From Previous Quarter	0.0%	(0.5%)		(4.1%)	(0.5%)

[1]Includes merchant market and internal shipments

Source: DATAQUEST, Inc.
August 1979

Table 3

ESTIMATED 1979 WORLDWIDE SHIPMENTS OF 4K STATIC MOS RAMS[1]

(Thousands of Units)

Company	1st Quarter 1Kx4	4Kx1	CMOS	Total	2nd Quarter 1Kx4	4Kx1	CMOS	Total
AMD	150	30	0	180	275	75	0	350
AMI	50	0	0	50	55	5	0	60
EMM	600	500	0	1,100	600	600	0	1,200
Fairchild	50	0	0	50	100	0	0	100
Fujitsu	80	0	0	80	150	0	0	150
Harris	0	0	40	40	0	0	75	75
Hitachi	450	0	150	600	450	25[1]	300	775
Intel	400	1,200[2]	0	1,600	600	1,800[3]	0	2,400
Intersil	200	100	0	300	230	130	0	360
Mostek	450	0	0	450	600	0	0	600
Motorola	270	30	0	300	320	30[4]	0	350
National	530	120	0	650	900	200[5]	0	1,100
NEC	400	600	100	1,100	600	130	270	1,000
RCA	0	0	50	50	0	0	80	80
Signetics	0	0	0	S	0	0	0	S
Synertek	560	0	0	560	600	0	0	600
Texas Instruments	500	500	0	1,000	500	500	0	1,000
Toshiba	150	0	200	350	210	0	660	870
Zilog	0	110	0	110	0	110	0	110
Total	4,840	3,190	540	8,570	6,190	3,605	1,385	11,180
Percent Change From Previous Quarter or Year				34.3%	27.9%	13.0%	156.5%	30.4%

[1]All CMOS 2147 RAMs

[2]Includes 800,000 2147s

[3]Includes 1,200,000 2147s, of which 50,000 were the 2147 H series at 35ns

[4]Includes 10,000 2147s

[5]Includes 10,000 2147s

Source: DATAQUEST, Inc.
August 1979

Table 4

ESTIMATED WORLDWIDE SHIPMENTS OF 8K EPROMS[1]

(Thousands of Units)

Company	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.	1979 2nd Qtr.
AMD	80	340	485	600	700
Electronic Arrays	60	60	200	75	100
Fairchild	60	120	280	160	200
Fujitsu	70	70	280	70	50
Intel	800	1,000	3,400	1,100	1,400
Motorola	300	400	1,020	700	750
National	300	500	1,250	600	800
Signetics	80	50	280	0	0
Texas Instruments	400	800	2,100	800	800
Toshiba	10	30	40	50	100
Total	2,160	3,370	9,335	4,155	4,900
Percent Change from Previous Quarter	(5.9%)	56.0%		23.3%	17.9%

[1] Includes merchant market and internal shipments

Source: DATAQUEST, Inc.
August 1979

Table 5

ESTIMATED WORLDWIDE SHIPMENTS OF 16K EPROMS[1]

(Thousands of Units)

Company	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.	1979 2nd Qtr.
Fairchild	0	0	0	S[2]	S
Fujitsu	0	5	5	70	200
Hitachi	5	30	35	125	200
Intel	250	450	1,350	550	750
Mostek	S	25	25	90	150
Motorola[3]	10	90	100	160	150
National	S	S	S	5	50
Texas Instruments[4]	200	300	850	400	900
Toshiba	S	5	5	25	50
Total	465	905	2,370	1,425	2,450
Percent Change from Previous Quarter	(28.5%)	94.6%		57.5%	71.9%

[1]Includes merchant market and internal shipments

[2]Indicates sampling

[3]About 10 percent represent parts having a 5 volt-only power supply

[4]About 40 percent represent parts having a 5 volt-only power supply

Source: DATAQUEST, Inc.
August 1979

Table 6

ESTIMATED WORLDWIDE SHIPMENTS OF 32K EPROMS
(Thousands of Units)

Company	1st Qtr.	2nd Qtr.
Intel	5	30
Texas Instruments	10	35
Total	15	65

Source: DATAQUEST, Inc.
August 1979

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Vol. II Newsletter

INTEL ANALYSTS' MEETING

Intel Corporation held a meeting for financial analysts on Friday, July 20, 1979, in Santa Clara, California. The meeting was attended by several members of the DATAQUEST staff. We feel information discussed at the meeting may be of interest to our clients, and therefore pass on our rough notes from that meeting.

Frederick L. Zieber
Michael R. Weisberg
James F. Riley

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INTEL ANALYSTS' MEETING

Friday, July 20, 1979 - Santa Clara, CA
(Rough Notes Prepared by DATAQUEST Staff)

General - Gordon Moore

1. Second quarter revenues were better than expected at the beginning of the quarter:

   - Better pricing; prices down, but not at normal rate.

   - Better manufacturing efficiencies as a result of a slowing in Q3 1978 hiring. This slowing began in Q3 1978 and first showed up in the Q2 1979 revenue rate.

   - Intel was successful in recruiting 800+ people in Q2 1979, and expects to add more in Q3 because of an increased headcount in overseas assembly plants.

2. Third quarter dollar revenue growth vs. Q2 should be about the same as Q2 vs. Q1 dollar revenue growth.

3. MRI was in for 3 months in Q2 and only two months in Q1, but this was a small increment.

4. IBM contract will be in for 2 months in Q3 and and then die. Intel does not expect the same growth increment in Q4 revenues.

5. Capital spending this year will be closer to $110 million rather than $120 million as projected earlier. It is locked into two-thirds of that amount in 1980, or $70-75 million.

6. Debt outstanding should not go up in next two quarters, as it hasn't spent money as fast as originally projected.

7. Employee stock purchases have been an important contribution to Intel's ability to finance growth. This source contributed $12 million in cash in the first half of 1979.

Current Business Trends - Ed Gelbach

1. Have seen no slowing; distributor business is strong, and customers tell Intel that their business is strong.

2. Intel has seen lead times come <u>in</u> by 5-10 percent.

3. Dynamic RAMs:

   - Pricing is firm, should stay that way through 1979 and then soften.

   - Demand for 16K RAMs will exceed supply throughout 1980.

- Although it gets less attention, the 4K dynamic shortage is even greater. The shifting of wafer allocations to 16K RAMs is the cause.

4. EPROMs:

   - Prices should start to decline in the fourth quarter of 1979 and first quarter of 1980 as new entrants come into market.
   - Last year, EPROM prices dropped by less than $1.
   - 16K EPROM shortages continue.
   - 8K business fluctuates - strong now.
   - Delivery is 12-30 weeks.

5. Microprocessors:

   - 8-35 weeks delivery. This is the strongest part of Intel's business right now.

6. Static RAMs:

   - High-speed devices have good delivery, firm prices, but it is positioned to respond to changes in pricing.
   - Low-speed device delivery is extended; pricing firm but can change overnight.
   - 4-20 weeks delivery

7. Systems:

   - The order rate has slowed, and Intel is now quoting 4-8 weeks as supply and demand are more closely matched.
   - Design aids are at the lower end of the growth curve at Intel. Customers talk about universal systems and are waiting for the Hewlett-Packard announcement which could be impacting demand.

<u>Memory Components Operation - Ron Whittier</u>

1. Standard memories:

   - DEC, Data General add-in/add-on memory
   - In 40, 1600, 7000, 3000
   - Series 90

2. Custom memories:

   - Major custom programs, such as IBM contract

- Intel has a standard BUS——introduced at NCC in June——which should simplify the design and reduce the cost of custom memories.

3. Dynamic RAMs:

- Total RAM market: $800 million in 1979 rising to $2 billion by 1983, including IBM external buying.

- Dynamic RAMs half the business in 1979, going to $1 billion in 1980. Growth rates will accelerate in 1980 due to IBM, solid-state discs, heavy demand.

<u>Intel Unit Forecast</u>

(16K RAM Equivalent Parts)

16K	1979	52M
	1980	70M
	1981	80M
	1982	70M
	1983	48M
64K	1980	4M
	1981	30M
	1982	105M
	1983	210M
5V16K	1980	10M
	1981	20M
	1982	30M
	1983	40M

- Will support 3 power supply parts through 1980/1981 to a well-defined customer base—around 20 major customers.

- Increased emphasis on 5v only part. Forcing as much business here as possible. Demand is very good.

4. 64K RAMs: Expect only 1 million pieces in 1980. It will sample in the second half of 1979. Currently processing material.

5. Static RAMs:

- Half of market now and should be half in 1983.

- The market for slow 4K static RAMs should peak in units in 1980/1981, but the fast 4K segment is expected to grow through 1982.

- 16K static RAMs - projecting 1 million units in 1980.

4K Static RAMs

(Millions of Units in Equivalent 4K)

Low Cost		4K	16K
	1979	30	0
	1980	40	6
	1981	40	40
	1982	35	120
	1983	25	200
Fast			
	1979	6	0
	1980	18	0
	1981	45	3
	1982	60	16
	1983	80	48

9. Static RAM strategy:

- Will support 2114, 2141 market through 1981.

- Intends to introduce a slow 16K RAM in 1980.

- HMOS - I (2115A, 2125A, 2147, 2148).

  Competition should emerge in second half of 1979
  Hitachi is the biggest near-term threat

- HMOS II can now compete fully with bipolar T^2L.

- HMOS II 16K RAM introduction in 1980.

Special Products (Nonvolatile Memory, Bipolar, Telecommunications) - George Schneer

1. DATAQUEST estimates: $250 million in 1979, $700 million in 1983 for total EPROM revenues.

2. Expect to continue to be synergistic with the growth in microprocessors and to maintain technological leadership.

3. Relative size vs. density:

32K EPROM	1.4
16K EPROM	1.3
8K EPROM	1.2
2K EPROM	1.0

4. Bipolar PROM has achieved a 4x increase in bits in the last 4 years with a 25% increase in die size.

   - Market is $143 million in 1979 going to $254 million in 1982 (excluding General Motors).

   - Intel is piggy backing their technology on what is happening in MOS.

   - Intel is #4 or #5 in bipolar PROM market now; hopes to be #2 in 1982.

   - Intel's limit to improved bipolar market share is the commitment of capacity.

   - 16K PROM - Intel's is the fastest unit (only Signetics is shipping in volume).

Questions and Answers

1. Is 1979 a replay of 1974? - In 1974, there was a qualitative change in the business before it was evidenced in the numbers. Also, field salesmen began getting more conservative and demand accelerated just before dropping off. None of these events has occurred yet.

2. Will order shortfall be the same as 1974? Gelbach thinks that it will.

3. (Gordon Moore) - No real reason to think that industry will react any differently in a recession this time than in past recessions.

4. Fully expect fast 2147 prices to be cut dramatically over the next year. Intel will move its business into the 2147H (using HMOS II) and the 16K static RAM as this happens.

5. Intel will suffer some in a recession. However, in 1974-1975, Intel had 1 "golden goose," now it has 5-10.

6. Intel intends to continue capacity expansion in 1980 on the same trend of line growth as in past few years.

7. Intel has these and many other contingency plans if demand softens:

   - More business with auto industry

   - Build up business with customers who need more parts in 1980

- Disc market

- Bubble memory market

8. The codec business is growing as planned—no better. There are two parts to the market, transmission and local distribution. The CMOS design is really suited only for the local distribution segment. Intel's whole package with filter sells for $12-13.

9. Intel is seeing more competition from Japan in Europe than in the U.S., especially in dynamic RAMs.

10. Intel is willing to make the wafer commitment to be the #1 64K dynamic RAM producer.

11. Does Gordon Moore believe that Intel will keep 70-80 percent of the 16-bit micro market? Yes. Intel feels stronger with 8086 vs. Z8000 and 68000, than with 8080 vs. 6800.

12. If the Hitachi part (2147) is producible, it should be a strong competitive part. Intel is watching Hitachi's progress closely.

13. Intel is shipping the majority of its 16K RAMs to only about 20 customers.

14. Commercial Division IBM add-on memory, slowed by IBM announcements. Smaller than at beginning of year - but not much smaller.

15. Disc - could be a significant lease business.

16. A new Fab building in Santa Clara will be occupied in November with first wafer starts then. It replaces original facility.

17. Yields getting back to where they should be; no dramatic improvement.

DATAQUEST RESEARCH NEWSLETTER
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SIS Code: Vol. III - 2.10 Integrated Circuit Packaging

INTEGRATED CIRCUIT PACKAGING

DATAQUEST's Semiconductor Industry Service has just published a comprehensive report on integrated circuit packaging that analyzes package consumption through 1982. Subscribers to the service will find a detailed analysis in SIS Volume I, Section 2.10 dated July 30, 1979.

OVERVIEW

Historical forces have influenced the choice of package technology and the choice of pin configuration and spacing. The increasing requirement for packages with more than 40 pins is creating demand for more compact packages than can be achieved with the traditional DIP (dual in-line package) configuration. This has led to the QUIP (quad in-line package), developed by Intel and 3M, and to the chip carrier. Sometimes these packages are leadless; often a socket is used to facilitate interconnection at the next level.

The interconnection of integrated circuit packages is required if useful electronic equipment is to be constructed. Popular mounting techniques include flow-soldered printed circuit boards, electronic watch assembly, hybrid assembly, and flip-chip assembly.

PACKAGING TRENDS

The key package technologies are TO header, flatpack, ceramic DIP, CERDIP, plastic DIP, and chip carriers. Demand for CERDIP and chip carriers is seen as growing faster than total package requirements. Plastic DIPs now account for 80.7 percent of integrated circuit packages, though this share is forecast to fall to 79.5 percent in 1982; plastic technology is believed to be very active and subject to significant future technological change. In particular, copper alloy lead frames with interdigitation and silver plating are seen as cost-reduction measures. (Interdigitated lead frames use less metal because the leads of one package occupy the space between the leads of the next package.) In addition, it is possible that thermoplastics will be substituted for thermosetting plastics in some applications.

Current 1979 prices for the 14-pin DIP configurations are about 6.3¢ for plastic DIPs, 9.9¢ for CERDIP, 82¢ for ceramic DIPs, and 51¢ for the chip carrier. These prices help explain the popularity of plastic DIPs in low cost applications. These prices are for 500,000 units and up, but price adders for lower quantities are provided in the notebook section. In addition, the effect of variations in gold prices on package prices is given for CERDIP and ceramic packages.

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We estimate that package consumption by U.S. companies accounts for roughly 73 percent of world IC manufacture on a dollar volume basis. The figures provided in this report include packages that are consumed by U.S. companies, but because of assembly yield losses, are less than the numbers shipped as finished IC units.

PACKAGE CONSUMPTION

Estimates of integrated circuit package consumption in this section use U.S.-based companies as a common basis for tables . However, there are features of this market which must be taken into account when using the data. Much assembly is accomplished outside the United States, these figures of necessity include packages and package materials that are consumed overseas. Once assembly is complete, many of the finished integrated circuits are sold into foreign markets. Although consumption of the packaged integrated circuits and package materials may occur overseas, most of the purchase commitments are made in the continental United States. Finally, packages sold are necessarily less than finished semiconductor components sold because of yield losses at assembly and test.

Table I gives estimated integrated circuit package consumption by U.S. companies for 1978. On a unit-count basis, most package requirements are presently being met by the plastic DIP. Nevertheless, some of the other package types offer lucrative markets to suppliers of packages and materials because of the higher unit selling prices.

Table II shows the way in which package shipments are distributed by pin count among the various package technologies. It is interesting to note that the CERDIP and plastic DIP show a heavier concentration in the low pin counts. This is probably due to the fact that most low-cost integrated circuits have low pin counts. Because of their low cost, these circuits generally employ the low-cost CERDIP and plastic technologies. The concentration of high pin counts for the ceramic DIP reflects the use of this package in LSI applications where pin count and circuit prices tend to be higher.

Table III presents forecasted unit IC package consumption by U.S. companies for 1978 through 1982. Unit consumption is expected to show a 15.2 percent compound annual growth rate through this period. A slightly greater growth rate is anticipated for both the CERDIP and chip carrier, as indicated by their increasing share of unit consumption.

Howard Z. Bogert

TABLE I

ESTIMATED 1978 CONSUMPTION OF IC PACKAGES
BY U.S. SEMICONDUCTOR COMPANIES

Package Type	Millions of Units	Unit Share (Percent)
Plastic DIP	4,020	80.7%
CERDIP	710	14.2
Ceramic DIP	120	2.4
Flatpack	60	1.3
TO Header	50	1.0
Chip Carrier	20	0.4
Total	4,980	100.0%

Source: DATAQUEST, Inc.
July 1979

TABLE II

ESTIMATED 1978 INTEGRATED CIRCUIT PACKAGE CONSUMPTION BY U.S. COMPANIES

(Percent Share of Units by Pin Count)

Pin Count	Chip Carrier	TO Header	Flat-pack	Ceramic DIP	CERDIP	Plastic DIP
8	-	55%	-	5%	3%	12%
10	-	30	20%	-	-	1
12	-	15	-	-	-	-
14	5%	-	28	9	31	33
16	24	-	19	11	45	24
18	36	-	-	20	6	8
20	-	-	-	-	1	1
22	-	-	9	21	5	8
24	32	-	17	12	7	9
28	2	-	-	12	1	4
36	1	-	7	-	-	-
40	-	-	-	10	1	-
	100%	100%	100%	100%	100%	100%

Source: DATAQUEST, Inc.
July 1979

TABLE III

ESTIMATED U.S. INTEGRATED CIRCUIT
PACKAGE CONSUMPTION BY YEAR

	1978	1979	1980	1981	1982	Compound Annual Growth in Units
Plastic DIP	80.7%	80.9%	79.7%	79.8%	79.5%	14.2%
CERDIP	14.2	14.5	15.5	15.8	16.1	18.2%
Ceramic DIP	2.4	2.0	1.9	1.7	1.6	2.8%
Flatpack	1.3	1.0	.8	.6	.6	(3.5%)
TO Header	1.0	.9	.9	.7	.6	.9%
Chip Carrier	.4	.7	1.2	1.4	1.6	62.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	14.6%
Units (Millions)	4,980	5,781	6,400	7,454	8,598	

Source: DATAQUEST, Inc.
July 1979

DATAQUEST RESEARCH NEWSLETTER
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SIS Code: Vol. III Newsletters

GENERAL INDUSTRY UPDATE

SUMMARY

The following points should be noted:

- The U.S. economy is clearly in a downturn, if not a recession. GNP fell 3.3 percent in the second quarter of 1979.
- The rapid growth of semiconductor demand can be expected to ease significantly by the fourth quarter of this year.
- DATAQUEST believes special factors should mitigate the affects on the semiconductor industry, however, and a demand decline comparable to 1974 is not expected. We forecast only a leveling of semiconductor consumption and demand for a limited duration.
- Extreme caution is nevertheless advisable; order rates should be closely scrutinized.

U.S. semiconductor consumption for 1979 is expected to be about 26 percent higher than in 1978. This increase follows strong 1978 growth for U.S. semiconductor consumption of 22.6 percent over 1977. The extremely strong growth of semiconductor shipments in the fourth quarter of 1978, up about 11 percent over the previous quarter, and strong growth in the second quarter of this year, up about 11 percent from the first quarter, provide most of the momentum for annual 1979 growth.

- Because the true extent of the economic downturn is unknown, and because the effect of that downturn on the semiconductor industry is questionable, extreme caution is nevertheless advised. Order rates should be examined closely in the short term for an indication of true demand.
- Currently, the economic downturn has occurred in sectors of the economy not directly related to strong semiconductor usage. Capital expenditures for business equipment have remained strong, which is beneficial for the semiconductor industry.
- Factors outside the semiconductor industry's normal relationship to the economy are expected to provide semiconductor demand in the remainder of 1979 and 1980. These factors include: the effects of inflation; new markets including automotive, telecommunications, industrial products, and games; a strong military and aerospace market; outside purchases by General Motors, IBM and Western Electric; and the lowering of the value of the dollar. We do not expect the industry to enter a period of significant negative growth in the foreseeable future.

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- Greatly aided by the gasoline crisis, the economy is now in a downturn, contrary to the expectations of most economists. Historically, the semiconductor industry has followed the general economy by about two quarters. This activity occurred in 1967, 1971, and 1974, and the current extremely strong demand for semiconductors is expected to ease later this year.

RECENT ECONOMIC TRENDS

The U.S. economy declined markedly in the second quarter of 1979 after very slow growth in the first quarter. The economy was slowed by the inclement weather in the first quarter and by gasoline and oil problems in the second quarter. Thus, the economic slowdown has come somewhat earlier than expected. Additionally, with the secondary and tertiary effects of the oil price increases, there is increasing concern that the slowing of the economy may turn into either a major recession or a prolonged downturn. A moderate prolonging of the downturn appears most likely, but the effects of inflation on economic indicators make all forecasts highly questionable. There are segments of the economy that show some strength, particularly business investment. Additionally, the gross economic distortions of 1973 and early 1974 are not apparent at this time.

The following recent economic developments are noteworthy:

- The Gross National Product (GNP) declined about 3.3 percent in real terms in the second quarter of 1979, following a growth of 1.1 percent in the first quarter of 1979.

- Most forecasts for GNP growth in 1979 are in the 2 to 3 percent range.

- Retail sales in recent months have declined considerably in both current and real dollars. Lead by a decline in automobile sales due to the gasoline crisis, decreased consumer spending has been the major factor in the economic downturn. Large borrowings by consumers now are apparently being paid off.

- Inflation has been at record levels in recent months, about 1 percent a month for retail goods. It is currently the major economic concern.

- Industrial production has remained essentially level through the second quarter of this year.

- The Index of Leading Indicators has declined moderately over the last several months. This pattern indicates a current and future economic slowdown, but not a major downturn.

- Money supply spurted considerably in the second quarter of this year after declining in the first quarter, indicating that further tightening of the money supply may occur.

- Capital expenditures for business equipment remain strong. Since the recession of 1975, capital expenditures recovered slowly and still remain below historic levels relative to GNP. Because of this shortfall, capital expenditures (and related semiconductor demand) are expected to be less affected by an economic slowdown.

- Economic growth in Europe will probably be slower than anticipated because of higher oil prices. However, in 1979 the European economies are expected to moderately out-perform the U.S. economy for the first time in several years. Increased inflation in Europe has clouded the long-term economic outlook.

- The Japanese economy currently remains strong.

The slowdown of the economy is here. The problems with energy and inflation make further forecasting questionable. It is likely that these problems may prolong the downturn, if not amplify its magnitude, and the economy should be closely watched over the next several months for indications on how the downturn will develop.

SEMICONDUCTOR INDUSTRY TRENDS

U.S. semiconductor demand in the second quarter of 1979 remained extremely strong. Book-to-bill ratios have recently been running in the range of about 1.2 to 1. Indications are that bookings for early July still showed strength. The extremely strong bookings resulted from a combination of heavy demand, an increase in long-term orders, and stable and increasing prices.

Semiconductor shipments and consumption in the second quarter were up significantly over the first quarter of 1979. DATAQUEST estimates that these shipments were about 11 percent above the previous quarter. It is increasingly clear that one factor in this increase in shipments is due to pricing. For most product lines, average selling prices (ASPs) have either remained stable or increased. Significantly, ASPs for MOS integrated circuits in the second quarter of 1979 were higher than in the fourth quarter of 1978. If future demand slackens, price adjustments could hold shipments level despite increasing unit sales. However, except for a small number of individual products, we do not foresee a repeat of major price/cost discrepancies that existed in 1974. However, a continuation of price increases could pose a serious problem for the industry.

The rapid expansion of production for the industry has had concomitant cost control problems. Significantly, several manufacturers have had isolated yield busts during late 1978 and early 1979. The rapid expansion of the work force by hiring employees new to the industry has weakened normal process control. It is our belief that yields have not increased throughout the industry as might be expected under normal circumstances of more regulated growth. If demand eases, this problem should work itself out gradually during the next year. Reduced costs from higher yields will compensate for some price erosion and, as a result, profits are expected to be somewhat less affected.

The heavy semiconductor demand has produced several industry problems: device shortages, equipment shortages, price increases (as mentioned above), lack of personnel, and some double-ordering. None of these problems are at the 1974 level with the exception of the current scarcity of trained labor and engineering talent. In many cases, availability and training of personnel has been the pacing item in increasing capacity. We believe that management, so far, has been more cautious than in 1973 and 1974. As a result, excessive double-ordering of semiconductors and inventory accumulation appears to be more moderate.

It is our perception that a strong demand for semiconductors is based on very real needs and usage, and is not an illusion created by an overheated economy. Significantly, inventory levels appear moderate. New applications, new companies using semiconductors, and the use of more semiconductors in old applications are major factors in the current strong semiconductor demand. This is a more positive situation than the industry has had entering past economic slowdowns.

It is clear that the industry has been operating at capacity or in excess of comfortable capacity. The ability to increase capacity has been made more difficult by the increasing complexity of semiconductor manufacturing. More complex facilities and equipment require longer lead times. More extensive planning is required for today's high-cost facilities. Furthermore, switching from small chips to larger, more complex devices, requires an increase in wafer fab capacity even though dollar shipments remain level. Larger chips are more wafer-fab intensive. As a result, despite the rapid increase in capital expenditures of the industry in recent years, we estimate that the new facilities coming on stream are barely adequate for reasonable industry expansion. An over-capacity situation is not expected.

SEMICONDUCTOR INDUSTRY FORECAST

Table 1 gives our estimates for U.S. semiconductor consumption in dollars. We believe that in 1978, semiconductor consumption increased about 22.6 percent over 1977. For 1979, we expect semiconductor consumption to increase by about 26 percent over 1978. This increase from our previous forecast reflects the very strong performance by the industry in the second quarter of this year. Furthermore, the industry entered 1979 at a running rate significantly above the average for 1978. While integrated circuits account for the majority of the increase in semiconductor consumption, with an annual increase of an estimated 30.1 percent over 1978, the growth of discrete devices should also be significant, with an estimated growth of 16.9 percent.

Our current estimates for 1979 U.S. semiconductor consumption by calendar quarter are shown in Table 2. We expect significantly slower growth in the second half of 1979 and the first half of 1980. It should be noted that the first and third quarters are seasonally lower in consumption than the second and fourth quarters. Reflecting the economy, semiconductor shipments in the fourth quarter of this year and the first quarter of 1980 should remain essentially level, with a resumption of growth, and increasing strength, beginning in the second quarter of 1980, We expect shipments for all of 1980 to be about 8 percent above shipments for 1979.

In forecasting for 1979, we have consistently noted that factors that do not have historical precedent or relate directly to the economy could have a major positive effect on semiconductor demand. Thus far, our reasoning has proved correct, and these factors have combined to make 1979 an exceptional year for the industry. It is increasingly apparent that the cumulative effects of inflation have made semiconductors, and products using semiconductors, the best buys in town and that circumstance has spurred markets relating to the industry. We expect the following to continue to be positive elements of semiconductor demand in 1980 and beyond:

- The cumulative effects of inflation
- Major new markets—automotive, telecommunications, industrial products, and others
- The military, government, and aerospace markets
- Outside purchases by the captive semiconductor manufacturers, especially General Motors, IBM, and Western Electric
- Increased competitiveness because of the devalued dollar

These factors are helping maintain semiconductor demand in the face of a weakening economy. The advent of VLSI continues to make semiconductors cost effective in new applications. Semiconductor design in manufacturing is an increasingly scarce resource. Although a leveling of demand is expected in the short term, the secular trend appears extremely positive.

Frederick L. Zieber
Lane Mason
Ralph R. Shaddock

Table 1

ESTIMATED U.S. SEMICONDUCTOR CONSUMPTION

(Dollars in Millions)

	1977	1978	Percent Increase 1977-78	1979	Percent Increase 1978-79
Discrete Devices	$ 926	$1,019	10.0%	$1,191	16.9%
Integrated Circuits	1,784	2,304	29.1%	2,998	30.1%
Total	$2,710	$3,323	22.6%	$4,189	26.1%

Source: DATAQUEST, Inc.
August 1979

Table 2

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION

(Dollars in Millions)

	1978				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$ 233	$ 255	$ 256	$ 275	$1,019
Integrated Circuits	502	567	581	654	2,304
Total	$ 735	$ 822	$ 837	$ 929	$3,323
Change From Previous Quarter or Year	0.4%	11.8%	1.8%	11.0%	22.6%

	1979				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$ 279	$ 309	$ 304	$ 299	$1,191
Integrated Circuits	678	755	771	794	2,998
Total	$ 957	$1,064	$1,075	$1,093	$4,189
Percent Change From Previous Quarter	3.0%	11.2%	1.0%	1.7%	
Percent Change From Previous Year	30.2%	29.4%	28.4%	17.7%	26.1%

	1980	
	1st Qtr.	2nd Qtr.
Discrete Devices	$ 292	$ 294
Integrated Circuits	777	797
Total	$1,069	$1,091
Percent Change From Previous Quarter	(2.2%)	2.1%

Source: DATAQUEST, Inc.
August 1979

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Vol. III Newsletters

GENERAL INDUSTRY UPDATE

SUMMARY

The following points should be noted:

- The U.S. economy is clearly in a downturn, if not a recession. GNP fell 3.3 percent in the second quarter of 1979.
- The rapid growth of semiconductor demand can be expected to ease significantly by the fourth quarter of this year.
- DATAQUEST believes special factors should mitigate the affects on the semiconductor industry, however, and a demand decline comparable to 1974 is not expected. We forecast only a leveling of semiconductor consumption and demand for a limited duration.
- Extreme caution is nevertheless advisable; order rates should be closely scrutinized.

U.S. semiconductor consumption for 1979 is expected to be about 26 percent higher than in 1978. This increase follows strong 1978 growth for U.S. semiconductor consumption of 22.6 percent over 1977. The extremely strong growth of semiconductor shipments in the fourth quarter of 1978, up about 11 percent over the previous quarter, and strong growth in the second quarter of this year, up about 11 percent from the first quarter, provide most of the momentum for annual 1979 growth.

- Because the true extent of the economic downturn is unknown, and because the effect of that downturn on the semiconductor industry is questionable, extreme caution is nevertheless advised. Order rates should be examined closely in the short term for an indication of true demand.
- Currently, the economic downturn has occurred in sectors of the economy not directly related to strong semiconductor usage. Capital expenditures for business equipment have remained strong, which is beneficial for the semiconductor industry.
- Factors outside the semiconductor industry's normal relationship to the economy are expected to provide semiconductor demand in the remainder of 1979 and 1980. These factors include: the effects of inflation; new markets including automotive, telecommunications, industrial products, and games; a strong military and aerospace market; outside purchases by General Motors, IBM and Western Electric; and the lowering of the value of the dollar. We do not expect the industry to enter a period of significant negative growth in the foreseeable future.

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- Greatly aided by the gasoline crisis, the economy is now in a downturn, contrary to the expectations of most economists. Historically, the semiconductor industry has followed the general economy by about two quarters. This activity occurred in 1967, 1971, and 1974, and the current extremely strong demand for semiconductors is expected to ease later this year.

RECENT ECONOMIC TRENDS

The U.S. economy declined markedly in the second quarter of 1979 after very slow growth in the first quarter. The economy was slowed by the inclement weather in the first quarter and by gasoline and oil problems in the second quarter. Thus, the economic slowdown has come somewhat earlier than expected. Additionally, with the secondary and tertiary effects of the oil price increases, there is increasing concern that the slowing of the economy may turn into either a major recession or a prolonged downturn. A moderate prolonging of the downturn appears most likely, but the effects of inflation on economic indicators make all forecasts highly questionable. There are segments of the economy that show some strength, particularly business investment. Additionally, the gross economic distortions of 1973 and early 1974 are not apparent at this time.

The following recent economic developments are noteworthy:

- The Gross National Product (GNP) declined about 3.3 percent in real terms in the second quarter of 1979, following a growth of 1.1 percent in the first quarter of 1979.

- Most forecasts for GNP growth in 1979 are in the 2 to 3 percent range.

- Retail sales in recent months have declined considerably in both current and real dollars. Lead by a decline in automobile sales due to the gasoline crisis, decreased consumer spending has been the major factor in the economic downturn. Large borrowings by consumers now are apparently being paid off.

- Inflation has been at record levels in recent months, about 1 percent a month for retail goods. It is currently the major economic concern.

- Industrial production has remained essentially level through the second quarter of this year.

- The Index of Leading Indicators has declined moderately over the last several months. This pattern indicates a current and future economic slowdown, but not a major downturn.

- Money supply spurted considerably in the second quarter of this year after declining in the first quarter, indicating that further tightening of the money supply may occur.

- Capital expenditures for business equipment remain strong. Since the recession of 1975, capital expenditures recovered slowly and still remain below historic levels relative to GNP. Because of this shortfall, capital expenditures (and related semiconductor demand) are expected to be less affected by an economic slowdown.

- Economic growth in Europe will probably be slower than anticipated because of higher oil prices. However, in 1979 the European economies are expected to moderately out-perform the U.S. economy for the first time in several years. Increased inflation in Europe has clouded the long-term economic outlook.

- The Japanese economy currently remains strong.

The slowdown of the economy is here. The problems with energy and inflation make further forecasting questionable. It is likely that these problems may prolong the downturn, if not amplify its magnitude, and the economy should be closely watched over the next several months for indications on how the downturn will develop.

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U.S. semiconductor demand in the second quarter of 1979 remained extremely strong. Book-to-bill ratios have recently been running in the range of about 1.2 to 1. Indications are that bookings for early July still showed strength. The extremely strong bookings resulted from a combination of heavy demand, an increase in long-term orders, and stable and increasing prices.

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August 1979

DATAQUEST RESEARCH NEWSLETTER
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SIS Code: Vol. III - 2.10 Integrated Circuit Packaging

INTEGRATED CIRCUIT PACKAGING

DATAQUEST's Semiconductor Industry Service has just published a comprehensive report on integrated circuit packaging that analyzes package consumption through 1982. Subscribers to the service will find a detailed analysis in SIS Volume I, Section 2.10 dated July 30, 1979.

OVERVIEW

Historical forces have influenced the choice of package technology and the choice of pin configuration and spacing. The increasing requirement for packages with more than 40 pins is creating demand for more compact packages than can be achieved with the traditional DIP (dual in-line package) configuration. This has led to the QUIP (quad in-line package), developed by Intel and 3M, and to the chip carrier. Sometimes these packages are leadless; often a socket is used to facilitate interconnection at the next level.

The interconnection of integrated circuit packages is required if useful electronic equipment is to be constructed. Popular mounting techniques include flow-soldered printed circuit boards, electronic watch assembly, hybrid assembly, and flip-chip assembly.

PACKAGING TRENDS

The key package technologies are TO header, flatpack, ceramic DIP, CERDIP, plastic DIP, and chip carriers. Demand for CERDIP and chip carriers is seen as growing faster than total package requirements. Plastic DIPs now account for 80.7 percent of integrated circuit packages, though this share is forecast to fall to 79.5 percent in 1982; plastic technology is believed to be very active and subject to significant future technological change. In particular, copper alloy lead frames with interdigitation and silver plating are seen as cost-reduction measures. (Interdigitated lead frames use less metal because the leads of one package occupy the space between the leads of the next package.) In addition, it is possible that thermoplastics will be substituted for thermosetting plastics in some applications.

Current 1979 prices for the 14-pin DIP configurations are about 6.3¢ for plastic DIPs, 9.9¢ for CERDIP, 82¢ for ceramic DIPs, and 51¢ for the chip carrier. These prices help explain the popularity of plastic DIPs in low cost applications. These prices are for 500,000 units and up, but price adders for lower quantities are provided in the notebook section. In addition, the effect of variations in gold prices on package prices is given for CERDIP and ceramic packages.

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We estimate that package consumption by U.S. companies accounts for roughly 73 percent of world IC manufacture on a dollar volume basis. The figures provided in this report include packages that are consumed by U.S. companies, but because of assembly yield losses, are less than the numbers shipped as finished IC units.

PACKAGE CONSUMPTION

Estimates of integrated circuit package consumption in this section use U.S.-based companies as a common basis for tables . However, there are features of this market which must be taken into account when using the data. Much assembly is accomplished outside the United States, these figures of necessity include packages and package materials that are consumed overseas. Once assembly is complete, many of the finished integrated circuits are sold into foreign markets. Although consumption of the packaged integrated circuits and package materials may occur overseas, most of the purchase commitments are made in the continental United States. Finally, packages sold are necessarily less than finished semiconductor components sold because of yield losses at assembly and test.

Table I gives estimated integrated circuit package consumption by U.S. companies for 1978. On a unit-count basis, most package requirements are presently being met by the plastic DIP. Nevertheless, some of the other package types offer lucrative markets to suppliers of packages and materials because of the higher unit selling prices.

Table II shows the way in which package shipments are distributed by pin count among the various package technologies. It is interesting to note that the CERDIP and plastic DIP show a heavier concentration in the low pin counts. This is probably due to the fact that most low-cost integrated circuits have low pin counts. Because of their low cost, these circuits generally employ the low-cost CERDIP and plastic technologies. The concentration of high pin counts for the ceramic DIP reflects the use of this package in LSI applications where pin count and circuit prices tend to be higher.

Table III presents forecasted unit IC package consumption by U.S. companies for 1978 through 1982. Unit consumption is expected to show a 15.2 percent compound annual growth rate through this period. A slightly greater growth rate is anticipated for both the CERDIP and chip carrier, as indicated by their increasing share of unit consumption.

Howard Z. Bogert

TABLE I

ESTIMATED 1978 CONSUMPTION OF IC PACKAGES
BY U.S. SEMICONDUCTOR COMPANIES

Package Type	Millions of Units	Unit Share (Percent)
Plastic DIP	4,020	80.7%
CERDIP	710	14.2
Ceramic DIP	120	2.4
Flatpack	60	1.3
TO Header	50	1.0
Chip Carrier	20	0.4
Total	4,980	100.0%

Source: DATAQUEST, Inc.
July 1979

TABLE II

ESTIMATED 1978 INTEGRATED CIRCUIT PACKAGE CONSUMPTION BY U.S. COMPANIES

(Percent Share of Units by Pin Count)

Pin Count	Chip Carrier	TO Header	Flat-pack	Ceramic DIP	CERDIP	Plastic DIP
8	-	55%	-	5%	3%	12%
10	-	30	20%	-	-	1
12	-	15	-	-	-	-
14	5%	-	28	9	31	33
16	24	-	19	11	45	24
18	36	-	-	20	6	8
20	-	-	-	-	1	1
22	-	-	9	21	5	8
24	32	-	17	12	7	9
28	2	-	-	12	1	4
36	1	-	7	-	-	-
40	-	-	-	10	1	-
	100%	100%	100%	100%	100%	100%

Source: DATAQUEST, Inc.
July 1979

TABLE III

ESTIMATED U.S. INTEGRATED CIRCUIT
PACKAGE CONSUMPTION BY YEAR

	1978	1979	1980	1981	1982	Compound Annual Growth in Units
Plastic DIP	80.7%	80.9%	79.7%	79.8%	79.5%	14.2%
CERDIP	14.2	14.5	15.5	15.8	16.1	18.2%
Ceramic DIP	2.4	2.0	1.9	1.7	1.6	2.8%
Flatpack	1.3	1.0	.8	.6	.6	(3.5%)
TO Header	1.0	.9	.9	.7	.6	.9%
Chip Carrier	.4	.7	1.2	1.4	1.6	62.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%	14.6%
Units (Millions)	4,980	5,781	6,400	7,454	8,598	

Source: DATAQUEST, Inc.
July 1979

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: 8.08 National Semiconductor Corporation

UPDATE ON NATIONAL SEMICONDUCTOR

SUMMARY

National Semiconductor Corporation (NSC) should continue to grow rapidly in fiscal 1980 (ending May 31), with sales increasing 28 percent to about $920 million and earnings growing 28 percent to $3.30 per share. The performance of the Semiconductor Division is expected to more than compensate for revenue and earnings declines in the Computer Systems Group, which has been hurt by the introduction of IBM's 4300 series. We perceive that the Company is currently reaping the rewards of a major commitment to improving its technological and manufacturing base in semiconductors. Important Company developments include:

- The Company has tempered its computer thrust, and we believe potential risks are limited.
- National is presently in production with its first XMOS product (reduced minimum dimensions), the 2147 fast 4K static RAM. If successful, it will be the second company in the industry in production in this extremely profitable high-density sector.
- Other major areas of technical effort include 16-bit and CMOS microprocessors, bipolar LSI, ECL, magnetic bubbles, and linear ICs.
- National participated significantly in the General Motors business recently released. Depending upon performance, it could be a major participant in this business.
- NSC has significantly upgraded its image with customers, and now ranks high in terms of meeting allocations, reliability, and delivery consistency.
- We believe a substantial debt agreement in the current quarter will ease financial constraints.

CORPORATE

National's sales are expected to grow about 28 percent in fiscal 1980 to $920 million. An estimated breakout of revenues and earnings by major division is shown in Table 1.

Due to its rapid growth and moderate margins, National has always been underfinanced. Currently, the Company has more growth opportunities than it can finance internally. We believe the Company will take on a substantial debt agreement with a major insurance company this year; it does not currently plan to finance growth through the sale of equity or through further joint arrangements with foreign firms.

We believe that the addition of Pierre Lamond to the Office of General Manager of the Semiconductor Division has had a major effect on National's organization and has been a catalyst in improving the Company's technological base.

Margin Analysis

We expect the contribution from the Computer Systems Group to decline from about $0.60 per share in fiscal 1979 to about $0.10 per share in fiscal 1980. Strong revenue growth and good margin expansion in semiconductors should more than offset this decline. Much of this expansion was already evident in fourth quarter operating rates. Paralleling the expected revenue increase, Company earnings are also expected to grow about 28 percent in fiscal 1980 to $3.30 per share.

In fiscal 1980, DATAQUEST estimates that semiconductors should account for 90 percent of operating profits at National Semiconductor. If this situation occurs, concerns about its other businesses would properly diminish.

SEMICONDUCTOR GROUP

National has always been considered one of the top production houses in the semiconductor industry. Successful implementation of its development efforts in semiconductors would enhance its technological position as well and thereby greatly improve its potential margins in its basic business.

National has made a substantial investment in component manufacturing and technology over the past two years and these efforts are starting to bear fruit. The most significant technical development may well be a 70-nanosecond 4K static RAM--NSC's first product with reduced dimensions. DATAQUEST believes this product is now entering a production mode, as discussed more fully in the section on memory.

In the past two years, the Company has had a major program to upgrade manufacturing and reliability. This program has apparently been quite successful. In surveying major semiconductor users, we found that NSC ranked high in its ability to deliver product during the current shortage situation. This image has not always existed in the past, and it has important positive implications for future customer relations.

The improved delivery ability is also indicative of increased control over production. NSC has been singularly successful in the past year in increasing integrated circuit production. Increased output in wafer fabrication has been provided primarily from Scotland and Utah. Increased efficiency and automation in overseas assembly has resulted in about a 40 percent increase in units produced with virtually no increase in overhead. The current attention to manufacturing costs supports our optimism for increased margins.

Table 1

National Semiconductor Corporation

SALES AND EARNINGS FORECASTS [1]

(Dollars in Millions)

	1978[2]			1979 (Estimate)			1980 (Estimate)		
	Sales	Operating Profits	Operating Margins	Sales	Operating Profits	Operating Margins	Sales	Operating Profits	Operating Margins
Semiconductors	$327	$35.9	10%	$497	$51.0	10%	$730	$87.5	12.0%
Computer Systems	75	9.0	12	125	18.0	14	75	4.0	6.0
POS	44	2.0	4	53	2.5	5	70	4.0	6.0
Consumer	48	0	0	45	1.5	4	45	1.5	4.0
Total	$494	$46.9	9.5%	$720[3]	$73.0	10.2%	$920	$97.0	10.5%
General Coporate Expenses		$ 4.3			$ 5.0			$ 6.0	
Interest Expense		$ 1.9			$ 5.7			$ 9.0	
Pretax Income		$40.6	8.2%		$62.3[3]	8.7%		$82.0	8.9%
Tax Rate		44.6%			45.0%			46.0%	
Net Income		$22.5	4.6%		$34.3[3]	4.8%		$44.0	4.8%
Average Shares Outstanding (Millions)		13.1			13.2[3]			13.3	
Earnings Per Share		$ 1.72			$ 2.57[3]			$ 3.30	

[1] Fiscal year ending May 31

[2] The group sales figures for fiscal 1978 do not agree with those in our January 24, 1979, newsletter on National Semiconductor. In prior newsletters we reported revenues based on the actual organization of groups at National, while in the above table we are conforming to numbers published by the Company in its Annual Report.

[3] Actual

Source: DATAQUEST, Inc.
July 1979

DATAQUEST estimates a 48 percent gain in semiconductor shipments in fiscal 1979 over 1978 to $540 million (before intracompany eliminations), and we are forecasting a 43 percent gain in revenues to $770 million in fiscal 1980. This is more than our forecast of semiconductor industry growth over this period and reflects several factors.

- National is starting fiscal 1980 with a much higher level of shipment capacity than a year ago. The Greenock, Scotland, fire cost National $40-50 million in lost revenues in fiscal 1979. Since it is using 4-inch wafers, the current potential dollar volume of the plant is higher than before the fire.

- The Utah wafer fabrication facility can significantly expand capacity.

- Because of rapid revenue growth in fiscal 1979, the Company is entering fiscal 1980 with operating rates significantly above 1979 levels. DATAQUEST estimates that National's semiconductor shipments in the fourth quarter of fiscal 1979 were at a $670 annual rate (after eliminations). Our semiconductor forecast for fiscal 1980 therefore implies 10 percent average growth from present shipment levels.

- New product introduction activities, in our opinion, justify an optimistic revenue forecast.

Semiconductor margins should definitely trend higher in fiscal 1980, aided by good profit levels from Greenock and higher price realization from market strength and new products. Table 2 shows estimated Semiconductor Group revenues by major product type. A discussion of each sector of the group follows, with highlights of new product development efforts.

Memory

This product area has been a source of intense concentration for National during the past few years, and the results of the Company's efforts are starting to become evident. DATAQUEST believes that National is now commencing volume production of its first product to use XMOS (3-3½ micron line geometry), a 70-nanosecond 2147 static RAM. Shipments of the 2147-3 (55 nanoseconds) are expected by DATAQUEST in September.

If the 2147 effort is successful, National would be the second company in the industry (after Intel) to put the 3-micron technology into production. It would open up lucrative markets to the Company, particularly if pricing on more standard memory products weakens in the coming year. For example, National is believed to have a single power supply 16K dynamic RAM in design that uses this process.

Other new products of note include:

- A target date of January 1980, for samples of a 64K dynamic RAM. This part will use a triple poly 3½ micron line width process and is expected to produce a very small die.

- A 4Kx8 quasi-static RAM, similar to the Zilog part, should be available in October 1979.

Table 2

National Semiconductor Corporation

ESTIMATED REVENUES OF THE SEMICONDUCTOR GROUP—1978-1980

(Dollars in Millions)

	Fiscal Year 1978[1]	Fiscal Year 1979	Fiscal Year 1980
Semiconductor Group:			
Memory	$ 40	$ 80	$150
Microprocessors	10	20	30
MOS LSI	40	45	50
Total MOS	$ 90	$145	$230
Bipolar Digital	$ 85	$120	$180
Linear	$ 87	$120	$170
Hybrid	$ 15	$ 30	$ 35
Discrete	$ 27	$ 35	$ 35
Special Products:[2]			
Optoelectronics	$ 15	$ 20	$ 25
Modules	10	20	30
Watch Modules	20	30	40
Dynacraft	15	20	25
Total	$364	$540	$770
Less: Intracompany Eliminations	(37)	(43)	(40)
Net	$327	$497	$730

[1] Fiscal year ending May 31
[2] Includes Dynacraft - a change from previous format

Source: DATAQUEST, Inc.
July 1979

- A 16K EPROM is currently being sampled. DATAQUEST expects National to be in production by the second quarter of fiscal 1980.

- A 32K EPROM should be sampled in December 1979.

- 2141 and 2142 4K statics are currently being sampled.

Like other suppliers, National is wafer fabrication limited. It is expected to divert wafer starts away from the lower priced commodity memories to newer parts, such as those listed above, which have higher selling prices.

Microprocessors

Progress in microprocessors has lagged behind other areas and National is now investing heavily to catch up. DATAQUEST estimates that the Company has about 50 professionals working on its 16-bit microprocessor project; the part will be called the NS-16000. We believe that this microprocessor will be able to utilize existing 8080 family software.

In the meantime, National, which has supported the Intel 8080 family vigorously with a wide range of peripherals, will be adding products to its 8-bit line: an 8049 single-chip microcomputer (using XMOS processing) to be sampled in July; and an 8050 8-bit microcomputer to be sampled in August. In the fourth quarter, National is expected to sample a CMOS version of the 8048 microcomputer, which employs a high density process called P^2CMOS, presumably employing double-layered polysilicon. A CMOS version of the Z80, but with 5 percent of the power, is also expected within six months, including peripheral devices. Clearly, National is making a major commitment to CMOS LSI, a market currently in the formative stages.

Shipments of IMP and PACE processors are believed to have leveled, while semiconductor microprocessor shipments continue to ramp. Demand for the COPS products are high, with backlogs exceeding six months.

Linear

National is currently the industry leader in the linear market. This market has paralleled the MOS market in growth in recent years. DATAQUEST expects NSC's strong position to become even stronger in the future. Its current Bi-FET and linear CMOS products give the Company a strong product position, especially in the rapidly expanding data acquisition market. Its new analog-to-digital converters (A/Ds) are proving popular.

Substantial product introductions are being made in this traditional area of National strength:

- Adjustable 3 amp and 5 amp voltage regulators. The advantage here is that several products can take the place of 20 to 25 products specified at particular voltages.

- A 10-bit digital-to-analog converter (DAC) is being shipped.

- An 8-bit A/D microprocessor-compatible converter is currently going into production.

- The LM-10—the new Widlar amplifier—operating from 1.5 to 20 volts power supply, is receiving good acceptance in the marketplace.

Bipolar Digital

Revenues in this product area are expanding rapidly due to the coincidence of product shortage in the market and rapidly expanding capacity at National. The Company has a full line (4-inch) devoted to LS TTL in Greenock, Scotland, and we understand that it is ramping its shipments at the rate of 10 percent per month. Significantly, the market leader—Texas Instruments—has recently raised prices for LS TTL.

Product development has been at a high level, with effort increasingly being focused on large chips. Additionally, NSC has been mapping its entry into the ECL market. Significant new product developments are:

- In a major new market entry, the Fairchild F100K will be second-sourced with a product offering of 10 to 15 parts.

- ECL—a 256x1 ECL RAM is now available. A 1Kx1 RAM is currently being sampled. DATAQUEST anticipates a 4K RAM within six months.

- 8K bipolar PROMs are now in production; DATAQUEST anticipates a 16K PROM by the end of the year. National is participating in the General Motors' PROM business which could be a large incremental piece of business for National in fiscal 1980.

- DATAQUEST anticipates National introducing product in the bipolar RAM area in this next fiscal year.

- Five new 2900 series parts are expected to be introduced this year.

Other Semiconductor Products

Other Semiconductor Group products at National cover a rather large business base. These include:

Hybrids: National is building laser-trimmed active filters, sample and hold circuits, and fast-rise time amplifiers.

Modules: Modules include LCD travel alarms, toys and games products, appliance controllers, trip computers, other automotive products, and transducers.

Optoelectronics: The focus in optoelectronics is on higher efficiency lamps and digits, and intelligent displays (pioneered by Litronix). We are observing applications where combining optoelectronics and linear technology is producing displays such as bar graphs, etc.

Bubbles: A year ago, National launched a major effort into this area. Currently, the group has 20 plus professionals and support staff. The 256K-bit memory is expected to be sampled and go into board products as the year moves along. We expect to see sales in the fourth calendar quarter. We are looking for National to introduce a 1-megabit bubble memory in mid-1980 with appropriate support circuitry.

Dynacraft: This division has three major areas of business; gold-plated lead frames, epoxy powders, and wafer fabrication chemicals. The lead frame business is the largest segment of this group and has an estimated annual revenues of about $12-13 million. We believe that about 40 percent is absorbed internally into National.

Telecommunications: A one-chip filter is announced for September, to be followed by a codec in December.

COMPUTER PRODUCTS GROUP

DATAQUEST revenue projections for the Computer Products Group are shown in Table 3. The well-published difficulties relating to shipments of IBM plug-compatible computers make projections for this group difficult. At this juncture, DATAQUEST believes that:

- Significant shipments to Itel are still continuing. Nevertheless, large systems revenues are expected to drop by over 50 percent in fiscal 1980, and large systems profits will drop by a greater percentage.

- Total group operating profit margins could approximate 5 percent in fiscal 1980, aided by improved earnings from general systems and a possible improvement in profits from microcomputer systems.

Large Systems

Although the details of the OEM agreement with Itel have never been made public, it is DATAQUEST's understanding that Itel's contractual obligations with National are scheduled to decline materially after the end of calendar 1979. We expect shipments of large computers to Itel to be heavily skewed toward the first half of fiscal 1980. Even in the first half, these shipments should run somewhat below year-earlier levels.

National's future efforts in the large systems business will apparently be heavily direct-sales oriented. With the recent decision to drop development of the DEC PDP-11/34 Compatible System/200, the direct sales effort should be concentrated on two products, the System/400 (compatible with the IBM 370/138) and the NS 8500 (a modified AS-5 compatible with the IBM 370/148). Test marketing of both machines will begin in the first half of fiscal 1980 in five cities. We believe National is going to introduce a 3033 plug-compatible computer in its second quarter. Availability of this product would be of major assistance to Large Systems in the second half of fiscal year 1980.

Currently Large Systems and General Systems have fewer than 25 direct sales personnel. However, these groups benefit also from more than 350 sales and service personnel in the POS group.

The major concern regarding National's large systems effort revolve around its level of profitability in fiscal 1980 and possible write-offs. We observe the following:

- DATAQUEST estimates that $15-20 million in Itel receivables were on the National balance sheet at the end of fiscal 1979. At present, we anticipate no problems with these receivables.

Table 3

National Semiconductor Corporation

ESTIMATED REVENUES OF THE COMPUTER PRODUCTS GROUP—1979-1980
(Dollars in Millions)

	Fiscal Year 1978[1]	Fiscal Year 1979	Fiscal Year 1980
Large Systems	$42	$ 95	$35
General Systems	18	15	20
Memory Systems	8	5	5
Microcomputer Systems	7	10	20
Intragroup	-	-	(5)
Total	$75	$125	$75

[1]Fiscal year ending May 31

Source: DATAQUEST, Inc.
July 1979

- We estimate division inventories at $10 million, but a good portion of this is for computers deliverable to Itel in the first half.

- With the potential problems in Large Systems, we believe the division can operate in the black in fiscal 1980, but significantly below average corporate margins. We believe that the risk to National in terms of future write-offs is in the range of $5 million pretax ($0.20 per share).

General Systems

Marketing efforts of General Systems (IBM add-on memory) are now almost entirely in the hands of 25 direct sales people, since National lost all of its OEM customers once the decision to go to direct sales was made. General Systems suffered an order hiatus along with the rest of the industry after the introduction of lower pricing by IBM, but we believe that orders have picked up substantially beginning in the fourth quarter of fiscal 1979. National is concentrating heavily on the 370/168 add-on business, offering 8- and 16-megabyte versions incorporating lower cost 16K RAMs. We expect its 303X computer add-ons to switch from 4K statics to 16K dynamics during the year. The first 16K unit is at beta site, i.e., field testing. We believe that General Systems can moderately improve margins on flat sales during fiscal 1980.

Microcomputer Systems

The growth of Microcomputer Systems over the past several years has been slower than National had planned. We believe that this area will benefit from National's general upgrading in technology. The Starplex Microcomputer Development System (MDS), which was introduced in the last year, is currently able to work with the 8085 microprocessor, but not the 8086. We believe that somewhat more than 200 Starplex systems have been shipped since introduction. The unit was very well received in Europe and enjoyed an initial surge in sales, which later settled. It is our belief that sales have been stronger lately.

We understand that National has more than 70 board-level computer configurations, of which almost half are proprietary. This selling and application effort must pay off to realize our $20 million revenue forecast for Microcomputer Systems for fiscal 1980. This group should also benefit from the introduction of the various microcomputers that National is planning. We believe that this group was unprofitable in fiscal 1979.

Memory Systems

This small group has had a difficult time getting itself started. It is our understanding that it has left the custom memory business and is concentrating on DEC and Data General add-on memory with a selected number of customers. We do not believe that the group is profitable at its current range of sales, and we do not expect profitability in fiscal 1980.

POS

National's position in the point-of-sale (POS) market is well established. It is the number two contender in the grocery point-of-sale market and has made excellent penetration at all accounts, with the exception of Safeway. It is our understanding that Safeway is taking six systems in Northern California for trial. Notwithstanding the problems at Safeway, National's growth in POS has been rapidly accelerating; a substantial investment in software has been made and is now paying off. The system selling most actively is the mid-range system consisting of a scanner, a register, and an in-store computer.

National's POS business should be capacity constrained in fiscal 1980. The Company plans to erect a new building in Santa Clara this year to alleviate the problem. Manufacturing margins in the POS Group have been good, but losses on the service business have limited total POS profitability. Margin improvement is expected to be limited by new production development and by the cost of the Santa Clara expansion.

CONSUMER

National's consumer business has settled into a build-to-order watch/calculator business. National is currently negotiating with a Far Eastern manufacturer to assemble its own thin-line calculator. This business has had a new General Manager appointed. DATAQUEST projects slightly higher consumer sales in fiscal 1980, with some improvement in margins possible. The low margins from this group do not take transfer prices into account. Substantial profits are gained by other groups supplying parts for the consumer business. Thus, this group's contribution to the Company is understated.

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DATAQUEST RESEARCH NEWSLETTER
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ESTIMATED MOS MICROPROCESSOR CONSUMPTION

Summary

DATAQUEST estimates that worldwide consumption of multichip microprocessors plus associated peripherals and I/O circuits should grow from an estimated $291 million in 1979 to $1,120 million by 1983 (see Table 1). Of this total, the multichip microprocessor CPUs represent an estimated $90 million in 1979, and are expected to grow to $331 million in 1983.

Single-chip microcomputers are becoming an increasingly important market. We estimate that consumption of single-chip microcomputer CPUs represents $115 million in 1979 and anticipate growth to $351 million in 1983. Peripherals and I/O circuits associated with single-chip microcomputers remain a small segment of that market.

RAM, ROM, and EPROM memory chips associated with microprocessor applications represent an important end use for MOS memory. We expect about $385 million of MOS memory to be consumed in microprocessor applications in 1979. This total should grow to about $1.5 billion by 1983.

Worldwide Totals

Table 1 presents summary numbers for microprocessor and microcomputer consumption by units and dollars as well as dollars for peripheral, I/O, and memory circuits associated with microprocessor applications. This table summarizes the details that are presented in Tables 2 through 4.

Consumption of microprocessor CPUs is expected to grow in both units and dollars through 1983. The compound annual growth rate for microprocessor consumption expressed in units and dollars is forecast at 36 and 38 percent, respectively. Peripheral and I/O circuit consumption for use with microprocessors is estimated at $201 million for 1979, growing at an estimated compound annual growth rate of 41 percent to about $789 million by 1983. Consumption of MOS RAMs, ROMs, and EPROMs associated with microprocessors is estimated at $382 million in 1979, growing to about $1.5 billion by 1983, which represents a compound annual growth rate of 40 percent.

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Consumption of single-chip microcomputers is expected to grow dramatically from 42 million units with a shipped value of $115 million in 1979 to almost 190 million units valued at about $350 million by 1983. Very few peripheral, I/O, or memory circuits are expected to be used with these single-chip microcomputers.

The nonzero figures represent our estimate that a few applications will use a peripheral or memory chip in addition to the microcomputer. The combined total microprocessor and microcomputer consumption is estimated at $205 million in 1979, growing to $682 million by 1983. The combined total consumption of peripheral and I/O circuits is estimated at $206 million in 1979, growing to $813 million by 1983. Hence, the estimated total of CPU, peripheral, and I/O circuits is growing from $411 million in 1979 to almost $1.5 billion by 1983. When associated memories are combined in the grand total the market reaches an estimated $796 in 1979 and is forecast to grow about $3.0 billion by 1983.

Microprocessor Consumption

Table 2 presents DATAQUEST's estimates of worldwide consumption of multichip microprocessors plus associated peripheral and I/O circuits. Consumption of multichip microprocessors is expected to grow in the 8-, 16-, and 32-bit categories. The 4-bit category has been declining and it is expected to disappear in the early 1980s.

As indicated in the table, we expect to see the first 32-bit microprocessors by 1981. Because of the complexity and computing power of these microprocessors, consumption growth in units is not expected to be as rapid as it has been for 8- and 16-bit microprocessors. However, because of the high ASPs of the 32-bit microprocessors, the market in dollars should eventually become a significant part of the microprocessor market.

Average selling prices for microprocessors generally follow semiconductor experience curves of 70 to 80 percent. In other words, the average selling price declines to 70 to 80 percent of the former price for a doubling of cumulative unit volume. The average selling price shown in Tables 2 and 3 follow this learning curve. Dollars associated with microprocessor CPU chips themselves are expected to grow at exceptional rates. They are expected to go from an estimated $90 million in 1979 to about $331 million by 1983, representing a compound annual growth rate of 38 percent.

The peripheral and I/O circuits associated with these microprocessors is a dollar market that is more than double that for the CPU chips themselves. The peripheral and I/O circuits category also includes any specialized memory that is especially configured for use with a microprocessor. The memory combo chip that combines RAM or ROM memory with I/O capability is one such example. We expect 1979 peripheral and I/O consumption to be $201 million, growing to $789 million by 1983. Therefore, the grand total for CPU, peripheral, and I/O chips should grow from $291 million in 1979 to about $1,120 million by 1983.

Single-Chip Microcomputers

Table 3 presents our estimates of single-chip microcomputer consumption. The strong growth of 4-bit microcomputers is expected to continue through the early 1980s. The market for 8-bit microcomputers is still in its early stages, but is growing rapidly to eventually become the largest segment of the microcomputer market. We expect to see only a limited number of 16-bit microcomputers. The total consumption of microcomputers should grow from $115 million in 1979 to about $351 by 1983.

Some microcomputers are not designed to accommodate any peripheral or I/O circuits, but others can use them. Peripheral and I/O circuits for use with microcomputers are forecast to account for a limited number of dollars, estimated at $5 million in 1979 and growing to about $24 million by 1983.

Memory Consumption with Microprocessors

For multichip microprocessors, associated RAM, ROM, and EPROM memory represents a significant number of dollars. Table 4 presents our estimates of memory consumption associated with multichip microprocessors. This total is expected to grow from $382 million in 1979 to about $1.5 billion in 1983.

The estimate for memory used with 8-bit microprocessors is based upon the following assumptions. Eighty to 90 percent of the 8-bit microprocessors use less than 16K bytes of ROM memory and less than 4K bytes of RAM memory. However, the usage is increasing so that ROM usage is growing toward 32K bytes and RAM usage is moving toward 8K and 16K bytes.

The estimate for memory use with 16-bit microprocessors is based upon the following assumptions. The older families have about 80 percent of the applications using less than 20K bytes total memory, with about 75 percent ROM and 25 percent RAM. The balance of the applications use up to 128K bytes of memory. Above 32K bytes, the split between ROM and RAM goes to more than 80 percent RAM. The newer 16-bit microprocessor families are expected to have about 50 percent of the applications using less than 64K bytes, with about the same split of 75 percent ROM and 25 percent RAM. However, these applications have an estimated 40 percent of the applications using 64K to 256K bytes of memory, with the balance of the distribution going out as far as 8M bytes. These applications above 64K bytes are very RAM-intensive, with the number of ROM bytes used remaining essentially flat, as peripherals such as floppy discs are then used to store program memory.

Daniel L. Klesken
Lane Mason

Table 1

ESTIMATED MICROPROCESSOR CONSUMPTION

(Millions of Dollars)

	1977	1978	1979	1980	1981	1982	1983	Compound Annual Growth Rate 1979-1983
Microprocessors (Multichip)								
CPUs (Millions of Units)	4.6	8.4	14.6	21.2	30.2	39.8	49.8	36%
CPUs (Millions of Dollars)	$ 42	$ 61	$ 90	$ 140	$ 204	$ 263	$ 331	38%
Peripheral & I/O Circuits	93	133	201	302	450	605	789	41%
Subtotal	$135	$194	$291	$ 442	$ 654	$ 868	$1,120	40%
Memory	174	256	382	543	778	1,087	1,477	40%
Total	$309	$450	$673	$ 985	$1,432	$1,955	$2,597	40%
Microcomputers (Single-Chip)								
CPUs (Millions of Units)	3.8	17.4	42.1	81.5	121.2	156.5	189.0	46%
CPUs (Millions of Dollars)	$ 12	$ 50	$115	$ 199	$ 253	$ 312	$ 351	32%
Peripheral & I/O Circuits	0	1	5	12	15	21	24	48%
Subtotal	$ 12	$ 51	$120	$ 211	$ 268	$ 333	$ 375	33%
Memory	0	1	3	8	11	14	19	59%
Total	$ 12	$ 52	$123	$ 219	$ 279	$ 347	$ 394	34%
Microprocessors + Microcomputers								
CPUs (Millions of Units)	8.4	25.8	56.7	102.7	151.4	196.3	238.8	43%
CPUs (Millions of Dollars)	$ 54	$112	$205	$ 339	$ 457	$ 575	$ 682	35%
Peripheral & I/O Circuits	93	134	206	314	465	626	813	41%
Subtotal	$147	$246	$411	$ 653	$ 922	$1,201	$1,495	38%
Memory	174	257	385	551	789	1,101	1,496	40%
Total	$321	$503	$796	$1,204	$1,711	$2,302	$2,991	39%

Source: DATAQUEST, Inc.
June 1979

Table 2

ESTIMATED MULTICHIP MICROPROCESSOR CONSUMPTION

	1977	1978	1979	1980	1981	1982	1983
Microprocessors (Millions of Units)							
4-Bit	0.4	0.4	0.3	0.2	0.15	0.10	N/A[1]
8-Bit	4.0	7.6	13.5	19.0	25.0	31.0	35.0
16-Bit[2]	0.2	0.39	0.75	1.4	3.2	5.0	7.0
16-Bit[3]	N/A	0.01	0.07	0.6	1.8	3.6	7.5
32-Bit	N/A	N/A	N/A	N/A	0.01	0.1	0.3
Total	4.6	8.4	14.62	21.2	30.16	39.8	49.8
Average Selling Price							
4-Bit	$ 4.00	$ 3.00	$ 2.50	$ 2.10	$ 1.85	$ 1.65	N/A
8-Bit	$ 8.00	$ 6.00	$ 4.75	$ 3.90	$ 3.30	$ 2.90	$ 2.65
16-Bit[2]	$40.00	$ 32.00	$ 24.00	$17.00	$ 12.00	$ 8.00	$ 6.00
16-Bit[3]	N/A	$150.00	$105.00	$70.00	$ 45.00	$ 32.00	$ 21.00
32-Bit	N/A	N/A	N/A	N/A	$240.00	$180.00	$125.00
Microprocessors ($ Millions)							
4-Bit	$ 2	$ 1	$ 1	$ 0	$ 0	$ 0	$ 0
8-Bit	32	46	64	74	83	90	93
16-Bit[2]	8	12	18	24	38	40	42
16-Bit[3]	0	2	7	42	81	115	158
32-Bit	0	0	0	0	2	18	38
Total	$ 42	$ 61	$ 90	$ 140	$ 204	$ 263	$ 331
Peripherals and I/O ($ Millions)							
4-Bit	$ 4	$ 2	$ 2	$ 0	$ 0	$ 0	$ 0
8-Bit	77	110	154	185	216	243	260
16-Bit[2]	12	18	27	41	68	80	97
16-Bit[3]	0	3	18	76	162	242	348
32-Bit	0	0	0	0	4	40	84
Total	$ 93	$ 133	$ 201	$ 302	$ 450	$ 605	$ 789
Microprocessors + Peripherals and I/O ($ Millions)							
4-Bit	$ 6	$ 3	$ 3	$ 0	$ 0	$ 0	$ 0
8-Bit	109	156	218	259	299	333	353
16-Bit[2]	20	30	45	65	106	120	139
16-Bit[3]	0	5	25	118	243	357	506
32-Bit	0	0	0	0	6	58	122
Total	$ 135	$ 194	$ 291	$ 442	$ 654	$ 868	$ 1,120

[1] N/A = Product not available
[2] Older products with direct addressing capability less than 128K bytes
[3] Newer products with direct addressing capability up to 8M bytes

Source: DATAQUEST, Inc.
June 1979

Table 3

ESTIMATED SINGLE-CHIP MICROCOMPUTER CONSUMPTION

	1977	1978	1979	1980	1981	1982	1983
Microcomputers (Millions of Units)							
4-Bit	3.7	16.0	35.0	60.0	85.0	100.0	115.0
8-Bit	0.1	1.4	7.0	21.0	35.0	54.0	70.0
16-Bit	N/A	N/A	0.1	0.5	1.2	2.5	4.0
Total	3.8	17.4	42.1	81.5	121.2	156.5	189.0
Average Selling Price							
4-Bit	$ 2.80	$ 2.25	$ 1.70	$ 1.35	$ 1.15	$ 1.05	$ 1.00
8-Bit	$15.00	$10.00	$ 7.25	$ 5.00	$ 3.80	$ 3.25	$ 2.85
16-Bit	N/A	N/A	$40.00	$25.00	$18.00	$12.50	$ 9.00
Microcomputers ($ Millions)							
4-Bit	$ 10	$ 36	$ 60	$ 81	$ 98	$ 105	$ 115
8-Bit	2	14	51	105	133	176	200
16-Bit	0	0	4	13	22	31	36
Total	$ 12	$ 50	$ 115	$ 199	$ 253	$ 312	$ 351
Peripheral + I/O							
4-Bit	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
8-Bit	0	1	5	11	13	18	20
16-Bit	0	0	0	1	2	3	4
Total	$ 0	$ 1	$ 5	$ 12	$ 15	$ 21	$ 24
Microcomputers + Peripherals + I/O ($ Millions)							
4-Bit	$ 10	$ 36	$ 60	$ 81	$ 98	$ 105	$ 115
8-Bit	2	15	56	116	146	194	220
16-Bit	0	0	4	14	24	34	40
Total	$ 12	$ 51	$ 120	$ 211	$ 268	$ 333	$ 375

[1]N/A = Product not available

Source: DATAQUEST, Inc.
June 1979

Table 4

ESTIMATED MEMORY CONSUMPTION ASSOCIATED WITH MICROPROCESSORS
(Millions of Dollars)

	1977	1978	1979	1980	1981	1982	1983
Microprocessor Memory Consumption							
4-Bit	$ 4	$ 2	$ 2	$ 0	$ 0	$ 0	$ 0
8-Bit	130	188	270	318	365	395	420
16-Bit[1]	40	62	90	130	185	230	265
16-Bit[2]	0	4	20	95	220	390	640
32-Bit	0	0	0	0	8	72	152
Total	$174	$256	$382	$543	$778	$1,087	$1,477
Microcomputer Memory Consumption							
4-Bit	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0	$ 0
8-Bit	0	1	3	7	9	11	14
16-Bit	0	0	0	1	2	3	5
Total	$ 0	$ 1	$ 3	$ 8	$ 11	$ 14	$ 19

[1] Older products with direct addressing capability less than 128K bytes
[2] Newer products with direct addressing capability up to 8M bytes

Source: DATAQUEST, Inc.
June 1979

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ESTIMATED WORLDWIDE MOS MEMORY CONSUMPTION

Summary

DATAQUEST estimates that worldwide consumption of MOS memory will grow from $1,238 million in 1979 to $3.0 billion in 1983, a 25 percent compound annual growth rate. Furthermore, we expect consumption of MOS memory bits to grow from 2.8 trillion bits in 1979 to 21.2 trillion bits in 1983, representing a compound annual growth rate of 65 percent.

Dynamic MOS RAM consumption in 1979 is estimated at $488 million and represents 39 percent of the total. We expect that dynamic RAMs will remain the largest segment of MOS memory, with an estimated total of $1,063 million in 1983. Static MOS RAMs are expected to be one of the fastest growing segments of the market in the next five years, growing from an estimated $252 million in 1979 to $739 million in 1983, which represents a 31 percent compound annual growth rate. MOS ROMs are expected to grow at a 21 percent rate reaching $352 million in 1983, while MOS EPROMs are growing at an estimated 27 percent compound annual growth rate and are expected to reach $697 million by 1983. EEPROMs should reach $105 million by 1983, representing a 37 percent compound annual growth rate. The future of CCDs remains a major question and shift registers have a declining market.

Total MOS Memory Consumption

DATAQUEST estimates of worldwide MOS memory consumption are presented in Table 1. We estimate 1979 worldwide MOS memory consumption at $1,238 million, up 47 percent over an estimated $843 million in 1978. Dynamic and static MOS RAMs represent 60 percent of the MOS memory market and are expected to grow at compound annual growth rates of 21 and 31 percent respectively. MOS ROMs represent about 13 percent of the MOS memory market and are expected to grow at a 21 percent compound annual rate. MOS EPROMs are growing at a 27 percent compound annual rate and represent 21 percent of total MOS consumption.

EEPROMs (electrically erasable PROMs) are expected to grow at 37 percent per year to about $105 million by 1983. It is still unclear whether CCD technology will produce a commercially viable device that

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is four times denser than MOS RAMs in order to realize a significant price advantage over RAMs. At this time, it appears that there are too many other good opportunities for MOS memory suppliers to concentrate on, hence the outlook for CCDs is not good.

MOS Dynamic RAMs

Table 2 represents DATAQUEST's estimates of worldwide MOS dynamic RAM consumption. Estimates of units, average selling prices, and total dollar revenues are included. The average selling price (ASP) represents an average for the entire year over all devices of that category. Therefore, the ASP for 16K dynamic RAMs represents the pricing for plastic and ceramic, high-speed and low-speed, and all quantities over a 12-month time frame.

Consumption of 16K dynamic RAMs is expected to reach 60 million units in 1979 and continue to about 110 million units in 1980. Growth in 1979 and 1980 seems limited only by the available capacity as users are converting their production from 4K dynamic to 16K dynamic RAMs. Unit volume should continue to grow until peaking in 1981, the year in which we estimate that 8 million 64K dynamic RAMs will be consumed.

We have listed separately the 5 volt only, sub-120ns 16K dynamic RAM since this is a new device with higher ASPs aimed at the cache and buffer memory markets. We expect this fast RAM to represent a $112 million market by 1982.

The 32K dynamic RAMs listed in Table 2 include 32K hybrids which use two 16K chips, as well as partially good 64K dynamic RAMs that can be used as 32K chips. Mostek has introduced its hybrid 32K RAM, while Intel and Texas Instruments are shipping hybrid 32K RAMs to IBM. We also understand that manufacturers producing 64K RAMs will ship some 64K partials for special applications such as memory systems.

The presence of IBM in the merchant market for 32K dynamic RAMs makes this device an important product for the next several years. We have included the estimated merchant market purchases by IBM in Table 2.

MOS Static RAMs

Table 3 presents DATAQUEST's estimates of static MOS RAM consumption. This market is expected to grow from $252 million in 1979 to $739 million in 1983, representing a 31 percent compound annual growth between 1979 and 1983. Consumption of slow 1K static RAMs continues to decline, but the fast 1K statics still represent a strong market because of some recent product announcements. Static 4K RAMs are still climbing in unit and dollar volume. We expect the total dollar revenues from 4K static RAMs to peak in 1980 at $228 million, but further expect the fast 4K static unit and dollar volume to continue growing through 1982. The 8K and 16K static RAMs represent important markets, as suppliers are expected to make important slow and fast product offerings at the both 8K and 16K level. It is still too early to tell about total user acceptance for 8K, 16K, and 32K RAMs.

MOS ROMs

Table 4 presents DATAQUEST's estimates of worldwide MOS ROM consumption. This market is expected to grow from $162 million in 1979 to $352 million in 1983, which represents a compound annual growth rate of 21 percent. In 1979 and 1980, the important ROM markets are at 16K and 32K bits, but the 64K bit ROM is getting an important start this year. We expect the dollar revenues to be fairly evenly distributed among 16K, 32K, and 64K ROMs in 1980, after which the 64K ROM should be the largest revenue producer through 1983. Widespread use of ROMs for program storage in microprocessor applications is adding greatly to the strength of the MOS ROM market.

MOS EPROMs and EEPROMs

Worldwide consumption of MOS EPROMs is expected to grow from $266 million in 1979 to $697 million by 1983 as shown in Table 5. Unit volume of 8K EPROMs is expected to peak in 1979 while 16K EPROM unit volume is expected to continue growing into 1981. In 1979, the first of the 32K and 64K EPROMs are expected to be available. Unit volumes for these devices should continue to grow well into the 1980s and not peak before the 1983-84 time frame.

MOS EEPROMs are expected to be an increasingly important market over the next five years. Total consumption in 1979 is estimated at about $28 million growing to $105 million by 1983. Currently the product offerings are at 1K, 4K, and 8K with higher density products expected within two years. This market is expected to experience good growth as additional suppliers and users are showing increased interest in these products. Note that these estimates do not include the substantial internal consumption from captive EEPROM facilities such as the one at NCR.

CCDs

Table 6 represents our estimate of worldwide CCD consumption. Note that our estimates have decreased substantially from the last issue of this newsletter on October 6, 1978. The 64K CCD market is now serviced actively by only one supplier; other previous suppliers have essentially dropped out of the market. Great uncertainty surrounds this market since CCD technology has not moved fast enough to produce commercial devices that are four times denser than MOS RAMs in order to offer significant price advantages. We believe that only a few suppliers will continue to support this market.

Bit Consumption

Table 7 presents our estimates of MOS memory bit consumption on a worldwide basis. Total bits consumed in 1979 are estimated at about 2.8 trillion bits and expected to grow to 21.2 trillion bits by 1983. This represents a compound annual growth rate of 65 percent. This growth in bit usage is truly phenomenal when one considers that as recently as 1977 annual consumption of MOS memory was only 0.6 trillion bits.

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Table 1

ESTIMATED WORLDWIDE MOS MEMORY CONSUMPTION
(Dollars in Millions)

	1977	1978	1979	1980	1981	1982	1983	Compound Annual Growth Rate 1979-1983
RAM	$351	$530	$ 740	$ 987	$1,235	$1,497	$1,802	25%
Dynamic	254	360	488	645	801	937	1,063	21%
Static	97	170	252	342	434	560	739	31%
ROM	100	125	162	205	251	300	352	21%
EPROM	66	134	266	375	461	573	697	27%
EEPROM	4	15	30	45	60	80	105	37%
CCD	2	3	8	15	22	27	33	43%
Shift Register	38	36	32	27	24	20	16	(16%)
Total MOS Memory	$561	$843	$1,238	$1,654	$2,053	$2,497	$3,005	25%
Percent Change From Previous Year	26%	50%	47%	34%	24%	22%	20%	

Source: DATAQUEST, Inc.
June 1979

Table 2

ESTIMATED WORLDWIDE DYNAMIC MOS RAM CONSUMPTION

	1977	1978	1979	1980	1981	1982	1983
Value ($ in Millions)							
1K	$ 20	$ 14	$ 4	$ 0	$ 0	$ 0	$ 0
4K	200	154	117	68	38	28	12
16K[1]	34	192	345	420	390	250	158
16K[2]	0	0	6	45	71	112	120
32K[3]	0	0	12	80	126	125	90
64K	0	0	4	32	176	400	520
256K	0	0	0	0	0	22	163
Totals	$254	$360	$488	$645	$801	$ 937	$1,063
Percent Change From Previous Year	24%	42%	36%	32%	24%	17%	13%
Units (Millions)							
1K	8.0	6.5	2.0	N/A[4]	N/A	N/A	N/A
4K	57.1	76.8	65.0	45.0	30.0	25.0	12.0
16K[1]	2.0	20.8	60.0	105.0	130.0	100.0	70.0
16K[2]	N/A	N/A	0.4	5.0	15.0	40.0	60.0
32K[3]	N/A	N/A	0.8	8.0	18.0	25.0	20.0
64K	N/A	N/A	0.04	0.8	8.0	40.0	80.0
256K	N/A	N/A	N/A	N/A	0.001	0.2	2.5
Average Selling Price							
1K	$ 2.50	$ 2.20	$ 2.00	N/A	N/A	N/A	N/A
4K	$ 3.50	$ 2.00	$ 1.80	$ 1.50	$ 1.25	$ 1.10	$ 1.00
16K[1]	$17.00	$ 9.25	$ 5.75	$ 4.00	$ 3.00	$ 2.50	$ 2.25
16K[2]	N/A	N/A	$14.00	$ 9.00	$ 4.75	$ 2.80	$ 2.00
32K[3]	N/A	N/A	$15.00	$10.00	$ 7.00	$ 5.00	$ 4.50
64K	N/A	N/A	$95.00	$40.00	$ 22.00	$ 10.00	$ 6.50
256K	N/A	N/A	N/A	N/A	$150.00	$110.00	$65.00

[1] Three power supplies

[2] Five volt only supply

[3] Two-chip hybrids and 64K RAM partials

[4] N/A - Product not available

Source: DATAQUEST, Inc.
June 1979

Table 3

ESTIMATED WORLDWIDE STATIC MOS RAM CONSUMPTION

	1977	1978	1979	1980	1981	1982	1983
Value ($ in Millions)							
1K (1Kx1)	$22	$ 17	$ 11	$ 8	$ 6	$ 3	$ 0
1K (256x4)	19	13	10	7	3	1	0
1K (Fast)	6	7	13	16	9	3	1
4K (Slow)	39	96	137	144	90	56	27
4K (Fast)	11	36	66	84	120	126	120
8K (Slow)	0	1	11	32	48	84	108
8K (Fast)	0	0	1	12	30	60	96
16K (Slow)	0	0	2	18	50	96	144
16K (Fast)	0	0	1	17	45	70	135
32K	0	0	0	4	32	50	80
64K	0	0	0	0	1	11	28
Total	$97	$170	$252	$342	$434	$560	$739
Percent Change From Previous Year	56%	75%	48%	36%	27%	29%	32%
Units (Millions)							
1K (1Kx1)	17.0	15.0	12.0	10.0	8.0	4.0	N/A
1K (256x4)	10.0	8.0	7.0	5.5	3.0	1.0	N/A
1K (Fast)	2.0	3.0	6.0	8.0	5.0	2.0	1.0
4K (Slow)	4.3	18.3	42.0	60.0	45.0	30.0	16.0
4K (Fast)	0.4	1.8	5.5	14.0	32.0	45.0	50.0
8K (Slow)	N/A[1]	0.04	0.8	4.0	12.0	28.0	40.0
8K (Fast)	N/A	N/A	0.02	0.5	2.5	10.0	20.0
16K (Slow)	N/A	N/A	0.05	0.9	5.0	16.0	32.0
16K (Fast)	N/A	N/A	0.01	0.3	1.5	5.0	15.0
32K	N/A	N/A	N/A	0.05	0.7	2.5	8.0
64K	N/A	N/A	N/A	N/A	0.01	0.2	0.8
Average Selling Price							
1K (1Kx1)	$ 1.30	$ 1.10	$ 0.95	$ 0.80	$ 0.80	$ 0.80	N/A
1K (256x4)	$ 1.85	$ 1.60	$ 1.40	$ 1.20	$ 1.10	$ 1.00	N/A
1K (Fast)	$ 2.80	$ 2.40	$ 2.15	$ 1.95	$ 1.70	$ 1.50	$ 1.40
4K (Slow)	$ 9.00	$ 5.25	$ 3.25	$ 2.40	$ 2.00	$ 1.85	$ 1.70
4K (Fast)	$28.00	$20.00	$12.00	$ 6.00	$ 3.75	$ 2.80	$ 2.40
8K (Slow)	N/A	$22.00	$14.00	$ 8.00	$ 4.00	$ 3.00	$ 2.70
8K (Fast)	N/A	N/A	$35.00	$24.00	$12.00	$ 6.00	$ 4.80
16K (Slow)	N/A	N/A	$35.00	$20.00	$10.00	$ 6.00	$ 4.50
16K (Fast)	N/A	N/A	$75.00	$55.00	$30.00	$14.00	$ 9.00
32K	N/A	N/A	N/A	$70.00	$45.00	$20.00	$10.00
64K	N/A	N/A	N/A	N/A	$95.00	$55.00	$35.00

[1]N/A - Product not available

Source: DATAQUEST, Inc.
June 1979

Table 4

ESTIMATED WORLDWIDE MOS ROM CONSUMPTION

	1977	1978	1979	1980	1981	1982	1983
Value ($ in Millions)							
4K	$ 8	$ 2	$ 1	$ 0	$ 0	$ 0	$ 0
8K	53	21	11	5	3	1	1
16K	33	81	100	55	26	14	6
32K	6	16	30	60	70	39	20
64K	0	5	16	60	91	119	140
128K	0	0	4	25	56	102	121
256K	0	0	0	0	5	25	64
Totals	$100	$125	$162	$205	$251	$300	$352
Percent Change From Previous Year	14%	25%	30%	27%	22%	20%	17%
Units (Millions)							
4K	3.0	1.0	0.5	N/A[1]	N/A	N/A	N/A
8K	15.0	8.0	5.0	3.0	2.0	1.0	0.5
16K	6.0	23.0	40.0	26.0	15.0	10.0	5.0
32K	0.4	1.8	5.0	14.0	20.0	14.0	8.0
64K	N/A	0.2	1.2	8.0	14.0	25.0	40.0
128K	N/A	N/A	0.1	1.0	4.0	12.0	22.0
256K	N/A	N/A	N/A	N/A	0.1	1.0	4.0
Average Selling Price							
4K	$ 2.75	$ 1.75	$ 1.40	N/A	N/A	N/A	N/A
8K	$ 3.50	$ 2.65	$ 2.10	$ 1.65	$ 1.40	$ 1.25	$ 1.10
16K	$ 5.50	$ 3.50	$ 2.50	$ 2.10	$ 1.75	$ 1.40	$ 1.25
32K	$15.00	$ 9.00	$ 6.00	$ 4.25	$ 3.50	$ 2.80	$ 2.50
64K	N/A	$25.00	$13.00	$ 7.50	$ 6.50	$ 4.75	$ 3.50
128K	N/A	N/A	$40.00	$25.00	$14.00	$ 8.50	$ 5.50
256K	N/A	N/A	N/A	N/A	$50.00	$25.00	$16.00

[1]N.A. - Product not available

Source: DATAQUEST, Inc.
June 1979

Table 5

ESTIMATED WORLDWIDE MOS EPROM CONSUMPTION

	1977	1978	1979	1980	1981	1982	1983
Value ($ in Millions)							
2K	$15	$ 5	$ 2	$ 1	$ 1	$ 0	$ 0
8K	35	70	100	45	21	13	7
16K	16	58	153	216	195	110	58
32K	0	1	9	67	102	132	140
64K	0	0	2	46	140	288	392
128K	0	0	0	0	2	30	100
Total	$66	$134	$266	$375	$461	$573	$697
Percent Change From Previous Year	53%	103%	99%	41%	23%	24%	22%
Units (Millions)							
2K	3.0	1.4	0.8	0.5	0.3	0.1	N/A[1]
8K	2.9	9.3	20.0	12.0	7.0	5.0	3.0
16K	0.5	2.4	9.0	18.0	26.0	22.0	16.0
32K	N/A	.02	0.2	2.4	6.0	12.0	20.0
64K	N/A	N/A	0.02	0.7	3.5	12.0	28.0
128K	N/A	N/A	N/A	N/A	0.01	0.4	2.0
Average Selling Price							
2K	$ 5.00	$ 3.50	$ 3.00	$ 2.70	$ 2.40	$ 2.20	N/A
8K	$12.00	$ 7.50	$ 5.00	$ 3.75	$ 3.00	$ 2.60	$ 2.20
16K	$32.00	$24.00	$17.00	$12.00	$ 7.50	$ 5.00	$ 3.60
32K	N/A	$60.00	$45.00	$28.00	$ 17.00	$11.00	$ 7.00
64K	N/A	N/A	$110.00	$65.00	40.00	$24.00	$14.00
128K	N/A	N/A	N/A	N/A	$150.00	$75.00	$50.00

[1] N/A - Product not available

Source: DATAQUEST, Inc.
June 1979

Table 6

ESTIMATED WORLDWIDE CCD CONSUMPTION

	1977	1978	1979	1980	1981	1982	1983
Value ($ in Millions)							
16K	$2	$2	$ 1	$ 0	$ 0	$ 0	$ 0
64K	0	1	7	11	11	2	0
256K	0	0	0	4	11	25	32
1024K	0	0	0	0	0	0	1
Total	$2	$3	$ 8	$15	$22	$27	$33
Percent Change From Previous Year	33%	50%	167%	88%	47%	23%	22%
Units (Millions)							
16K	0.25	0.4	0.2	0.1	N/A	N/A	N/A
64K	0.001	0.02	0.2	0.6	1.0	0.3	N/A
256K	N/A[1]	N/A	N/A	0.04	0.2	1.0	2.0
1024K	N/A	N/A	N/A	N/A	N/A	.001	.01
Average Selling Price							
16K	$ 8.00	$ 4.80	$ 3.75	$ 3.25	N/A	N/A	N/A
64K	$50.00	$40.00	$35.00	$18.00	$ 11.00	$ 8.00	N/A
256K	N/A	N/A	N/A	$90.00	$ 55.00	$ 25.00	$16.00
1024K	N/A	N/A	N/A	N/A	N/A	$125.00	$80.00

[1] N/A - Product not available

Source: DATAQUEST, Inc.
June 1979

Table 7

ESTIMATED WORLDWIDE MOS MEMORY CONSUMPTION
(Bits in Billions)

	1977	1978	1979	1980	1981	1982	1983	Compound Annual Growth Rate 1979-1983
RAM	323.7	771.5	1,515	2,737	4,194	6,954	10,580	63%
Dynamic	274.9	662.1	1,287	2,301	3,613	5,889	8,733	61%
Static	48.8	109.4	228	436	581	1,065	1,847	69%
ROM	246.6	518.5	954	1,565	2,386	4,104	6,902	64%
EPROM	38.1	119.1	321	519	911	1,634	3,039	75%
EEPROM	1.1	5.4	12	20	40	80	140	85%
CCD	4.1	7.9	16	51	118	283	535	140%
Shift Register	19.0	20.0	19	19	18	17	16	(4%)
Total MOS Memory	632.6	1,442.4	2,837	4,911	7,667	13,072	21,212	65%
Percent Change From Previous Year	136%	128%	97%	73%	56%	70%	62%	

Source: DATAQUEST, Inc.
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DATAQUEST RESEARCH NEWSLETTER
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GENERAL INDUSTRY UPDATE

Summary

U.S. semiconductor consumption for 1979 is expected to be about 21 percent higher than in 1978. This increase follows strong 1978 growth for semiconductor consumption, which was up about 21 percent over 1977. The extremely strong growth in semiconductor shipments in the fourth quarter of 1978 and strong expected growth in the first half of this year provide most of the momentum for 1979 growth.

It seems increasingly likely that later this year the economy will enter a slowdown, but not a full recession. Even in a slowdown, the strong demand for semiconductor devices is expected to provide the industry with continued growth. We believe that factors outside the semiconductor industry's normal relationship to the economy will provide this strong semiconductor demand throughout 1979 and 1980. These factors include: the effects of inflation; new markets such as automotive electronics, telecommunications, and industrial products; a strong military market; the low price of the dollar; and outside purchases by captive manufacturers. Although demand has been exceptionally heavy recently, we do not see a situation similar to that of 1974 developing, and we do not see the industry entering a period of significant negative growth in the foreseeable future.

Recent Economic Trends

U.S. economic growth slowed markedly in the first quarter of 1979, partly due to inclement weather, but is expected to increase in the second quarter. Nevertheless, economic growth is expected to slow later in 1979, and early indications that this is happening have appeared. Currently, there is less concern that a slowdown may turn into a major recession; however, the effects of inflation on economic indicators make forecasts highly questionable. Almost unanimously, economic and econometric forecasters grossly miscalculated the strength of the economy in the fourth quarter of 1978.

The appearances of an imminent slowdown in the economy may give the readers a feeling of deja vu: similar indications have arisen several times during the current upturn of the economy. Current indications, however, are more prevalent and stronger.

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The following recent economic developments are noteworthy:

- The Index of Leading Indicators declined in March for the third consecutive month. Normally, this pattern indicates a future economic downturn, but because of extremely strong growth in previous months, it is a less certain indication in this instance.

- The gross national product (GNP) grew about 0.7 percent in real terms in the first quarter of 1979, following a growth of 6.9 percent in the fourth quarter of 1978.

- Retail sales in recent months have not kept pace with inflation. Housing starts and automobile sales have slowed.

- Industrial production has continued to grow at a steady pace in the first quarter. Taken with declining retail sales, this situation indicates that inventories are increasing.

- Money supply declined considerably throughout the first quarter of 1979, although most of that decline was reversed with a spurt in April.

- Economic growth in Europe will apparently slow as a result of higher oil prices. Furthermore, the strengthening dollar increases the European inflation outlook. Measures to abate this inflation cloud the economic outlook.

- Movements to spur consumption in Japan indicate that its economy should see excellent growth in 1979.

The U.S. economy currently remains strong. Its resiliency, despite efforts to slow it down, indicates that the economy may grow more slowly in the next year but not suffer severe problems.

<u>Semiconductor Industry Trends</u>

U.S. semiconductor demand in the first quarter of 1979 was extremely strong. Book-to-bill ratios have been running in the range above 1.3 to 1. Early indications are that bookings for April showed little slackening in this trend. The extremely strong bookings result from a combination of heavy demand, an increase in long-term orders, and stable and/or increasing prices.

In general, industry prices declined throughout 1978. Forward pricing in early 1978 reflected a consensus that demand would slow later in the year. Current heavy demand and large backlogs of semiconductor manufacturers are changing that practice. Semiconductor users, in their quest to get priority treatment, have recently been more than willing to accept higher prices. Longer term orders are also an indication of users' attempts to obtain adequate allocation of parts from their suppliers. This is not an entirely healthy situation for the industry. If price stability or price increases continue, they can set the semiconductor industry up for a painful reversal when demand slackens. At this point, we believe the situation has not yet existed long enough to be critical, but it must be watched closely.

Semiconductor manufacturers have had cost control problems related to their attempts to rapidly expand production. We believe that yields have not increased nearly as much as might be expected under normal circumstances. Ideally, this problem will work itself out gradually during reduced demand later this year.

Heavy demand is reflected also in other industry problems: shortages of devices, equipment shortages, and some double ordering. None of these problems has reached the levels of 1974. Generally, although the situation is tight, people are receiving the devices and equipment needed. In many cases, the scarcity of labor is the pacing item in increasing capacity. Lead times, however, are excessive. We feel that management so far has been far more cautious than in 1973 and 1974. As a result, the double ordering of semiconductor devices and inventory accumulation has been fairly moderate.

It is our perception that the very strong demand for semiconductors is based on real and expanded usage, and is not an illusion created by the economic situation. New applications, new companies using semiconductors, and the use of more semiconductors in old applications is the primary engine of the current strong semiconductor demand. This is a much more positive situation than in past cycles. The current situation differs from 1974 in several other respects, including the ability to use order entry data processing to police double ordering, greater management caution, less inventory accumulation, and more long-term ordering of semiconductors.

It is increasingly evident that the cumulative effects of inflation are a major market stimulus to semiconductor demand. Basically, while other prices have risen, the cost of electronic products for any given function has decreased. The electronics deflation has provided capital equipment using electronics with a strong market advantage. There is no reason to expect this trend to cease abruptly. The perception of continued inflation, as well as past history, should maintain this basic shift in the market pattern for many years.

The growth in semiconductor production, especially in the fourth quarter of 1978, has increased the stress on semiconductor production capacity. It is clear that the industry is operating in excess of comfortable capacity both in terms of facilities and people. Although the capital expenditures of the industry have grown tremendously in recent years, new facilities coming on stream are estimated by DATAQUEST to be only barely adequate for reasonable future industry expansion. An overcapacity situation is definitely not expected.

Semiconductor Industry Forecast

Table 1 gives our estimate for U.S. semiconductor consumption in dollars. We believe 1978 semiconductor consumption increased about 21 percent over 1977. For 1979, we expect semiconductor consumption to increase by about 21 percent over 1978. This increase from our previous forecast is primarily because the strong finish in 1978 provided the industry with a running rate entering 1979 significantly above the average for 1978. While we see integrated circuits accounting for the majority of the increase in semiconductor consumption, we also see considerable growth in the discrete device market.

Our current estimates for 1979 U.S. semiconductor consumption by calendar quarter are shown in Table 2. It should be remembered that normally the first and third quarters of the year are seasonally slower in growth. We expect stronger growth in the first half of 1979 to be moderated late in the year and in the first quarter of 1980. The current general economic activity and the high rate of semiconductor orders and backlogs indicate that strong shipments in the first half of the year and through most of the third quarter are assured. While we see some slowdown in demand developing, we do not at this time see a prolonged downturn occurring. A seasonal pause in the first quarter of 1980 should be followed by a resumption of strong semiconductor demand growth.

Our econometric model does not take into account factors that do not have historical precedence, nor does it take into account factors not relating to the economy. However, several of these non-economic and non-historical factors have increased actual semiconductor demand in 1978, and should continue to increase demand for semiconductors in 1979 and 1980. Thus, we expect greater possible variance from our forecast on the up side. Major factors are shown below:

- The effects of inflation, as previously mentioned. It is also possible that the high rate of current inflation may add some industry growth in terms of current dollars. In a deflationary industry, we have no good way to account for this.

- Large new markets:

  - The automotive industry. This will see its greatest increment in semiconductor usage in model year 1981. This relates to semiconductor deliveries beginning in early 1980.

  - The telecommunications market. This is an extremely large market with its growth phase spread over the next several years.

- Industrial products. The microprocessor revolution is changing many products from a mechanical or an electromechanical base to electronics, which is creating heavy demand with a large new customer base for the industry.

- The military and government markets are experiencing strong growth for the first time since the early 1960s. This is exactly the opposite of the situation in 1974.

- We believe the captive semiconductor manufacturers will need to make major purchases of semiconductors beginning late 1979. We see no prospect that these companies—especially General Motors, IBM, and Western Electric—will be able to meet their needs for several years.

- The devalued dollar is making U.S. semiconductor companies more competitive in overseas markets.

These factors are helping to spur semiconductor demand. The advent of VLSI is making semiconductor design and semiconductor manufacturing an increasingly scarce resource. Unless a major recession occurs, the outlook for the industry appears quite positive.

Frederick L. Zieber
James F. Riley
Mary Ellen Hrouda

Table 1

ESTIMATED U.S. CONSUMPTION OF SEMICONDUCTORS

(Dollars in Millions)

	1977	1978	Percent Increase 1977-78	1979	Percent Increase 1978-79
Discrete Devices	$ 925	$1,017	9.9%	$1,140	12.1%
Integrated Circuits	1,787	2,264	26.7%	2,823	24.7%
Total	$2,712	$3,281	21.0%	$3,963	20.8%

Source: DATAQUEST, Inc.
May 1979

Table 2

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Dollars in Millions)

	1978				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$ 233	$255	$ 255	$ 274	$1,017
Integrated Circuits	495	559	572	638	2,264
Total	$ 728	$814	$ 827	$ 912	$3,281
Percent Change From Previous Quarter or Year	0.6%	11.8%	1.6%	10.3%	21.0%

	1979				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$ 279	$290	$ 287	$ 298	$1,140
Integrated Circuits	660	697	716	736	2,823
Total	$ 939	$987	$1,003	$1,034	$3,963
Percent Change From Previous Quarter	3.0%	5.1%	1.6%	3.1%	
Percent Change From Previous Year	29.0%	21.3%	21.3%	13.4%	20.8%

	1980
	1st Qtr.
Discrete Devices	$ 295
Integrated Circuits	740
Total	$1,035
Percent Change From Previous Quarter	0.1%

Source: DATAQUEST, Inc.
May 1979

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

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MOS MICROPROCESSOR SHIPMENTS

Summary

Worldwide shipments of MOS microprocessors in the first quarter of 1979 were an estimated 10.3 million units, up about 23 percent over estimated fourth quarter shipments. Shipments of 4-bit microprocessors were an estimated 6.7 million units, or 65 percent of the total; shipments of 8-bit microprocessors were an estimated 3.5 million units, or 34 percent of the total, and 16-bit products represented about 1 percent of total first quarter shipments with an estimated 121,000 units.

Single-chip microcomputer shipments in the first quarter of 1979 were an estimated 7.6 million units representing about 73 percent of total first quarter microprocessor shipments. This percentage remains about the same as in the fourth quarter of 1978, but is up from 55 percent in the first quarter of 1978.

Quarterly Microprocessor Shipments

Table 1 presents DATAQUEST's estimates of worldwide microprocessor CPU shipments for the first quarter of 1979. Estimated shipments refer to CPU chips only and do not include any I/O or peripheral chips.

Estimated shipments in the first quarter of 1979 were 10.3 million units, up about 23 percent over the fourth quarter of 1978. This quarter to quarter change in microprocessor shipments is up from the 13 percent increase registered in the fourth quarter of 1978 but is not as strong as the 34 percent increase of the first quarter 1978 over the fourth quarter 1977 registered one year ago. At that time, however, the total base was significantly lower. In fact, total shipments in the first quarter of 1979, at 10.3 million units, are more than double the estimated 4.5 million units shipped in the first quarter of 1978.

Table 2 presents DATAQUEST's estimates of worldwide shipments of single-chip microcomputers. Estimated first quarter 1979 shipments of microcomputers were 7.6 million units, up about 24 percent over estimated fourth quarter 1978 shipments of 6.1 million microcomputers.

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The growing importance of single-chip microcomputers is demonstrated by the rapid growth in total units shipped as well as the growing number of product offerings. The 7.5 million units shipped in the first quarter of 1979 is up 203 percent over estimated first quarter 1978 shipments of 2.5 million units. Furthermore, in the first quarter of this year there were 11 distinct single-chip microcomputer families on the market, up from eight families one year ago.

4-Bit Microprocessors

Table 3 presents DATAQUEST's estimates of worldwide microprocessor shipments by bit length. Shipments of 4-bit microcomputers in the first quarter of 1979 are estimated at 6.7 million units, up about 21 percent over estimated fourth quarter shipments.

Shipments of 4-bit microprocessors continued to grow at a strong rate in the first quarter. This quarter-to-quarter change is significantly larger than the fourth quarter 1978 change over the third quarter of that year. The increase reflects the cost-effectiveness of these products. For example, note that shipments of the TMS 1000 and the COM-4 are up dramatically over the first quarter of 1978.

Prices of 4-bit microprocessors for delivery in the second quarter are in the $1.25 to $3.00 range. These prices represent large-quantity shipments in excess of 100,000 units. The 4-bit market continues to grow because of its cost-effectiveness and the continued new product introductions that add to the flexibility and ease of use of these low-cost controllers.

8-Bit Microprocessors

Worldwide shipments of 8-bit microprocessors in the first quarter of 1979 were an estimated 3.5 million units, up 29 percent over estimated fourth quarter shipments. This quarter-to-quarter growth in 8-bit microprocessor shipments continues the trend of the fourth quarter after a relatively flat quarter-to-quarter growth in 1978. Much of the gain for 8-bit microprocessors, however, comes from single-chip 8-bit microcomputers. In the first quarter 1979, 8-bit microcomputers represented 28 percent of the total 8-bit microprocessor shipments. This is up from 23 percent in the fourth quarter of 1978.

Prices of 8-bit microprocessors remain in the $4 to $8 range for deliveries in the second and third quarters of 1979. Prices have been relatively stable since the last publication of this newsletter in March. Strong demand for some single-chip microcomputers such as the 8048 and the 3870 is keeping their prices in the $6 to $7 range. These prices, which are higher than fourth quarter 1978 prices, are expected to continue well into the second half of 1979.

16-Bit Microprocessors

Worldwide shipments of 16-bit microprocessors in the first quarter of 1979 were an estimated 121,000 units, up about 14 percent over estimated fourth quarter shipments. Most of the increase was due to the increased shipments of TMS 9900 products. Continued strong increases are expected in coming quarters as product designs incorporating 16-bit microprocessors move into production and as new 16-bit microprocessors become available.

Prices for 16-bit microprocessors still vary widely as they are correlated with availability and quantities being shipped. The TMS 9980 is available for \$10 to \$15 in quantities of 1,000 units, whereas the 8086 still commands a price in the \$75 to \$100 range, depending upon the quantity purchased.

Daniel L. Klesken
James F. Riley
Frederick L. Zieber

Table 1

ESTIMATED WORLDWIDE SHIPMENTS OF MOS MICROPROCESSORS
(Units in Thousands)

Company	MPU Products	Bits	MOS Process	1978 1st Qtr.	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.
AMD	8080A	8	N	90	105	115	125	435	135
	8085	8	N	0	0	S[1]	5	5	15
AMI	S2000	4	N	0	9	8	12	29	30
	6800	8	N	35	30	30	35	130	38
EFCIS[2]	6800	8	N	0	0	0	0	0	8
Fairchild	F8	8	N	110	130	190	200	630	150
	3870	8	N	3	5	5	10	23	40
	6800	8	N	55	45	80	90	270	155
	6802	8	N	0	0	0	S	S	20
General Instrument	PIC-1650	8	N	75	95	105	175	450	300
	CP-1600	16	N	10	20	15	15	60	15
Harris	6100	12	C	5	5	5	7	22	8
Hitachi	HMCS-40	4	P&C	85	95	110	120	410	130
	6800	8	N	10	15	20	25	70	30
Hughes	1802	8	C	5	8	10	12	35	12
Intel	4004	4	P	42	42	40	35	159	35
	8008	8	P	28	28	25	22	103	20
	8080A	8	N	165	170	180	190	705	190
	8048/8021	8	N	60	100	150	170	480	210
	8748	8	N	0	0	5	25	30	50
	8085	8	N	50	80	95	125	350	175
	8086	16	N	0	1	10	13	24	13
Intersil	6100	12	C	8	10	10	10	38	10
MOS Technology	6500	8	N	50	55	60	60	225	65
Mostek	F8	8	N	50	30	35	45	160	60
	Z80	8	N	70	50	60	80	260	100
	3870	8	N	20	50	75	205	350	260
Motorola	141000	4	C	0	0	5	15	20	30
	6800	8	N	120	140	150	160	570	165
	6802/6808	8	N	5	20	65	90	180	150
	6809	8	N	0	0	0	0	0	S
	3870	8	N	5	10	15	40	70	80
National	COPS	4	N&C	300	500	675	850	2,325	900
	4004	4	P	30	35	35	30	130	30
	IMP	4	P	20	20	20	20	80	18
	8080A	8	N	85	90	100	100	375	150
	SC/MP	8	P	65	70	100	100	335	100
	PACE	16	P	18	18	25	25	86	25
NEC	COM-4	4	P&C	150	225	525	600	1,500	1,100
	8080A	8	N	70	85	90	60	305	65
	8048	8	N	0	0	S	15	15	25
	8085	8	N	0	0	5	25	30	55
	Z80	8	N	0	0	5	25	30	80
RCA	1802	8	C	75	75	85	90	325	115
Rockwell	PPS-4	4	P	400	550	675	650	2,275	700
	6500	8	N	260	200	75	60	595	75
Sescosem[3]	6800	8	N	5	6	7	7	25	0
Signetics	2650	8	N	20	25	35	45	125	45
	8048	8	N	0	0	S	S	S	15
Synertek	6500	8	N	325	225	60	70	680	100
Texas Instruments	TMS 1000	4	P&C	1,400	1,800	3,000	3,200	9,400	3,700
	TMS 8080A	8	N	30	30	40	35	135	32
	TMS 9900	16	N	40	44	48	53	185	68
Zilog	Z80	8	N	90	100	150	210	550	250
Total Microprocessors				4,539	5,446	7,428	8,386	25,799	10,347
Percent change from previous quarter				34.1%	20.0%	36.4%	12.9%		23.4%

[1] S = Sampling

[2] EFCIS, a joint venture between Sescosem and the French AEC, now handles the MOS MPUs formerly handled by Sescosem, a Division of Thompson-CSF.

[3] Sescosem is no longer shipping MOS MPUs since these are now handled by EFCIS.

Source: DATAQUEST, Inc.
May 1979

Table 2

ESTIMATED WORLDWIDE SHIPMENTS OF SINGLE-CHIP MICROCOMPUTERS

(Units in Thousands)

Company	MPU Products	1978 1st Qtr.	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.
AMI	S2000	0	9	8	12	29	30
Fairchild	3870	3	5	5	10	23	40
General Instrument	PIC-1650	75	95	105	175	450	300
Hitachi	HMCS-40	85	95	110	120	410	130
Intel	8048/8021	60	100	150	170	480	210
	8748	0	0	5	25	30	50
Mostek	3870	20	50	75	205	350	260
Motorola	141000	0	0	5	15	20	30
	3870	5	10	15	40	70	80
National	COPS	300	500	675	850	2,325	900
NEC	COM-4	150	225	525	600	1,500	1,100
	8048	0	0	S	15	15	25
Rockwell	PPS-4	400	550	675	650	2,275	700
Signetics	8048	0	0	S	S	S	15
Texas Instruments	TMS 1000	1,400	1,800	3,000	3,200	9,400	3,700
Total Microcomputers		2,498	3,439	5,353	6,087	17,377	7,570
Percent change from previous quarter			37.7%	55.7%	13.7%		24.4%

Source: DATAQUEST, Inc.
May 1979

Table 3

ESTIMATED WORLDWIDE SHIPMENTS OF MICROPROCESSORS BY BIT LENGTH
(Units in Thousands)

		1978					1979
4-Bit Products	MPU Products	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total	1st Qtr.
AMI	S2000	0	9	8	12	29	30
Hitachi	HMCS-40	85	95	110	120	410	130
Intel	4004	42	42	40	35	159	35
Motorola	141000	0	0	5	15	20	30
National	COPS	300	500	675	850	2,325	900
	4004	30	35	35	30	130	30
	IMP	20	20	20	20	80	18
NEC	COM-4	150	225	525	600	1,500	1,100
Rockwell	PPS-4	400	550	675	650	2,275	700
Texas Instruments	TMS 1000	1,400	1,800	3,000	3,200	9,400	3,700
Total		2,427	3,276	5,093	5,532	16,328	6,673
Percent change from previous quarter		57.8%	35.0%	55.5%	8.6%		20.6%
8-Bit Products							
AMD	8080A	90	105	115	125	435	135
	8085	0	0	S[1]	5	5	15
AMI	6800	35	30	30	35	130	38
EFCIS	6800	0	0	0	0	0	8
Fairchild	F8	110	130	190	200	630	150
	3870	3	5	5	10	23	40
	6800	55	45	80	90	270	155
	6802	0	0	0	S	S	20
General Instrument	PIC-1650	75	95	105	175	450	300
Hitachi	6800	10	15	20	25	70	30
Hughes	1802	5	8	10	12	35	12
Intel	8008	28	28	25	22	103	20
	8080A	165	170	180	190	705	190
	8048/8021	60	100	150	170	480	210
	8748	0	0	5	25	30	50
	8085	50	80	95	125	350	175
MOS Technology	6500	50	55	60	60	225	65
Mostek	F8	50	30	35	45	160	60
	Z80	70	50	60	80	260	100
	3870	20	50	75	205	350	260
Motorola	6800	120	140	150	160	570	165
	6802/6808	5	20	65	90	180	150
	6809	0	0	0	0	0	S
	3870	5	10	15	40	70	80
National	8080A	85	90	100	100	375	150
	SC/MP	65	70	100	100	335	100
NEC	8080A	70	85	90	60	305	65
	8048	0	0	S	15	15	25
	8085	0	0	5	25	30	55
	Z80	0	0	5	25	30	80
RCA	1802	75	75	85	90	325	115
Rockwell	6500	260	200	75	60	595	75
Sescosem	6800	5	6	7	7	25	0
Signetics	2650	20	25	35	45	125	45
	8048	0	0	S	S	S	15
Synertek	6500	325	225	60	70	680	100
Texas Instruments	TMS 8080A	30	30	40	35	135	32
Zilog	Z80	90	100	150	210	550	250
Total		2,031	2,072	2,222	2,731	9,056	3,535
Percent change from previous quarter		18.8%	2.0%	7.2%	22.9%		29.4%
12-Bit Products							
Harris	6100	5	5	5	7	22	8
Intersil	6100	8	10	10	10	38	10
Total		13	15	15	17	60	18
Percent change from previous quarter		30.0%	15.4%	0%	13.3%		5.9%
16-Bit Products							
General Instrument	CP-1600	10	20	15	15	60	15
Intel	8086	0	1	10	13	24	13
National	PACE	18	18	25	25	86	25
Texas Instruments	TMS 9900	40	44	48	53	185	68
Total		68	83	98	106	355	121
Percent change from previous quarter		13.3%	22.1%	18.1%	8.2%		14.2%

[1] S = Sampling

Source: DATAQUEST, Inc.
May 1979

DATAQUEST RESEARCH NEWSLETTER
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DYNAMIC AND STATIC MOS RAM AND EPROM SHIPMENTS

Summary

Worldwide shipments of 16K dynamic MOS RAMs increased to 10.2 million units in the first quarter of 1979, up about 27 percent over an estimated 8.0 million units in the fourth quarter of 1978. Prices are remaining relatively stable in the $5.50 to $6.50 range, as demand far outstrips available supply and lead times remain in the 20 to 25 week range.

Worldwide shipments of 4K dynamic MOS RAMs in the first quarter of 1979 were an estimated 18.9 million units, down about 3 percent from an estimated 19.5 million units shipped in the fourth quarter of 1978. Shipments continued to decline, as some suppliers are dropping their commitment to this product.

An estimated 8.3 million units of 4K static MOS RAMs were shipped in the first quarter of 1979, up about 30 percent over the fourth quarter. Of this number, about 340,000 units were 4K static CMOS RAMs.

First quarter shipments of 8K EPROMs were an estimated 4.2 million units, up about 23 percent over the fourth quarter. Shipments of 16K EPROMs were an estimated 1.4 million units, up about 57 percent over estimated fourth quarter shipments.

Dynamic MOS RAMs

16K RAMs

DATAQUEST estimates of worldwide 16K dynamic MOS RAM shipments are presented in Table 1. We estimate that worldwide shipments in the first quarter of 1979 were 10.2 million units, an increase of 27 percent over estimated fourth quarter shipments of 8.0 million units. DATAQUEST estimates include the total shipments by each company, including any shipments to other divisions of the same company. Note that our estimates of Intel's 16K RAM shipments for 1978 have been revised.

Long lead times associated with 16K dynamic RAMs that developed suddenly in the first quarter of 1979 continue in the second quarter. Extremely strong demand has resulted in lead times that are still in the 20 to 25 week range. We expect the long lead times to continue

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into the third quarter when some shortening is likely. By that time, added capacity and improved yield, coupled with slightly lower demand, should ease lead time problems somewhat.

Prices of 16K dynamic RAMs for current delivery remain in the $5.50 to $6.50 range for plastic package types and in the $6.50 to $7.00 range for ceramic and cerdip packages. At this time, we are expecting prices of 16K dynamic RAMs to remain relatively firm throughout the year with price declines of only 10 to 15 percent.

4K RAMs

DATAQUEST estimates of worldwide 4K dynamic MOS RAM shipments in the first quarter of 1979 are presented in Table 2. We estimate that about 18.9 million units were shipped in the first quarter of 1979, down about 3 percent from estimated fourth quarter shipments. Unit shipments of 4K dynamic RAMs have now declined for two consecutive quarters and will probably continue to decline, because new product designs are using 16K RAMs and older designs are being upgraded to the 16K RAM. However, there will certainly be several more years of important usage of the 4K dynamic RAM for some long-running product designs.

Lead times for 4K dynamic RAMs remain in the 15 week range and are likely to remain there throughout the second quarter. Prices for current deliveries have increased from the $1.40 to $1.60 range for plastic packages up to the $1.80 to $2.00 range. This recent price increase reflects a strong demand for the part as well as a price that was previously too low to yield reasonable margins.

32K RAMs

In 1978, Mostek introduced a hybrid 32K dynamic RAM consisting of two chip carriers each containing a 16K chip and mounted side-by-side on an 18-pin ceramic substrate. Currently, Mostek is the only supplier of this hybrid part and shipped an estimated 30,000 units in the first quarter of 1979. Prices of this unit are in the $17.00 to $20.00 range. It is not known how many suppliers will follow suit with a similar hybrid package, but it appears that Mostek is vigorously pursuing this market.

It appears that a significant market may develop for 32K RAMs which are 64K RAM partials. The initial low yields on 64K RAMs result in a large number of chips which have a defect in half of the memory but can still function as a 32K dynamic RAM. For many memory system applications the partials with error correction function meet all the system specifications.

64K RAMs

Currently, Fujitsu, Motorola, and Texas Instruments are sampling 64K dynamic RAMs. Motorola and TI are following the same practice of shipping samples to their customer at no cost but retaining ownership and requiring that the parts be returned at some future time. Sample quantities shipped in the first quarter were in the range of 100 to

300 units for each company and will likely continue in that range during the second quarter. We expect additional suppliers to announce 64K RAMs in 1979, but we currently foresee no more than 25,000-50,000 units being shipped in the year.

1K RAMs

Intel is the only remaining supplier of 1K dynamic RAMs, as ITT dropped out in late 1978. Intel has publicly stated that 1979 will be its last year to supply this product. In light of this situation, we expect the remaining users of the device to redesign their products to use 4K and 16K RAMs.

Static MOS RAMs

4K RAMs

Table 3 presents DATAQUEST estimates of 4K static MOS RAM shipments in the first quarter of 1979. An estimated 8.3 million units were shipped in the first quarter, up about 30 percent over estimated shipments in the fourth quarter of 1978. Included in this total are an estimated 340,000 units of 4K static CMOS RAMs. The current suppliers include Harris, Hitachi, NEC, and RCA. Others are expected to enter the market in the next few quarters..

Lead times for most 4K static RAMs are in the 10 to 15 week range with prices for the 2114 type in plastic being in the $3.75 to $4.75 range. Packages in cerdip or ceramic command a $.50 to $1.00 premium above this. 4K static CMOS RAMS are currently commanding prices in the $16 to $20 range in the smaller quantities being shipped; however, CMOS RAM prices are expected to fall to the $9 to $12 range when suppliers are able to ship larger volumes later in 1979.

Intel is still the only producer of the 2147 fast 4K static. A number of suppliers are beginning to sample the product, but have not begun production shipments. We estimate that Intel shipped 800,000 2147's in the first quarter or one-half of its estimated first quarter 4K static RAM shipments.

8K RAMs

The 8K static MOS RAM market is just beginning to develop. Mostek shipped an estimated 30,000 1Kx8 static RAMs in the first quarter of 1979, and EMM sampled its 1Kx8 RAM. Several suppliers are developing products for this market while others have decided to bypass it and focus attention on the 16K static RAM market.

1K RAMs

1K static RAMs are available from suppliers. Lead times are in the range of 8 to 10 weeks and prices are in the $1.00 range.

EPROMs

8K EPROMs

Table 4 presents DATAQUEST's estimates of worldwide shipments of 8K EPROMs. We estimate that worldwide shipments in the first quarter of 1979 were about 4.2 million units, up about 23 percent from fourth quarter shipments. Prices are currently in the $4.00 to $6.00 range. Prices actually increased slightly in the first and second quarters of 1979, as the demand for EPROMs has been far greater than available supply.

16K EPROMs

Table 5 presents our estimate of worldwide shipments of 16K EPROMs. It shows that an estimated 1.4 million units were shipped in the first quarter of 1979, up about 57 percent over estimated fourth quarter shipments. Currently prices are in the $16.00 to $22.00 range, depending upon quantity and speed of the device. Lead times remain greater than 20 weeks and are likely to remain firm throughout the second quarter and into the second half of the year.

32K and 64K EPROMs

Intel and Texas Instruments are both shipping limited quantities of 32K EPROMs. We estimated that Intel shipped about 5,000 units in the first quarter while TI shipped an estimated 10,000 units. Prices range from $50.00 to $80.00 depending upon quantity and speed. We understand that some vendors plan to bypass the 32K EPROM; they are working on 64K EPROMs, which might be introduced in late 1979 or early 1980.

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Table 1

ESTIMATED WORLDWIDE SHIPMENTS OF 16K DYNAMIC MOS RAMS[1]
(Units in Thousands)

Company	1978 1st Qtr.	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.
AMD	0	0	0	S[2]	S	S
Fairchild	25	40	200	200	465	300
Fujitsu	250	350	500	900	2,000	1,100
Hitachi	120	240	350	500	1,210	800
Intel	400	500	600	900	2,400	600
Intersil	0	0	0	S	S	S
ITT	3	25	75	100	203	200
Mostek	700	1,000	1,400	1,800	4,900	2,400
Motorola	200	500	550	500	1,750	700
National	12	50	75	150	287	250
NEC	650	800	1,100	1,300	3,850	1,700
Siemens	5	15	25	40	85	65
Signetics	S	30	30	80	140	75
Texas Instruments	300	500	950	1,400	3,150	1,800
Toshiba	20	35	80	150	285	225
Zilog	10	15	15	20	60	20
Total	2,695	4,100	5,950	8,040	20,785	10,235
Percent Change From Previous Quarter	146.2%	52.1%	45.1%	35.1%		27.3%

[1]Includes Merchant Market and Internal Shipments

[2]Indicates sampling

Source: DATAQUEST, Inc.
May 1979

Table 2

ESTIMATED WORLDWIDE SHIPMENTS OF 4K DYNAMIC MOS RAMS[1]
(Units in Thousands)

	1978					1979
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total	1st Qtr.
AMD	1,100	1,500	1,800	2,200	6,600	2,600
Fairchild	500	400	200	100	1,200	0
Fujitsu	600	600	400	300	1,900	200
Hitachi	330	500	500	450	1,780	350
Intel	3,000	3,000	2,700	2,300	11,000	2,000
Intersil	150	100	100	100	450	100
ITT	200	300	300	800	1,600	1,100
Mostek	4,000	4,000	4,800	4,200	17,000	3,800
Motorola	1,000	1,300	1,500	1,900	5,700	1,500
National	1,200	1,200	1,500	1,700	5,600	2,000
NEC	1,600	1,600	1,600	1,350	6,150	1,350
Signetics	250	300	300	300	1,150	300
Texas Instruments	4,200	4,700	4,000	3,800	16,700	3,600
Total	18,130	19,500	19,700	19,500	76,830	18,900
Percent Change From Previous Quarter	2.3%	7.6%	1.0%	(1.0%)		(3.1%)

[1] Includes Merchant Market and Internal Shipments

Source: DATAQUEST, Inc.
May 1979

Table 3

ESTIMATED WORLDWIDE SHIPMENTS OF 4K STATIC MOS RAMS[1]

(Units in Thousands)

	1978 1st Qtr.	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.
AMD	200	250	300	230	980	180
AMI	0	0	0	15	15	115
EMM	900	1,150	1,000	1,100	4,150	1,100
Fairchild	0	0	0	S[2]	S	50
Fujitsu	50	75	100	100	325	80
Harris	0	0	S	15	15	40[3]
Hitachi	90	130	200	300	720	600[4]
Intel	800	1,050	800	1,400	4,050	1,600
Intersil	70	50	140	200	460	300
Mostek	120	250	200	230	800	450
Motorola	50	200	250	250	750	300
National	0	100	250	400	750	650
NEC	500	600	650	800	2,550	1,100[5]
RCA	0	0	0	0	0	50[3]
Signetics	0	0	0	0	0	S
Synertek	160	280	350	450	1,240	560
Texas Instruments	700	800	700	800	3,000	1,000
Zilog	60	90	40	90	280	110
Total	3,700	5,025	4,980	6,380	20,085	8,285
Percent Change From Previous Quarter	80.0%	35.8%	(0.9%)	28.1%		29.9%

[1]Includes Merchant Market and Internal Shipments

[2]Indicates Sampling

[3]4K CMOS RAMs only

[4]Includes 150,000 4K CMOS RAMs in 1st Qtr.

[5]Includes 100,000 4K CMOS RAMs in 1st Qtr.

Source: DATAQUEST, Inc.
May 1979

Table 4

ESTIMATED WORLDWIDE SHIPMENTS OF 8K EPROMS[1]

(Units in Thousands)

Company	1978 1st Qtr.	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.
AMD	15	50	80	340	485	600
Electronic Arrays	30	50	60	60	200	75
Fairchild	40	60	60	120	280	160
Fujitsu	50	90	70	70	280	70
Intel	700	900	800	1,000	3,400	1,100
Motorola	100	220	300	400	1,020	700
National	150	300	300	500	1,250	600
Signetics	75	75	80	50	280	0
Texas Instruments	350	550	400	800	2,100	800
Toshiba	0	0	10	30	40	50
Total	1,510	2,295	2,160	3,370	9,335	4,155

[1]Includes Merchant Market and Internal Shipments

Source: DATAQUEST, Inc.
May 1979

Table 5

ESTIMATED WORLDWIDE SHIPMENTS OF 16K EPROMS[1]

(Units in Thousands)

Company	1978 1st Qtr.	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total	1979 1st Qtr.
Fairchild	0	0	0	0	0	S[2]
Fujitsu	0	0	0	5	5	70
Hitachi	0	0	5	30	35	125
Intel	250	400	250	450	1,350	550
Mostek	S[2]	S	S	25	25	90
Motorola	0	S	10	90	100	160
National	0	0	S	S	S	5
Texas Instruments	100	250	200	300	850	400
Toshiba	0	0	S	5	5	25
Total	350	650	465	905	2,370	1,425

[1]Includes Merchant Market and Internal Shipments

[2]Indicates Sampling

Source: DATAQUEST, Inc.
May 1979

DATAQUEST RESEARCH NEWSLETTER
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UPDATE ON BIPOLAR MEMORIES

Summary

DATAQUEST estimates that worldwide consumption of bipolar memory will grow at a compound annual rate of 15 percent, from an estimated $249 million in 1978 to $435 million in 1982. Consumption of bipolar ROMs and PROMs was an estimated $143 million in 1978 or about 57 percent of the total. We expect ROMs and PROMs to represent about 58 percent of the total in 1982, or $254 million.

Signetics had a 20 percent share of the 1978 bipolar memory market, followed by Fairchild with 19 percent, Monolithic Memories with 12 percent, and Harris with 10 percent. Other suppliers in 1978 included AMD, Intel, Intersil, Motorola, National, and Texas Instruments.

Overview

Table 1 presents DATAQUEST's estimates of worldwide consumption of bipolar memory. Consumption is expected to grow about 15 percent per year through 1982 to a total of $435 million. The split between ROMs/PROMs and RAMs is expected to remain relatively stable at about 57 percent and 43 percent, respectively.

Consumption of bipolar memory by major regions of the world is also presented in Table 1. We estimate that North American consumption was about 76 percent of the total in 1978, but expect it will decline to about 68 percent of the total in 1982. Consumption in Japan is expected to increase from about 12 percent of the total in 1978 to about 16 percent of the total in 1982 while consumption in Western Europe is expected to increase from 12 percent to 14 percent during this time frame.

Table 2 presents DATAQUEST's estimates of bipolar memory market shares for the years 1976 through 1978. These shares are believed accurate, but not all RAM production has been identified, especially for older products. Table 3 presents the market shares expressed as a percent of the total. Signetics has gained a number one position in bipolar memory in 1978, and had an estimated 20 percent of the market in 1978. Fairchild is a close second, with about 19 percent market share in 1978.

Table 4 presents DATAQUEST's estimates of 1978 North American bipolar memory consumption by technology, i.e., TTL or ECL. The TTL technology accounts for 97 percent of the total 1978 bipolar ROMs/PROMs devices, but only 58 percent of the 1978 bipolar RAM devices.

Bipolar ROMs/PROMs

The PROM represents the major portion of the bipolar memory market although only a few manufacturers participate in this market segment. PROM sales are closely tied to minicomputer and high-performance microcomputer applications for control store memory. The automotive industry is expected to use large quantities of PROMs to adjust engine control computers for specific "strategies" that are functions of the transmission, axle ratios, etc., used with the engine.

Masked ROMs are an insignificant part of the bipolar memory market. Most of the requirement for the ROM function is filled with factory—or distributor—programmed PROMs. We estimate that 10 percent of PROM shipments are programmed by the manufacturers and that another 15-20 percent are programmed by distributors. Thus, approximately one-third of the PROM shipments are for "ROM" applications. The economics of mask charges, inventory, and lead times appear to have been resolved in favor of the PROM.

Semiconductor manufacturers use four different technologies to fabricate the programming feature of bipolar PROMs. These technologies include nichrome links, titanium tungsten links, polysilicon links, and avalanche-induced migration (AIM). The links technologies open the circuit; the AIM technology completes the circuit. The choice of technology for the link method is held to be primarily a function of the process the manufacturer has available and understands. Nichrome links are said to be the most expensive technology since more process steps are required. Titanium tungsten metallurgy is used for making Schottky diodes and is an integral part of the process flow for TTL memories. Intersil has chosen not to enter the Schottky-TTL marketplace; therefore, its memories are lower performance since they rely on older gold-doped processing. NEC is the only other manufacturer known to be using the AIM technology. The industry position on relative reliability is that AIM holds a slight positive edge and that the others are essentially equal to each other.

The 16K PROM represents state-of-the-art PROM density. Signetics has been actively shipping its 16K PROM since mid-1978 when its competitors began shipping the 8K PROM, and is reported to have shipped nearly as many 16Ks as its competitors have shipped 8Ks. Signetics reports that it has its 32K PROM ready and is now developing a 64K PROM. Intel is known to be sampling its 16K PROM now. The status of the other suppliers is shown in Table 5.

Bipolar RAMs

The market for bipolar RAMs is currently defined as those applications requiring speeds faster than 50 nanoseconds. However, this speed is continually decreasing as faster MOS RAMs become available. Access times for TTL RAMs are 10-20 nanoseconds for 1K devices and 20 nanoseconds for 4K devices . ECL RAMs are now being offered at speeds below 10 nanoseconds and are projected to reach speeds below 2 nanoseconds.

The state-of-the-art for bipolar RAMs is illustrated by the following projected product introduction schedule for Fairchild:

Time	Architecture	Technology	Access Time (ns)	Current (mA)	Part Number
2Q79	1024x4	TTL	25	180	10475/100475
2Q79	4096x1	TTL	35-45	100	93471
3Q79	4096x1	ECL	25-35	120	F10470/100470
1Q80	16Kx1	TTL	35-45	100-135	Undecided

Conclusions

Bipolar devices have long been characterized as requiring larger die and consuming more power than MOS devices to achieve their higher speeds. According to a WESCON paper by Jasper, Shields, and Campbell, these generalizations are not always true. For example, they cite a comparison of the 82S400 and the 2147-3:

	Maximum Power	Access Time	Die Size
82S400 (Bipolar)	130mA	45ns	17K sq. mils
2147-3 (MOS)	180mA	55ns	25K sq. mils

However, bipolar processes are generally more complex. The competition between fast static MOS ROMs and bipolar RAMs is expected to intensify in coming years. Recent MOS devices described by Intel at trade conferences have access times as low as 15 nanoseconds.

Willard T. Booth
Daniel L. Klesken
Mary Ellen Hrouda

Table 1

ESTIMATED WORLDWIDE BIPOLAR MEMORY CONSUMPTION[1]

(Dollars in Millions)

	1976	1977	1978	1979	1980	1981	1982
Worldwide Total	$162	$205	$249	$280	$325	$375	$435
ROMs/PROMs	$100	$115	$143	$160	$188	$217	$254
RAMs	$ 62	$ 90	$106	$120	$137	$158	$181
North America	$128	$159	$189	$207	$235	$263	$297
Europe	$ 21	$ 25	$ 30	$ 36	$ 42	$ 52	$ 61
Japan	$ 13	$ 21	$ 30	$ 37	$ 45	$ 56	$ 69
Rest of World	$ 0	$ 0	$ 0	$ 0	$ 3	$ 4	$ 8

[1]Captive consumption is not included.

Source: DATAQUEST, Inc.
April 1979

Table 2

ESTIMATED BIPOLAR MEMORY MARKET SHARES

(Dollars in Millions)

	1976			1977			1978		
	RAMs	ROMs/ PROMs	Total	RAMs	ROMs/ PROMs	Total	RAMs	ROMs/ PROMs	Total
AMD	$ 0	$ 0	$ 0	$ 0	$ 2	$ 2	$ 0	$ 4	$ 4
Fairchild	25	9	34	31	9	40	38	10	48
Harris	0	15	15	0	21	21	0	25	25
Intel	1	8	9	1	10	11	1	13	14
Intersil	4	6	10	0	6	6	0	7	7
Monolithic Memories	1	18	19	1	23	24	1	27	31
Motorola	3	0	3	7	2	9	11	2	13
National Semiconductor	2	3	5	2	5	7	4	8	12
Signetics	12	10	22	10	30	40	12	38	50
Texas Instruments	6	10	16	2	6	8	2	8	10
Others	1	1	2	36	1	37	37	1	35
Total	$55	$80	$135	$90	$115	$205	$106	$143	$249

Source: DATAQUEST, Inc.
April 1979

Table 3

ESTIMATED BIPOLAR MEMORY MARKET SHARES

(Percent of Total)

	1976			1977			1978		
	RAM	ROM/ PROM	Total	RAM	ROM/ PROM	Total	RAM	ROM/ PROM	Total
AMD	0%	0%	0%	0%	2%	1%	0%	3%	2%
Fairchild	45	11	25	35	8	20	36	7	19
Harris	0	19	11	0	18	10	0	17	10
Intel	2	10	7	1	9	5	1	9	6
Intersil	7	8	7	0	5	3	0	5	3
Monolithic Memories	2	23	14	1	20	12	1	18	12
Motorola	5	0	2	8	2	4	10	1	5
National Semiconductor	4	4	4	2	4	3	4	6	5
Signetics	22	12	16	11	26	20	11	27	20
Texas Instruments	11	12	12	2	5	4	2	6	4
Others	2	1	2	40	1	18	35	1	14
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: DATAQUEST, Inc.
April 1979

Table 4

ESTIMATED NORTH AMERICAN BIPOLAR MEMORY CONSUMPTION - 1978
(Dollars in Millions)

	TTL	ECL	Total
ROMs/PROMs	$111	$ 4	$115
RAMs	43	31	74
Total	$154	$35	$189

Source: DATAQUEST, Inc.
April 1979

Table 5

PROM TECHNOLOGY AND STATUS

Company	Programming Technology	Status
Fairchild	Nichrome links	Densities to 4K in production 256x4 in ECL 1K family
Harris	Nichrome links	Densities to 8K in production 32K and 64K not expected until 1980
Intel	Polysilicon links	16K now being sampled
Intersil	Avalanche-Induced Migration (AIM)	Densities to 2K in gold-doped TTL
Monolithic Memories	Nichrome links; new product to use Titanium Tungsten links	16K scheduled for current introduction; with production late 1979
Motorola	Nichrome links	Densities to 8K TTL; 1K ECL
National	Titanium Tungsten links	8K in production
Raytheon	Nichrome links	Densities to 8K; expects to sample the 16K in Q2 1979
Signetics	Nichrome links	16K in volume production 32K believed to be ready for introduction 64K in development
Texas Instruments	Titanium Tungsten links	8K sampled Q3 1978; 16K expected to be available in 1979

Source: DATAQUEST, Inc.
April 1979

DATAQUEST RESEARCH NEWSLETTER
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CAPTIVE SEMICONDUCTOR MANUFACTURING

Introduction

Semiconductor manufacturing facilities owned by electronic equipment manufacturers are called "captive facilities." During the last four years, the number of captive facilities has increased from 19 to 43, while the number of merchant suppliers has dropped from 93 to 81. DATAQUEST has maintained an ongoing dialogue with a number of these captive suppliers; this newsletter summarizes their perspective.

The driving force behind captive manufacturing is the continuing increase in complexity of LSI and VLSI circuits. As a result, more and more system functions are being performed within the LSI circuit, forcing electronic equipment manufacturers to seek control of LSI circuit architecture in order to control the architecture of their equipment. The LSI circuits they require have high design costs and low production volumes—a combination that may be unattractive to the merchant semiconductor supplier. The resultant lack of responsiveness from the semiconductor industry, combined with strong strategic implications for competition, control, and security have led many electronic equipment manufacturers to develop captive semiconductor capability.

Captive suppliers represent a significant market for design software and for semiconductor manufacturing equipment; it is estimated that they consume betwen 30 and 40 percent of the manufacturing equipment in the United States. The last section of this newsletter deals with the way in which their needs differ from those of the merchant semiconductor firms.

The Chip is the System

LSI chip complexities have now reached the point where a single device may encompass a significant portion of the circuitry in a system. As a result, the performance of the system is more and more determined by the way the circuitry inside the LSI device is interconnected; therefore, electronic equipment manufacturers desiring to differentiate their products from those of competitors must control the design of LSI devices.

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As device geometries shrink, LSI computing speeds improve. Eventually, the performance of an LSI device cannot be duplicated with conventional MSI and SSI logic; the physical volume of equipment constructed from these conventional circuits is so large that the logic delays in the wiring are greater than they are inside an LSI chip. Since most mainframes and large minicomputers are sold on a "computations-per-second-per-dollar" basis, competition tends to force computer makers to seek high-speed LSI circuits. This helps explain why Hewlett-Packard has developed its own SOS process and also why many computer manufacturers have become captive suppliers of their own custom designed ECL devices.

The high cost of assembling MSI and SSI circuits is another factor that pushes electronic equipment manufacturers toward LSI. A typical system using these devices may have a manufacturing cost for items like printed circuit boards, power supplies, cabinetry, and labor that is many times the cost of the circuits themselves. Table 1 indicates the way these costs change as more complex LSI devices are introduced into the system.

Table 1

IMPACT OF LSI ON SYSTEM MANUFACTURING COSTS

	MSI/SSI Design	LSI Gate Arrays		
	10 Gates	100 Gates	500 Gates	2,000 Gates
Component Price	$0.40	$ 4.00	$20.00	$140.00
Manufacturing Cost per Component	$3.14	$12.00	$18.00	$ 23.00
Component Price per Gate	$0.04	$0.04	$ 0.04	$ 0.07
Manufacturing Cost per Gate	0.314	0.12	0.036	0.0115
Total Manufacturing Cost per Gate	$ .354	$ .16	$ .076	$ .0815
Component Cost (Percent of Total)	11%	25%	53%	86%

Source: DATAQUEST, Inc. April 1979

In Table 1, the device price per gate remains relatively constant as the number of gates in the array increases. This reflects current pricing practices in the industry for gate arrays.

Gate arrays are used in the example because they are more cost-effective than custom LSI devices for the production quantities typical of most computer manufacturers.

In the example in Table 1, it is interesting to note that as LSI devices increase in complexity, the component cost constitutes an increasing percentage of the total manufacturing cost. This implies that the computer factory of the future may have more capital investment associated with the manufacture of LSI devices than with their assembly. IBM's commitment to gate arrays is well known; there are 10 electron-beam machines at IBM dedicated exclusively to the direct wafer exposure of gate arrays. Currently, IBM has two gate arrays in production, one of 704 gates and one of 1,500 gates. Judging from Table 1, these arrays would seem to be of about the right complexity to minimize total manufacturing cost per gate.

<u>Make What You Cannot Buy</u>

The semiconductor industry has always felt that captive suppliers cannot be competitive. In one sense DATAQUEST agrees, for there are many examples where head-on competition with the semiconductor industry by captives has failed. However, electronic equipment manufacturers have many needs that are not filled by the semiconductor industry. The captive semiconductor manufacturers that focus on satisfying these unfilled needs are usually successful and make a positive contribution to their company's profits. However, "vertical integration" by itself has not proven to be a profitable strategy; it does not appear viable to build a captive semiconductor facility with the sole objective of capturing the profits that merchant semiconductor suppliers make on standard components. However, the current strategy of focusing on those applications and technologies that the semiconductor industry is unwilling or unable to address appears eminently workable.

Semiconductor companies and electronic equipment manufacturers have markedly different perspectives regarding what it takes to be successful in business. These different perspectives cause them to operate their semiconductor organizations in dissimilar manners. Semiconductor manufacturers operate in an almost perfectly competitive environment. Indeed, many of them have difficulty convincing equipment manufacturers to buy their product unless a completely equivalent second source is available. They have little or no control over the prices that can be charged and, as a result, tend to focus on cost reduction rather than achieving higher prices through product differentiation.

Two factors are of supreme importance in reducing costs: achieving full utilization of plant capacity and obtaining market leadership so that costs can progress down the learning curve more rapidly than those of competitors. Semiconductor manufacturers believe their markets are elastic. If they cut selling prices, they expect that the increase in unit sales will be great enough to cause the market to be larger than it was before. By being the price leader one can thereby hope to dominate what is ultimately a larger market.

By contrast, electronic equipment manufacturers operate in a market that most economists would characterize as imperfectly competitive. Usually, their products are not identical to those produced by others, and the product features are often as important as the price in making a sale. Accordingly, they tend to concentrate more on improving product features than on reducing costs.

Equipment manufacturers believe their market is relatively inelastic compared to the components market. Indeed, most equipment products are segmented into recognizable classes (e.g., small, medium, and large computers) that fit into a definite hierarchy of selling prices, and most manufacturers strive to preserve this hierarchy and avoid pricing that causes products in one class to compete with those in another class. While costs are important, most equipment manufacturers do not attach as much significance to achieving full utilization of plant capacity and to learning curve effects as do the semiconductor manufacturers.

Table 2 illustrates how these different perspectives lead to sharply different goals for competitive (merchant) and captive semiconductor manufacturers.

Table 2

COMPETITIVE AND CAPTIVE MANUFACTURER GOALS

Competitive (Merchant) Manufacturer Goals	Captive Manufacturer Goals
Keep factory full.	Save capacity for emergencies.
Cut prices to expand market.	Increase component complexity to expand product performance.
Improve yields.	Seek new uses for excess capacity.
Sacrifice design time for manufacturing efficiency.	Ensure quick turn-around.
Seek second sources for products.	Strive for unique product features.
Lower components cost.	Expand component complexity to reduce assembly costs.

Source: DATAQUEST, Inc.
April 1979

Semiconductor companies have limited research and engineering capabilities. Typically, these budgets may be 6 percent to 20 percent of sales. In turn, semiconductor component costs may be only 10 percent of the ultimate system selling price. If an electronic equipment manufacturer budgets 10 percent of systems sales for research and engineering, the funds available are equal to 100 percent of component purchases—10 times larger than those available to the component maker. The electronic equipment maker can therefore afford to develop processes and LSI circuits that enhance his products only and do not necessarily have a broad market. Hewlett-Packard's commitment to SOS technology falls in this category. It is a technology that makes HP's products more competitive yet represents a market sufficiently limited that it is unlikely to interest semiconductor firms.

Competition, Control, and Security

Competition, control, and security represent important strategic factors that motivate the equipment companies to set up their own captive facilities. Some companies are concerned about competition from semiconductor manufacturers integrating upwards into their markets, or about their competitors' use of captive semiconductor technology. Others seek to incorporate custom LSI devices into their equipment to make it difficult for other equipment makers to copy. Finally, many hope to become more competitive through the cost savings generated by LSI.

Some companies build captive semiconductor facilities to gain control of their own future. They seek to control the design of LSI so that they can control system performance, and look to the captive facility as a means of shortening design times and educating their engineers.

Security is the final motivator. The captive facility is seen as providing assured delivery or a second source to merchant suppliers. The existence of a captive facility is also a help in purchasing: it can improve a company's negotiating position, assist in vendor qualification, help vendors with delivery problems, and provide support in reliability analysis.

Software and Equipment Needs of Captive Suppliers

The captive supplier environment is typically characterized by a greater emphasis on circuit development than is typical of the merchant semiconductor companies, by relatively low production volumes, and by a relatively large variation in month-to-month production rates. These differences lead to software and equipment demands that differ from those of merchant suppliers.

Captive manufacturers need software aids to help reduce their relatively high design costs. These software aids include automatic chip layout, automatic wire routing in gate arrays, and automatic generation of LSI chip test sequences. Since each design or design variation of an LSI chip is produced in relatively low volume, most captive manufacturers (unlike the merchant suppliers) are willing to sacrifice LSI chip area in order to reduce design time and cost. Even IBM, the largest of the captives, has stated that 4 percent to 20 percent of the area of its 704 gate array chip is associated with extra logic that serves only to make test program generation simpler.

Many captive suppliers use their semiconductor fabrication areas as engineering pilot lines for prototyping purposes. Typical production volumes may be on the order of 100 to 5,000 wafers a month—approximately 5 percent to 30 percent of the volume produced in the typical module of a merchant supplier. Thus, a captive supplier may be satisfied with relatively low throughput capital equipment if it satisfies other requirements.

We believe that direct slice writing with electron-beam equipment will be particularly appealing to captive suppliers. The relatively low throughput of this equipment will be more than compensated for by its ability to handle fine lines and compensate for wafer distortion on a die-by-die basis. Another advantage to captive manufacturers is the fact that this equipment shortens design time by completely eliminating the maskmaking step.

Captive suppliers try to maintain a relatively large variety of processes at relatively low production rates—rates that may vary markedly if merchant suppliers are unable to meet current demand for a part. These factors lead captive suppliers to favor flexible, automatic equipment. It is flexible so that it can handle many different processes, and automatic so that the process is programmed into the equipment rather than being in the operator's head. Automatic equipment also has the advantage of reducing the number of operators required, which tends to make line management simpler because the number of operators need not vary widely as production rates change.

Howard Z. Bogert

DATAQUEST RESEARCH NEWSLETTER
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INTEL ANALYSTS' MEETING

Introduction

DATAQUEST attended the Intel Analysts' Meeting on March 2, 1979. Dr. Robert Noyce made the opening remarks, commenting briefly on the recent change of titles among the top three executives. Dr. Noyce is now Vice Chairman, and Dr. Gordon Moore is Chairman of the Board. Dr. Andrew Grove, formerly Executive Vice President, becomes President of Intel. Dr. Noyce mentioned that the new titles more accurately reflect the roles that these three executives have already been playing at Intel.

The meeting consisted primarily of presentations by Leslie Vadasz and David House on microprocessors, and then a lengthy question and answer session.

Intel officers and managers in attendance included: Robert Noyce, Gordon Moore, Andrew Grove, Larry Hootnick, Leslie Vadasz, David House, and Roger Borovoy.

Intel's Microprocessor Strategy

Leslie Vadasz, Vice President and General Manager of the Microcomputer Components Division, made the presentation on Intel's microcomputer businesses. He made an interesting comparison between the new MCS-86 family and the older MCS-80 family of microprocessors. He noted that the MCS-86 family had a total of 19 products at the time of its introduction, including components, system hardware, and software, versus nine products in the MCS-80 family. One year after its introduction, the total MCS-86 family contains 36 total products, whereas the MCS-80 family contained 12 products. He pointed at this situation as an example of the dedication and level of investment by Intel in its MCS-86 family. The product introductions history for these two microprocessor families is shown in Table 1. He showed a chart that compared the complexity of memory devices and microprocessor devices versus time. He then described how a memory device or technology led naturally to a corresponding microprocessor product or family. Table 2 shows the lead memory products and the microprocessor products that evolved from that memory lead product.

Mr. Vadasz closed his presentation with the very emphatic statement that the Microcomputer Components Division of Intel is the fastest growing division in the Company.

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Table 1

Intel Corporation

COMPARISON OF MCS-80 AND MCS-86 PRODUCT FAMILIES

	MCS-80 (1974)	MCS-86 (1978)
Products at Introduction		
Number of Components	3	7
System Hardware	5	4
Software	1	8
Total	9	19
Total Products One Year Later		
Number of Components	5	10
System Hardware	5	15
Software	2	11
Total	12	36
Total Products Two Years Later		
Number of Components	9	
System Hardware	10	
Software	7	
Total	26	

Source: Intel Corporation
March 1979

Table 2

Intel Corporation

MOS MEMORY LEAD PRODUCTS AND FOLLOWING MICROPROCESSOR PRODUCTS

Memory Lead Products	Microprocessor Products
1103 (1K Dynamic)	4004, 4040, 8008
2107 (4K Dynamic)	8080
2102 (1K Static)	8021, 8022, 8048, 8049
2716 (16K Dynamic)	8748, 8755, 8741
2147 (4K Fast Static)	8086

Source: Intel Corporation
March 1979

David House, General Manager of the Microprocessor and Peripherals Operation, discussed Intel's microprocessor product lines and their positions in the product life cycle. He noted that the 8086 is still in the early introduction and distributor stocking portion of its life cycle, while the 8048 mask-programmed microcomputer is in a great many initial design-ins. The 8085 has been in a number of design-ins and is now moving into some fairly good-sized production orders. The 8080 product line has been in existence for several years and is now supported by a good number of second sources. The 4040 is now a commodity product and has passed the peak of its product life cycle.

Mr. House indicated that in the first quarter of 1979, Intel expects its quarterly unit shipments of 8085s to exceed its quarterly unit shipments of 8080 microprocessors. He also noted that the 8048 microcomputer had a very substantial step function increase in unit shipments in 1978. It is now Intel's highest volume microprocessor product.

The year 1979 will be an important design-in year for the 8086, and Intel expects that 1980 will be the year when the 8086 moves into a number of production programs.

Question and Answer Session

A lengthy question and answer session followed.

1. Q. How is Intel supporting the service required for its microcomputer systems products?

   A. About two years ago, Intel made a commitment through its IBM add on memory systems business to set up the sales and service centers required to support a systems business.

2. Q. What is the drag factor associated with Intel's microprocessor products?

   A. The CPU is becoming a smaller percentage of the total microprocessor revenues. About one or two years ago the CPU represented about 40 percent of the revenues. It is now less than 25 percent and is expected to become less than 10 percent in the future. The major impact has been the large amount of memory being used in microprocessor systems. The average memory size for an 8086 micro-processor system is about 128K bytes of memory.

3. Q. How much do you sell in kits?

   A. Kit sales of microprocessors are not the majority but still represent an important part of our business.

4. Q. How many 8086 design-ins displaced minicomputers?

A. This was not a significant number. The microprocessor and the minicomputer business do not have an extensive overlap. We note that Intel stated that it shipped more 8080s in 1978 than Digital Equipment Corporation has shipped minicomputers in its total corporate lifetime.

5. Q. Discuss the 8022 microprocessor and the new analog microcomputer recently announced.

A. The 8022 microcomputer fits a broad number of applications very well including consumer, energy management systems, and industrial processing. The marketplace is much broader than was originally expected with industrial processing turning out to be significantly larger than originally expected.

The analog microcomputer is designed to handle signal processing and filtering applications. Intel is not totally sure about the breadth of the applications or the total unit volumes. The answer must evolve over time.

6. Q. Compare the Z8000 and the 8086 microprocessors.

A. The basic difference between the 8086 and Z8000 is architecture. The state of the art in computer architecture in the late 1960s and the early 1970s was very much oriented toward assembly level languages and this spawned the PDP-11 and ECLIPSE series of minicomputers. However, in the late 1970s, there was a need to focus on compiler-generated code with a more regular and organized software system. This is the philosophy behind the 8086 architecture. The compiler group that developed P/LM-1 for Intel was instrumental in the basic architecture design of the 8086. The Z8000 is a generalized architecture and uses more memory than the 8086 to do the same function.

7. Q. Are there any patents on the 8086 family?

A. Several patents have been applied for on the bus structure of the 8086.

8. Q. Comment on the LSI-11 versus the 8086.

A. The overlap between these products is minimal. Some users need the maturity of the PDP-11 product line and quickly choose the LSI-11. However, the 8086 is finding many applications where the LSI-11 is not a factor in the market.

9. Q. In light of limited resources, what might be expected from Intel in terms of memory products?

A. Intel must support its sole source products even at the expense of multiple sourced products such as the 16K dynamic RAM.

10. Q. Discuss the product life cycle of Intel's memory products.

A. Intel will cease producing the 1103 1K dynamic RAM in 1979. There are only two major users now. The 4K dynamic RAM is in the mature part of its product life cycle while the 16K dynamic RAM is still building. We don't expect any significant quantity for the 64K dynamic RAM until 1981. The 1K static RAM is a mature product, the 4K static is still growing.

11. Q. When will Intel's capacity catch up with its demand?

A. Not until the economy slows a little. We can't accelerate the rate of our capacity additions any more than we are currently doing. Our Fab V facility in Portland, Oregon, is now processing its first silicon, and in February Intel broke ground in Phoenix, Arizona, for its largest plant ever.

12. Q. What are the lead times on some of your major products?

A. Lead times for EPROMs are about 48 weeks; the 2147 4K static, about two weeks; and the 8086 is available from stock. The EPROM microprocessor products (8748/8755/8751) are running some 30-40 weeks. The 8085 has about a 20-week lead time. Note that the real demand on EPROMs is nowhere as high as the 48-week lead time would suggest. This is one area where significant double ordering exists. The overall average lead time for Intel products is about 20 to 26 weeks.

13. Q. What level of capital spending do you project for 1979?

A. Capital spending is projected at $120 million in 1979.

14. Q. How will Intel handle its short-term debt?

A. We are looking at alternatives to roll it over into longer-term debt, but will have to look at the economy over the next six months.

15. Q. Comment on the Intel add-on memory business since the IBM announcements.

A. Intel's add-on memory business serves two purposes for Intel. First, it provides flexibility on the upside when memory component output is excessive. Second, it puts Intel into direct contact with the commercial end users of data processing products and exposes it to the marketing and servicing problems of its customer base. Previously, Intel did not have any good contact in that area. The experience helps Intel to understand how complex silicon systems are moving toward the data processing users.

16. Q. Discuss the magnetic bubble memory efforts at Intel.

A. The technology of magnetic bubbles is reasonably compatible with that of silicon. Intel had the opportunity to acquire a good group of people and did so. The program is progressing well.

17. Q. Is the Intel lead time on unique or leadership products increasing or decreasing?

A. In the microprocessor area, it is definitely increasing since one must consider total system capability. It is also increasing in HMOS. Intel is somewhat surprised at the length of time it is taking our competitors to catch up in EPROMs. However, it isn't totally unexpected, as it takes a good understanding of oxides to succeed in EPROMs.

18. Q. What will keep Intel ahead of the competition in the next 10 years?

A. We expect fewer new entries because of the high capital cost of entry. Intel is about to become the largest semiconductor research institution in the world.

19. Q. Comment on the multichip substrate approach with IBM.

A. Intel started in business with three major goals: Schottky TTL, silicon gate MOS, and multichip substrates. It has achieved the first two, but not the last as priorities and goals have changed. IBM, however, has become the world leader in multichip substrates. Intel focuses its efforts on more complex integrated structures. We believe this approach better serves the merchant market needs.

20. Q. Why did IBM go to the multichip approach?

A. IBM gets a density advantage with more bits per board or system. However, we still find the cost of bumps on the chips too high. It is possible you may get a cost advantage if you can put the entire mainframe memory on a single board.

21. Q. Comment on your start-up costs and the possible effect on margins.

A. Start-up costs are a continuing aspect of our doing business. It is not a one-time thing for Intel. We hope this doesn't have a major impact on margins.

22. Q. Comment on the total microcomputer market in 1978 and the outlook for the future.

A. In the past five years, the microcomputer market grew slowly but steadily and continued unabated through the 1974-75 recession. Now microcomputer unit shipments are growing at large rates, especially in the last six months. The present growth rate is probably greater than 50 percent per year.

23. Q. How is the codec being accepted by telecommunication companies?

A. Much slower than originally expected. However, this might have been anticipated when one analyzes the telecommunications industry. We expect that there will be different designs including per-line codecs and shared-line codecs. Telephone networks are going toward a more distributed network which favors the per-line codec. Intel now has design activities with all major telecommunication customers in the free world except NTT.

24. Q. Can Intel maintain its pretax margins of about 22 percent?

A. Our interest expense is up this year and next, but we need to keep margins high to fund future growth.

25. Q. What growth can we expect in the first quarter of 1979 versus the fourth quarter of 1978?

A. The dollar growth will probably be about the same as the fourth quarter of 1978 versus the third quarter of 1978, but this represents a declining percentage growth.

26. Q. Will the availability of capital equipment from the suppliers be a problem?

A. No. We don't expect it to be. We've been able to order and plan for equipment and materials well in advance of our needs.

27. Q. Will Intel move into Japan?

A. We need to have a scenario by which we can move a plant there successfully, but we do not presently have one. However, our business in Japan is quite strong. The Japanese are buying more in foreign markets, so this helps Intel.

28. Q. Comment on the size of your 64K dynamic RAM effort.

A. It is a major effort at Intel. Intel has a sizable dedicated effort on dynamic RAMs.

29. Q. Discuss the Mostek and Intel agreements on 64K dynamic RAMs.

A. We are trying to get a common pin-out agreement, but have not yet reached that point.

30. Q. Is automotive electronics a good business with good margins?

A. There are two parts to this market: engine control, and comfort and convenience. Intel's effort is with the engine control. The semiconductor industry must learn to meet the strict delivery requirements and the reliability requirements of the auto industry.

Daniel L. Klesken

DATAQUEST RESEARCH NEWSLETTER
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SIS Code: Newsletters March 23, 1979

UPDATE ON DISCRETE SEMICONDUCTORS

Summary

This newsletter is the first of a regular series dealing with discrete semiconductors.

DATAQUEST estimates of worldwide consumption of discrete devices are presented in Table 1. Total consumption of discrete devices is expected to grow at a compound annual rate of 7.2 percent between 1978 and 1982. In this period power transistors, power diodes (rectifiers), and thyristors are expected to have strong compound annual growth rates of 8.7 percent, 9.2 percent, and 10.4 percent, respectively. Small signal transistors and small signal diodes are likely to grow more slowly, at compound annual growth rates of 3.1 percent and 3.8 percent, respectively.

DATAQUEST estimates of North American consumption of discrete devices are presented in Table 2. Total North American discrete consumption is expected to grow at an annual compound growth rate of 6.0 percent, with power transistors growing at 7.3 percent, power diodes (rectifiers) at 7.2 percent, and thyristors at 8.6 percent.

Overview

The microprocessor's pervasive growth into areas not previously served by electronics provides a major impetus for the growth of discrete devices. These new applications, including automobiles, appliances, and telecommunications, require discrete devices for power supply rectification and regulation, power handling, and actuation.

The market for small signal transistors and diodes has been adversely affected by the integration of discrete devices onto integrated circuit (IC) chips. Improved technology and expanded applications for integrated circuits have been the driving forces behind the gradual shrinking of the small signal discrete markets.

The major technological events impacting the discrete device world recently have been associated with the packaging. In power transistors, plastic packages capable of handling up to 200 watts are now appearing. Other packaging activities include the use of a steel TO-3 package for better seal integrity and cosmetics. General Instrument's "Super Rectifier," utilizes lead braze under glass with a plastic overmold and is reported to be a very successful approach to achieve high quality and low cost.

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Unitrode's "Chip Strate" package places a thyristor chip on a suitable ceramic substrate; it can be used as a stand-alone package in some applications, or it can be incorporated in an enclosure.

For industrial control applications, some manufacturers are making a hybrid assembly with diodes, Silicon Controlled Rectifier (SCR)/Triac, and possibly an IC, to facilitate use in controllers. This packaging concept is known by several names including "Power Mod" (FMC), "Power Cube" (GE), and "Paceback" (International Rectifier).

However, packaging is not the only area benefiting from technological innovation. Schottky rectifiers are being developed and introduced to satisfy the demands of the switching power supply manufacturers for rectifiers with low forward voltages for increased efficiency. The switching power supply is rapidly becoming the most popular power supply design, and the switching power supply market is expected to grow nearly 30 percent per year. Ballasts for fluorescent lamps are now being implemented with small switching power supplies. Virtually every rectifier manufacturer (FMC, International Rectifier, ITT, Motorola, TRW, Unitrode, Varo) is starting production of Schottky rectifiers.

The VMOS transistor represents a major process innovation in the power transistor segment. The fast switching speeds and low "ON" voltage provide the VMOS device with the potential to replace the traditional bipolar transistor in many applications and to open many new ones. For example, the major deterrent to using semiconductors to control automotive lighting has been the voltage loss across the power transistor; VMOS technology promises to remove that restriction. The market for VMOS is only beginning: the present market is about $2 million; Fairchild, Siliconix, and Supertex are the leading suppliers. Nearly all power transistor manufacturers are installing or developing VMOS processing.

Selenium rectifiers are still being produced by a few manufacturers as replacement items for older TV and other entertainment products.

Triacs are the fastest growing part of the thyristor segment due to the demands for AC control in appliances; the microwave oven is a very large consumer of triacs in current ratings up to 40 amperes. Hair dryers are large consumers of small SCRs.

In the European market, Philips is estimated to be the largest supplier followed by Siemens, Motorola, Texas Instruments, ITT, AEG Telefunken, Sescosem, and RCA. The total discrete market in Europe is reported to be flat, with power transistors enjoying an increasing market.

The epitaxial-base general purpose power transistor is built offshore by nearly all of the major suppliers; for example, International Rectifier builds its transistors in Mexico and India.

The discrete market is dominated by Motorola in all categories except thyristors, where it is an important competitor, and small signal diodes, where it does not participate. Texas Instruments, General Electric, ITT, RCA, and Fairchild follow for U.S.-based manufacturers. The remainder of the U.S. market consists largely of companies serving special interest markets with narrow product lines.

The major Japanese manufacturers, Hitachi, Matsushita, Nippon Electric, and Toshiba are each roughly one-half the size of Motorola in worldwide discrete sales. Mitsubishi's sales are approximately one-half of the other Japanese suppliers.

The RF power transistor, which primarily serves the communications industry, is enjoying stable growth fed by mobile radio and pocket pagers. Approval of 900 MHz pocket paging systems is expected to cause significant new growth. Touch-Tone telephone systems are also viewed as a growth opportunity for this device.

The market for the small signal diode is less vulnerable to integration than is the small signal transistor market, because very large numbers of small signal diodes are used as transient suppressors in systems using MOS.

Metal-can small signal transistors are becoming rare except in high reliability applications. The cost of metal has increased, and acceptance of the plastic package by most computer manufacturers has removed most of the demand.

U.S.-Based Suppliers

A listing of the major U.S.-based suppliers in each of the discrete devices categories follows:

Small Signal Diodes

Fairchild, General Electric, General Instrument, ITT, Texas Instruments, and Unitrode.

Small Signal Transistors

Amperex, Communication Transistor Corp. (CTC), Fairchild, General Electric, Intersil, ITT, Motorola, National Semiconductor, RCA, Raytheon, Signetics (DMOS), Siliconix (principally FET), Sprague, Texas Instruments, and TRW.

Zener Diodes

Fairchild, ITT (to 5 watts only), MicroSemiconductor, Motorola, Semtech, Texas Instruments, and Unitrode (primarily military). Teledyne is withdrawing from the zener market.

Rectifiers (Power Diodes)

Fairchild, FMC, General Electric, General Instrument, International Rectifier, ITT, Motorola, National Electronics, Semtech, Sensitron, Texas Instruments, TRW, Unitrode, Varo, and Westinghouse.

Power Transistors

Amperex, CTC, Fairchild, General Electric, Germanium Power Transistors, Motorola, National Semiconductor, Power Tech, RCA, Siliconix (VMOS), Solid State Scientific, Solitron, Supertex (VMOS), Texas Instruments, TRW, and Unitrode.

Thyristors

FMC, General Electric, Hutson, International Rectifier, Motorola, National Electronics, RCA, Teccor, Texas Instruments, Unitrode, and Westinghouse.

Willard T. Booth
Daniel L. Klesken

Table 1

ESTIMATED WORLDWIDE DISCRETE SEMICONDUCTOR CONSUMPTION

(Dollars in Millions)

	1978	1979	1980	1981	1982	Compound Annual Growth Rate 1978-1982
Total Discrete	$2,825	$2,987	$3,207	$3,460	$3,730	7.2%
Transistor	$1,387	$2,451	$2,540	$1,641	$1,739	5.8%
Small Signal	744	754	777	811	840	3.1%
Power	643	697	763	830	899	8.7%
Diode	$1,008	$1,068	$1,161	$1,254	$1,354	7.7%
Small Signal	278	285	302	312	323	3.8%
Power	595	639	700	769	846	9.2%
Zener	135	144	159	173	185	8.2%
Thyristor	$ 298	$ 326	$ 353	$ 393	$ 442	10.4%
Other	$ 132	$ 142	$ 153	$ 172	$ 195	10.2%

Source: DATAQUEST, Inc.
March 1979

Table 2

ESTIMATED NORTH AMERICAN DISCRETE SEMICONDUCTOR CONSUMPTION

(Dollars in Millions)

	1978	1979	1980	1981	1982	Compound Annual Growth Rate 1978-1982
Total Discrete	$897	$943	$996	$1,064	$1,133	6.0%
Transistor	$430	$450	$474	$ 504	$ 528	5.3%
Small Signal	207	210	216	227	232	2.9%
Power	223	240	258	277	296	7.3%
Diode	$310	$324	$343	$ 366	$ 388	5.8%
Small Signal	69	72	74	75	78	3.1%
Power	178	187	200	218	235	7.2%
Zener	63	65	69	73	75	4.5%
Thyristor	$115	$125	$132	$ 143	$ 160	8.6%
Other	$ 42	$ 44	$ 47	$ 51	$ 57	7.9%

Source: DATAQUEST, Inc.
March 1979

DATAQUEST RESEARCH NEWSLETTER
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MOS MICROPROCESSOR SHIPMENTS

Summary

Worldwide shipments of MOS microprocessors in the fourth quarter of 1978 were an estimated 8.4 million units up about 13 percent over estimated third quarter shipments of 7.4 million units. For the year 1978, total microprocessor shipments were an estimated 25.8 million units up 206 percent from an estimated 8.4 million units shipped in 1977.

Single-chip microcomputer shipments in the fourth quarter were an estimated 6.1 million units and represented about 72 percent of total fourth quarter microprocessor shipments. In 1978, an estimated 17.4 million single-chip microcomputers were shipped representing about 67 percent of all microprocessor shipments in 1978.

During 1978, shipments of 4-bit microprocessors were an estimated 16.3 million units representing about 63 percent of the total. Total shipments of 8-bit microprocessors were about 9.1 million units, or 35 percent of the total microprocessor shipments. Sixteen-bit products represented about 1 percent of the total shipments with an estimated 355,000 units.

Quarterly Microprocessor Shipments

Table 1 presents DATAQUEST estimates of worldwide microprocessor CPU shipments for the fourth quarter of 1978. The estimated shipments refer to CPU chips only and do not include any I/O or peripheral chips.

Estimated shipments in the fourth quarter were about 8.4 million units, up about 13 percent over the previous quarter. This was the smallest quarter-to-quarter change in 1978, but is not totally unexpected in light of the seasonality of the toy, game, and appliance markets that use these microprocessors.

By comparing previous DATAQUEST newsletters on MOS microprocessor shipments, one notes that total annual shipments have risen dramatically in the past three years. In 1976, total estimated worldwide shipments were 2.4 million units, 1977 total shipments were 8.4 million units, and 1978 shipments were up dramatically to 25.8

million units. Part of the large growth is due to high volume usage of 4-bit microcomputers in game and appliance applications. We expect this rapid growth to continue for the low-cost microcontrollers as well as many other microprocessor families.

Table 2 presents DATAQUEST's estimates of worldwide shipments of single-chip microcomputers. Estimated fourth-quarter shipments of microcomputers were 6.1 million units, up about 13 percent over estimated third-quarter shipments of 5.4 million units. In the fourth quarter, shipments of single-chip microcomputers represented about 72 percent of total shipments, up sharply from 55 percent of the total in the first quarter of 1978.

4-Bit Microprocessors

Table 3 presents our estimates of worldwide microprocessor shipments by bit length. Shipments of 4-bit microprocessors in the fourth quarter of 1978 are estimated at 5.5 million units, up about 9 percent over estimated third quarter shipments. For the entire year 1978, worldwide shipments of 4-bit microprocessors reached 16.3 million units, up very dramatically from an estimated 4.1 million units in 1977.

In the fourth quarter of 1978, the shipments of 4-bit microprocessors continued to grow, but at a slower rate than in previous quarters. This slowing in shipment growth is primarily attributable to the seasonality of the end-user markets which these devices serve. The toys, games, and appliance markets are very large users of 4-bit microprocessors.

Prices for 4-bit microprocessors are in the $1.50 to $2.50 range for deliveries in the first and second quarters of 1979. These prices represent shipments of quantities in excess of 100,000 units. We expect to see continued significant growth in this 4-bit microprocessor market because of their utility as low cost controllers for consumer applications.

8-Bit Microprocessors

Worldwide shipments of 8-bit microprocessors in the fourth quarter of 1978 were an estimated 2.7 million units, up 22 percent over estimated third-quarter shipments. This is the first strong quarter-to-quarter gain for 8-bit microprocessors since the first quarter of 1978. Total 1978 shipments of 8-bit microprocessors were an estimated 9.1 million units, more than double the estimated 4.1 million units shipped in 1977.

Prices of 8-bit microprocessors still remain in the $4.00 to $8.00 range for deliveries in the first and second quarters of 1979. Prices have been relatively stable during the last quarter and, in some cases, have actually increased. Because of the large demand for 8-bit single-chip microcomputers, such as the 3870 and the 8048, the prices for these devices have actually increased during the first quarter of this year. In late fourth quarter 1978, large quantity orders were being shipped for $5.00 to $5.50. In mid-first quarter 1979, increased demand and limited supply actually forced prices up to the $6.50 to $7.00 range. We expect these higher prices to continue well into the second half of 1979 until additional capacity becomes available.

Quarterly shipments of several major 8-bit microprocessor families are presented in Table 4. The quarter-to-quarter increase in shipments is generally declining because of the maturity of several of these products. The greatest emphasis now appears to be in the single-chip, 8-bit microcomputers. During the fourth quarter, 8-bit microcomputers comprised 23 percent of the total 8-bit microprocessor shipments, up from 13 percent in the second quarter of 1978 and 16 percent in the third quarter.

16-Bit Microprocessors

Worldwide shipments of 16-bit microprocessors in the fourth quarter of 1978 were an estimated 106,000 units, up about 8 percent over estimated third quarter shipments. We do not expect the 16-bit microprocessor shipping rates to increase dramatically for several more quarters until more participants have entered the market and these devices have passed the design-in stage. Later in 1979, as some products move toward first production stages, unit volumes should begin to grow dramatically.

Announced prices on some 16-bit microprocessor products fell in the first quarter of 1979. However, since most of these products are not available in large production quantities yet, their higher unit prices for quantities under 100 are not totally representative. We understand that the TMS-9980 is available for $10.00 to $15.00 in 1,000-unit quantities, while the 8086 is still priced above $50.00 in quantities under 1,000.

The drag factor for peripherals, I/O, and memories is an important factor for 16-bit devices. Many of the new 16-bit product designs are using about 128K bytes of memory as compared with 16K to 32K bytes of memory for typical 8-bit microprocessor applications. This heavy usage of memory, together with peripherals and I/O, leads to drag factors in the range of 7 to 12 and increasing as high as 15 to 20 in some cases. It is dangerous, however, to generalize about drag factors because they vary so dramatically depending upon application.

Daniel L. Klesken
James F. Riley

Table 1

ESTIMATED WORLDWIDE SHIPMENTS OF MOS MICROPROCESSORS
(Units in Thousands)

Company	MPU Products	Bits	MOS Process	1977 Total	1978 1st Qtr.	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total
AMD	8080A	8	N	165	90	105	115	125	435
	8085	8	N	0	0	0	S[1]	5	5
AMI	6800	8	N	89	35	30	50	55	170
	S2000	4	N	0	0	9	8	12	29
Fairchild	F8	8	N	655	110	130	190	200	630
	3870	8	N	0	3	5	5	10	23
	6800	8	N	15	55	45	80	90	270
General Instruments	CP-1600	16	N	31	10	20	15	15	60
	PIC-1650	8	N	0	75	95	105	175	450
Harris	6100	12	C	13	5	5	5	7	22
Hitachi	HMCS-40	4	P&C	140	85	95	110	120	410
	6800	8	N	25	10	15	20	25	70
Hughes	1802	8	C	10	5	8	10	12	35
Intel	4004	4	P	215	42	42	40	35	159
	8008	8	P	124	28	28	25	22	103
	8080A	8	N	510	165	170	180	190	705
	8048/8021	8	N	95	60	100	150	170	480
	8748	8	N	0	0	0	5	25	30
	8085	8	N	55	50	80	95	125	350
	8086	16	N	0	0	1	10	13	24
Intersil	6100	12	C	16	8	10	10	10	38
MOS Technology	6500	8	N	280	50	55	60	60	225
Mostek	F8	8	N	90	50	30	35	45	160
	Z80	8	N	85	70	50	60	80	260
	3870	8	N	20	20	50	75	205	350
Motorola	141000	4	C	0	0	0	5	15	20
	6800	8	N	435	120	140	150	160	570
	6802	8	N	0	5	20	65	90	180
	3870	8	N	0	5	10	15	40	70
National	COPS	4	N&C	N/A[2]	300	500	675	850	2,325
	4004	4	P	110	30	35	35	30	130
	IMP	4	P	55	20	20	20	20	80
	8080A	8	N	145	85	90	100	100	375
	SC/MP	8	P	189	65	70	100	100	335
	PACE	16	P	47	18	18	25	25	86
NEC	COM-4	4	N	225	150	225	525	600	1,500
	8080A	8	N	162	70	85	90	60	305
	8085	8	N	0	0	0	5	25	30
	Z80	8	N	0	0	0	5	25	30
RCA	1802	8	C	222	75	75	85	90	325
Rockwell	PPS-4	4	P	575	400	550	675	650	2,275
	6500	8	N	225	260	200	75	60	595
Sescosem	6800	8	N	20	5	6	7	7	25
Signetics	2650	8	N	39	20	25	35	45	125
	8048	8	N	0	0	0	S	S	S
Synertek	6500	8	N	250	325	225	60	70	680
Texas Instruments	TMS 1000	4	P&C	2,825	1,400	1,800	3,000	3,200	9,400
	TMS 8080A	8	N	100	30	30	40	35	135
	TMS 9900	16	N	95	40	44	48	53	185
Zilog	Z80	8	N	95	90	100	150	210	550
Total Microprocessors				8,447	4,539	5,446	7,445	8,381	25,811
Percent change from previous quarter					34.1%	20.0%	36.7%	12.6%	

[1]S = Sampling

[2]N/A = Not Available

Source: DATAQUEST, Inc.
March 1979

Table 2

ESTIMATED WORLDWIDE SHIPMENTS OF SINGLE-CHIP MICROCOMPUTERS

(Units in Thousands)

Company	MPU Products	1977 Total	1978 1st Qtr.	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total
AMI	S2000	0	0	9	8	12	29
Fairchild	3870	0	3	5	5	10	23
GI	PIC-1650	0	75	95	105	175	450
Hitachi	HMCS-40	140	85	95	110	120	410
Intel	8048/8021	95	60	100	150	170	480
	8748	0	0	0	5	25	30
Mostek	3870	20	20	50	75	205	350
Motorola	3870	0	5	10	15	40	70
	141000	0	0	0	5	15	20
National	COPS	N/A[1]	300	500	675	850	2,325
NEC	COM-4	225	150	225	525	600	1,500
Rockwell	PPS-4	575	400	550	675	650	2,275
Texas Instruments	TMS 1000	2,825	1,400	1,800	3,000	3,200	9,400
Total		3,880	2,498	3,439	5,353	6,072	17,362

[1] N/A = Not Available

Source: DATAQUEST, Inc.
March 1979

Table 3

ESTIMATED WORLDWIDE SHIPMENTS OF MICROPROCESSORS BY BIT LENGTH

(Units in Thousands)

4-Bit Products	MPU Products	1977 Total	1978 1st Qtr.	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total
AMI	S2000	0	0	9	8	12	29
Hitachi	HMCS-40	140	85	95	110	120	410
Intel	4004	215	42	42	40	35	159
Motorola	141000	0	0	0	5	15	20
National	COPS	N/A[1]	300	500	675	850	2,325
	4004	110	30	35	35	30	130
	IMP	55	20	20	20	20	80
NEC	COM-4	225	150	225	525	600	1,500
Rockwell	PPS-4	575	400	550	675	650	2,275
Texas Instruments	TMS 1000	2,825	1,400	1,800	3,000	3,200	9,400
Total		4,145	2,427	3,276	5,093	5,532	16,328
Percent change from previous quarter			57.8%	35.0%	55.5%	8.6%	
8-Bit Products							
AMD	8080A	165	90	105	115	125	435
	8085	0	0	0	S[1]	5	5
AMI	6800	89	35	30	50	55	170
Fairchild	F8	655	110	130	190	200	630
	3870	0	3	5	5	10	23
	6800	15	55	45	80	90	270
General Instruments	PIC-1650	0	75	95	105	175	450
Hitachi	6800	25	10	15	20	25	70
Hughes	1802	10	5	8	10	12	35
Intel	8008	124	28	28	25	22	103
	8080A	510	165	170	180	190	705
	8048/8021	95	60	100	150	170	480
	8748	0	0	0	5	25	30
	8085	55	50	80	95	125	350
MOS Technology	6500	280	50	55	60	60	225
Mostek	F8	90	50	30	35	45	160
	Z80	85	70	50	60	80	260
	3870	20	20	50	75	205	350
Motorola	6800	435	120	140	150	160	570
	6802	0	5	20	65	90	180
	3870	0	5	10	15	40	70
National	8080A	145	85	90	100	100	375
	SC/MP	189	65	70	100	100	335
NEC	8080A	162	70	85	90	60	305
	8085	0	0	0	2	15	17
	Z80	0	0	0	5	25	30
RCA	1802	222	75	75	85	90	325
Rockwell	6500	225	260	200	75	60	595
Sescosem	6800	20	5	6	7	7	25
Signetics	2650	39	20	25	35	45	125
	8048	0	0	0	S	S	S
Synertek	6500	250	325	225	60	70	680
Texas Instruments	TMS 8080A	100	30	30	40	35	135
Zilog	Z80	95	90	100	150	210	550
Total		4,100	2,031	2,072	2,239	2,726	9,068
Percent change from previous quarter			18.8%	2.0%	8.1%	21.8%	
12-Bit Products							
Harris	6100	13	5	5	5	7	22
Intersil	6100	16	8	10	10	10	38
Total		29	13	15	15	17	60
Percent change from previous quarter			30.0%	15.4%	0%	13.3%	
16-Bit Products							
General Instruments	CP-1600	31	10	20	15	15	60
Intel	8086	0	0	1	10	13	24
National	PACE	47	18	18	25	25	86
Texas Instruments	TMS 9900	95	40	44	48	53	185
Total		173	68	83	98	106	355
Percent change from previous quarter			13.3%	22.1%	28.1%	8.2%	

Source: DATAQUEST, Inc.
March 1979

Table 4

ESTIMATED 8-BIT MICROPROCESSOR SHIPMENTS BY TYPE[1]

(Units in Thousands)

Microprocessors	1977 Total	1978 1st Qtr.	1978 2nd Qtr.	1978 3rd Qtr.	1978 4th Qtr.	1978 Total
8080A	1,082	440	480	525	510	1,955
F8	745	160	160	225	245	790
6800	584	225	236	307	337	1,105
6500	755	635	480	195	230	1,540
Total	3,166	1,460	1,356	1,252	1,322	5,390

[1]Numbers in this table include all manufacturers of these types.

Source: DATAQUEST, Inc.
March 1978

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Newsletters March 16, 1979

SILICON ON SAPPHIRE

Summary

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In the four years since DATAQUEST published its "Silicon on Sapphire" (SOS) notebook section, SOS technology has been established as a viable technology. Substantial commitments by several major manufacturers have advanced the technology, thus removing much of the uncertainty that it faced in earlier years. While major technical problems remain, the recent announcements of the HP-3000 Series 33 and HP 300 (AMIGO) computers have demonstrated that an SOS-based system can now compete in a major commercial systems market. However, a significant commercial market at the component level still does not exist. H-P's vertically integrated operation and its corporate commitment to SOS are felt to be important keys to bringing SOS to market.

Overall market penetration has been much slower to achieve than had been forecast in 1973-74. On the other hand, many major technical problems have been overcome, and SOS has found a place in several diverse applications. The 1978 component-level SOS market is estimated to have been $15 million in 1978, and is expected to double to approximately $30 million in 1979.

SOS activity at a dozen companies lends credence to the belief that the industry continues to look upon SOS as a potentially competitive technology. In 1978, each of the high-volume MOS manufacturers, Intel and Motorola, increased its corporate commitment to the SOS technology, joining long-standing SOS programs at Hewlett-Packard, RCA, and Rockwell. There continue to be a number of lower-level programs at companies that wish to stay abreast of developments but that lack resources or commitment to forcefully develop the technology.

SOS Technological Evolution

In the semiconductor industry, many technologies and process concepts have continued to be proposed and researched, but frequently they are not developed. SOS fits this pattern to a large degree. In the early 1970s, every major semiconductor firm worldwide experimented with a small number of SOS wafers (the sales of which sustained the life of Inselek in this time period). During this time frame, relatively major technological advances were being made in both silicon PMOS and NMOS. Profits could be made by simply improving device yields, reducing critical dimensions (from 10 micrometers to 7 micrometers, then to 5, and finally to 3-4 micrometers), and increasing manufacturing volume.

From the beginning, SOS has promised an exceptionally low speed-power product unattainable in bulk silicon technology; but all the test data indicated that it could not be achieved profitably in volume manufacturing. SOS devices also feature higher noise immunity, operate over a wider temperature range, and have much-increased radiation hardness over devices built on silicon substrates. These qualities have provided the basis for a steadily growing space and military market since the early 1970s. Finally, SOS is particularly well suited for use in VLSI applications because: (1) the insulating substrate is inherently free of defects between transistors; and (2) the payoff for lower power will become increasingly advantageous as geometries become smaller.

Current Technical Status

Two major technical limitations have slowed the rate of development of commercially available SOS products. First, sapphire wafers of adequate quality remain very expensive and in short supply. From a user's point of view, only Union Carbide (UCC) sapphire is of adequate quality for widespread SOS production use today. RCA's Edge defined, Film fed, Growth Process (EFG) wafers can match the UCC wafers in surface quality, and RCA is now moving its EFG process from its research facility to its production facility in Mountain Top, New Jersey, for wafer production. Allied Chemical and Kyoto Ceramics currently manufacture EFG sapphire wafers. High quality EFG wafers should become available in 1979. UCC is also expanding its sapphire wafer production near the lower-cost Columbia River hydroelectric power.

Prices to date have shown little tendency to decline quickly, but price declines may speed up, possibly as increased demand for sapphire substrates makes market entry more lucrative.

Second, despite a number of technical advances, the poor quality of the silicon-sapphire interface continues to limit device performance. The silicon epitaxy layer on the sapphire is of very poor crystal quality. Recently, it was reported that the crystal structure of the silicon epitaxy layer could be destroyed by heavy silicon implants into silicon at liquid nitrogen temperature. The implant process was done in a manner that left the epitaxy surface silicon undamaged. This surface layer acts as the seed crystal for the recrystalization or regrowth process performed at 550°C. The resultant silicon crystal is almost free of crystal defects. It may now be possible to manufacture dynamic RAM and bipolar devices via SOS, if the carrier mobility and lifetime are shown to be near their values in bulk silicon.

Major Corporate Technical Efforts and Results

Bell Telephone Labs (BTL)

Scientists at BTL are actively looking at SOS for its future low-power, high-speed communications, memory, and logic circuits. Bell's effort currently is research only.

Digital Equipment Corporation

Standard MOS device designs have been built in SOS to evaluate the SOS processing techniques. Devices using the special features of SOS are not yet being manufactured.

Hewlett-Packard (H-P)

H-P initially field tested the CMOS SOS ROMs in its 2640, 2644, and 2645 general purpose display terminals beginning in late 1976. However, in these cases, the systems were not designed around the special SOS features, but the components merely replaced NMOS ROMs piece for piece. The present SOS utilization in the HP-3000 System 33 and HP 300 has gone further, with unique SOS designs incorporated at the chip level and complete systems built around these unique features. H-P is continuing its major effort in SOS. Two new generations of devices and processes incorporating reduced dimensions will soon be used in their systems.

Hughes Aircraft

An R&D group has expanded its SOS manpower in recent years. All developments and devices have been for internal system applications and other military programs. Hughes could become a second source to RCA.

Intel

The intentions of Intel in cross-licensing its microprocessor line to RCA in exchange for SOS technology have yet to be fully revealed. Intel's stated purpose was to broaden its 8085 applications base, but the cross-licensing agreement also clearly provides it access to SOS developments.

Motorola

EFCIS, the joint-venture company of Thompson-CSF and the French Government, is reported to have begun its SOS/CMOS design of Motorola's 6802 microprocessor in June 1978 and expects to sample SOS/CMOS 6802 devices in mid-1979. While SOS technology is not an explicit part of Motorola's agreement with EFCIS and the French Government, it is possible that Motorola will transfer SOS/CMOS technology to the United States in late 1979.

Nippon Electric Company (NEC)

NEC's effort is concerned with short channel devices of 1 to 2 micrometers, where it believes SOS is superior to bulk silicon MOS devices.

RCA

RCA has designed and produced working 16K static RAMs with access times of 75 nanoseconds at 10 volts and 130 nanoseconds at 5 volts and with quiescent power dissipation of 0.01 milliwatts. Customers have been sampled, with production scheduled in 1979. Currently, RCA is selling its SOS/CMOS 4K static RAM at a competitive price of $7.00 each, but a second source is needed.

Raytheon (Bedford)

This Raytheon group has designed the AMD 2901 and 2909 in SOS/CMOS, initially for internal system application. However, if SOS acceptance expands rapidly, these 2900 series 4-bit microprocessors could become available commercially.

Rockwell

Both the Microelectronics Division and the Aerospace Systems Division are actively producing SOS/CMOS LSI devices. The highest volume product is an SOS/CMOS frequency synthesizer for military portable radios. Rockwell is a strong contender for the U.S. Department of Defense's Very High Speed Integration (VHSI) program money, as it is working on 100 megahertz logic. Rockwell has not as yet returned to the commercial market in SOS/CMOS, and continues to use all its SOS production internally in systems applications.

Sperry Univac

Univac has an internal effort to manufacture SOS devices for its military and commercial systems. Its first group of circuit designs is nearly complete. After manufacturing is proved, the process technology will probably be moved from the research level to the manufacturing facility in Minneapolis, Minnesota.

Texas Instruments (TI)

TI, having twice reduced its SOS activities, is believed to be building up its program again.

Toshiba

Toshiba produced an SOS/CMOS microprocessor in 1977, mostly for its own internal applications. Its SOS activity is less visible at the present time.

U.S. Government VHSI Program

The U.S. DOD-funded VHSI program will allocate $200 million over the next six years, with the goals of producing large chips populated with fast and very dense circuits. It is expected that SOS technologies will receive as much as 15 percent of these development funds.

VLSI Labs

A small group of engineers is looking for major development leaps to yield better quality silicon crystal on sapphire. It will be interesting to see what success they have beyond the recent advances reported above.

SOS Markets

There are two noteworthy features of the SOS market, which have developed over the last several years. First, the major successes of SOS to date have been in military and space markets, which can afford a higher price premium for higher performance than can the strictly commercial markets. Second, an SOS-based systems market exists to a greater degree than an SOS-based components market.

It is not surprising that the available major systems level products making use of SOS technology are from vertically integrated firms such as H-P. Vertical integration enables designers to take full advantage of component-level features in systems level applications through total systems design. Manufacturers for military markets (Hughes, RCA, Rockwell) use a large portion of their production in their own systems. Furthermore, the higher SOS component cost can often be effectively buried in the system price, which may be why the first SOS applications are coming from systems manufacturers having their own design and wafer fabrication capability.

Conclusion and Prospects

While SOS technology has not in the last four years developed as fully as had been thought possible, it has secured a foothold in the market, but more at the systems level than at the component level. Military and space applications continue to contribute to overall demand for the process technology.

Technical progress has been steady, although slower than hoped for. The potential of the technology remains great, although its reputation is somewhat diminished by its failure to pay off more quickly. At present, there appears to be ample support in U.S. Government-funded programs and in private firms to carry the commercial and technical development of SOS into at least the mid-1980s.

Future growth of the market may, in the short term, be limited by the availability of quality sapphire wafers. However, recently increased industry commitment to the SOS technology should eventually be reflected in the sapphire supply market with an attendant reduction in substrate costs.

O. D. Trapp
Lane Mason

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*Out of Print

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Newsletters March 9, 1979

MOSTEK ANALYSTS' MEETING
February 26, 1979

DATAQUEST attended an Analysts' Meeting given by Mostek on February 26. Our observation of the meeting was that it was a forthright, upbeat meeting. Among those present were Vin Pothro, President; Berry Cash, Vice President of Marketing; Robert Palmer, Vice President of Wafer Fabrication/R&D; Jim Peoples, Vice President, Manufacturing; and Chuck Barker, Vice President of Finance.

The beginning of the meeting was devoted to a discussion of 1978 results and the impact of the Fab IV start-up problems on 1978 results.

Looking into 1979, some interesting data were presented.

1. Financial

Mostek's long-term goal is to achieve a 14 percent net profit before taxes. In light of the Company's 11.8 percent NPBT in 1978, DATAQUEST is assuming that Mostek's NPBT will improve slightly this year.

DATAQUEST expects that the first quarter will continue to show to some extent the financial effect of the Fab IV yield problem which was resolved in late 1978-early 1979.

Sales per employee increased to $29,000 in 1978 from $26,000 in 1977.

2. Capital and Capacity

Mostek expects capital expenditures to reach $32 million in 1979 of which $7 million will be for new facilities. DATAQUEST anticipates that a significant portion of this capital will be expended on its new facilities in Colorado Springs. We understand that the initial facility will be about 150,000 square feet. It will contain one wafer fabrication module which will be roughly equivalent in capacity and technology to Fab IV, which began processing silicon in mid-1978.

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3. 1977-1978 Comparisons

Mostek displayed several charts showing the shift of business mix between 1977 and 1978 and also data relative to unit shipments on various key products. Table 1 represents DATAQUEST's estimates of dollar shipments by major business segment. This table was constructed by using the slide presented by Mostek showing major segments and DATAQUEST's estimates within the Miscellaneous category.

Table 2 was presented at the meeting.

Table 1

MOSTEK CORPORATION
ESTIMATED REVENUES BY MAJOR CATEGORY

($ in Millions)

	1978	1979
Memory	$105	$119
Memory Systems	5	12
Microprocessors & Systems	5	20
Telecommunications	8	12
Miscellaneous	11	12
Total Revenues	$134	$175

Source: Mostek Corporation
DATAQUEST, Inc., Estimates
March 1979

Table 2

MOSTEK CORPORATION
KEY PRODUCT SALES COMPARISONS

(Units in Millions)

Product Type	1978	1979
16K Dynamic RAM	5.0	13.0
4K Dynamic RAM	16.0	10.0
4K Static RAM	0.8	3.5
Microprocessors	1.2	3.5
Telecommunications	3.0	4.4

Source: Mostek Corporation
March 1979

4. Corporate Focus/New Products

Mostek then commented on its areas of concentration:

Memory
In 1978, the Company introduced four new products. In 1979, the plan is for eleven new memory products—four dynamic, five static, one EPROM, and one ROM. The 64K dynamic MOS RAM is scheduled for sampling in the second quarter.

Telecommunications
In 1978, the Company introduced four new products. In 1979, Mostek expects to introduce seven new products including a filter utilizing CCD technology. The part number is MK5200. It will be a rather small chip, 88x201 mils.

Microcomputers
In 1979, Mostek expects to introduce eight new products.

Miscellaneous
- Mostek's backlog of orders for dynamic and static RAMs is scheduled into the third quarter.

- Distributor shipments in 1978 were about 15 percent of total sales.

The outlook for Mostek in 1979 appears quite good. If DATAQUEST's sales estimate of $175 million is achieved, along with a retention of the 40 percent tax rate, Mostek should earn between $2.55 and $2.65 per share in 1979 (based on 12 percent NPBT).

James F. Riley

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

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March 6, 1979

U.S GOVERNMENT ISSUES AFFECTING THE SEMICONDUCTOR INDUSTRY: INTERNATIONAL TRADE NEGOTIATIONS AND EXPORT CONTROL LEGISLATION

Summary

Federal Government activities that could impact the U.S. semiconductor industry continued on two fronts in recent months. First, the Executive branch is presently lobbying to secure eventual Congressional support for a trade bill containing the key provisions of agreements reached recently at the Multilateral Trade Negotiations in Geneva. These agreements address several nontariff issues that are felt to restrain free and open trade among participating countries, i.e., subsidies and countervailing duties, technical barriers to trade, government procurement policies, import-licensing procedures, and customs valuation policies. Second, the proposed Technology Transfer Ban Act of 1978 (see DATAQUEST Research Newsletter, October 31, 1978) has been revised, and a new, less restrictive bill is expected to be introduced soon in the House of Representatives.

Provisions of the Multilateral Trade Negotiations - Geneva

Selected representatives from various industry groups, including the U.S. semiconductor industry, have been meeting in Washington, to review those key provisions of an international trade agreement that have already been agreed to in the Multilateral Trade Negotiations in Geneva. The purpose of these initial meetings is to assess the results of the international negotiations on tariff and nontariff barriers to trade, and to begin to prepare an analysis of the outcome of these negotiations and their likely impact on U.S. industry.

These provisions will likely form a significant part of a trade bill which the Carter Administration will submit to Congress in April 1979. The President's Special Trade Advisor, Robert Strauss, is heading an intensive lobbying program aimed at securing congressional approval for this bill.

Of particular interest to the U.S. semiconductor industry are the agreements reached in the following nontariff areas:

1. Subsidies and countervailing duties
2. Technical barriers to trade (standards)

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3. Government procurement
4. Import licensing procedures
5. Customs valuation

DATAQUEST has obtained a copy of the working documents covering these and other issues on which agreement has been reached during the Multilateral Trade Negotiations. These documents will form the basis for drafting the final legal agreement that should be signed in Geneva shortly. Below is a summary of those agreements of particular interest to the semiconductor industry.

Subsidies and Countervailing Duties

Stronger controls have been sought over use of foreign government subsidies that confer what are felt to be unfair competitive advantages upon the products of the subsidizing country. A draft Arrangement on Subsidies and Countervailing Duties was developed in Geneva and provides the following items that address this issue.

1. A flat prohibition of export subsidies on nonprimary products as well as on primary mineral products

2. A definition of export subsidy that abolishes the existing dual-pricing requirement and provides an updated list

3. Recognition that while domestic subsidies are often used to promote important objectives of national policy, they can also have harmful trade effects. Relief, including countermeasures, is made available where such subsidies either:

   (a) Injure producers in the importing country

   (b) Nullify or impair benefits of earlier concessions reached under the General Agreements on Trade and Tariffs (GATT)

   (c) Cause serious prejudice to the interests of other GATT signatories

4. Recognition that where domestic subsidies are granted on noncommercial terms, trade distortions are likely to arise. Commitment by the signatories to "take into account" conditions of world trade and production (e.g. prices, capacity, etc.) in drafting of their subsidy practices

5. Provision for special and differential treatment under which Less Developed Countries (LDCs) could not use export subsidies where such subsidies adversely affect the trade or production interests of other countries. Provision for negotiated phase-outs of export subsidies by LDCs

6. Adoption of tight dispute settlement process to enforce the Code which would require that panel findings regarding rights and obligations within 120 days of a complaint

7. Provision for the design of an injury and causation test to afford relief in cases where subsidized goods have impacted producers in the importing country either through a volume or price effect. This provision makes no distinction between export or domestic subsidies, but is concerned only with whether the goods have been subsidized. These countervailing duty action requests must include sufficient evidence of the existence of:

   (a) A subsidy and, if possible, the amount of that subsidy

   (b) Injury, which is taken to mean material injury or threat of injury to an industry in the importing country, or material retardation of the establishment of such an industry

   (c) A causal link between the subsidized products and the alleged injury

   No countervailing duties may be levied on any exported product in excess of the amount of the subsidy, calculated in terms of subsidization per unit of the subsidized exported product. In instances where a finding of a threat of injury or material retardation is made (but no injury has yet occurred), countervailing duties may be imposed only from the date of the finding of the threat of injury or material retardation.

Technical Barriers to Trade (Standards)

The Code of Conduct for Preventing Technical Barriers to Trade (Standards Code) is designed to reduce trade obstacles that result from the preparation, adoption, and application of product standards and certification systems. The code contains specific obligations and procedures to ensure that standards and certification systems are not used as barriers to trade. Standards (both voluntary and mandatory) and certification systems promulgated by central governments, state and local governments, and private sector organizations are all subject to the Code's provisions, although only central governments are bound by the Code.

A fundamental obligation of the Code is that signatories not allow standards and certification systems to be prepared, adopted, or applied so as to create unnecessary obstacles to international trade. The Code also obliges national and regional certification systems to grant access (i.e., permit goods to be certified under the rules of the system) to foreign or nonmember suppliers on the same basis that access is granted to a domestic or member supplier.

All standards and rules of certification systems must be published.

Upon a specific request, Code signatories are to provide technical assistance in the standards field to developing countries.

Government Procurement

The keystone of this Code is the elimination of discrimination against foreign suppliers when governments purchase articles for their own use. The most obvious form of such discrimination against foreign suppliers is the clearly stated preference maintained by some countries for domestic suppliers.

A much more difficult task addressed by the Code is the elimination of discrimination caused by the absence of procurement rules, or the invisible use of existing practices and procedures to bring about discrimination. The first obligation of the Code signatories is that they publish their procurement laws and regulations and that those laws and regulations reflect the rules of the Code.

Purchasing entities are obligated to publish all bid opportunities. Under this procedure, all interested suppliers may bid, but the Code does provide for a "selective" procedure under which the government may invite bids from selected suppliers. Use of "single tender" procedures, or going to a single supplier is permitted only under strictly defined conditions, e.g., when a national disaster demands immediate procurement from the first available source.

Code rules are designed to discourage discrimination against foreign suppliers and supplies at all stages of the procurement process. Specific rules are prescribed on the drafting of specifications for goods to be purchased, advertising of prospective purchases (including the details for inclusion in the notice and the tender document), and time allotted for the preparation and submission of bids.

Governments will be prohibited from requiring that a supplier license his technology as a condition for an award of a procurement contract. While the Code would not prohibit the granting of an offset as a condition of award, signatories might recognize that offsets should be limited and used in a non-discriminatory way.

Import Licensing

The draft Code deals with the administration of import licensing procedures, rather than with the existence or extent of quantitative import restrictions. Its purpose is to simplify and harmonize to the greatest extent possible the procedures that importers must follow in obtaining an import license. To accomplish this simplification, the draft Code stipulates that the rules governing procedures for submitting applications to import licensing systems must be available in published form. The Code also specifies that importers will have to go to only one administrative body to apply for a license. A "reasonable" time period is to be allowed for applying for a license, and no application is to be refused for minor documentation errors.

A section on automatic import licensing (defined as instances under which licenses are granted freely) specifies that automatic import licensing systems should be maintained for as long as the circumstances that gave rise to their introduction prevail, or as long as their underlying administrative purposes cannot be achieved in another way. The Code states that licenses required under this type of system are to be made available to anyone fulfilling the prescribed criteria, and that they are to be granted immediately.

A section on nonautomatic import licensing systems (those under which licenses are not granted automatically, including licenses required for the administration of quotas and other import restrictions) specifies that governments are to provide information concerning the number and value of licenses granted, and to permit any person, firm, or institution to apply for a license.

Customs Valuation

The Customs Valuation Agreement sets out five methods for determining customs value. These five methods are arranged in a hierarchical fashion; that is, the order of precedence governs the application of each of the methods. The first, or primary, method is to be used in all cases unless a valid customs value cannot be found. In such cases, the second method is to be used. If a valid customs value cannot be found using the second method, the third method is to be used and so on.

The first or primary method specifies that a customs value shall be determined based on the transaction value of the imported goods. The transaction value is the price actually paid or payable for the goods with additions of certain charges, costs, and expenses incurred with respect to the imported goods that are not actually paid for or payable (i.e., selling commissions, brokerage fees, and container costs).

The Code specifies four conditions for which the transaction value of the imported goods may be rejected as the customs value. These are:

1. Where the seller places restrictions on the buyer as to the use or disposition of the goods

2. Where the sale or price of the goods is contingent on some factor for which a value cannot be determined

3. Where the seller, in partial payment for his goods, receives some percentage of the proceeds from the resale of the goods by the importer, and the transaction value cannot be adjusted to reflect this amount

4. Where the buyer and the seller are related and their relationship influences the price of the imported goods

The second method of calculating customs value uses the transaction value of identical goods for export to the same country of importation at about the same time as the sale of the imported goods.

The third method of determining customs value, to be used if the first and second cannot, uses the transaction value of similar goods for the export to the same country at, or about, the same time as the sale of the imported goods.

The fourth method bases customs value on the unit price at which the imported (or identical or similar) goods are resold in the greatest aggregate quantity, at or about the time of the importation of the goods being valued, in the country of importation, and in the same condition as imported to unrelated buyers.

The fifth method bases customs value on a computed value, which consists of material and manufacturing costs, profit, and general expenses. This method is similar to the constructed value method in U.S. customs law.

Export Controls—Technology Transfer Ban Act

A new, less restrictive version of the Technology Transfer Ban Act of 1978 will be introduced into the U.S. House of Representatives soon.

Last year's version of this legislation, which was endorsed by 77 members of the House of Representatives, would have prohibited the sale of any technology or product which had a potential military or crime control and detection application to any Communist country or to any other country which failed to impose similar restrictions on the sale of such equipment to non-market countries. U.S. high technology companies were strongly opposed to this legislation last year because of its likely adverse impact on the sale of many products to destinations throughout the world.

The new version of the Technology Transfer Ban Act, expected to be introduced later this month by Rep. Clarence Miller (R.-Ohio), will shift the responsibility of determining what technologies and products should be banned or otherwise controlled for sale to Communist countries from the Commerce Department to the Department of Defense (DOD). Under the draft provisions of the new legislation, the Secretary of Defense would have 180 days to develop a list of "critical" and "significant" goods and technologies whose export would be either banned or subject to additional controls.

Under the proposed legislation, the export of "critical" goods and technologies would be prohibited to Communist countries, while the sale of "significant" technologies or products would be permitted only after review by the U.S. government on a case-by-case basis. Even significant technologies or goods could not be sold to non-Communist countries unless that country provided "adequate assurances" that the exported item will not be re-exported to a Communist country.

Under the provision of the draft proposal, "critical goods" are defined to be any product which:

1. May contribute significantly to the transfer of a critical technology because it:

   (a) Embodies extractable critical technology

   (b) Fills a gap in the recipient nation's knowledge and so would enable it to utilize fully a critical technology which it had partially developed or otherwise obtained

2. If analyzed, would reveal all or part of the nature of a U.S. military system and thus facilitate the development of countermeasures to such a system

"Significant" technologies and goods are defined to be:

1. A U.S. technology or good (other than a critical technology or good) which would make a significant contribution to the military potential of a controlled (i.e., Communist) country

2. A technology which is obsolete by U.S. standards, but which nevertheless is superior to a controlled nation's technology or goods

While the proposed legislation does not specifically outline which criteria should be used by the DOD to develop the lists of "critical" and "significant" technologies and goods, U.S. firms have some idea of what the DOD might consider to be critical in nature from the Department's own efforts to develop a "critical technologies" list.

Late last year, the DOD identified nine technologies which it viewed as being critical to U.S. national security. These were:

- Array Processor Technology
- Acoustic Array Technology
- Computer Network Technology
- High Energy Laser Technology
- Diffusion Bonding Technology
- Large Scale Integrated Circuit Production Technology
- Jet Engine Technology
- Infrared Detection Technology
- Wide-Bodied Aircraft Technology

Just last month, however, a DOD representative told a group of industry officials that the DOD's critical technologies list would consist of "about 18 items" or twice the number originally identified.

The list of 18 critical technologies has been distilled from an initial list of over 130 items originally compiled by the DOD about two years ago. In fact, however, many of the original 130 categories not now listed as "critical" could well find themselves on the list of "significant" technologies should the revised Technology Transfer Ban Act be enacted into law.

Should this bill be enacted into law, U.S. high technology exporters could be faced with a whole new set of unilaterally imposed controls on the shipment of goods and the exchange of technologies to most countries in the world. Even if U.S. companies are allowed to sell their products, many such sales will have to be reviewed on a case-by-case basis, which will add delay, uncertainty, and possibly result in a competitive disadvantage in world markets.

James F. Riley
Daniel L. Klesken
Frederick L. Zieber

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Newsletters March 7, 1979

PROPOSED 1979 SEMICONDUCTOR INDUSTRY SERVICE PUBLICATIONS

This newsletter contains the proposed research schedule of DATAQUEST's Semiconductor Industry Service for 1979. We are planning approximately 53 newsletters, 14 notebook sections, and 29 company financial updates. Among the notebook sections are major research efforts on telecommunications, semiconductor markets by end-user, distribution, and semiconductor equipment markets.

DATAQUEST's annual Semiconductor Industry Conference is scheduled for October 17 to 19 in Scottsdale, Arizona.

Newsletters

Newsletters are published on timely industry events and issues. Quarterly newsletters are published on MOS memory shipments, MOS microprocessor shipments, the general industry forecast, and U.S. Government issues affecting the semiconductor industry.

Beginning in the second quarter of 1979, we plan an important series of newsletters on the European semiconductor industry and markets, which we propose to update semiannually. We also plan a newsletter on the Japanese semiconductor industry and updates on the five major U.S. semiconductor companies.

We plan to publish a number of other short newsletters throughout the year on subjects of interest to our clients, including semiconductor procurement outlook, captive suppliers, silicon forecast, capital expenditures, facilities, and packaging. Major notebook sections dealing with semiconductor markets by end-user, telecommunications, and distribution trends will be accompanied by a condensed version in newsletter form.

Notebook Sections

In 1979, we plan to publish an expanded edition of Appendix A in which the problem created by fluctuating exchange rates will be dealt with more completely. We have already published a preliminary version of Appendix B: Market Share Estimates, in February 1979; the final version will be available in the second quarter.

Several major market reports are proposed for the notebook including semiconductor equipment markets, the telecommunications market, trends in distribution, and semiconductor markets by end-users.

As in past years, financial updates for major semiconductor manufacturers and distributors will be provided.

As always, the Semiconductor Industry Service attempts to be responsive to the needs of our clients and to report on timely issues in a timely manner. Therefore, items may be added to or deleted from this list so that we may be flexible enough to respond to changing needs. Your recommendations and requests are always welcome.

Conference

The annual DATAQUEST Semiconductor Industry Service Conference is scheduled for Scottsdale, Arizona, on October 17 through 19. The Conference will focus on several important aspects of VLSI and the electronics world trade issue.

James F. Riley
Frederick L. Zieber
Daniel L. Klesken

1979 PROPOSED SIS NEWSLETTERS

	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total
General Industry Forecast	1	1	1	1	4
*European Semiconductor Industry and Markets		1		1	2
*Major European Semiconductor Manufacturer Updates			1		1
Japanese Semiconductor Industry			1		1
Fairchild Update	1			1	2
National Update	1			1	2
Intel Update			1		1
Motorola Update			1		1
Texas Instruments Update			1		1
*Signetics Update			1		1
MOS Memory Quarterly Shipments	1	1	1	1	4
MOS MPU Quarterly Shipments	1	1	1	1	4
*Bipolar Memory Market Share Estimates	1				1
*MOS Memory Market Share Estimates		1			1
*Estimated MOS Microprocessor Consumption	1				1
Estimated MOS Memory Consumption		1		1	2
*Discrete Device Market	1		1		2
*Magnetic Bubble Market		1			1
*CCD Market			1		1
U.S. Government Issues Affecting the Semiconductor Industry	1	1	1	1	4
*Optoelectronics Market			1		1
*Telecommunications Market		1			1
*Manufacturing Model Update				1	1
*Semiconductor Procurement Outlook		1		1	2
*Captive Supplier Analysis		1		1	2
*Silicon Forecast and Trends			1		1
*Semiconductor Markets by End User		1			1
*Silicon-on-Sapphire Update	1				1
Capital Expenditures		1		1	2
*Facilities Census	1				1
*Packaging Trends	1				1
Preliminary Market Share Estimates-Appendix B	1				1
*Semiconductor Equipment Trends			1		1
Totals	13	13	15	12	53

*Indicates new subjects for 1979

1979 PROPOSED SIS NOTEBOOK SECTIONS

Chapter/ Section	Title	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total
*2	Semiconductor Equipment Trends			1		1
*2	Telecommunications Market		1			1
*2	Microprocessor Update			1		1
*3	Manufacturing Model Update				1	1
*3	Facilities Census			1		1
*3	Packaging Trends		1			1
*4	Silicon Forecast Techonology/Trends			1		1
* 6	International Subjects (to be determined)			1		1
*7	Quo Vadis Distribution?		1			1
App.A	Market Estimate Worksheets		1			1
App.B	Preliminary Market Share Estimate Worksheets	1				1
App.B	Final Market Share Estimate Worksheets		1			1
App.B	Captive Semiconductor Production			1		1
App.C	Semiconductor Markets by End-User		1			1
	Totals	1	6	6	1	14

Company Financial Updates

U.S. Companies

8.02	Fairchild	1				1
8.04	Intel	1				1
8.06	Motorola		1			1
8.08	National			1		1
8.10	Signetics		1			1
8.12	Texas Instruments		1			1
8.20	AMD			1		1
8.24	AMI		1			1
* 8.25	Analog Devices	1				1
8.26	Electronic Arrays			1		1
* 8.30	International Rectifier				1	1
8.34	Intersil	1				1
8.40	Mostek	1				1
* 8.41	Siliconix			1		1
8.56	Unitrode			1		1
8.86	Varo			1		1

*Indicates new subjects for 1979

1979 PROPOSED SIS NOTEBOOK SECTIONS (Continued)

Chapter/ Section	Title	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total
	Japanese Manufacturers					
10.02	Hitachi		1			1
10.04	Matsushita Electric		1			1
10.06	Mitsubishi		1			1
10.08	Nippon Electric Co.		1			1
10.10	Toshiba		1			1
10.12	Fujitsu		1			1
	Distributors					
12.00	Arrow				1	1
12.01	Avnet				1	1
12.02	Cramer	1				1
12.03	Pioneer Standard				1	1
12.04	Sterling				1	1
12.05	Wyle				1	1
*12.15	Kierulff	1				1
Totals		7	10	6	6	29

*Indicates new subjects for 1979

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Newsletters March 6, 1979

INTERNATIONAL SOLID STATE CIRCUITS CONFERENCE 1979

Introduction

The International Solid State Circuits Conference (ISSCC) is probably the most important annual technical conference in the semiconductor industry; it is at this forum that many new technological trends become apparent. The conference was held in Philadelphia from 1953 to 1977. The 1978 meeting in San Francisco marked the first time the conference was held elsewhere. The 1979 conference was held in Philadelphia on February 14 to 16. In the future, it will alternate between the two cities.

Large Scale Integration

The tenor of this year's conference was set in the keynote speech by Dr. Gordon Moore of Intel. Dr. Moore indicated his belief that we are entering a new era in large scale integration—one in which it is difficult to define complex functions that totally utilize all the components that can be placed on an LSI chip. Dr. Moore showed a slide that plotted the complexity of various Intel products by calendar year. Interestingly, memory products have increased in complexity, according to "Moore's Law," but other products such as microprocessors and microprocessor peripherals have not. ("Moore's Law," as formulated by Dr. Moore, predicts a doubling in complexity every year, declining somewhat in the 1980s.) Dr. Moore believes that the lower complexity of non-memory products stems from an inability to create functions that totally use the power of today's LSI circuits.

A manufacturer of complex LSI circuits must have a span of capability that ranges from silicon processing to systems. That span of talent is being assembled by components manufacturers, by systems manufacturers with captive manufacturing capability, and by various cooperative arrangements between systems and semiconductor manufacturers. Dr. Moore commented that systems manufacturers with captive semiconductor facilities now have a greater opportunity for success because they can make unique systems functions that preserve their investment in architecture and software; generally the necessary LSI circuits are made in such small quantities that the semiconductor industry cannot handle these requirements economically. Dr. Moore supported this thesis by citing DATAQUEST information that indicates that the number of captive suppliers increased by 226 percent (from 19 to 43) between 1975 and 1979, while the number of merchant suppliers fell by 13 percent (from 93 to 81). Dr. Moore also commented that the cost of designing a circuit is increasing, roughly in proportion to its complexity. Since manufacturing cost does not increase in proportion to complexity, each new design will need to be amortized over a larger production quantity if the design cost is to remain a constant percentage of the manufacturing cost. This trend may favor increased captive production of LSI.

Papers Presented at Technical Sessions

Interestingly, a number of papers, presented mainly by systems organizations, tended to support Dr. Moore's thesis. These papers all described LSI devices that tolerated inefficient use of LSI technology to obtain other objectives:

- Random access memories (RAMs) that incorporate extra bits to replace those rendered inoperative by yield defects were described by Bell Labs (Session 12.6), IBM (Session 12.8), and in Session 1.4 by Nippon Telephone and Telegraph (NTT). Bell Labs' 64K RAM stores the bad locations on-chip through the use of laser-fusible links. IBM's 64K RAM stores bad locations in fusible links that are blown by a high current pulse. Significantly, it appears that IBM has the only 64K RAM now in production, although Bell Labs may also be producing the device. In NTT's circuit, a one megabit full-wafer RAM is achieved, and the "bad location" storage is off-chip.

- LSI arrays were described in four papers given in Session 6. These arrays reduce design cost because only the metal mask or masks need be changed to produce a custom circuit. These arrays use silicon inefficiently because most designs do not require all the logic available on the chip. These papers were given by IBM (2 papers), NTT-Hitachi, and Siemens.

- A method of designing a chip that reduces both the engineering cost of developing a test program and the manufacturing cost of performing the test was described by Philips (Session 18.4) and IBM (Session 18.5 and 18.6). Philips estimates that the method adds 3 percent to chip area and IBM estimates the added area is between 4 percent and 20 percent. IBM estimates that only 10,000 test patterns are required with the new method whereas at least 10 to 100 times more test patterns are required with older methods, and implied that the savings in test time more than makes up for the cost of the added silicon.

This year, 97 papers (exclusive of panel discussions) were presented at ISSCC. This is an increase of five papers over last year and an increase from 49 papers in 1964. However, if anything, the quality of papers has improved with the increasing quantities, thus indicating that the technological capability of the semiconductor industry is still strong.

Of the 97 papers presented, 65 percent were of U.S. origin, 21 percent of Japanese origin, and 14 percent of European origin. Interestingly, these percentages roughly reflect the share of merchant semiconductor sales shipped by U.S., Japanese, and European companies—63 percent, 23 percent, and 14 percent, respectively. All but two of the European papers were given by either Philips, Siemens, or Thompson-CSF.

Other Highlights

The topic of combined digital and linear circuitry accounted for the largest number of papers (25). Sessions 2 and 7 were devoted to telecommunications circuit techniques and analog signal processing. Of the 11 papers presented at these sessions, five described filters mechanized with the switched capacitor technique, while only two described CCD filters; it appears that the switched capacitor filter represents an important new technique. The other four papers did not discuss filtering. Sessions 11 and 14 were devoted to data acquisition and mostly discussed various analog-to-digital converter implementations. Notable among these was AMD's circuit (Session 14.2) that managed to achieve 12-bit accuracies using only untrimmed diffused resistors. Intel (Session 16.3) described a novel microprocessor with analog inputs and outputs. This device can be programmed to achieve up to 40 poles of filtering and can also perform functions usually done by mixers, detectors, and automatic gain control circuits.

Semiconductor memory, with three sessions and 21 papers devoted to it, represented the second most popular topic. It appears that it will someday be possible to eliminate capacitor storage from dynamic RAMs. Instead, charge will be stored under the gate of an MOS transistor, where it effectively acts to modify the threshold of the device. This technique has three advantages:

- The storage cell is smaller because no capacitor is required.
- Sensing is much simpler; the impedance of the MOS device is sensed instead of the charge being stored on a capacitor.
- Storage times are longer at high temperature because certain types of leakage current are rendered ineffective.

Texas Instruments described a "taper isolated cell" (Session 1.6) and Intel described a "vertical CCD" (Session 12.7). Both approaches promise to achieve the three objectives listed above.

Also notable in the memory sessions were descriptions of NTT's 128K-bit ROM (Session 1.1), a device fabricated with direct electron-beam data writing and boasting 2-micron geometries. Intel described a self-refreshing n-channel 4K RAM (Session 1.3) that achieves standby power similar to that of CMOS RAMs. Intel also described a 4K static RAM (Session 9.2) with access time of 25 nanoseconds and a 16K static RAM (Session 9.5) with access time of 40 nanoseconds. Both devices employ channel lengths of 2 to 3 microns.

Bipolar memories still maintained a speed advantage, with two RAMs by Hitachi achieving a 5.5 nanosecond access time for a 1K-bit chip (Session 9.1) and a 6 nanosecond access time for a 4K-bit chip (Session 9.6). The 4K-bit chip employed 2-micron geometries. Dynamic RAMs showed few unexpected technical innovations, but both Mostek's 2Kx8 RAM (Session 12.3) and Zilog's 4Kx8 RAM (Session 12.9) provided on-chip circuitry that manages refreshing for the user. These RAMs offer 8-bit outputs and are intended for use in micro-processor applications.

Digital circuits (18 papers) and microwave applications (13 papers) were the third and fourth most popular areas.

Howard Z. Bogert

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: 8.02 Fairchild Camera & Instrument

February 20, 1979

UPDATE ON FAIRCHILD

Summary

Fairchild has reported total 1978 sales of $534 million plus royalties and other income of $16 million for total revenues of $550 million. This is an increase of 17 percent over 1977's $470 million. Net income in 1978 was $24.8 million ($4.48 per share) up sharply from $11.2 million ($2.06 per share) in 1977. This increase comes despite continued difficulties in consumer electronics. Fairchild faces intense competition, especially in semiconductors, but has benefited from a strong market. The following major factors shape the Company's current outlook:

- Inadequate capacity expansion in 1977 caused Fairchild's 1978 semiconductor growth to lag the semiconductor industry, resulting in a loss of market share. This loss was exacerbated by product positioning problems in some of the Company's key product lines.

- Fairchild's major LSI strength—bipolar memories—continues to expand with extremely strong market demand, but faces increased competition from other companies.

- DATAQUEST expects that Fairchild will make MOS a major corporate priority in 1979.

- Fairchild has had successful market entry with its new high-speed Schottky circuits, but market size and acceptance remain in doubt.

- Fairchild is expected to become an important second source of 6800 microprocessors to General Motors, and is also expected to participate in other significant automotive opportunities.

- Fairchild's Government and Industrial Products Group is profitable and should grow about 17 percent this year, while its Test Systems Group is quite profitable and should grow about 56 percent in 1979.

- DATAQUEST expects that Fairchild may withdraw totally from the consumer electronics business in 1979 as this group had losses and write-offs estimated at $18 million in 1978.

- Capital expenditures for 1979 are expected to increase to more than $80 million, up more than 150 percent from $32 million in 1978.

- Part ownership of Magnuson (35 percent) and a joint venture with GEC in England appear to be progressing satisfactorily.

Estimated Revenues

DATAQUEST's revenue estimates for 1976 through 1979 for each of Fairchild's operating groups are presented in Table 1. Total revenues in 1978 were $550 million, up 17 percent from $470 million in 1977. We expect Fairchild's 1979 revenues to grow about 12 percent to $615 million. This growth is reasonable in view of declining revenues from its consumer operations. Estimated consumer revenues were $59 million in 1977, $36 million in 1978, and are expected to be about $5 million in 1979. Fairchild's growth in 1979 should come from systems, which is expected to grow about 56 percent to $125 million, and semiconductors, which is expected to grow about 14 percent to $434 million.

DATAQUEST expects Fairchild's first quarter 1979 revenues to decline about $15 million from the fourth quarter of 1978 because of lower consumer product revenues and fewer shipments of test systems. The latter group experienced a shipping bulge in the fourth quarter and is now adding three new systems service centers. Fairchild is allocating some of its first quarter test system production for the equipping of these service centers. This will result in higher manufacturing costs with no commensurate increase in first quarter shipments and revenues.

Royalties and other income provided Fairchild revenue of about $16 million in 1978. We believe that about $6 million came from interest income, sale of Cray Research stock, and special one-time technology licensing. About $10 million, therefore, represents a recurring but decreasing base of patent royalty income.

Semiconductors are the largest product group in Fairchild. DATAQUEST estimates of Fairchild's revenues from semiconductors are shown in Table 2. Fairchild divides its Semiconductor Group into two areas, components and LSI (large scale integration). Generally, small chips are included in the Components Group and larger chips in the LSI Group. Because of changes in reporting from year to year, comparisons for these groups over time are hazardous. During 1978, some product groups were moved from LSI to Components. Thus, year-to-year growth in the digital IC area is not as high as the numbers imply and the LSI numbers do not reflect all growth in the bipolar memory area as some of the products are in the Components Group.

Table 1

Fairchild Camera and Instrument Corporation

ESTIMATED REVENUES 1976-1979

(Dollars in Millions)

	1976	1977	1978	1979
Semiconductor	$307	$323	$380	$434
Government and Industrial	42	49	57	67
Government	-	-	36	43
Industrial	-	-	21	24
Test Systems	23	43	80	125
Consumer	104	59	36	5
Games	10	29	18	-
Watches	69	30	18	-
Components[1]	25	-	-	-
Intracompany	(33)	(14)	(19)	(25)
Royalties & Licensing[2]	7	10	16	9
Total Revenues	$450	$470	$550	$615
Net Profit After Tax (Percent)	2.77%	2.37%	4.50%	5.00%
Net Income	$12.46	$11.16	$24.76	$30.75
Earnings Per Share (In Dollars)	$ 2.41	$ 2.06	$ 4.48	$ 5.55

[1]This figure, primarily Optoelectronics, is included in Semiconductor after 1976.

[2]In 1978, approximately $10 million of the total was royalty income.

Source: DATAQUEST, Inc.
February 1979

Table 2

Fairchild Camera and Instrument Corporation

ESTIMATED SEMICONDUCTOR REVENUES 1976-1979[1]

(Dollars in Millions)

	1976	1977	1978	1979
Components				
Digital ICs	$ 70	$ 78	$ 92	$102
Linear	63	52	61	68
Discrete	78	79	87	95
Hybrids	-	-	20	25
Optoelectronics	25	16	18	20
Total Components	$236	$225	$278	$310
LSI				
Bipolar	$ 36	$ 40	$ 51	$ 63
MOS	35	58	51	61
Total LSI	$ 71	$ 98	$102	$124
Total Semiconductor	$307	$323	$380	$434

[1]During 1978, some product groups were moved from LSI to Components. Thus, year-to-year numbers are not comparable.

Source: DATAQUEST, Inc.
February 1979

Margin Analysis

In 1978, Fairchild earned $24.8 million after taxes ($4.48 per share) for an after-tax margin of 4.5 percent. Its pretax earnings were $40.6 million, which includes an estimated $18 million of operating losses and write-offs in its consumer operations. Partially offsetting the consumer losses were some one-time income items from the sale of Cray Research stock, patent settlements with Thompson CSF, and possibly other items. Discounting the heavy losses in consumer operations, Fairchild's operating margins for the other operations are estimated by DATAQUEST to be: Semiconductors about 8 percent, Government about 10 percent, Industrial Products about 15 percent, and Test Systems about 20 percent.

On a normalized basis, excluding nonrecurring items such as losses from consumer operations, the sale of Cray Research stock, and individual patent settlements, DATAQUEST estimates that Fairchild could have earned about $52 million net profit before taxes in 1978, or $31.2 million net profit after taxes ($5.65 per share). True earnings computations are never as simplistic as the above, but the analysis indicates Fairchild's ability to be reasonably profitable in its basic businesses of semiconductors, systems, government, and industrial. We believe that these basic and continuing operations earned about $1.40 per share in the fourth quarter of 1978, after excluding year-end adjustments as discussed above, versus the $1.09 per share reported.

Realizing that in 1979 Fairchild must invest substantially in its basic semiconductor business, and assuming a 13 percent growth in U.S semiconductor consumption, DATAQUEST estimates that Fairchild can earn at least 5 percent net profit after taxes on revenues of about $615 million for a net after-tax profit of at least $30.75 million ($5.55 per share). We believe the above numbers can be achieved, despite a substantial investment in MOS and Test Systems in 1979.

Semiconductor Groups

In 1978, the Semiconductor Groups at Fairchild grew by about $57 million or 17.6 percent. This performance is somewhat less than U.S. semiconductor consumption, which grew about 20 percent; therefore, the Company lost market share in 1978. In integrated circuits (ICs), it slipped from third to fifth in dollar volume among U.S. suppliers, taking a place behind Texas Instruments, Motorola, National, and Intel.

Fairchild's growth in 1978 was limited by a lack of wafer fabrication capacity at the start of the year. This problem has been remedied by new capacity coming on stream, and 1979 revenue growth for the Semiconductor Groups is expected to be about $54 million or 14.2 percent, which is slightly above the expected growth in U.S. semiconductor consumption of 13.1 percent. Achieving this growth is closely related to Fairchild's ability to improve its position in MOS.

Both Fairchild's competitive position in semiconductors and its long-term growth are constrained by its current product mix. This product positioning problem can be expected to remain for some time. Although over two-thirds of the semiconductor revenues are ICs, a number of major revenue segments are in product areas that are currently experiencing slow growth, or are expected to slow in the near future. Specifically, these include small signal transistors and diodes, digital bipolar integrated circuits (SSI - small scale integration), some linear circuits, and some MOS products. The Company's position in MOS (eleventh among U.S. producers) was a weakness in 1978 and is the major corporate challenge in 1979.

To support both future growth and profits, Fairchild needs to find growth areas in which it can gain a significant market share and then use these growth areas to strengthen its competitive position. Because of its general weakness in MOS, it must invest heavily in this area and find those market niches where it can excel. Fairchild does have several areas of promise, including bipolar memory, CCD devices, low-power Schottky, CMOS, ECL, hybrids, and others.

Digital ICs

The digital bipolar market grew rapidly in 1978, but it is expected to have much slower growth rates in the future as its markets are eroded by incursions from MOS LSI. Thus, we believe Fairchild's position in TTL SSI has only a limited future. However, Fairchild is well positioned within that segment to take advantage of the growing low-power Schottky TTL market. While this market is still dominated by Texas Instruments, Fairchild has a significant market share.

Recently, Fairchild introduced a new line of fast Schottky TTL devices. These devices, with the acronym FAST (Fairchild Advanced Schottky TTL), are designed to compete in the market niche between TTL and very fast ECL devices. They have improved performance over the older Schottky TTL. Because of Fairchild's product announcements, a similar line due to be introduced by Texas Instruments was delayed. These circuits were designed at Fairchild's facility in England, with initial production at its facility in Portland, Maine.

Initial market acceptance has been enthusiastic, but Fairchild will have to fill out the line with a full range of products. It is still too early to estimate total market size and acceptance. However, the movement of minicomputer manufacturers to faster logic may open some large potential markets.

Fairchild has become increasingly competitive in ECL (see DATAQUEST's newsletter dated August 3, 1978, "The Domestic ECL Market"). Overall in ECL, Fairchild is second in production only to Motorola. There are no other major merchant competitors at this time, although ECL is produced by Signetics and will probably be introduced in 1979 by National Semiconductor. Fairchild has the largest market share of ECL memory. Its 100K series devices, with subnanosecond gate delays, is providing competition to Motorola. Fairchild's ECL gate array, being the only one currently in production, is proving popular with computer manufacturers. Although other companies have more complex devices in the process of being designed, the availability of the Fairchild part has given it a significant market advantage.

Linear and Discrete

Fairchild's linear product line suffers from a number of older products. As a result, the Company has been losing market share in this product area for the past several years.

Fairchild suffers in the discrete semiconductor market from a lack of strong product focus and the generally slow (or negative) market growth for small signal devices. By generally holding margins in discrete, Fairchild can use it as a "cash cow" to finance investment in newer high-growth areas. As a result of this strategy, the Company has been gradually losing market share in discretes.

Hybrids

The Automotive/Hybrid Division makes devices for the automotive, consumer, industrial, and telecommunications industries. The majority of its production is automotive ignition systems; Fairchild recently shipped its ten millionth ignition module to General Motors. Because of the increase in automotive electronics and the general growth of hybrid devices in other areas, this division is expected to grow rapidly. The introduction of solid state engine control systems in automobiles in 1980 should allow rapid expansion. Sales in 1978 were about $20 million for this division and are expected to exceed $25 million in 1979.

DATAQUEST believes Fairchild has been selected by General Motors to second source the 6800 type microprocessor for GM's engine control system. Other substantial automotive revenues could result for 8K PROMs, as automobile manufacturers are planning to use PROMs in odometers and engine control systems. In the odometer application, a PROM fuse could be blown every 10 miles, thereby yielding a tamperproof odometer.

Fairchild has licensed Bosch in West Germany and Femsa in Spain to produce hybrids for automobiles. The Company gets royalties as well as device sales, and in this way has penetrated Ford Europe, Opel, and Volkswagen.

Optoelectronics

Fairchild's Optoelectronic Division is prospering despite the loss of significant captive business as its consumer operations decline. The Company has become a major producer of liquid crystal displays (LCDs), especially for the large digits used in industrial displays. LCD revenues were about $5 million in 1978 and are expected to double in 1979.

Bipolar

Fairchild is the leading producer of bipolar RAMs and has dominated this market for several years, but it now has competition from Signetics and Motorola. In addition, National Semiconductor is believed to be poised to enter the market in 1979, and MOS fast static RAMs available from Intel affect the market for bipolar RAMs. In 1978, Motorola and Signetics provided price competition in the bipolar RAM market in their bids to increase market share. Prices for 1K RAMs fell to about $3.00, resulting in decreased margins for Fairchild in this area. However, we note recent activity by Signetics appears to emphasize bipolar PROMs over bipolar RAMs.

Demand for bipolar RAMs has exceeded available supply, a condition that should last through part of 1979. We perceive that Fairchild has a cost advantage in bipolar RAMs and that competitive pressures have eased in recent months. Fairchild's 4K bipolar RAMs should be available in production volumes in 1979.

In bipolar PROMs, Fairchild shipped an estimated $15 million in 1978. This is an area where Signetics has a clear market advantage by virtue of being the only company shipping 16K bipolar PROMs—an advantage that it has used as a lever to increase its penetration in bipolar memory. Fairchild must meet this competition in 1979 to maintain its market leadership.

Fairchild is still the only major producer of devices with isoplanar technology—a technology that enables it to design extremely small die sizes. We understand that its 1K bipolar RAM is 6,000 square mils, the smallest on the market. As the market moves to 4K and 16K bipolar RAMs, this ability should be of increasing importance to Fairchild. We estimate that this process will account for 50 percent of its bipolar digital revenues by 1980.

The 9440 16-bit I^3L microprocessor has been sampled to more than 100 accounts. While this microprocessor may miss the mainstream 16-bit market, it should nonetheless provide good business for Fairchild. The microprocessor can compete effectively at the board or system level in specific applications and should prove popular with the military market. Fairchild's board and system products incorporating the 9440 are referred to as its Microflame products.

MOS

In MOS, Fairchild suffers from a lack of scale and a limited investment in design personnel. The inability to become a major MOS producer has been a significant problem with the Company for several years. However, rapid market growth in 1979 and industry undercapacity for MOS could provide the Company with time to improve its product and market position and attain improved economies of scale. We believe the Company will make a significant effort with substantial investment in MOS in 1979.

Fairchild and TI are the only major producers of charge coupled devices (CCDs). While market acceptance of this technology has been slower than previously anticipated, it is accelerating; the use of these devices for digital and optical applications can provide good future growth. Storage Technology and Memorex, among others, have designed CCDs into new memory systems that buffer large amounts of data between disc memory and main memory. The Company's 64K CCD has a $15 million backlog and production is capacity limited. Fairchild must get its CCD production down the learning curve quickly or some of the CCD opportunities will switch to alternate technologies. We believe that Fairchild is developing a large CCD memory system for a mainframe computer manufacturer.

Fairchild has a good market position in digital CMOS and trails only Motorola and RCA in this market. It is estimated that the Company shipped $12 million of CMOS in 1978.

Test Systems Group

The Test Systems Group was the fastest growing area in Fairchild in 1978 and is estimated by DATAQUEST to be the most profitable. Table 3 presents DATAQUEST's estimates of Test Systems Group revenues by major product line. Estimated revenues in 1978 were about $80 million and pretax profits are estimated to be in excess of $16 million. The group is expected to show substantial growth in 1979, with estimated revenues of about $125 million.

Fairchild is setting up service centers for its test systems, with six centers in the United States and three international centers in Munich, Hong Kong, and Singapore. While equipping these service centers will have a negative short-term effect, it will help place the Company in a good long-range position as less knowledgeable users begin to acquire test equipment.

The Test Systems Group is currently the largest manufacturer of semiconductor test equipment. Its Sentry testers have been extremely popular, with 1978 sales of about $55 million. The Sentry was designed several years ago and will be at an increasing competitive disadvantage as time progresses. However, the only major competitor that is positioned to take advantage of this is Tektronix. Fairchild must redesign its testers and revamp its product line in 1979 and 1980 to maintain its market share. This may have some impact on group profits.

The Company has recently introduced the Sentinel test system. This is a high-speed, high-throughput, low-priced LSI tester. The Sentinel system is aimed at Fairchild's current Sentry customers. We believe that this system represents a stopgap attempt by Fairchild to protect its customer base against smaller, lower-cost systems—a strategy that appears successful. We also believe that the Company already has a $10 million order backlog for the Sentinel at an average selling price of $150,000 per unit.

Table 3

Fairchild Camera and Instrument Corporation

ESTIMATED TEST SYSTEMS GROUP REVENUES 1976-1979

(Dollars in Millions)

Product Lines	1976	1977	1978	1979
Sentry	$20	$36	$55	$ 70
Sentinel	0	0	0	15
Xincom	1	5	10	15
Faultfinders and Testline[1]	0	0	14	25
Other Instruments[2]	2	2	1	0
Total Group Revenues	$23	$43	$80	$125

[1]Faultfinders and Testline were purchased in 1978. Estimated revenues for the full year are $19 million.

[2]Includes instruments such as digital panel meters and other bench-top testers. The last of these product lines was sold in 1978.

Source: DATAQUEST, Inc.
February 1979

Xincom had estimated revenues of more than $10 million in 1978, and its memory testers continue to be popular. In 1979, it is expected to introduce a high speed (25 mHz) memory tester to meet the rapidly growing market for fast MOS memories. In addition, Xincom is expected to introduce a tester for magnetic bubble memories. Fairchild is also expected to introduce a linear tester and an ECL tester in 1979 in a move to broaden and expand the Company's market position.

In 1978, the Company acquired two small test equipment manufacturers—Faultfinders in Latham, New York, and Testline in Titusville, Florida. Both of these groups make testers for in-circuit printed circuit board testers. These companies are expected to provide combined revenues of about $25 million in 1979.

Fairchild's commitment to this business is indicated by its capacity plans for 1979. Faultfinders will add 150,000 square feet, Testline will add 60,000 square feet, and Systems will add 60,000 square feet to support the Sentry product line.

Government and Industrial Products Group

The Government and Industrial Products Group has been consistently profitable for Fairchild for the last several years. The Government operation makes aerial reconnaissance cameras and electronic countermeasures equipment. A cockpit video camera for the military has generated considerable interest. The system uses Fairchild's 400-mil-square CCD die. Sales in 1978 are estimated at $35 million with 10 percent operating profit margin.

The Industrial Products Division makes rear-screen slide projectors, crash recorders, and cockpit voice recorders. A new weight and balance system for aircraft cargo loading is proving popular. DATAQUEST estimates that the Industrial Products Division had sales in 1978 of about $21 million, with an operating profit margin in the 15 percent range.

Consumer Products Group

The Consumer Products Group revenues declined in 1978 to an estimated $36 million from an estimated $59 million in 1977 and $79 million in 1976. At the end of 1978, Fairchild decided to withdraw from the digital watch business, and 1978 results include the write-offs associated with withdrawal. DATAQUEST believes that in 1978 the Consumer Products Group had an operating loss of $12 million plus an additional $6 million write-off for the Watch Division.

It is estimated that 1978 watch sales were about $18 million and that game sales were about $18 million. The Company has been hampered by a lack of new products, and its costs and prices are not competitive with other products on the market. Short term, we believe the games business will continue at a minimum level, with no new game consoles but continued sales of cartridges for an inventory workdown. At the appropriate time, we expect Fairchild to withdraw from the game business. The consumer business should not have a significant effect on Fairchild henceforth.

Capacity Expansion

Fairchild made moves to significantly expand its semiconductor capacity in 1978. Total capital expenditures for 1978 are estimated at $32 million and are believed to be budgeted at about $80 million for 1979. Semiconductor expansion in 1978 included a new 4-inch NMOS fabrication module in South San Jose, California, a 4-inch bipolar fabrication module for its FAST product family in Portland, Maine, and an update of its facility in Wappingers Falls, New York.

Joint Venture

In 1978, Fairchild concluded a joint venture agreement with the General Electric Company in England (no connection with General Electric in the United States) to establish a semiconductor production facility in the United Kingdom. The British Government will supply half the initial funding of $38 million. This venture will provide Fairchild with production facilities and market access in Europe as well as capital funds, as the British Government is providing Fairchild with funds for some of the Company's future capacity expansion. This deal is not dissimilar in that respect to arrangements made by Motorola and National Semiconductor in France.

Magnuson Industries

Fairchild now owns about 35 percent of Magnuson. Its initial investment was $4.5 million, part of which was convertible bonds. Magnuson is currently shipping computers and rapidly building production. However, the recent introduction by IBM of Models 4331 and 4341 may put some price pressure on plug-compatible manufacturers like Magnuson, but it is too early to determine the extent of this pressure.

James F. Riley
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DATAQUEST INCORPORATED RESEARCH NEWSLETTER

SIS Code: Newsletters January 24, 1979

PRELIMINARY MARKET SHARE ESTIMATES OF LEADING DOMESTIC MERCHANT SEMICONDUCTOR SUPPLIERS

Summary

Preliminary estimates of semiconductor shipments by the 18 leading U.S. semiconductor suppliers in 1978 demonstrate a 24.2 percent growth over 1977 estimated shipments. These 18 U.S. semiconductor companies shipped 85.1 percent of the total semiconductor shipments by all U.S. semiconductor companies in 1977 and are estimated to have shipped a comparable percentage in 1978.

Preliminary market share estimates of the 11 leading IC and 10 leading discrete suppliers in 1978 show a 30.7 percent and a 11.8 percent increase over 1977 shipments respectively. In 1977, the 11 leading IC suppliers shipped 78.2 percent of the worldwide IC shipments by all U.S. IC suppliers while the 10 leading discrete suppliers shipped 78.5 percent of the worldwide shipments by all U.S. discrete suppliers. Note that discrete devices here include optoelectronics.

Preliminary market share estimates of the top 12 MOS suppliers in 1978 depict a 35.3 percent increase in their MOS shipments, over 1977 estimates. The MOS market segment showed the highest growth in the 1978 semiconductor marketplace. The 12 MOS market leaders in 1977 shipped 84.2 percent of the worldwide MOS shipments by all U.S. MOS suppliers.

Semiconductor Suppliers

Table 1 shows the preliminary ranking of the 18 leading U.S. semiconductor suppliers broken down into ICs, Discretes and Other. It is significant to note that Table 1 includes Optoelectronics under Discretes, unlike prior DATAQUEST market share estimates which separate the two. In addition, the "Other" category consists primarily of modules and hybrids.

DATAQUEST's Preliminary Appendix B, which is scheduled for publication in early February, will include preliminary shipment estimates by product type for all products for all companies covered in our annual Appendix B—Market Share Estimate Worksheets. The final revision of Appendix B is scheduled for publication in May.

IC Suppliers

The preliminary estimates for the 1978 leading U.S. IC suppliers are shown in Table 2. Clearly, 1978 was a good year for IC growth as is exemplified by the 30.7 percent market share growth of the top 11 IC suppliers during 1977-1978. Note that Harris has moved from twelfth place among IC suppliers in 1977 to tenth place with a 41.7 percent increase in shipments. Due to this shift, we have included 11 IC suppliers in the analysis of Table 2.

Table 2 also singles out AMD, Harris, Intel, and Mostek as having greater than 40 percent annual growth in the IC market segment. AMD's 61.0 percent market growth in ICs has brought the company up to seventh place in 1978 from ninth place in 1977.

Discrete Suppliers

Table 3 shows the preliminary estimates for the 1978 leading U.S. discrete suppliers. Overall growth in the discrete area was not as good as in the IC area, as indicated by the 11.8 percent growth in shipments by the leading discrete suppliers. Hewlett-Packard and General Instrument had the highest annual growth in discretes with 55.8 percent and 37.5 percent growth respectively. Again, it is important to note that, unlike prior DATAQUEST market share estimates, the preliminary estimates in Table 3 include optoelectronics both for 1977 and 1978.

MOS Suppliers

Preliminary estimates for the 1978 leading U.S. MOS suppliers are shown in Table 4. The 35.3 percent growth in shipments by the 12 leading MOS suppliers marks the MOS market segment as the fastest growth segment in the semiconductor marketplace.

AMD, Intel, Mostek and National all had 1978 MOS revenues that were up at least 50 percent over 1977 levels. The two-way tie for fourth place in 1977 was broken in 1978 as National clearly established itself as the fourth largest U.S. MOS supplier in 1978. AMD's remarkable 91.9 percent growth in MOS shipments has placed the company eighth in 1978, up from eleventh place in 1977.

James F. Riley
Mary Ellen Hrouda
Daniel L. Klesken
Frederick L. Zieber

Table 1

PRELIMINARY ESTIMATES

1978 WORLDWIDE SHIPMENTS BY LEADING U.S. SEMICONDUCTOR SUPPLIERS
(Dollars in Millions)

	ICs	Discretes[1]	Other[2]	Total
Texas Instruments	$666	$254	-	$920
Motorola	318	351	$11	680
National	325	45	51	421
Fairchild	275	105	-	380
Intel	300	0	-	300
RCA	127	113	-	240
Signetics	205	0	-	205
ITT	70	100	-	170
General Instrument	80	55	-	135
AMD	132	0	-	132
Mostek	120	0	-	120
General Electric	2	111	-	113
Harris	85	0	-	85
Hewlett-Packard	0	81	-	81
Rockwell	80	0	-	80
International Rectifier	0	70	-	70
Intersil	60	9	-	69
AMI	67	0	-	67

[1] Includes optoelectronics

[2] Consists primarily of hybrids and modules

Source: DATAQUEST, Inc.
January 1979

Table 2

PRELIMINARY ESTIMATES

1978 WORLDWIDE SHIPMENTS BY LEADING U.S. IC SUPPLIERS
(Dollars in Millions)

	1977	1978	Annual Growth Percent
Texas Instruments	$ 518	$ 666	28.6%
National	246	325	32.1%
Motorola	235	318	35.3%
Intel	207	300	44.9%
Fairchild	226	275	21.7%
Signetics	175	205	17.1%
AMD	82	132	61.0%
RCA	108	127	17.6%
Mostek	80	120	50.0%
Harris	60	85	41.7%
General Instrument	77	80	3.9%
Total Market Share of 11 Top Companies	$2,014	$2,633	30.7%

Source: DATAQUEST, Inc.
January 1979

Table 3

PRELIMINARY ESTIMATES

1978 WORLDWIDE SHIPMENTS BY LEADING U.S. DISCRETE SUPPLIERS[1]
(Dollars in Millions)

	1977	1978	Annual Growth Percent
Motorola	$ 313	$ 351	12.1%
Texas Instruments	227	254	11.9%
RCA	98	113	15.3%
General Electric	109	111	1.8%
Fairchild	99	105	6.1%
ITT	105	100	(4.8%)
Hewlett-Packard	52	81	55.8%
International Rectifier	64	70	9.4%
General Instrument	40	55	37.5%
National	42	45	7.1%
Total Market Share of 10 Top Companies	$1,149	$1,285	11.8%

[1]Figures include Optoelectronics

Source: DATAQUEST, Inc.
January 1979

Table 4

PRELIMINARY ESTIMATES

1978 WORLDWIDE SHIPMENTS BY LEADING U.S. MOS SUPPLIERS
(Dollars in Millions)

	1977	1978	Annual Growth Percent
Intel	$ 192	$ 300	56.3%
Texas Instruments	180	240	33.3%
Motorola	110	143	30.0%
National	80	130	62.5%
Mostek	80	120	50.0%
General Instrument	72	75	4.2%
Rockwell	59	80	35.6%
AMD	37	71	91.9%
RCA	61	69	13.1%
AMI	71	67	(5.6%)
Fairchild	58	60	3.4%
Signetics	25	32	28.0%
Total Market Share of 12 Companies	$1,025	$1,387	35.3%

Source: DATAQUEST, Inc.
January 1979

DATAQUEST INCORPORATED RESEARCH NEWSLETTER

SIS Code: 8.08 National Semiconductor Corporation

January 24, 1979

UPDATE ON NATIONAL SEMICONDUCTOR CORPORATION

Summary

National Semiconductor has reported revenues for the first half of fiscal 1979 of $353 million, up 41 percent over the $250 million reported for the first half of fiscal 1978. Net income for the first half was $1.26 per share versus $0.84 per share in fiscal 1978, an increase of 50 percent. DATAQUEST expects National Semiconductor's revenues for fiscal 1979 to grow 39 percent to a level of $685 million. We expect net earnings to be up 51 percent to $34 million, or $2.60 per share.

The following items are also worth noting:

- Capital expenditures in fiscal 1979 should be about $82 million, almost double 1978 expenditures and the company is currently evaluating several U.S. sites for its expansion.

- Semiconductor Group revenues are expected to grow to $490 million in fiscal 1979, up 34 percent over fiscal 1978.

- The Semiconductor Group is recovering from the disastrous fire in Greenock, Scotland which it estimates cost about $60 million in lost business in fiscal 1978. Two modules are now operating at less than full capacity and the third module is just now beginning production.

- National plans to design, develop, and manufacture a completely new 16-bit microprocessor. DATAQUEST is concerned about the viability of a fifth major 16-bit microprocessor family as software development costs will be substantial for National. Furthermore, second sources for the other four 16-bit microprocessors have either been announced or are imminent.

- The Computer Products Group revenues are estimated to be up 92 percent to $115 million in fiscal 1979. DATAQUEST believes that National's IBM-compatible computer business is vulnerable to expected IBM product introductions and price competition.

- The Consumer Products Group is maintaining a limited but profitable profile in the marketplace with a well styled line of watches and calculators.
- The Point-of-Sale (POS) Systems Division added to its field sales organization in fiscal 1979 and has an excellent market position in U.S. supermarkets.

Revenues and Margin Analysis

DATAQUEST revenue estimates for fiscal 1977-1979 for each of National Semiconductor's operating groups or divisions are presented in Table 1. We expect fiscal 1979 revenues to grow to $685 million, an increase of 39 percent over fiscal 1978. In Table 1 it should be noted that estimated revenues for Consumer Products do not include revenues of watch modules; these are included in the revenues of the Semiconductor Group.

DATAQUEST expects National Semiconductor's net after-tax profit margin to be about 5 percent with profitability shifting among the groups. Semiconductor Group profit margins are estimated to be improving and slightly higher than Corporate margins; but they are offset somewhat by the higher costs of technical investment. The Computer Products Group still faces heavy development expenses over the next year or two; margins will probably not improve significantly. Consumer Products is expected to increase its margins and the Point-of-Sale Systems Division is improving its profitability as the service operation becomes profitable in 1979.

Table 1

National Semiconductor Corporation

ESTIMATED REVENUES 1977-1979

(Dollars in Millions)

	Fiscal[1] Year 1977	Fiscal Year 1978	Calendar Year 1978	Fiscal Year 1979
Semiconductor	$285	$365	$421	$490
Computer Products	35	60	80	115
Consumer Products	45	45	45	45
POS	30	35	40	45
Dynacraft	15	15	18	20
Intracompany	(23)	(26)	(27)	(30)
Total	$387	$494	$577	$685

[1]Fiscal year ending May 31

Source: DATAQUEST, Inc.
January 1979

Corporate Overview

National Semiconductor is striving to create for itself the image of a computer company. In fiscal 1978, the revenues of its Computer Products Group represented about 11 percent of corporate revenues while in fiscal 1979, they are estimated to represent about 17 percent of corporate revenues. This move into computer systems is extremely important as National moves toward its first billion-dollar year.

However, this aggressive approach, which National refers to as its "Crossing the Rubicon," is not without risk. IBM has taken an aggressive posture in the last year with both General Systems and Data Processing Divisions introducing new products with very competitive pricing. Although IBM's aggressiveness should not eliminate National Semiconductor's markets, it could make rapid growth and profitability more difficult to achieve.

The Semiconductor Group, even though growing in revenues, represents a smaller percentage of the company revenues each year (74 percent of total revenues in fiscal 1978 and 71 percent in fiscal 1979). This downward trend is indicative of what can be expected as National grows and diversifies into other businesses.

National has recently become much more aggressive in technology development. During 1978 it acquired its first E-Beam machine, which is being used to shorten the design cycle of complicated chips. The Company is also working on image technology and has acquired its first direct step on wafer (DSW) machine, which will be used initially for fabrication of magnetic bubbles. National also has the XMOS process, which is the name for its high density MOS circuits. It is using the 2147 4K static RAM as the first vehicle for implementating XMOS. A 16-bit microprocessor announced for 1980 will be the second. National is doing substantial development work on OXIS (oxide isolated silicon) to develop higher speed bipolar devices, and we expect a 1K ECL RAM using OXIS in the near future. Other advanced technologies under way at National include small geometry technology, plasma etching, and magnetic bubbles.

National is spending heavily to expand its capacity. In fiscal 1979, it will spend an estimated $85 million on capital improvements, up from $42 million in fiscal 1978. The capital improvements are primarily for the Semiconductor and Computer Products Groups. Semiconductor improvements include wafer fabrication additions in Salt Lake City, Utah, Santa Clara, California, and Greenock, Scotland. In 1978, the Salt Lake City facility began operation of a 4-inch facility for NMOS memory circuits.

R&D expenditures are also an important and increasing expense. In fiscal 1978, they were $42 million, or about 8.5 percent of corporate revenues. We expect them to increase slightly both in dollars and as a percentage of total revenues, to a level of about $60 million in fiscal 1979.

In April 1977, there was a serious fire at National's Greenock, Scotland, facility. The Company has stated that it lost about $60 million in component sales as a result of this fire. The facility was rebuilt within nine months and began shipping products in April 1978. This wafer fabrication facility produces linear, bipolar digital, and silicon gate NMOS circuits. The new plant has three times the capability of the old plant. Wafer handling capability has been upgraded to handle 4-inch wafers. We estimate that this new facility is processing more than 30,000 4-inch wafer starts per month.

In Table 2, DATAQUEST has analyzed the impact of the fire on National's revenues and earnings. The analysis indicates a loss of $60 million in revenues and $0.30 per share in fiscal 1978. Had the fire not occurred, we believe that National's fiscal 1979 revenue growth would be about the same as is now occurring, and that fiscal 1979 revenues would have been approximately $744 million (about $2.90 per share) instead of the $685 million ($2.60 per share) that we now expect.

Table 2

National Semiconductor Corporation

IMPACT OF THE APRIL 1977 FIRE AT GREENOCK, SCOTLAND

ESTIMATED REVENUES AND EARNINGS WITH THE FIRE

(Dollars in Millions)

	Fiscal[1] Year 1977	Fiscal Year 1978	Fiscal Year 1979
Revenues	$387.3	$494.3	$685.0
Net Income	$ 10.2	$ 22.5	$ 34.0
Net Profit After Tax (Percent)	2.63%	4.55%	4.96%
Earnings Per Share (In Dollars)	$ 0.78	$ 1.72	$ 2.60

ESTIMATED REVENUES AND EARNINGS ASSUMING NO FIRE

(Dollars in Millions)

	Fiscal Year 1977	Fiscal Year 1978	Fiscal Year 1979
Revenues	$387,3	$554.3	$744.0
Net Income	$ 10.2	$ 26.3	$ 37.9
Net Profit After Tax (Percent)	2.63%	4.75%	5.10%
Earnings Per Share (In Dollars)	$ 0.78	$ 2.00	$ 2.90

[1]Fiscal year ending May 31

Source: DATAQUEST, Inc.
January 1979

In October 1978, National had a one-week shutdown of its Danbury, Connecticut, facilities due to a leak of diborene chemicals. We estimate that full capacity was not re-achieved until several weeks after the shutdown. Partly as a result of the shutdown, we believe that AMI is processing up to several thousand CMOS wafers per month for National. We also understand that National is buying CMOS chips from Intersil and others.

In the fourth quarter of 1978, National Semiconductor and Saint Gobain Pont a Mousson agreed in principle to form a French subsidiary for the manufacture of MOS integrated circuits. This subsidiary is to receive about $42 million in aid from the French Government and is to be capitalized at $16 million, with 51 percent ownership by Saint Gobain and 49 percent ownership by National Semiconductor. Over a five-year period, the level of investment is expected to be close to $120 million. First production is to begin by the end of 1980. At the writing of this newsletter, final agreements had not yet been signed. DATAQUEST believes that the French Government intends to sponsor at least two efforts to build up its domestic semiconductor interests. Motorola and Thompson CSF have signed a letter of intent for a similar joint effort in France.

DATAQUEST considers it particularly significant that National has placed its international activities under the direction of an experienced veteran of the international semiconductor scene, Dr. Robert Heikes, formerly of Motorola. He will be located in Munich, West Germany, with responsibility for computers and semiconductors in Europe and Latin America. Reporting to him will be the Greenock plant, Charles Arkebauer, General Manager for Semiconductors in Europe, and Derek Thompson, Marketing Manager for Computer Products in Europe.

Semiconductor Group

National's estimated Semiconductor Group revenues are presented in Table 3 by major product type. We expect the Company's semiconductor revenues to increase 34 percent to about $490 million in fiscal 1979. Major growth areas are MOS, linear, and digital integrated circuits. Discrete devices and optoelectronics remain a relatively small part of National's semiconductor business. Note that the Semiconductor Group total includes watch modules and other modules that it ships to Sears and other outside users.

Bipolar Digital

National is strengthening its bipolar digital products which include a full line of TTL and low-power Schottky devices. It is expanding its ECL memories and is in limited production of a 1K ECL RAM with plans to introduce a 4K ECL RAM in 1979.

National is adding 12,000 square feet of 4-inch wafer fabrication area in Santa Clara, California, for Schottky bipolar fuse link PROMs.

Its PROMs use a titanium tungsten link, which the Company considers to be a better technology; it is less costly than the nichrome used by some competitors.

Table 3

National Semiconductor Corporation

ESTIMATED REVENUES OF THE SEMICONDUCTOR GROUP—1977-79

(Dollars in Millions)

	Fiscal[1] Year 1977	Fiscal Year 1978	Calendar Year 1978	Fiscal Year 1979
Semiconductor Group:				
Bipolar Digital	$ 80	$ 90	$105	$110
MOS	70	100	130	170
Memory	30	45	60	90
Microprocessors	5	10	17	20
MOS LSI	35	45	53	60
Linear	65	78	90	100
Hybrid	9	20	20	25
Discrete	27	27	30	30
Special Products:				
Optoelectronics	15	15	15	20
Modules	7	10	10	15
Watch Modules	12	25	21	20
Total	$285	$365	$421	$490

[1] Fiscal year ending May 31

Source: DATAQUEST, Inc.
January 1979

National is also putting significant effort into its BIFET technology. Several new BIFET products were introduced in 1978 and more are expected in 1979.

National's lead times on bipolar digital products range from off-the-shelf delivery to 40 weeks. Low-power Schottky products have lead times as long as 30 to 40 weeks, a situation that existed during most of the fourth quarter of 1978 and is expected to continue in the first quarter of 1979. However, we expect National's lead times for low-power Schottky products to improve as the third module in Scotland goes into production.

Memory

National has recently split its memory components operation into separate operations for MOS and bipolar memory. National's MOS memory shipments during calendar 1978 are estimated at $60 million, whereas its bipolar memory shipments are estimated at $20 million. Although National has not historically been one of the leading memory manufacturers, it is now taking an aggressive stance in memory components and currently has development programs under way for a 64K x 1 dynamic MOS RAM, an 8K x 8 dynamic MOS RAM with on-chip refresh for microprocessor applications, a 4K ECL RAM, an 8K PROM, and a 16K PROM.

We understand that National's wafer fabrication capability in memories is currently limited, and that it is therefore converting some 16K dynamic RAM wafer starts to 4K static RAM wafer starts. This conversion has limited its total production of 16K dynamic RAMs to about 250,000 units in calendar 1978. National produced about 5.5 million 4K dynamic RAMs in calendar 1978.

National has been supplying both the merchant market and its own Computer Products Group with memory components. It has been unable to supply its internal requirements adequately, thereby requiring the Computer Products Group to buy dynamic RAMs from other sources.

Two very important milestones for National's memory components in 1979 will be the successful introduction and sampling of the 64K x 1 dynamic RAM and of the fast 4K static RAM (2147).

Microprocessors

National has a wide array of microprocessor products ranging from the 4-bit COPS, 4004, and IMP families through the 8-bit microprocessor, including the 8080A and SC/MP up through the 16-bit PACE. It is also establishing itself as a second source for the 8048 microprocessor.

National has done an excellent job of supporting the 8080A family with a broad array of peripherals and interface circuits. Because of its strength in linear circuits, it has been able to expand its product offering to the point where it now has one of the broadest lines of 8080A peripherals and interface circuits.

The 4-bit COPS family has been a great success for National. This single-chip microcomputer, which sells for about $1.50 in large quantities with an overall ASP of about $2.00, is broadly used in a wide variety of consumer and industrial applications. It has upgraded its older PMOS version and now has NMOS and CMOS versions.

National has undertaken the development of a completely new 16-bit microprocessor family. It currently has no partnership arrangements and must therefore carry the extensive software development costs alone. DATAQUEST questions the viability of a fifth major 16-

bit microprocessor family, particularly since the other suppliers either have existing or imminent agreements for second sources. Software development costs for National could be substantial.

It is DATAQUEST's opinion that National has such a wide array of microprocessor products that product depth is limited on some products. DATAQUEST believes it might be better for National to concentrate its efforts on a smaller set of products.

MOS Logic

National has a broad line of CMOS, NMOS, and PMOS logic products. CMOS 4000 and 74C Series are especially lucrative businesses for National. We estimate that its CMOS logic revenues total $25 million while NMOS and PMOS standard and custom logic revenues total $50 million.

Linear

Linear integrated circuits are one of National's strengths. The Company has been a leader in this market and its strong position has enabled it to become a major supplier to the automotive industry. National has penetrated a number of automotive accounts, particularly General Motors, by supplying linear integrated circuits for engine control, entertainment, and instrumentation products.

National has an 8-bit CMOS A/D converter for automotive applications and is developing more advanced versions of this product which will give National a broad line of 8-, 10-, and 12-bit microprocessors for the automotive, industrial, and computer markets.

In calendar 1978, National introduced a number of single, dual, and quad amplifiers using its new BIFET technology. It also introduced an operational amplifier using its new one-volt linear process which we expect to be the basis of a new product family.

Hybrids, Modules, and Transducers

National has always done well in making hybrids, modules, and transducers for the industrial, telecommunications, and automotive markets. It has been able to develop some proprietary products and continue its penetration of the automotive markets with these products. Recently, however, it has experienced increased competition in transducers from Japanese semiconductor companies who are especially interested in automotive applications for transducers.

Discrete Devices and Optoelectronics

The growth in National's transistor line has been in the power segment, which accounts for approximately 25 percent of its transistor revenues. Small signal has not been a growing market for National. All of its power transistor products are packaged in plastic, but it plans to introduce some metal packages during 1979.

Its activity in optoelectronics is restricted to LED displays and lamps. National has pioneered in the single chip 0.6- and 0.8-inch high LED digits that are widely used in industrial displays and are now second sourced. National has begun to make LCDs for use in its consumer products, but it still must depend on external sources of supply.

Watch Modules

National makes LCD watch modules in Malacca, but no longer makes LED watch modules. We estimate that the Company produced about $20 million worth of modules in calendar 1978, or about four million units. The market for watch modules appears to have peaked and will mature at a lower level because the number of watch suppliers with their own manufacturing facilities has increased. Sears is National's largest watch module customer.

Bubbles and CCDs

In calendar 1978, National launched a major effort into developing magnetic bubbles and currently has a staff of about 20 people. It dedicated its first GCA-made DSW machine for this facility.

National plans to introduce and sample a 256K-bit magnetic bubble device by the end of 1979. It is using a 2.7 micron diameter magnetic bubble, which will yield a 300 x 300 mil chip. The Company is also working on the peripheral circuits required for this bubble chip and expects to have them available at the end of 1979 as well.

Advanced Technology

As we discussed earlier, the Semiconductor Group is emphasizing new technology. Another interesting development under way is P^2CMOS, a double-poly CMOS process. The first production vehicle will be a 4K static CMOS RAM followed by the NSC 800, an 8-bit CMOS microprocessor. This chip will have the processing capability and speed of the 8085 and Z80 microprocessors but will dissipate only 4 percent of the power.

Computer Products Group

DATAQUEST estimates that National's Computer Products Group revenues will increase about 92 percent to $115 million in fiscal 1979 compared to about $60 million in fiscal 1978. We expect that the group is now profitable with pretax margins of about 10 percent. Profitability is expected to be constrained by heavy development expenditures over the next year or so, and future price and product moves by IBM could also impact its margins.

National is investing heavily in extremely capable people for its computer operations. For example, Frank Zurcher, formerly of Burroughs small systems operations, heads up all northern California computer operations (except large systems), and Wes Thrasch, formerly of Mohawk Data Systems, heads up field service.

The Computer Products Group comprises four divisions: Large Systems, General Systems, Memory Systems, and Microcomputer Systems. DATAQUEST's estimates of this group's revenues are shown in Table 4.

Table 4

National Semiconductor Corporation

ESTIMATED REVENUES OF THE COMPUTER PRODUCTS GROUP—1977-79

(Dollars in Millions)

	Fiscal[1] Year 1977	Fiscal Year 1978	Fiscal Year 1979
Large Systems	$ 2	$32	$ 75
General Systems	13	15	20
Memory Systems	12	8	10
Microcomputer Systems	8	5	10
Total	$35	$60	$115

[1]Fiscal year ending May 31

Source: DATAQUEST, Inc.
January 1979

Large Systems

The Large System operation designs and manufactures two product types. The first is a series of computers that is plug-compatible with IBM's 370 series and is a gate for gate copy. The second is a newly introduced computer that emulates the software of IBM and DEC through micro-code implementation.

The first plug-compatible computers from National were the AS/4 and AS/5 computers, which are compatible with the IBM 370/148 and 370/158 computers. The AS/4 is actually a 370/148 plug compatible with 1.8 times the capability. The AS/5 is an upgrade of the AS/4.

Both of these machines have cycle times of 155 nanoseconds, and because of this slower speed, they are almost obsolete since newer IBM computers are considerably faster.

These products were first introduced in calendar 1977, and we estimate that about 55 units were shipped in that year, with the AS/5s representing about 90 percent of the units. We estimate that National has shipped another 190 of these machines by the end of calendar 1978, with AS/5s still representing close to 90 percent of the new units.

In August 1978, National shipped its first AS/3 computer which is plug compatible with the IBM 370/138 and 370/148 and sells at 70 percent of the IBM prices.

Until now, Itel Corporation has been National's exclusive agent for the marketing and servicing of its AS Series computers. The agreement is still in force, but it is not clear whether National will continue its agreement with Itel.

In May 1978, National announced its System/400 computer which uses bit-slice microprocessor architecture to emulate the software of the IBM 370 series. The selling price is about $160,000 and we expect National to ship about 25 to 30 units in fiscal 1979, representing $4 million to $5 million in revenues. The first unit is currently undergoing customer checkout and DATAQUEST expects additional evolutionary computer product introductions from the Large Systems operation in 1979.

During fiscal 1979, National plans to increase the size of its field service organization to about 600 people. This field service organization previously served only the Point-of-Sale (POS) and Memory Systems operations. Field service is now being expanded to handle the entire product line of the Computer Products Group, with the exception of those products served by Itel.

General Systems

The General Systems operation designs, manufactures, and markets IBM-compatible add-on memories for the IBM 370 series computers. National products are compatible with IBM 370 series models 135, 138, 145, 148, 158, and 168, as well as the new IBM series of computers: 3031, 3032, and 3033. National also makes add-on memory for its own AS/3, AS/4, and AS/5 computers.

National's General Systems are marketed and serviced by third parties such as Itel, Memorex, and Storage Technology Corp. National is now starting to provide its own marketing and service organization.

Memory Systems

The Memory Systems operation designs and manufactures memory boards and total systems for original equipment manufacturers plus add-on and add-in memories for Data General, Digital Equipment, and Hewlett-Packard minicomputers. It also offers the NS/3 Memory System, which can be attached to a wide range of computer systems, and it builds custom circuit boards and systems to customer specifications.

Microcomputer Systems

The Microcomputer Systems operation designs and manufactures boards and systems using National's microprocessors, memory, logic, and interface circuits. Products include microprocessor development systems, such as the recently announced STARPLEX, microcomputer disc operating systems, and card-level systems for PACE, SC/MP, and IMP microprocessors. Some of the advanced work includes the board and systems that will use National's new 16-bit microprocessor.

The Microcomputer Systems operation recently announced a System/200 minicomputer product. System/200 is implemented with microprocessors and emulates the PDP-11 instruction set. We understand that the first unit is now undergoing customer acceptance tests; shipments are scheduled for second calendar quarter of 1979. The units sell for $10,000 to $12,000. Fiscal 1979 revenues for this product are currently estimated at less than $1 million.

In calendar 1978, National surprised many industry watchers when it filed suit against Digital Equipment Corporation (DEC) in Federal District Court in San Francisco. Its brief claims that four DEC patents, covering the Unibus and the PDP-11/34, are invalid and unenforceable, and therefore National will not be infringing on these patents by producing its new Series/200 product line. Thus, National is going on the legal offensive by filing in the State of California (as opposed to having to defend an action in Massachusetts), and by directly attacking the legality of the DEC patents. If the Company is successful in its action, the flood gates could be opened for other competitors to emulate the PDP-11.

Point-of-Sale Systems Division

National's Point-of-Sale (POS) Systems include three market segments. The first is the stand-alone cash register which National seems to be de-emphasizing in favor of the other two segments. The second is the in-store distributed processor with one register acting as a master and the rest as slaves. The third segment is the POS system with a backroom CPU that runs all the registers as dumb terminals.

We estimate that National has an installed base of 2,000 POS systems, representing about 20,000 cash registers. Approximately 15,000 of these are backed by the National Semiconductor 1600, which is a PACE single-board computer.

Creating these products has required a great deal of original software development which, fortunately, is now almost completed. National can therefore concentrate on marketing and servicing the products. We believe that National is currently capacity-limited in the production of its POS systems; we understand it has a one year lead time for delivery.

National has developed and begun shipping a series of enhancements for its POS systems which include energy management, timekeep ing, payroll, and attendance systems. National is now in production on its XX Scanner which scans the universal product codes on items at supermarkets. We estimate that it shipped 700 scanners in calendar 1978.

The 300-person field service operation, which had served only the POS Division is being expanded to serve the Computer Products Group as well. Total size of this service operation should reach 600 by the end of fiscal 1979.

Consumer Products Group

This group designs and manufactures a selected line of moderately-priced calculators and digital watches. Although it still has some LED calculators in its product line, most of the introductions during the last two years have LCD or vacuum fluorescent display modules.

National now has a fairly wide line of LCD men's and ladies' watches, which for the most part are nicely styled and have good features. The watch line now includes some alarm and chronograph models.

Although National does not have a large consumer marketing effort, we believe that it can be successful as a number of its competitors are dropping out of the business. Aside from producing watches under its own name, it is also private labeling watches for other firms such as Sears.

During calendar 1978, National Semiconductor worked closely with Mattel Electronics, a division of Mattel Incorporated, on chip development, case production, packaging, and assembly for Mattel's very successful hand-held electronic hockey and soccer games. We understand that this business was worth about $5 million in calendar 1978 for National.

DATAQUEST believes that the consumer operation was profitable in calendar 1978 and that National will continue in this business as long as it remains reasonably profitable.

Dynacraft

The Dynacraft operation has two areas of business: gold-plated lead frames and epoxy powders. The lead frame operation is the larger with about 40 percent of its production used internally. National is one of the two largest suppliers of lead frames to the merchant market with revenues estimated at $18 million. Epoxy powders and other plastic compounds are manufactured by one of National's subsidiaries, Dynamold with revenues estimated at $2 million.

Daniel L. Klesken
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DATAQUEST INCORPORATED RESEARCH NEWSLETTER

SIS Code: Newsletters January 19, 1979

GENERAL INDUSTRY FORECAST

Summary

U.S. semiconductor consumption for 1979 is expected to be 13 percent greater than in 1978. This follows an expected 1978 semiconductor consumption increase of about 20 percent over 1977. The strong growth in the first half of 1978 slowed somewhat in the second half of the year but less than expected. Demand remained strong and this strength is expected to continue through the first half of 1979. Some slowdown—not a downturn—is expected in the second half of 1979 but, to be prudent, the possibility of a downturn must be considered.

Factors that could make semiconductor demand stronger than expected this year include the effects of inflation, the dollar devaluation, and outside purchases by captive manufacturers. If the U.S. economy merely pauses in the second half of 1979, it is possible that demand for electronics and semiconductors will remain good. Although demand has been exceptionally heavy recently, we do not see a situation similar to that of 1974 developing.

Recent Economic Trends

U.S. economic growth remained good during the fourth quarter of 1978. This growth has been helped by strong consumer purchases, as a "buy now" attitude prevails because of the expectation of continued high inflation rates. Economic growth is expected to slow later in 1979, however. Early indications that the economy might slow have appeared. There is continued concern that a slowdown may turn into a recession, although that outcome is at present only a possibility.

The following recent economic developments are noteworthy:

- The prime rate has risen to nearly 12 percent; the effects on some economic sectors such as housing should begin to show presently.

- The Gross National Product (GNP) in real terms continued its healthy growth in the fourth quarter of 1978 with estimated growth of 6.1 percent following an estimated 2.6 percent growth (annualized rate) in the third quarter.

- Industrial production has continued to grow at an unusually steady pace with an increase of about 0.7 percent in November.

- Retail sales continued strong with a 2 percent jump in November (current dollars) and apparent strength in December.

- The Federal Reserve Board of Leading Indicators showed its expected decline in November, partially due to a large drop in the stock market. One month, however, is not a sufficient indication of a future downturn.

- Money supply growth has slowed considerably due to President Carter's actions. In real dollars, M1 has apparently decreased during the last two months.

- The 1979 economic outlook in Japan and Europe indicates a slightly higher growth than in the United States for the first time in years. The OECD in 1979 forecasts show European GNP growth at 3 percent. However, higher oil prices and a strengthening dollar may impair the economic and inflation outlook in Japan and Western Europe.

- The worldwide economic situation is clouded by recent events in Iran. This raises the possibility of tighter oil supplies and reduced purchases of industrial goods by that country, causing potential balance of payments problems.

The U.S. economy currently remains strong despite efforts to slow it down; its resiliency has surprised economists. Nevertheless, the consensus is that the economy can be expected to grow much more slowly during the second half of 1979.

Semiconductor Industry Trends

U.S. semiconductor demand in the fourth quarter of 1978 was extremely strong, and there is a fear that excessively strong current demand could exacerbate problems in a subsequent slowdown. The semiconductor industry has been hard pressed to fill demand and some products have been difficult to obtain. In particular, 16K RAMs, a highly visible part, were subject to increased demand. Production problems have extended delivery times considerably. The 16K RAM situation and other circumstances have caused an order surge for semiconductors. Real semiconductor demand, as evidenced by electronic equipment shipments, does not exhibit this unusual strength. Semiconductor shipments appear to be in line with actual needs, and actual shortages have not developed to any great extent. We see only limited evidence of shortages although they have occurred selectively. Real supply and demand appear to be in a relatively good balance. As a result, DATAQUEST does not anticipate a severe shortage problem.

If demand increases further, however, problems could develop. The industry is currently running at a very high percentage of capacity, and the dangers of excessive demand are thus quite real. Any increase in demand could strain the ability of the industry to deliver parts. At this time, prices that fell routinely through most of 1978 appear to be showing some signs of stabilizing. User inventories, while increasing, remain at moderate levels. Labor availability still remains a major problem for the industry and salaries appear to be rising at a faster than normal pace, particularly for professional personnel. A situation similar to 1974 has not yet occurred, but could still develop. (In 1974, excessive demand caused shortages, double ordering, and higher prices. This led to excess capacity, high inventories, and a false sense of strong real demand; resulting in a severe amplified downturn in orders later in the year.)

DATAQUEST estimates that third quarter 1978 U.S. semiconductor consumption exceeded that of the second quarter by less than 2 percent, a sharp drop in growth from the earlier period. However, we estimate that fourth quarter 1978 shipments were probably about 4 percent greater than in the third quarter. In addition, shipments to foreign countries by U.S. semiconductor companies increased at an even more rapid pace during 1978's second half.

The strength of semiconductor demand appears centered in capital equipment, both data processing equipment and industrial products. The military market for semiconductors also showed increasing vitality in 1978. The cumulative effects of several years' inflation in nonelectronic goods, and the continued deflation in electronics, appear to be providing a significant market stimulus that is reflected in semiconductor demand. Capital expenditures for electronics far outpace other forms of industrial capital expenditures and are significantly higher than might be expected from an historical analysis of economic activity. There is no reason to expect this trend to cease.

Semiconductor Industry Forecast

Table 1 gives our estimate for U.S. semiconductor consumption in terms of millions of dollars. We believe 1978 semiconductor consumption increased about 20 percent over 1977. For 1979, we expect semiconductor consumption to increase by about 13 percent over 1978. This is a very slight increase from our previous forecast. A part of that increase can be attributed to the momentum of the industry built up through the fourth quarter of 1978. While we see integrated circuits accounting for the majority of the increase in semiconductor consumption, we also see considerable growth in the discrete device market.

Table 1

ESTIMATED U.S. CONSUMPTION OF SEMICONDUCTORS
(Dollars in Millions)

	1977	1978	Percent Increase 1977-78	1979	Percent Increase 1978-79
Discrete Devices	$ 925	$1,024	10.7%	$1,092	6.6%
Integrated Circuits	1,787	2,238	25.2%	2,598	16.1%
Total	$2,712	$3,262	20.3%	$3,690	13.1%

Source: DATAQUEST, Inc.
January 1979

Our current estimates for 1979 U.S. semiconductor consumption by calendar quarter are shown in Table 2. It should be remembered that the first and third quarters of the year normally are seasonally slower in growth. We expect stronger growth in the first half of 1979 to be moderated later in the year. The current general economic activity and semiconductor orders and backlogs indicate that strong shipments in the first half of this year are assured. Thus, if the first half of the year shows even stronger growth than anticipated, second half results might be correspondingly worse. Our expectations of a severe slowdown in demand continue to recede into the future. We do not at this time see a downturn developing, only slower growth.

Our econometric model does not take into account factors that do not have historical precedence. Several of these could increase actual 1979 semiconductor consumption to levels above our forecast. These factors are the effects of inflation, purchases by captive manufacturers, and higher exports due to the lower value of the dollar. Inflation in particular appears to be a positive stimulus on semiconductor demand. Despite a slowing in demand in the second half of 1979, the year looks promising for the industry.

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Mary Ellen Hrouda
James F. Riley

Table 2

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Dollars in Millions)

	1978				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$236	$258	$261	$269	$1,024
Integrated Circuits	499	564	574	601	2,238
Total	$735	$822	$835	$870	$3,262
Percent Change From Previous Quarter	0.6%	11.8%	1.6%	4.2%	

	1979				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$269	$275	$271	$277	$1,092
Integrated Circuits	615	645	659	679	2,598
Total	$884	$920	$930	$956	$3,690
Percent Change From Previous Quarter	1.6%	4.1%	1.1%	2.8%	
Percent Change From Previous Year	20.3%	11.9%	11.4%	9.9%	13.1%

Source: DATAQUEST, Inc.
January 1979

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GENERAL INDUSTRY UPDATE

SUMMARY

DATAQUEST continues to expect a resumption of growth for U.S. semiconductor consumption in the first half of 1981. However, because present concerns about the future of the U. S. economy are causing extreme caution in the business community, weakness in semiconductor shipments is expected to continue through the first quarter. The current contraction in U.S. semiconductor consumption, forecast by DATAQUEST at the beginning of this year, is continuing along a very moderate course. We believe that shipments in the third quarter have been only about 3.1 percent lower than in the second quarter of 1980. We expect a similar contraction in the fourth quarter of this year, with a leveling of shipments continuing through the first quarter of 1981. DATAQUEST estimates that U.S. semiconductor consumption for all of 1980 will be 26.2 percent higher than in 1979, reflecting very strong momentum at the beginning of 1980. Although we expect strength to return to U.S. semiconductor consumption in early 1981 and to accelerate throughout the year, we forecast the total for 1981 to be only about 8.1 percent more than in 1980.

The U.S. economy, which fell abruptly in the second quarter of this year, has been recovering at a slow to moderate pace for the last four or five months. But the currently high (approximately 21 percent) prime rate precludes a strong economic recovery. For this forecast we assume a benign economy with very gradual improvement. Nevertheless, in planning for the future, the probability of a second major downturn in the U.S. economy cannot be excluded. That occurence could have major negative consequences in the semiconductor industry. So far, we remain optimistic. The electronics industry, and specifically the semiconductor industry, continues to outperform significantly the U.S. and world economies. The current situation bears no resemblance to the debacles of 1970 and 1975.

RECENT ECONOMIC TRENDS

The Good News

The economic recession that arrived abruptly during the second quarter of this year has bottomed out, and conditions have been on the road to slow improvement:

- Retail sales have been improving for the last six months (in current dollars).
- The Index of Leading Indicators has been up for the last five months.

- Housing starts have been up for the last five months.

- Industrial production has been up for the last four months.

This news is both consistent and encouraging. Declines in unemployment, and other indications that the business cycle is on an upturn, confirm this good news.

The Bad News

Efforts to curb inflation contributed greatly to the recession just experienced. Those efforts were a dismal failure, and the downturn was perhaps too brief to prime the economy for a major upward cycle. Efforts to control inflation have led to some definite bad news:

- Inflation continues at double-digit rates.

- The prime rate is approximately 20 percent.

- Although at this writing no major economic measures have turned down, their delayed reporting may conceal the fact that the recovery has been halted abruptly.

- Efforts to contain the money supply (worldwide) have met with little success.

- The economies of Japan and Europe are presently in a downturn, having trailed the U.S. economy by several months.

The Outlook

Obviously, the high prime rate has engendered considerable caution in the business community. We cannot predict whether this high prime rate will cause a renewed contraction of the U.S. economy. But clearly, the probability of a W-type (double dip) economic cycle has increased (we will know within a few weeks whether that probability becomes a reality). Just as clearly, a new administration in the government would prefer to incur economic pain now rather than two or four years hence.

However, the high interest rates are also a reflection of the economic recovery. If the recovery were less strong, inflation and interest rates would be lower. In other words, the very high cost of money may be as much a result of renewed economic strength increasing the demand for money as it may be an indicator of future problems. It is not fore-ordained that the economy will turn down. It is more probable that the economy will experience much slower growth, with a very gradual recovery. This benign economy is the basis for our forecast of semiconductor consumption.

Part of the current economic problems results from a major restructuring of the U.S. and world economies. Those industries that are sensitive either to inflation or to the higher cost of energy—directly or indirectly—are continuing to suffer severe problems. These industries include such areas as housing, forest products, automotive, steel, airlines, tourism, and so forth. On the other hand, some industries benefit from this restructuring including the electronics and semiconductor industries.

SEMICONDUCTOR INDUSTRY TRENDS

The U. S. semiconductor industry presently is experiencing a contraction in shipments. As expected and forecast by DATAQUEST, this contraction has been relatively mild. We can expect lower shipment levels due to recent order weakness. Shipments in the third quarter of 1980 were approximately 3.1 percent less than in the second quarter. A further contraction of about 2.9 percent is expected in fourth quarter of 1980 and 0.2 percent in the first quarter of 1981.

Semiconductor orders have increased consistently since bottoming in July. The book-to-bill ratio for the industry in November appears to have been close to unity. This is encouraging, although DATAQUEST has noted considerable inconsistency among individual companies. Major semiconductor manufacturers appear to have book-to-bill ratios in November varying from 0.7 to 1.2--a highly unusual degree of variation. Early this summer major order problems were in MOS devices, especially memory. This situation appears to have spread generally throughout the industry with less severity recently in MOS, and some present order weakness occurring in bipolar digital, linear, discrete devices, and optoelectronics. Distribution currently is a very weak segment for suppliers.

The price weakness in MOS memory of the past several months appears to have stabilized. Interestingly, the rapid price declines in MOS memory occurred despite a continued growth in unit consumption throughout 1980. However, the unit consumption did not keep pace early in the year with the rapid growth in capacity. Recently, order strength in MOS has been encouraging. In addition, low prices have slowed expansion of capacity. Although DATAQUEST has noted price weakness in bipolar devices, we do not expect a major decline in prices similar to that which has occurred in MOS memory. DATAQUEST believes that additional new capacity coming onstream in bipolar devices will be somewhat limited for the next nine months; this fact may help maintain a balance between supply and demand. Some discrete device areas have been especially weak, particularly those associated with consumer products. In optoelectronics, LED displays are experiencing significant weakness in orders. Oddly enough, lack of new capacity in Japan (possibly due to excessive attention to MOS LSI) has caused a temporary shortage in small-signal devices.

It is DATAQUEST's perception that actual usage of semiconductor devices remains relatively strong and is increasing. There are some other positive aspects:

- Virtually all double orders now have been purged from backlogs.

- Inventory levels of semiconductors at the user level are believed to be quite low (with a few exceptions). Generally the high cost of money has caused significant attention to inventories, and further reductions are not likely.

- DATAQUEST does not foresee further major reductions in semiconductor prices.

- Order changes for either a stretch-out of delivery or for price reductions caused a major problem in the second and third quarter. We do not expect a continuation of this trend.

It is likely that the factors mentioned above preclude any problems of the magnitude experienced in previous recessions. Those problems, such as double ordering, excessive inventory, and excessive prices, have now been worked through, which places the order book in a fairly healthy condition. However, backlogs of most semiconductor manufacturers have been declining during the last several months. Further order weakness could cause significant problems in maintaining shipments at present levels.

Suppliers of material to the semiconductor industry recently have been experiencing a fairly stable shipment and order situation. Most shipments and orders are at levels moderately below the peak of early 1980. Equipment suppliers, especially those with long lead time products, have experienced continued strong demand throughout the third quarter. It is our belief that that demand may be slackening, but major weakness is not expected. Manufacturers of smaller, lower cost equipment, the purchase of which is more easily postponed, have experienced most of the softness in this area.

Semiconductor manufacturers have not significantly reduced capital expenditure plans. Such spending is further augmented by major capital expenditures for semiconductor facilities and equipment by captive manufacturers and foreign governments. The expected conversion to VLSI production capability in wafer fabrication (sub 5 micron dimensional tolerances) is an additional positive factor for the equipment market. That portion is independent of the strength in semiconductor orders. As a result, DATAQUEST expects no future weakness of equipment orders.

The current situation is significantly different from previous slowdowns in semiconductor demand. Manufacturers of semiconductors do not wish to be caught short of capacity when significant growth resumes in demand. Those manufacturers that did not expand in capacity in 1975 paid a significant price in lost growth potential after the market resumed strength in 1976 through 1979.

Most major companies in the industry will have work stoppages (layoffs) during the Christmas holidays ranging from 5 to 10 days (including the holidays). These stoppages are as much a result of the timing of Christmas and New Years on Thursdays as it is a reflection of demand weakness. Even in times of strong growth, many Silicon Valley companies have closed for a week during this season. It is highly significant that the semiconductor industry has yet to have or to need major layoffs. Hiring freezes were begun early this year, and employment reductions through attrition have been adequate to match any changes in shipment rates. Employment advertisements in Silicon Valley have remained at high levels throughout the fourth quarter. We believe this is significant, a rapid increase in the demand for components in 1981 could find the industry short of personnel--both hourly workers and professionals. In previous recessions, reductions of employment in the industry have exceeded 30 percent. These reductions represented excess available capacity—both in people and in facilities. That excess capacity is not currently available, and could engender a supply/demand imbalance sooner in the economic cycle.

Semiconductor Industry Forecast

Table 1 presents DATAQUEST's estimate for U.S. semiconductor consumption in dollars. We believe that U.S. semiconductor consumption in 1980 will show an increase of about 26.2 percent over 1979. In 1979, U.S. semiconductor consumption increased approximately 37.6 percent over that of 1978. It should be noted that these figures also include exports to the United States from Japan and Europe, and these exports increased significantly over the last two years through the first half of 1980. However, the falling prices in MOS memory have recently caused a decline in the rate of semiconductor imports into the United States. DATAQUEST expects further growth in U.S. semiconductor consumption in 1981, to an estimated level of 8.1 percent over this year.

Table 1

ESTIMATED U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1979	Percent Increase 1979-80	1980	Percent Increase 1980-81	1981
Discrete Devices	$1,322	4.5%	$1,382	(0.7)%	$1,373
Integrated Circuits	$3,375	34.7%	$4,545	10.8%	$5,035
Total	$4,697	26.2%	$5,927	8.1%	$6,408

Source: DATAQUEST, Inc.
December 1980

Table 2 presents our current estimates for U.S. semiconductor consumption by calendar quarter. (See Figure 1.) We expect the moderate decline in semiconductor consumption experienced in the third quarter of this year to continue through the fourth quarter, with a leveling in the first quarter of 1981. Specifically, we forecast that fourth-quarter semiconductor consumption will be about three percent below that of the third quarter of 1980. DATAQUEST forecasts a healthy resumption of growth in semiconductor consumption in 1981, beginning by the second quarter. (However, we should reiterate that if the economy does move strongly negative, a resumption of growth in semiconductor consumption would be delayed further.)

Table 2

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

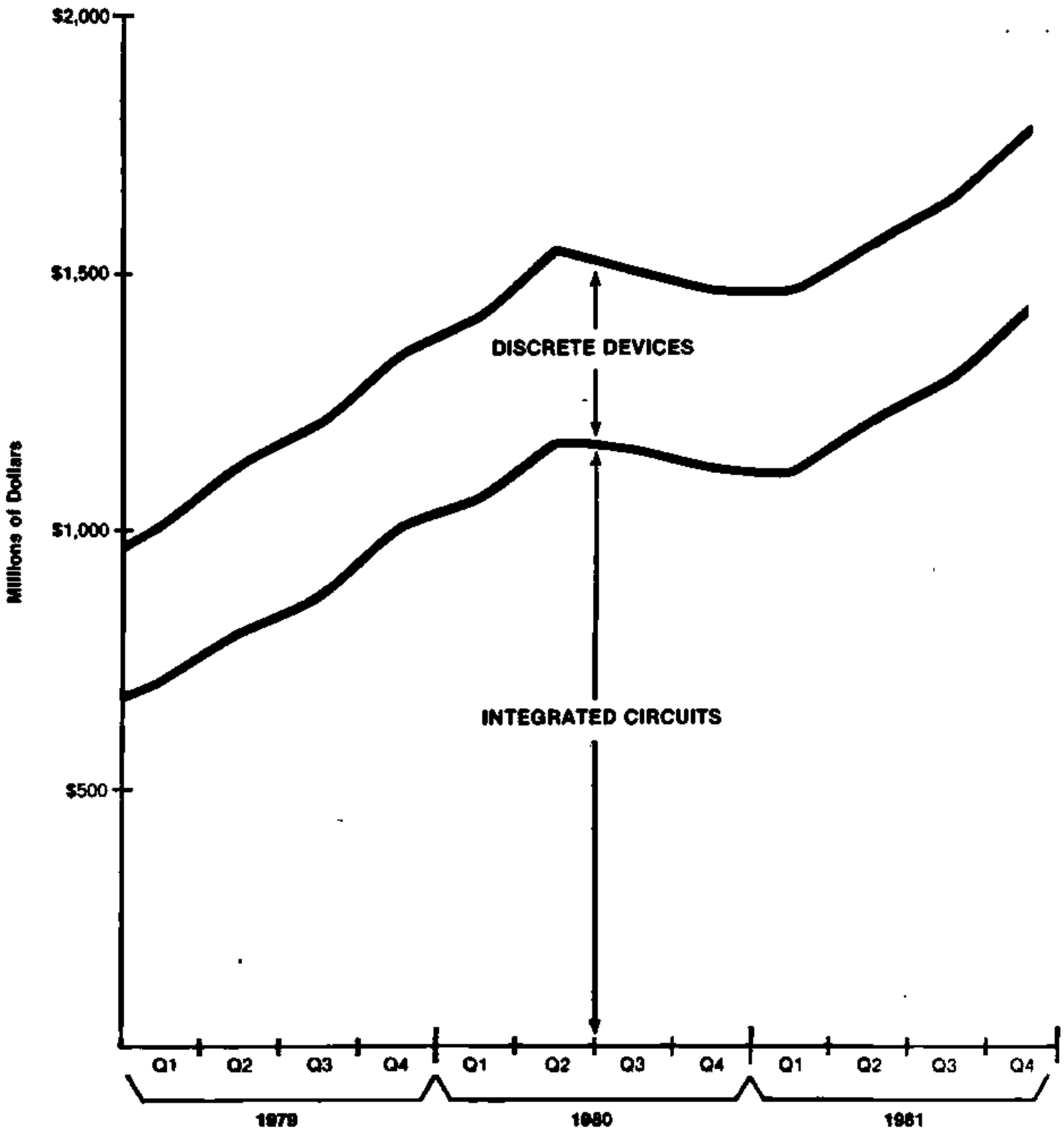
	1979				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$ 301	$ 340	$ 344	$ 347	$1,322
Integrated Circuits	700	805	868	1,002	3,375
Total	$1,001	$1,145	$1,202	$1,349	$4,697
Percent Change From Previous Quarter	4.4%	14.4%	5.0%	12.2%	
Percent Change From Previous Year	33.6%	36.0%	39.1%	40.7%	37.6%

	1980				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$ 354	$ 364	$ 334	$ 330	$1,382
Integrated Circuits	1,066	1,185	1,167	1,127	4,545
Total	$1,420	$1,549	$1,501	$1,457	$5,927
Percent Change From Previous Quarter	5.3%	9.1%	(3.1%)	(2.9%)	
Percent Change From Previous Year	41.9%	35.3%	24.9%	8.0%	26.2%

	1981				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$ 329	$ 340	$ 343	$ 361	$1,373
Integrated Circuits	1,125	1,216	1,278	1,416	5,035
Total	$1,454	$1,556	$1,621	$1,777	$6,408
Percent Change From Previous Quarter	(0.2%)	7.0%	4.2%	9.6%	
Percent Change From Previous Year	2.4%	0.5%	8.0%	22.0%	8.1%

Source: DATAQUEST, Inc.
December 1980

Figure 1
ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION



Source: DATAQUEST, Inc.
December 1980

The decline in semiconductor consumption in the second half of 1980 is of course tied to the very rapid decline in the U.S. economy during the second quarter of this year. But this decline has been caused essentially by an adjustment in semiconductor prices. It is important to point out that unit demand for large chips has remained strong. In other words, actual usage has not collapsed. The resumption of price stability coupled with this growth in unit demand can provide market growth.

Long-Term Outlook

Over the last two years, the semiconductor industry has clearly outperformed the economy. Any econometric model, including ours, no longer can be used to predict semiconductor demand. While we feel our model remains reasonably accurate for timing or inflections, it no longer holds for accurate assessments of the magnitude of industry growth. Thus, the past is no longer useful to predict accurately the future of the industry. In the eight quarters ending with the second quarter of 1980, U.S. semiconductor consumption grew 79.3 percent. During the same period of time, industrial production, after a long period of stagnation, fell more than nine percent. Automobile sales were down more than 30 percent, and housing starts were down more than 40 percent from their peak. Obviously, demand for electronics is not linked strictly to economic strength. Changes in the structure of the U.S. economy are providing a background for significant sales of electronics. We believe that 1979 and early 1980 presage a period of several years in which the semiconductor industry will experience only moderate problems in recessions and extremely rapid growth in periods of economic strength. There are very strong engines of demand driving semiconductor consumption:

- The increasing price performance of semiconductor devices and the electronic systems made from them compared with inflating prices of almost everything else.
- Sales of electronics to combat higher material and energy costs.
- Sales of electronics to combat higher inventory costs.
- Sales of electronics to combat higher expected future labor costs.

The high costs of inventory, energy, labor, and materials have had a major effect on the economics of the purchasing decision for equipment. The payback on many types of electronic equipment has been significantly increased. We discussed these engines of demand in our "Outlook for 1981" presented at the DATAQUEST annual conference in October. DATAQUEST believes the long-term outlook for the industry is highly positive.

Frederick L. Zieber

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JAPANESE EQUIPMENT MANUFACTURERS INCREASE PRESENCE AT SEMICON/JAPAN '80

OVERVIEW

The Semiconductor Equipment and Materials Institute, Inc., (SEMI) of Mountain View, California, presented the fourth annual SEMICON/Japan '80 show at the Tokyo Harumi Fairground, November 19-21. SEMICON/Japan is clearly the second most important of five technical/trade shows held for semiconductor equipment manufacturers by SEMI.

The three-day show drew 13,335 visitors, compared to about 10,000 in 1979 and about 3,500 in 1976, its first year. Industry representatives attended other SEMICON shows this year in Zurich, Switzerland (March 11-13); San Mateo, California (May 20-22); Boston, Massachusetts (September 23-25); and Dallas, Texas (October 8-9). SEMICON/Europa (Zurich) drew 4,500 visitors; SEMICON/West (San Mateo), 22,500; SEMICON/East (Boston), 5,200; and SEMICON/Southwest (Dallas), 3,200.

SEMICON/Japan consisted of a three-day technical program in addition to the equipment show, which featured more than 450 booths. The technical program included three seminars on the following subjects: electron beam exposure apparatus; dry etching technology trends; and production processes and their applications. Representatives of Japanese companies presented most of the technical papers.

THE PRESENCE OF JAPANESE COMPANIES

DATAQUEST noted that U.S. manufacturers seemed surprised at the increased presence of Japanese equipment suppliers at SEMICON/Japan, probably in part because the SEMICON shows generally are considered to be American equipment shows. Japanese companies accounted for about 25 percent of the equipment exhibited this year, we believe, compared with almost no Japanese equipment exhibited at the first SEMICON/Japan show in 1976. European companies accounted for another 5 percent of the equipment this year, down from 10 percent in 1976. The percentage of U.S.-manufactured equipment exhibited dropped from 90 percent in 1976 to 70 percent in 1980.

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U.S. REACTION

The reaction of U.S. equipment manufacturers to the new Japanese equipment ranged from resignation to the inevitability of a strong Japanese presence in the Japanese semiconductor manufacturing equipment industry, to the recognition that U.S. manufacturers must get into the Japanese marketplace and establish a strong presence to preserve market share. Some of those who expressed resignation also showed bitterness, and some made accusations of "unfair trade practices" and "double standards," prompted by cultural, legal, and communications barriers. (This opinion was observed by DATAQUEST and is not necessarily shared by us.) Those who recognized that U.S. manufacturers must establish manufacturing facilities and support organizations in Japan feel that the best way to do that is to enter into joint ventures or cross-licensing agreements with Japanese companies. We observed many U.S. companies approaching Japanese companies about joint ventures at SEMICON/Japan. At least six U.S. manufacturers made offers of joint ventures to one major Japanese manufacturer.

JAPANESE REACTION

The Japanese reaction to U.S. equipment was that U.S. manufacturers do not pay enough attention to detail, and that their equipment consequently lacks reliability. The Japanese equipment suppliers voiced the opinion that Japanese engineers demand more and have very specific requirements for new equipment (especially in the area of field support), and that Japanese engineers are best served by Japanese equipment manufacturers. (These opinions are not necessarily shared by DATAQUEST). In the words of one U.S. manufacturer, "There are no good old boy type engineers (in Japan) who will buy equipment and then make it work. Japanese engineers look at the published specs and then chain your installation engineers to the equipment until it is well within claimed tolerances."

JAPANESE EQUIPMENT

The following list highlights some of the new Japanese equipment exhibited at SEMICON/Japan this year.

Alignment

- Canon—mirror projection aligner, available in the United States in April, 1982.
- Hitachi—stepper aligner, not available in the United States.
- Nikon—stepper aligner, available in the United States in late 1981.
- Dainippon Screen— soft contact aligner.
- Nippon Kogaku—soft contact aligner.

It is interesting that Canon is developing a projection aligner. Most new aligners in the United States are projection aligners, but the Japanese industry has favored proximity/soft contact aligners, which U.S. manufacturers consider to be an outdated technology. Nevertheless, it is noteworthy that many Japanese 16K RAMs are made with the aid of proximity/soft contact aligners.

Plasma Etch

- JEOL—reactive ion etch (RIE) equipment, not available in the United States.
- Kokusai Electric—load lock RIE equipment, not available in the United States.
- Tokuda—cassette-to-cassette, load lock etcher, just becoming available in the United States.
- Tokyo Ohka—Barrel and planar etchers, available in the United States in early 1981.
- Kanematsu—Inline cassette-to-cassette etcher, not available in the United States.

Spin/Coat/Develop/Scrubber

- Dainippon Screen—track and resist, not available in the United States.
- Setek—tracks and scrubbers.
- Tokyo Ohka—positive photoresist developer, cassette-to-cassette, not available in the United States.
- Nissho—tracks and coaters, not available in the United States.
- Chuo Riken—scrubber.

Implanters

- Ulvac—high current, not available in the United States.

Others

- Akashi—scanning electron microscope.
- Kokusai Electric—low pressure chemical vapor deposition (CVD) epitaxial system, not available in the United States.
- Nikek—Flatness tester, not available in the United States.
- Nippon Electric—laser annealer, not available in the United States.

- Nikon—mask and reticle defect detection system, just becoming available in the United States.

CONCLUSION

One representative of a Japanese trading company at SEMICON/Japan said, "With every business spike (dramatic growth), we are third in attention. U.S. firms are generally directly represented in the U.S. and European markets, and our needs are considered after those of their direct and probably most profitable areas." DATAQUEST believes that the near-term challenge for U.S. equipment manufacturers is not that the Japanese are selling equipment in the United States, but that the Japanese are selling equipment in their own market. Some Japanese purchasers of semiconductor equipment believe that their engineers have special requirements that only domestic manufacturers can meet. Others have the feeling that the United States neglects the Japanese market. These beliefs, combined with the perceived high quality of some Japanese semiconductor equipment, will put increased pressure on U.S. equipment manufacturers to establish a strong presence in Japan, and to develop a worldwide market outlook.

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1980 CAPITAL SPENDING HOLDS STEADY - CAUTIOUS PLANS FOR 1981 -

SUMMARY

Recent estimates of U.S. merchant semiconductor manufacturers' capital spending plans for facilities and equipment are holding firm, seven months after the first signs of a business flattening appeared. Small reductions from some companies' early-year spending plans appear to have been made up by increases from other companies, and total 1980 industry outlays are, in fact, up about five percent from earlier expectations. Furthermore, preliminary 1981 plans by these manufacturers indicate that the business slack is expected to be shallow and short-lived. Tentative 1981 plans show an increase of about 12 percent over 1980 levels.

Table 1 shows DATAQUEST's estimates of merchant manufacturers' capital spending. In the first column are DATAQUEST's 1980 estimates from an earlier newsletter (see DATAQUEST Research Newsletter dated 1 April 1980 entitled "U.S. Semiconductor Manufacturers' Capital Spending 1979-1980"). The second column has current estimates of what 1980 will finally see. Third are estimates of 1981 spending plans based on public statements by company spokesmen and industry sources. Based on a preliminary estimate of 1981 U.S. semiconductor manufacturers' factory shipments as shown in Table 2, it appears that capital spending will rise at about the same rate as revenues next year.

MANUFACTURERS' RESPONSE TO 1980 RECESSION

The mild recession now evident has done little to shake the merchants' solid commitment to build additional capacity for the future. Total capital spending by all manufacturers has remained firm, although there has been more commitment to put in brick and mortar than to place firm orders for equipment. There have been stretch outs on equipment orders—which we view as an adjustment for the short term—and reductions in backlogs among equipment suppliers. However, forfeitable down-payments and extremely long lead times on the highest ticket items have forced semiconductor manufacturers to plan carefully and hold to their contractual delivery agreements.

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Table 1

ESTIMATED U.S. MERCHANT MANUFACTURERS' CAPITAL SPENDING
(SEMICONDUCTORS ONLY)
(Millions of Dollars)

	Earlier 1980 Estimate*	Current Estimate For 1980	Planned 1981
Advanced Micro Devices	$ 65	$ 65	$ 80
Fairchild	70	95	120
Intel	125	125	140
Mostek	85	85	85
Motorola	200	175	175
National Semiconductor	90	120	145
Signetics	80	80	110
Texas Instruments	190	220	250
Other U.S. Companies	415	415	450
Total Spending	$ 1,320	$1,380	$ 1,555

*DATAQUEST Research Newsletter dated 1 April 1980 entitled "U.S. Semiconductor Manufacturers' Capital Spending 1979-1980"

Source: DATAQUEST, Inc.
December 1980

Table 2

U.S. MERCHANT SEMICONDUCTOR CAPITAL SPENDING
AS PERCENT OF REVENUES
(Millions of Dollars)

Year	Revenues	Industry Capital Expenditures	Percent
1973	$2,830	$ 341	12.0%
1974	$3,366	$ 421	12.5%
1975	$2,796	$ 195	7.0%
1976	$3,519	$ 356	10.1%
1977	$4,079	$ 431	10.6%
1978	$5,123	$ 680	13.3%
1979	$6,880	$ 1,065	15.5%
1980*	$8,650	$ 1,380	16.0%
1981*	$9,650	$ 1,555	16.1%

*1980 and 1981 data are preliminary estimates

Source: DATAQUEST, Inc.
December 1980

1980 RECESSION DIFFERS FROM 1974-75 RECESSION...SO FAR

In the 1974-75 recession, total capital spending by merchant manufacturers was cut in half compared to pre-recession levels. In our opinion, the present situation differs in many ways:

- The business weakness to date has been much more modest than during the previous recession period with no massive long-term layoffs, no manufacturers reporting unprofitable quarters, and no large return of products from users.

- Users' inventories have been better controlled, and market declines have been less precipitous.

- Semiconductor manufacturers had expected the recession for 18 months and planned accordingly.

- The general industry consensus is that hesitancy to build during or after 1974-75 resulted in lost opportunities in 1978-79.

- Two strong years of industry growth have left long lead times for much equipment. These lead times have kept equipment shipments playing catch-up in a flat components market. The situation has been exacerbated by significant increases in the time required to build high-complexity manufacturing equipment.

- Supply excesses are confined to just a few markets, and, we believe, the failure of revenues to grow in the last half of 1980 has resulted more from component price attrition than from relaxation of demand for units.

RISING INTEREST RATES PROLONG UNCERTAINTY

Recent weeks have seen a continual rise in interest rates, and many economists are expressing concern that the overall economy will turn down again. If this occurs, it would essentially nullify the scenario that had the semiconductor industry experiencing a continuing slow rebound in the first and second quarters of next year. It might force merchant semiconductor manufacturers to reconsider their spending plans for next year, as profits are squeezed and borrowing becomes increasingly expensive. In an extreme situation, it may be difficult for manufacturers to keep focused on the post-recession recovery when the present makes investment so difficult. Concern over interest rates seems to have dampened earlier positive signs within the semiconductor industry when bookings improved and prices firmed up. It seems apparent that the longer interest rates remain at their present level, the more probable it will be that the economy will turn down and that capital spending plans for 1981 will need to be adjusted downward.

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INNOVATION

This newsletter is a condensation of remarks delivered by Robert N. Noyce, vice chairman of Intel Corporation of Santa Clara, California, on September 8, 1980 to the Affiliates Program of the Graduate School of Business at Stanford University.

INNOVATION

Innovation is declining in America, despite its importance to our economy and society.

The evidence is substantial. The number of patents issued to Americans by the U.S. Patent Office, the number of new companies issuing stock to the public, the productivity of American industry, and U.S. expenditures on research and development are all declining.

Innovation benefits our society. It has accounted for about half of our economic growth, outranking capital and the increase in our labor force in its contribution. The present administration recognized the importance of innovation and initiated a Domestic Policy Review of Industrial Innovation. The findings were submitted to the president nearly a year ago, but little action has been taken.

Innovation cannot be mandated, but it can be encouraged by creating an environment conducive to innovation. Nearly every government action affects innovation in some way, either positively or negatively. Necessity is not the only mother of invention.

- Motivation. The innovator must see some personal advantage. Rewards may include recognition, personal satisfaction, and money.

- Optimism. The innovator must believe that problems can be solved with available resources. Without optimism, the individual is risk-averse.

- Opportunity. A growing economy presents the potential innovator with more problems to attack. In a static world, there is little opportunity for the success of innovations.

- Knowledge. This is the basic tool kit for the innovator and must be replenished through basic research.

- Money. The innovator must have private, corporate, or public risk capital to explore new ideas.

Unfortunately, conditions that would encourage innovation have eroded over the last 10 to 20 years in the United States.

- Increasing regulation bars the introduction of new ideas and reflects the risk aversion of our society.
- Inflation has made a mockery of the ethic of saving, and has promoted immediate consumption. Consequently, the availability of capital has suffered.
- Poor investment performance also has limited the availability of risk capital.
- Anti-technology sentiment has caused many of our brightest young people to choose careers in which innovation is unlikely.
- Zero growth sentiment, espoused by the Club of Rome, has convinced many that economic growth is undesirable. Even the most optimistic innovator is discouraged.
- Conflict in our society discourages both the innovator and the cooperative effort that is necessary to make innovation effective.

Policy Options

Any actions that restore vitality to the American economy will promote innovation. Such actions include the elimination of inflation, control of government spending, elimination of counter-productive regulations, increases in savings and investment rates, and increasing rewards for success.

There are other options, however, that are necessary today for the health of emerging industries and that will benefit our industry tomorrow.

One option is to set an industrial policy. The United States has not deliberately set an industrial policy that favors a particular industrial group, and that in itself is an industrial policy. This informal policy tends to maintain established industries at the expense of the emerging industries.

Mature industries gain favor because emerging companies based on new technology and innovation have not yet established relationships with the government. They are typically small companies, and the expense of lobbying is beyond them. Consequently, they are not adequately represented in government decision making.

And, although only 25 percent of the labor force in the U.S. belongs to unions, unions represent labor in government decisions. Again, emerging industries are not adequately represented in Washington because their labor forces do not, typically, belong to unions.

An industrial policy based on shifting requirements for industrial output and the relative competitiveness of American industry would back our strengths and not our weaknesses. The Chrysler loan, for example, would create many more jobs if used to promote new ventures instead of to preserve life support systems for a corporate geriatric.

Research and Development

As a nation, we are not investing enough in research and development, which lies at the heart of innovation. R&D expenditures have dropped by about one-third in the last decade.

Any policy that promotes innovation should include increasing our national expenditures on research and development, preferably by private industry and in areas in which the results can be used by the private sector. Public support of research, except in the areas of public health or national defense, tends to drive out corporate funding.

The best methods available to increase corporate R&D expenditures are tax incentives. Such incentives could include investment tax credit for research and development or greater than 100 percent deductibility for research and development.

University Research

Our universities have become increasingly more dependent on government funding since World War II. As a result, they are becoming less responsive to the needs of the private sector.

University research has two important characteristics in particular: it produces trained manpower, and research results are spread rapidly, through publication and departing students. However, students are too often trained in fields in which the government is nearly the only employer or in which there are few job opportunities. There is little university research directed toward the needs of industry, yet such direction is common practice in countries that have an articulated industrial policy.

Industrial sponsorship of university research is limited today because its benefits are also available to the sponsor's competition. Sponsorship benefits the entire society, and its cost should be borne in part by that society.

The most effective way to promote industrial sponsorship of university programs is to give tax credits rather than deductions to sponsors. Such credits could be limited to a fraction of internal research and development to ensure that programs are approved by those active in managing research and development and that jobs await graduates.

New Companies, Growth Companies

Innovation is the most successful strategy for a new company. Therefore, any policies that support new companies will have a favorable effect on innovation. Such policies could include more favorable treatment of capital gains on new issues, easing of SEC regulations for issuing new stock, or more favorable treatment of loss carry forward for start-up companies.

Furthermore, successful innovative companies become growth companies and usually continue to innovate. Policymakers have another opportunity to support innovation through increased tax credits for the creation of jobs and deferred taxation on increased earnings, both of which help solve a major problem for a growth company -- financing that growth.

The re-establishment of the restricted stock option also favors the growth company and at the same time increases federal revenues.

Social Philosophy

If we as a nation are to excel, we must reward excellence. It is a simple tenet, but one that is not accepted by large segments of our society. All men are created equal, but some contribute more than others. If we wish to encourage such contribution, we cannot insist that all men finish the contest together because they were equal at the beginning. Countries that outperform us, most notably Japan, have an operating meritocracy as a practical philisophy.

We should insist upon equality of opportunity because that will promote innovation. But we must let each seek the rewards that must be, both corporate and individual, or we will complete the job of killing America's golden goose.

Robert N. Noyce

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DRY ETCH PROCESSING

SUMMARY

The semiconductor industry is fast approaching two, one, and even submicron lines in its quest for small-geometry, high-speed devices. Fine-line geometries demand changes in many wafer fabrication processes and the etch process is no exception. In response to the demand, the industry is developing dry etch processes, including plasma etching, reactive ion etching (RIE), and ion mill etching.

DATAQUEST believes that worldwide dry etch wafer processing equipment consumption was $50 million in 1979, up from $29 million in 1978. We believe that worldwide consumption should reach $90 million in 1980, and $335 million in 1984.

The most important advantage of dry etch processing is that some methods can perform an anisotropic, or vertical, etch. It will be necessary to etch vertically as device lines become finer. So far, the most successful application of dry etch processing is to nitride and polysilicon layers but dry etch processing applied to other materials is some months away from production use.

The opportunities in the dry etch market have created a proliferation of suppliers that shows no sign of slowing at this time. Consequently, DATAQUEST believes that it may be some time before a dominant supplier emerges.

THE PROCESS

Wet Chemical Etching

Traditionally, the most common method of etching a wafer patterned with photoresist is to submerge the wafer in a wet chemical etch solution that attacks the exposed surface at a slower rate than the rate at which it attacks the photoresist. DATAQUEST estimates that 70 to 90 percent of mask layers are etched in wet chemical solutions.

Wet chemical etching has some very positive characteristics. The equipment used in the process is relatively inexpensive, and it produces relatively high selectivity. Selectivity is the difference in etch rates between the material in the layer that is being etched and the underlying layer.

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Wet chemical etching has some negative characteristics, however. It may be hazardous to personnel because of the potentially dangerous chemicals used in the solution. The use of wet chemicals also creates a waste disposal problem. Another production problem may occur as the acids and bases in the solution are used up, which may cause the etch to change during the processing of a batch of wafers.

In addition, wet chemical etching has some serious technological limitations. It produces an isotropic etch—an etch that proceeds horizontally as well as vertically—that may lead to resist undercutting. It is also difficult to control the slope of the walls produced by the etch. These problems will become more critical as the industry approaches submicron lithography. Faithful reproduction of fine-line geometries may require vertical walls; isotropic etching broadens the lines by undercutting.

Dry Etching

Dry etch processing has both production and technological advantages over wet chemical etching. Dry etching is safer because it requires fewer potentially dangerous chemicals in less volume, and because human operators are not directly exposed to the chemicals in the process. Furthermore, dry etching partially eliminates the waste disposal problem, and reduces the problem of inconsistent etching associated with processing a batch of wafers in wet chemicals.

Among its technological advantages, dry etching produces clean lines, and may allow control of the slopes of the walls. Some types of dry etching produce an anisotropic etch, which is a single-direction (vertical) etch that creates 90 degree walls, and some types eliminate undercutting.

Of the three types of dry etch processes currently in use or in development, plasma etching is the most common. This process employs gases to remove the material that is being etched in a chemical reaction. Reactive ion etching (RIE) is partly a chemical process and partly a mechanical process. It combines chemical activity and directed, charged particles to remove the material that is being etched. Ion mill etching is entirely a mechanical process. It employs accelerated gas ions to bombard the wafer in a collimated beam. Another process, reactive ion beam etching (RIBE), is actually a combination of RIE and ion mill etching.

The plasma etching process uses two different types of equipment—barrel reactors and planar (or parallel plate) reactors. Barrel reactors are currently the most common and inexpensive type of equipment and are used for etching and photoresist stripping. Wafers are positioned vertically inside the barrel reactor chamber, which is then evacuated and the gas mixture admitted. The ionized gas forms around the wafers and the etching process is performed by the ions, which are chemically activated. Barrel reactors generally perform an isotropic etch. They have greater wafer throughput than planar reactors, however, and are relatively inexpensive, at about $30,000.

Planar reactors etch wafers as they lie flat between parallel electrodes. Planar reactors can perform anistropic etches and they have good selectivity. However, the equipment is more expensive than barrel reactors ($125,000 and up) and cannot process as many wafers per hour.

RIE equipment is similar to planar reactors; in fact, there is some controversy in the industry over the similarities/differences between planar reactors and RIE equipment. DATAQUEST has not attempted to settle the issue, but we do combine planar reactors and RIE equipment under the same heading in our estimates of consumption of dry etch processing equipment. Some industry observers believe that RIE equipment produces a better anisotropic etch than plasma planar equipment. RIE equipment tends to be expensive, in the same range as planar reactors.

The ion mill etching process performs the best anisotropic etch of all the dry etch processes, but the process is slow because it is entirely mechanical. Selectivity is also very low. Ion mill equipment costs are in the range of $150,000 to $200,000.

MARKET GROWTH

DATAQUEST estimates that worldwide dry etch wafer processing equipment consumption was $50 million in 1979, an increase of 72 percent over the $29 million of consumption in 1978 (see Table 1). Worldwide consumption should reach $90 million in 1980, and $335 million in 1984, representing a 39 percent compound annual growth rate (CAGR) between 1980 and 1984.

Table 1

ESTIMATED WORLDWIDE DRY ETCH WAFER PROCESSING EQUIPMENT CONSUMPTION, BY GEOGRAPHICAL AREA
(Millions of Dollars)

	1978	1979	1980	1984
North America	$15	$28	$60	$253
Japan	12	19	25	52
Western Europe	2	3	5	30
Total	$29	$50	$90	$335

Source: DATAQUEST, Inc.
December 1980

By geographical area, North American consumption of dry etch processing equipment should increase at 43 percent CAGR between 1980 and 1984. Japanese consumption should increase at a 20 percent CAGR during that same period. Western European consumption should increase at a 57 percent CAGR.

North American equipment consumption estimates by product reveal that the fastest growth is in consumption of planar/RIE equipment (see Table 2). North American consumption of planar/RIE equipment was an estimated $3 million in 1978, rose to $10 million in 1979, and should reach $32 million in 1980, representing a 227 percent CAGR. North American consumption of barrel reactors should increase at a 35 percent CAGR and consumption of ion mill equipment should increase at a 183 percent CAGR between 1978 and 1980.

Table 2

ESTIMATED NORTH AMERICAN DRY ETCH WAFER PROCESSING EQUIPMENT CONSUMPTION, BY PRODUCT
(Millions of Dollars)

	1978	1979	1980
Barrels/Strip & Etch	$11	$15	$20
Planar/RIE	3	10	32
Ion Mill	1	3	8
Total	$15	$28	$60

Source: DATAQUEST, Inc.
December 1980

Japanese consumption of planar/RIE equipment should increase at a 41 percent CAGR between 1978 and 1980, while consumption of barrel reactors should increase at a 51 percent CAGR during the same period (see Table 3). Japanese consumption of ion mill equipment is negligible at this time.

Table 3

ESTIMATED JAPANESE DRY ETCH WAFER PROCESSING EQUIPMENT CONSUMPTION, BY PRODUCT
(Millions of Dollars)

	1978	1979	1980
Barrels/Strip & Etch	$3.5	$ 5.5	$ 8.0
Planar/RIE	8.5	13.5	17.0
Ion Mill	-	-	-
Total	$12.0	$ 19.0	$ 25.0

Source: DATAQUEST, Inc.
December 1980

Production of planar/RIE equipment in North America and Japan has increased more than two times over the last three years. In addition, the production ratio between North America and Japan has changed from Japan producing slightly more to North America producing more (about 2:1). DATAQUEST believes that this change reflects a greater commitment to dry etch processing in proportion to wafer starts in North America than in Japan.

The advent of dry etch processing may affect other wafer fabrication process markets. For example, as more manufacturers shift to dry processing, they should require fewer wet chemicals in less volume. There are more than two dozen wet chemicals used in the wafer fabrication process and it is likely that dry processing will affect each chemical usage separately. However, the increase in wafer starts and the number of layers per device creates growth potential for both dry etching and wet etching, and DATAQUEST believes that the wet chemical market should continue growing at least through 1985.

The photoresist market may also change as a result of dry etch processing. One property of photoresist is that it erodes faster at higher temperatures. One way to increase etch rates is to use a photoresist that erodes more slowly at high temperatures. High etch rates are particularly important in the single-wafer dry etch machines. Currently, single-chamber machines do not have etch rates comparable to typical line throughputs in most wafer processing factories. Thus, high throughput machines require more than one chamber and, as a result, are more expensive than single-chamber machines. Consequently, suppliers of photoresist may be under some pressure to develop photoresist that can withstand higher temperatures. A high-temperature photoresist could also improve the sales of single-chamber etch machines.

One new growth market that should emerge because of dry etch processing is the specialty gas market. The gas usage per wafer is not particularly large, but the overall market should grow significantly between 1980 and 1984. Excluding dopant and deposition gases, the specialty gas market is an estimated $6 million to $10 million in 1980 and should reach $30 million to $50 million in 1984. Specialty gases currently constitute only 10 percent of the total gas market. There is a lot of experimentation with specialty gases, and the gases used currently may not necessarily be the gases used in the future. At present, manufacturers use oxygen in dry photoresist stripping, and use mixtures of fluorocarbons and gases such as argon in dry etching.

TRENDS

The ideal etch is controlled, selective, and uniform throughout the wafer and the run. No one etch process can perform the ideal etch, so there are some trade-offs in the use of dry etch over wet etch and vice versa.

The most important advantage of dry etch processing over wet chemical etching is that some methods can perform an anisotropic etch; it will become necessary to etch vertically as device lines become finer. DATAQUEST believes that ultimately all etching will be performed with dry etch processes, but that it could take a long time to complete the transition.

So far, dry etch processing has been applied most successfully to silicon nitride and polycrystalline silicon layers. Nitride etching is the most popular application and polysilicon etching is becoming more popular. DATAQUEST believes that there is some difference in perception between customers and suppliers over the current capabilities of dry etch processes for other materials such as aluminum or silicon oxide. Effective processes for use with aluminum and oxide may be further away than suppliers think. It appears that offering the equipment is sometimes not enough—many customers need to be told what gases to use and how to use them. Suppliers often do not have the resources to do that kind of research, or they do not have the qualified process personnel to work with customers. Some of the larger customers are purchasing equipment and developing their own processes, but that information does not get back to the supplier to pass along to other customers.

Nevertheless, opportunities in the dry etch market have created a proliferation of suppliers and a large number of suppliers who are considering the market. There are currently about 20 suppliers with products to offer, and perhaps as many as 12 additional suppliers plan to enter the market in the next year or two (see Table 4). One reason for the proliferation of suppliers is that suppliers must invent lots of technology before device manufacturers can perform the previously described ideal etch. There are many possible solutions to the problems and no one company can provide all of them. Companies tend to concentrate on just one or two solutions, which means that the field is crowded, and it may be some time before a dominant supplier emerges.

Howard Z. Bogert
Susan A. Thomas

Table 4

DRY PROCESSING EQUIPMENT SUPPLIERS

	Barrel Reactors	Planar/ RIE	Ion Mill
Anelva (NEC) Japan		X	
Applied Materials Santa Clara, CA		X	
CHA Menlo Park, CA		X	
Commonwealth Scientific Alexandria, VA		X	X
CVC Rochester, NY		X	
D&W (Eaton) Santa Clara, CA		X	
ET Equipment (Electrotech) Hauppauge, NY		X	
GCA Bedford, MA		X	
IPC/Dionics Hayward, CA	X	X	
LFE Waltham, MA	X	X	
MRC Orangeburg, NY		X	
Perkin-Elmer Norwalk, CT		X	
Plasma-Therm Kresson, NJ	X	X	
Technics Alexandria, VA	X	X	X

Table 4 (continued)

DRY PROCESSING EQUIPMENT SUPPLIERS

	Barrel Reactors	Planar/ RIE	Ion Mill
Tegal Richmond, CA	X	X	
Tokuda (Toshiba) Japan		X	
Tokyo-Oka Japan	X	X	
Varian Palo Alto, CA		X	
Veeco Sunnyvale, CA			X

Source: DATAQUEST, Inc.
December 1980

DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

Vol. II - No. 10 December 2, 1980

This letter is a condensation of recent Research Newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific Newsletters should be directed to the author. A list of recent DATAQUEST Newsletters appears at the end of this letter.

SMALL COMPUTERS/OFFICE AUTOMATION

The recent introduction of Datapoint's high-end processor, the 8800, was important not only because of the product itself, but also because of some information that was made available in conjunction with the announcement, indicating that Datapoint is making very encouraging progress in penetrating the office automation market.

One of the potential weak spots at Datapoint was the relatively small main memory capacity of the 6600 processor, which was its largest processor prior to the 8800 announcement. The 6600 has only 256 Kbytes of main memory, which could have potentially limited its ability to process large programs. Each 8800 can support up to one megabyte of main memory, four times the size of the 6600, eliminating any problem with main memory capacity. While the 8800 uses a different operating system, its compatibility with the operating system used on the existing ARC system is relatively good, which was another strong point of the announcement.

Delivery of the 8800 with software that will allow it to be integrated into ARC systems will not begin until the summer of 1981, but it could have some impact on orders for this fiscal year. Potential customers who were concerned about the processing power of individual units of the ARC system may now see a clear upgrade path, and this could encourage them to order ARC systems now, with the knowledge that they can add 8800 processors in the future as needed.

During the announcement, it was indicated that there were over 1,000 ARC systems installed and that 300 of these installations are already using Datapoint's integrated electronic office. The company's definition of an integrated electronic office user is a customer who is utilizing at least two of the four functions that Datapoint offers (data processing, word processing, electronic mail, communications management), but the nature of Datapoint's product line makes it very hard to determine accurately how intensively each function is being used.

For example, a data processing user has only to invest about $1,000 to be able to use word processing on an ARC system. The incremental cost for electronic message switching is equally minimal for a user who has spare processing capacity. This difficulty in accurately determining the functional use of an ARC system makes the company's statement regarding 300 integrated office users a little loose, but it also speaks to one of Datapoint's major advantages—the low incremental cost of adding features onto an ARC system once it is installed. Based on the present installed base, Datapoint would have to be placed among the leaders in office automation. Furthermore, when the company's widely expected digital PBX announcement is made, Datapoint will have a feature that not even Wang Laboratories can offer.

Order trends at Datapoint appear to be improving somewhat domestically and weakening in Western Europe. We ascribe the softness in Western Europe more to the deceleration in economic growth in that part of the world than to any difficulties with the TRW distributors in light of the anticipated sale of this distribution network to Datapoint at the end of this fiscal year. Obviously, however, the progress in Western European orders and sales must be monitored very closely over the next nine months because of economic and internal reasons. We believe that overall order growth at Datapoint during this fiscal year will be sufficient to sustain a 30 percent increase in revenues in fiscal 1981 to a level of $415 million.

Margin trends in the first quarter of fiscal 1981 were encouraging. Operating margins turned up after having declined during the last half of fiscal 1980. Flex, Incorporated, the subsidiary that owns Inforex, made a positive contribution to Datapoint's earnings in the first quarter. This contribution is a small plus in itself, but somewhat enhances our confidence in Datapoint's ability to make the difficult integration of TRW's distributors next year without any major problems.

We believe that earnings gains in excess of 30 percent to around $5.00 per share are likely in fiscal 1981. If Datapoint can successfully integrate the TRW European dealers into its sales network, we believe that earnings in the $7.00 per share range are not unreasonable in fiscal 1982.

INSTRUMENTS

The last year or so at Perkin-Elmer has been a period during which all five of its divisions have been enjoying strong growth in orders, sales, and earnings. It is not reasonable to expect that five divisions that are affected by very different economic variables would continue to all fare extremely well at the same time, and indeed there were several comments at the recent Perkin-Elmer analysts' meeting to indicate otherwise.

Specifically, analytical instrument orders were flat year-to-year in the first quarter of fiscal 1981 and, after a number of years of above average growth, it appears that fiscal 1981 may be one of average- to below-average results in instruments, with our target being 10 percent revenue growth and flat margins. Second, after experiencing revenue growth of over 20 percent in fiscal 1980, it is likely that U.S. government revenues will be flat this year. Third, the peripherals year-to-year basis and growth this year is being deemphasized at the expense of higher profit margins. Finally, first quarter earnings in fiscal 1981 were generally below expectations ($0.77 vs. $0.74).

In our opinion, the negatives noted above were offset by a number of other factors. The company clearly expects that operating profit margins will improve in fiscal 1981 versus 1980, with the principal swing occurring in the semiconductor equipment division because of the absence of startup costs on the Micralign 200. First quarter operating profit margins were down somewhat year-to-year, but the company noted that first quarter results are usually not indicative of full-year trends. There are a lot of companies where a similar explanation for lower margins would be viewed with skepticism, but our long experience with Perkin-Elmer makes us very comfortable in taking management at its word.

We were very impressed with the company's very frank discussion of its position in the minicomputer industry. In our view, its assessment of Perkin-Elmer Data System's strengths (very high performance hardware for the price) and weaknesses (relatively poor application software support and lack of experience in making anything but an engineer-to-engineer sell) was very accurate. The company appears to have a very good concept of its opportunities and limitations in the minicomputer industry and we believe that this will allow Perkin-Elmer to obtain reasonably good growth in this division without major downside risks.

In our estimation, the most important discussion was the progress cited by the company in its development of the next generation of projection alignment equipment for the semiconductor industry, the Micralign 500. Perkin-Elmer has completed its preproduction run of the Micralign 500 and has met or exceeded all of its specifications in terms of speed, resolution, and distortion. It has not shipped any products to customers yet but is presently ordering equipment to begin its first production run. If Perkin-Elmer can achieve the same results with Micralign 500 on a full production basis that it has experienced in its preproduction run, then there is little question that this will be a major contributor to the company's growth over the next three to five years.

Perkin-Elmer expects to begin shipments of Micralign 500 during the first half of calendar 1981 and hopes to achieve volume production during the first part of calendar 1982. It is not unreasonable to expect a $100 to $200 million increment to revenues during calendar 1982 at very high profit margins. The revenue gains should be largely incremental because the revolutionary nature of the Micralign 500 should have very little initial impact on shipments of the Micralign 200, which we believe has a present backlog in excess of $200 million.

The net result of the meeting in our view was, first, to centralize earnings expectations for fiscal 1981 at around $4.00 per share (up 23 percent from fiscal 1980) and, second, to increase one's confidence that Perkin-Elmer can achieve earnings gains in excess of 20 percent in fiscal 1982 and 1983.

SEMICONDUCTORS

After being consistently bullish about the prospects of the semiconductor industry in 1981, we would like to temper our enthusiasm. The forecast that we made at our annual Semiconductor Conference for a 10 to 11 percent growth in domestic semiconductor consumption in 1981 was based on a moderate upturn in the economy beginning early next year. We are not changing either our forecast or our economic outlook; however, because of the increase in interest rates that has occurred in the past month, we now believe that the chances of the economy taking another downward dip may approximate 40 percent versus perhaps a 10 percent probability one month ago.

If the recovery is postponed until later in 1981, this will definitely impact semiconductor demand. If the downturn affects the consumer, auto, and industrial markets, but capital-equipment related areas (computers, telecommunications) remain relatively strong, then we believe that the linear and bipolar digital markets will weaken more relative to MOS, which has taken the brunt of price weakness (collapse) to date. In this scenario, Intel may do relatively better than the norm among the major participants, and Texas Instruments and National Semiconductor may do worse. In a more general economic slowdown, all sectors of the industry (and therefore all companies) will be affected.

We want to emphasize that we are not changing our economic forecast at this point. However, we want to point out that the risks of our forecast being too optimistic have increased, as have the stock prices.

Just as the domestic market seems to be picking up somewhat, there is clear evidence that the Western European market is turning down. One major difference between that market and the United States is that there is evidence of excessive inventories on both the user and distributor levels in Western Europe, a situation that has not prevailed in the United States this year. We understand, for example, that one major user hasn't taken delivery on a 16K RAM in six months. We expect a turnup in semiconductor demand in the second half of 1981 in Western Europe, but, because of the inventory overhang and the heavier mix of consumer and lower mix of computer business, we believe that semiconductor consumption will grow only five to eight percent in Western Europe in 1981.

Of the major semiconductor suppliers, Advanced Micro Devices (AMD) seems to have a good degree of protection against a downturn in the market. AMD has been very successful in picking good market niches, where overall unit growth may not be as high as in other sectors, but where price competition is generally less severe and where AMD can effectively gain market share. This strategy is less risky in an economic downturn than competing in the more commodity-type items.

Of the $310 million in revenues that we expect in the March 1981 fiscal year, something over 50 percent should come from bipolar operations. Within bipolar, about half of revenues come from what could legitimately be called proprietary products — its bipolar microprocessor line and the related memory chips that are "dragged" along by microprocessor demand. The remainder of bipolar revenues come from the bipolar logic and the linear area, where AMD has somewhat less of a competitive advantage.

AMD's MOS strategy is to emphasize its microprocessor product line and the peripherals and other support devices that can be sold with it. To date, AMD has not had a large part of its revenues in the most highly competitive MOS memory markets. The present weakness in MOS has hurt AMD by slowing its ability to move into these high-growth markets, which may defer the company's intention of gaining market share in MOS memory.

If we get another downturn in the economy that affects the automotive, consumer, and industrial markets, AMD should fare better than the typical semiconductor manufacturer, as it does no business at all in the automotive or consumer sectors. Only in a severe downturn that affects all areas of semiconductor demand do we think that AMD would be markedly impacted. We expect a 19 percent increase in earnings per share in fiscal 1981 to $1.75 per share and, assuming our still positive industry outlook for 1981 does not have to be revised, we believe that growth may accelerate to a 26 percent rate in fiscal 1982, with earnings reaching $2.20 per share.

COPYING AND DUPLICATING

Our long-term positive stance on Xerox has been based on two premises. First, that the company was getting its house in order in terms of internal cost controls, and that profit margins would begin stabilizing, allowing profits from copying and duplicating to begin rising as fast as revenues. Second, that Xerox had a reasonably good chance of being successful in office automation and that, given the stabilization of margins in its copier business, the market was not paying anything for this opportunity in office automation. We have not changed on viewpoint on Xerox, but we are getting a bit more concerned about the first of our two premises — profit margin stabilization.

The company is leading one to expect that pretax profit margins in 1980 will drop to about 16.3 percent compared with 18.3 percent in 1979. This number would imply a drop in fourth quarter profit margins to 13.2 percent versus 15.5 percent last year. Last year's fourth quarter was depressed by operating losses and a large one-time write-off in word processing, but we believe that word processing is operating close to break even in the fourth quarter of this year. The question is whether the drop in fourth quarter margins is a function of earnings "management" against a weak quarter in 1979, whether it relates to write-offs on the 3300 copier (see below), or whether there are more deep-seated problems.

The 3300 Copier program has been a source of disappointment to Xerox. This machine was developed under the "new culture" at Xerox, when products were supposed to be introduced without glitches—in the Xerox vernacular, "do it once - do it right." Yet, Xerox had to suffer the embarrassment of pulling the 3300 off of the market shortly after initial customer installations were made, because of machine malfunctions. The problem has not been fixed yet and the machine has not been re-introduced. We know that there were relatively large write-offs relating to the 3300 in the third quarter and wonder if there are more write-offs coming in the present quarter.

The key to Xerox's margins remains the middle and especially the high end of the copier market. Despite recent rumors and announcements by IBM, Canon, and others, there is nothing occurring to shake our belief that Xerox will remain dominant at the high end. This dominance should translate to a stabilization of copier profit margins, but we frankly need a bit of encouragement from management that our positive premise is correct.

PAPER AND FOREST PRODUCTS

We are somewhat more optimistic than some on the housing picture over the next two years, expecting 1.5 million starts in 1981 and 1.8 million starts in 1982. We are also very optimistic on the outlook for lumber and plywood pricing over the next two years. Because of cost-push factors in 1981 and demand-pull factors in 1982, we believe that plywood and lumber prices can increase 15 to 30 percent annually in each of the next two years.

The major beneficiaries of this trend should be the large integrated forest products producers, which have a relatively fixed stumpage cost structure. Champion International should benefit from the rapidly rising plywood and lumber prices that we project, and it is also in a favorable position relative to the industry in its paper operations.

The recently completed 50-percent expansion in Champion's linerboard capacity is the key element in Champion's strategy to change its Hoerner Waldorf subsidiary into a competitor in the larger tonnage sector of the market. We believe that Hoerner Waldorf's very capable sales organization can effectively place this new capacity, and we believe that linerboard will be one of the most attractive profit sectors in the paper market over the next few years, due to low rates on industry expansion and the optimistic outlook for linerboard exports. Readers of the Paper and Forest Products section of the Portfolio Letter should note that we have been positive on the long-term outlook for linerboard for over a year, and it appears that the rest of Wall Street is starting to agree with us. Operating income at Champion's Paper Packaging Division (which is primarily linerboard), should be 50 percent higher in 1982 than in the previous peak achieved in 1979.

In its paper and milk carton division, Champion should benefit from a new pulp mill that will ensure pulp self-sufficiency over the next few years and a longer-term strategy of enhancing its appeal to paper distributors by combining a mix of lower-cost commodity paper with highly desirable premium grades and ensuring continual increases in capacity to the distributors. We believe that operating income in paper and milk cartons will increase by 9.5 percent next year and by 15 percent in 1982.

In the aggregate, we project a strong rebound in earnings at Champion during 1981, up to $3.80 per share fully diluted, and we believe that record earnings of $5.80 per share fully diluted can be attained in 1982. The major driving force in both years should be a turn-around in its building products division. We readily concede that our outlook for the company and for the forest products industry is more optimistic than many, but the stocks seem to be discounting a much more conservative outlook and we believe that our argument for higher lumber and plywood prices because of cost-push factors is a very compelling case for the group. We should also note that some paper companies with high linerboard exposure (Union Camp, for example) have done well in the stock market recently. Linerboard operating rates will be good in 1981 only if there is an economic recovery and it is hard to justify a recovery without better housing markets.

CAPITAL EQUIPMENT

The Japanese competitors in the capital equipment business have been relatively quiet for the past few years, but we believe that they may be readying a much more aggressive assault on the U.S. market.

Most of the Japanese technology has been developed by licensing agreements with various U.S.-based competitors. Some of the licensing agreements are joint ventures in which both the U.S. and Japanese company contribute funds to construct a facility for development of products in Japan and then share in the profits in such a facility. One example is International Harvester-Komatsu (KIMCO), and Caterpillar Tractor-Mitsubishi. These joint arrangements are relatively firm ones and it would be very difficult for the Japanese partner to break an agreement in order to begin shipments into the United States.

A more common type of license agreement, however, is one in which neither company contributes capital and a paper corporation is set up to hold the licenses and to funnel royalties back to the parent organizations. This type of arrangement is relatively easy to dissolve by one of the partners. For example, Bucyrus Erie and Komatsu had such a "paper" agreement allowing Komatsu to build hydraulic excavators in Japan. The agreement terminated on July 25, 1980, and was not renewed. On July 27, 1980, Komatsu introduced a new line of hydraulic excavators. While there is no intention at present to ship this new excavator line into the U.S. market, Komatsu is in the process of negotiating a new agreement for mining machinery with Bucyrus that could influence its marketing decision. Clark Equipment and Toyo Umpaki have a license agreement for the production of wheel loaders in Japan that expires in April 1981. It is our belief that this agreement will not be renewed by the Japanese partner. Harnischfeger and Kobe Steel have a similar arrangement for cranes and mining machinery that is being renegotiated at this time.

The rapid rise in the value of the yen during 1978 and 1979, and the very poor U.S. construction equipment market have delayed the efforts of the Japanese, but we believe they will soon make a major assault on the U.S. market. We are starting to see hydraulic excavators from Hitachi and Mitsubishi, expect Kawasaki to introduce a line of rubber-tired loaders, and expect Komatsu and Kobe Steel to introduce a number of different product lines.

If our analysis is correct, the strength will lie in the hands of the U.S. distributors. There will be more products available to sell than there will be distributors and, therefore, there will be tremendous pressure to carry multiple product lines, including Japanese products. Only companies that have the power to force dealers to carry the company's products exclusively would prosper in this competitive environment. Caterpillar and Deere are the only U.S. manufacturers that have this power.

TELECOMMUNICATIONS

Although data communications equipment is a small piece of the total U.S. telecommunications market (estimated revenues of $2.0 billion in 1980 versus industry revenues of $66.5 billion), it is the fastest growing sector of the marketplace, with an estimated five-year growth rate of 20 percent.

The data communications equipment market is composed of four elements: communications terminals ($800 to $900 million), communications processors ($300 to $350 million), modems ($700 million), and data multiplexers ($80 million).

We believe that the modem market will grow at a 21 percent compound rate between 1980 and 1985. The low-speed sector (including acoustic couplers) accounts for about one-third of the total modem market and should grow at an 11 percent compound rate. The high-speed sector (2400 bits per second and up) should grow at 25 percent. Western Electric is the leading supplier in the low end, followed by General DataComm Industries, Inc., the UDS subsidiary of Motorola, and a Racal subsidiary. Racal/Milgo has the largest market share at the high end, followed by Western Electric, the Codex subsidiary of Motorola, and Paradyne. While Paradyne is only number four in the overall high end, it is widely regarded as an innovator and a technology leader in this area. Paradyne is also a major factor in the very high end of the market, which is also the fastest growing.

The data multiplexer market is a relatively small one but it is growing at an estimated 27 percent rate overall, and at a 30 percent to 35 percent rate at the high end (statistical multiplexers and intelligent statistical multiplexers). The major participants in the high end of the market are the Codex subsidiary of Motorola, Micom, Timeplex, Infotron, DCA, and Halcyon division of Torotel. Micom, Infotron, and DCA are privately held companies. The DCC subsidiary of M/A-COM is also a participant in this market.

DATAQUEST defines communications terminals as terminals that are connected to computers via common carrier circuits. This market is highly competitive with over 150 participants. Major suppliers to the market are the mainframe and minicomputer manufacturers as well as plug-compatible manufacturers such as Telex and Memorex. Suppliers to this market do not normally segment their market by telecommmunications applications, so this segment of the terminal market is not separately identifiable for investment purposes.

Communications processors provide such functions as off-loading the communications functions from mainframes. This area is a relatively slow-growing part of the whole data communications market (about 11 percent per year), and is dominated by the computer and minicomputer manufacturers—especially since NCR's acquisition of Comten. However, Paradyne is trying to attack this market by selling IBM-compatible systems that combine the communication processor, modem, and display terminal capabilities.

Michael R. Weisberg

RECENT NEWSLETTERS OF NOTE

SMALL COMPUTERS

Main and Disk Memory Purchases on New Computer Systems	10/10/80

SEMICONDUCTOR

Estimated U.S. Quarterly Semiconductor Consumption	11/21/80
Intel Corporation - Financial Analysts' Meeting	11/10/80
Advanced Micro Devices, Inc. - Financial Analysts' Meeting	11/10/80
National Semiconductor Corporation - Financial Analysts' Meeting	11/10/80

COPYING & DUPLICATING

3M Announces Six New Copiers	11/13/80
Visit to Minolta's New "MIZUHO" Copier Plant	11/13/80
Canon Introduces Three New Copiers Based on Its "Jumping" Toner Technology	10/24/80
Rumors Reach Fever Pitch That IBM Will Begin Marketing The Minolta EP310 and EP520 on an OEM Basis	10/24/80

CAPITAL EQUIPMENT

U.S. Farm Tractor Sales Outlook - 1981	10/31/80

TELECOMMUNICATIONS

Worldwide Market for Central Office Switching Equipment Forecasted to Exceed $16 Billion in 1985	10/15/80

WORD PROCESSING

Digital Reduces Price of its WS78 Stand-Alone Word Processor	11/21/80
IBM Reduces Prices on Memory Typewriters	11/21/80
Xerox Office Products Division Announces the 8000 Network System for Ethernet	11/21/80

DATAQUEST RESEARCH NEWSLETTER
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ESTIMATED U.S. QUARTERLY SEMICONDUCTOR CONSUMPTION

This newsletter presents DATAQUEST's quarterly estimates for U.S. semiconductor consumption. These estimates have been compiled from several different sources, including trade association data, U.S. Government statistics, foreign government statistics, and estimates supplied by major manufacturers. The information is useful to clients wishing to study the historical growth of semiconductor consumption in the United States.

Several items should be noted:

- The volatility of the semiconductor industry, and its sensitivity to declines in the economy, are shown in Table 1. Semiconductor consumption has become consistently less sensitive to declines in industrial production during the last four recessions.

- The seasonal variation of shipments is clearly visible in Table 2, especially in years such as 1978 and 1979. The second and fourth quarters of the year are normally significantly stronger, and the first and third quarters of each year are weaker.

- Table 2 shows the time lag of semiconductor consumption from the general economy, although the lag is somewhat obscured by seasonal factors. For example, shipments fell in the first quarter of 1967, two quarters after a decline in industrial production. Similarly, consumption increased in the fourth quarter of 1975, two quarters after a similar resumption of growth in the U.S. Gross National Product.

- Quarterly information, especially percentage growth, is somewhat less exact than annual data. Shipment information may be shifted to a preceding or following quarter. This is true particularly during periods of especially rapid growth. For example, between the third quarter of 1972 and the third quarter of 1973 (four quarters), industry shipments increased 54 percent. Between the fourth quarter of 1978 and the fourth quarter of 1979, U.S. consumption of semiconductors rose 41 percent. The four quarters in 1972 and 1973 represent the fastest growth achieved by the industry.

- The data presented here include imports. U. S. imports have grown significantly in recent years, and this has added incremental annual growth of 1-3 percent, in addition to the increase in domestic shipments.

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- Between 1973 and 1975, no trade association collected data in the United States. (This void occurred prior to the existence of DATAQUEST's Semiconductor Industry Service.) Therefore, these data are potentially less accurate than data for other years.

- Data for the third and fourth quarters of 1980 are still not available. Table 1 includes DATAQUEST's forecasts for U.S. consumption for those quarters.

- The data have been adjusted to provide a basis consistent with that normally used by DATAQUEST. Captive manufacturing of semiconductors and the consumption of captive production—primarily that of IBM and Western Electric—are not included in these data. Data include only merchant semiconductor consumption and the captive production of those companies that also market semiconductors.

Frederick L. Zieber
Jean Page

Table 1

FOUR RECESSIONS - PEAK TO TROUGH
(Percent of Decline)

Years	Industrial Production	Semiconductor Consumption	Multiple
1966-1967	(1.7%)	(9.6%)	5.7
1970-1971	(6.8%)	(27.4%)	4.0
1974-1975	(14.6%)	(28.6%)	2.0
1980-1981	(9.5%)	n.a.	---

Source: DATAQUEST, Inc.
November 1980

Table 2

ESTIMATED U.S. QUARTERLY SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

Year and Quarter		Discrete Device	Integrated Circuit	Total Semi-Conductor	Percent Change From Previous Quarter
1966	1	n.a.	n.a.	$ 250	---
	2	n.a.	n.a.	270	8.0%
	3	n.a.	n.a.	262	(3.0)%
	4	n.a.	n.a.	267	1.9%
Total				$1,049	
1967	1	n.a.	n.a.	$ 250	(6.4)%
	2	n.a.	n.a.	250	0.0%
	3	n.a.	n.a.	244	(2.4)%
	4	n.a.	n.a.	261	7.0%
Total				$1,005	
1968	1	n.a.	n.a.	$ 263	0.6%
	2	n.a.	n.a.	268	1.9%
	3	n.a.	n.a.	251	(6.3)%
	4	n.a.	n.a.	270	7.6%
Total				$1,052	
1969	1	$ 183	$ 96	$ 279	3.3%
	2	199	117	316	13.3%
	3	190	113	303	(4.1)%
	4	201	124	325	7.3%
Total		$ 773	$ 450	$1,223	
1970	1	$ 177	$ 130	$ 307	(5.5)%
	2	169	127	296	(3.6)%
	3	153	107	260	(12.2)%
	4	133	110	243	(6.5)%
Total		$ 632	$ 474	$1,106	
1971	1	$ 131	$ 105	$ 236	(2.9)%
	2	139	112	248	5.1%
	3	142	119	261	5.2%
	4	151	131	285	9.0%
Total		$ 563	$ 467	$1,030	
1972	1	$ 156	$ 140	$ 296	3.9%
	2	167	158	325	9.8%
	3	174	163	337	3.7%
	4	199	178	377	11.9%
Total		$ 696	$ 639	$1,335	
1973	1	$ 223	$ 205	$ 428	13.5%
	2	245	248	493	15.2%
	3	249	269	518	5.1%
	4	258	297	555	7.1%
Total		$ 975	$1,019	$1,994	

Table 2 (Continued)

ESTIMATED U.S. QUARTERLY SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

Year and Quarter		Discrete	Integrated Circuit	Total Semi-Conductor	Percent Change From Previous Quarter
1974	1	$ 260	$ 316	$ 576	3.8%
	2	261	340	601	4.3%
	3	255	314	569	(5.3)%
	4	229	289	518	(9.0)%
Total		$1,005	$1,259	$2,264	
1975	1	$ 199	$ 251	$ 450	(13.1)%
	2	197	244	441	(2.0)%
	3	187	242	429	(2.7)%
	4	209	281	490	14.2%
Total		$ 792	$1,018	$1,810	
1976	1	$ 235	$ 316	$ 551	12.4%
	2	241	351	592	7.4%
	3	229	370	599	1.2%
	4	230	381	611	2.0%
Total		$ 935	$1,418	$2,353	
1977	1	$ 228	$ 404	$ 632	3.4%
	2	239	432	671	6.2%
	3	233	447	680	1.3%
	4	236	501	737	8.4%
Total		$ 936	$1,784	$2,720	
1978	1	$ 239	$ 510	$ 749	1.6%
	2	264	578	842	12.4%
	3	268	596	864	2.6%
	4	289	670	959	11.0%
Total		$1,060	$2,354	$3,414	
1979	1	$ 301	$ 700	$1,001	4.4%
	2	340	805	1,145	14.5%
	3	334	868	1,202	5.0%
	4	347	1,002	1,349	12.3%
Total		$1,322	$3,375	$4,697	
1980	1	$ 354	$1,066	$1,420	5.3%
	2	364	1,185	1,549	9.1%
	3 est.	357	1,135	1,492	(3.7)% (3.1)
	4 est.	347	1,099	1,446	(3.1)% (0.9)
Total		$1,422	$4,485	$5,907	

Source: DATAQUEST, Inc.
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INTEL CORPORATION FINANCIAL ANALYSTS' MEETING

Intel Corporation held a meeting for financial analysts on October 29, 1980 in Palo Alto, California. Gordon E. Moore, chairman and chief executive officer, gave an overview of the outlook for the Company. Edward L. Gelbach, senior vice president and general manager, Components Group, commented on the worldwide business outlook, Intel's capacity expansion program, and the progress of the 64K RAM. Jack C. Carsten, vice president and general manager, Microcomputer Components Division, reported on MOS markets, new products, and new technologies. William H. Davidow, vice president and general manager, Microcomputer Systems Division, gave an update on Intel's 16-bit microprocessor marketing program. Vaemond Crane, vice president and general manager, Commercial Systems Division, reported on storage device-based products, systems level hardware products, and the Database Systems Division.

OVERALL OUTLOOK

Mr. Moore said that Intel will probably not show sequential growth in revenues in the fourth quarter of 1980 because of significant price erosion in MOS memory markets, particularly the 16K RAM and 16K EPROM. Consequently, any bias on profit margins in the fourth quarter should be down rather than up. Significant price pressure will continue in 1981, limiting revenue gains and putting continued pressure on profit margins. There are signs that the worst is over in price erosion, however, and there is some indication that orders have improved, as well. Intel's overall book-to-bill ratio in October was greater than 1, according to Mr. Gelbach. The book-to-bill ratio in the fourth quarter should be about 1.

COMPONENTS GROUP

Mr. Gelbach said that Intel had expected bookings to decrease during the summer, but that the company had also expected bookings to improve in September and October. Bookings picked up in September, but did not meet forecasts and the book-to-bill ratio was less than 1. Unit number forecasts were met, but the Company did not neet its dollar volume forecasts because of a decline in average selling prices (ASP). Intel now expects a fourth quarter book-to-bill ratio of about 1 in the Components Group.

The U.S. economy has been flat in at least the last three quarters but began to pick up in September. Nevertheless, orders from Intel's major accounts have slowed. There have been no problems with excess inventory, but there has been significant price pressure, according to Mr. Gelbach. The Company's mid-sized accounts ($100,000 to $500,000) have been very strong and distribution seems to be firming, especially in the United States where distributors seem willing to make long-term commitments.

In Europe, the signals are confusing but there is a definite weakening. The major accounts are giving Intel problems and it is difficult to get long-term commitments. There may also be a problem with inventories at major European accounts, as opposed to U.S. accounts, where overstocking has generally not occurred.

Orders in Japan appear to have bottomed out and bookings and billings are up. Bookings did not turn around at the end of the summer as much as the company predicted, however.

By product area, Intel has experienced some weakening in the 8-bit single chip microcomputer market and is projecting a two- to three-month slowdown. The Company also sees a flattening in the 8-bit microprocessor market and a strengthening in the 16-bit microprocessor market, said Mr. Gelbach. The 16K RAM market is strong, but the 4K RAM market, both static and dynamic, is slow. The EPROM market remains strong. In particular, the 16K EPROM unit demand remains strong, but once again declining prices are a problem. The price of 16K EPROMs declined 20 percent in the first quarter, 30 percent in the second quarter and another 40 percent in the third quarter (from $21.70 to $17.40 to $12.45 to $7.45). Intel has priced its 16K EEPROM at $100.00, compared to Hitachi's price of $57.00. However, the Intel product has 50 percent better performance, according to Mr. Gelbach.

The Components Group's emphasis for 1980 and 1981 is to introduce between 50 and 75 new products—the largest introduction of new products in Intel's history. New products include the 64K dynamic RAM, 64K EPROM, 16K E^2PROM, 16K static RAM and the 8051/8751 8-bit microcontroller. All of these products are being sampled; at least half will be in production by early 1981.

Intel plans to increase wafer fabrication capacity overall by 85 percent between September 1980 and the fourth quarter of next year, with $100 million in capital investments. The expansion will take place in Santa Clara; Livermore; Aloha, Oregon; Phoenix; and Albuquerque. Activity in the assembly area should increase about 40 percent in the same time period, with expansion slated for Malaysia, the Philippines, and Barbados, with a concentration on Barbados. Overall, Intel plans $150 million in capital expenditures in 1980, according to Mr. Moore. With the exception of recent college graduates, Intel has been very selective about hiring, however, especially in administrative functions. There have been no cuts in technical or long-term programs, however.

In response to a question from the audience, Mr. Gelbach commented that the price pressure Intel has experienced comes both from oversupply and raw competition. For example, Intel has 12 competitors in the EPROM product markets. He also feels that pricing has bottomed out in the 16K EPROM market, but that price erosion will continue in other areas.

In response to another question, Mr. Gelbach commented that he did not think that the advent of the 64K RAM will have any effect on the availability of the 16K RAM, at least not at Intel and probably not in the industry overall. Mr. Moore said that it is unlikely that any competitor in the 64K RAM market will have a market share greater than 20 percent because too many suppliers are starting at the same time. At least eight producers are likely to have 10 to 20 percent market shares, however.

NEW PRODUCTS AND TECHNOLOGY

The 16-bit microprocessor is Intel's fastest growing business, according to Mr. Carsten. The market for 16-bit microprocessors was $25 million in 1979, was $100 million in 1980, and should reach $175 million in 1981. Still, it is not a big business compared to the total components market, which is $500 million now and should reach $1.5 billion by 1982. And, the 8-bit microprocessor is still nearly 60 percent of Intel's business.

The number of products offered by Intel continues to increase, said Mr. Carsten. The company now has 85 different sets of tooling, with each set reflecting R&D and tooling costs of between $100,000 and $1 million. Many of the tooling sets for Intel's new products will exceed $1 million.

Technology—not volume-related effects--is the key to cost reduction, performance, and reliability, said Mr. Carsten. In particular, costs can be reduced by making die smaller on new products; long-term cost reduction demands a strategic program at the time of original design. Finally, quality and reliability must be designed into the technology. For example, the 8049 8-bit microcontroller is a large volume device introduced in 1977. At the time, Intel was using NMOS technology and the die size was 223 mils on a side and the price was $15.00. In 1980, when Intel is using HMOS, the 8049 is 182 mils on a side and the price is $6.00 to $7.00. The area was cut by one-third and the price was cut by 55 percent. Intel plans to move to advanced HMOS technology in 1982, thereby decreasing die size to 145 mils on a side with an expected price of $4.00 to $6.00. The product should also be three times more reliable, said Mr. Carsten.

There are tremendous tooling costs of up to $500,000 associated with that kind of technology improvement, however. Intel is using computer-aided design (CAD) to cut costs and reduce design times. All changes are now done via software and not optically. The process now takes only four to six months and costs only 10 percent of what it would otherwise. Mr. Gelbach commented that Intel's use of CAD is not unique but the company's ability to use it practically is, and this provides Intel with its best weapon against second sourcing.

In response to a question about the current status of bubble memory at Intel, Mr. Moore said that the Company is making a major push but it lost momentum because of problems with the controller. The Company has been trying to regain the lost momentum, but with little response thus far.

MICROCOMPUTER SYSTEMS

Mr. Davidow told analysts that the microcomputer business has been mostly flat, but that business is beginning to pick up because of design wins of the 8086 and the introduction of Intel's 16-bit microprocessor development system.

Mr. Davidow also updated Intel's progress on the Crush Program for Intel's 16-bit microprocessor, which was started in late 1979 when competitors to the Intel product emerged. The objectives were to produce 100,000 inquiries, generate 10,000 qualified leads and win 2,000 designs. The program began by identifying the strengths of the iAPX 86, Intel's 16-bit integrated central processor. The top five selling strengths identified by Intel were that the product is a "complete solution;" Intel is viewed as a leader; product performance; ease of use; and the system bus architecture.

Intel launched a blitz in the first quarter of FY1979 to address 59 customer locations. The company held 38 seminars with 7,000 attendees worldwide, conducted three press tours and placed 12 major articles, hired recruits from college campuses and developed a sales campaign with an arsenal of 35 pitches. From the 59 accounts, Intel won 37 designs, lost 7 and registered 15 as undecided. The system is logging 500 design wins a quarter, according to Mr. Carsten, and Intel should reach its goal of 2,000 design wins in early FY1981. Mr. Davidow outlined potential revenues from the program as follows:

- 1981—2,000 designs 150 systems each ASP=$320 $ 96 million revenue
- 1982—2,000 designs 500 systems each ASP=$250 $250 million revenue

COMMERCIAL SYSTEMS

Mr. Crane reported that Intel continues to market IBM memory add-on units, but primarily to loyal customers. The company does not plan to expand its actitivies in that area. In the systems level hardware business, Mr. Crane highlighted two products—the 3805 semiconductor disk, which is 16-bit microprocessor based and uses high quality "partial" memory parts, and the 3805 block memory, which has a wide range of high performance applications. Shipments of the 3805 started in June 1980.

Intel acquired MRI of Austin, Texas two years ago to provide database software systems. MRI operated as a separate company in the first year following the acquisition and revenues were up 40 percent. This year has been flat and somewhat disappointing, but it has also been a year of integration. Intel has doubled MRI's sales force, but Mr. Moore commented that it takes time for a new salesperson to sell a software product. Intel expects that MRI will announce new products within 12 to 15 months.

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ADVANCED MICRO DEVICES, INC.
FINANCIAL ANALYSTS' MEETING

Advanced Micro Devices, Inc. (AMD) held a meeting for financial analysts on October 30, 1980 in Sunnyvale, California. W.J. Sanders, III, chairman, president and chief executive officer, expressed confidence that AMD's sales will continue "monotonic growth in sequential quarters." In addition to Mr. Sanders' report on the Corporation, Frank Zurcher, president of Advanced Micro Computers (AMC), reported on the activities of that subsidiary; James Downey, vice president and division manager for MOS operations, reported the progress of the MOS Division; and Anthony B. Holbrook, vice president and division manager of bipolar operations, delivered an update on the company's bipolar activities.

CORPORATE

Mr. Sanders' projection forecasted monotonic growth in sales for AMD. He said that current market conditions are cyclical and will improve, but cited major new forces in the form of increased foreign competition in the marketplace. AMD's strategy in dealing with increased foreign competition has two parts.

First, AMD has embarked on a program to improve the quality of outgoing products above the company's recent average quality level (AQL) of 0.65 percent. The progam is called "secundus nulli"—second to none—and establishes the "tightest quality level in the history of the industry". Specifically, the goal for outgoing AQL of MOS RAM and ROM products will be 0.1 percent; 0.2 percent in bipolar commodity products; and 0.3 percent in LSI logic and other memory. The new standard of quality, which AMD has pledged to achieve by the end of the current fiscal year, will enable AMD to achieve parity with the Japanese, said Mr. Sanders. Once AMD has achieved parity with the Japanese in quality levels, the second part of the strategy is to compete with a broad product line.

Mr. Sanders predicted sales of more than $300 million in FY1981, ending in March 1980, up from $225 million in FY1980. If the industry grows 14 to 17 percent in 1981, AMD should achieve sales of $400 million in FY1982. He also forecast $80 million in sales in the next quarter and an overall book-to-bill ratio of 1.

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Mr. Sanders said that AMD's capital spending plans will proceed unabated. Capital spending in FY1981 should exceed capital spending in FY1980 by 20 percent, yet, the total figure is $15 million to $20 million less than planned. Mr. Sanders attributed this difference to a rescheduling of construction at the Gilroy site and at the site of an assembly plant in Malaysia because of a lack of demand, and to slow delivery of some fab and test equipment for other facilities. AMD will continue to spend in excess of 10 percent of sales on research and development.

In response to a question on pre tax margins, Mr. Sanders reminded the analysts that AMD has been saying for a year that margins in FY1981 would not be as good as those in FY1980. He attributed that to extensive start-up costs for both the Sunnyvale Technology Development Center and the wafer fab facility in Austin, Texas. Mr. Sanders predicted that margins will decline for one more quarter but will improve when more fab plants are up to full capacity and overhead is spread out.

Another question addressed the possibility that AMD will develop CMOS technology; the Company currently does not have any CMOS products on the market. "We will not tell you that we have a secret plan; but if we did we'd announce it soon," said Mr. Sanders. He added that any company that plans to be competitive must be in the CMOS business.

A final question about financing elicited a response from Mr. Sanders that AMD had $17 million cash equivalents at the end of the last quarter, and that the Company plans no additional financing beyond its bank lines for the next 18 to 24 months.

AMC

Mr. Zurcher reported on AMD's two-year-old subsidiary, AMC. He noted that Mr. Sanders has set "modest financial goals by Silicon Valley standards" for AMC: 100-plus percent annual growth, $10 million in sales in FY1981, and $100 million in sales in FY1984. The future thrust of AMC will be on the AmZ8000 16-bit microprocessor, developed by Zilog and second sourced by AMD. AMC's focus will be on development and board systems for the AmZ8000, said Mr. Zurcher.

AMC's sales in FY1980 were $6.6 million and are expected to reach $10 million in FY1981. In response to a question that followed his prepared remarks, Mr. Sanders noted that AMC's book-to-bill ratio is about 1.

MOS

AMD had earlier forecast FY1981 sales of between $150 million and $170 million for the MOS division, reported Mr. Sanders. The Company still expects to be in that range, but probably at the low end. This compares with sales of $113 million in FY1980. FY1980 unit volume was 30 million, according to Division Manager Mr. Downey. The forecast for FY1981 is about 35 million units. This implies an increase in the average selling price (ASP) for MOS products, despite severe price erosion in MOS memory markets. In fact, FY1980 ASP was $3.67 and increased to $4.40 thus far in FY1981. The higher ASP was achieved through improving product mix, however, and not through raising prices, noted Mr. Sanders.

The MOS division began producing the AmZ8000 nine months ago and is ramping up production each quarter, noted Mr. Downey. Originally, AMD was using masks made from designs obtained from Zilog but now is using AMD masks. This has improved yields despite the relatively large chip size of the AmZ8000, which is 250 mils on a side. Production of the AmZ8000 was transferred to AMD's wafer fabrication plant in Austin in September 1980. The product is winning "its fair share of designs," added Mr. Downey.

In an update on the progress of AMD's present and planned wafer fab plants, Mr. Downey noted that the Austin plant, which includes Fab V and Fab X, consists of 100,000 square feet. Fab V is currently producing 16K RAMs and the AmZ8000. Fab X should be producing advanced RAM by the end of the summer of 1981. The Sunnyvale Technology Development Center houses Fab VI, Fab VII, and Fab VIII. Fab VI went into production in August 1980. It consists of 7,200 square feet and is AMD's VLSI center, in which AMD is using its polyplanar technology to produce the 64K RAM. FAB VII is operational in three shifts and is producing non-volatile memory such as MOS EPROMs. The focus is on producing 16K EPROMs and developing 32K EPROMs. As AMD's non-volatile memory center, it is also developing EEPROMs.

Mr. Sanders noted that the near-term sales outlook for the MOS division is "modest," and that sales should accelerate, depending on market conditions. The book-to-bill ratio in the MOS division is "less than 1." AMD suffers along with the rest of the industry from overcapacity in some MOS memory markets. AMD recently repriced its backlog in MOS to market prices. The book-to-bill ratio in September was 0.85:1, and AMD considers September to be the trough for the Company during the 1980 recession. Mr. Sanders expects the MOS division to grow 30 percent in the next fiscal year.

In response to a question from the audience on market shares of the AmZ8000 microprocessor family between AMD and Zilog, Mr. Sanders said that market share will depend on price and delivery. He is confident, however, that AMD will achieve "at least 50 percent."

AMD's telecommunications products fall into the MOS division. The Company plans to introduce new subscriber-line audio processor circuits (SLACs, which convert voice signals to digital signals); and subscriber-line interface circuits (SLICs, which condition voice signals so that SLACs can handle them); and modulator/demodulators (modems, which allow digital transmissions over analog lines). Mr. Sanders predicted that telecommunications will be AMD's largest market by 1990. Consequently, the proliferation of captive semiconductor manufacturing among computer manufacturers does not worry him.

BIPOLAR

AMD had earlier forecast sales in the bipolar division in the $150 million to $170 million range. The company still expects to be in the upper end of that range and also expects that bipolar sales will exceed sales of MOS products. Sales in the bipolar division were $110 million in FY1980.

Mr. Holbrook provided the update for the bipolar division, which includes microprocessor, logic, and interface (MLI); bipolar memory; and linear. Mr. Holbrook also has responsibility for AMD's 100-acre Gilroy bipolar facility, which should break ground in November or December of 1980 and should be in production by the end of FY1982.

The bipolar division has achieved a tripling of sales from FY1978 to FY1981 (a compound annual growth rate of about 50 percent). The greatest sales growth occurred in memory products, which grew seven times over the last three years; microprocessors and interface products have grown five times in that same period. Mr. Holbrook noted that the division is limited only by its manufacturing capacity; AMD's goal is to be the leader in bipolar LSI products.

In an update on bipolar wafer fab facilities, Mr. Holbrook said that Fab I is producing linear products and is currently near capacity; Fab II produces logic and interface and is at capacity; and Fab IV, which started out evenly split between bipolar and MOS products, will be converted completely to bipolar by March 1981. The conversion is currently 70 percent complete. Fab VIII, which is part of the Sunnyvale Technology Development Center, is currently under construction and should be producing IMOX process devices by the first quarter of 1981. Fab VIII initially will produce bipolar digital products and then shift to linear. Fab XI, to be located in Gilroy, will be primarily a production facility but will eventually house some technology and product development.

The sales outlook for the bipolar division should moderate somewhat from its recent 12 percent quarter-to-quarter growth because of AMD's inability to increase capacity. Bipolar memory bookings in the last quarter were the highest in Company history. The current book-to-bill ratio in the bipolar division is greater than 1.

In response to questions from the audience, Mr. Sanders said that AMD has seen some price attrition in bipolar products as well as in MOS products. Lead times have dropped from 26 weeks to 8 weeks for 8K PROMs, for example, and the Company expects prices to come down in new orders. The softening business outlook in Europe may also affect bipolar products because it could cause some delay in the inventory liquidation of U.S. computer manufacturers.

AMD's proprietary oxide-isolated process, called IMOX (implanted micro oxide), allows smaller geometries, increased speed and improved yields. IMOX II is playing an important role in AMD's development of bipolar PROM and RAM markets.

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NATIONAL SEMICONDUCTOR CORPORATION FINANCIAL ANALYSTS' MEETING

National Semiconductor Corporation held a meeting for financial analysts on October 30, 1980, in Sunnyvale, California. Charles E. Sporck, president, expressed guarded optimism about the future sales and profits of the Company. John R. Finch, vice president and member of the general manager's office of the Semiconductor Division, presented the outlook for the data acquisition segment of National's business. Pierre Lamond, vice president, technical director, and member of the general manager's office of the Semiconductor Division, discussed upcoming technology and new product improvements. E. Joseph Willits, vice president, Finance, and secretary, summarized the Company's financial performance in recent years.

BUSINESS OUTLOOK

Mr. Sporck characterized National as a company primarily in the semiconductor component business, which represents about 70 percent of the Company's sales. That percentage should stay about the same, he said.

Mr. Sporck cited National's broad-based and balanced approach to the semiconductor business as particular strengths of the Company. Net sales have shown a compound annual growth rate (CAGR) of 44 percent since the present management took over in 1967, and profits have been good in all years except FY1977, which ended May 31, 1977. Sales in FY1980 were $960.4 million, up from $719.7 million in FY1979.

Components

National saw a decline in order strength in the semiconductor area beginning in June 1980 when the Company's overall components book-to-bill ratio dropped below 1. The book-to-bill ratio dropped even further during the summer, then improved in September and October, but is still below 1. The figures cover all markets except the military markets.

Mr. Sporck noted that the book-to-bill ratio is worse in the MOS product families than in the bipolar families. MOS has suffered from severe overcapacity, inadequate unit volume and a significant decline in prices, particularly in the 16K RAM market. The overcapacity is particularly severe in the 16K RAM market. Mr. Sporck said that he does not know how long it will last, but noted that the decline in 16K RAM prices may delay the production of the next-generation 64K RAM by customer decision, because the comparative economics have now shifted strongly in favor of 16K parts. The price erosion may have the same effect on the development of bubble memory.

Prices of some bipolar products, on the other hand, are higher this year than they were last year. Bipolar memory prices are especially strong, bipolar logic is strong, and pricing is firm in both digital and linear products. The book-to-bill ratio in the bipolar area is in excess of 1: bipolar memory is greater than 1, linear is close to 1, digital is "relatively close" to 1, and MOS memory, in both units and prices, is considerably lower. The book-to-bill ratio for MOS LSI products, however, is greater than 1.

Mr. Sporck said that he does not know how long the softness in some of National's components business will last, noting that it depends on the recession. He does not expect that the book-to-bill ratio will reach 1 in the current quarter. National will suffer if the book-to-bill ratio does not return to 1 before the current backlog runs out. That probably will not happen in the first or second quarters of 1981, but could happen in the second half of the year. A major shakeout in the MOS RAM market is expected over the next two years, during which a number of present participants should drop out.

Nevertheless, management at National "is as confident as ever." Some forecasts estimate that the semiconductor industry will be a $50 billion or $60 billion industry by 1990. "We expect to participate in that growth in the same manner as we have in the past," said Mr. Sporck.

Systems

Mr. Sporck reported that National's point of sales (POS) business seems to follow interest rates in an inverse relationship. Now that interest rates are climbing, the POS business is again softening. National still expects to meet its business plan in POS in the current fiscal year.

National's plug-compatible mainframe (PCM) business is relatively strong and should meet the Company's forecast for the current fiscal year and should be profitable in FY1981. The Company lost $20 million in the PCM business last fiscal year when Itel, National's sole outlet, disappeared from the marketplace. National originally entered the PCM business to address the largest single end-user market for its components and it is a major contributor to the Company's profits and cash flow.

LINEAR AND BIPOLAR

Mr. Finch highlighted National's activity in the data acquisition/conversion market, which he characterized as a $260 million business in 1980 that should reach $780 million by 1985. The Company plans three new A/D converters leading from the Naked-8 product line and he focused on one, the COP-330 8-lead mini-dip serial I/O.

In the area of programmable array logic (PAL), National has 15 device types and is the only direct second source for Monolithic Memories. PALs are a natural lead-in to gate arrays, noted Mr. Finch.

The fiber optics market is forecast to be a $1 billion market by about 1990 and offers a rapid growth opportunity for fiber optics interface products. The Company has complete transmitters and receivers in development and is addressing the data communications segment of the market with the introduction of its universal receiver/amplifier, the LH0082.

TECHNOLOGY

Mr. Lamond discussed National's activities in low power technology, the COPS (Controller Oriented Processor Systems) 4-bit microprocessor, and speech synthesis. He reviewed the advantages to designing with high performance, low power CMOS. These advantages include the capability of portable operation, improved noise immunity, lower system cost and improved reliability. National has pioneered use of its oxide-isolated P^2CMOS applications in the military, automotive, telecommunications, and portable instrumentation markets.

In a comparison of instruction capability features of the NSC800 and competitive products, Mr. Lamond made the following distinctions, among others: the NSC800 is capable of 158 instructions, while the 8085 is capable of 80; the Z80, of 158; the 6800, of 72; and the 1800, of 91.

National implements COPs microcontrollers in two technologies, NMOS and CMOS. A key feature of the COP400 family is its fully upward-compatible software. National wins more designs than its major competitors in the 4-bit markets, according to Mr. Lamond.

National is addressing the speech recognition and speech synthesis markets because the two features are part of greater efforts toward higher productivity through the use of electronics. National's present focus in the development of speech synthesis is on the telecommunications and automotive markets.

Mr. Lamond also reviewed the Company's progress with the 16000 16-bit microprocessor and the 64K RAM. The design of the 16000 began two years ago. The Company will see silicon on the 16032 by the end of November and plans to introduce one peripheral every two months for a total of 6 in 12 months. The 16000 compares very favorably with the 68000, 8086, and Z8000, and it has some upward expansion capabilities that are absent in some of the competitive products.

National has implemented the 64K RAM using a triple poly silicon process and will start sampling in December 1980 or January 1981. National chose this approach, even though it offers a significant technical challenge, because it will give the Company a competitive advantage in the move to the 256K RAM, said Mr. Lamond.

CAPITAL SPENDING

Capital spending in FY1981 should exceed that of FY1980 by at least 50 percent. Capital spending in FY1980 was $116.2 million, up from $72.1 million in FY1979. A portion of the planned capital spending is for short-term growth and that may in fact be slowed, but the long-term plans for wafer fab capacity increases are not expected to change.

Specifically, capacity in the West Jordan, Utah wafer fabrication facility will increase and will have large amounts of MOS and advanced process capability. The Arlington, Texas plant should break ground in November or December of 1980 and will process entirely 5-inch wafers. Eventual capacity will be 100,000 wafers every four weeks. The Greenoch, Scotland plant is undergoing expansion into MOS and bipolar in addition to linear. The plant will also process 5-inch wafers. The expansion represents a tripling of European wafer fab capacity.

No new physical expansion is planned for the Santa Clara facility, but the plant is being refurbished with heavy investment in conversion of older processes to new processes and increased wafer size. Two bipolar modules will be converted from 3-inch and 4-inch wafers respectively to 5-inch wafers.

FINANCIAL HIGHLIGHTS

Mr. Willits presented the following financial information for National:

	FY 1977	FY 1978	FY 1979	FY 1980
Percent Increase in Sales	19.1	27.6	45.6	36.2
Percent Return on Beginning Equity	10.9	21.0	26.1	31.2
Capital Expenditure ($ Million)	$42.4	$43.1	$72.1	$116.2
Percent Total Debt to Equity (May 31)	25.3	19.0	37.1	46.7

The Company's debt-to-equity ratio reached 50 percent at the end of the first quarter of FY1981 and it will be maintained at that level in the near future. National's recent offering of $1.5 million shares raised nearly $63 million. The offering was designed to reduce debt and to provide a base for future financing. Mr. Willits showed how the offering combined with a 50 percent debt-to-equity ratio enabled the Company to produce signficant additional capital.

Reborrow Amount Received	$62.8	million
50 Percent Debt/Equity	31.4	million
Total Additional Capital	$92.2	million

Mr. Willits also said that if National can maintain its historical 20 percent return on average capital employed after tax it can achieve per share earnings of $11.27 from the $94.2 million additional capital.

20% After Tax Return on Additional Capital	.20 x 94.2 =	$18.8	million
Interest Expense on Additional Debt at 6% After Tax	.06 x 31.4 =	(1.9)	million
Net Earnings Added		$16.9	million
Per Share Issued	$11.27		

National's net sales in the first quarter of FY1981, which ended September 21, 1980, were $346.2 million, up from $242.1 million in FY1980, representing an increase of 43 percent. Net earnings in the first quarter of FY1981 were $18.9 million, up from $12.6 million in FY1980, representing an increase of 50.8 percent. Earnings per share were 91 cents, up from 62 cents, representing an increase of 46.8 percent.

Susan A. Thomas
Lane Mason

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Vol. II, 3.1

MASKMAKING

INTRODUCTION AND SUMMARY

Maskmaking is important to the semiconductor industry because masks create the patterns that make it possible to place more and more functions on a single integrated circuit. The production of an integrated circuit includes between 6 and 11 masking steps. Each step requires a unique mask, which consists of patterns reproduced hundreds of times in emulsion, chrome, or iron oxide on a coated blank. These patterns must remain intact during the maskmaking process, and the mask is ruined if it is scratched, smudged, or contaminated. In a very real sense, then, progress in the semiconductor industry depends on progress in the technology of maskmaking.

The U.S. coated blank market reached an estimated $78 million in 1979 and should grow to an estimated $156 million in 1984. The total U.S. maskmaking market, which includes coated blanks, was an estimated $375 million in 1979 and we believe that it will reach $697 million in 1984. The most significant trends in the maskmaking industry are the developments of higher quality, longer lasting masks and of non-contact aligner technology in the wafer manufacturing process. DATAQUEST believes that these trends will affect the maskmaking industry in two ways: first, the push for higher quality products and equipment should change the industry's orientation from one of commodity production to one of service, and, second, the push for higher quality may eventually put smaller maskmakers at a competitive disadvantage.

PROCESS

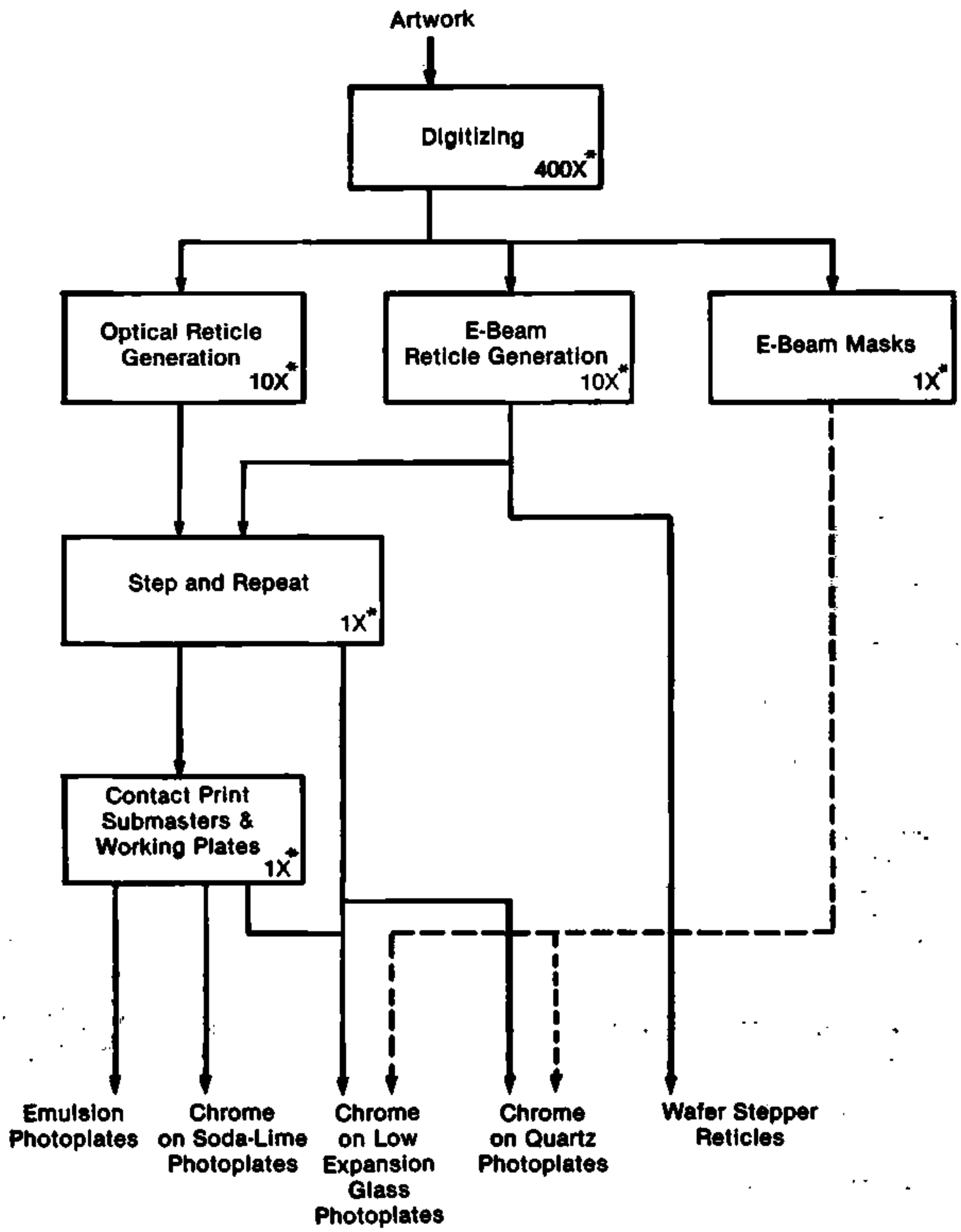
Maskmaking involves creating a set of masks from an engineering drawing of a VLSI circuit. The masks are used in the manufacturing process to expose photosensitive material on semiconductor wafers. The process of making a mask from an engineering drawing usually includes digitizing, pattern or reticle generation, step and repeat, and the making of tooling and working plates (see Figure 1).

Digitizing converts VLSI circuit drawings, which are usually 400 times the final part size, into a form that can be read by a computer. Points on the drawings are converted into x,y digital coordinates. In the next step, a set of photographic images or reticles are created from data generated during the digitizing process. Each

19055 Pruneridge Ave. / Cupertino, CA 95014 / (408) 725-1200 / TWX (910) 338-7695 / DATAQUEST CPTO

Figure 1

THE MASKMAKING PROCESS



*Indicates scale in relation to actual size of mask

Source: DATAQUEST, Inc.
October 1980

reticle contains the desired mask pattern for a single layer of a device, enlarged 10 times. The step and repeat process reduces the oversized image to final part size and exposes copies of the image to create the final master mask image. In some cases, the process continues with the creation of submasters from the master masks, which are in turn used to make working plates. The term "tooling plate" is used to identify any photoplate that is not a working plate; for example, reticles, masters, and submasters are all tooling plates. A working plate is the plate that will be used in factory production of integrated circuits.

Figure 2 presents the relationships between suppliers and customers in the maskmaking industry. Note that photoplates are made from three types of glass: soda-lime, low-expansion, and ultraviolet transmissive. Low-expansion glass is favored for VLSI circuits with smaller critical dimensions because it does not change size with temperature changes as much as do other types of glass. Ultraviolet transmissive glass is used in applications in which the photosensitive material on the semiconductor wafer is exposed in ultraviolet light. The short wavelength of ultraviolet light makes it useful for applications with extremely small critical dimensions.

Hoya and Corning are the major suppliers of glass to the maskmaking industry. Hoya supplies soda-lime glass, low-expansion glass (quartz and fused silicia), and uncoated glass to the U.S. market.

Emulsion coaters include major suppliers of materials to the photographic industry, such as Kodak, Konishiroku, and Agfa Gevert. Since the semiconductor industry consumes only a small portion of the photographic materials produced by these companies, some of the companies do not cater to the industry. Emulsion conversion companies, on the other hand, serve the industry directly. They generally purchase large sheets of emulsion-covered glass and convert them into smaller working plates. At the same time, emulsion conversion companies perform an important quality control function.

Hard-surface coaters purchase new glass and coat it with an opaque material and with a photosensitive material, usually chrome and photoresist.

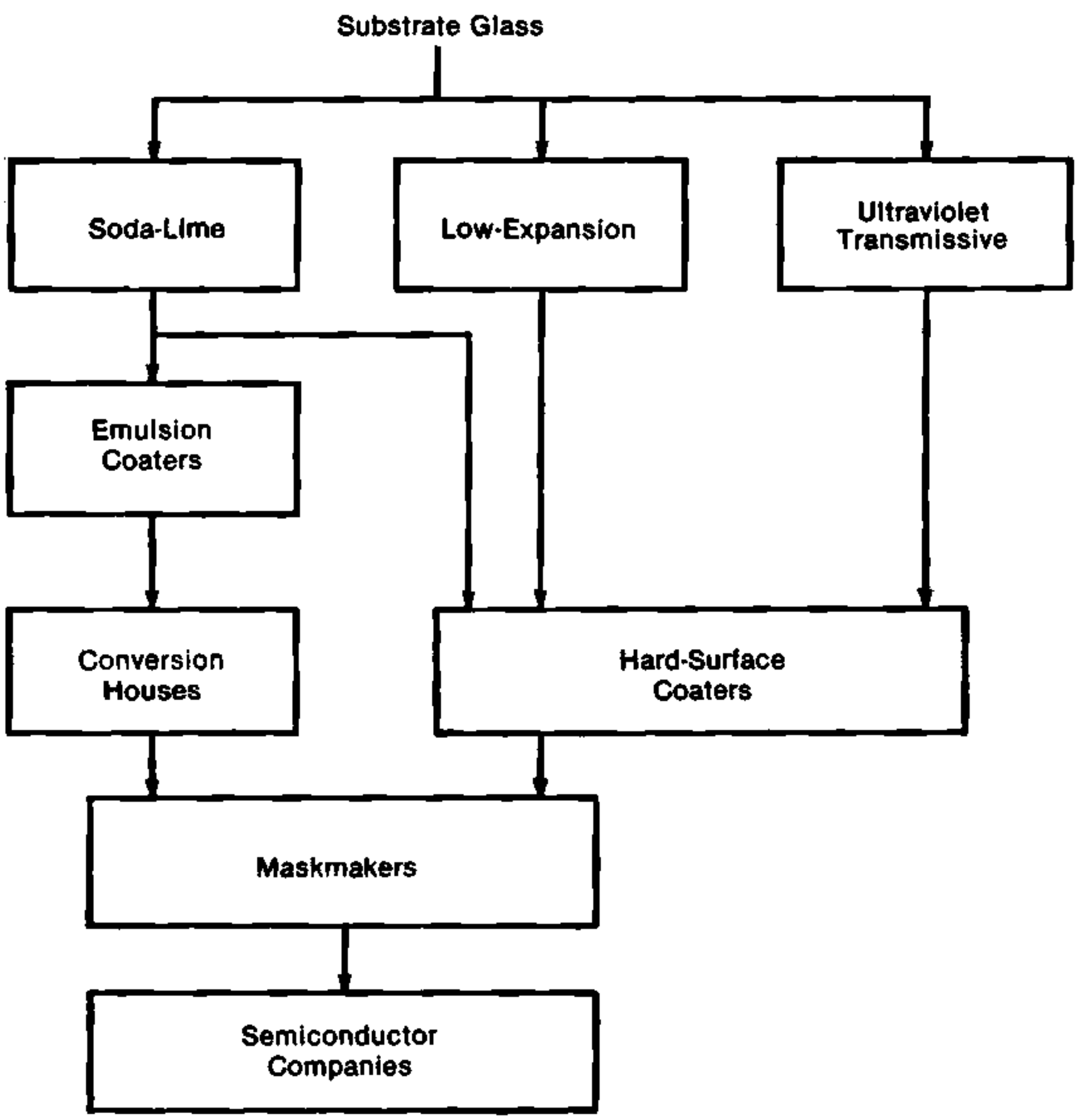
MARKET GROWTH

Coated Blanks

A coated blank is a mask in its raw state, that is coated with a photosensitive material but without an image. The U.S. coated blank market in 1979 was an estimated $78 million. The market should grow to an estimated $156 million in 1984, representing a compound annual growth rate (CAGR) of 15 percent (see Table 1). These estimates were developed from an analysis of wafer starts and the installed aligner base. They are based on no increase in the average selling prices (ASP) of coated blanks. But mix will shift to higher ASP types + units will decline. (?)

Figure 2

MASKMAKING SUPPLY FLOWCHART



Source: DATAQUEST, Inc.
October 1980

Table 1

ESTIMATED U.S. MERCHANT AND CAPTIVE COATED BLANK MARKET
1979-1984
(Millions of Dollars)

	1979	1984	CAGR[1] 1979 to 1984
Emulsion	$ 18	$ 16	(2%)
Chrome	60	140	21%
Total	$ 78	$156	15%

[1]Compound Annual Growth Rate

Source: DATAQUEST, Inc.
October 1980

The two most common materials used to coat blanks are emulsion and chrome. Maskmakers have shifted from emulsion coating to chrome coating in recent years, however, for several reasons. Emulsion is more susceptible than chrome to scratches and other defects. Furthermore, emulsion is not made especially for the semiconductor industry; instead, it is made for the photographic market. Chrome coating for masks is made primarily by the semiconductor industry for use in the semiconductor industry, which ensures higher quality.

Chrome coated blanks produce a better quality product and also garner a higher ASP in the marketplace. Customers seem willing to pay the higher prices for improved yields. The yield improvements achieved through using chrome masks are particularly significant for larger die sizes. Average yields for some VLSI circuits are running well under 50 percent, so there is obviously considerable opportunity for yield improvement. In addition, chrome coated masks do not wear out as easily as other masks, even when they come in contact with wafers. Thus, chrome masks may actually offer a reduced mask cost per wafer, even though the mask is more expensive.

Current typical selling prices for five-inch by five-inch coated blanks are $2.50 for emulsion, $12.00 for chrome on soda-lime glass, $120.00 for chrome on low-expansion glass, and $850.00 for chrome on ultraviolet transmissive glass.

Merchant coating companies comprise about 40 percent of the hard-surface (chrome) mask market. They sell to both merchant maskmaking companies and semiconductor companies. DATAQUEST believes that the merchant market will grow more rapidly than the captive market because it is unlikely that merchant semiconductor manufacturers will begin making their own coated blanks if they do not already make them. The companies that do not make their own coated blanks tend to be among the faster growing in the industry and they are generally conserving capital to build manufacturing plants, not maskmaking facilities. Furthermore, the trend in the industry is to buy products rather than make them in-house.

The major merchant emulsion conversion and chrome coating facilities are listed in Table 2. Some merchant semiconductor companies with captive chrome coating facilities are Mostek, Motorola, and Texas Instruments.

Maskmaking and Tooling

The total U.S. merchant and captive maskmaking market was an estimated $375 million in 1979 and should grow to $697 million in 1984, representing a CAGR of 13 percent (see Table 3). Mask tooling accounted for 53 percent of the total market in 1979; in 1984, tooling should account for 61 percent. The increase in tooling reflects a shift to the use of tooling plates instead of working plates in the manufacturing process.

Tooling includes digitizing, reticle generation, and pattern generation. DATAQUEST believes that a typical VLSI circuit has between 6 and 11 mask layers and passes through the maskmaking cycle 3 times: once for the initial design and twice to correct major or minor design errors. A typical 9-layer circuit of 200 mil by 200 mil might incur maskmaking charges of $4,500 in digitizing, $5,800 in pattern generation, and $8,000 in step and repeat.

DATAQUEST estimates that approximately 290,000 reticles were generated in 1979 to support $6.9 billion in U.S. semiconductor industry sales. This corresponds to revenue of $24,000 per reticle, or $648,000 per circuit design.

The cost of finished tooling and working plates depends on defect density. ASPs for five-inch by five-inch photoplates for four-inch wafers are: $5 to $8 for emulsion plates with approximately 12 defects per square inch; $50 to $70 for chrome plates with approximately 8 defects per square inch; and $600 to $1,000 for repaired masters with approximately 1 defect per square inch. Manufacturers generally want only 1 defect per square inch, however, and consequently should expect to pay about $1,000 per plate. Maskmakers may quote different prices if they include some tooling costs in plate costs.

Plates are currently inspected for defects by human operators. However, some manufacturers have installed computerized inspection equipment and these systems tend to discover more defects than their human counterparts. DATAQUEST believes that semiconductor companies may eventually use similar systems to inspect wafers in the manufacturing process.

Table 2

COATED BLANK SUPPLIERS

Emulsion Conversion Suppliers

Imtec Products, Inc.	Sunnyvale, CA
Oak Laboratories	Los Angeles, CA
Precision Photoglass, Inc.	Mountain View, CA
R.O.K.	Mountain View, CA
Semi Mask	Oak Park, IL
Sempro, Inc.	Sunnyvale, CA
Others	

Chrome Coating Suppliers (Merchant)

Basic Microelectronics, Inc.	Lake Park, FL
EMC (Micro Mask, Inc.)	Sunnyvale, CA
IMR	Santa Clara, CA
Optifilm Co.	Gardena, CA
Precision Photoglass, Inc. (Supplier Only)	Mountain View, CA
Tau Labs	Yorktown Heights, NY
Telic Corp.	Santa Monica, CA
Towne Laboratories, Inc.	Somerville, NJ
Others	

Source: DATAQUEST, Inc.
October 1980

Table 3

ESTIMATED U. S. MERCHANT AND CAPTIVE MASKMAKING MARKET
1979-1984
(Millions of Dollars)

	1979	1984	CAGR[1] 1979 to 1984
Photoplates	$177	$270	9%
Mask Tooling	198	427	17%
Total	$375	$697	13%

[1] Compound Annual Growth Rate

Source: DATAQUEST, Inc.
October 1980

Merchant maskmaking companies (see Table 4) supplied only 13 percent of the total maskmaking market in 1979; however, these companies should increase their market share 1 or 2 percent per year, primarily because the faster-growing semiconductor companies seem unwilling to commit resources to maskmaking as long as they can buy masks. The trend is already evident among some of the industry leaders; neither Advanced Micro Devices nor Intel have their own maskmaking facilities.

has

CURRENT TRENDS

The trends toward higher quality, longer lasting masks and non-contact alignment in the manufacture of integrated circuits have significant implications for both maskmakers and semiconductor manufacturers. In particular, longer lasting masks and non-contact alignment reduces the number of masks required in the manufacturing process.

The most dramatic effect of the reduction in the number of masks required in manufacturing is that the unit count of plates sold by maskmakers is growing less rapidly than semiconductor component sales. The plates are of higher quality, however, and higher quality plates cost more. Consequently, maskmakers are concentrating on generating more revenue for higher quality products to compensate for the slower growth in unit count.

The shift from emulsion coating to chrome coating is one push for quality in the maskmaking industry that is already evident. Its implications have already been discussed: chrome produces a better quality, longer lasting mask that garners a higher ASP in the marketplace. DATAQUEST believes that the shift to chrome will continue as the maskmaking market grows. The size of the emulsion coating market may not necessarily decrease, but it certainly will not keep pace with growth in the chrome coating market.

One benefit of making masks that last longer is that tooling plates can now be used in the manufacturing process. In the past, when emulsion was the standard coating, maskmakers made tooling masks first and then made working plates, which were used in factory production. These plates were brought into contact with wafers during the manufacturing process and, as a result, would wear out. Tooling plates made from chrome coated masks do not wear out as easily. In addition, they can be used in non-contact aligners, which almost eliminates wear.

DATAQUEST believes that the shift to the use of tooling plates instead of working plates in manufacturing will continue and, consequently, that tooling will continue to command larger shares of the total maskmaking market.

The shifts from emulsion coating to chrome coating and from working plates to tooling plates complement the new strategy in the maskmaking industry of generating more revenue for higher quality products. One result of the strategy is a change in the maskmaking industry from an orientation of commodity production to

Table 4

MERCHANT MASKMAKING COMPANIES

Company	
Align-Rite Corp.	Burbank, CA
Electromask, Inc.	Woodland Hills, CA
Master Images	San Jose, CA
Micro Arrays	Newtown, PA
Microfab Systems Corp.	Palo Alto, CA
Microlab	Livingston, NJ
Micro Mask, Inc.	Sunnyvale, CA
NBK Corp.	Santa Clara, CA
Photronic Labs, Inc.	Danbury, CT
Qualitron Corp.	Danbury, CT
Tau Labs	Yorktown Heights, NY
Telic Corp.	Santa Monica, CA
Towne Laboratories, Inc.	Somerville, NJ
Transmask, Inc.	Newport Beach, CA
Ultratech	Santa Clara, CA
Others	

Source: DATAQUEST, Inc.
October 1980

service. We expect that the semiconductor industry will generate more custom designs with longer design times, and that maskmaking companies will become more responsive to the needs of their customers in order to survive. It will become essential for maskmaking companies to give customers quick turnaround times and firm delivery commitments.

The development of non-contact aligners for use in the wafer fabrication process parallels the development of higher quality masks. There are several non-contact technologies in use today. The most common is projection alignment, but by 1984, aligners that perform the step-and-repeat function during the process of exposing photoresist on the wafer will have gained a visible presence.

Several manufacturers are developing Electron-beam (E-beam) equipment that writes directly on the wafer and totally eliminates the need for maskmaking. DATAQUEST expects that a number of products of this type will be introduced between 1981 and 1984 by companies such as ETEC, GCA, Varian, and Veeco. These products should have little effect on the maskmaking industry during this time period, however, because so few systems will be sold. The effect may be more significant by 1990, when more equipment is installed. Nevertheless, it is likely that the production of wafers will in most cases require masks. In particular, DATAQUEST believes that many semiconductor manufacturers will use X-ray aligners, which require masks.

Electron-beam equipment is already used in maskmaking to generate reticles. This equipment can produce both low defect densities and quick turnaround. Turnaround is particularly improved when E-beam equipment is used for complex designs.

However, E-beam equipment creates roughly four times more capacity for a typical mix of die sizes than optomechanical equipment; therefore its use makes more sense for maskmakers who can use the additional capacity. The use of E-beam equipment in the maskmaking process may eventually put smaller maskmakers at a competitive disadvantage.

E-beam equipment has been commercially available for several years and it is estimated that about 25 systems are in use in the United States. However, most maskmaking companies still use optomechanical reticle generators because E-beam equipment is not cost effective unless used for larger chips, and because E-beam reticle generators cost about $1.5 million.

Howard Z. Bogert
Susan A. Thomas

DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

Vol. II - No. 9 October 27, 1980

This letter is a condensation of recent Research Newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific Newsletters should be directed to the author. A list of recent DATAQUEST Newsletters appears at the end of this letter.

SEMICONDUCTORS

Turning points in industry fundamentals are usually a time of controversy and indecision and we believe that we are presently in that situation in the semiconductor industry.

DATAQUEST has long forecasted that the semiconductor industry will ride through a recession relatively well and that order trends should start improving in September of this year. It is our belief that this is exactly what is happening. We know of at least three major broadbased suppliers who had order months in September that exceeded expectations; and it is our perception that the overall domestic book-to-bill ratio in September was close to 0.9. We also perceive that MOS memory pricing, which has been one of the hardest hit areas in 1980, has started to stabilize.

These events justify what we consider to be a very optimistic outlook for 1980 and 1981: a 25 percent increase in revenues this year and a 10-11 percent increase in revenues in 1981. At our just completed Semiconductor Conference in Scottsdale, Arizona, the general feedback from most of manufacturers and distributors was somewhat less optimistic than the DATAQUEST forecast outlined above. They tied the improvement in September more to seasonal factors than any real evidence of a recovery, and concern about MOS pricing in particular was very widespread.

In justifying these two divergent sets of opinions, we should make one thing clear. We are not forecasting a period of strong industry conditions over the next three to five months. Rather, we are saying that business will still be relatively lackluster, but that the valley has been passed and that fundamentals will gradually start to improve from present levels, first in orders and then in sales and profits. It is sometimes difficult for people within the industry to sense a change in conditions, particularly when the change is not a dramatic one. We believe that industry participants will confirm a better order climate later this year, after a few more months of data is received. It is likely that MOS may lag the rebound because of the heavier competitive pressures existent in this market, but we believe that the rebound will be widespread across all sectors of the industry.

The major risk in our forecast is the chance that the overall economy could fall back into a significant recession. This would obviously moderate the optimistic tone of our forecast. If this relapse does not occur, however, then it appears that the semiconductor industry has come through a recession better than it ever has before and that industry growth will begin accelerating markedly by the second quarter of 1981.

COPYING AND DUPLICATING

Several points of controversy regarding Xerox have arisen recently that need to be addressed.

Canon has announced a new product at the higher end of the copier market. Named the SUPER NPX, this copier is the fastest on the market, with a speed of 135 copies-per-minute versus 120 copies-per-minute for the Xerox 9000 Family. No price has been announced for the SUPER NPX, but we would expect it to be very aggressive. On the surface, this appears to be a problem for Xerox -- the initial sign of Japanese competition at the high end of the copier market. It is DATAQUEST's opinion, however, that the long-term fundamental impact of this announcement will not be significant.

The major roadblock for the Japanese in penetrating the high end of a copier market has always been distribution, and things have not changed in this regard. Canon has a limited direct sales force in Europe and almost none at all in the United States, and this type of product must be marketed on a direct sales basis. Down the road, we believe it is likely that Canon or other Japanese suppliers will sign distribution agreements with U.S. and European companies that have the requisite direct distribution and financial resources. Even then, however, there are very few companies that can successfully market and support a product such as the SUPER NPX. Another very important feature on a high-end copier is its input and output features: the development of a good, reliable, high-speed document handler and sorter is not a trivial task and the Canon product does not yet have these capabilities (nor do any other Japanese copiers).

Nevertheless, we are not naive enough to disregard any new product announcement from the Japanese, particularly from a company with Canon's technical capability and this announcement may be a harbinger of increased competition. However, the fact remains that we do not believe this product can make any meaningful penetration of the high-end copier market in the foreseeable future. Even if Canon is very successful in initial development and production of the new machine, the Company would be unlikely to ship more than 100 machines in 1981; in comparison, Xerox's worldwide shipments at the high end in 1981 will range between 10,000 - 15,000 units.

Xerox's third quarter earnings grew 10 percent compared to a 17 percent increase in revenues. The lower margins were attributable to a lower rate of gain in outright copier sales and to lower margins in Xerox's OEM computer-related businesses (Shugart Associates, for example). Both shortfalls are recession related. Xerox has already changed commission schedules to bolster outright sales, and has raised prices nine percent to try to bolster overall margins. We believe that the margin slide at Xerox will abate in 1981, allowing earnings growth to accelerate to a

14 percent rate from 10 percent this year. This would produce earnings of $8.40 per share in 1981 versus $7.35 for this year. The third quarter earnings report does not change our view in this regard.

IBM finally announced an extension of its copier family, the Series III, Models 30 and 40. There was concern in some quarters several months ago that IBM would be making a very strong competitive entry into the high end of the copier market to compete directly with the Xerox 9000 Family. If the people expecting this new aggressive stance from IBM were banking on the Models 30 and 40, we think that they will be very disappointed. These products provide the expected improvements in IBM's existing position, but are not significant threats to the Xerox (Segment 6) 9000 Family.

IBM badly needs replacements for its Copier I (Segment 1) and Copier II (Segment 2) and we expect this to occur within six months. To meet this deficiency, we think that IBM will do the unthinkable — we expect that the two low-end copiers to be announced and marketed by IBM will be manufactured for the Company by a major Japanese company, probably the Minolta 310 and 520.

The most significant recent new product announcement at Xerox in the past month was the announcement of the 5700 Intelligent Copier. Because this product really relates to the word processing/office automation industry, we will discuss its ramifications in our section on Word Processing.

PAPER AND FOREST PRODUCTS

In an earlier Portfolio Letter (Vol. II - No. 6), we commented on the outlook for stumpage prices in the present recession. It was our thesis that the relative scarcity of woodlands would cause bid prices for stumpage to rebound much more rapidly than in the past two recessions, when prices did not move back above their cyclical peak for three years and two years, respectively.

It appears that our thesis is being borne out. Bid prices for all species of wood peaked at $345 per thousand board feet (tbf) in the first quarter of 1980 and dropped to $295 in the second quarter. The average bid prices in July and August have already bounced back to $354 per tbf. Bid prices may come down again if the housing market weakens, but it appears clear that we are not getting the extended and steep declines in bid prices that occurred during past recessions. Our previous statement that we would see a new high in stumpage prices by early 1981 appears more likely than ever.

The implications of these pricing trends are that there will be a tremendous cost push on plywood and lumber prices from the smaller producers in late 1982 and early 1983. This fits very well with our scenario for the forest products industry over the next four years, namely that end-product prices will escalate much more rapidly than inflation, allowing material profit increases for the companies who are well integrated, and have plentiful, low-cost fiber bases. All of the major forest products companies should benefit from these trends, but Weyerhaeuser may be the company most positively impacted.

INSTRUMENTATION

Order softness has now spread to all aspects of the automated test equipment (ATE) market. Circuit board tester demand, which was reasonably strong in the first half, is now flattening out or declining from levels achieved earlier this year. Semiconductor testers remain soft, although some areas (LSI testers) have improved recently. Present revenue gains being achieved by companies are primarily a function of working off high backlogs.

It is DATAQUEST's belief that order rates in the ATE industry will turn up early in calendar 1981. This would mean that the industry has come through the economic downturn better than it ever has before. We project sales gains in the semiconductor tester area of 19 percent in 1980 and 21 percent in 1981, and sales gains in circuit board testing of 31 percent this year and 29 percent in 1980. The pattern in both sectors of this industry should be the same: order gains trailing revenue gains this year and exceeding revenue gains in 1981.

The two "pure plays" in the ATE business, GenRad and Teradyne, are both very well-positioned longer term, although each approaches the market somewhat differently.

GenRad has been very aggressive in trying to attract a lot of the new customers in the ATE business. In semiconductor testing, the Company has done very well at the very low end of the market and will soon have its first products announced at the very high end — LSI and VLSI testing. In circuit board testing, GenRad has been trying to hold its dominant position in functional testers and is gaining share rapidly in the fast growing in-circuit sector of the circuit board testing market.

DATAQUEST gives GenRad's management very high marks in terms of its product positioning and for its aggressiveness in pursuing many of the growth opportunities open to it. It gets somewhat lower marks in terms of its financial controls. GenRad was late in recognizing the likelihood that its orders would slow down and this has resulted in disappointing earnings results in 1980. Further, the company's inventories were allowed to grow disproportionately and have caused the company to be a heavy cash user.

GenRad should earn $1.35 to $1.40 per share in 1980 versus $1.25 last year. We expect the Company's order growth to accelerate early in 1981 and, therefore, believe that revenue growth may exceed 25 percent next year. At this juncture, we would expect earnings to approximately track the rate of revenue growth, with our full year estimate for next year being $1.70 per share. There is room for considerable variance on either side of this estimate, however, depending on how effectively the company improves profit margins and manages its cash needs. GenRad is extremely well-positioned longer term, but it needs to improve its ability to bring revenue gains down to the bottom line.

Teradyne is taking a somewhat different tack, concentrating more heavily on servicing its existing client base. Its soon-to-be announced high-end functional board tester will probably improve its position in functional testers in general. However, the company may not grow as fast as the industry in in-circuit testers because of a lack of emphasis on the low end of this market. Teradyne is the number two participant in the semiconductor test area with very broadbased capabilities. We expect its entry into the LSI tester market to occur some time in 1981, and we believe that Teradyne should at least hold market share in semiconductor testers over time.

Teradyne experienced the worst of its order slowing during the summer and we expect a gradual improvement in orders from this point on. The company managed its backlog very well this year during the period of order slowing and, as a result, should be able to keep its earnings growth intact. We project $2.75 per share in earnings in 1980, up 17 percént from last year, with a 24 percent gain to $3.40 likely in 1981. Teradyne is not as aggressive a company as GenRad, but is well positioned to share in the growth in the ATE market.

SMALL COMPUTERS

The recent Prime Computer analysts' conference could hardly have been more upbeat. Order trends continue excellent and management forecasted a 50 percent increase in revenues in 1981. Based on comments by management on margins and tax rates, reasonable targets for earnings appear to be $1.55 per share in 1980 and $2.20 per share in 1981.

Apart from the numbers, a few interesting things came out of the meeting. First, one of the longer term results of the very heavy emphasis that Prime is putting on the office automation market may be to dramatically increase its average system sales. The Company claims to be looking at orders of very large magnitude (50-60 CPUs, 1500 terminals) versus its present $150,000 average selling price. DATAQUEST has not yet completed a full evaluation of Prime's word processing software or its overall office automation capabilities, but the company is moving very aggressively in this regard and the opportunities facing it are obvious.

Second, Prime's development work in the CAD/CAM field appears to be unique. The company has developed an in-house CAD system that puts more processing power in each terminal and requires less transfer of data with the central computer. Prime is also the first company to use a 32-bit computer to drive its CAD system. These improvements allow the computer to be stationed up to 500 yards away from any of the terminals and dramatically increases the number of terminals that can be strung on a CPU. The pilot CAD system was shipped to Ford Motor, which is doing a lot of the development work on the system itself. It does not appear that CAD/CAM will be a major business for Prime in itself, but rather that it may create another functional area of customer needs that the company can satisfy with its computer systems.

In general, Prime is doing all of the "right" things — its basic minicomputer business is booming and it is moving into hot areas such as office automation and CAD/CAM, which is just what analysts and portfolio managers want to hear. It is important to understand that Prime's efforts in both of these new areas are in the formative stage and one should not expect too much too soon. Nevertheless, the story is a good one. The only legitimate question may be the extent to which its near-term prospects are discounted in the stock.

WORD PROCESSING

We understand that some of IBM's salesmen may have been too aggressive in promising early 1981 delivery of the Displaywriter. Some major accounts who were promised January delivery when they ordered quantity early, have apparently been told to expect delivery in the fall. This slippage is not widespread, however and we do know of accounts expecting March 1981 deliveries.

The recent software enhancements for the Displaywriter fill out the product, making it more of a complete word processing machine. In order to take advantage of all of the new hardware and software features, however, the typical single unit price rises to $11,500 from the announced price in June of $7,895. Thus, as the features and capability of the Displaywriter improve, its price advantage is being reduced or eliminated.

We believe that the Displaywriter is basically sold out for next year, and that IBM will ship 30,000 to 35,000 units domestically in 1981, or about 17 percent of total industry shipments. In our opinion, the market is growing fast enough to easily absorb the impact of IBM in 1981 and beginning in 1982, IBM should become more of a competitive factor.

Xerox's announcement of the 5700 Electronic Printing System is another important step in Xerox's attempt to penetrate the office information market. The 5700 is designed to work as a direct output medium from multiple word processing stations and can operate as the hub of a combined word processing/data processing printing system.

Xerox made the 5700 compatible with all Xerox word processors and the IBM 6670 printer. It is not compatible with any Wang products. The compatibility strategy at Xerox becomes fairly clear: it wants to use the 5700 to stimulate demand for its word processing systems and does not want to strengthen Wang's position in the marketplace by allowing compatibility with Wang's products. If it had done so, it would have generated increased sales for the 5700, but would have also justified the use of Wang word processors. The compatibility with IBM is guided by the fact that the 5700 is a direct replacement for the IBM 6670 and, assuming comparable reliability and copy quality, the 5700 appears to be clearly superior in price/performance. The 5700 may allow Xerox to knock numerous IBM 6670s out of users' offices and possibly allow Xerox to penetrate the offices with word processing systems as well.

The 5700 fits well with Xerox's strategy of eliminating the need for a central computer to control all aspects of an integrated office system. In order for this strategy to work, there must be widespread acceptance of Xerox's Ethernet intra-office communication system, so that a user can mix products from different vendors. Otherwise, Xerox's lack of data processing capability may prove a major negative relative to offerings from Datapoint, IBM, Prime, Wang, and others.

Michael R. Weisberg

RECENT NEWSLETTERS OF NOTE

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COPYING & DUPLICATING

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Canon Announces Fastest PPC Copier in the World	10/17/80
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IBH Holding Company Buys the Terex Division of General Motors Corporation	10/10/80

SMALL COMPUTERS

Data General Unveils New MPT Family of Intelligent Terminals	10/16/80

WORD PROCESSING

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DATAQUEST RESEARCH NEWSLETTER
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WPIS Code: Newsletters

UPDATE ON VOICE RECOGNITION

As we enter the 1980s, we expect automatic speech recognition to play an increasingly important role in man-machine communication due to three major factors: the inherent superiority of speech over other modes of human communication, technological breakthroughs, and the growing need for better control of complex machines.

Even though recent technology has produced significant aids to human communication and information processing, nothing can replace or equal speech: it is the most familiar and convenient way for humans to communicate. Without speech recognition, man must interact with machines in machine languages. With speech recognition, a person can communicate with machines in natural-language human terminology. Furthermore, voice input allows the speaker to use hands and eyes to perform the primary task and to move about. The most significant advantages of effective voice control or voice data entry systems over other methods of man-machine interaction are the dramatic reduction of operator training time and the reduction in operator errors, which result in reduced time utilization and operating costs.

The first half of the decade should produce dramatic advances for voice recognition capability within word processing products. One of the earliest to be expected is the replacement of some or all function keys with voice input commands. Voice actuated electronic display typewriters are also a possibility in the early 80s but accuracy is only expected to be 90 to 95 percent. Continuous speech recognition products with almost perfect accuracy are not expected until after 1990.

In August of this year, Interstate Electronics Corporation of Anaheim, California, presented a seminar on voice recognition in Santa Clara, California. At the seminar, Interstate demonstrated its automatic speech recognition system, the Voice Recognition Module (VRM). This seminar serves as an excellent update; and our notes are reprinted below.

INTERSTATE ELECTRONICS SEMINAR

Interstate is a subsidiary of ATO, Inc., a diversified manufacturer of industrial, consumer, and technical products, and markets a series of low-cost voice recognition modules that are priced from $1,650 to $2,255. These units recognize vocabularies of 40 to 100 words with as high as 99+ percent accuracy.

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Interface

Interstate's VRM is a single printed-circuit board that contains all analog-to-digital, processing, memory, and input-output interfaces necessary to convert the spoken word into digital code. It can be tied into a variety of users' systems by virtue of a full duplex 8-bit-wide parallel signal interface. The connection uses common TTL signal-level logic that may be connected to a host computer communications port or to the digital control logic typical of modern control system panels. An optional asynchronous RS-232C or 20-mA serial port enables the display of host output on peripheral devices. Its other option replaces the parallel interface to the host with a second serial interface that permits full compatibility with standard computer communications ports and their associated software drivers.

Accuracy Efficiency

The VRM can achieve up to 99+ real-time accuracy under host computer control or by means of front-panel switches. An operator can select a particular threshold value for rejection of invalid words or background noise, thus ensuring word recognition accuracy independent of language, dialect, or accent.

Three Vocabulary Sizes

Voice recognition is a particularly valuable human-to-machine input technique because it allows the operator (speaker) to interact in his or her own language—a natural interaction that greatly reduces data capture errors and operator training time. Interstate considers a 40-word vocabulary the minimum possible size to permit basic entry of alphanumeric data along with edit control words. To allow for increasingly complex requirements, the VRM is designed to accommodate 70- and 100-word vocabularies. A two-level syntax capability provides for automatic data-editing at the data capture source.

Support Design Tools

The VRM is supported by the VOTERM and VRM emulator. VOTERM, the chassis that houses the VRM, contains all the control switches, power supplies, and connectors required, and serves to speed up system integration.

The VRM emulator is based upon Interstate's intelligent voice terminal, the Voice Data Entry System. By using the VRM emulator, the system designer can quickly detect confusing vocabulary words and build a data base for such features as automatic operator update training. The emulator also permits rapid testing of proposed system designs without requiring expensive modifications to host system computer software.

Training

Interstate conducts a VRM Programming Workshop, a highly concentrated three-day training course for each user's system designer. Its purpose is to teach the system designer how to adapt the VRM product and its associated development support tools to handle desired applications.

Language Compatibility

The VRM is designed to be compatible with such high-level computer languages as FORTRAN, PASCAL, and BASIC by means of its special voice recognition communications protocol. Host system control programs for the VRM can be developed rapidly, debugged, and modified by the user, through the use of the software power inherent in these high-level languages.

Voice Recognition Technology

Interstate explains that two sets of criteria must be addressed in developing voice recognition technology: (1) speaker dependent or independent, and (2) discrete word or continuous speech.

A speaker-dependent system recognizes the voice of the speaker for such applications as quality control inspection. This technology is much further advanced at the present time. While capable of handling many more users, the speaker-independent system is limited by its vocabulary size and universe of terms.

Discrete-word systems separate words by stop gaps, while continuous-speech systems have no speech rate restrictions. The latter technology was stated to be several years away and will be preceded by "connected words" in specific patterns such as NEC's current products.

Interstate's systems, which are an example of speaker-dependent/discrete word technology, emphasize the significance of the system designer's attention to human factors. A digital pattern, called a "reference pattern," is created from multiple spoken samples: the speaker repeats discrete words several times to establish this individual's "pattern." These samples are stored in the interface processor, which correlates the speaker's input with the system's application features. Input speech is analyzed by a 16-filter spectrum analyzer and converted to a digital representation of the characteristics of the spoken input. This digital data is next converted to a fixed-size pattern that preserves the information content of the spoken inputs while discarding redundant features. These patterns are used during word training to derive a template for each utterance. These templates, which are stored in onboard random access memory (RAM), are then used during recognition for comparison with incoming spoken words. Processing algorithms are contained in real-only memory (ROM), operating in conjunction with a microprocessor.

Device Training

The VRM utilizes three basic training modes: (1) normal training in which the specified reference patterns are cleared and then trained during a selectable number of passes; (2) updating the word patterns in which the stored reference patterns for the specified vocabulary are augmented by additional training; and (3) single-word replacement mode in which to retrain a single word. In the latter mode, the single word is trained for the same number of passes as the other words in the vocabulary.

Rejects

During training, the VRM will automatically reject utterances that do not sufficiently agree with the same utterance from previous training samples of that word. This prevents significant alteration of a vocabulary reference pattern caused by spurious noise sources (such as bumping the microphone, coughing, speech inconsistencies, background noises, or simply failing to utter the specified vocabulary word). As a result, the user may need to repeat an utterance more than once before being prompted to the next sequential utterance.

Operational Modes

The VRM operates in either of two modes: under the control of a host processor, or in a stand-alone configuration with appropriate peripherals. In the host mode, vocabulary reference patterns can be transferred either from the host processor to the VRM or vice versa. This allows for permanent storage of reference patterns, much larger vocabularies, or separate files for different speakers.

When in the host mode, the first and last word indices must be specified when placing the VRM in recognition, training, or update mode. Consequently, any contiguous sequence of vocabulary words can be selected for an operation. (This is particularly useful during a recognition operation in order to ensure that the VRM accepts only appropriate valid responses—a subset of the vocabulary—for input commands to a system.)

A second syntax level (termed "common vocabulary") allows the user to select a second contiguous sequence of vocabulary words to be appended to the first set in the recognition mode. Therefore, command and edit words can be appended automatically to the specified set of valid input words without complex or redundant vocabulary structuring.

Inputting

The VRM's microphone preamplifier accommodates use of a light-weight microphone (Shure Brothers SM-10), boom-mounted Telex CS-75, or equivalent microphone, for direct microphone input. Alternately, a preamplifier bypass switch on the board permits use of a remote microphone and preamplifier without any loss in audio signal integrity. Input is AC-coupled and terminated by a resistance exceeding 10 kilohms. Typical remote preamplifier complex speech signal level should be 6.5V $\pm$ 2V for average utterances. The VRM's useful audio bandwidth is from 200 to 7,000Hz. Excellent recognition can be maintained with the reduced telephone bandwidths.

Performance Measurement

Recognition accuracy is a function of training examples and optimum performance is usually achieved after seven to ten training examples of each word or phrase. Recognition accuracy of 99+ percent reflects the percentage of times the classification result will be correct on the first attempt when a valid utterance is spoken. This level was attained with properly trained speakers using typical application vocabularies of up to 100 words.

Human Factors

VRM performance is affected significantly by the manner in which the speaker uses the system. Recommended operator guidelines are:

- Microphone: Be consistent in how you hold or wear the microphone. Significant changes alter the acoustical input, adversely affecting system performance.
- Speech: Speak normally while holding the microphone about a half inch from your lips and uttering the vocabulary words in a consistent manner.
- Update: If the VRM exhibits a high error rate in responding to your voice, update your reference patterns using the update command for the entire vocabulary.
- Single-Word: If the VRM exhibits a high error rate for a single word, execute a single-word training command. This will clear the reference pattern for the error word and generate a new template.
- Host Mode: When operating in the host mode, structure your vocabulary so that only those words that are valid responses at that point are checked for recognition with each spoken input.
- Selecting Vocabulary Words or Phrases: Avoid selecting words or phrases that are excessively long and that cause the VRM to decide to advance to the next item in the TRAIN mode before you have finished speaking. Similarly, avoid extremely short words that seem to be ignored consistently by the VRM. The ideal length of a word or phrase is between 200 milliseconds and 1.2 seconds.

Speech Recognition Applications

Interstate's list of criteria that should exist when selecting automatic voice recognition applications includes:

- Computerized reporting systems
- Reasonable vocabulary (as natural as possible)
- Data entry (repetitive steps)
- Limited or defined number of operators (Chase Manhattan Bank is currently conducting a pilot application)
- Importance of cost savings

Other factors to look for include those in which operators must do one or more of the following:

- Capture data at the source
- Avoid mental encoding
- Use eyes and hands in transactions
- Move about from place to place
- Access a computer by telephone

Data Entry Applications and Advantages

Today's data entry systems are costly, error-prone, labor intensive, and result in slow throughput. By using automatic voice recognition for these applications, one can:

- Reduce costs
- Improve data availability
- Increase productivity (capture and verify at the source)
- Improve data validity (0.1 percent error rate in Interstate's pilot text)
- Reduce manpower at the source point (supervisors, verifiers, etc.)
- Reduce training time and materials (learning to keypunch or enter key-to-disk, etc., takes much longer)

Most of today's systems on the market are speaker-dependent applications. However, copiers will use speaker-independent systems since anyone is expected to use a copier.

Examples of telephone input for speech recognition applications include: sales order entry, financial reports, PABX (digital), digital voice store and forward, and automatic dialing.

Japan is currently making the most aggressive push and is several years ahead of the United States in product development and implementing internal company procedures utilizing speech recognition technology.

Cost Comparisons

Using present methods of data entry, input represents 60-80 percent of the cost, while direct voice input results in two to three times cost reduction. A cost comparison study, in which speech recognition was used in place of other methods of input for quality control inspection, resulted in a one-year payback period in the worst situation.

WHAT LIES AHEAD?

Dave Culpiss, an attendee from Stanford Research Institute, stated that SRI predicts the future market size for speech recognition to be:

	1980	1984	1987
Optimistic	$15,000,000	$200,000,000	$1,400,000,000
Most Likely	$10,000,000	$150,000,000	$1,000,000,000

Interstate predicts a dramatic increase in industrial applications, including movement into the professional area. Studies of data entry applications have shown excellent results. One of the many applications in which voice serves as supplemental input is in word processing where an operator enters voice commands. According to Interstate, it takes three months for a skilled word processing operator to learn the command structures for a new WP system, while it takes two days using automatic voice recognition.

Another potentially significant application is that of access security. In this case, the major problem to be overcome is that of denying access to the correct person. In other words, the speech recognition unit is more apt to reject than accept the operator.

Interstate predicts that two-chip technology should occur in the near future, while one-chip technology is further away. IBM's recent announcement of successful results with 1,000-word vocabularies, along with NEC's progress with connected-word installations, indicate significant technological breakthroughs.

COMPANIES OFFERING SPEECH RECOGNITION PRODUCTS IN THE EARLY 1980s

Those firms marketing speech recognition products in the early 1980s include:

Threshold Technology, Inc. (Delran, New Jersey): the first company to successfully market speech recognition equipment. Threshold has developed complete dedicated systems built around its voice entry terminals, Threshold's prices range from $10,500-$16,000 per terminal, and $26,000-$150,000 for a full system. Current installed terminals (estimated to be over 500 to date) serve applications ranging from inspection of motor vehicles to grading of meat.

QUIKTALK, Threshold's latest market entry, an isolated speech system, offers a computer technique called dynamic programming allowing voice input at 180 words per minute with over 99 percent accuracy. The average person does not speak faster than 180 words per minute. QUIKTALK's peak rates range from 250 to 280 words per minute with 99 percent accuracy. Its dynamic programming technique allows pauses between words to be even shorter than pauses within words.

Heuristics, Inc. (Sunnyvale, California): the current volume leader in terms of units sold to date has sold an estimated 11,000 units since 1977, mainly to owners of small personal computers. Heuristics' low-cost voice recognizer sells for $2,000 to $3,000 and recognizes a 32- or 64-word vocabulary with 85-95 percent accuracy. Its two most recent products, Model 5000 and Model 7000, interface a stand-alone voice terminal with larger computers and produce higher recognition accuracy. The 5000 is a 4-level 64-word vocabulary unit that sells for $2,220 and fits inside a Lear-Siegler 80M 3A terminal, while the 5000 stand-alone system has a 64-word vocabulary that produces better than 99 percent accuracy, is RS232 compatible, and sells for $3,330.

Centigram Corporation (Sunnyvale, California): the company markets a speech recognition terminal called MIKE. Its main feature is recognizing 12 vocabularies, each containing 16 words. MIKE, a stand-alone unit, includes voice response (brief, nonsynthesized prerecorded messages), and sells for approximately $3500. Centigram is currently introducing OEM board versions for the PDP-11, an Intel multi-bus system. These units are priced under $1000.

"Verbex" formerly known as Dialog Systems, a subsidiary of Exxon Enterprises (Bedford, Massachusetts): producer of the only American speaker-independent system on today's market. (Most speaker independence is accomplished by an assimilation of speech patterns by more than 1,000 different speakers over 1,000 different telephone lines. These patterns are then reduced to four composite patterns which are used for speech recognition.) Verbex utilizes a high-speed computer, and trains each system with hundreds of samples of each word as spoken by people with many regional accents. Verbex has recently delivered its first connected speech system to a large governmental agency.

NEC America, Inc. (Melville, New York, a subsidiary of Nippon Electric Company, Tokyo, Japan): NEC's Model DP-100 introduced in 1978 is the only connected speech recognition system in the world. A DP-100 user may speak without pausing after each word. A terminal without host computer, interactive software, or additional peripherals sells for about $48,000. A two-input channel version sells for about $56,000. NEC's terminal provides a 120-word vocabulary, and can handle up to five words per spoken utterance, provided the speaker's input is between .4 and 2.5 seconds per utterance. The terminal is trained by practicing each word and digit for consistency. Accuracy is both vocabulary and user dependent.

Scott Instruments, Inc. (Denton, Texas): has developed a speech recognition system designed to run on the Radio Shack TRS-80, Commodore Pet, and Apple computer.

Auricle, Inc. (Cupertino, California): a wholly-owned subsidiary of Threshold Technology as of May 1980. Its charter is to serve the OEM markets and to incorporate the latest in micro-electronic technology to voice recognition. One product will be a semiconductor chip selling for an estimated price of less than $100, with introduction expected in the second half of 1981.

Clifford M. Lindsey

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JAPANESE SEMICONDUCTOR PRODUCTION AND TRADE STATISTICS

SUMMARY

This newsletter presents data derived from published Japanese import, export, and production statistics. It summarizes a broader and more detailed data set. Current trends are presented graphically and numerically.

The following comments are noteworthy:

- Declining domestic consumption (in dollars) in 1979 and through the first quarter of 1980 was more than offset by increased exports; thus, Japanese semiconductor production increased and excess capacity was exported.
- Japan now enjoys substantial positive net balances of trade in semiconductors with all other regions of the world.
- Japanese semiconductor consumption has grown more slowly than that of the world as a whole since 1976.
- Japanese production, consumption, and imports of semiconductors turned up markedly in the second quarter of 1980.

SOURCES

The data presented in this newsletter are derived from the Ministry of International Trade and Industry's (MITI) published export, import, and production statistics of Japan. The data include all production in Japan, including that by non-Japanese companies, notably Texas Instruments. Export of products by Japanese companies outside Japan is not included. The data are converted into dollars at the annual or quarterly exchange rates during each period. Note that consumption is derived from the published statistics by the following formula: Consumption equals production, less exports, plus imports.

DATA

Table 1 presents Japanese semiconductor production and trade statistics for 1970 through 1979 and gives a historical perspective on these trends that is graphically presented in Figure 1.

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These data are comparable to those found in Table A-8, Appendix A of the Semiconductor Industry Service notebooks. Data previously published in Appendix B - Market Share Estimates, give a breakdown of Japanese production by individual company market share. The Japanese totals of Appendix B do not include U.S.-based companies' production in Japan (e.g., TI Japan), while MITI includes them in Japanese production figures. However, Appendix B includes U.S.-based companies' production in Europe, Japan, and Rest of World in the U.S. totals.

Conversion from yen to dollars can be misleading, and using either yen or dollars can distort data, depending on the situation. From early 1970 to 1979, the value of the dollar, expressed in terms of yen, declined from 360 yen to 221 yen. A low of around 170 yen per dollar was reached in late 1978. More recently, the value of the dollar increased about 20 percent from 205 yen in the first quarter of 1979 to 246 yen in the first quarter of 1980. In the second quarter of 1980, this trend reversed and the dollar declined about 8 percent to 221 yen. As a result of these currency fluctuations, the growth of Japanese production according to MITI data expressed in yen averaged 12.0 percent compound annual growth between 1970 and 1979, while this same growth expressed in dollars averaged 17.9 percent. This is compared to growth in U.S. company production of 18.6 percent for the same time period.

Table 2 gives quarterly data for 1979 and the first half of 1980. This is shown graphically in Figure 2. During this period, exports of integrated circuits—led by MOS RAMs—have increased more than 2-1/2 times. This has allowed increasing Japanese production despite declining consumption (in dollars) through the first quarter of this year. In terms of yen, however, consumption increased, albeit slowly. The future strength of exports in the current weak semiconductor market in the United States and Europe is questionable. In particular, falling prices of 16K dynamic RAMs should make growth of exports difficult for the remainder of 1980 and 1981.

Table 3 presents 1979 Japanese semiconductor trade statistics segmented by product class. Table 4 segments Japanese trade by region. Noteworthy is the fact that Japan has eliminated its 1977 trade deficits in most regions of the world, and by 1980 has established itself as a major net exporter of semiconductors. Most of the imports to Japan from the Rest of World are shipments from U.S. company assembly and test facilities in Asia.

Becky Bogert
Mary Ellen Hrouda
Frederick L. Zieber

Table 1

JAPANESE SEMICONDUCTOR PRODUCTION AND TRADE
1970-1979
(Millions of Dollars)

	1970	1971	1972	1973	1974
Production					
Integrated Circuit	$148.9	$148.0	$239.4	$ 417.9	$ 430.1
Discrete and Opto	502.3	434.6	579.1	866.6	759.4
Total	$651.2	$582.6	$818.5	$1,284.5	$1,189.5
Export					
Integrated Circuit	$ 0.0	$ 0.0	$ 0.0	$ 9.7	$ 23.0
Discrete and Opto	27.1	28.3	42.1	71.0	98.0
Total	$ 27.1	$ 28.3	$ 42.1	$ 80.7	$ 121.0
Import					
Integrated Circuit	$ 57.5	$ 70.5	$ 54.3	$ 123.5	$ 175.2
Discrete and Opto	35.1	20.7	20.5	47.3	51.7
Total	$ 92.6	$ 91.2	$ 74.8	$ 170.8	$ 226.9
Consumption[1]					
Integrated Circuit	$206.4	$218.5	$293.7	$ 531.7	$ 582.3
Discrete and Opto	510.3	427.0	557.5	842.9	713.1
Total	$716.7	$645.5	$851.2	$1,374.6	$1,295.4
Exchange Rate (Y/$)	357.8	343.3	302.0	268.7	291.8

[1]By definition: Production, less export, plus import

(Continued)

Table 1 (Continued)

JAPANESE SEMICONDUCTOR PRODUCTION AND TRADE
1970-1979
(Millions of Dollars)

	1975	1976	1977	1978	1979
Production					
Integrated Circuit	$396.1	$ 666.4	$ 798.4	$1,367.2	$1,729.9
Discrete and Opto	534.8	868.6	1,021.1	1,220.6	1,147.1
Total	$930.9	$1,535.0	$1,819.5	$2,587.8	$2,877.0
Export					
Integrated Circuit	$ 45.5	$ 56.7	$ 100.8	$ 208.9	$ 397.1
Discrete and Opto	80.1	159.4	193.4	237.2	256.9
Total	$125.6	$ 216.1	$ 294.2	$ 446.1	$ 654.0
Import					
Integrated Circuit	$134.7	$ 199.5	$ 191.8	$ 262.8	$ 401.6
Discrete and Opto	36.4	77.3	82.4	82.5	98.1
Total	$171.1	$ 276.8	$ 274.2	$ 345.3	$ 499.7
Consumption[1]					
Integrated Circuit	$485.3	$ 809.2	$ 889.4	$1,421.1	$1,734.4
Discrete and Opto	491.1	786.5	910.1	1,065.9	988.3
Total	$976.4	$1,595.7	$1,799.5	$2,487.0	$2,722.7
Exchange Rate (Y/$)	296.9	296.2	265.9	205.9	221.3

[1]By definition: Production, less export, plus import

Source: DATAQUEST, Inc.
MITI
October 1980

Figure 1
JAPANESE SEMICONDUCTOR PRODUCTION AND TRADE
1970-1979
(Billions of Dollars)

Source: DATAQUEST, Inc.

Table 2

JAPANESE SEMICONDUCTOR PRODUCTION AND TRADE
1978-1980
(Millions of Dollars)

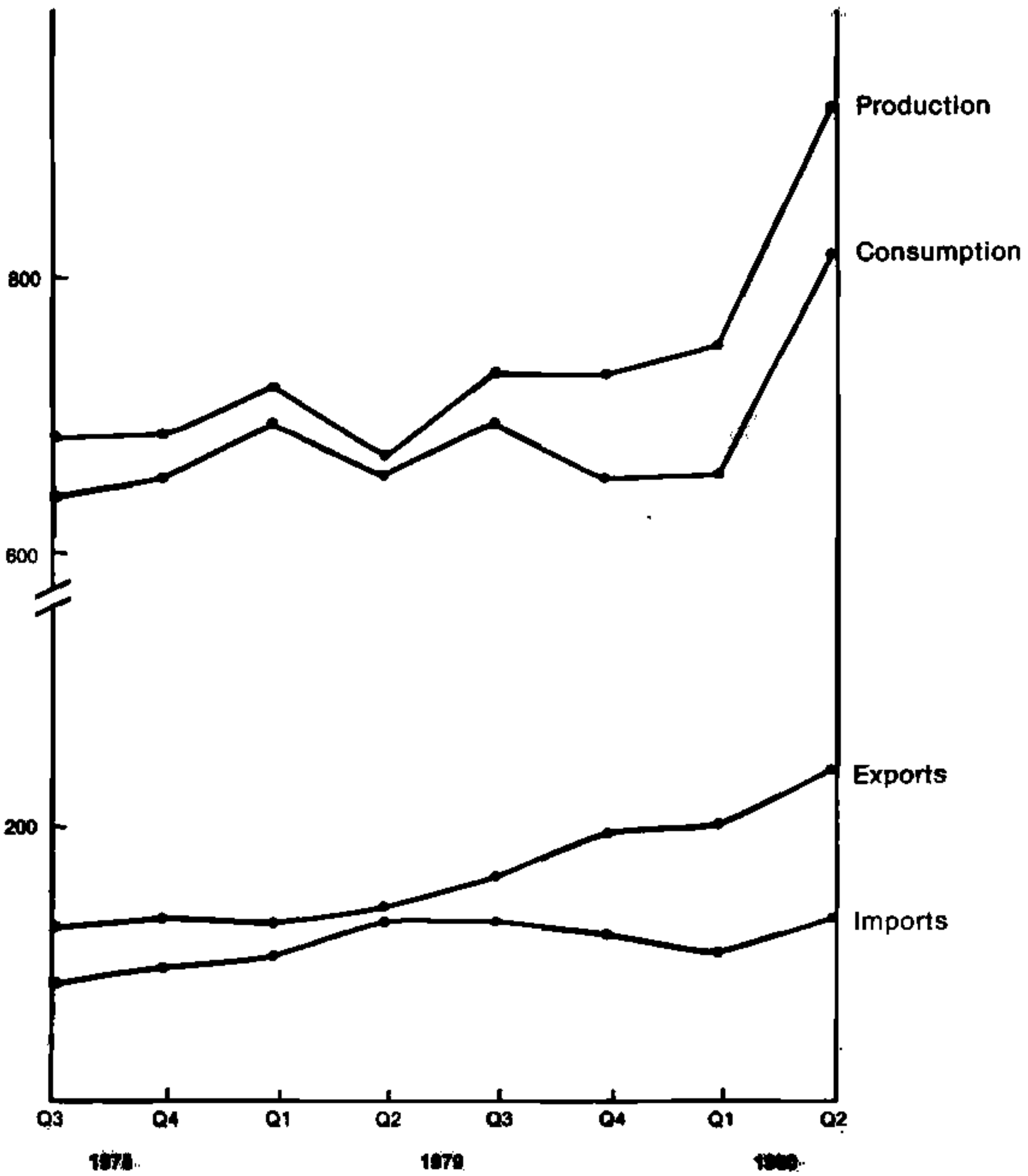
	1978	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.	1979 4th Qtr.	1980 1st Qtr.	1980 2nd Qtr.
Production							
Integrated Circuit	$1,367.2	$415.8	$398.0	$443.1	$463.0	$489.7	$607.0
Discrete and Opto	1,220.6	305.3	278.5	291.6	270.6	267.9	317.4
Total	$2,587.8	$721.1	$676.5	$734.7	$733.6	$757.6	$924.4
Export							
Integrated Circuit	$ 208.9	$ 71.3	$ 84.5	$105.4	$130.0	$147.5	$180.5
Discrete and Opto	237.2	64.4	58.9	62.5	69.3	61.6	60.2
Total	$ 446.1	$135.7	$143.4	$167.9	$199.3	$209.1	$240.7
Import							
Integrated Circuit	$ 262.8	$ 87.9	$108.7	$106.3	$ 96.6	$ 91.1	$103.5
Discrete and Opto	84.5	21.0	24.8	25.3	25.8	20.2	31.0
Total	$ 347.3	$108.9	$133.5	$131.6	$122.4	$111.3	$134.5
Consumption[1]							
Integrated Circuit	$1,421.1	$432.4	$422.2	$444.0	$429.6	$433.3	$530.0
Discrete and Opto	1,067.9	261.9	244.4	254.4	227.1	226.5	288.2
Total	$2,489.0	$694.3	$666.6	$698.4	$656.7	$659.8	$818.2
Exchange Rate (Y/$)	205.9	205.4	220.1	221.2	241.7	246.7	226.8

[1]By definition: Production, less export, plus import

Source: DATAQUEST, Inc.
MITI
October 1980

Figure 2

JAPANESE SEMICONDUCTOR PRODUCTION AND TRADE
1978-1980
(Millions of Dollars)



Source: DATAQUEST, Inc.

Table 3

JAPANESE SEMICONDUCTOR PRODUCTION AND TRADE BY PRODUCT

1979

(Millions of Dollars at 221.3 Yen = $1.00)

	Production	Export	Import	Consumption
Total Semiconductor	$2,877.0	$654.0	$499.7	$2,722.7
Total Discrete and Opto	$1,147.1	$256.9	$ 98.1	$ 988.3
Diode	153.2	72.7	18.8	99.3
Transistor	471.7	106.6	52.4	417.5
Thyristor and Other	373.6	44.8	10.4	339.2
Optoelectronic	148.6	32.8	16.5	132.3
Total Integrated Circuit	$1,729.9	$397.1	$401.6	$1,734.4
Bipolar	230.9	N/A[1]	N/A	N/A
MOS	886.9	N/A	N/A	N/A
Linear	432.8	N/A	N/A	N/A
Hybrid	179.4	N/A	N/A	N/A

[1]N/A indicates not available

Source: DATAQUEST, Inc.
MITI
October 1980

Table 4

JAPANESE SEMICONDUCTOR TRADE BY REGION

1977-1980
(Millions of Dollars)

	Exports From Japan	Imports To Japan	Net Balance of Trade	Exchange Rate (Y/$)
1980-Six Months				236.8
United States	$194.2	$143.6	$ 50.6	
Europe	71.7	19.0	52.7	
Rest of World	197.5	82.4	115.1	
Total	$463.4	$245.0	$ 218.4	
1979				221.3
United States	$232.6	$333.9	$(101.3)	
Europe	83.4	28.0	55.4	
Rest of World	338.0	137.8	200.2	
Total	$654.0	$499.7	$ 154.3	
1978				205.9
United States	$118.5	$205.0	$ (86.5)	
Europe	44.5	35.5	9.0	
Rest of World	276.5	106.8	169.7	
Total	$446.1	$347.3	$ 92.2	
1977				265.9
United States	$ 67.2	$141.4	$ (74.2)	
Europe	35.6	43.3	(7.7)	
Rest of World	198.0	89.5	108.5	
Total	$294.2	$274.2	$ 26.6	

Source: DATAQUEST, Inc.
MITI
October 1980

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SEMICONDUCTOR INDUSTRY STATUS REPORT

DATAQUEST perceives that positive indications signalling the end of order weakness in the semiconductor industry have occurred. Furthermore, the U.S. economy is now improving, which reinforces our belief that the effect on semiconductor demand of the current U.S. economic recession will be mild. Several factors are noteworthy:

- Domestic semiconductor bookings exceeded expectations in September. At least three major broad-based suppliers had excellent bookings, and it is DATAQUEST's perception that the domestic book/bill ratio was close to 1.0. This is especially positive because DATAQUEST believes that September was a good shipping month.

- The industry has successfully weathered the period of order weakness. DATAQUEST estimates that the value of shipments in the United States (including imports) declined only slightly in the third quarter, with only a moderate effect on margins.

- Prices appear to have stabilized after falling rapidly for several months in some product areas, especially in MOS memory. However, some prices, such as those for bipolar logic gates, are expected to increase in 1981.

- The semiconductor industry has had no major layoffs this year, in contrast to the 1970-71 and 1974-75 recessions when the industry reduced employment by 25 to 30 percent. This indicates the industry is operating close to capacity.

- The U.S. economy appears to have bottomed out and is on a path of slow improvement.

  — Retail sales have been rising for the last four months.

  — The Index of Leading Indicators and housing starts have both improved during the last three months.

  — Industrial production increased in August, and early indications show a continued increase in September.

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A stronger economy should give U.S. industry the confidence to maintain and increase capital expenditures for electronic equipment, although weakness in the European economy is expected to continue for two or three more quarters. Nearly all inputs appear to be consistent. The inputs reinforce DATAQUEST's beliefs that semiconductor bookings will continue to improve, that shipments will begin to show growth around year end, and that the industry growth rate will accelerate throughout 1981.

Frederick L. Zieber
Daniel L. Klesken
James F. Riley

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Vol. I, 2.8.1

MOS MICROPROCESSOR SHIPMENTS

SUMMARY

Worldwide shipments of MOS microprocessors continued their strong growth in the second quarter of 1980. Unit shipments were up about 19 percent over the first quarter of 1980 to an estimated 37.4 million units. On a year-to-year comparison, worldwide shipments in the second quarter of 1980 were up about 137 percent over shipments in the same quarter of 1979.

Microprocessor prices eased somewhat in the second quarter of 1980 as supply caught up with—and now generally exceeds—demand in most microprocessor families. In the second quarter of 1980, 4-bit microprocessors represented about 67 percent of the total worldwide unit shipments while 8-bit and 16-bit microprocessors represented about 32 percent and 1 percent, respectively, of the total unit shipments.

Figure 1 depicts estimated quarterly microprocessor shipments, segmented by bit length. In the second quarter of 1980, worldwide shipments of 4-bit microcomputers grew an estimated 20 percent, while shipments of 8-bit microcomputers grew only 6 percent. As a result, microcomputers represented 82 percent of the total worldwide microprocessor shipments in the second quarter of 1980, compared with 83 percent of the total in the first quarter.

DATAQUEST's estimates for worldwide microprocessor Central Processor Unit (CPU) shipments for the second quarter of 1980 are presented in Table 1. Our estimates refer to microprocessor CPU units only and do not include I/O or peripheral chips.

4-Bit Products

Table 2 presents DATAQUEST's estimates of worldwide shipments of 4-bit microcomputers. In the second quarter of 1980, estimated shipments of 4-bit microcomputers were 25.2 million units, up about 20 percent over estimated first quarter 1980 shipments of 21.1 million units and about 146 percent over estimated second quarter 1979 shipments of 10.2 million units. Despite some softening of demand for microcomputers in the consumer segment, especially in the Far East, 4-bit microcomputers experienced good growth in the second quarter.

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Table 3 presents DATAQUEST's estimates of worldwide shipments of 4-bit microprocessors. Note the change in format from earlier newsletters in which the 4-bit microprocessor table included all 4-bit microcomputers as well as microprocessors. These older products experienced no growth in the second quarter and are actually expected to decline in coming quarters as the current shipments are going only into older existing designs. No new designs are expected for these products.

8-Bit Products

Table 4 presents DATAQUEST's estimates of worldwide shipments of 8-bit microcomputers. In the second quarter of 1980, an estimated 5.3 million units of the 8-bit microcomputers were shipped, up only 6 percent over an estimated 5.1 million units shipped in the first quarter of 1980. The quarterly percentage gain in unit shipments of 8-bit microcomputers is notably less than the 20 percent gain in unit shipments of 4-bit microcomputers. This anomaly in the data is not readily explainable other than to note that apparently there was a much stronger demand for the lower-priced 4-bit products than for the higher-priced 8-bit products.

The majority of these microcomputers are masked ROM products whose lead times are governed by the turn-around time of the masking operation. In most cases these lead times are in the 15- to 20-week range. The only exception to these long lead times is the EPROM version used in limited quantities for product development. The EPROM versions generally are available off the shelf or within three to four weeks.

Table 5 presents DATAQUEST's estimates of worldwide shipments of 8-bit microprocessors. Note the change in format from earlier newsletters in which the 8-bit microprocessor table included all 8-bit microcomputers as well as microprocessors. Second quarter 8-bit microprocessor shipments of 6.5 million units were up about 29 percent over first quarter 1980 shipments. Although these products generally are more mature than the 8-bit microcomputers, a few of them showed surprising strength in the second quarter. Some of this strength can be attributed to major contract shipments which distort the figures for one quarter. A similar large gain is not expected in the third quarter.

12-Bit Products

There has not been a new product family or supplier in the 12-bit product arena for several years now, and none is expected. The quarterly shipments of 12-bit microprocessors, shown in Table 6, were an estimated 14,000 units in the second quarter, up slightly from an estimated 13,000 in the first quarter.

16-Bit Products

Worldwide shipments of 16-bit microprocessors during the second quarter of 1980, shown in Table 7, were an estimated 289,000 units, up about 25 percent over estimated first quarter 1980 shipments. Pricing on most 16-bit microprocessors declined during the second quarter as availability continued to improve.

The TMS 9900 and 8086 microprocessors have now been on the market long enough for some of their early designs to move into production. This is reflected in the substantial quarter-to-quarter unit gains for these products. The design cycle is typically about 18 to 24 months for most 16-bit applications. The newer 16-bit products have been available for only 4 or 5 quarters, hence the quarter-to-quarter unit growth for these products more closely follows a typical sampling and development cycle.

Multi-Sourced Microprocessor Families

Figure 2 compares the estimated total quarterly shipments of the major multi-sourced 8-bit microprocessors by all suppliers. The continued strong growth of the 8048, 6500, and Z-80 product families is evident from the graph. Some of the more mature 8-bit microprocessor families are experiencing lower quarter-to-quarter shipments growth.

Additional Microprocessor Products

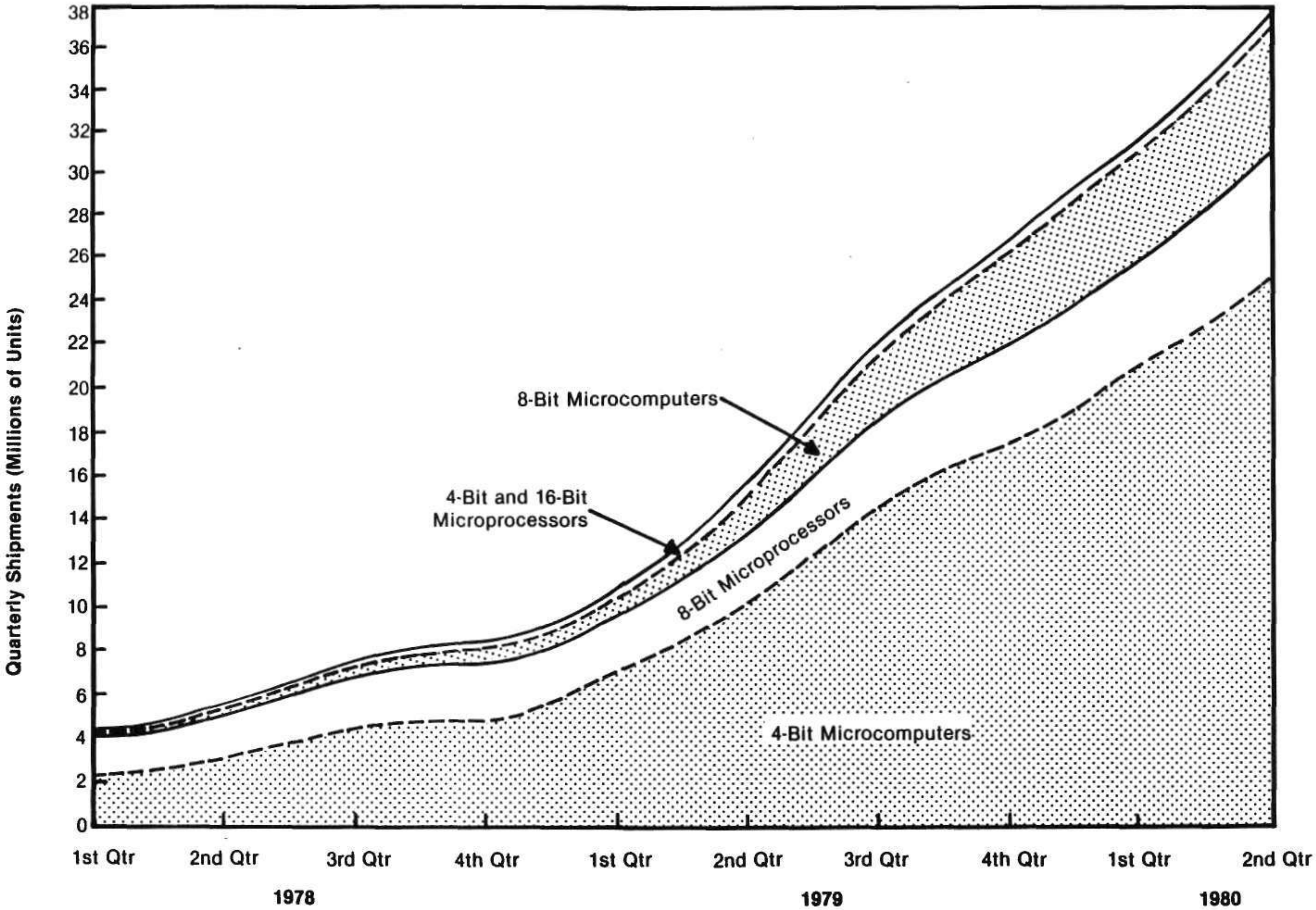
DATAQUEST is aware of the fact that Fujitsu, Sharp, and Toshiba have been shipping microprocessors into the Japanese market for some time. Each of these suppliers is now beginning to ship microprocessor products into the United States. Estimates of the quantities shipped are not available, but as they become available they will be added to this newsletter.

Products available from Fujitsu include the 8850, a 4-bit CMOS microcomputer; Sharp is offering the SM-4, SM-5, both 4-bit CMOS microcomputers, and the Z-80; and Toshiba is offering the TLCS-43, the TLCS-46 (4-bit NMOS and CMOS microcomputers, respectively), as well as the 8048, 8049, and 8085. We understand that Oki also will soon be offering microprocessors in the U.S. market.

Daniel L. Klesken
Lane Mason

Figure 1

ESTIMATED WORLDWIDE MICROPROCESSOR AND MICROCOMPUTER SHIPMENTS



Source: DATAQUEST, Inc.

TABLE 1
ESTIMATED WORLDWIDE SHIPMENTS OF MOS MICROPROCESSORS
(THOUSANDS OF UNITS)

COMPANY	PRODUCTS	BITS	MOS PROCESS	1978 TOTAL	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 TOTAL	1980 1ST QTR	1980 2ND QTR
AMD	8080A	8	N	435	135	325	335	285	1080	235	185
	8085	8	N	5	15	40	75	70	200	60	100
	8048	8	N	0	0	S	3	20	23	5	38
	Z8000	16	N	0	0	0	0	S	S	1	1
AMI	S2000	4	N	29	50	300	675	400	1425	180	340
	6800	8	N	130	35	30	30	40	135	45	60
	6802/6808	8	N	0	S	10	10	30	50	40	50
	9900	16	N	0	0	0	S	5	5	5	5
EFCIS	6800	8	N	0	8	10	12	15	45	18	20
	6802	8	N	0	0	0	0	0	0	2	5
FAIRCHILD	F8	8	N	630	150	150	180	170	650	170	150
	3870	8	N	23	40	50	120	300	510	345	380
	6800	8	N	210	35	35	40	40	150	30	30
	6802/6808	8	N	S	S	S	15	30	45	54	90
GENERAL INSTRUMENT	PIC-1650	8	N	450	300	950	1250	1600	4100	1700	1700
	CP-1600	16	N	60	15	20	20	25	80	30	40
HARRIS	6100	12	C	22	7	7	7	7	28	8	9
HITACHI	HMCS-40	4	C,P	410	130	150	175	200	655	225	300
	6800	8	N	70	50	100	125	150	425	200	300
HUGHES	1802	8	C	35	12	14	18	22	66	35	45
INTEL	4004	4	P	159	35	32	28	25	120	20	25
	8008	8	P	103	20	18	15	12	65	10	7
	8080A	8	N	705	190	200	210	180	780	200	200
	8021/8022	8	N	S	10	20	50	80	160	110	200
	8048	8	N	480	190	390	570	800	1950	1000	1000
	8049	8	N	10	20	30	60	100	210	140	175
	8748	8	N	30	50	75	75	100	300	125	160
	8085	8	N	350	175	260	300	350	1085	400	475
	8086	16	N	24	13	15	19	25	72	32	60
	8088	8	N	0	0	0	0	0	0	2	5
INTERSIL	6100	12	C	15	4	4	5	5	18	5	5
MATSUSHITA (PANASONIC)	MN1400	4	N,C&P	N/A	500	800	1400	1700	4400	2200	3000
MOS TECHNOLOGY	6500	8	N	225	65	70	80	90	305	250	300
MOSTEK	F8	8	N	160	90	125	125	130	470	55	70
	Z80	8	N	260	100	120	125	170	515	215	400
	3870	8	N	350	260	300	425	485	1470	530	570
MOTOROLA	141000	4	C	20	30	75	90	90	285	70	50
	6800	8	N	570	165	175	215	205	760	200	225
	6801/6803	8	N	0	0	S	3	10	13	15	35
	6802/6808	8	N	180	150	240	275	325	990	325	490
	6805	8	N	0	0	0	S	3	3	10	50
	6809	8	N	0	S	2	8	10	20	25	35
	3870	8	N	70	80	125	125	170	500	150	150
	68000	16	N	0	0	0	S	3	3	4	5

(CONT'D)

TABLE 1(CONT'D)
ESTIMATED WORLDWIDE SHIPMENTS OF MOS MICROPROCESSORS
(THOUSANDS OF UNITS)

COMPANY	PRODUCTS	BITS	MOS PROCESS	1978 TOTAL	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 TOTAL	1980 1ST QTR	1980 2ND QTR
NATIONAL	COPS	4	N,C	2325	900	1100	1500	2100	5600	2700	3100
	4004	4	P	130	30	26	20	15	91	12	9
	IMP	4	P	80	18	15	15	15	63	14	12
	8080A	8	N	375	150	175	220	240	785	250	250
	8048	8	N	0	0	0	0	S	S	S	5
	8049	8	N	0	0	0	S	10	10	25	40
	8050	8	N	0	0	0	0	S	S	5	10
	8070	8	N	0	0	0	0	S	S	S	5
	SC/MP	8	N	335	100	140	160	175	575	175	175
	PACE	16	N	86	25	25	25	25	100	22	18
NEC	UCOM-4	4	N,C&P	1500	1100	1300	2300	3100	7800	3300	4200
	8080A	8	N	305	65	90	105	100	360	135	170
	8021	8	N	0	0	0	0	0	0	0	S
	8048	8	N	15	25	160	250	300	735	610	470
	8049	8	N	0	0	S	100	150	250	200	250
	8085	8	N	30	55	75	120	150	400	240	275
	Z80	8	N	30	80	80	60	40	260	80	75
	768	16	N	0	0	0	0	S	S	S	S
PHILIPS/MULLARD	2650	8	N	0	0	0	0	S	S	5	20
	8048	8	N	0	0	0	0	S	S	2	5
RCA	1802	8	C	325	115	115	125	135	490	250	330
ROCKWELL	PPS-4	4	P	2275	600	1100	1100	1100	3900	1400	1700
	6500	8	N	595	50	60	60	60	230	65	450
	6500/1	8	N	0	0	S	3	5	8	8	15
SGS-ATES	Z80	8	N	S	5	15	25	35	80	40	50
	3870	8	N	S	5	10	15	20	50	20	25
SIEMENS	8080A	8	N	0	3	10	25	40	78	40	25
	8085	8	N	0	0	0	5	10	15	20	25
SIGNETICS	2650	8	N	125	45	90	110	110	355	115	115
	8048	8	N	S	15	30	60	75	180	60	60
SOLID STATE SCI	1802	8	C	12	10	11	12	10	43	0	0
SYNERTEK	6500	8	N	680	100	120	280	300	800	500	600
TEXAS INSTRUMENTS	TMS 1000	4	C,P	9400	4200	5400	7500	9000	26100	11000	12500
	TMS 8080A	8	N	135	32	25	18	5	80	0	0
	TMS 9900/9980	16	N	185	68	80	92	105	345	120	140
	TMS 9940	16	N	0	0	0	0	5	5	10	15
ZILOG	Z8	8	N	0	0	0	0	S	S	S	3
	Z80	8	N	550	195	250	375	450	1270	550	700
	Z8000	16	N	0	0	1	2	4	7	7	5
TOTAL MICROPROCESSORS				25713	11120	15770	21975	26366	75231	31461	37387
PERCENT CHANGE FROM PREVIOUS QUARTER					33.4	41.8	39.3	20.0		19.3	18.8

SOURCE: DATAQUEST, INC.
OCTOBER, 1980

TABLE 2
ESTIMATED WORLDWIDE SHIPMENTS OF 4-BIT MICROCOMPUTERS
(THOUSANDS OF UNITS)

			1979					1980	
COMPANY	*PRODUCTS*	1978 *TOTAL*	*1ST QTR*	*2ND QTR*	*3RD QTR*	*4TH QTR*	1979 *TOTAL*	*1ST QTR*	*2ND QTR*
AMI	*S*2000	29	50	300	675	400	1425	180	340
HITACHI	*HMCS*-40	410	130	150	175	200	655	225	300
MATSUSHITA (PANASONIC)	*MN*1400	*N/A*	500	800	1400	1700	4400	2200	3000
MOTOROLA	141000	20	30	75	90	90	285	70	50
NATIONAL	*COPS*	2325	900	1100	1500	2100	5600	2700	3100
NEC	*UCOM*-4	1500	1100	1300	2300	3100	7800	3300	4200
ROCKWELL	*PPS*-4	2275	600	1100	1100	1100	3900	1400	1700
TEXAS INSTRUMENTS	*TMS* 1000	9400	4200	5400	7500	9000	26100	11000	12500
TOTAL MICROCOMPUTERS		15959	7510	10225	14740	17690	50165	21075	25190
PERCENT CHANGE FROM PREVIOUS QUARTER			37.9	36.2	44.2	20.0		19.1	19.5

SOURCE: DATAQUEST, INC.
OCTOBER, 1980

TABLE 3
ESTIMATED WORLDWIDE SHIPMENTS OF 4-BIT MICROPROCESSORS
(THOUSANDS OF UNITS)

			1979					1980	
COMPANY	*PRODUCTS*	1978 *TOTAL*	*1ST QTR*	*2ND QTR*	*3RD QTR*	*4TH QTR*	1979 *TOTAL*	*1ST QTR*	*2ND QTR*
INTEL	4004	159	35	32	28	25	120	20	25
NATIONAL	4004	130	30	26	20	15	91	12	9
	IMP	80	18	15	15	15	63	14	12
TOTAL MICROPROCESSORS		369	83	73	63	55	274	46	46
PERCENT CHANGE FROM PREVIOUS QUARTER			(2.4)	(12.0)	(13.7)	(12.7)		(16.4)	0.0

SOURCE: DATAQUEST, INC.
OCTOBER, 1980

TABLE 4
ESTIMATED WORLDWIDE SHIPMENTS OF 8-BIT MICROCOMPUTERS
(THOUSANDS OF UNITS)

			1979					1980	
COMPANY	PRODUCTS	1978 TOTAL	1ST QTR	2ND QTR	3RD QTR	4TH QTR	1979 TOTAL	1ST QTR	2ND QTR
AMD	8048	0	0	S	3	20	23	5	38
FAIRCHILD	3870	23	40	50	120	300	510	345	380
GENERAL INSTRUMENT	PIC-1650	450	300	950	1250	1600	4100	1700	1700
INTEL	8021/8022	S	10	20	50	80	160	110	200
	8048	480	190	390	570	800	1950	1000	1000
	8049	10	20	30	60	100	210	140	175
	8748	30	50	75	75	100	300	125	160
MOSTEK	3870	350	260	300	425	485	1470	530	570
MOTOROLA	6801/6803	0	0	S	3	10	13	15	35
	6805	0	0	0	S	3	3	10	50
	3870	70	80	125	125	170	500	150	150
NATIONAL	8048	0	0	0	0	S	S	S	5
	8049	0	0	0	S	10	10	25	40
	8050	0	0	0	0	S	S	5	10
	8070	0	0	0	0	S	S	S	5
NEC	8021	0	0	0	0	0	0	0	S
	8048	15	25	160	250	300	735	610	470
	8049	0	0	S	100	150	250	200	250
PHILIPS/MULLARD	8048	0	0	0	0	S	S	2	5
ROCKWELL	6500/1	0	0	S	3	5	8	8	15
SGS-ATES	3870	S	5	10	15	20	50	20	25
SIGNETICS	8048	S	15	30	60	75	180	60	60
ZILOG	Z8	0	0	0	0	S	S	S	3
TOTAL MICROCOMPUTERS		1428	995	2140	3109	4228	10472	5060	5346
PERCENT CHANGE FROM PREVIOUS QUARTER			53.1	115.1	45.3	36.0		19.7	5.7

SOURCE: DATAQUEST, INC
OCTOBER, 1980

TABLE 5

ESTIMATED WORLDWIDE SHIPMENTS OF 8-BIT MICROPROCESSORS

(THOUSANDS OF UNITS)

			1979					1980	
COMPANY	PRODUCTS	1978 TOTAL	1ST QTR	2ND QTR	3RD QTR	4TH QTR	1979 TOTAL	1ST QTR	2ND QTR
AMD	8080A	435	135	325	335	285	1080	235	185
	8085	5	15	40	75	70	200	60	100
AMI	6800	130	35	30	30	40	135	45	60
	6802/6808	0	S	10	10	30	50	40	50
EFCIS	6800	0	8	10	12	15	45	18	20
	6802	0	0	0	0	0	0	2	5
FAIRCHILD	F8	630	150	150	180	170	650	170	150
	6800	210	35	35	40	40	150	30	30
	6802/6808	S	S	S	15	30	45	54	90
HITACHI	6800	70	50	100	125	150	425	200	300
HUGHES	1802	35	12	14	18	22	66	35	45
INTEL	8008	103	20	18	15	12	65	10	7
	8080A	705	190	200	210	180	780	200	200
	8085	350	175	260	300	350	1085	400	475
	8088	0	0	0	0	0	0	2	5
MOS TECHNOLOGY	6500	225	65	70	80	90	305	250	300
MOSTEK	F8	160	90	125	125	130	470	55	70
	Z80	260	100	120	125	170	515	215	400
MOTOROLA	6800	570	165	175	215	205	760	200	225
	6802/6808	180	150	240	275	325	990	325	490
	6809	0	S	2	8	10	20	25	35
NATIONAL	8080A	375	150	175	220	240	785	250	250
	SC/MP	335	100	140	160	175	575	175	175
NEC	8080A	305	65	90	105	100	360	135	170
	8085	30	55	75	120	150	400	240	275
	Z80	30	80	80	60	40	260	80	75
PHILIPS/MULLARD	2650	0	0	0	0	S	S	5	20
RCA	1802	325	115	115	125	135	490	250	330
ROCKWELL	6500	595	50	60	60	60	230	65	450
SGS-ATES	Z80	S	5	15	25	35	80	40	50
SIEMENS	8080A	0	3	10	25	40	78	40	25
	8085	0	0	0	5	10	15	20	25
SIGNETICS	2650	125	45	90	110	110	355	115	115
SOLID STATE SCI	1802	12	10	11	12	10	43	0	0
SYNERTEK	6500	680	100	120	280	300	800	500	600
TEXAS INSTRUMENTS	TMS 8080A	135	32	25	18	5	80	0	0
ZILOG	Z80	550	195	250	375	450	1270	550	700
TOTAL MICROPROCESSORS		7565	2400	3180	3893	4184	13657	5036	6502
PERCENT CHANGE FROM PREVIOUS QUARTER			17.7	32.5	22.4	7.5		20.4	29.1

SOURCE: DATAQUEST, INC.
OCTOBER, 1980

TABLE 6
ESTIMATED WORLDWIDE SHIPMENTS OF 12-BIT MICROPROCESSORS
(THOUSANDS OF UNITS)

			1979					1980	
COMPANY	*PRODUCTS*	1978 *TOTAL*	*1ST QTR*	*2ND QTR*	*3RD QTR*	*4TH QTR*	1979 *TOTAL*	*1ST QTR*	*2ND QTR*
HARRIS	6100	22	7	7	7	7	28	8	9
INTERSIL	6100	15	4	4	5	5	18	5	5
TOTAL MICROPROCESSORS		37	11	11	12	12	46	13	14
PERCENT CHANGE FROM PREVIOUS QUARTER			0.0	0.0	9.1	0.0		8.3	7.7

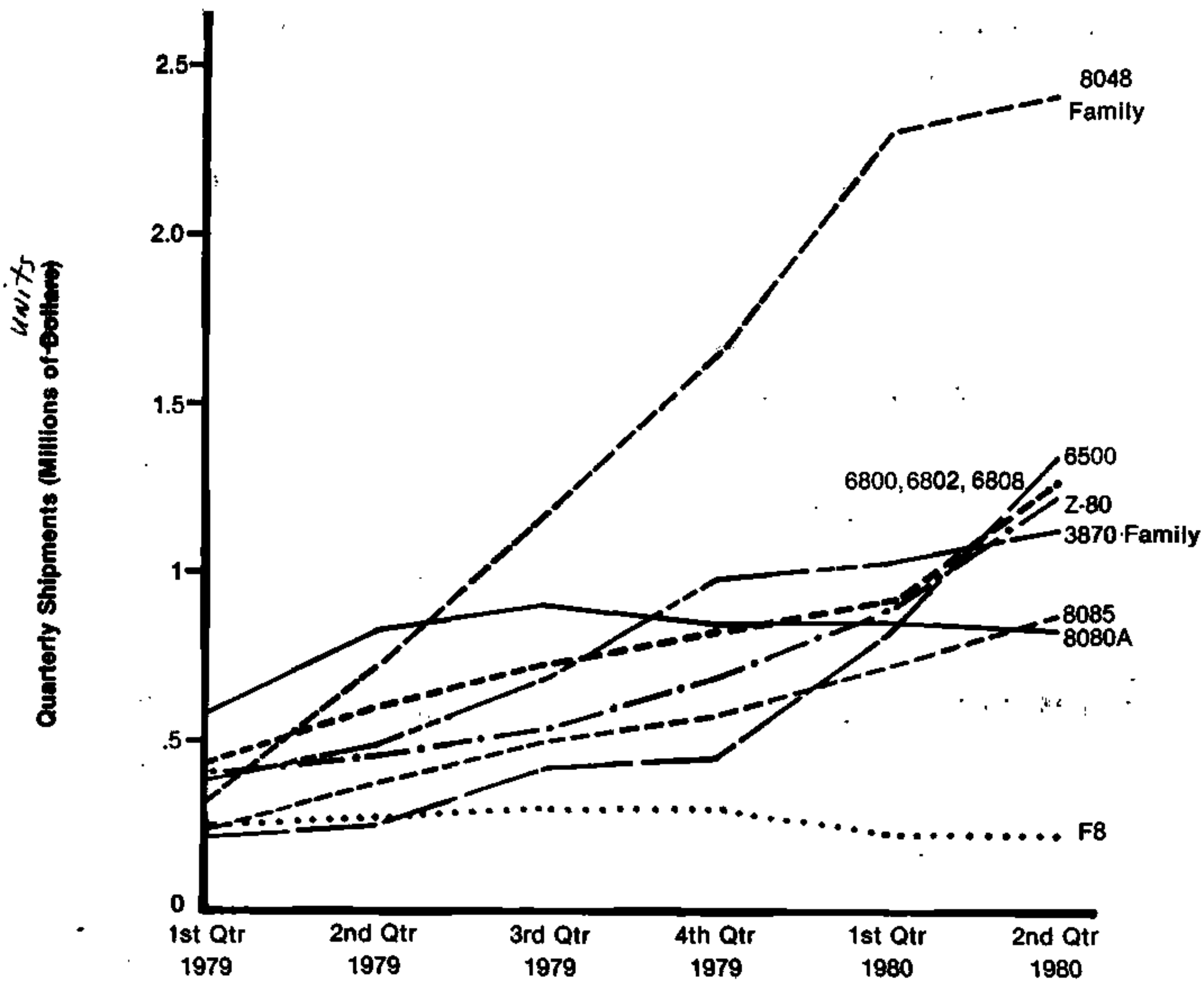
SOURCE: DATAQUEST, INC.
OCTOBER, 1980

TABLE 7
ESTIMATED WORLDWIDE SHIPMENTS OF 16-BIT MICROPROCESSORS
(THOUSANDS OF UNITS)

			1979					1980	
COMPANY	*PRODUCTS*	1978 *TOTAL*	*1ST QTR*	*2ND QTR*	*3RD QTR*	*4TH QTR*	1979 *TOTAL*	*1ST QTR*	*2ND QTR*
AMD	Z8000	0	0	0	0	*S*	*S*	1	1
AMI	9900	0	0	0	*S*	5	5	5	5
GENERAL INSTRUMENT	*CP*-1600	60	15	20	20	25	80	30	40
INTEL	8086	24	13	15	19	25	72	32	60
MOTOROLA	68000	0	0	0	*S*	3	3	4	5
NATIONAL	*PACE*	86	25	25	25	25	100	22	18
NEC	768	0	0	0	0	*S*	*S*	*S*	*S*
TEXAS INSTRUMENTS	*TMS* 9900/9980	185	68	80	92	105	345	120	140
	TMS 9940	0	0	0	0	5	5	10	15
ZILOG	Z8000	0	0	1	2	4	7	7	5
TOTAL MICROPROCESSORS		355	121	141	158	197	617	231	289
PERCENT CHANGE FROM PREVIOUS QUARTER			14.2	16.5	12.1	24.7		17.3	25.1

SOURCE: DATAQUEST, INC.
OCTOBER, 1980

Figure 2
ESTIMATED WORLDWIDE SHIPMENTS OF MULTISOURCED MICROPROCESSORS



Source: DATAQUEST, Inc.

DATAQUEST RESEARCH NEWSLETTER
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CORRECTIONS TO NEWSLETTER "DYNAMIC AND STATIC MOS RAM AND EPROM SHIPMENTS"

SUMMARY

This brief newsletter corrects two errors that appeared in the DATAQUEST Semiconductor Industry Service Newsletter dated September 19, 1980.

Dynamic MOS RAMs

32K RAMs

The newsletter indicated that Mostek shipped an estimated 200,000 units in the second quarter of 1980 at prices in the range of $8.00 to $10.00. The correct price was in excess of $15.00.

MOS EPROMs

64K EPROMs

The newsletter indicated that Texas Instruments was the sole supplier of 64K EPROMs in the second quarter. The correct statement is that Motorola and Texas Instruments were the only suppliers sampling the 64K EPROM in the second quarter of 1980. Motorola and Texas Instruments shipped an estimated 1,000 and 3,000 units respectively in the second quarter.

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APPENDIX B MARKET SHARE ESTIMATES

DATAQUEST's Semiconductor Industry Service has recently completed the final version of Appendix B - Market Share Estimates, which can be found in Volume III of the SIS notebooks. This 32-page Appendix update analyzes semiconductor markets through estimation of market share by manufacturer. Please see the SIS notebook holder in your location for more details.

Appendix B follows all semiconductor product segments chronologically and divides the merchant semiconductor market among 50 U.S. companies, 7 European companies, 8 Japanese companies, and Rest-of-World (ROW) companies.

Worldwide Semiconductor Market Share Estimates

Worldwide semiconductor market share estimates segmented by geographical region, are shown in Figure 1 for the years 1974 through 1979. The worldwide semiconductor market grew at a compound annual rate of 15.5 percent between 1974 and 1979. Semiconductor shipments by U.S.-based companies, which grew at 15.4 percent, were very close to the industry growth rate, while Japanese company shipments grew faster (19.8 percent) and European company shipments grew more slowly (10.4 percent).

The U.S. companies' percent of market has remained at approximately 62 percent of total factory shipments between 1974 and 1979 while the Japanese shipments have grown from 21 percent in 1974 to 25 percent in 1979. European factory shipments have decreased from 16 percent of total factory shipments in 1974 to 13 percent in 1979.

Estimates of total semiconductor revenues for over 65 merchant market semiconductor suppliers can be found in Appendix B for the years 1974 through 1979. Included are U.S companies, as well as European, Japanese, and Rest-of-World companies. The growth rates for specific companies can be calculated from the data presented and compared against one another, against industry averages, or against regional factory shipments' growth.

The totals given for U.S. companies reflect worldwide production. For example, Texas Instruments manufactures semiconductors in many parts of the world; however, its entire production is included under the U.S. companies' market share section. In contrast, foreign-owned subsidiaries such as FMC, Litronix, and Signetics, are included in the U.S. total market, not in the total of the parent company location. This inconsistency occurs because most foreign-owned subsidiaries in the United States maintain their own identity and do not always carry the name of their parent company.

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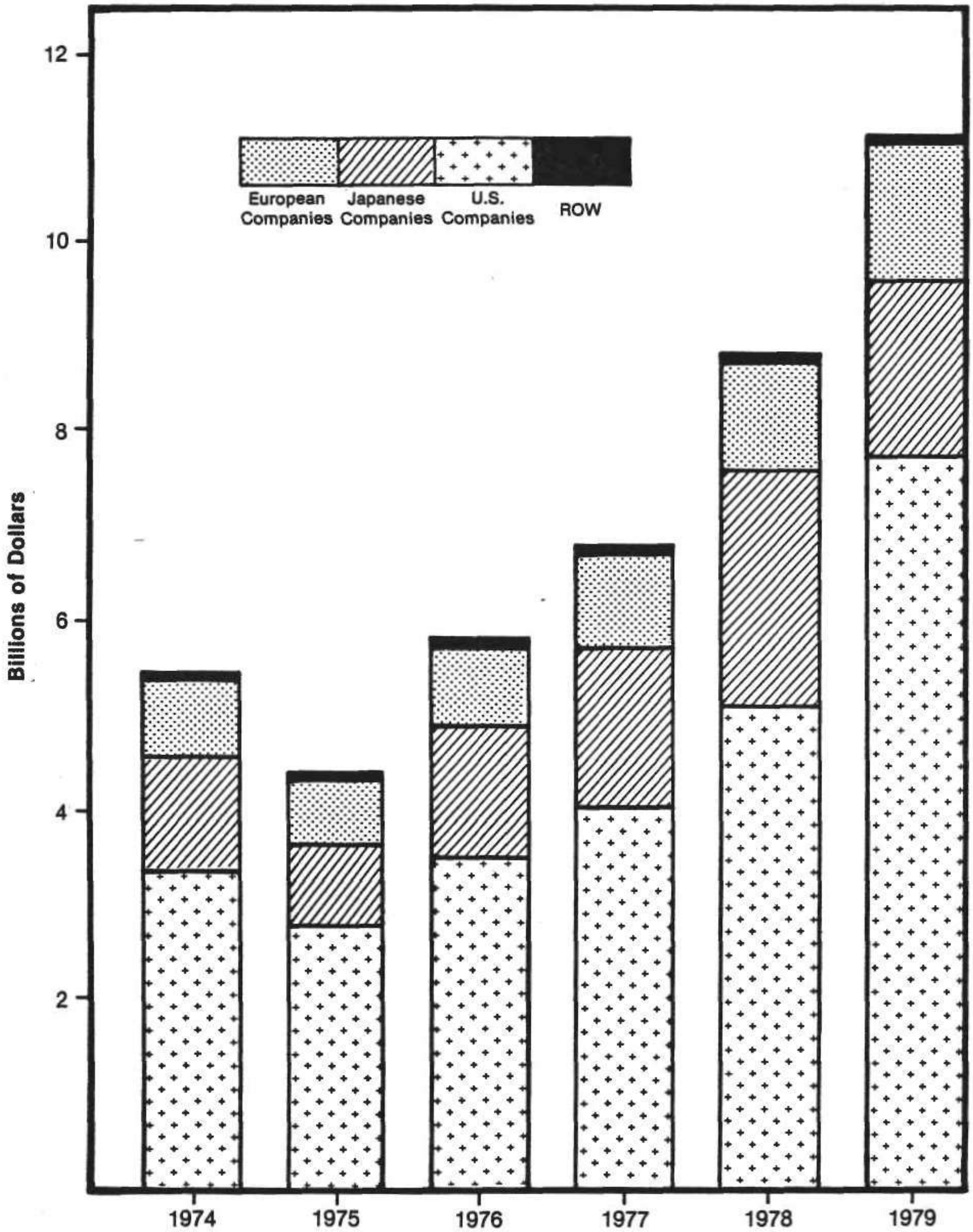
Figure 1
TOTAL SEMICONDUCTOR MARKET SHARE ESTIMATES



Source: DATAQUEST, Inc.

Worldwide Integrated Circuit Market Share Estimates

Figure 2 presents the DATAQUEST estimates of worldwide integrated circuit market shares segmented by geographical region for the years 1974 through 1979. The compound annual growth rate for total integrated circuit shipments between 1974 and 1979 was 23 percent. During this period, U.S. factory shipments grew only 21 percent while European and Japanese shipments grew 24 percent and 34 percent respectively. IC shipments by U.S. companies represented 75 percent of the total integrated shipments in 1974, and 68 percent of the total in 1979. IC shipments by European companies represented 8.5 percent of total IC shipments in both 1974 and 1979 while Japanese companies increased their percent of total IC factory shipments from 15 percent in 1974, to 23 percent of the total in 1979. The Rest-of-World companies representing the remaining percent of total IC factory shipments decreased from just above one percent in 1974 to just below one percent in 1979.

Appendix B presents the integrated circuit market share estimates for over 50 U.S., European, and Japanese companies, as well as breaking the IC market down into Bipolar Digital, MOS, and Linear market shares. Bipolar Digital is further segmented in TTL, DTL, ECL, and Other.

Worldwide Discrete/Optoelectronic Market Share Estimates

Figure 3 presents DATAQUEST's estimates of the worldwide discrete plus optoelectronics market share estimates for 1974 through 1979 by geographical region. Unlike Appendix B which presents discrete devices and optoelectronic devices separately, Figure 3 includes optoelectronic revenues with discrete revenues. This combined product segment has experienced a compound annual growth of 6.6 percent between 1974 and 1979. U.S. companies experienced similar growth with factory shipments growing at 6.4 percent. Between 1974 and 1979, European discrete shipments only grew 4.7 percent per year, while Japanese shipments' growth outperformed the industry at an 8.5 percent rate.

The U.S. companies' discrete market share remained constant at 51 percent of total discrete factory shipments. European companies' market share during these years declined from 23 percent to 21 percent. The Japanese companies estimated market share increased from 26 percent of the total discrete-plus-opto shipments in 1974, to 28 percent of the total in 1979.

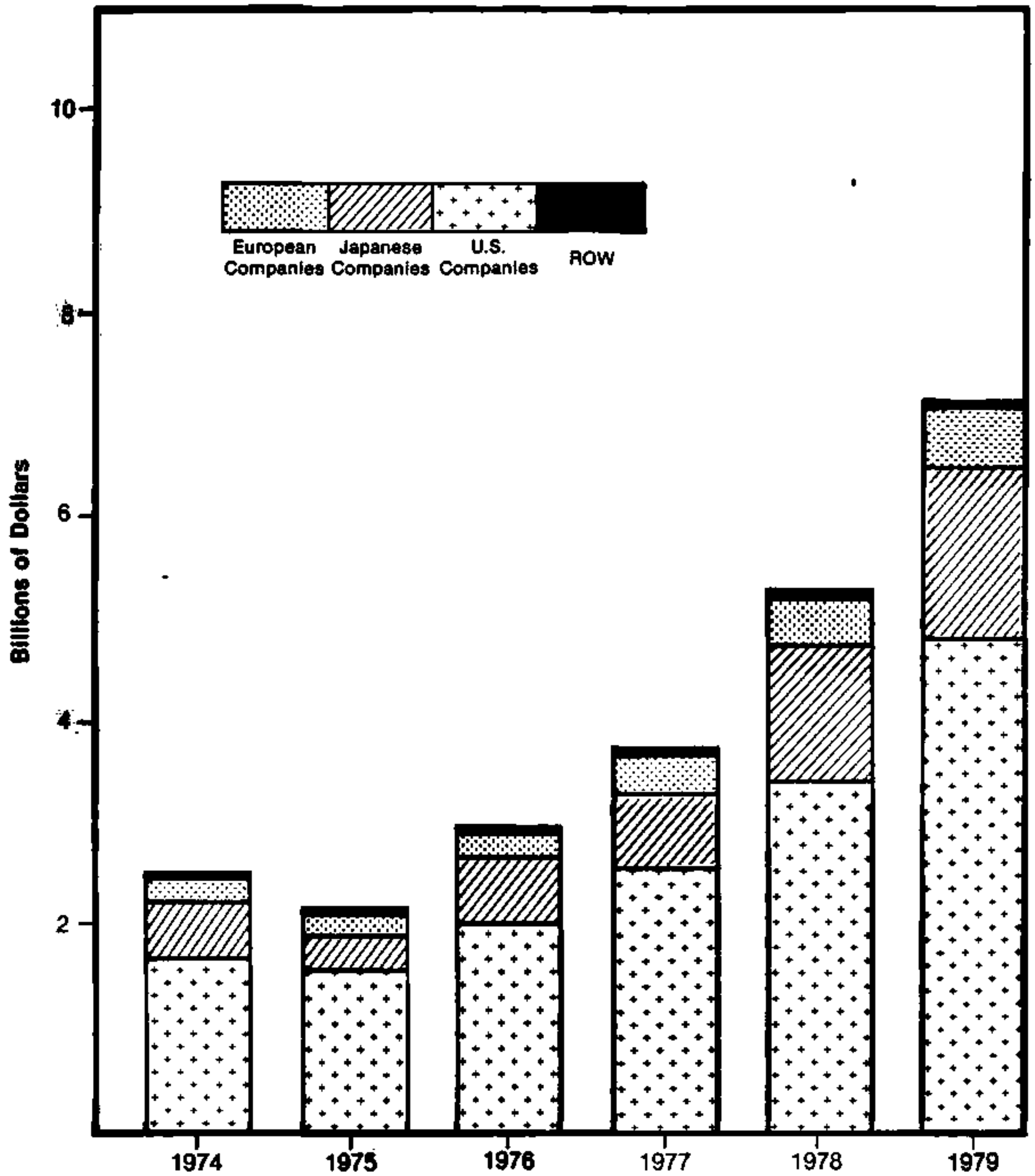
The discrete market share tables of Appendix B provide market share estimates for over 30 U.S., European, and Japanese companies. The discrete market is segmented into Transistor, Diode, Thyristor, and Other. The diode market is further segmented into Small Signal, Power, and Zener Diodes, while transistors are segmented into Small Signal and Power Devices. The optoelectronics market is segmented into LED Lamps, LED Displays, Optical Couplers, and Other.

Value of Appendix B Market Share Estimates

Semiconductor Suppliers

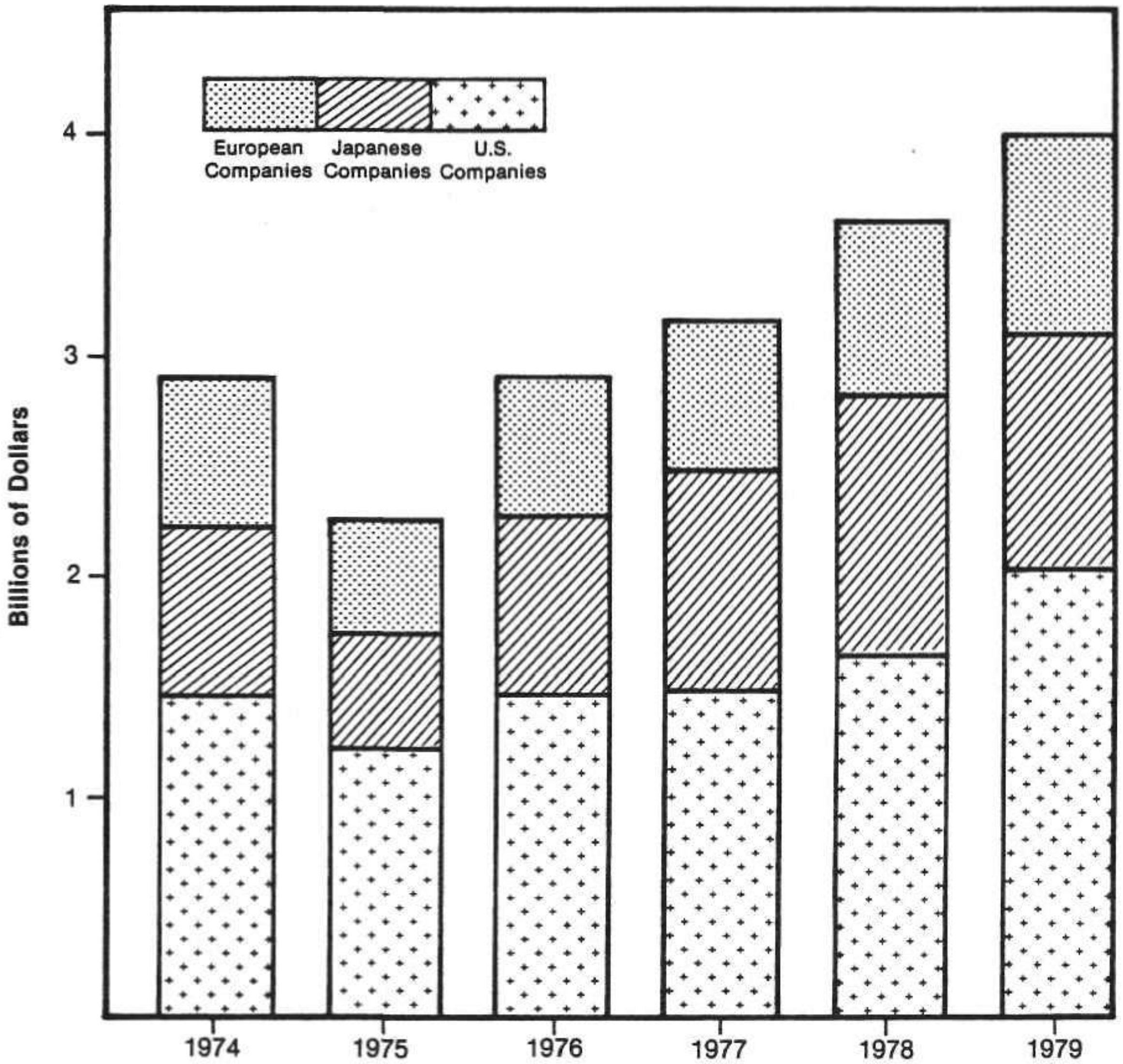
Appendix B is a valuable asset to semiconductor suppliers as it enables semiconductor manufacturers to assess their activity and potential in a particular

Figure 2
TOTAL INTEGRATED CIRCUIT MARKET SHARE ESTIMATES



Source: DATAQUEST, Inc.

Figure 3
TOTAL DISCRETE/OPTOELECTRONIC MARKET SHARE ESTIMATES



Source: DATAQUEST, Inc.

market segment by looking at their market share compared to that of their competitors; what other product areas their competitors are involved in; the scope of their competitors' activities; and the feasibility of entering foreign markets, based on the number and sizes of the competitors in those markets.

Semiconductor Users

Semiconductor users find Appendix B useful in identifying the suppliers within a given product segment as well as in ranking their relative size. It is important for users to understand how their suppliers rank in the market, as well as against one another. Large users also can determine the fraction of their vendor's output they are consuming.

Equipment Suppliers

Equipment suppliers serving the semiconductor industry find Appendix B is a valuable reference. Since semiconductor markets are highly specific with respect to equipment, it is beneficial to know exactly to what degree their customers are involved in a particular market. It also provides a list of potential buyers for a given type of equipment associated with product segments. The growth of a given market indicates the need for new manufacturing equipment. In addition, the more rapidly growing companies tend to purchase more equipment in relation to sales than the more slowly growing companies.

Material Suppliers

Material suppliers find Appendix B useful for referencing semiconductor revenues of the semiconductor manufacturers in a particular market, applying the appropriate industry standard A/S ratio (sq. in. silicon/sales dollar), and determining the subsequent square inches of silicon consumed by a company. Many other materials suppliers develop similar ratios for materials such as chemicals, gases, photoresist, masks, and indirect materials. Since Appendix B shows historic semiconductor revenues by market, trends can then be observed. Appendix B also provides names of potential customers in new geographical markets.

Electronic Distributors

Electronic distributors use Appendix B to determine the relative market position of their principals in each market. By observing the overall growth of semiconductor shipments, the semiconductor distributors can also determine their potential market shares. Appendix B also provides insight into alternate vendors and potential geographical markets.

Mary Ellen Hrouda

DATAQUEST RESEARCH NEWSLETTER
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SIS Code: Vol. I, 2.1

MARKET ESTIMATES - APPENDIX A

SUMMARY

Estimates of semiconductor consumption for 1975 through 1984 and estimates of semiconductor factory shipments for 1970 through 1979, both worldwide and by major geographical segment, were published and mailed to all notebook holders by the DATAQUEST Semiconductor Industry Service on September 8, 1980, in Appendix A - Market Estimate Worksheets. The estimates are segmented into three major categories: integrated circuits, discrete devices, and optoelectronic devices; and each category is then further subdivided.

CONSUMPTION

Worldwide semiconductor consumption, as shown in Table 1 and Figure 1, was estimated at $11,116 million for 1979 and is forecast to reach $25,926 million by 1984; a compound annual growth rate of 18.4 percent. MOS integrated circuits are the fastest-growing segment of the industry. Worldwide consumption of MOS integrated circuits was estimated at $3,430 million in 1979 and is forecast to achieve a compound annual growth rate of 26.4 percent, reaching $11,084 million in 1984. Integrated circuits are estimated to have been 64.1 percent of total semiconductor consumption in 1971 and to be more than 75 percent of the total in 1984.

Estimates for North America, Europe, and Rest of World are made directly in dollars, but estimates for Japan are first calculated in yen and then converted to dollars at the prevailing rate for each year. Because wide fluctuations in the yen/dollar exchange rate tend to distort the growth rate of the Japanese market, Japanese factory shipments and consumption estimates are expressed in dollars and also given in separate tables in Appendix A in yen. Historical estimates are given in current dollars for each year but forecasts are given in constant 1979 dollars using 1979 exchange rates.

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Table 1

ESTIMATED WORLDWIDE SEMICONDUCTOR CONSUMPTION BY DEVICE TYPE
(Millions of Dollars)

	1979	1984	CAG[1] 1979-1984
Bipolar Digital	$ 1,799	$ 4,353	19.3%
MOS	3,430	11,084	26.4%
Linear	1,897	4,019	16.2%
Integrated Circuits	$ 7,126	$19,456	22.3%
Discrete Devices	3,395	4,923	7.7%
Optoelectronic Devices	595	1,547	21.1%
Total	$11,116	$25,926	18.5%

[1]Compound Annual Growth

Source: DATAQUEST, Inc.
August 1980

FACTORY SHIPMENTS

Worldwide semiconductor factory shipments were estimated at $4,373 million in 1975, increasing to $11,116 million in 1979. The United States is the major producer of integrated circuits (ICs). In 1975 U.S. IC production accounted for 48.0 percent of all ICs, and in 1979, the U.S. IC shipments total was estimated at $5,308 million, or 47.8 percent of worldwide factory shipments. Factory shipments segmented by geographical region are shown in Table 2. Figure 2 shows factory shipments by device type and major geographical segment for 1975 and 1979.

Table 2

ESTIMATED WORLDWIDE SEMICONDUCTOR FACTORY SHIPMENTS
(Millions of Dollars)

	1975	1979	CAG[1] 1975-1979
North America	$2,119	$ 5,308	20.2%
Japan	925	2,878	25.5%
Europe	1,209	2,542	16.0%
Rest of World	120	388	26.5%
World Total	$4,373	$11,116	20.5%

[1]Compound Annual Growth

Source: DATAQUEST, Inc.
August 1980

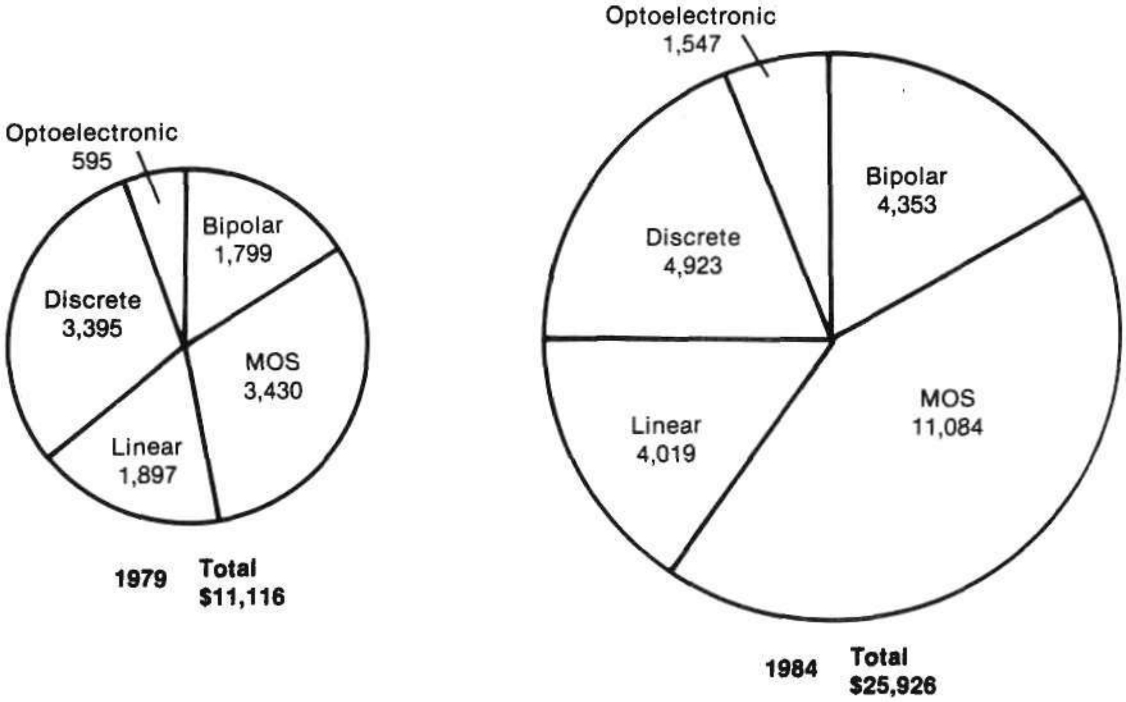
USES OF APPENDIX A

The data in Appendix A can be used in a variety of ways by those involved in different areas of the semiconductor industry. Equipment and materials manufacturers can use the forecasts in projecting the semiconductor industry's needs for materials and equipment over the next few years. Semiconductor manufacturers can use the information as a basis for production decisions, while users of semiconductors can use it to understand the expected growth rate of various product categories as well as ASP trends. Table A-11 gives a forecast of worldwide semiconductor consumption in units. Comparing the units estimate in Table A-11 with the worldwide revenues estimate in Table A-6 will show average selling price (ASP) trends.

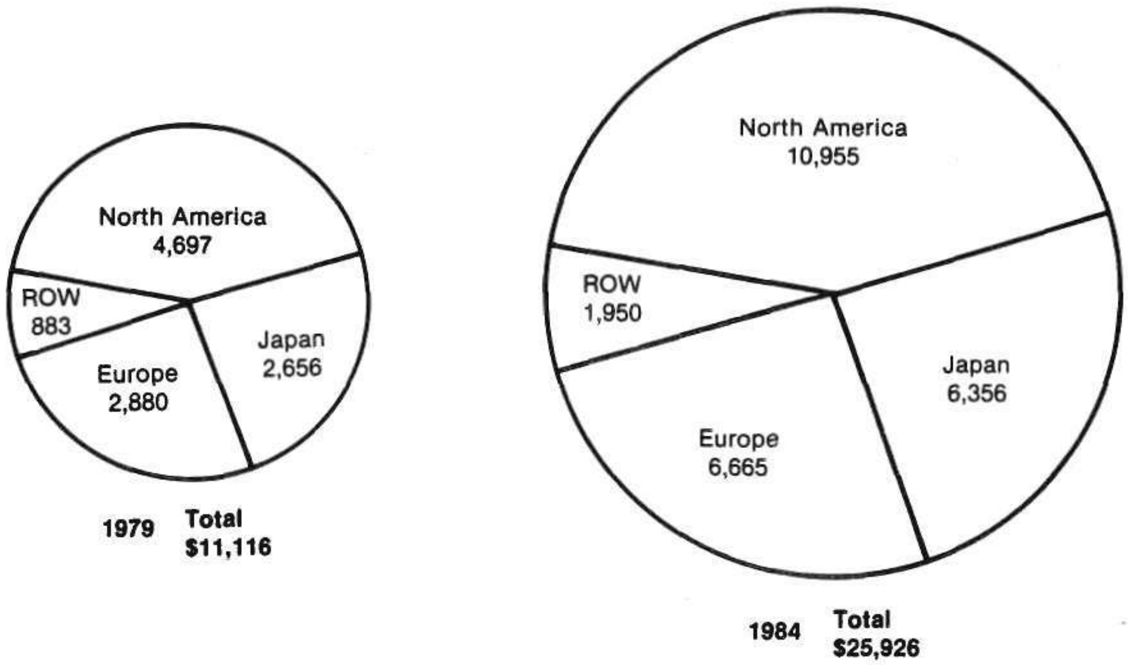
Jean Page

Figure 1

ESTIMATED SEMICONDUCTOR CONSUMPTION BY DEVICE TYPE
(Millions of Dollars)



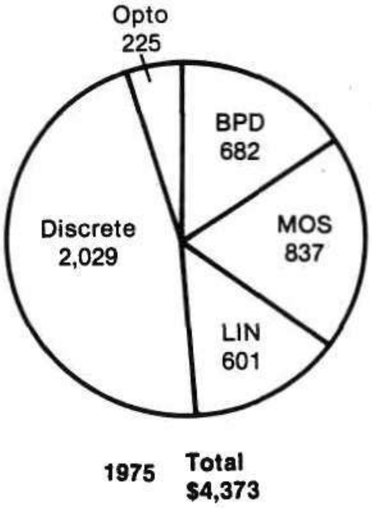
ESTIMATED SEMICONDUCTOR CONSUMPTION BY GEOGRAPHICAL REGION
(Millions of Dollars)

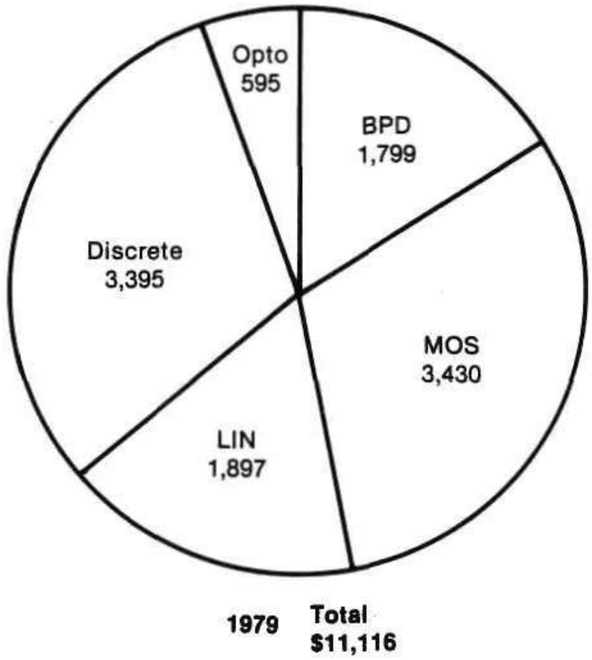


Source: DATAQUEST, Inc.

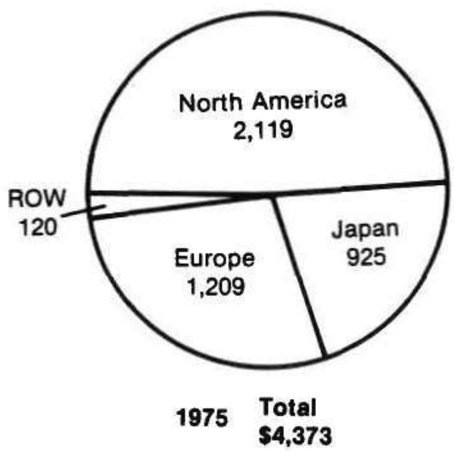
Figure 2

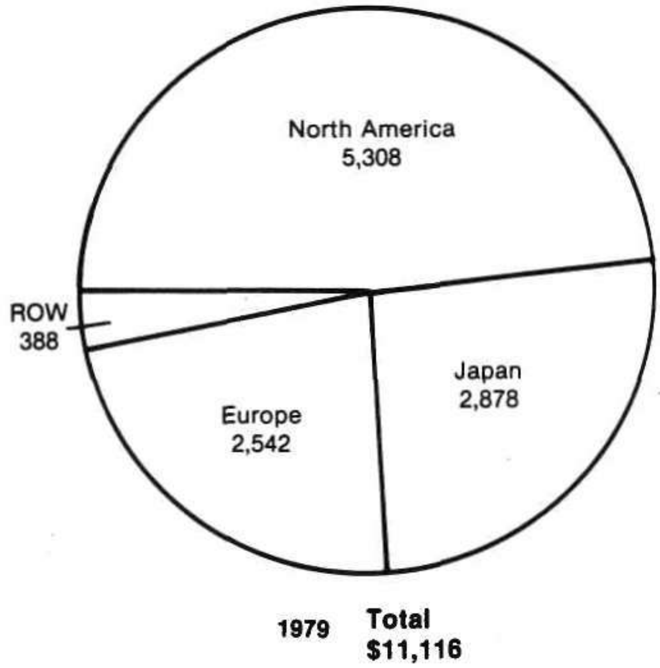
ESTIMATED SEMICONDUCTOR FACTORY SHIPMENTS BY DEVICE TYPE
(Millions of Dollars)





ESTIMATED SEMICONDUCTOR FACTORY SHIPMENTS BY GEOGRAPHICAL REGION
(Millions of Dollars)





Source: DATAQUEST, Inc.

DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

Vol. II - No. 8 September 22, 1980

This letter is a condensation of recent Research Newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific Newsletters should be directed to the author. A list of recent DATAQUEST Newsletters appears at the end of this letter.

SMALL COMPUTERS

Data General's recent announcement of a slowdown in orders that should cause sequential hardware shipments to be flat in the September and December quarters is the second disappointment in fundamentals in the last fifteen months and brings up several pertinent questions that need to be answered. Is the slowing in orders presently being experienced a company problem or the beginnings of an industry slowdown? Is the minicomputer market moving away from areas of Data General's strength? What are the near-term and long-term implications of the slowdown in growth being experienced?

In general, we believe that Data General's difficulties are basically company — not industry — related, being heavily a function of relatively poor product positioning within areas of strength and weakness in the minicomputer industry. Two somewhat simplistic statements can be made about the minicomputer industry at present: first, companies with strong 32-bit product positions are doing better than companies that are heavily concentrated in 16-bit computers; second, companies with strong end-user orientation are doing better than companies with strong OEM orientation. Data General has very high (at least 65 percent) exposure to the OEM market and has not yet shipped its first 32-bit computer; in our opinion, this explains to a great extent why the company is not growing as fast as the industry at present.

As we have previously stated, we believe that Data General's entry into the 32-bit marketplace, the MV-8000, is a very well-designed machine offering very easy software upgrades for existing Data General 16-bit users. Initial shipments of the 8000 will not be made until October and volume shipments are not expected before February or March. Data General has always been a fast delivery company, and its customers are not used to long lead times. In our opinion, if Data General can meet its initial shipment schedules and experience no meaningful problems with initial installations (and these are two significant ifs), then we believe that MV-8000 orders will start to accelerate during the March quarter, when customers could reasonably order the machine in some quantity and receive delivery in three or four months. We also expect a general economic recovery in 1981 and believe that the OEM sector of Data General's business could start improving early next year.

Under the relatively positive scenario outlined above, total company orders could start improving in the second quarter of fiscal 1981 and accelerate in the second half. Even in this case, earnings progress next year would be unexciting. We now project a 15 percent gain in earnings in fiscal 1981 (from $5.25 per share to $6.00 per share compared to our previous forecasts of $5.50 per share and $6.75 per share respectively), but almost all of the gain will come in the fourth quarter. If our scenario in terms of fundamental demand at Data General plays out, however, the groundwork would be laid for earnings gains well in excess of 30 percent in fiscal 1982, as year-to-year sales gains accelerate and margins improve. Awareness of this opportunity for earnings acceleration would certainly begin if orders started improving early in calendar 1981.

A few cautionary notes. First, if we are wrong and the minicomputer industry is in the beginning stages of a general decline, then the recovery at Data General would be postponed. Second, as noted above, the company will be beginning shipments of a major new product very soon and the opportunities for problems in terms of initial product performance, software, or delivery are very real. These shortcomings would also serve to delay an acceleration in orders. Finally, and most importantly, is the question of long-term product positioning at Data General. The major growth opportunities in the small computer market are increasingly moving towards commercial applications, which carry with them the need for strong software and service support. Data General has recognized this trend and made some dramatic moves to improve the level of its support personnel, but in the last year, it has apparently retrenched on this effort somewhat in the effort to maintain margins. It is vitally important over the next year for Data General not to sacrifice the long term in exchange for short-term improvement in profit margins.

In summary, then, in contrast to a year ago, the company was early in recognizing the extent of its problems and very forthright in discussing them. The near-term outlook is unexciting, but probably discounted in the stock. The intermediate term offers the opportunity of major increases in earnings if industry conditions hold and Data General's new product introductions proceed on schedule. The long-term challenge of diversifying into the more lucrative growth sectors of the small computer market remains.

INSTRUMENTATION

First quarter results at Tektronix were a bit of a shocker as incoming orders, revenues, and earnings per share were all well below expectations. A bit of analysis and a re-evaluation of the company's present positioning seems in order.

The earnings shortfall was entirely a function of sales being about $10 million dollars below budget. The shortfall in sales was a real surprise to us at first, as the company's backlogs are swollen and would seemingly allow the company to meet its shipment forecasts irrespective of order trends. After a bit of checking, it appears that there were some internal problems in terms of metal parts fabrication that prevented the company from shipping everything it wanted to ship. The problem is not serious and should be corrected in the second quarter. However, one must note that Tektronix has had a recurrence of seemingly unrelated production difficulties over the past 18 months, which is very surprising since this is a basically well managed company that is highly vertically integrated, and which has not undertaken any major production changes that would explain its difficulties.

Orders in the first quarter were down 11 percent (down 3.5 percent if one adjusts for the extra week in last year's first quarter) versus our expectation of about flat comparisons. The slowdown was fairly widespread throughout Tektronix, encompassing orders for graphic terminals from its Information Display Division (IDD) as well as test and measurement instrument demand. The drop-off in weekly order receipts was alarming, but we are somewhat encouraged by the fact that orders have apparently improved somewhat thus far in the second quarter.

The slowing in instrumentation orders by Tektronix is indicative of trends that we believe are fairly widespread throughout the industry. It is our belief that industry and company instrument orders will remain soft through the end of this calendar year and then begin to improve early in calendar 1981. Graphic terminal-products, while experiencing somewhat stronger demand than that for instrumentation, need to be watched more closely. The softest part of IDD's business is its OEM sector and this in part reflects the evolution towards in-house production of raster scan displays by its CAD/CAM customers (an important component of total OEM business) instead of purchasing Tektronix storage tubes. This trend has long been expected, but Tektronix's difficulty in delivering tubes during fiscal 1980 has probably accelerated the trend somewhat.

It has been our view that Tektronix can still sustain relatively good growth in its IDD business even allowing for reduced penetration of the CAD/CAM market. It is also true that its OEM sales have historically been somewhat cyclically sensitive. It will be vitally important for Tektronix to demonstrate renewed growth in its Information Display Division as we move into 1981.

We have dropped our earnings estimates for the May 1981 fiscal year to $4.85 per share from our most recent $5.60 per share estimate. If orders accelerate during the second half or if the company chooses to eat more heavily into its backlogs, our estimate may prove conservative. The fundamentals at Tektronix still look positive to us, but part of our positive thesis was strong earnings comparisons in fiscal 1981 and 1982 and there has clearly been some loss of momentum in this regard. In our opinion, the key investment development over the balance of this fiscal year will be the pace of new orders in its Information Display Division.

WORD PROCESSING

As noted in previous Portfolio Letters, IBM's latest entry into the stand-alone word processing market, the Displaywriter, is not quite as inexpensive as it appears at first glance and is lacking in software support. It has already had the impact, however, of forcing competitive prices somewhat lower in the stand-alone market as well as offering a real long-term threat if the Displaywriter can be successfully integrated with a wide range of IBM computer systems.

We believe that industry leader Wang Laboratories is readying a very effective response to the Displaywriter. We expect introduction of its newest stand-alone word processor, the WP 4 before the end of this calendar year, possibly as early as October. We would expect a retail price of $6,000-$7,800 compared with $7,800 for the IBM Displaywriter. Our information to date indicates that the Wang product will have two advantages over IBM: first, the Wang price will include software, while the IBM user must pay a separate license fee for all software; second, we expect the Wang daisywheel printer to be 40 percent faster than the IBM printer.

We do not expect the WP 4 to be a major revenue generator for Wang. The company derives only about five percent of its total revenues from the stand-alone word processor market and simply does not have enough sales and support people to market a stand-alone product widely to low volume customers. Rather, we expect the WP 4 to be sold in larger numbers to existing Wang customers and to other buyers who can use the product as an entry level means of upgrading into larger Wang systems. The real benefit to Wang will be that it should effectively keep IBM out of existing Wang accounts. We also expect this product to exert further downward pressure on stand-alone word processor prices generally, particularly if pricing comes in at the low end of our forecast.

SEMICONDUCTORS

While information in September is still very sketchy, there are some signs from a few of the major suppliers that business has improved from August levels. In part, this reflects normal seasonal patterns, but it is also a sign that inventory cutbacks and order deferrals by customers may have run their course. Industry bookings in August were relatively soft, but it is our understanding that all of the major companies made their booking goals for the month.

We have been expecting an upturn to occur in the September-October period and these initial signs appear to be a confirmation of our forecast. Continuation of this trend would mean that the industry has weathered the recession extremely well and that it is poised for a resumption of substantial growth in 1981.

The slowdown in hardware orders recently disclosed by Data General is a source of some concern, especially considering that Hewlett-Packard's computer orders are also relatively soft. It is very important for semiconductor demand from the computer industry to remain strong this fall. At this point, it is our view that the softening experienced by both of these companies is not an indication of industry trends, which we expect to remain reasonably strong.

In MOS memory, a large number of returns are being experienced and there is also widely fluctuating month-to-month device requirements. Both are signs of market weakness. DATAQUEST projects consumption of 180 million 16K RAMS in 1980 versus 70 million parts last year. Our preliminary forecast for 1981 is for consumption of 260 million parts. This would leave an excess supply next year, so some pricing pressure on this product should continue into 1981. We should note, however, that we have detected some flattening in prices on 16K RAMS as the 1981 contract negotiations get underway. As prices come down, wafer allocations will increasingly shift toward the 64K RAM and other products.

Bipolar prices have started to come down in some instances, but not nearly as dramatically as MOS prices. Prices have actually moved somewhat higher in the low end of the bipolar market, driven by higher packaging costs. Bipolar memory prices are still very strong and should stay that way for at least another nine months, driven by strong demand from General Motors.

A clearer view of industry trends for the balance of 1980 may not be obtainable before early October, but initial signs are favorable.

PAPER AND FOREST PRODUCTS

We have previously noted that there was evidence of considerable cancellations and delays in new paper machines scheduled for the 1983-1985 time frame. We have now identified at least six machines, all with capacity of at least 150,000 tons per year, which have been either indefinitely delayed or cancelled. When the American Paper Institute capacity numbers for 1981-1983 are published in December of this year, we believe that they will show significantly less capacity additions during the last year of the survey than had been generally anticipated.

We have always believed that brown paper (linerboard, etc.) was facing potential industry shortages beginning in the 1982 time span and recent cancellations could extend that period of tight industry supply. The postponements and cancellations have also allayed our fear of over capacity in white paper beginning in 1983. It still appears a bit early to get excited about the paper group in general, particularly with the degree of economic recovery in 1981 highly uncertain. However, a very favorable long-term supply demand picture is now in the process of being established.

The forest products stocks have generally underperformed the market during the last six weeks or so. In good part, this is a function of the upturn in long-term interest rates. While acknowledging that the housing recovery next year may have been seriously impaired, we nevertheless think that the risk/reward for the forest products group looks very interesting here, particularly relative to the rest of the market.

If indeed long-term interest rates maintain their upward trend, there will be a relatively unexciting housing picture next year. In this scenario, however, we would seriously question the degree of overall economic recovery next year. For example, there are sectors of the technology industry (OEM business, for example) that are very sensitive to prolonged levels of high interest rates. Conversely, as pointed out in our last letter, we believe that there are strong driving forces towards higher plywood and lumber prices even if housing starts reach only 1.5 million in 1981. In a 1.5 million start year, for example, we believe that the major integrated forest product companies could, as a group, have near record earnings in 1981 and major gains in earnings in 1982. There seems to be a lot of fundamental upside potential for these companies in a positive industry environment and the possibility of more adverse conditions is starting to be discounted by lackluster stock performance relative to the overall market.

Michael R. Weisberg

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DATAQUEST RESEARCH NEWSLETTER
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DYNAMIC AND STATIC MOS RAM AND EPROM SHIPMENTS

SUMMARY

In the second quarter of 1980 the worldwide supply of 16K dynamic RAMs caught up with and exceeded worldwide demand. Worldwide shipments of 16K dynamic RAMs in the second quarter of 1980 were an estimated 47.6 million units, an increase of about 28 percent over the estimated 37.3 million units shipped in the first quarter of 1980. The industrywide average selling price (ASP) for the second quarter was about $4.75, whereas in the third quarter the industrywide ASP is estimated at $4.00. These prices include both contract prices and spot market prices.

Worldwide shipments of 64K dynamic RAMs are still growing slowly as the product is still in the sampling mode. We estimate that 68,000 units were shipped in the second quarter of 1980 with prices in the $60 to $100 range.

The 4K dynamic RAM market continues to decline. An estimated 7.1 million units were shipped in the second quarter of 1980 a decrease of about 39 percent from the first quarter. Large quantity prices still remain about $2.00.

The markets for the 2147 fast 4K NMOS static RAM softened in the second quarter of 1980, and shipments were up only 10 percent to an estimated 2.0 million units. The market for slow 4K static RAMs also softened in the second quarter and shipments increased only three percent to an estimated 12.6 million units. Prices softened further to about $2.50 in the third quarter. Several companies sampled the 16K NMOS static RAM in the second quarter.

Shipments of 4K CMOS static RAMs continued to climb to an estimated 2.8 million units in the second quarter, up about 15 percent over estimated first quarter shipments. Prices softened on this product with about a 25 percent decline in the second quarter. The first of the 16K CMOS static RAMs were sampled in the second quarter of 1980.

Second quarter shipments of 8K EPROMs were an estimated 4.4 million units, down about four percent from estimated first quarter shipments. Worldwide shipments of the 16K EPROM increased about 22 percent to an estimated 6.5 million units in the second quarter of 1980. Prices on this device have plummeted drastically in the last two quarters, however, and are now being quoted as low as $6.00. Worldwide shipments of the 32K EPROM increased in the second quarter to an estimated 711,000 units, up about 122 percent. Limited samples of the 64K EPROM were also shipped in the second quarter of 1980.

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Dynamic MOS RAMs

16K RAMs

Table 1 presents DATAQUEST's estimates of worldwide shipments of 16K dynamic MOS RAMs. In the second quarter of 1980 worldwide shipments were an estimated 47.6 million units, up about 28 percent over an estimated 37.3 million units shipped in the first quarter of 1980. These estimates include the two-chip hybrids shipped to IBM.

During the second quarter of 1980, the supply of 16K dynamic RAMs exceeded demand by a substantial amount. This is the first time that supply has exceeded demand since the product was introduced in 1977. As a result of the excess supply, prices dropped significantly in the second quarter and continued to fall in the third quarter of 1980.

During the second quarter of 1980 the industrywide average selling price for 16K RAMs was close to $4.75 and in the third quarter, we estimate that it declined to about $4.00. This industrywide ASP reflects contract pricing as well as aggressive spot market pricing. For example, in the third quarter spot market prices for 16K RAMs were in the range of $2.25 to $3.00. Of course, these are not qualified parts and there is no guarantee of future availability. They do serve the need for some users, but the majority of EDP users must use fully qualified devices, and they were paying a third quarter price in the $3.80 to $4.20 range.

The 16K RAM is available off-the-shelf from all suppliers as well as through distribution. Despite the current excess supply, it appears that prices are beginning to stabilize as major users are entering their 1981 contract negotiations with the suppliers.

32K RAMs

Mostek continues to be the only merchant market producer of a 32K dynamic RAM hybrid device. It shipped an estimated 200,000 units in the second quarter of 1980 at prices in the range of $8.00 to $10.00.

64K RAMs

Table 2 presents DATAQUEST's estimates of worldwide shipments of 64K dynamic MOS RAMs. As indicated in that table, seven companies are sampling or shipping limited quantities of the devices. In the second quarter of 1980, an estimated 68,000 units were shipped, up about 224 percent over estimated shipments in the first quarter.

The 64K dynamic RAM market is essentially still in a sampling mode. Only Fujitsu, Hitachi, and Motorola are shipping significant quantities of the device at this time, but by year end, several additional suppliers are expected to enter the market. Prices of the 64K dynamic RAMs in the second quarter of 1980 were in the $60 to $100 range in the small quantities being shipped. However, these prices are expected to fall rapidly over the next two quarters as more suppliers enter the market.

4K RAMs

Table 3 shows the 4K dynamic MOS RAM market continuing to decline in the second quarter of 1980. Demand for this device is definitely on the decline as most users are now using the 16K dynamic RAM and are beginning to design in the 64K dynamic RAM. Only the older existing product designs that are still in production are using the 4K dynamic RAM. Although 12 suppliers shipped this product in the second quarter of 1980, only five or six are still actively taking orders for new business. The rest are filling orders currently on the books but are not taking any new orders.

Worldwide shipments in the second quarter were an estimated 7.1 million units, down about 39 percent from the first quarter. Average selling prices for this device are about $2.00, with ASPs for the plastic devices in the $1.80 to $2.00 range, and ASPs for the CERDIP devices in the $2.25 to $2.50 range. Lead times for this device are generally less than four weeks, but there is no excess inventory or capacity as this product is being phased out by most producers.

NMOS Static RAMs

4K RAMs

Table 4 presents DATAQUEST's estimates of worldwide shipments of the fast 4K NMOS static RAMs. This market softened in the second quarter and worldwide shipments were up only 10 percent to an estimated 2.0 million units. Prices continued to decline and were about $8.00 during the second quarter; in the third quarter, prices were in the $5.50 to $6.00 range for plastic devices, and in the $6.25 to $6.75 range for CERDIP devices. About 80 percent of the devices are shipped in CERDIP packages because of hermeticity requirements on this high-speed product. Lead times are generally under six weeks. Some suppliers are offering 25 and 35 nanosecond versions. These faster parts command a $3.00 to $5.00 price premium over the prices quoted above for the 2147 standard device.

Table 5 presents DATAQUEST's estimates of worldwide shipments of slow 4K NMOS static RAMs. This market grew only slightly in the second quarter of 1980 with shipments up about three percent to an estimated 12.6 million units. The 1K x 4 devices continued to be the more popular device with an estimated 8.9 million units, up about five percent over first quarter 1980 shipments. An estimated 3.7 million units of the 4K x 1 device was shipped which is down about one percent from the first quarter. Pricing on the 1K x 4 device in the second quarter was in the range of $3.00 to $3.25 and fell to the $2.50 to $2.75 range for third quarter shipments. The 4K x 1 device usually commands about a $0.25 premium because it is not manufactured in such high quantities. Lead times on this device range from off-the-shelf to four or six weeks.

Table 6 lists the five suppliers currently sampling 16K static NMOS RAMs. Now that several producers are sampling the device, we expect shipments to increase substantially over the next several quarters. Prices in the second quarter were in the $70 to $80 range and are expected to be under $50 by year end.

It does not appear that the 8K static NMOS market will have many participants. At this time only GTE Microcircuits and Mostek are pursuing the market. GTE is still sampling and Mostek shipped an estimated 200,000 units in the second quarter.

CMOS Static RAMs

Harris, Hitachi, and Toshiba were sampling the 16K CMOS static RAM in the second quarter of 1980. Total shipments were an estimated 10,000 units as noted in Table 7. Additional participants are expected over the next few quarters.

Table 8 presents DATAQUEST's estimates of worldwide shipments of 4K CMOS static RAMs. Shipments of this product in the second quarter of 1980 were an estimated 2.8 million units, up about 15 percent over the first quarter of 1980. The 1K x 4 architecture continued to be the more popular device as it represented 61 percent of the total units in the second quarter. Shipments of the 1K x 4 device were up about four percent to an estimated 1.7 million units in the second quarter. Shipments of the 4K x 1 devices increased about 39 percent to 1.1 million units. Prices on these devices have dropped substantially over the last two quarters. In the second quarter, prices were still in the $12 to $14 range, but most shipments in the third quarter were in the $6.00 to $8.00 range. Lead times for these devices are still in the 6 to 12 week range from most suppliers.

MOS EPROMs

8K EPROMs

Worldwide shipments of 8K EPROMs continued a quarter-to-quarter decline that began in the fourth quarter of 1979. In the second quarter, worldwide shipments declined about four percent to an estimated 4.4 million units (Table 9). Prices for the 2708 EPROM in the third quarter of 1980 were in the $4.50 to $5.25 range. This device still represents about 90 percent of the total.

Some suppliers are shipping the 2758, which is a partial 16K EPROM, selling at prices between $4.00 and $4.50 in the third quarter. We estimate that these devices represent about 10 percent of the total quarterly shipments.

16K EPROMs

Worldwide shipments of 16K EPROMs increased about 22 percent in the second quarter of 1980 to an estimated 6.5 million units (Table 10). Prices for the device were in the $10.00 to $12.00 range in the second quarter of 1980 but fell substantially to the $6.00 to $8.00 range in the third quarter. Devices are available off-the-shelf from suppliers as well as distributors.

32K EPROMs

Worldwide shipments of the 32K EPROM were up about 122 percent to an estimated 711,000 units in the second quarter of 1980 (Table 11). At the end of the second quarter there were eight suppliers in this market. The second quarter prices were in the $35.00 to $40.00 range but average prices in the third quarter were in the $25.00 to $30.00 range and are expected to be close to $20.00 in the fourth quarter of 1980.

64K EPROMs

Texas Instruments was the sole supplier of 64K EPROMs in the second quarter of 1980, shipping an estimated 3,000 units. Additional suppliers are expected to enter the market soon.

Daniel L. Klesken
Lane Mason

TABLE 1
ESTIMATED WORLDWIDE SHIPMENTS OF 16K DYNAMIC MOS RAMS
(THOUSANDS OF UNITS)

COMPANY	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 YEAR	1980 1ST QTR	1980 2ND QTR
AMD	S	5	10	50	65	300	700
FAIRCHILD	300	400	500	700	1,900	800	1,000
FUJITSU	1,100	1,300	1,600	2,500	6,500	3,000	4,000
HITACHI	800	1,400	2,200	2,700	7,100	3,200	3,700
INTEL	600	700	950	1,000	3,250	1,150	1,200
INTERSIL	S	5	5	0	10	0	0
ITT	200	300	600	600	1,700	750	1,050
MATSUSHITA	0	0	0	0	0	5	100
MITSUBISHI	100	200	400	550	1,250	700	1,100
MOSTEK	2,400	3,600	4,800	6,000	16,800	7,400	10,500
MOTOROLA	700	1,200	1,000	1,800	4,700	3,000	3,000
NATIONAL	250	450	1,000	1,500	3,200	3,500	4,800
NEC	1,700	2,200	3,200	4,200	11,300	6,100	7,500
SGS-ATES	0	0	0	3	3	10	30
SIEMENS	100	150	250	375	875	600	750
SIGNETICS	75	40	50	10	175	0	0
TEXAS INSTRUMENTS	1,800	2,200	1,800	3,200	9,000	4,200	5,200
TOSHIBA	225	550	900	1,800	3,475	2,500	3,000
ZILOG	20	50	50	70	190	50	0
TOTAL	10,370	14,750	19,315	27,058	71,493	37,265	47,630
PERCENT CHANGE FROM PREVIOUS QUARTER	28.2	42.2	30.9	40.1		37.7	27.8

SOURCE: DATAQUEST, INC.

TABLE 2
ESTIMATED WORLDWIDE SHIPMENTS OF 64K DYNAMIC MOS RAMS
(THOUSANDS OF UNITS)

COMPANY	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 YEAR	1980 1ST QTR	1980 2ND QTR
FUJITSU	3.0	5.0	7.0	9.0	24.0	10.0	25.0
HITACHI	0.0	0.0	0.0	S	S	S	10.0
INTEL	0.0	0.0	0.0	0.0	0.0	0.0	S
MITSUBISHI	0.0	0.0	0.0	S	S	S	S
MOTOROLA	S	1.0	3.0	6.0	10.0	10.0	30.0
TEXAS INSTRUMENTS	S	0.4	1.0	1.0	2.4	1.0	3.0
TOSHIBA	0.0	0.0	0.0	0.0	0.0	S	S
TOTAL	3.0	6.4	11.0	16.0	36.4	21.0	68.0
PERCENT CHANGE FROM PREVIOUS QUARTER		113.3	71.9	45.5		31.3	223.8

*THE LETTER S IN TABLE DENOTES SAMPLING.

SOURCE: DATAQUEST, INC.

TABLE 3
ESTIMATED WORLDWIDE SHIPMENTS OF 4K DYNAMIC MOS RAMS
(THOUSANDS OF UNITS)

	1979					1980	
COMPANY	*1ST QTR*	*2ND QTR*	*3RD QTR*	*4TH QTR*	*YEAR*	*1ST QTR*	*2ND QTR*
AMD	2,600	3,000	3,000	1,600	10,200	1,300	750
FUJITSU	200	200	200	150	750	100	200
HITACHI	350	200	200	100	850	100	100
INTEL	1,700	1,700	1,500	1,200	6,100	900	100
INTERSIL	100	100	300	500	1,000	600	300
ITT	1,100	1,300	1,300	1,500	5,200	1,400	600
MOSTEK	3,800	3,300	3,400	3,600	14,100	2,500	2,000
MOTOROLA	1,500	1,150	1,800	2,000	6,450	1,700	1,000
NATIONAL	2,000	2,400	2,000	1,500	7,900	1,500	1,300
NEC	1,350	1,900	1,300	1,000	5,550	400	275
SGS-ATES	150	175	200	225	750	300	350
SIGNETICS	300	100	50	10	460	0	0
TEXAS INSTRUMENTS	3,600	3,200	2,700	1,200	10,700	700	100
TOTAL	18,750	18,725	17,950	14,585	70,010	11,500	7,075
PERCENT CHANGE FROM PREVIOUS QUARTER	(4.0)	(0.1)	(4.1)	(18.7)	-	(21.2)	(38.5)

SOURCE: DATAQUEST, INC.

TABLE 4
ESTIMATED WORLDWIDE SHIPMENTS OF FAST 4K NMOS STATIC RAMS
(THOUSANDS OF UNITS)

	1979					1980	
COMPANY	*1ST QTR*	*2ND QTR*	*3RD QTR*	*4TH QTR*	*YEAR*	*1ST QTR*	*2ND QTR*
AMD	0	0	0	0	0	*S*	*S*
AMI	5	10	5	5	25	0	0
FUJITSU	0	0	15	60	75	150	200
INTEL	800	1,200	650	900	3,550	1,125	1,100
INTERSIL	0	0	3	20	23	35	40
MOSTEK	0	0	0	0	0	*S*	*S*
MOTOROLA	0	10	20	50	80	70	70
NATIONAL	0	10	25	65	100	200	325
NEC	25	70	250	250	595	200	150
TEXAS INSTRUMENTS	0	0	0	5	5	30	40
TOSHIBA	0	0	0	15	15	25	90
TOTAL	830	1,300	968	1,370	4,468	1,835	2,015
PERCENT CHANGE FROM PREVIOUS QUARTER		56.6	(25.5)	41.5		33.9	9.8

**THE LETTER S IN TABLE DENOTES SAMPLING.*

SOURCE: DATAQUEST, INC.

TABLE 5
ESTIMATED WORLDWIDE SHIPMENTS OF SLOW 4K NMOS STATIC RAMS
(THOUSANDS OF UNITS)

COMPANY	1979 4TH QUARTER 1K×4	1979 4TH QUARTER 4K×1	1979 YEAR 1K×4	1979 YEAR 4K×1	1980 1ST QUARTER 1K×4	1980 1ST QUARTER 4K×1	1980 2ND QUARTER 1K×4	1980 2ND QUARTER 4K×1
AMD	420	220	1,175	465	350	200	400	250
AMI	50	0	250	0	5	0	0	0
FAIRCHILD	400	0	850	0	450	0	450	0
FUJITSU	100	0	580	0	50	0	0	0
GTE MICROCIRCUITS	700	700	1,400	1,350	800	800	800	800
HITACHI	450	0	1,800	0	450	0	450	0
INTEL	800	200	2,650	1,300	800	250	800	250
INTERSIL	200	250	880	630	500	350	250	130
MATSUSHITA	75	0	145	0	75	0	75	0
MITSUBISHI	200	0	800	0	180	60	270	125
MOS TECHNOLOGY	175	0	305	0	175	0	175	0
MOSTEK	0	1,000	0	2,950	0	750	0	600
MOTOROLA	300	50	1,340	130	425	75	425	75
NATIONAL	1,100	400	3,430	910	1,200	600	1,500	750
NEC	1,000	300	2,800	1,750	1,350	270	1,800	330
OKI	0	0	0	0	S	0	50	0
SYNERTEK	1,000	0	3,060	0	1,000	0	750	0
TEXAS INSTRUMENTS	350	350	1,900	1,800	350	350	350	350
TOSHIBA	350	0	1,010	0	350	0	350	0
ZILOG	0	45	0	415	0	0	0	0
TOTAL	7,670	3,515	24,375	11,700	8,510	3,705	8,895	3,660
PERCENT CHANGE FROM PREVIOUS QUARTER	2.6	10.9			11.0	5.4	4.5	(1.2)

*THE LETTER S IN TABLE DENOTES SAMPLING.

SOURCE: DATAQUEST, INC.

TABLE 6
ESTIMATED WORLDWIDE SHIPMENTS OF 16K NMOS STATIC RAMS
(THOUSANDS OF UNITS)

COMPANY	1980 1ST QTR	1980 2ND QTR
INTEL	S	S
MITSUBISHI	0.0	S
OKI	3.0	7.0
TEXAS INSTRUMENTS	S	S
TOSHIBA	0.0	S
TOTAL	3.0	7.0
PERCENT CHANGE FROM PREVIOUS QUARTER	0.0	133.3

SOURCE: DATAQUEST, INC.

TABLE 7
ESTIMATED WORLDWIDE SHIPMENTS OF 16K CMOS STATIC RAMS
(THOUSANDS OF UNITS)

COMPANY	1980 1ST QTR	1980 2ND QTR
HARRIS	0.0	S
HITACHI	0.0	S
TOSHIBA	4.0	10.0
TOTAL	4.0	10.0
PERCENT CHANGE FROM PREVIOUS QUARTER	0.0	150.0

*THE LETTER S IN TABLE DENOTES SAMPLING. SOURCE: DATAQUEST, INC.

TABLE 8
ESTIMATED WORLDWIDE SHIPMENTS OF 4K CMOS STATIC RAMS
(THOUSANDS OF UNITS)

	1979				1980			
	4TH QUARTER		YEAR		1ST QUARTER		2ND QUARTER	
COMPANY	1K×4	4K×1	1K×4	4K×1	1K×4	4K×1	1K×4	4K×1
FUJITSU	S	S	S	S	30	30	100	150
HARRIS	125	125	290	270	150	150	200	200
HITACHI	0	400	0	950	50	500	100	600
MITSUBISHI	55	0	90	0	60	0	60	0
NATIONAL	5	5	5	5	15	15	30	30
NEC	500	0	1,320	0	600	0	425	0
OKI	0	0	0	0	0	0	5	5
RCA	100	0	355	0	150	0	150	0
TOSHIBA	500	100	1,625	275	600	100	650	120
TOTAL	1,285	630	3,685	1,500	1,655	795	1,720	1,105
PERCENT CHANGE FROM PREVIOUS QUARTER	6.2	20.0			28.8	26.2	3.9	39.0

*THE LETTER S IN TABLE DENOTES SAMPLING.

SOURCE: DATAQUEST, INC.

TABLE 9
ESTIMATED WORLDWIDE SHIPMENTS OF 8K EPROMS
(THOUSANDS OF UNITS)

	1979					1980	
COMPANY	1ST QTR	2ND QTR	3RD QTR	4TH QTR	YEAR	1ST QTR	2ND QTR
AMD	600	700	700	500	2,500	600	700
ELECTRONIC ARRAYS	75	100	125	35	335	0	0
FAIRCHILD	160	200	350	600	1,310	750	1,000
FUJITSU	70	50	50	50	220	50	50
INTEL	1,100	1,400	1,400	1,100	5,000	700	500
MITSUBISHI	190	240	240	270	940	160	60
MOTOROLA	700	750	1,000	1,000	3,450	500	500
NATIONAL	600	800	800	900	3,100	1,000	1,000
TEXAS INSTRUMENTS	800	800	800	800	3,200	800	600
TOSHIBA	50	100	100	50	300	35	0
TOTAL	4,345	5,140	5,565	5,305	20,355	4,595	4,410
PERCENT CHANGE FROM PREVIOUS QUARTER	24.3	18.3	8.3	(4.7)		(13.4)	(4.0)

SOURCE: DATAQUEST, INC.

TABLE 10
ESTIMATED WORLDWIDE SHIPMENTS OF 16K EPROMS
(THOUSANDS OF UNITS)

	1979					1980	
COMPANY	1ST QTR	2ND QTR	3RD QTR	4TH QTR	YEAR	1ST QTR	2ND QTR
AMD	0	S	5	10	15	25	50
FAIRCHILD	0	0	0	S	S	30	300
FUJITSU	70	200	300	300	870	350	750
HITACHI	125	200	350	500	1,175	700	700
INTEL	550	750	800	900	3,000	950	1,200
MATSUSHITA	0	0	0	0	0	S	50
MITSUBISHI	10	20	50	90	170	210	260
MOSTEK	90	150	250	350	840	275	250
MOTOROLA	160	150	160	200	670	250	350
NATIONAL	5	50	80	120	255	250	250
SYNERTEK	0	0	0	S	S	S	25
TEXAS INSTRUMENTS	400	900	1,100	1,800	4,200	2,000	2,000
TOSHIBA	25	50	90	200	365	300	330
TOTAL	1,435	2,470	3,185	4,470	11,560	5,340	6,515
PERCENT CHANGE FROM PREVIOUS QUARTER	58.6	72.1	28.9	40.3		19.5	22.0

*THE LETTER S IN TABLE DENOTES SAMPLING.

SOURCE: DATAQUEST, INC.

TABLE 11
ESTIMATED WORLDWIDE SHIPMENTS OF 32K EPROMS
(THOUSANDS OF UNITS)

COMPANY	1979 *1ST QTR*	1979 *2ND QTR*	1979 *3RD QTR*	1979 *4TH QTR*	1979 *YEAR*	1980 *1ST QTR*	1980 *2ND QTR*
FUJITSU	0	0	0	*S*	*S*	*S*	15
HITACHI	0	0	0	*S*	*S*	*S*	100
INTEL	5	30	50	100	185	165	250
MITSUBISHI	0	0	0	*S*	*S*	*S*	6
MOTOROLA	0	0	0	*S*	*S*	5	30
NATIONAL	0	0	0	0	0	*S*	10
TEXAS INSTRUMENTS	10	35	60	90	195	150	300
TOSHIBA	0	0	0	0	0	0	*S*
TOTAL	15	65	110	190	380	320	711
PERCENT CHANGE FROM PREVIOUS QUARTER		333.3	69.2	72.7		68.4	122.2

* *THE LETTER S IN TABLE DENOTES SAMPLING.*

SOURCE: DATAQUEST, INC.

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SEMICONDUCTOR INDUSTRY SERVICE

3.0 MANUFACTURING (15 May 1980)

ERRATA

Page 3.0-1	Last paragraph, last sentence in parenthesis: see Appendix A, Volume III (not Volume II).
Page 3.1-6	Last paragraph on Photomasking, fourth sentence beginning "On 4-inch wafers" should read "On 3-inch wafers."
Page 3.2-8	Second item from bottom in parentheses - delete "and carbon."
Page 3.2-20	Second series of bulleted items, second item beginning "Cumulative fab yields..." should read "...and 80%...," not "85%."
Page 3.3-11	Dotted curve marked "C" should be marked "A." Dotted curve marked "A" should be marked "C."
Page 3.4-2	Under heading "Production," item "d.," add "..., 13 accounting periods per year."
Page 3.4-3	Under heading "Yields," item "a." should read "80%" not "75%."

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Page 3.4-5	Table 3.4-1:	
	Under heading "Depreciation," change:	
	"Equipment: $6,364,950; 60 months	$106,083"
	to read:	
	"Equipment: $5,144,460 (excluding test equipment); 60 months	$85,741"
	The amounts ($195,407, $180,376, and $18.04) on the last part of this table should be deleted and this section should now read as follows:	
	Total per calendar month	$175,065
	Total per period	$161,598
	For 10,000 yielded wafers out per period, the cost per wafer (Table 3.4-3, Item I)	$16.16

Page 3.4-6 — The values of the ordinates on the graph should be reduced by 1.0, i.e., 1 becomes 0, 2 becomes 1, etc..

Page 3.4-7 — Table 3.4-2, the heading "Wafer Fab..." should read "...(80% Cumulative Yield)", not "75%."

Under the "Materials" section, item four, replace the word "Indirect" with "Miscellaneous."

Under the "Materials" section, item six, "DI Water," the amount should read $0.98, not $0.10.

Change the amount on the line "Cost per wafer out (Table 3.4-3, Item II)" to read $21.81, not $20.93.

Page 3.4-9 — Table 3.4-3:

Delete the following figures: $18.04, 29%, 20.93, 35%, 9.5%, 22.2%, 36%, $60.84, and 100%. This table should now read as follows:

		Cost		Percent
Fixed Monthly Costs		$16.16		27.0%
Fab Materials		21.81		36.4
Fab Labor:				
Direct	$ 5.75		9.6%	
Indirect	2.59		4.3	
Allocated	13.53		22.7	
Subtotal		21.87		36.6
Total		$59.84		100.0%

Page 3.4-11 Table 3.4-4:

Delete the following figures: $60.59, $0.1102, $0.1324 (a+b), 0.1324, $0.8275, $0.8275, $0.2300, $1.0575, 90%, $1.1750, $1.3786, 80%, and $1.7233. The relevant lines in this table should now read as follows:

E-Sort (Wafer Sort)

- Wafer Fab cost per gross die = $59.84 ÷ 550 = $0.1088 (b)
- Total cost per gross die $0.1310 (a+b)
- Cost per net die at E-Sort 0.131 ÷ (16% E-Sort yield) $0.8188 (c)

Assembly

- Cost of die from E-Sort = $0.8188 (c)
- Assembly cost per gross die = $0.1800 (d)
- Cost per gross die = (c) + (d) = $0.9988 (e)

Therefore, cost per net die = e ÷ 0.9 = $1.110 (f)

Final Test

- Total cost per gross die = (f) + (h) = $1.3133 (i)

Therefore, cost per net die = (i) ÷ 0.8 = $1.6417 (j)

Pack and Ship

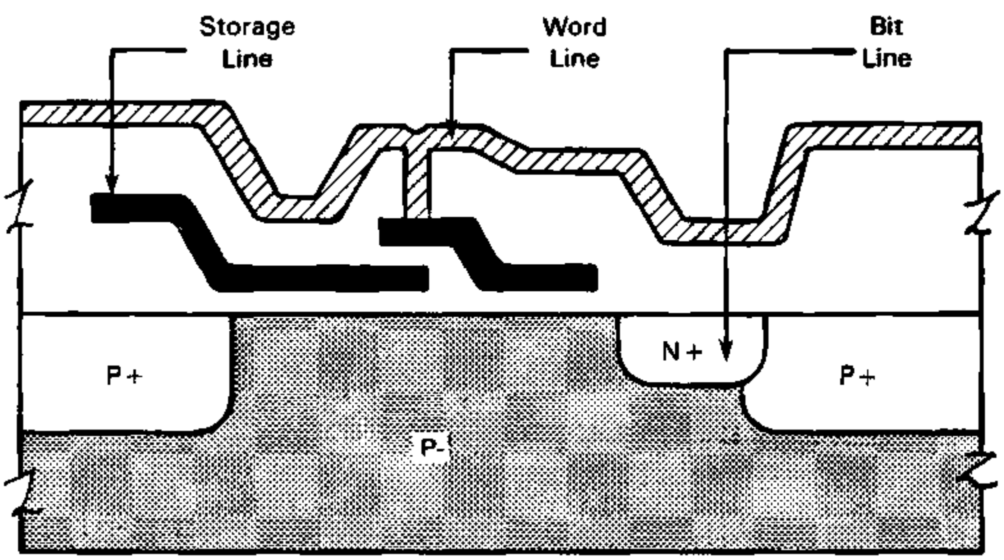
- Therefore, (j + k) = Total Cost Per Net Die = $1.6616

Page 3.4-12	First sentence should read "The detailed equipment lists for the N-channel MOS are given in the Appendix." (Add "the" and delete "A".)
Page 3.4-13	Table 3.4-7: Delete all figure amounts. Table should now read as follows:

	Capital Cost	Percent of Total
Equipment	$ 6,364,950	62%
Facilities	3,832,300	38%
Grand Total	$10,197,250	100%

Page 3.4-16	Figure 3.4-2
	Darken the "Z"-shaped, cross-hatched section beneath the Word Line and adjacent to the Storage Line.

Figure 3.4-2
16K DRAM CELL
(Not to Scale)



Source: DATAQUEST, Inc.

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MANUFACTURING MODEL

DATAQUEST's Semiconductor Industry Service has just published a comprehensive manufacturing model. This report of over one hundred pages is a complete revision of Section 3 of the Semiconductor Industry Service notebook and replaces earlier material published in 1975 and 1977.

TECHNOLOGY AND EQUIPMENT

Wafer fabrication technology continues to evolve, and the interplay of equipment technology, device technology, plant layout and design, site selection, cost, and personnel management becomes increasingly complex. The trend toward greater device complexity and larger die size has been spurred on by lowered defect densities. As device geometries approach the 2-micron level and below, processing, environmental and equipment technologies must be carefully coordinated.

Of the many process technologies, photolithography has been one of the key factors in determining the pace of Very Large Scale Integration (VLSI) design and manufacture. The trend is away from contact printing toward proximity and projection printing.

Dry etching techniques are being developed as a necessary concomitant of projection printing in order to etch fine patterns in a variety of materials.

Deposition of materials is becoming more sophisticated with the addition of sputtering and plasma deposition to the tried-and-true electron beam and chemical vapor deposition technologies.

Ion implantation techniques have kept pace to achieve, quickly and inexpensively, control of impurity concentrations and junction depths.

Although complex and expensive, with increasing delivery times, wafer fabrication equipment is proving to be cost effective. The equipment is increasingly

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controlled electronically (by the integrated circuits it is used to fabricate). The result is greater automation, control, and reproducibility of results, as well as lower defect levels due to lower operator/wafer interfacing.

The clean room facilities in 1980 are geared toward Class 100 rating and better rather than toward the Class 1000 rating that was acceptable until 1978.

Deionized (DI) water is being elaborately treated and tested to meet the new clean standards. The water is pretreated through activated carbon and diatomaceous earth filters before it goes through reverse osmosis and deionization stages.

Four-inch diameter wafers are expected to be the standard during the mid-1980s; larger wafers may be used for many standard memory lines. Thus, for a facility processing 10,000 wafers out per four-week period with manufacturing costs of $40 to $80 per wafer and gross revenues of $300 to $600 per wafer, at least $3.0 million dollars per period can be realized.

At the same time, equipment purchases for today's use must nevertheless be chosen for eventual upgrading to handle five-inch, and even six-inch diameter wafers, as long as the particular technology will not be obsolete by the time of the upgrading. It is also possible to adapt machines to suit other products. With the high capital cost of some equipment, care must be taken to obtain maximum utilization of such equipment while it is in service.

PLANT LAYOUT AND DESIGN

Several factors determine the way in which a particular plant is laid out. Cleanliness for VLSI production is influencing what portion of the equipment remains in the clean room. Only the loading end of diffusion furnaces are being allowed in the clean room. The heat and dust generating portions are being separated from the clean room by a fire wall. The same is true for ion implanters and the trend will be continued for other equipment where appropriate.

Servicing of equipment and work stations in old facility designs meant frequent ingress of personnel into the clean room to deliver bottles of chemicals, replace furnace tubes, and repair plumbing. New layouts obviate the necessity for these entries by pumping chemicals (except photoresist) to other points of use. Plumbing can be done outside the clean room if a service corridor rings the fabrication area. Furnace tubes can be pulled and replaced behind the fire wall and outside the clean room. If gases are pumped overhead through a crawl space, gas lines can often be serviced in these crawl spaces without need for entry into the clean room.

Philosophies of equipment design have shifted toward single wafer and in-line processing and wafer handling, away from the purely batch-type handling. Thus, there is greater interplay between different processing areas (as opposed to the almost strict quarantine that existed before) as long as cleanliness is maintained, material flow facilitated, and cross-contamination avoided. New demands for material accountability have made production control supervision the heart of the entire operation and this fact has also affected the overall plant layout. Increased usage of computers and terminals will make this approach even more effective.

AUTOMATION

Perhaps the most persistent and pervasive trend is that towards automatic sequencing of events within a given piece of equipment. Also popular is the drive toward computer automation of the entire fabrication area for control, reproducibility, data collection, and analysis. The benefits to be reaped are legion and include:

- Less wafer handling
- Process monitoring and control
- Correct process sequencing
- Proper routing of material
- System self-diagnostics and self-correction
- Data collection for off-line processing
- Elimination of paper work
- Material accountability (especially useful since lot sizes vary for different operations in the manufacturing process)

Equipment manufacturers are following the trend toward automated equipment, some with micro- and minicomputers. Some automation now exists in the areas of diffusion/oxidation, physical and chemical vapor deposition, ion implantation, masking, alignment, mask making, mask inspection, testing, plasma etching, DI water, and environment monitoring.

Variables which constitute the particular process at the factory level are sensed and measured. The supervisory element compares the measured data against set values and adjusts the system to initiate or shut down the process. Communication and display terminals are at the floor or factory level and through them data are transmitted to the highest level, the management computer.

Exciting as it is, the prospect of a fully computerized, semiconductor manufacturing facility is not foreseen before the mid- to late-1980s, even though an experimental automated line has been constructed at Texas Instruments and automated production lines are used by several captive manufacturers. The determining element is, of course, equipment development. Much of the equipment today is being "updated" by adding microprocessors for sequencing. However, very few pieces of equipment are designed around computer control with adequate supporting software. More and more companies have placed computer terminals in their manufacturing areas but these terminals are almost always to handle data rather than direct and control manufacturing processes.

The development cycle for very sophisticated equipment can range from two to five years. Delivery times of equipment costing above $200,000 often range from nine to eighteen months. Development costs are often high too, as is the rate of obsolescence. Consequently, only the wealthiest semiconductor manufacturers can undertake their own development programs toward full computerization of the factory. The rest must wait for market forces to react.

Batch processing will probably never disappear in the foreseeable future. However, more and more equipment manufacturers are offering cassette-to-cassette wafer systems to eliminate tweezer handling. Tweezers are a well-known cause of damaged patterns, silicon particle generation, and wafer defects. In properly controlled equipment, each wafer is subject to almost the same set of process parameters.

STAFFING

The cumulative effects of the recessions of 1970 and 1974 are now evident in the acute shortage of trained engineering staff. The trend of decreased enrollment in engineering colleges since these recessionary periods has not been reversed at rates compatible with industry growth. For those engineers who remained, it has become a sellers' market. In Santa Clara (Silicon) Valley, California, unemployment at 4.7 percent in September 1979 was at a five-year low, unparalled anywhere in the country. At the lower end of the wage scale, turnover rates ranged from 50 to 100 percent among operators. Although mothers of young children have rejoined the work force, the industry still faces severe labor shortages while professional personnel are being wooed by "headhunters" and by print, skywriting, radio, and television ads. Incentives and bounties are offered to staff already in place to ensure successful recruiting.

Housing costs, already prohibitive for engineering staff, are even more prohibitive for operators (see "Site Selection"). Commuting is only a partial solution to the problem of staffing expanding operations. The trend, therefore, has been to relocate new operations in more favorable labor markets, all other things being equal.

WAFER FABRICATION GUIDELINES

Certain guidelines became apparent as U.S. merchant and captive semiconductor manufacturers were surveyed to develop the costs to be used in this model. A summary of these guidelines follows.

Direct labor in most wafer fabrication areas correlates well with the number of wafers out (assuming adequate wafer fabrication yields) and with the number of mask layers; the product of these two factors is approximately 250. In other words, if an 8-layer device were being manufactured, each worker should account for approximately 31 wafers out per week.

Supervision of direct labor typically runs 15 to 20 percent of direct labor hours and, because of higher pay rates, 36 to 48 percent of direct labor dollars.

Allocated labor accounts for all indirects in the wafer fabriction area. This category includes process sustaining engineers, product engineers, quality control and quality assurance, production control, and equipment maintenance. Allocated labor is the largest labor category and may run from 180 to 280 percent of direct labor cost.

We found in our survey a few cases where older processes are in production and little technological change is taking place; in these cases, allocated labor costs were much lower.

Typically, the wafer fabrication area floor space depends on the wafer start capacity required. Our model assumes approximately 12,500 wafer starts per period (there are 13 four-week periods per year) and has approximately 12,160 square feet of wafer fabrication area and 12,840 square feet of area for testing and office space. Thus, the wafer fabrication area required is approximately 1 square foot per wafer start.

The construction costs for these facilities are substantial, particularly in wafer fabrication areas. An analysis of company annual reports suggests that the semiconductor industry spends about 25 percent of its capital on facilities and 75 percent on equipment. Our model shows higher facilities expenditures on a percentage basis because all construction is new; as the equipment ages, it is to be expected that new equipment will be purchased before the facilities become obsolete. This phenomenon accounts for the lower ratio in mature companies.

In our N-channel RAM wafer fabrication model, total capital expenditures for facilities and equipment are:

	Cost	Percent
Facilities:	$ 3,832,300	38%
Equipment	6,364,950	62
	$10,197,250	100%

The facilities expenditure includes both wafer fabrication and office space and is divided as follows:

	Cost	Cost Per Sq.Ft.
Fab Area (12,160 sq.ft.)	$3,319,300	$273
Offices and Test (12,840 sq.ft.)	513,000	$ 40
	$3,832,300	

In the table above, the costs per square foot are in addition to the cost of the basic building shell. In our model, it is assumed that the land and building shell are leased at a cost of $1.00 per square foot per month. If land were purchased and a building constructed, additional costs of $40 to $85 per square foot would be incurred. The variation in these figures depends on the price of the land; it may vary from $40,000 to $400,000 per acre or more.

MODEL COSTS

Our 1980 cost model is based on an MOS 16K DRAM, fabricated using a 6-layer process that does not employ silicon nitride. Other companies may use an 8-layer process. Basic assumptions are listed below:

Technology

- 16K DRAM, MOS N-channel
- 6-layer double-poly process
- 5-micron geometry
- 140 mil x 140 mil chip size (= 20,000 mil^2)
- 16-pin DIP plastic package
- 4-inch diameter silicon wafer
- 1:1 projection aligners (UV)
- Negative photoresist
- Wet etching
- Plasma ashing of photoresist

Production

- Two full shifts per day (skeleton graveyard shift mainly for maintenance)
- Seven hours effective work per shift
- Five day week = 20 days per period
- 12.5 productive periods per year
- 25 percent benefit package including shift premiums
- Minimum throughput at any step = 60 wafers per hour
- 10,000 wafers out per period
- Productivity at approximately 42 wafers out per operator per week (6 layers)
- All assembly operations offshore

Yields

- Cumulative Fab yield - 80%
- E-Sort (16K DRAM) - 16%
- Assembly yield - 90%
- Final test yield - 80%

Facilities

- Building rented as shell at $1.00 per sq.ft. per calendar month
- Space rented = 25,000 sq.ft.
- Minimum of 15 percent inflation rate on construction, materials, and equipment
- All facilities and services supplied from scratch
- All design services contracted to outside engineering firms
- All chemicals (except photoresist) to be pumped into the fab area from storage tanks to points of use
- Masking can accommodate up to 10 projection aligners
- Diffusion can accommodate 20 furnaces
- Fab area = 12,160 sq. ft; E-Sort, Test, Offices = 12,840 sq.ft. total

Equipment

- Highly automated operation
- Convertible for use on 5-inch diameter substrates
- Equipment will be used eventually on 2- to 3-micron gates and shallow junctions (less than 1.0 micron)
- Need filled for data collection and information management to facilitate trend analysis

Volume-sensitive wafer making costs appear in Table 1, a summary of wafer making costs appears in Table 2, and a summary of equipment costs in Table 3. The fixed monthly costs of Table 2 include building rent, sewage, electric power, gas, and depreciation of buildings and equipment.

Howard Z. Bogert

Table 1

VARIABLE (VOLUME-SENSITIVE) COSTS
(Data Gathered From Company Surveys)

Wafer Fab (80% Cumulative Yield)		
Materials:		
- Silicon	$13.33	
- Masks	0.25	
- Chemicals	3.00	
- Indirect Materials	2.25	
- Gases	2.00	
- DI Water	0.98	
Cost per Wafer Out		$21.81
Labor:		
- Direct (Adjusted for 6-layer Process)	$ 5.75	
- Indirect	2.59	
- Allocated	13.53	
Cost per Wafer Out		$21.87

Source: DATAQUEST, Inc.
June 1980

Table 2

COST PER WAFER OUT

		Cost		Percent
Fixed Monthly Costs		$16.16		27%
Fab Materials		21.81		36
Fab Labor:				
Direct	$ 5.75		9.6%	
Indirect	2.59		4.3	
Allocated	13.53		22.6	
Subtotal		21.87		37
Total		$59.84		100%

Source: DATAQUEST, Inc.
June 1980

Table 3

EQUIPMENT COSTS: N-CHANNEL MODEL

	Capital Cost	Percent of Total
Diffusion Area	$1,339,450	21.0%
Masking Area	2,283,300	35.9
Deposition Area	1,039,700	16.3
Fab Support and Test Areas	1,287,900	20.3
Backside Processing	414,600	6.5
Grand Total ($6\frac{1}{2}$% Tax Included)	$6,364,950	100.0%

Source: DATAQUEST, Inc.
August 1980

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GENERAL INDUSTRY UPDATE

SUMMARY

DATAQUEST expects a moderate downturn in U.S. semiconductor consumption during the second half of 1980, primarily caused by weakening demand and falling prices. This downturn in consumption results from the surprising strength of semiconductor consumption in the first half of 1980 and recent effects on semiconductor usage due to the current economic recession. U.S. semiconductor consumption grew an estimated 5.3 percent in the first quarter of 1980 compared to the fourth quarter of 1979, and grew another 9.1 percent in the second quarter of 1980. DATAQUEST forecasts U.S. semiconductor consumption in both the third and fourth quarters will decline by 3 to 4 percent on a quarter-to-quarter basis. U.S. semiconductor consumption for all of 1980 is expected to be 25.8 percent higher than 1979, reflecting a strong momentum entering this year. An upturn in U.S. semiconductor consumption is expected to begin in 1981, increasing in strength throughout the year, with the total for 1981 up about 10 percent over 1980.

The U.S. economy, which was flat in 1979 and fell abruptly in the second quarter this year, appears to have bottomed out. A gradual recovery appears likely, but not certain. In this recession, the electronics industry has been relatively much less affected than other economic segments. This fact and the lack of serious excess components inventory leads us to cautious optimism. As we have stated in previous Research Newsletters, the current situation bears no resemblance to the 1974 debacle.

RECENT ECONOMIC TRENDS

The U.S. economy is in a moderate-to-severe recession. Some segments of the economy reacted strongly to the very high interest rates earlier this year. From the second quarter, several major segments of the economy have been severely hit: automotive sales are down approximately 30 percent; housing starts are down approximately 40 percent; steel, forest products, air transportation, agriculture, and tourism are strongly affected. Additionally, small business in general has felt the effects of the slowdown.

Although the immediate cause of the recession has been the tightening of credit by the Federal Reserve Board, the longer term causes include the long period of industrial expansion beginning in 1975, problems with persistent and pernicious inflation, energy costs, and the lack of productivity improvements in industry.

- The GNP fell at a 9.1 percent annual rate in the second quarter of 1980. Momentum will cause it to fall further in the third quarter.

- Inflation remains high as wholesale prices surged 1.7 percent in July, an annual rate of more than 20 percent.

- Except for the week ending August 6, the money supply appears to have shown very modest growth, indicating continued restraint by the Federal Reserve Board despite the political pressures of an election year.

- The Index of Leading Indicators declined in April and May, but showed a significant 2.5 percent increase in June, presaging potential improvement in the economy.

- Capital expenditures for business equipment have weakened in recent months, reflecting their normal lag behind the general economy.

- The economic outlook in both Europe and Japan appears to be worsening. Unlike 1974, but similar to 1970, economies in the rest of the world appear to be lagging developments in the United States.

- Consumers have been reducing their overall level of indebtedness quite rapidly, even though disposable incomes have been falling.

- The prime rate has fallen rapidly from its high of approximately 20 percent to about 11 percent now. Further declines of interest rates, if any, are expected to come slowly.

Evidence is mounting that the rapid deterioration of the economy during the second quarter is over. Both housing starts and automotive sales have shown very modest increases recently; retail sales are again rising; and the Index of Leading Indicators is improving. Temporarily, the rise in the unemployment rate has halted. Falling interest rates have reduced problems and pressures throughout the economy.

A salient aspect of this recession is that it is affecting various segments of the economy quite differently. We believe the U.S. economy is undergoing some major structural changes, partly causing this recession. Up to now, the general structure of the U.S. economy has remained relatively unchanged since the end of World War II. This structure, we believe, is now being altered more significantly than in any period during the last 35 years. Segments of the economy which are highly affected by inflation or energy, or industries which have recently matured are bearing the brunt of the downturn. Changes in buying habits and foreign competition are having a major effect. Some of these industries, such as the automotive industry, may experience slower future growth and a declining role in the economy. DATAQUEST believes that electronics, and the semiconductor industry, will play an increasingly more important role in the worldwide economy.

The outlook for the U.S. economy is not particularly bright in the short term. The general problems causing this recession have not yet been resolved. In particular, it is very likely the United States will have significant inflation for some time. This may cause potential problems as the Federal Reserve Board attempts to fine-tune an economic recovery. If interest rates fall rapidly and money supply increases, consumer spending and inflation will rebound rapidly, leading to major future problems. Conversely, if the money supply remains too tight, rising interest rates could cause severe problems for those segments of the economy already experiencing difficulties, and the current recession could worsen markedly. Thus, it is generally expected that the Fed will try to hold middle ground, with little change in availability of money or interest rates and the probability of only a slowly improving economy.

SEMICONDUCTOR INDUSTRY TRENDS

The U.S. semiconductor industry is experiencing a decline in orders. The "imminent slowdown" forecast in our Update Newsletter of April 11 has arrived. DATAQUEST estimates that the ratio of book-to-bill remained significantly above 1.1:1 throughout the first four months of 1980. But in June, that ratio was an estimated 0.85 and fell further to about 0.6 in July. Bookings are expected to remain weak in August. However, because of strong bookings in the first part of the year, most backlogs remain adequate. The recent poor bookings have several causes:

- Semiconductor shipments and consumption in the United States grew 12.2 percent in the fourth quarter of 1979, over the previous quarter; another 5.3 percent in the first quarter of 1980; and 9.1 percent in the second quarter. Clearly, these increases do not fully reflect additional capacity—they are partly the result of price stability and price increases. With supply now exceeding demand in many product areas, price reductions are having a major effect. Indeed, DATAQUEST believes that price corrections will be the primary cause of negative growth in the value of semiconductors consumed in the United States.

- The extremely heavy demand in 1979 and early 1980 has resulted in some chaos among bookings that is now being cleaned up—including double-ordering, incorrect product mixes, overpricing, etc. Significantly, the bookings decline in July affected ICs more than discretes, a clear sign that order correction is more responsible than end usage.

- With supplies more readily available, most users have reduced inventories from an estimated average of about 12 weeks to 4 weeks.

- July and August are traditionally weak months for semiconductor bookings.

- Order changes, reflecting delivery stretchouts and price reductions, appear to be having an effect on recent bookings.

- Obviously, although unit demand remains strong, some weakness in general semiconductor usage exists.

It is DATAQUEST's perception that usage of semiconductors remains relatively strong. Most major areas of semiconductor demand remain strong, with the exception of consumer products. We do not expect unit demand to show significant weakness. However, with slower industry growth, improvements in yield and other costs will result in a reduction in prices. This is expected to have an effect on dollar volumes, as is already being experienced in memory products. (See DATAQUEST's Semiconductor Industry Status Report, July 25, 1980.)

The effects of the demand slowdown have not fallen evenly on the industry. Bipolar LSI remains strong in total units and revenue. MOS memory, especially the overpriced devices, is experiencing major price adjustments. Linear products have seen only moderate effects while discretes see little change from the weakness that began some quarters ago.

Suppliers of material to the industry (except silicon) felt a swift contraction of orders about May as semiconductor manufacturers adjusted order rates and inventory levels. Orders have rebounded and stabilized about 10 to 15 percent below peak levels. Fears of wafer shortages moderated effects on the silicon suppliers. Conversely, equipment suppliers, especially long lead time products, have seen demand remain strong. Semiconductor manufacturers have not significantly reduced capital expenditure plans.

Most major semiconductor companies reacted swiftly to the economic decline in the second quarter, instituting many of the following:

- Hiring freezes, except in critical areas

- Inventory reduction and control

- Acceleration of new product development

- Cost controls and other spending limits

- Yield and cost improvement programs

- Increased scrutiny of the order book

These measures were not as universally applied early in 1974. Significantly, the industry has yet to have, or need, major layoffs, although employment reductions in some companies (especially suppliers) have occurred. The Sunday employment ads of the San Jose Mercury-News are at 40 pages—hardly a recession, but down from 55 pages in February and 60 pages in December.

SEMICONDUCTOR INDUSTRY FORECAST

Table 1 presents DATAQUEST's estimate for U.S. semiconductor consumption in dollars. We believe that U.S. semiconductor consumption in 1980 will show an increase of about 25.8 percent over 1979. In 1979, U.S. semiconductor consumption increased approximately 37.6 percent over 1978. It should be noted that these figures not only include shipments by U.S. manufacturers within the United States, but also exports to the United States from Japan and Europe. These exports to the United States have increased significantly over the last two years. DATAQUEST expects further growth in U.S. semiconductor consumption in 1981, to an estimated level of 10.4 percent over this year. However, given the high degree of economic uncertainty, long-term forecasts are currently not well-founded.

Our current estimates for U.S. semiconductor consumption by calendar quarter are shown in Table 2. We expect a moderate decline in semiconductor consumption for the second half of 1980, with average quarterly consumption declining by 3 to 4 percent for each quarter. A healthy resumption of growth in semiconductor consumption is expected for 1981, beginning early in the year. The decline in consumption forecast for the second half of the year is somewhat less optimistic than our previous forecast. This results from two primary factors: significantly greater than expected growth in the second quarter, primarily due to price stability; and a very rapid decline in the U.S. economy during the second quarter. Essentially, unit demand is expected to remain strong, but price weakness and a correction of other imbalances resulting from the market strength of the last two years will cause a market contraction in terms of dollars.

Given the level of the current recession in the economy, our forecast for semiconductor consumption is optimistic. We believe the semiconductor industry will continue to outperform other segments of the U.S. economy. The long-term demand factors of the industry remain extremely positive. Although currently the supply/demand imbalance of 1979 has moderated, we expect tight semiconductor supply to resume sometime after the world economy improves. This viewpoint is apparently shared by many semiconductor manufacturers; expenditures for increased capacity remain at high levels.

It is important to point out some major differences between the current situation in the semiconductor industry and that of 1974. In particular, we are impressed by the very strong consumption of semiconductors over the last few years. Past relationships of semiconductor consumption and the economy no longer hold. For example, industrial production leveled in November 1973 and remained level through the first three quarters of 1974. This was reflected rapidly in semiconductor demand with orders falling in the first quarter of 1974 and shipments peaking in the second quarter. Similarly, industrial production leveled in November 1978 and remained essentially extremely flat through March 1980. However, during this period, semiconductor demand and shipments grew extremely rapidly. Semiconductor consumptionduring the second quarter of 1980 was more than 50 percent higher than the first quarter of 1979. Semiconductor demand was affected only after the economy began a rapid downturn in April 1980.

Thus, semiconductor consumption is outperforming the U.S. economy. DATAQUEST believes this has several causes, including structural changes in the economy and the indirect effects of inflation, which have made nearly all electronics far better bargains. This altered relationship with the economy is expected to continue.

Frederick L. Zieber

Table 1

ESTIMATED U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1979	Percent Increase 1979-80	1980	Percent Increase 1980-81	1981
Discrete Devices	$1,322	7.6%	$1,422	1.8%	$1,447
Integrated Circuits	$3,375	32.9%	$4,485	13.2%	$5,076
Total	$4,697	25.8%	$5,907	10.4%	$6,523

Source: DATAQUEST, Inc.
August 1980

Table 2

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1979				
	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Total Year
Discrete Devices	$ 301	$ 340	$ 334	$ 347	$1,322
Integrated Circuits	700	805	868	1,002	3,375
Total	$1,001	$1,145	$1,202	$1,349	$4,697
Percent Change From Previous Quarter	4.4%	14.4%	5.0%	12.2%	
Percent Change From Previous Year	33.6%	36.0%	39.1%	40.7%	37.6%

Table 2 (Continued)

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1980 1st Qtr.	1980 2nd Qtr.	1980 3rd Qtr.	1980 4th Qtr.	1980 Total Year
Discrete Devices	$ 354	$ 364	$ 357	$ 347	$1,422
Integrated Circuits	1,066	1,185	1,135	1,099	4,485
Total	$1,420	$1,549	$1,492	$1,446	$5,907
Percent Change From Previous Quarter	5.3%	9.1%	(3.7%)	(3.1%)	
Percent Change From Previous Year	41.9%	35.3%	24.1%	7.2%	25.8%

	1981 1st Qtr.	1981 2nd Qtr.	1981 3rd Qtr.	1981 4th Qtr.	1981 Total Year
Discrete Devices	$ 349	$ 360	$ 361	$ 377	$1,447
Integrated Circuits	1,123	1,233	1,289	1,431	5,076
Total	$1,472	$1,593	$1,650	$1,808	$6,523
Percent Change From Previous Quarter	1.8%	8.2%	3.6%	9.6%	
Percent Change From Previous Year	3.7%	2.8%	10.6%	25.0%	10.4%

Source: DATAQUEST, Inc.
August 1980

DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

Vol. II - No. 7 August 21, 1981

This letter is a condensation of recent Research Newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific Newsletters should be directed to the author. A list of recent DATAQUEST Newsletters appears at the end of this letter.

WORD PROCESSING

The momentum at Wang Laboratories in terms of new orders and market penetration is so strong at present that one must ask two basic questions: can competition seriously impair the company's progress and can an internal organization that is stretched very thin hold together and manage the company's phenomenal growth?

To the first question, we would answer a reasonably comfortable no. The recent IBM Displaywriter affects about 5 percent of Wang's present market and we believe that Wang will have a new product in the stand-alone word processing market during the current fiscal year. IBM's other recent move of adding word processing software to its 8100 line would have been very effective if there were thousands of 8100s in the field that could make an inexpensive upgrade and incorporate word processing. However, the new version of the 8100 has just begun to be shipped during 1980. Effective shared resource word processing that could easily tie into the 4300 line of IBM might be more of a problem for Wang, but no such product is available.

The successful implementation of Xerox's ETHERNET network might pose a longer term problem for Wang, but this product is at least a year away from full implementation. By announcing the product early, Xerox definitely aided its own ability to sell word processing machines; it also afforded Wang a long time to study the Xerox proposal and effect a defense. Datapoint and Prime Computer have both announced intriguing integrated office systems, but both companies are well behind Wang in implementation and the market is certainly large enough to allow all three companies to prosper and not get in each other's way.

The question of Wang's ability to handle its growth internally is a much harder one to answer. The most visible problem is the difficulty the company has had in the numbers and quality of its field service organization. We have been aware of considerable dissatisfaction among many Wang word processing users about service. It is difficult to determine whether any large customers who would have otherwise purchased Wang equipment were dissuaded by the reputation for bad service. We know of no customers who have actually replaced Wang equipment because of this problem, though we know of one large university who took Wang off their acceptable vendor list.

Wang management is acutely aware of the difficulty and has been working very hard to solve it. In our opinion, the critical point was probably passed sometime during fiscal 1980. With the rate of revenue growth likely to slow to more reasonable rates (40 to 50 percent) this year, the company has a good opportunity to truly get a handle on this problem.

The company is chewing up cash at about a $10 million per month rate and its balance sheet looks more like that of a public utility than a technology company (debt is approximately 63 percent of total capitalization). However, 60 percent of its debt is in the form of convertibles, half of which can be called and converted into common stock at the company's convenience and the recent convertible offering should cover the company's cash needs for at least nine months and possibly longer. The company's relatively lower rate of growth in its European business has also been a problem in the past, but extensive management changes have apparently improved the European situation markedly.

The risks are certainly there at Wang, but in our view, they are outweighed by two clear and overwhelming positives: excellent products, and brilliant product positioning and integration. Our earnings estimate is $2.80 per share fully diluted in the June 1981 fiscal year on a 45 percent revenue gain to $780 million.

PAPER AND FOREST PRODUCTS

One of the concerns voiced about the forest products companies is that an upturn in long-term interest rates could abort any major housing recovery in 1981, which in turn would exert downward pressure on lumber and plywood pricing. The concerns about housing starts next year is a valid one, but in our view, there are forces at work that can push plywood and lumber prices higher next year even with only a moderate rebound in housing starts.

In most years, prices are demand driven; in relatively weak years, prices are cost driven in this industry. In our opinion, the major determinant of lumber and plywood prices at present is the marginal cost of the small producer. Statistical work that we have done indicates that the correlation between marginal producer costs and end market prices during soft economic periods is very high.

Because the small producer has been paying substantially higher prices every year for stumpage, his costs are escalating at a very rapid rate. This in some measure explains the very rapid rebound in Western plywood pricing from $189 per thousand board feet in the second quarter to $224 at present.

In our view, even if housing starts move from an estimated 1.2 million level this year to only 1.5 million in 1981, the escalation in small producer costs will push plywood prices up 15 percent next year from present levels and lumber prices up 25 percent. We should caution that our model works in moderate housing start years, but not in very poor years. For example, if starts rebounded to only 1.3 million next year, we do not believe that our price expectations would be met.

If, however, starts reach 1.5 million next year and then move closer to 2 million by 1982, we believe that the outlook for the forest products producers would be extremely positive. In this environment, for example, we envision Western plywood averaging $265 per thousand board feet next year and reaching $400 per thousand board feet in the mid-1980s. Because of the relatively low stumpage costs of the large integrated producers, we believe that this scenario would produce very high rates of earnings gains for them.

We are in the process of working up earnings forecasts over the next two years for the major forest products companies, given differing housing scenarios. In a 1.5 million housing start year in 1981, for example, we believe that Weyerhaeuser could earn $3.75 per share and that Champion International could earn $4.15 per share, fully diluted.

SMALL COMPUTERS

In our view, there are currently two important developments at Digital Equipment. First, it is clearly gaining market share at the expense of its major rivals in the minicomputer business. Second, it is making a major bet on continued strong growth in demand for its products over the next two years.

Digital Equipment's fourth-quarter earnings were close to forecast. Hardware shipments in the fourth quarter at Digital grew 32 percent and total revenues grew 33 percent. It is our belief that incoming orders are presently running 30 percent or more higher than last year's. In comparison, we estimate that Data General's order growth at present is running at a 15 to 20 percent rate and that Hewlett-Packard's computer orders (excluding its Corvallis operation) are running 10 to 15 percent ahead on a year-to-year basis. In part, the high order rate at Digital can be explained by differences in product cycle timing. Digital's major new product, the VAX 11/780, is now in a relatively full order and shipment phase. In comparison, volume deliveries of Data General's new 32-bit machine will not begin until early 1981 and upgrades to HP's 3000 line have not yet been announced (more on HP in our Instruments section).

Capital expenditures at DEC are expected to increase to $350 to 400 million in the June 1981 fiscal year compared with $210 million in fiscal 1980. Most of the capacity will not be added until the end of fiscal 1981 or the beginning of fiscal 1982. While strong orders and long lead times at Digital ensure good revenue and operating income gains in fiscal 1981, the key is the level of demand about one year from now, when the new capacity comes on-stream. DEC is restricting new OEM customers because of long backlogs and we have some concern that this restriction, plus possible double ordering by existing OEM's, could cause a softening in demand in mid-1981 similar to that in 1978. While there are obvious economic risks, particularly because the minicomputer industry tends to lag the overall economy, it seems a good bet that the demand will be there when DEC needs it. For example, the much-rumored scaled-down version of its VAX 11/780 could be introduced to coincide with the increase in capacity.

We are projecting a 34 percent increase in operating earnings this year at DEC, but the earnings per share gain will be held down to about 15 percent, or $6.25 per share, by the heavy use of cash anticipated over the next twelve months, and by dilution caused by the recent convertible offering. Price increases instituted in the last six months will not impact shipments until the third fiscal quarter. We are anticipating only a modest improvement in operating margins in the second half when these products are shipped and more favorable margin comparisons would make our $6.25 per share estimate conservative. More importantly, if demand maintains itself in the following year, the rate of gain in earnings per share in fiscal 1982 should accelerate considerably.

INSTRUMENTS

Year-to-year gains in Test and Measurement (T&M) orders, by our estimates, are now running at or below 10 percent for the industry leaders (Hewlett-Packard, Tektronix) and at lower rates for some of the smaller competitors. The slowdown, first evidenced in the United States earlier this year, is now spreading overseas. More than half the gains are probably coming from price increases instituted in the last year. To date, the deceleration is no greater than we had forecasted; as noted in our last Portfolio Letter we expect orders to begin turning up in the first quarter of 1981.

Hewlett-Packard's third fiscal quarter sales were in line with our expectations but at the low end of our expected ranges in both incoming orders and earnings per share. Our biggest concern at Hewlett-Packard in terms of orders lies in its Computer Division. Total EDP Group orders for the third quarter were up 20 percent, but if one excludes the Corvallis, Oregon Division, which makes the highly successful hand-held calculators and personal computers, orders for the rest of the group were up an estimated 13 percent in the last quarter. As noted above in our Small Computer section, this order rate gain is markedly below that of Digital Equipment and somewhat below that of Data General, and it indicates particular softening in HP's major product line, the 3000.

The slowing in 3000 orders may be attributable to several different factors. First, IBM has begun shipping its System/38, which is a direct competitor to the HP 3000. Second, Hewlett-Packard has made very good penetration in the manufacturing market in the Mid-West, which has been particularly hard hit in the present recession. Third, customers may have heard about possible new products by Hewlett-Packard and may be holding back on orders.

There is no question but that Hewlett-Packard needs some upgrades of its 3000 line. We expect two introductions by Hewlett-Packard before the end of calendar 1980; one of them should be a high-end extension of the 3000. At present, Hewlett-Packard appears to be committed to 16-bit architecture in its 3000 line, despite the fact that all of its competitors have now introduced 32-bit products. In the commercial and manufacturing end markets that the HP 3000 serves, we do not believe that 32-bit capabilities are particularly important, and well designed 16-bit offerings can meet its customers' needs very effectively. However, the 3000 is reaching the end of its product life cycle. It is likely that the next generation product will incorporate 32-bit architecture.

Our estimates for Hewlett-Packard's earnings for fiscal 1980 and 1981 are now $4.40 to $4.45 per share and $5.10 per share respectively, down slightly from our previous forecasts. To maintain a positive attitude on Hewlett-Packard at this juncture necessitates a belief that management can make the right moves to accelerate the relative growth of its computer operation. Considering management's previous record, this does not appear to be a dangerous bet. In fact, it is the first time in several years that fundamental questions of any consequence about Hewlett-Packard have arisen.

SEMICONDUCTORS

The recent Motorola Analysts' Meeting contained almost no good news. Communications orders are soft and communications earnings will likely be down for all of 1980. Motorola's Semiconductor Group seems to be doing less well at present than its major competitors; as expected, the outlook for the automotive related divisions is uninspiring, and Codex profits will be down for the year.

Looking over the next 18 months, however, the positives and negatives are a bit more balanced. On the negative side are the following items:

- The major reason for DATAQUEST's historic enthusiasm for Motorola was the dramatic turnaround that we saw in the company's Semiconductor Group. In essence, that turnaround has already been effected. There appears little further room for margin expansion in semiconductors.

- The opportunities for management to improve profit margins in the Communications Group have always been present, but this has not happened to date and there is little reason to project any meaningful change in this scenario. In fact, if anything, Communication's margins seem to be declining somewhat on secular basis.

- The highly promising Codex Division is also suffering margin declines and the rate of revenue growth is decelerating.

- Its automotive business is skewed heavily towards domestic manufacturers.

On the positive side, however, we note the following:

- A good way of making money in Motorola historically has been to buy the stock when fundamentals look dull and sell the stock when consensus seems to be warming up to the opportunities for earnings acceleration. It appears that we are much closer to the former situation than the latter right now.

- Motorola is taking a much more conservative stance on the outlook for the semiconductor business over the next twelve months than are many of its competitors. In part, this is due to the fact that the company's large discrete business makes it the first to feel an economic downturn. The conservatism is also a sign of management's desire to avoid the bloodbath that occurred in 1975. If the semiconductor industry does get hit fairly hard in the next six months, Motorola will probably be better prepared than its competition.

- The company has sold two components of its Automotive Group this year, both of which were money losers. While the company will of course deny any intentions of further de-emphasis on the automotive market, any further retrenchments in the future would certainly be viewed very positively from an investment standpoint.

- We are presently estimating earnings of $5.35 per share for Motorola in 1980, versus $5.21 per share last year, which implies slightly lower earnings in the second half. Next year, however, earnings comparisons appear relatively easy in the communications group, government electronics, automotive, and Codex. It is not hard for us to make a case for $6.10 per share in 1981, although at this time we would view that as the top of a $5.70-6.10 range. The company's management has laid out such a conservative scenario for 1980, that it appears to us that any surprises that occur during the balance of 1980 may be on the upside, which would positively affect expectations for next year.

CAPITAL EQUIPMENT

We continue to believe that the outlook for Caterpillar Tractor over the next 12 to 18 months is unexciting, but that the ground work is being laid for a strong rebound in earnings beginning in 1982.

Caterpillar has filled up its dealer pipeline much more rapidly than we had anticipated in the first half of this year and this fact, coupled with the recession-related decline in retail sales of construction equipment, causes us to project only a 4 percent increase in total revenues this year, which adjusted for price increases would indicate a 6 percent decline in real unit sales. Fully diluted earnings should approximate the strike-depressed results in 1979, or about $5.50 per share fully diluted.

We believe that domestic revenues should start to improve by the second half of 1981 and foreign revenues should start accelerating in the fourth quarter of next year, but the turnaround will not come soon enough to result in good full-year comparisons. In total, we expect flat real domestic shipments in 1981, a 5 percent decline in real foreign shipments, and (assuming 10 percent price increases) a 7 percent increase in overall sales. Earnings may improve slightly next year to a $5.50 to $6.00 per share range fully diluted.

As noted above, the groundwork is being laid for a strong resurgence in growth beginning in 1982. Caterpillar is about to announce officially its first hydrostatic drive crawler loader, which we mentioned in our last Portfolio Letter. We expect hydrostatic drive to be expanded to cover almost all of Caterpillar's crawler loader and crawler tractor line within the next two years and we believe this could allow Caterpillar to make definite inroads into the market share of its competition, with the probable exception of Deere. In addition, we believe that demand for surface coal mining equipment will start to rebound in the second half of 1981 and that 1982 will be a very strong demand year for such products. Caterpillar has one of the largest exposures to the coal mining market, with about 25 percent of its domestic sales potentially affected. Therefore, it appears that many positive factors could start to affect the company simultaneously.

Michael R. Weisberg

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DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

Vol. II - No. 6 July 28, 1980

This letter is a condensation of recent Research Newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific Newsletters should be directed to the author. A list of recent DATAQUEST Newsletters appears at the end of this letter.

COPYING AND DUPLICATING

A lot of rumors seem to be in the air regarding Xerox. Speculation seems to center on possible new competitive product introductions at the high end by IBM and Kodak and the increasingly competitive stance of the Japanese manufacturers.

Xerox has the only products in the very high end of the copier market (DATAQUEST's Segment 6). The key to the long-term growth of Xerox in the copier business lies in Segment 6, which we expect to grow at a compound rate of between 25 and 30 percent worldwide over the next four years. Some of our competitors are talking about a direct competitive product announcement from IBM, and while this is possible, our sources indicate otherwise. We do expect an enhanced version of the IBM Copier III to be introduced within the next three months. However, this enhanced version should compete in Segment 4 and the lower portion of Segment 5 rather than Segment 6 and should not have any material impact on Xerox. In fact, our placement forecasts for Xerox assume just such an announcement by IBM. A strong competitive product by IBM at the high end of the market would definitely cause us to reduce our placement numbers for Xerox in Segment 6, but we frankly do not believe that such a product is likely. By 1984 DATAQUEST expects Xerox to still have 90 to 95 percent of the Segment 6 market revenues.

Ultimately, we do expect Kodak to introduce a direct competitive product to Xerox in Segment 6, but we do not expect this to happen soon. We believe that the next move for Kodak is down the product line (Segments 3 and 4) not up. If Kodak did introduce a product, the impact on Xerox would be much less significant than an IBM introduction, since Kodak lacks the extensive sales and service organization to make really strong penetration with such a product.

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To restate our often expressed opinion about the Japanese, we believe that they presently dominate the entire low end of the market, but that the lack of a sales and service organization will be an important impediment to their moving up the product line into some of Xerox's more lucrative markets. The recent introduction of the Canon NP Color Copier into the middle-range segment of the marketplace should have no real impact on Xerox. This product has been available in Japan for 7 years and has not been a strong competitive offering.

Our stance on Xerox continues to be that in a copier market growing at a long-term rate of about 18 percent, Xerox will grow at a 12-13 percent rate, maintaining share at the high end and losing it at the low end. Our earnings estimates remain at $7.25 per share for this year and $8.45 for 1981.

SEMICONDUCTORS

Industry conditions are clearly deteriorating, but the situation is not as bad as some would have us believe. The industry book-to-bill ratio, by DATAQUEST estimates, declined to a .83 to .87 range in June, not the .6 to .65 range reported by some. Inventories and back orders are getting cleaned out and only real business is presently being booked. Overpriced devices, principally memory, have seen prices fall more in line with costs. These are healthy industry developments at this stage in the economy.

It is our expectation that book-to-bill ratios in the industry should remain below 1.0 in July and August. By the fall, conditions should stabilize and then begin to improve, with book-to-bill ratios climbing back above 1.0 by year end.

In terms of shipments, we presently project a 4 percent sequential decline in third-quarter shipments followed by a 2 percent decline in the fourth quarter of this year, bringing the full year gain in shipments to about 26 percent. Beginning in the first quarter of 1981, some upturn in sequential shipments should occur. We expect U.S. consumption of semiconductors to increase by about 10 percent in 1981, but such an increase is as misleading towards understatement as this year's 26 percent growth is towards overstatement. The important factor is the rate of acceleration and deceleration in orders, and it is presently our posture that industry orders should begin accelerating early next year and gain momentum through 1981.

In terms of year-to-year shipment and earnings comparisons, the three most difficult periods should be the fourth quarter of 1980 and the first two quarters of 1981. While the possibility of lower earnings comparisons in some of these quarters is very real, our stance is basically a very positive one: there will be ample evidence of improving order trends in these quarters even though earnings comparisons may be disappointing.

At its quarterly analyst's meeting, Intel was understandably cautious about near-term business trends. They made one comment that was very relevant to our positive thesis, namely that unit demand is very strong and does not show signs of softening. As we have stated in the past, unit demand is the key to the industry outlook. If it holds, further price deterioration can be contained.

National Semiconductor is a company we have spoken favorably of in the past and we maintain our positive stance. National has two strong points going for it during a slowdown in industry activity: it is a low- cost producer in general who can fare relatively well when industry conditions tighten up and also it has a relatively large amount of linear and related industrial business where there are fewer competitors and where price competition during slack periods is usually somewhat less than for other market areas.

The biggest risk area for National in our view remains the computer business. We should point out two things in this regard however. First, National presently makes several times as much money in its semiconductor operation as it did five years ago. The relative impact of any writeoffs in computers would therefore not be nearly as significant in the total scheme of things at National as the problems in the consumer business were several years ago. Second, the company ran the consumer business very aggressively, trying to become a major factor in the market; it is not adopting the same strategy with computers. Because its aggressiveness is greatly diminished, the risk of downside surprises is diminished as well.

We are presently forecasting $3.10 per share for National in its 1981 fiscal year versus $2.58 per share in fiscal 1980. Our estimate conservatively assumes a $10 million operating loss in computers, despite the fact that this business is reportedly running at breakeven now. Our estimate implies little or no earnings growth in the second half of fiscal 1981, with a resumption in earnings growth beginning early in fiscal 1982.

INSTRUMENTS

It is clear that the rate of order growth in test and measurement (T&M) instruments is slowing, but thus far the deceleration has been very gradual. We are presently forecasting 15 percent growth in T&M industry shipments in 1980, somewhat higher than our 13 percent growth forecast made at the beginning of this year. This shift reflects the fact that the slowing in orders is coming somewhat later than we had anticipated. We would expect total industry order rates to slow in the second half of 1980 and then begin improving early in 1981.

Our preliminary projection for 1981 industry revenue growth is 16 percent, buoyed by continued strong growth from military and defense markets and a rebound in demand from communications end markets, which have been relatively lackluster so far this year. Normally, backlogs are worked down to below average levels after a period of order slowing, but because backlogs were very high entering the present slowdown, they should be at average levels entering 1981. This better than normal situation will also aid shipment growth next year. In short, then, we do not presently believe that the T&M market has much economic exposure over the next 12 months. This situation will benefit companies such as Hewlett-Packard, Tektronix, and luke.

Tektronix reported surprisingly good fiscal fourth-quarter results, with incoming orders up 23 percent and some improvement in gross margins. We believe that new product introductions at Tektronix should remain at a relatively high rate over the next eighteen months and add measurably to the company's overall order rates. Shipments in the present quarter will begin to reflect the full impact of the three price increases of fiscal 1980, which should allow the company to consistently improve sequential gross profit margins during fiscal 1981. Based on the strong fourth-quarter performance, we are raising our fiscal 1981 earnings estimate on Tektronix to $5.60 per share from our previous $5.30 per share forecast and continue to regard our forecast as conservative.

SMALL COMPUTERS

Order trends in the small computer business are beginning to show some impact from the recession, but the evidence is still very sketchy. Data General has recently begun to see some softening in overall order rates. As expected, the softness is focused on the company's hardware OEM customers. We understand that the response to the company's new MV 8000 computer has been very strong, although it is not encouraging orders until it begins actual shipments this fall. Despite the softening order picture and high OEM exposure, we see no reason for Data General's incoming orders to fare materially worse than the industry over the next twelve months, as MV 8000 orders should start building by the end of calendar 1980. The company should benefit from relatively easy margin comparisons for at least the next three quarters and probably longer. Our earnings estimates remain at $5.50 to $5.60 per share in fiscal 1980 and $6.75 to $7.00 per share in fiscal 1981.

Conversely, we believe that orders at Datapoint are relatively strong at present. Surprisingly, we sense that the low end of Datapoint's business, where one would reasonably expect some weakness to have developed is holding up very well. Part of the explanation may be that a lot of Datapoint's small business systems go to large corporations who would typically be less cyclically sensitive.

It appears that ARC orders have accelerated recently after a slower than anticipated start. Part of the order rate increase may be due to enhancements in memory availability and features such as remote inquiry capability to IBM terminals. However, a more likely reason for the acceleration in orders may be that it has taken longer than expected for the Datapoint sales force to learn how to market the ARC system effectively and for customers to understand and evaluate its capabilities. We also believe that extensions of the company's ARC system may occur during the present calendar year on both the high end and low end. These extensions would be very important, as we have had some concerns in the past about the maximum memory capabilities of Datapoint's processors. We are maintaining our $3.70 per share and $4.60 per share estimates for the July 1980 and 1981 fiscal years, but now have greater confidence in our numbers and believe that any changes may be on the upside.

PAPER AND FOREST PRODUCTS

As detailed in our last Portfolio Letter, we expect that stumpage prices in the Northwest and South should increase at 2 to 4 percent above the inflation rate over the next ten years, substantially higher than the historic rate of real price appreciation. Perhaps the best indication of current trends in stumpage pricing is the bids for stumpage in U.S. Forest Service land in the West.

In the past two recessions, bid prices peaked early in the recession and prices remained below the peaks for three years and two years respectively. In the second quarter of 1980, bid prices declined 17 percent from the first-quarter 1980 peak. As part of our thesis of escalating stumpage prices in the long term, it is our expectation that the period of depressed prices will be substantially shorter this time around.

We expect that the decline in prices may last for six months at most. We expect new highs on stumpage prices to be achieved no later than the first quarter of 1981. If this rapid pricing turnaround occurs, it would substantially support our bullish thesis on stumpage prices and might in fact indicate that we are understating the situation somewhat. This thesis would greatly favor those companies with low-cost timber holdings, particularly in the South. The primary beneficiary would thus clearly be Weyerhaeuser.

WORD PROCESSING

There are three ways of looking at the Displaywriter, IBM's new product introduction in the stand-alone word processing market: how it compares with what IBM previously offered to the marketplace, with the existing competition in the stand-alone word processing market, and with what the Displaywriter might look like in a year or so.

There is no question that IBM has significantly enhanced its position in the stand-alone market. Basically, IBM OPD had no real state-of-the-art product offering in this market segment; now it does. The most immediate impact will be on the existing IBM mag card product line. Previously, these users had a very limited upgrade path, the OS/6 line, and could easily stray towards other word processing vendors. Now they will be much more likely to stay with IBM.

The Displaywriter is very attractively priced on a pure hardware basis. In terms of equivalent hardware performance, the Displaywriter cost is about $11,000 per workstation versus competitive product offerings from CPT, Lanier, NBI, Wang, Xerox, and others that range from $10,000 to $15,000. However, all competitive products include software in the price of their systems, while IBM is charging separately for it. It is easy for us to foresee a typical IBM user paying $50 per month or more for the software licenses, which would cancel the price superiority of the IBM products. More importantly, IBM has offered very little software with the Displaywriter to date and its present capabilities do not compare with those of the competition. IBM plans to make additional software product offerings, but until it does, the lack of software affords the competition an easy way of selling around IBM.

Perhaps most significant however are the long-term implications for the Displaywriter. If IBM can introduce strong applications software (such as forms handling, mail lists, and a math package) over the next year or two, as we expect it will, this software will significantly enhance the product's capabilities. Furthermore, we expect IBM to ultimately offer more communications options that allow the Displaywriter to communicate with a broad range of IBM data processing and telecommunications equipment.

There is no question but that the Displaywriter can ultimately be a very powerful product offering. It is also true that the competition can now sense the direction that IBM is taking and have ample time to react.

CAPITAL EQUIPMENT

Part of the success that Deere has enjoyed in the construction equipment market over the past few years can be traced to the company's early introduction of hydrostatic drive transmissions in its crawler loaders and crawler tractors. It now appears clear that its sole source position in the hydrostatic drive market should end.

Caterpillar has announced its first hydrostatic drive crawler loader, the Model 943, to its dealers. While this product has not been shown on a retail level yet (probably allowing Cat dealers to reduce their inventories of the mechanical drive loaders that the 943 will replace), we expect retail introduction within a few months. Subsequently, we expect additional hydrostatic drive model introductions by Caterpillar in its larger crawler loader products.

Once successful implementation of hydrostatics in its crawler loader line is complete, we believe that Caterpillar will next move towards hydrostatic drive in its crawler tractor product line as well. While these moves by Caterpillar should obviously hurt Deere to some degree, the real losers will be the other competitors. We know of no other company who has hydrostatic drives under development, and implementation of this technology by both Caterpillar and Deere will definitely put the competitors (J. I. Case, International Harvester, Fiat-Allis, and possibly Komatsu) at a distinct long-term disadvantage. Incidently, Cat is developing its own hydrostatic drive and the hopes of some investors that Sunstrand, who supplies Deere with this component, will ultimately get a large new customer are unlikely to be realized.

Michael R. Weisberg

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DATAQUEST RESEARCH NEWSLETTER
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SEMICONDUCTOR INDUSTRY STATUS REPORT

SUMMARY

Semiconductor demand is reflecting the rapid worsening of the economy in the second quarter. Bookings have softened in the last three months with the June book-to-bill ratio for the U.S. semiconductor market declining to an estimated 0.85. Further weakness is expected in July, August, and September. Second-quarter U.S. consumption of semiconductors was up about 11 percent over the first calendar quarter, but quarter-to-quarter declines are expected in the third and fourth quarter.

Despite this expected weakness, U.S. semiconductor consumption in 1980 is expected to be up 26% over 1979. DATAQUEST presently estimates that 1981 will be up about 10% over 1980, reflecting the lack of momentum entering the year.

Hiring in the semiconductor industry has become much more selective. There have been a few layoffs by both semiconductor manufacturers and distributors, but most companies appear to be reluctant to reduce employment.

U.S. SEMICONDUCTOR MANUFACTURERS

In our Industry Update in April, we noted that a demand slowdown was imminent. That order weakness has now occurred. DATAQUEST has recently polled many of the U.S. semiconductor manufacturers and users regarding the current and future outlook. The integrated circuit manufacturers still see relatively strong business. Unit demand is still increasing, although at a slower rate. In most areas, excluding some memory, prices are not falling precipitously. MOS memory and microprocessor revenues in the third and fourth quarters are now projected lower than we expected six months ago. MOS memory is experiencing price softness, but still relatively good unit volume.

In 1980 DATAQUEST expects worldwide consumption of 16K dynamic RAMs to be an estimated 185 million units, up from 70 million units in 1979. Additionally, worldwide consumption of microprocessors is expected to exceed 150 million units, up from 75 million units in 1979. This strong unit growth should keep the quarter-to-quarter MOS revenue growth positive despite the price weakness.

The bipolar PROM and RAM business has been extremely strong with lead times still greater than 15 weeks. Demand is especially strong for some of the smaller volume, older components, due to discontinuation by some suppliers. We see strong demand and firm pricing holding in bipolar PROMs throughout 1980, with no near-term shortening of lead times.

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Low-power Schottky (LS) has become more available as Texas Instruments and others have increased their output. TI has taken LS off allocation, but this move has not been followed by all suppliers. Standard TTL has become more difficult to procure as fewer suppliers now remain and TI still has standard TTL on allocation.

Discretes consumption has been soft for several quarters, since it is more strongly tied to the consumer business. The first softening in discretes started over a year ago when the appliance industry and consumer electronics turned soft in the second quarter of 1979. DATAQUEST estimates that most discrete manufacturers are experiencing book-to-bill ratios below 0.8 at this time.

During June a few U.S. semiconductor companies began to experience more product returns than in previous months. It is too early to determine if this phenomenon will spread, but it is something that will be monitored carefully in the coming weeks.

INDUSTRY CAPACITY

There is no doubt that some suppliers have excess capacity in some product areas. This is especially true in MOS memory as wafer starts have increased, yields have improved, and IBM has temporarily pulled out of the merchant market for 16K RAMs. As a result of the excess of supply over demand, some suppliers have begun to de-emphasize this product as they shift their focus to the 64K dynamic RAM.

DATAQUEST has noted only minor reductions in capital spending plans by the merchant market semiconductor manufacturers. However, Motorola has reduced its semiconductor capital spending from $200 million to about $160 million this year, representing a 20 percent reduction. The cancellation of the planned Vancouver, Washington, facility by National is expected to delay some purchases. Elsewhere we have seen capital spending cuts ranging from 5 to 15 percent. Companies are continuing the acquisition of land and construction of buildings because these are long lead items whose impact is more than two years out.

The erratic behavior of the capital equipment business is evidenced by the fact that requisitions have been put on hold by certain manufacturers. In some cases this hold has been released once management has had time to reevaluate plans. Generally, captive manufacturers and merchant manufacturers acquired by larger corporations (e.g., Fairchild, Mostek) have retained their capital spending programs.

SUPPLIERS TO THE SEMICONDUCTOR INDUSTRY

DATAQUEST has learned that the suppliers of CERDIP and side-brazed ceramic packages have recently experienced a significant reduction in their business. In the first quarter of 1980, chemical suppliers for the industry experienced a decline in orders but they are now back to December's rate. Various other materials, such as mask blanks have seen order reductions. DATAQUEST believes this slowdown in business is partially due to a paring of incoming materials inventory by the semiconductor manufacturers. Reductions are more significant in the Eastern United States because the companies located in that area manufacture a higher proportion of discrete semiconductors. Silicon orders have not been impacted, and we believe industry wafer starts have not declined.

The suppliers of capital equipment have seen business continuing strong, but somewhat uneven. Large ticket items ranging upwards from $200,000 are experiencing strong business. Orders for DSW and projection aligners continue at a very strong pace, but the contact aligner market has softened. Orders for small ticket items, such as $10,000 to $20,000 testers, have declined somewhat. Delivery of major items continues at earlier projected rates because of the long lead times. It appears that the delivery of less expensive items with shorter lead times is being postponed one or two quarters by semiconductor manufacturers to avoid spending the money in 1980 and to allow more time to watch developments in the second half of the year. Orders for test equipment being shipped into the integrated circuit manufacturers have remained quite strong, but demand for testers going into the discrete device manufacturers has softened.

DISTRIBUTION

DATAQUEST has polled several of the major distributors of semiconductors and has found that book-to-bill ratios in April, May, and June have been quite soft with book-to-bills as low as 0.85. Shipments have been affected by customers purging their backlog and reducing incoming inventory. For example, DATAQUEST has learned that many mainframe and minicomputer companies have cut their incoming inventory from about twelve weeks down to less than four weeks as products have become much more readily available. Distributors have found that the computer segment is still strong with peripherals becoming a little soft. Telecommunications and military have been good, but the consumer sector has been very soft.

Daniel L. Klesken
Frederick L. Zieber

DATAQUEST RESEARCH NEWSLETTER
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TCIS Code: Newsletters

WORLDWIDE REVENUES FOR TELECOMMUNICATIONS SERVICES FORECASTED TO EXCEED $200 BILLION IN 1985

SUMMARY

This Newsletter provides a brief overview of the material presented in Telecommunication Industry Service, Section 1.2.1 on worldwide telecommunication service revenues.

DATAQUEST's forecasts for total worldwide revenues are $138.6 billion in 1980, rising to $217.6 billion in 1985 at a compound annual growth rate of 9.4 percent. Our estimates for the three major regions covered are as follows:

- North American revenues should go from $58.9 billion in 1980 to $94.6 billion in 1985, at a compound annual growth rate of 9.9 percent.
- Western European growth should go from $50.1 billion in 1980 to $73.7 billion in 1985, at a compound annual growth rate of 8.0 percent.
- Growth for the Rest of the World should go from $29.6 billion in 1980 to $49.3 billion in 1985 at a compound annual growth rate of 10.7 percent.

WORLDWIDE REVENUES AND GROWTH FACTORS

DATAQUEST's estimates for worldwide revenues for telecommunications services for the years 1980 and 1985 are shown in Figure 1. These figures are basically for voice communication and do not include revenues for data communication (covered in Telecommunication Industry Service, Section 1.2.2), telex, telegraph, or facsimile transmission services. Also excluded from our estimates are non-communications revenues, such as those for directory advertising which in North America, for example, we expect to exceed $3 billion in 1980. However, the figures do include revenues for image transmission — television and video telephone — where these transmissions are by common carrier service. Such revenues amount to only about 1 percent of the total.

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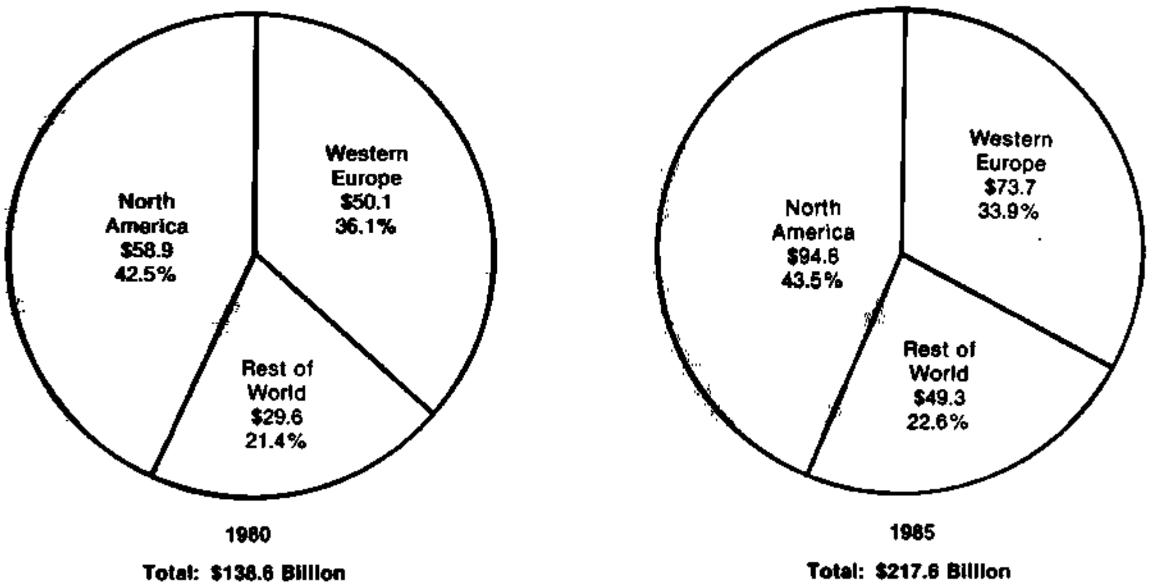
Figure 1
ESTIMATED WORLDWIDE REVENUES FOR TELECOMMUNICATIONS SERVICES
(Billions of Dollars)



Worldwide Average Annual Growth Rate: 9.4%

Source: DATAQUEST, Inc.

The estimated total worldwide revenues of $138.6 billion in 1980 and $217.6 billion in 1985 make up about 1-1/2 percent of the gross world product. Real revenue growth is attributed to three factors:

- Growth in the number of subscribers
- Growth in usage by each subscriber
- Increases in tariffs by telecommunications service suppliers

North American Revenues

The revenues for telecommunication services for North America are estimated by DATAQUEST to be $58.9 billion in 1980 and $94.6 billion in 1985. Canada should have a higher growth rate than the United States, both in increase of subscribers and in revenues per subscriber.

We estimate that the average revenue for each installed telephone should grow in real terms from $305 in 1980 to $397 in 1985 for North America. Long-distance revenues, which are charged on a usage basis, will continue to have appreciably higher growth than local revenues, which are still mostly on a flat-rate basis in this region.

Local U.S. Revenues - The revenues received in the United States by telephone operating companies for local services include both charges for equipment and for basic exchange services. These tariff charges are normally bundled so that the user is not aware of the distribution of costs between equipment and service.

DATAQUEST has estimated the revenues accruing to the Bell System and to the independent telephone operating companies for each of the major voice equipment categories, exclusive of network access charges. We forecast the total for 1980 to be $7.58 billion, including revenues from PBXs, key systems, and main and extension telephones.

Long-Distance U.S. Revenues - DATAQUEST forecasts that revenues for long-distance voice (and video) telecommunications services should increase from $29.1 billion in 1980 to $49.8 billion in 1985. These figures include approximately $500 million in 1980 and $1.6 billion in 1985 for revenues accruing to specialized common carriers and domestic satellite system operators. These revenues are largely for interstate services, and include COMSAT (Communications Satellite Corporation) revenues for its COMSTAR satellite, and SBS revenues for voice and video in 1985.

Western European Revenues

DATAQUEST forecasts that voice telecommunications revenues for Western European administrations — PTTs — should increase from $50.1 billion in 1980 to $73.7 billion in 1985. This 1985 figure should be significantly higher if greater increases in real revenue per telephone are made. However, most Western European countries appear to be holding tariff increases at or below the inflation rate. Since telephone service is run by the governments in almost all of Western Europe, there appears to be an attempt to avoid tariff increases above the inflation rate, which could be regarded as another form of increased taxation.

Rest of the World Revenues

The major territories considered in this region are Japan, Latin America, Africa and Oceania, and other Asian countries. Eastern bloc countries and mainland China are not included. Our forecasts for this region for 1980 and 1985 are $29.6 billion and $49.3 billion respectively for a compound average growth rate of 10.7 percent. Japan's revenues are expected to remain the largest in 1980 and 1985, being 56 percent and 46 percent respectively of total Rest of World revenues. We anticipate that revenue growth for Latin America and other Asian countries should be above average, while those for Africa and Oceania should be about average for this region.

Martin W. Fletcher

DATAQUEST RESEARCH NEWSLETTER
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MOS MICROPROCESSOR SHIPMENTS

SUMMARY

In the first quarter of 1980, worldwide shipments of MOS microprocessors were an estimated 31.6 million units, up about 19 percent over estimated fourth-quarter 1979 shipments of about 26.6 million units. First-quarter 1980 shipments were up a dramatic 184 percent over an estimated 11.1 million units shipped in the first quarter of 1979.

In the first quarter, 4-bit microprocessors represented about 67 percent of total worldwide unit shipments, while 8-bit and 16-bit microprocessor shipments represented about 32 percent and 1 percent, respectively, of the total unit shipments.

Figure 1 graphically shows the continuing growth in quarterly microprocessor shipments. The dramatic growth of 4- and 8-bit single-chip microcomputers (MCUs) is very evident from the figure. In the first quarter of 1980, microcomputer shipments represented 83 percent of total worldwide microprocessor shipments. Demand for microprocessors was strong in the first quarter of 1980, and continued in the second quarter. Prices generally remained firm throughout the first and second quarter of the year as demand still generally exceeds supply in many of the product areas.

QUARTERLY MICROPROCESSOR SHIPMENTS

DATAQUEST estimates of worldwide microprocessor CPU shipments for the first quarter of 1980 are presented in Table 1. DATAQUEST estimates refer to microprocessor CPU units only and do not include I/O or peripheral chips. Total microprocessor shipments in the first quarter of 1980 were an estimated 31.6 million units, up about 19 percent over the fourth quarter of 1979.

Table 2 presents DATAQUEST estimates of worldwide shipments of 4-bit single-chip microcomputers. In the first quarter of 1980 estimated shipments of 4-bit microcomputers were 21.1 million units, up about 19 percent over estimated fourth-quarter 1979 shipments of 17.7 million units. The 4-bit microcomputers are not second sourced and unit shipments are highly concentrated in a few families. The top five 4-bit microcomputer families (out of eight in total) represent 98 percent of the total 4-bit MCU shipments.

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Table 3 presents DATAQUEST estimates of worldwide shipments of 8-bit microcomputers. In the first quarter of 1980 an estimated 5.3 million units of the 8-bit MCUs were shipped, up 21 percent over an estimated 4.3 million units shipped in the fourth quarter of 1979. Demand for 8-bit single-chip microcomputers continued strong throughout the first and second quarters of 1980. Lead times for these mask ROM-based products are still in the 15- to 20-week range because of the inherent handling time for a mask ROM product. Prices for most of these products are in the $7.00 to $8.00 range, but high-volume pricing is now as low as $4.75 to $5.00.

In contrast with the 4-bit microcomputers, 8-bit microcomputers are widely second sourced. If one groups all of the 8048-based products (including the 8048, 8049, 8050, 8070, 8021, and 8022) into one family and then adds the PIC-1650 family and the 3870 family, one finds that these three MCU families represent 99 percent of all 8-bit MCUs. This high market share by three MCU families will likely decrease as the other families move into higher volume production.

4-BIT MICROPROCESSORS

DATAQUEST estimates of worldwide shipments of 4-bit microprocessors are presented in Table 4. In the first quarter of 1980, shipments of these products were an estimated 21.1 million units, up about 19 percent over the fourth quarter of 1979, and up 178 percent over the first quarter of 1979.

Current pricing on the major 4-bit microcomputers is still relatively firm in the $1.50 to $3.50 range depending upon the particular product. Some of the newer products with CMOS versions command premiums of two to three times these prices. Pricing remained relatively firm for most 4-bit products throughout the first half of 1980.

8-BIT MICROPROCESSORS

Worldwide shipments of 8-bit microprocessors in the first quarter of 1980 were an estimated 10.3 million units, up about 19 percent over estimated fourth-quarter 1979 shipments (Table 5). In the first quarter of 1980 8-bit single-chip microcomputers continued to increase their share of the total 8-bit microprocessor market, reaching 51 percent of the total, up from 50 percent in the fourth quarter of 1979.

Prices for the mature 8-bit microprocessors during the first and second quarter of 1980 were in the $3.50 to $6.25 range. Lead times for most of these products are generally less than five weeks.

12- AND 16-BIT MICROPROCESSORS

Table 6 presents estimates of worldwide shipments of 12-bit microprocessors. Shipments of the 12-bit microprocessors were an estimated 13,000 units in the first quarter of 1980, compared to an estimated 12,000 units in the fourth quarter of 1979 and an estimated 11,000 units in the first quarter of 1979.

Worldwide shipments of 16-bit microprocessors in the first quarter of 1980 were an estimated 231,000 units, up about 17 percent over estimated fourth quarter 1979 shipments (Table 7). Current pricing on most of the 16-bit microprocessors has declined somewhat in the first and second quarters of 1980 as the newer products are going from sampling into higher levels of production. The 8086 was priced in the $60 to $75 range, while the Z8000 and 68000 were priced in the $150 to $175 range.

PACKAGING

The vast majority of MOS microprocessors and microcomputers are packaged in 40-pin dual in-line plastic packages. We estimate that about 98 percent of the units are packaged in plastic with the balance using CERDIP or side-brazed ceramic. The exceptions to the 40-pin package are that some of the lower priced devices use 28 pins, while some of the 16-bit devices use 48 or 64 pins. Until now the 64-pin products such as the TMS 9900 have been packaged in side-brazed ceramic, but we understand that Texas Instruments has started to offer the 9900 family in a plastic package. This will be one of the first plastic packages for a 64-pin dual in-line package.

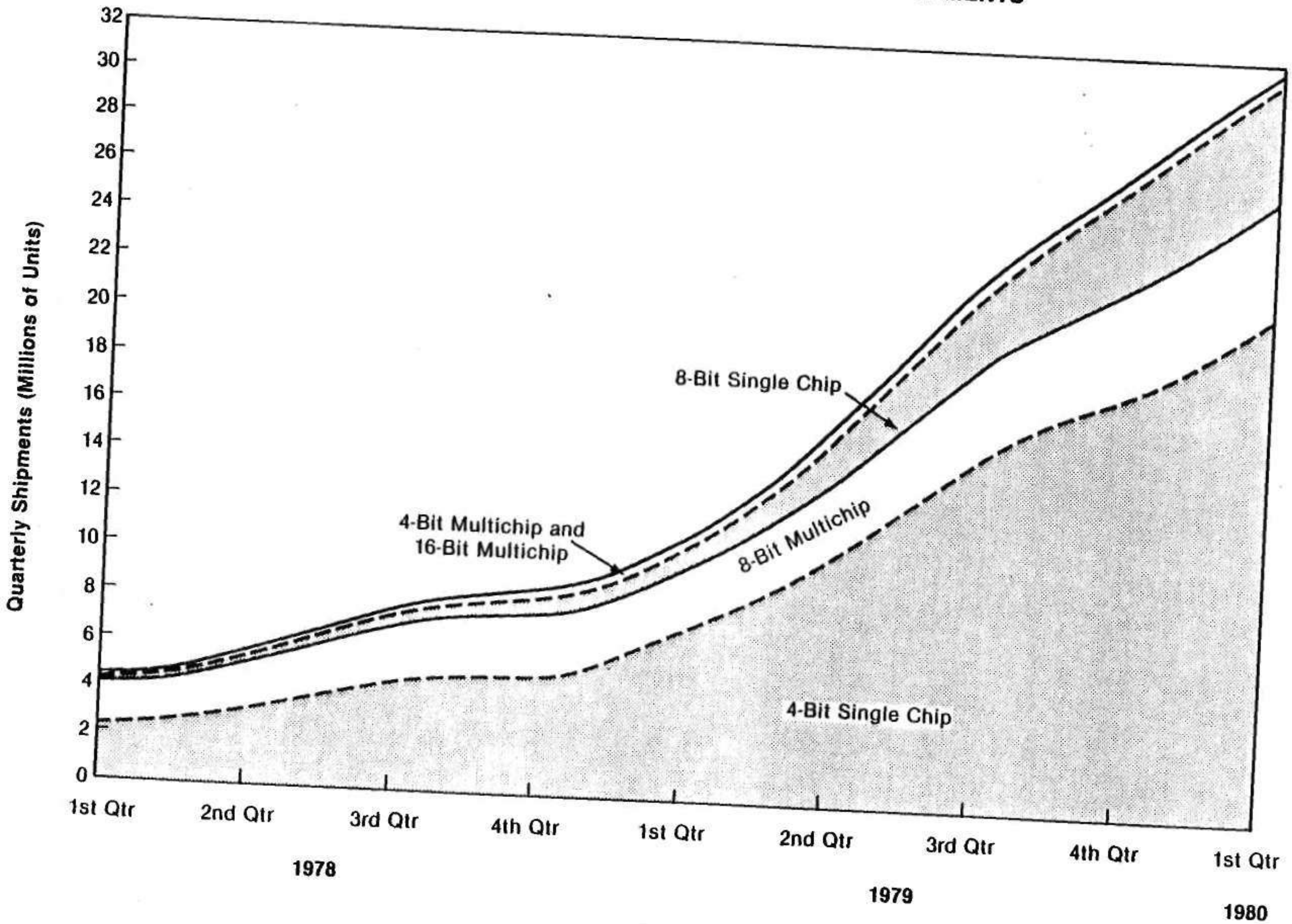
The importance of price competition in the microprocessor market dictates the use of a plastic package instead of a side-brazed or CERDIP package. The same microprocessor in plastic or CERDIP generally costs $0.50 to $1.00 more; in a side-brazed package it costs $8.00 to $11.00 more.

MULTISOURCED MICROPROCESSOR FAMILIES

Most of the 8-bit and 16-bit microprocessor products are multisourced. Figure 2 compares the total quarterly shipments by all suppliers of the major multisourced products. The figure shows the dramatic growth of the 8048 and 3870 families over the last few quarters as a result of strong shipments from primary sources as well as second sources. The 8048 family includes the combined shipments of 8048, 8049, 8050, 8070, 8021, and 8022 MCUs. The mature 8-bit MPU families such as the 6800, 8080A, 8085, and F8 are experiencing much lower quarter-to-quarter shipments growth. In fact the F8 shipments declined in the first quarter of 1980 and the 8080A and 6800 had a very small quarter-to-quarter shipments growth.

Daniel L. Klesken
Lane Mason

Figure 1
ESTIMATED WORLDWIDE MICROPROCESSOR SHIPMENTS



Source: DATAQUEST, Inc.

TABLE 1
ESTIMATED WORLDWIDE SHIPMENTS OF MOS MICROPROCESSORS
(THOUSANDS OF UNITS)

COMPANY	PRODUCTS	BITS	MOS PROCESS	1978 TOTAL	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 TOTAL	1980 1ST QTR
AMD	8080A	8	N	435	135	325	335	285	1080	235
	8085	8	N	5	15	40	75	70	200	60
	8048	8	N	0	0	S	3	20	23	5
	Z8000	16	N	0	0	0	0	S	S	1
AMI	S2000	4	N	29	50	300	675	400	1425	180
	6800	8	N	130	35	30	30	40	135	45
	6802/6808	8	N	0	S	10	10	30	50	40
	9900	16	N	0	0	0	S	5	5	5
EFCIS	6800	8	N	0	8	10	12	15	45	18
	6802	8	N	0	0	0	0	S	S	2
FAIRCHILD	F8	8	N	630	150	200	275	260	885	168
	3870	8	N	23	40	50	120	300	510	345
	6800	8	N	210	35	35	40	40	150	30
	6802/6808	8	N	S	S	S	15	30	45	54
GENERAL INSTRUMENT	PIC-1650	8	N	450	300	950	1250	1600	4100	1700
	CP-1600	16	N	60	15	20	20	25	80	30
HARRIS	6100	12	C	22	7	7	7	7	28	8
HITACHI	HMCS-40	4	C,P	410	130	150	175	200	655	225
	6800	8	N	70	50	100	125	150	425	175
HUGHES	1802	8	C	35	12	14	18	22	66	35
INTEL	4004	4	P	159	35	32	28	25	120	20
	8008	8	P	103	20	18	15	12	65	10
	8080A	8	C,P	705	190	200	210	180	780	200
	8048/8021	8	N	480	200	400	600	1000	2200	1300
	8049/8022	8	N	10	20	40	70	100	230	150
	8748	8	N	30	50	75	75	100	300	125
	8085	8	N	350	175	260	300	350	1085	400
	8086	16	N	24	13	15	19	25	72	32
INTERSIL	6100	12	C	15	4	4	5	5	18	5
MATSUSHITA (PANASONIC)	MN1400	4	N,C&P	N/A	500	800	1400	1700	4400	2200
MOS TECHNOLOGY	6500	8	N	225	65	70	80	90	305	250
MOSTEK	F8	8	N	160	90	125	125	130	470	55
	Z80	8	N	260	100	120	125	170	515	215
	3870	8	N	350	260	300	425	485	1470	530
MOTOROLA	141000	4	C	20	30	75	90	90	285	70
	6800	8	N	570	165	175	215	205	760	200
	6801/6803	8	N	0	0	S	3	10	13	15
	6802/6808	8	N	180	150	240	275	325	990	325
	6805	8	N	0	0	0	S	3	3	10
	6809	8	N	0	S	2	8	10	20	25
	3870	8	N	70	80	125	125	170	500	150
	68000	16	N	0	0	0	S	3	3	4
NATIONAL	COPS	4	N,C	2325	900	1100	1500	2100	5600	2700
	4004	4	P	130	30	26	20	15	91	12
	IMP	4	P	80	18	15	15	15	63	14
	8080A	8	N	375	150	175	220	240	785	250
	8048	8	N	0	0	0	0	S	S	S
	8049	8	N	0	0	0	S	10	10	25
	8050	8	N	0	0	0	0	S	S	5
	8070	8	N	0	0	0	0	S	S	S
	SC/MP	8	N	335	100	140	160	175	575	175
	PACE	16	N	86	25	25	25	25	100	22
NEC	COM-4	4	N,C&P	1500	1100	1300	2300	3100	7800	3300
	8080A	8	N	305	65	90	105	100	360	135
	8048/8049	8	N	15	25	160	350	450	985	810
	8085	8	N	30	55	75	120	150	400	240
	Z80	8	N	30	80	80	60	40	260	80
	768	16	N	0	0	0	0	S	S	S
PHILIPS/MULLARD	2650	8	N	0	0	0	0	S	S	5
	8048	8	N	0	0	0	0	S	S	2
RCA	1802	8	C	325	115	115	125	135	490	250
ROCKWELL	PPS-4	4	P	2275	600	1100	1100	1100	3900	1400
	6500	8	N	595	50	60	60	60	230	70
	6500/1	8	N	0	0	S	3	5	8	8
SGS ATES	Z80	8	N	S	5	15	25	35	80	40
	3870	8	N	S	5	10	15	20	50	20
SIEMENS	8080A	8	N	0	3	10	25	40	78	40
	8085	8	N	0	0	S	5	10	15	20
SIGNETICS	2650	8	N	125	45	90	110	110	355	115
	8048	8	N	S	15	30	60	75	180	60
SOLID STATE SCIENTIFIC	1802	8	C	22	10	11	12	10	43	0
SINERTEK	6500	8	N	680	100	120	280	300	800	500
TEXAS INSTRUMENTS	TMS 1000	4	C,P	9400	4200	5400	7500	9000	26100	11000
	TMS 8080A	8	N	135	32	25	18	5	80	0
	TMS 9900	16	N	185	68	80	92	105	345	120
	TMS 9940	16	N	0	0	0	S	5	5	10
THOMSON-CSF	6800	8	N	25	0	0	0	0	0	0
ZILOG	Z8	8	N	0	0	0	0	S	S	S
	Z80	8	N	550	195	250	375	450	1270	550
	Z8000	16	N	0	0	1	2	4	7	7
TOTAL MICROPROCESSORS				25748	11120	15820	22060	26576	75576	31637
PERCENT CHANGE FROM PREVIOUS QUARTER					33.3	42.3	39.4	20.5		19.0

SOURCE: DATAQUEST, INC.
JUNE 1980

TABLE 2
ESTIMATED WORLDWIDE SHIPMENTS OF 4-BIT MICROCOMPUTERS
(THOUSANDS OF UNITS)

			--------------1979-------------					1980
COMPANY	PRODUCTS	1978 TOTAL	1ST QTR	2ND QTR	3RD QTR	4TH QTR	1979 TOTAL	1ST QTR
AMI	S2000	29	50	300	675	400	1425	180
HITACHI	HMCS-40	410	130	150	175	200	655	225
MATSUSHITA (PANASONIC)	MN1400	N/A	500	800	1400	1700	4400	2200
MOTOROLA	141000	20	30	75	90	90	285	70
NATIONAL	COPS	2325	900	1100	1500	2100	5600	2700
NEC	COM-4	1500	1100	1300	2300	3100	7800	3300
ROCKWELL	PPS-4	2275	600	1100	1100	1100	3900	1400
TEXAS INSTRUMENTS	TMS 1000	9400	4200	5400	7500	9000	26100	11000
TOTAL MICROPROCESSORS		15959	7510	10225	14740	17690	50165	21075
PERCENT CHANGE FROM PREVIOUS QUARTER			37.9	36.2	44.2	20.0		19.1

SOURCE: DATAQUEST, INC.
JUNE 1980

TABLE 3
ESTIMATED WORLDWIDE SHIPMENTS OF 8-BIT MICROCOMPUTERS
(THOUSANDS OF UNITS)

			--------------1979-------------					1980
COMPANY	PRODUCTS	1978 TOTAL	1ST QTR	2ND QTR	3RD QTR	4TH QTR	1979 TOTAL	1ST QTR
AMD	8048	0	0	S	3	20	23	5
FAIRCHILD	3870	23	40	50	120	300	510	345
GENERAL INSTRUMENT	PIC-1650	450	300	950	1250	1600	4100	1700
INTEL	8048/8021	480	200	400	600	1000	2200	1300
	8049/8022	10	20	40	70	100	230	150
	8748	30	50	75	75	100	300	125
MOSTEK	3870	350	260	300	425	485	1470	530
MOTOROLA	6801/6803	0	0	S	3	10	13	15
	6805	0	0	0	S	3	3	10
	3870	70	80	125	125	170	500	150
NATIONAL	8048	0	0	0	0	S	S	S
	8049	0	0	0	S	10	10	25
	8050	0	0	0	0	S	S	5
	8070	0	0	0	0	S	S	S
NEC	8048/8049	15	25	160	350	450	985	810
PHILIPS/MULLARD	8048	0	0	0	0	S	S	2
ROCKWELL	6500/1	0	0	S	3	5	8	8
SGS ATES	3870	S	5	10	15	20	50	20
SIGNETICS	8048	S	15	30	60	75	180	60
ZILOG	Z8	0	0	0	0	S	S	S
TOTAL MICROPROCESSORS		1428	995	2140	3099	4348	10582	5260
PERCENT CHANGE FROM PREVIOUS QUARTER			53.1	115.1	44.8	40.3		21.0

SOURCE: DATAQUEST, INC.
JUNE 1980

TABLE 4
ESTIMATED WORLDWIDE SHIPMENTS OF 4-BIT MICROPROCESSORS
(THOUSANDS OF UNITS)

COMPANY	PRODUCTS	1978 TOTAL	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 TOTAL	1980 1ST QTR
AMI	S2000	29	50	300	675	400	1425	180
HITACHI	HMCS-40	410	130	150	175	200	655	225
INTEL	4004	159	35	32	28	25	120	20
MATSUSHITA (PANASONIC)	MN1400	N/A	500	800	1400	1700	4400	2200
MOTOROLA	141000	20	30	75	90	90	285	70
NATIONAL	COPS	2325	900	1100	1500	2100	5600	2700
	4004	130	30	26	20	15	91	12
	IMP	80	18	15	15	15	63	14
NEC	COM-4	1500	1100	1300	2300	3100	7800	3300
ROCKWELL	PPS-4	2275	600	1100	1100	1100	3900	1400
TEXAS INSTRUMENTS	TMS 1000	9400	4200	5400	7500	9000	26100	11000
TOTAL MICROPROCESSORS		16328	7593	10298	14803	17745	50439	21121
PERCENT CHANGE FROM PREVIOUS QUARTER			37.3	35.6	43.7	19.9		19.0

SOURCE: DATAQUEST, INC.
JUNE 1980

TABLE 5
ESTIMATED WORLDWIDE SHIPMENTS OF 8-BIT MICROPROCESSORS
(THOUSANDS OF UNITS)

			----------1979----------					1980
COMPANY	PRODUCTS	1978 TOTAL	1ST QTR	2ND QTR	3RD QTR	4TH QTR	1979 TOTAL	1ST QTR
AMD	8080A	435	135	325	335	285	1080	235
	8085	5	15	40	75	70	200	60
	8048	0	0	S	3	20	23	5
AMI	6800	130	35	30	30	40	135	45
	6802/6808	0	S	10	10	30	50	40
EFCIS	6800	0	8	10	12	15	45	18
	6802	0	0	0	0	S	S	2
FAIRCHILD	F8	630	150	200	275	260	885	168
	3870	23	40	50	120	300	510	345
	6800	210	35	35	40	40	150	30
	6802/6808	S	S	S	15	30	45	54
GENERAL INSTRUMENT	PIC-1650	450	300	950	1250	1600	4100	1700
HITACHI	6800	70	50	100	125	150	425	175
HUGHES	1802	35	12	14	18	22	66	35
INTEL	8008	103	20	18	15	12	65	10
	8080A	705	190	200	210	180	780	200
	8048/8021	480	200	400	600	1000	2200	1300
	8049/8022	10	20	40	70	100	230	150
	8748	30	50	75	75	100	300	125
	8085	350	175	260	300	350	1085	400
MOS TECHNOLOGY	6500	225	65	70	80	90	305	250
MOSTEK	F8	160	90	125	125	130	470	55
	Z80	260	100	120	125	170	515	215
	3870	350	260	300	425	485	1470	530
MOTOROLA	6800	570	165	175	215	205	760	200
	6801/6803	0	0	S	3	10	13	15
	6802/6808	180	150	240	275	325	990	325
	6805	0	0	0	S	3	3	10
	6809	0	S	2	8	10	20	25
	3870	70	80	125	125	170	500	150
NATIONAL	8080A	375	150	175	220	240	785	250
	8048	0	0	0	0	S	S	S
	8049	0	0	0	S	10	10	25
	8050	0	0	0	0	S	S	5
	8070	0	0	0	0	S	S	S
	SC/MP	335	100	140	160	175	575	175
NEC	8080A	305	65	90	105	100	360	135
	8048/8049	15	25	160	350	450	985	810
	8085	30	55	75	120	150	400	240
	Z80	30	80	80	60	40	260	80
PHILIPS/MULLARD	2650	0	0	0	0	S	S	5
	8048	0	0	0	0	S	S	2
RCA	1802	325	115	115	125	135	490	250
ROCKWELL	6500	595	50	60	60	60	230	70
	6500/1	0	0	S	3	5	8	8
SGS ATES	Z80	S	5	15	25	35	80	40
	3870	S	5	10	15	20	50	20
SIEMENS	8080A	0	3	10	25	40	78	40
	8085	0	0	S	5	10	15	20
SIGNETICS	2650	125	45	90	110	110	355	115
	8048	S	15	30	60	75	180	60
SOLID STATE SCIENTIFIC	1802	22	10	11	12	10	43	0
SYNERTEK	6500	680	100	120	280	300	800	500
TEXAS INSTRUMENTS	TMS 8080A	135	32	25	18	5	80	0
THOMSON-CSF	6800	25	0	0	0	0	0	0
ZILOG	Z8	0	0	0	0	S	S	S
	Z80	550	195	250	375	450	1270	550
TOTAL MICROPROCESSORS		9028	3395	5370	7087	8622	24474	10272
PERCENT CHANGE FROM PREVIOUS QUARTER			26.2	58.2	32.0	21.7		19.1

SOURCE: DATAQUEST, INC.
JUNE 1980

TABLE 6
ESTIMATED WORLDWIDE SHIPMENTS OF 12-BIT MICROPROCESSORS
(THOUSANDS OF UNITS)

			1979					1980
COMPANY	PRODUCTS	1978 TOTAL	1ST QTR	2ND QTR	3RD QTR	4TH QTR	1979 TOTAL	1ST QTR
HARRIS	6100	22	7	7	7	7	28	8
INTERSIL	6100	15	4	4	5	5	18	5
TOTAL MICROPROCESSORS		37	11	11	12	12	46	13
PERCENT CHANGE FROM PREVIOUS QUARTER			0.0	0.0	9.1	0.0		8.3

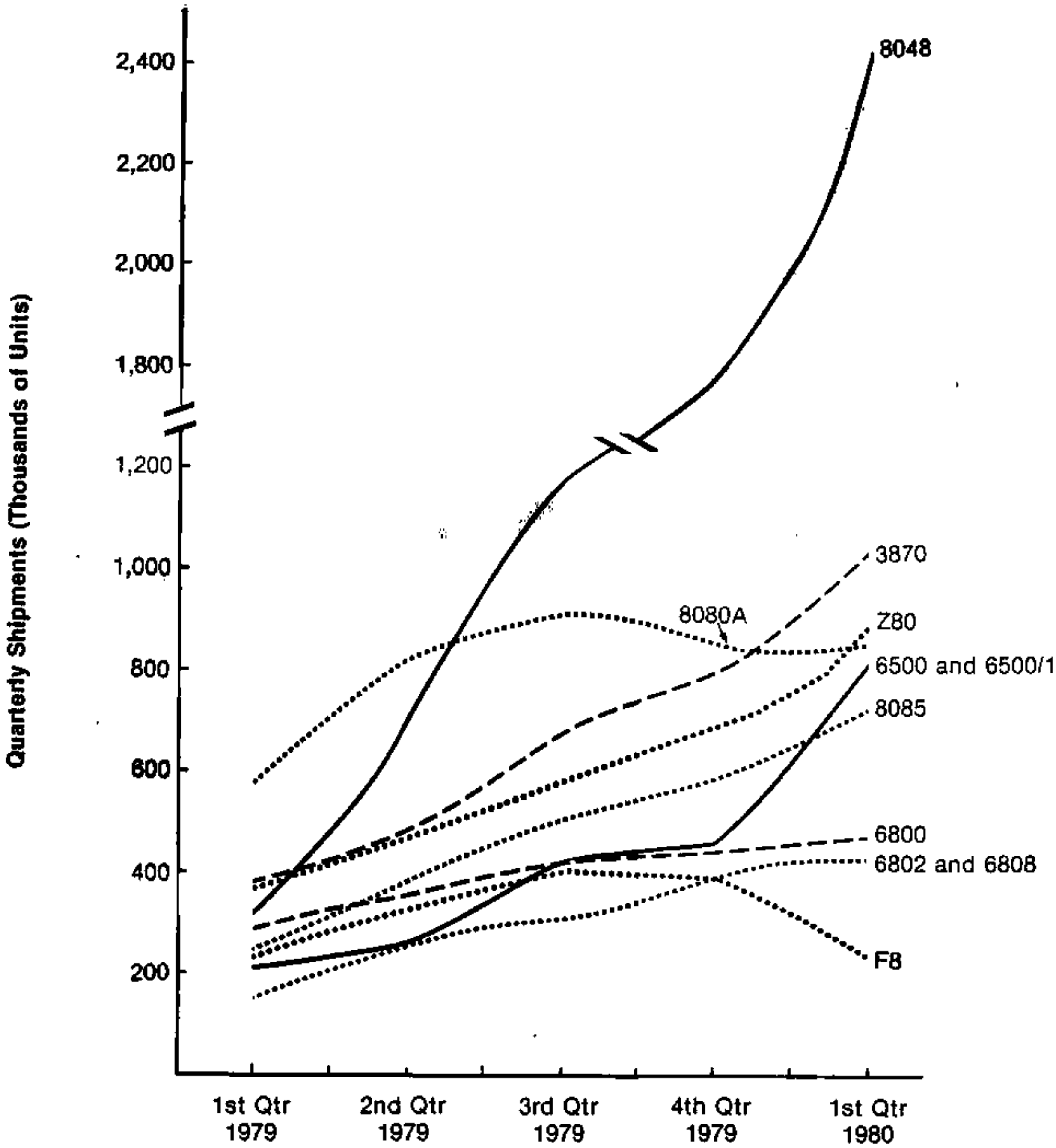
SOURCE: DATAQUEST, INC.
JUNE 1980

TABLE 7
ESTIMATED WORLDWIDE SHIPMENTS OF 16-BIT MICROPROCESSORS
(THOUSANDS OF UNITS)

			1979					1980
COMPANY	PRODUCTS	1978 TOTAL	1ST QTR	2ND QTR	3RD QTR	4TH QTR	1979 TOTAL	1ST QTR
AMD	Z8000	0	0	0	0	S	S	1
AMI	9900	0	0	0	S	5	5	5
GENERAL INSTRUMENT	CP-1600	60	15	20	20	25	80	30
INTEL	8086	24	13	15	19	25	72	32
MOTOROLA	68000	0	0	0	S	3	3	4
NATIONAL	PACE	86	25	25	25	25	100	22
NEC	768	0	0	0	0	S	S	S
TEXAS INSTRUMENTS	TMS 9900	185	68	80	92	105	345	120
	TMS 9940	0	0	0	S	5	5	10
ZILOG	Z8000	0	0	1	2	4	7	7
TOTAL MICROPROCESSORS		355	121	141	158	197	617	231
PERCENT CHANGE FROM PREVIOUS QUARTER			14.2	16.5	12.1	24.7		17.3

SOURCE: DATAQUEST, INC.
JUNE 1980

Figure 2
ESTIMATED WORLDWIDE SHIPMENTS OF MULTISOURCED MICROPROCESSORS



Source: DATAQUEST, Inc.

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THE WESTERN EUROPEAN SEMICONDUCTOR MARKET

SUMMARY

The Western European market for semiconductors was an estimated $2.9 billion in 1979, up about 26 percent from $2.3 billion in 1978. In 1980 the market is forecast to grow about 15 percent to an estimated $3.4 billion. European consumption of integrated circuits should grow about 22 percent from $1.6 billion in 1979 to $1.9 billion, and total consumption of discrete devices should grow about 6 percent from $1.3 billion in 1979 to $1.4 billion in 1980. The European semiconductor market is expected to experience a strong demand from the computer and industrial segments, but a weak demand from the consumer segment. Excess inventory of color television sets as well as a softening of the European economy are leading to reduced consumer electronics consumption.

The 1980 semiconductor consumption in France is expected to grow about 26 percent to $646 million, up from an estimated $510 million in 1979. In West Germany 1980 semiconductor consumption is estimated up 20 percent to about $1,237 million compared with $1,031 million in 1979. The United Kingdom's 1980 semiconductor consumption is estimated up 18 percent to about $572 million.

WESTERN EUROPEAN SEMICONDUCTOR CONSUMPTION

Table 1 presents DATAQUEST's estimates of semiconductor consumption in Western Europe. Total European semiconductor consumption in 1980 is estimated at $3.4 billion, up about 15 percent from 1979 levels. Total IC consumption is estimated at $1.93 billion, up about 22 percent, whereas discretes are up about 7 percent to $1.29 billion, and optoelectronic components are is up about 26 percent to $195 million.

The year-to-year growth of semiconductor consumption in various countries depends greatly upon the currency valuation used to express the growth. Table 2 compares the years 1978 and 1979 for the United States, France, Germany, Japan, and the United Kingdom. First the year-to-year growth is expressed as a percent change in local currency, and then it is expressed as a percent change in U.S. dollars where the local currency was converted to U.S. dollars at the exchange rate of the given year.

Table 1

ESTIMATED WESTERN EUROPEAN SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1977	1978	1979	1980
Total Semiconductor	$1,819	$2,340	$2,940	$3,414
Total IC	$ 830	$1,166	$1,578	$1,930
Bipolar Digital	$ 259	$ 371	$ 496	$ 587
MOS	$ 278	$ 428	$ 612	$ 763
Linear	$ 293	$ 367	$ 470	$ 580
Total Discrete	$ 907	$1,059	$1,207	$1,289
Transistor	$ 453	$ 485	$ 532	$ 570
Diode	$ 327	$ 422	$ 510	$ 543
Thyristor	$ 99	$ 113	$ 121	$ 130
Other	$ 28	$ 39	$ 44	$ 46
Optoelectronic	$ 82	$ 115	$ 155	$ 195

Source: DATAQUEST, Inc.
June 1980

Table 2

EFFECT OF CURRENCY VALUATION ON
SEMICONDUCTOR CONSUMPTION GROWTH RATES

Country	Currency (in Millions)	1978	1979	Percent Increase in Local Currency
United States	U.S. Dollars	3,323	4,625	39.2%
France	French Francs	1,683	2,162	28.4%
Germany	Deutsche Marks	1,663	1,876	12.8%
Japan	Yen	512,048	592,305	15.7%
United Kingdom	Pounds	195	228	16.9%

Country	Currency (in Millions)	1978	1979	Percent Increase in U.S. Dollars
United States	U.S. Dollars	3,323	4,625	39.2%
France	U.S. Dollars	379	510	34.6%
Germany	U.S. Dollars	840	1,031	22.7%
Japan	U.S. Dollars	2,487	2,676	7.6%
United Kingdom	U.S. Dollars	375	485	29.3%

Exchange Rate (Foreign currency units per U.S. Dollar)

	1978	1979
France (Francs)	4.44	4.24
Germany (Deutsche Marks)	1.98	1.82
Japan (Yen)	205.89	221.34
United Kingdom (Pounds)	0.52	0.47

Source: DATAQUEST, Inc.
June 1980

Between 1978 and 1979, the currencies of France, Germany, and the United Kingdom strengthened against the dollar (i.e., it took fewer local currency units to buy $1.00) and, hence, the percent change in 1979 expressed in the local currency is lower than the percent change expressed in dollars. In West Germany and the United Kingdom, the growth rate of semiconductor consumption expressed in the local currency was a little more than half the growth rate expressed in dollars. Therefore, to a company conducting business in dollars, the market in West Germany or the United Kingdom appeared to be much better than to a company conducting business in the local currency. In Japan, the yen weakened against the dollar, hence the percent change expressed in yen was higher than the percent change expressed in dollars.

In generating Table 1, every attempt was made to look first at the consumption expressed in local currency and then to convert it to U.S. dollars. All percentage changes expressed in this Newsletter were calculated using values in U.S. dollars unless otherwise stated.

ESTIMATED EUROPEAN SEMICONDUCTOR CONSUMPTION BY COUNTRY

Western Europe cannot easily be treated as a single economic entity. The different nations, differing nationalities, customs, and political leanings affect each country differently. In the following paragraphs, we present estimates of European semiconductor consumption by country (Table 3) as well as a discussion of GNP growth for the individual Western European countries (Table 4).

Table 3

ESTIMATED EUROPEAN SEMICONDUCTOR CONSUMPTION BY COUNTRY

(Millions of Dollars)

	1978		1979	
Country	Semiconductor Consumption	Percent of Total	Semiconductor Consumption	Percent of Total
West Germany	$ 840	35.8%	$1,031	35.0%
France	379	16.2	510	17.4
United Kingdom	375	16.0	485	16.5
Italy	220	9.4	295	10.0
Sweden	98	4.2	115	3.8
Netherlands	84	3.6	98	3.3
Switzerland	77	3.3	85	2.9
Spain	56	2.4	61	2.2
Belgium	54	2.3	62	2.1
Austria	37	1.6	50	1.7
Denmark	35	1.5	42	1.4
Finland	28	1.2	35	1.2
Norway	27	1.2	34	1.2
Portugal	18	0.8	22	0.8
Ireland	12	0.5	15	0.5%
Total	$2,340	100.0%	$2,940	100.0%

Source: DATAQUEST, Inc.
June 1980

Table 4 includes a composite number for GNP growth in Western Europe. It shows annualized GNP growth for 1980 estimated to be 2.7 percent, down slightly from estimated growth of 2.9 percent in 1979. This compares favorably with estimated decline in the U.S. GNP of 1 percent in 1980 and increase of 2.3 percent in 1979.

Table 4

ESTIMATED GROSS NATIONAL PRODUCT GROWTH

(Percent Increase Over Preceding Year)

	Estimated Growth 1978	Estimated Growth 1979	Estimated Growth 1980
European Countries			
Austria	1.5%	5.0%	2.2%
Belgium	2.2%	3.2%	2.0%
Denmark	2.0%	2.0%	(1.0%)
France	4.7%	3.2%	1.5%
Italy	2.5%	3.7%	0.5%
Netherlands	2.0%	3.1%	2.5%
Norway	3.0%	3.0%	3.8%
Portugal	3.3%	3.0%	3.7%
Spain	2.0%	1.0%	0.5%
Sweden	2.2%	4.2%	3.0%
Switzerland	1.0%	1.5%	3.0%
United Kingdom	3.2%	1.0%	(1.5%)
West Germany	3.3%	4.7%	2.5%
All of Western Europe	2.8%	2.9%	2.7%
United States	5.0%	2.3%	(1.0%)
Japan	8.6%	6.1%	3.2%

Source: DATAQUEST, Inc.
June 1980

West Germany

After growing almost 23 percent in 1979 to $1,031 million, West German consumption of semiconductors is expected to grow about 20 percent to an estimated $1,237 million in 1980. Computers and telecommunications are the major elements of this semiconductor consumption growth as the consumer segment is expected to be weak in 1980.

GNP growth in West Germany in 1980 is estimated to be 2.5 percent, down markedly from 1979 growth of 4.7 percent. The balance of payments surplus decreased sharply in the first quarter of 1980 and the Bundesbank's efforts to control the growth in the money supply could result in increased unemployment. Consumer prices are expected to increase by 6.3 percent in 1980 after very slow growth of 3.7 percent in 1979.

France

Semiconductor consumption in France during 1980 is expected to grow about 26 percent to an estimated $646 million, up from $510 million in 1979. Just as in West Germany, the fastest growing markets in France are expected to be the computer and communications segments. The French GNP grew by 3.2 percent in 1979, but in 1980 the increase is expected to be only about 1.5 percent. The inflation rate in 1980 is expected to be about 15 percent, up from an estimated 11.5 percent inflation rate in 1979.

United Kingdom

Total semiconductor consumption in the United Kingdom in 1979 was an estimated $485 million, up from an estimated $375 million in 1978. In 1980 this total is expected to increase about 18 percent to an estimated $572 million. The outlook for semiconductor consumption in the United Kindom is still reasonably good in spite of the fact that the United Kingdom is facing a period of sharp recession. Mrs. Thatcher's monetary policies do not appear to be working and potentially high wage inflation is still a serious problem. The consumer price index is expected to increase by 16.5 percent in 1980, which is up from an increase of 13.4 percent in 1979. The GNP is expected to decline by at least 1.5 percent in 1980 compared with 1979.

Benelux

Semiconductor consumption in Belgium and the Netherlands, is somewhat moderate compared with France and West Germany. In 1979 Belgium consumed an estimated $62 million in semiconductors while the Netherlands consumed an estimated $98 million. Belgium and the Netherlands are expected to achieve moderate economic growth in 1980 of 2.0 percent and 2.5 percent, respectively. Belgium depends to a large degree on its exports of steel for its income, so a downturn in the world economy is likely to affect Belgium adversely.

Scandinavia

Sweden was the largest user of semiconductors in Scandinavia, consuming $115 million in 1979. Denmark and Norway consumed $42 million and $34 million respectively in 1979.

The economies in the Scandinavian countries are generally expected to grow more slowly this year than in 1979. Sweden's GNP is expected to grow only by 3 percent compared with 4.2 percent in 1979. A decline of 1 percent is predicted for the Danish economy since Denmark as well as Sweden is adversely affected by the need to import oil. North Sea oil makes Norway a net exporter of oil and this, combined with the relaxation of the austerity measures in effect in 1979, should produce a growth in GNP of 3.8 percent in 1980.

Central and Southern Europe

The countries of Austria, Italy, Portugal, Spain, and Switzerland are included in this region. Among these, Italy has the largest semiconductor consumption estimated at $295 million in 1979. Each of the other countries consumed less than $100 million during 1979.

Austria's GNP grew by 5 percent in 1979 making it one of the fastest growing countries in Europe in that year, but a more modest growth of 2.2 percent is forecast for 1980. Switzerland's GNP grew by only 1.5 percent in 1979, but a higher growth rate of 3.0 percent is expected for 1980. Italy achieved an increase of 3.7 percent growth in 1979. However, the worsening economic situation will probably result in growth of less than 1 percent in 1980. Spain, with its serious problems of unemployment and inflation, is expecting a 1980 GNP growth of less than 1 percent, whereas Portugal's GNP is expected to increase an estimated 3.7 percent, up from 3 percent growth in 1979.

THE SEMICONDUCTOR INDUSTRY IN WESTERN EUROPE

Joint Ventures and Government Participation

In the last three years, the governments of the major Western European countries have come to realize the importance of the semiconductor industry to their economies. Additionally, European industry has recognized the importance of becoming more self-sufficient in integrated circuits. As a result of this awareness, a number of joint ventures and government-funded development programs have been established. Some of these are described briefly in the following paragraphs.

United Kingdom

Britain's major entry into the integrated circuits arena is INMOS. Partly funded by the National Enterprise Board (NEB), it has a design facility in Bristol, England, and a production facility in Colorado Springs, CO. The initial products of INMOS will be a 16K static MOS RAM and a 64K dynamic MOS RAM which are to be followed by microprocessor products.

Since the founding of INMOS in 1978, there has been a change of government in Britain and with it a change in the political climate. The Conservative Government of Margaret Thatcher has been selectively disposing of NEB holdings since it took office. Although the rationale for funding INMOS was the establishment of a British presence in the integrated circuits field, the suitability of government involvement in an entrepreneurial role in such a fast-moving, unpredictable industry has been questioned. The possibility of a link between General Electric Company (GEC) (Britain) and INMOS was discussed but GEC has now decided against this. Other private investors are apparently considering INMOS at present. The Government has still not given INMOS the second $50 million grant that was expected.

GEC is also involved in a joint venture with Fairchild to build a semiconductor plant in Neston, Cheshire. Since the agreement was made, Fairchild has been acquired by Schlumberger of France, but the plant is going ahead on schedule according to GEC.

The British Government has also made substantial investments in microprocessor applications funding, specifically with the Microprocessor Applications Project (MAP). Under this project, companies can obtain financial support from the Government for the investigation and application of microprocessors to their products.

West Germany

The West German government gives matching funds to a number of semiconductor projects through the Ministry for Research and Technology. It is giving major support to VLSI research; AEG-Telefunken, Siemens, and Valvo are the major companies involved in this area.

Several German companies have established connections with American semiconductor companies. Siemens purchased Litronix as well as Microwave Semiconductor and Sitronix (formerly FMC); it also has a minority holding in Advanced Micro Devices (AMD). Siemens second-sources the Intel 8080 and 8085 microprocessors. Robert Bosch has an interest in American Microsystems.

France

In 1977 the French government acted to establish a French semiconductor industry. The plans included $200 million of government subsidies and the encouragement of links between French and American semiconductor companies.

In April 1979 National Semiconductor and Saint-Gobain-Pont-a-Mousson agreed to establish a joint MOS manufacturing subsidiary known as Eurotechnique. National Semiconductor has a 49 percent holding in the company and is mainly contributing technological information. Funding for the venture is coming from Saint-Gobain and from the French government's IC program.

The Matra Group is building a $40 million fabrication facility in Nantes, France, in cooperation with Harris Semiconductor of Melbourne, Florida. The facility will manufacture CMOS circuits and plans to start shipping products in 1981.

EFCIS, a joint venture between Thomson-CSF and the French atomic energy authority, currently produces mainly custom MOS circuits but is planning to expand its line of standard NMOS circuits and hopes to double its sales and place more emphasis on standard products by 1982. Thomson-CSF and EFCIS also made a technology transfer and second-source agreement with Motorola in November 1978.

Italy

Italy has developed an overall electronics plan which includes support for the semiconductor industry. SGS-ATES is the major recipient of this support. They manufacture linear and MOS integrated circuits as well as discrete components. They have agreements with Zilog to second source the Z-80 and Z-8000 microprocessors.

Government Incentives for the Location of Industry

Apart from involvement in joint ventures, many countries in Europe, realizing the need to establish local microelectronics fabrication facilities, are offering substantial incentives to companies that build facilities in their areas. Some examples are given below.

United Kingdom

The United Kingdom offers a variety of incentives for different locations. These include tax breaks, grants for factory building, and financial assistance for retraining employees. In England, the main areas to receive such support are in the industrial North.

Scotland - Depending on the location chosen, the Scottish Development Agency will offer substantial financial assistance and concessions for plants located in Scotland. The Wolfson Microelectronics Institute at Edinburgh University (recently nominated as one of the two U.K. centers for the development of microelectronics technology) offers a source of appropriately trained graduates. Both Motorola and National Semiconductor have established facilities in Scotland.

Wales - Wales offers a wide range of grants and tax incentives to companies locating there. Several Welsh universities, including Bangor and Swansea, have major electronics departments. Bangor includes an Industrial Development Unit to make the facilities and expertise of the University available to industry. Siliconix has an assembly plant near Swansea and is considering a wafer fabrication facility. Several Japanese companies, including Sony and Matsushita, are also established in Wales.

Ulster - In Northern Ireland the Industrial Development Organization is offering cash grants for plant construction, equipment, and training costs to encourage new industry. International Rectifiers has had a subsidiary in Newry since 1969.

Republic of Ireland

The Industrial Development Authority of the Republic of Ireland is endeavoring to attract high-technology industry to the country by offering grants of up to 55 percent of the cost of fixed assets as well as tax exemptions for profits on exports until 1990. A new plan, which will eventually replace the existing one, reduces the current tax rate of 45 percent on corporate profits to 10 percent. Analog Devices built a design and fabrication facility near Limerick in 1978 and Unitrode is building a plant near Shannon which will be completed this year. Mostek has committed to a major expansion in Dublin. It will begin with testing of components but will eventually do wafer fab there as well.

France

There are a number of areas in France that are currently endeavoring to attract high-technology industry. The West Atlantic area, which includes Brittany and the Loire Valley, is offering an incentive package which includes $5,000 per job created, local tax exemptions, and vocational training aid. They are particularly interested in establishing the area as a center for electronics, and several major electronics facilities including Thomson-CSF and SGS-ATES are already in operation.

Tax incentives and low-cost sites are being offered to attract the electronics industry to the Valbonne area close to the Mediterranean coast between Nice and Cannes. Texas Instruments and IBM both have plants in the area.

Public Perceptions of the Microelectronics Industry

Despite the incentives offered by European governments for the establishment of semiconductor facilities in their countries, public opinion on the subject is more ambivalent. In an environment where unemployment is increasing, the most immediate worry is that with more automation, unemployment will increase further. Recent forecasts published for the United Kingdom predict total unemployment by the end of 1980 will be 1.7 million compared with 1.2 million in October of 1979.

The microelectronic revolution is viewed by many as comparable to the Industrial Revolution of the last century. In Europe major technological change is seen as causing short-term upheaval followed by long-term benefits. It is the magnitude of the possible short-term upheaval that worries many people.

European Trade Union concern is that the introduction of microelectronic technology will cause high structural unemployment. The European Trade Union Institute (ETUI) in Brussels published a report in November 1979 expressing these concerns. Specifically they feel that unions should have early access to information on the proposed introduction of new technology in order "to ensure that the technology is introduced at a pace at which its social impact can be spread fairly over societies, and to ensure that the benefits of new technology accrue to working people." The general opinion seems to be that, while the technological advances are welcome, care must be taken so that no one sector of the population bears an unreasonable burden because of the changes.

END-USER MARKETS IN WESTERN EUROPE

Table 5 presents DATAQUEST's estimate of end-user consumption in Western Europe compared with that of the United States. The consumer segment plays an important role in semiconductor consumption in Western Europe using about 33 percent of the total as compared with only 16 percent of the total in the United States. In the industrial segment, Europe consumes about 35 percent of the total whereas the United States consumes an estimated 32 percent. The United States consumes far more semiconductors in the computer segment with an estimated 40 percent compared with only 23 percent computer consumption in Europe. The government and military consumption is nearly equal, with Europe consuming 9 percent and the U.S. consuming 12 percent.

Table 5

ESTIMATED END-USER MARKETS - 1979

(Percent)

	Western Europe			United States
	Discrete	Total IC	Total Semiconductor	Total Semiconductor
Computer	14%	29%	23%	40%
Industrial	44%	28%	35%	32%
Consumer	35%	32%	33%	16%
Automobile	3%	5%	4%	4%
Television	18%	14%	17%	4%
All Other Consumer	14%	13%	12%	8%
Government & Military	7%	11%	9%	12%

Source: DATAQUEST, Inc.
June 1980

EUROPEAN MARKET SHARES

Table 6 presents DATAQUEST estimates of the worldwide revenues of European semiconductor manufaturers for the years 1977, 1978, and 1979. Worldwide semiconductor revenues of the European producers in 1979 were an estimated \$1.8 billion, up about \$300 million from an estimated \$1.5 billion in 1978. This growth rate of 21 percent is less than the 27 percent growth rate of worldwide semiconductor consumption in 1979. The worldwide revenues of Philips and Signetics are presented in Table 6; however, the European revenues of Philips without Signetics and of Signetics alone are presented in Tables 7 and 8 respectively. Table 7 presents DATAQUEST's estimates of the European revenues of European semiconductor companies. In 1979 the European producers shipped an estimated $1.3 billion of semiconductors into the Western European market, up 18 percent from an estimated $1.1 billion shipped into Europe in 1978.

Table 8 presents estimated European revenues of American semiconductor manufacturers. For 1979, total shipments into Europe by American producers were an estimated $1,542 million, up about 31 percent from an estimated $1,179 million in 1978. IC shipments by American companies in 1979 were an estimated $1,037 million, up about 36 percent from $760 million whereas discretes grew an estimated 21 percent from $419 million in 1978 to $505 million in 1979. Table 9 presents the estimated European revenues to the Japanese companies. In 1978 they shipped an estimated $55 million into Europe whereas in 1979 they shipped an estimated $95 million, up about 75 percent.

Table 10 summarizes the data in Tables 7, 8, and 9 showing the percentage of European semiconductor consumption supplied by the European, American, and Japanese companies. Although Japanese sales in Europe represent a small percentage of total sales, they are growing rapidly, from 2 percent in 1977 to 4 percent in 1979.

Daniel L. Klesken
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Table 6

ESTIMATED WORLDWIDE REVENUES OF EUROPEAN SEMICONDUCTOR MANUFACTURERS

(Millions of Dollars)

	1977			1978			1979		
Company	IC	Discrete	Total	IC	Discrete	Total	IC	Discrete	Total
AEG Telefunken	$ 16	$ 71	$ 87	$ 23	$ 88	$ 111	$ 28	$ 107	$ 135
AEI (Subs GEC)	12	0	12	14	0	14	17	0	17
ASEA	1	1	2	1	1	2	2	1	3
Brown-Boveri	0	19	19	0	20	20	0	22	22
Cogie	0	9	9	0	10	10	0	12	12
EFCIS	0	0	0	0	0	0	7	0	7
EMI	0	9	9	0	10	10	0	12	12
Eurosil	9	0	9	10	0	10	11	0	11
Ferranti	13	10	23	16	11	27	19	12	31
GEC	0	4	4	0	4	4	0	5	5
Philips (with Signetics)[1]	286	244	530	379	266	645	480	290	770
Piher	0	7	7	0	8	8	0	9	9
Plessey	17	0	17	25	0	25	27	0	27
RIFA	7	0	7	8	0	8	10	0	10
Semikron	0	15	15	0	20	20	0	25	25
SGS-ATES	49	35	84	59	41	100	74	46	120
Siemens[2]	83	167	250	106	186	292	150	206	356
TAG	0	18	18	0	20	20	0	21	21
Thomson-CSF	20	73	93	30	100	130	40	120	160
Others	2	10	12	3	11	14	4	13	17
Total	$515	$692	$1,207	$674	$796	$1,470	$869	$ 901	$1,770

[1]Philips (w/o Signetics)	$111	$244	$ 355	$165	$266	$ 431	$215	$ 290	$ 505
Signetics	$175	$ 0	$ 175	$214	$ 0	$ 214	$265	$ 0	$ 265

[2]Includes Litronix, excludes MSC and FMC for 1979.

Source: DATAQUEST, Inc.
June 1980

Table 7

ESTIMATED EUROPEAN REVENUES OF EUROPEAN SEMICONDUCTOR MANUFACTURERS
(Millions of Dollars)

Company	1977 IC	1977 Discrete	1977 Total	1978 IC	1978 Discrete	1978 Total	1979 IC	1979 Discrete	1979 Total
AEG Telefunken	$ 13	$ 66	$ 79	$ 20	$ 82	$ 102	$ 21	$ 97	$ 118
AEI (Subs. GEC)	12	0	12	14	0	14	17	0	17
ASEA	1	1	2	1	1	2	2	1	3
Brown-Boveri	0	17	17	0	18	18	0	20	20
Cogie	0	9	9	0	10	10	0	12	12
EFCIS	0	0	0	0	0	0	7	0	7
EMI	0	9	9	0	10	10	0	12	12
Eurosil	9	0	9	10	0	10	11	0	11
Ferranti	11	9	20	12	10	22	13	11	24
GEC	0	4	4	0	4	4	0	5	5
Philips (w/o Signetics)	90	220	310	134	244	378	168	262	430
Piher	0	7	7	0	8	8	0	9	9
Plessey	15	0	15	18	0	18	20	0	20
RIFA	7	0	7	8	0	8	10	0	10
Semikron	0	14	14	0	18	18	0	23	23
SGS-ATES	20	31	51	43	37	80	57	42	99
Siemens	65	151	216	85	170	255	117	187	304
TAG	0	18	18	0	20	20	0	20	20
Thomson-CSF	18	68	86	26	91	117	30	111	141
Others	1	9	10	2	10	12	3	15	18
Total	$262	$633	$895	$373	$$733	$1,106	$476	$827	$1,303

Source: DATAQUEST, Inc.
June 1980

Table 8

ESTIMATED EUROPEAN REVENUES OF AMERICAN SEMICONDUCTOR MANUFACTURERS

(Millions of Dollars)

Company	1977 IC	1977 Discrete	1977 Total	1978 IC	1978 Discrete	1978 Total	1979 IC	1979 Discrete	1979 Total
AMD	$ 12	$ 0	$ 12	$ 18	$ 0	$ 18	$ 28	$ 0	$ 28
AMI	10	0	10	15	0	15	27	0	27
Fairchild	48	15	63	60	18	78	72	23	95
General Electric	0	15	15	0	17	17	0	19	19
General Inst.	16	12	28	24	14	38	35	22	57
Harris	15	0	15	21	0	21	29	0	29
Hewlett-Packard	0	19	19	0	22	22	0	25	25
Intel	52	0	52	82	0	82	116	0	116
International Rectifier	0	20	20	0	25	25	0	30	30
Intersil	10	0	10	13	0	13	18	0	18
ITT	39	65	104	50	78	128	65	92	157
Mostek	20	0	20	33	0	33	58	0	58
Monolithic Memories	7	0	7	9	0	9	11	0	11
Motorola	70	82	152	90	96	186	122	125	247
National	46	10	56	65	13	78	102	18	120
RCA	18	26	44	23	29	52	27	32	59
Signetics	42	0	42	56	0	56	68	0	68
Texas Instruments	120	55	175	165	73	238	215	90	305
TRW	2	0	2	5	0	5	7	0	7
Westinghouse	0	8	8	0	9	9	0	11	11
Zilog	0	0	0	3	0	3	5	0	5
Others	18	13	31	28	25	53	32	18	50
Total	$545	$340	$885	$760	$419	$1,179	$1,037	$505	$1,542

Source: DATAQUEST, Inc.
June 1980

Table 9

ESTIMATED EUROPEAN REVENUES OF JAPANESE SEMICONDUCTOR MANUFACTURERS

(Millions of Dollars)

	1977			1978			1979		
Company	IC	Discrete	Total	IC	Discrete	Total	IC	Discrete	Total
Fujitsu	N/A[1]	N/A	4	N/A	N/A	6	N/A	N/A	12
Hitachi	N/A	N/A	9	N/A	N/A	13	N/A	N/A	22
Matsushita	N/A	N/A	1	N/A	N/A	3	N/A	N/A	6
NEC	N/A	N/A	18	N/A	N/A	24	N/A	N/A	40
Toshiba	N/A	N/A	7	N/A	N/A	9	N/A	N/A	15
Total	$23	$16	$39	$33	$22	$55	$65	$30	$95

[1]N/A = Not available

Source: DATAQUEST, Inc.
June 1980

Table 10

SEMICONDUCTOR SUPPLIERS TO WESTERN EUROPE

(Percent of Total)

	1977			1978			1979		
Company	IC	Discrete	Total	IC	Discrete	Total	IC	Discrete	Total
American companies	66%	34%	49%	65%	34%	50%	65%	37%	52%
European companies	31	64	49	32	64	47	30	61	44
Japanese companies	3	2	2	3	2	3	5	2	4
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%

Source: DATAQUEST, Inc.
June 1980

DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

Vol. II - No. 5 June 12, 1980

This letter is a condensation of recent newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific newsletters should be directed to the author. A list of recent DATAQUEST Research Newsletters appears at the end of this letter.

SEMICONDUCTORS

Price declines in semiconductors have begun to accelerate in the last eight weeks and book-to-bill ratios are coming down as well. We expect book-to-bill ratios to be below 1.0 for certain products in the second quarter and we would expect book-to-bill ratios for many of the semiconductor companies to be around 1.0 for the next four months, resulting in a pronounced slowing of industry growth. None of these developments should be any news to DATAQUEST clients as these developments were within our earlier forecasts of 20 percent revenue growth in domestic semiconductor consumption this year and 18 percent growth in European consumption.

As we have stated in the past, our positive scenario for the semiconductor industry is based on our belief that unit demand will remain relatively strong. The key question is the extent to which the slowing in capital expenditures affects the growth rate of the computer-related industries. If computer industry growth continues at a relatively healthy rate, which is our present expectation, then we believe that semiconductor industry fundamentals will remain intact as well. If computer industry growth rates fall by 50 percent or more, then the downside variance from our semiconductor growth expectations will increase accordingly.

As you know, the Japanese threat in this industry is a very real one. In our view, the ball is squarely back in the court of the U.S. manufacturers. Domestic manufacturers have spent the last year concentrating on maximizing unit production to take advantage of extremely attractive price/cost ratios and have increased market share in all segments of the semiconductor business as a result. The major Japanese companies, by comparison, have sacrificed market share and have concentrated more on increasing product reliability, improving manufacturing processes, and allocating wafers to new devices, such as 64K dynamic RAMs and 16K static RAMs.

With industry conditions softening, we believe that the Japanese will put more emphasis on pricing and market share, but we feel that the Japanese are too sensitive about the political cross-currents to be extremely aggressive on the pricing front, with the exception of Europe where they are seeking to establish inroads into new markets. Actually, one could look at the present industry slow-down as being of some long-term benefit to U.S. manufacturers, as it will allow them time to focus on areas such as reliability and process improvements where the biggest threat from the Japanese will ultimately come.

One company that does not have to worry about keeping up with the Japanese is Intel; it remains far ahead of its competition in terms of technology, product positioning, processing, and systems expertise. There is always the risk that the competition will catch up with Intel in key product areas and eliminate its sole source pricing advantage faster than Intel can generate new proprietary product positions. The present risk in this regard centers on 4K static RAMs and 16K EPROMs. By our estimates, these two products accounted for 21 percent of revenues last year with extremely high profit margins. We estimate that average pricing on these two components may drop 40-50 percent in 1980 and that Intel will have to find other lucrative products in new areas in order to maintain margins. Finding such products should not be a problem: opportunities exist for Intel in memory over the next year in 32K and 64K EPROMs, 16K static RAMs, and 16K EEPROMs. In addition, its very profitable microprocessor divisions are more price protected and continue to grow more rapidly than the company as a whole.

Obviously, risk of a shortfall by Intel in a difficult economic period always exists, but Intel has a lot of alternatives that the other manufacturers do not. For example, Intel is putting very little silicon into the 64K RAM development effort at present, yet we believe that they could be the number one producer in fairly short order should they choose to be. As a second alternative, Intel could push 16K EEPROM prices, where they have a sole source position, down more rapidly to force conversion of 16K EPROM users, where Intel is facing some competition. If there is a margin glitch at Intel, it is most likely to come in the third quarter of this year, since that is the period when the company may have difficulty in increasing volume on new products fast enough to offset declining prices on formerly proprietary products that are becoming more competitive. For the year, we expect only a slight decline in pretax margins at Intel, with earnings increasing by 30 percent to $4.65 per share on a 34 percent gain in revenues.

Probably the most significant activity right now at Intel is the company's attempt to develop a standardized operating system that will be available on a chip as a key part of its microcomputer product line. If Intel is successful in executing this program, the potential end markets will be huge and the company will have made the transition to a true microcomputer systems company. If the software that Intel develops on a chip is patentable (and we believe there to be some legal question), then Intel should not only have created a broader market for its products, but may protect itself from second sourcing as well, which has very positive implications for longer term profit margins.

SMALL COMPUTERS

We are searching for evidence that the recession has affected demand in any sector of the small computer industry, but there is little indication to date.

At this juncture, we are forecasting growth of at least 20 percent in revenues for every sector of the small computer market in both 1980 and 1981. The strength in orders at Digital Equipment may be attributable to double ordering to compensate for long lead times, but Data General, where deliveries are generally under three months, is also experiencing relatively strong demand. It is now our feeling that the economy will have more of a negative impact on the general purpose minicomputer (GPMC) sector of the small computer market in 1981 than 1980. We now expect 29 percent growth in revenues in the GPMC market in 1980 versus our previous 25 percent forecast. We are tentatively forecasting a decline in growth to 20 percent in 1981, but have little current evidence to justify this deceleration.

We continue to believe that the most dynamic growth in this industry will come in very small business computers (VSBC), which we define as computers selling for $5,000-15,000. DATAQUEST expects revenues to grow 60-70 percent this year and 40-45 percent in 1981, even allowing for a fairly severe recession. One of the reasons for the forecast is that we expect new product introductions in VSBC from Apple Computer and Tandy, as both companies expand their offerings beyond the personal computer market.

The public company on the fastest growth track in this industry right now is Tandem Computer. Tandem has developed a unique architecture that allows for virtually 100 percent reliability without loss of data should any single element in the system fail. This high reliability is offered at very little incremental cost to the user. There are some disadvantages to the Tandem approach, chiefly relating to difficulty in writing applications software and the additional system overhead required to provide non-stop operation. However, the benefits to the user are obvious. Tandem's market to date has been primarily transaction processing in the commercial sector, but we see opportunities for the company in other areas as well, including the office automation market.

Very simply, we believe that Tandem has achieved something relatively unique in the computer industry and that the demand by users for continuous processing is something that will grow, forcing other manufacturers to offer similar capabilities. The problem that we foresee for other manufacturers is the ability to offer continuous processing at a reasonable cost while maintaining compatibility with existing software.

We believe that Tandem can probably generate revenue growth greater than 50 percent through fiscal 1981 and probably through fiscal 1982 as well. Earnings per share growth will likely trail revenue growth somewhat because of equity dilution. We are projecting earnings of $2.05 per share in the September 1980 fiscal year on revenues of $110 million and are tentatively projecting $2.85 per share in fiscal 1981 on revenues of $180 million, assuming that another equity financing is needed next year.

PAPER AND FOREST PRODUCTS

Within the next two months, the U.S. Forest Service plans to publish its preliminary draft of "The Outlook for Timber in the United States." The most recent published edition was in 1973. Having seen some of the preliminary data used in the report, we believe that it will point out that the growing shortage of mature softwood sawtimber in the Pacific Northwest will be only partially compensated for by increased cutting in the South. As a result, the Forest Service expects stumpage prices in the South to appreciate more rapidly than prices in the Northwest, so that by 1990 prices from the two regions should be almost equal. We expect that the Forest Service will project annual real price increases for stumpage of 3.2 percent in the Northwest and 4.6 percent in the South during the next 10 years. Having talked to several of the people who put together the data, we believe that the Forest Service could be using a somewhat optimistic forecast of housing starts over the next ten years (2.2 million starts per year). However, using our own assumptions of 1.8 million starts per year, DATAQUEST projects minimum real price increases in the two regions of 2.6 percent and 3.6 percent per year respectively, which would still be considerable.

The implications of this data are that stumpage, lumber, and plywood should continue to rise in prices at rates considerably above the overall inflation rate in the future. By the mid-1980s, we expect increased substitution of plywood by waferboard and composite board, which could well result in plywood prices increasing less rapidly than stumpage and lumber prices.

The clear beneficiaries of these trends would be, first, those companies who are most self-sufficient in their forest products production and, second, those companies who have extensive mature Southern woodland holdings. On the first score, only Weyerhaeuser is even close to being fiber self-sufficient in its forest products manufacturing. Weyerhaeuser also has extensive holdings of mature Southern timberlands. International Paper, after the purchase of Bodcaw last year, has the largest absolute acreage in the South, but we are not sure how much of IP's holdings are of the more mature woodlands that should enjoy the most rapid price appreciation. Potlatch Corporation is another interesting beneficiary, as over one-third of its woodlands are in the South and it also has two waferboard plants under construction.

The forest products stocks have appreciated 15-20 percent since our favorable comments about the group in our last Portfolio Letter. The new Forest Service report could stimulate additional interest in companies with strong Southern woodland holdings.

COPYING AND DUPLICATING

Despite booming conditions in the European copying and duplicating market in general, Rank Xerox continues to have margin problems. Rank has been slower than Xerox USA in adjusting its prices downward to meet the competitive threats of European and Japanese companies. Xerox USA took the steps in 1976-78 while Rank Xerox did most of its price adjusting in 1979, so comparisons for Rank will be difficult this year, as it has many machines on rentals that are generating less revenue than they were a year ago. In addition, they have not yet received the benefit of all of the new product introductions at the medium and high end (5600, 8200, 9500) that the domestic subsidiary has.

We had expected that Rank Xerox's operating earnings could increase about 10 percent this year on a 14 percent gain in revenues, but it now looks as if operating earnings (ex-currency effects) will be up only about 3 percent, which has caused us to bring our full year estimate for Xerox down to $7.25 per share from $7.40 per share.

However, we do believe that most of the problems facing Rank Xerox will have sufficiently abated by the end of this year to allow margins to remain almost flat in 1981 and earnings growth to therefore accelerate. For one thing, the comparisons with this year should be easier in terms of average pricing on machines. Secondly, new products such as the 3450, 5600, 8200, and 9500 should all be introduced in Europe this year, with the benefits starting to accrue in 1981. Third, we believe that a totally new low-end copier could be coming from Fuji Xerox late in 1980 and that this product will be introduced in both Europe and the United States. Finally, we think that the impact of the recession should begin hitting Europe by the second half of 1980 and that the depth or length of the recession will be less than in the United States, allowing Europe as a whole to show about 2 percent real growth in 1981.

Thus, while we are somewhat more pessimistic about Rank Xerox this year, we do believe that earnings gains from the subsidiary can exceed 13 percent in 1981. Coupled with a swing to at least break-even operations in word processing, the result should be an acceleration of earnings growth at Xerox next year to about $8.45 (excluding currency fluctuations) which would represent a gain of over 16 percent from our present 1980 estimate. More on Xerox's ETHERNET network in our word processing section.

WORD PROCESSING

The recent joint announcement of development efforts on ETHERNET by Xerox, Digital Equipment, and Intel has interesting implications not only for these companies, but for other participants in the office of the future. Xerox is trying to establish ETHERNET as the industry standard for intra-office communications. Conceptually, it is a relatively simple system designed to allow various peripherals to attach to a coaxial cable running through an office with full communication between each peripheral. Theoretically, the products of any manufacturer standardizing on ETHERNET will be able to communicate with products of other standardized manufacturers.

If ETHERNET can be implemented successfully (and we should note that we believe this to be at least one year away) the clearest beneficiaries would seem to be DEC and Xerox, since both lack the full product line necessary for implementing an integrated office, yet are relatively strong in certain segments of the office environment. Having DEC assist on the design of the system will certainly increase the likelihood that it will operate effectively in a data processing mode.

The degree to which ETHERNET is adapted as a standard is open to considerable question. If it is successful, however, it may pose some threat to companies who have already announced office communications systems encompassing only their own products, such as Datapoint and Wang Laboratories. Much would depend on their ability and desire to adapt to this standard. The impact of ETHERNET, of course, is purely hypothetical. In the real world, Wang and others are selling products today into a market that is growing at a tremendous rate and which shows no sign of falling prey to recessionary influences.

While deliveries of ETHERNET are still well in the future, it is having the impact of generating word processing orders for Xerox now. Xerox can effectively use ETHERNET as a marketing tool in selling its word processing workstations by claiming that its products will be compatible with the intra-office communication standard, while other products may prove to be incompatible with this standard in the future. This marketing approach appears to be working, as we believe that Xerox's word processing orders are substantially ahead of last year's levels.

CAPITAL EQUIPMENT

Our forecast for retail sales of farm tractors (over 40 HP) remains 120,000 units this year, which would represent a 14 percent decline from 1979 levels. Through April, sales to date are down 29 percent from last year, but prices received by farmers improved somewhat in May, with crop prices doing better than livestock prices, all of which should help farm tractor demand somewhat. Our 1981 forecast remains relatively conservative, with a median forecast of 125,000 units sold next year.

It seems as if we are perennially looking for an upturn in demand for surface coal mining equipment about 12 months in the future. The upturn that we had expected to occur in the second half of 1980 now appears unlikely and we now expect demand to improve in (you guessed it) about 12 months. Previously, we had thought that intermediate-sized equipment would improve first, followed in 6 to 9 months by draglines and power shovels. It now looks to us as if orders for both types of equipment may improve almost simultaneously in the second half of 1981.

This altered outlook has some interesting investment significance. The manufacturers of intermediate-sized equipment (Caterpillar, Clark, IH) have the bulk of their business in other mobile construction markets that we believe will remain depressed into 1982. We do not anticipate a strong resurgence in heavy, residential, or non-residential construction spending for some time, and together these areas account for about 60 percent of demand for mobile construction equipment. The dragline and power shovel manufacturers (Bucyrus-Erie and, to a lesser extent, Harnischfeger) are heavily concentrated in coal-related markets and would therefore benefit more dramatically from an upturn in coal-related business.

Michael R. Weisberg

RECENT NEWSLETTERS OF NOTE

(continued on page 8)

RECENT NEWSLETTERS OF NOTE
(continued)

Instrumentation

1. Update on Tektronix	05/30/80
2. XY Recorder Market	05/30/80
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Electronic Printers

1. Hewlett-Packard 7310A Graphics Printer	05/15/80
2. Documation Announces Fiscal 1980 Loss and Further Management Re-alignments	04/18/80

Telecommunications

1. The FCC Makes a Landmark Deregulation Decision	04/18/80

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Vol. III, 7.8

SEMICONDUCTOR SALES THROUGH DISTRIBUTION

SUMMARY

"Tight" is the key word when considering U.S. semiconductor distribution in 1980. Although the situation is not as extreme as in 1974, there is still tight money for growth, and a resulting tight monitoring of inventory levels and accounts receivable. Distribution depends heavily upon the availability of money. The high prime rate has affected distributors' short-term borrowing capability and has also caused accounts receivable periods to lengthen.

Semiconductor supply is presently catching up with demand. The long lead times for specific parts in 1979 have shortened in the first half of 1980, and supply is not as tight as it was in 1974. Formerly hard-to-get components are more readily available from both U.S. and Japanese vendors. For example, low-power Schottky devices which had one year lead times through distribution three months ago are now available off-the-shelf or in a few weeks. The 16K dynamic RAMs are available off distributor shelves as are most static MOS RAMs and most EPROMs.

In spite of a tight component supply in 1979, semiconductor distribution resales were up 33.5 percent, and are expected to increase 24 percent in 1980. The estimated semiconductor distributor resales are shown in Table 1.

Table 1

ESTIMATED U.S. DISTRIBUTOR SEMICONDUCTOR AND SYSTEMS[1] RESALES
(Millions of Dollars)

	1978	1979	1980
Distributor Semiconductor Resales	$1,075	$1,435	$1,780
Percentage growth from previous year		33.5%	24.0%

[1] Systems include board-level computers and development systems.

Source: DATAQUEST, Inc.
June 1980

19055 Pruneridge Ave. / Cupertino, CA 95014 / (408) 725-1200 / TWX (910) 338-7695 / DATAQUEST CPTO

The geographical breakdown of the semiconductor distribution resales shows all geographical segments to have 1979 markets that are equal to or greater than the 1978 markets.

DISTRIBUTION SCENARIO FOR 1980

In a tight money market where supply is catching up with demand, semiconductor distribution takes on a different character. The following points should be considered in 1980:

- The distributor with sound marketing skills will gain market share. It becomes less important for the distributor to get the parts and more important for the distributor to get the customers. In a buyer's market, the distributor's marketing skill plays a vital role.
- Distributors with a tight grip on management should benefit during this time. An organization must work closely together to watch expenses, efficiency, inventories, receivables, and overall morale during uncertain economic periods. Small distributors have the advantages in uncertain economic times since they need not worry about a large bureaucracy, and can therefore react more quickly.
- The distributor who can minimize his dependence on bank loans to finance his growth at today's high prime rate has a definite advantage.

RESALES BY U.S. DISTRIBUTORS

In 1979 the estimated U.S. distributor resale of semiconductors and systems was $1,435 million. Table 2 presents DATAQUEST's estimates of the market shares of the major U.S. distributors. Note that the $1,435 million resales include $135 million in board-level computers and development systems and $37 million in peripherals. The 10 leading U.S. semiconductor distributors account for 66 percent of total U.S. distributor semiconductor resales.

Semiconductors play an important role in electronics distribution. In general, 60 to 70 percent of the larger electronics distributors' total resales are semiconductor, while smaller distributors' resales are 30 to 40 percent semiconductor. For example, the largest U.S. semiconductor distributor, Hamilton/Avnet, reported 1979 total industrial sales of $512 million, of which DATAQUEST estimates that $360 million, or 70 percent, came from semiconductor resales.

The semiconductor distributors experienced a gain in market share in 1975. High interest rates and an uncertainty about end demand resulted in the cutting back of OEM inventories. Having cut back commitments with their semiconductor vendors, the OEMs were later forced to make up deficiencies with purchases through distribution. The distributors' gain in market share was permanent. However, since components are not in such short supply now, it is not expected that the distributors will gain such a significant market share in 1980.

SALES BY MANUFACTURERS TO DISTRIBUTORS

Semiconductor sales to U.S. distributors as a percent of total domestic sales by U.S. vendors have been increasing in the last three years. In 1977 21 percent of domestic semiconductor sales by U.S. companies went to distributors. In 1978 and 1979 the distributors' shares increased to 23 and 24 percent, respectively.

Table 3 shows the 1979 estimated semiconductor sales by major manufacturers to U.S. distributors. The table reveals that Fairchild's semiconductor sales through distribution are an estimated 34 percent of its domestic sales, the largest percentage of all semiconductor manufacturers. Signetics ranks second with an estimated 32 percent of U.S. semiconductor sales through distribution.

In terms of sales through U.S. distribution, the 12 leading semiconductor suppliers account for 81 percent of total sales to U.S. distributors. With this small number of manufacturers having such a large share of semiconductor sales through distribution and with the increasing number of large user accounts, some distributors are concerned that in the future they will be unable to get the components they need. Each year the number of large users of semiconductors (over $100 million per year) continues to climb while the number of merchant suppliers shrinks. However, the 1980 outlook for component supply should be good due to the increased capacity of the U.S. and foreign suppliers.

SYSTEMS RESALES

Systems resales are estimated to be $135 million in 1979 and are expected to grow to $188 million in 1980. Systems include board-level computers and development systems. Table 4 shows the systems resales broken down by manufacturer. Intel has 56 percent of the 1979 resales with $75 million, followed by National with $15 million resales or 11 percent of the total systems resales.

RESALES BY GEOGRAPHICAL AREA

Table 5 presents the 1979 semiconductor distribution total available market (TAM) for 32 specific U.S. regional markets. All geographic segments have 1979 TAMs that are equal to or greater than 1978 TAMs. The 11 western states account for 36 percent of the total U.S. market. The two major metropolitan areas, San Francisco and Los Angeles, account for 28 percent of the total 1979 U.S. semiconductor resales, up from 26 percent in 1978. The 11 northeastern states account for 26 percent of the total market, with Boston having an 8.4 percent market share.

Mary Ellen Hrouda
Daniel L. Klesken

Table 2

ESTIMATED 1979 U.S. DISTRIBUTION MARKET SHARES AT RESALE
SEMICONDUCTORS AND SYSTEMS[1]
(Millions of Dollars)

	Semiconductor Sales 1979
Hamilton/Avnet	$ 360
Arrow	110
Wyle	100
Schweber	85
Kierulff	65
Hall-Mark	65
Pioneer	55
Cramer	47
Bell Industries	32
Marshall	30
Jaco	30
Harvey	30
Components Plus	25
Diplomat	25
Future	25
Intermark	25
TI Supply	25
Almac/Strom	23
Sterling	20
Semiconductor Specialists	20
Newark	18
Wilshire	18
Milgray	15
RVW	15
Summit	15
Zeus	15
United Components, Inc.	12
Component Specialties	10
Powell	10
Subtotal	$1,325
All Others	110
Total U.S. Distributors Semiconductor Resale	$1,435

[1]Includes an estimated $37 million peripheral resales and an estimated $135 million in board-level computers and development systems.

Source: DATAQUEST, Inc.
June 1980

Table 3

ESTIMATED 1979 SEMICONDUCTOR SALES TO U.S. DISTRIBUTORS
(Millions of Dollars)

	1979 Total Est. U.S. Sales	1979 Sales To Distributors	Distributor Sales as a Percent of U.S. Semiconductor Sales
Texas Instruments	$710	$ 167	23.5%
Motorola	607	140	23.1%
National Semiconductor	434	100	23.0%
Fairchild	282	95	33.7%
Intel	275	75	27.3%
Signetics	188	60	31.9%
RCA	184	40	21.7%
AMD	150	40	26.7%
Mostek	160	30	18.8%
General Instrument	116	24	20.7%
Hewlett-Packard	n.a.	20	--
General Electric	n.a.	20	--
Subtotal		$ 811	
All Others		199	
Total Sales to U.S. Distributors		$1,010	
Inventory Adjustment		(50)	
Total Sales to U.S. Distributors		$ 960	
Resale Value (24% Gross Margin)		$1,263	
Systems Resale		135	
Peripherals Resale		37	
Total Distributor Semiconductor Resale		$1,435	

Source: DATAQUEST, Inc.
June 1980

Table 4

ESTIMATED 1979 SYSTEMS[1] RESALES
(Millions of Dollars)

	1979 Systems Resales
Intel	$ 75
National Semiconductor	15
Motorola	15
Texas Instruments	10
Zilog	5
Mostek	5
Subtotal	$125
All Others	10
Total Systems Resales	$135

[1]Systems include board-level computers and development systems.

Source: DATAQUEST, Inc.
June 1980

Table 5

ESTIMATED 1979 DISTRIBUTION RESALE MARKET BY REGION
SEMICONDUCTORS & SYSTEMS[1]
(Millions of Dollars)

Region	Total Available Market	Percent of U.S. TAM
Boston	$ 120	8.4%
Connecticut	38	2.6
Long Island	55	3.8
Upstate New York	32	2.2
Northern New Jersey	68	4.7
Southern New Jersey/Philadelphia	60	4.2
Washington/Baltimore/Virginia	70	4.8
North and South Carolina	15	1.0
Atlanta	20	1.4
Huntsville/Tennessee/Mississippi	20	1.4
Florida	45	3.1
Cleveland	28	2.0
Pittsburgh	13	0.9
Dayton/Cincinnati	25	1.7
Detroit	28	2.0
Indiana	14	1.0
Chicago	64	4.4
Wisconsin	14	1.0
Minneapolis	38	2.6
St. Louis	22	1.5
Kansas City	16	1.1
Oklahoma	11	0.8
Dallas	48	3.3
Austin/San Antonio	12	1.0
Houston/Louisiana	33	2.3
Alabama	8	0.6
Phoenix/Albuquerque	23	1.6
Denver/Salt Lake City	28	2.0
Seattle/Portland	40	2.8
San Francisco/Nevada	195	13.6
Los Angeles/Orange County	202	14.1
San Diego	30	2.1
Total	$1,435	100.0%

[1] Systems include board-level products and development systems.

Source: DATAQUEST, Inc.
June 1980

DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code Vol. I, 2.8.6

DYNAMIC AND STATIC MOS RAM AND EPROM SHIPMENTS

SUMMARY

Worldwide shipments of 16K dynamic RAMS in the first quarter of 1980 were an estimated 37.3 million units, up about 38 percent over an estimated 27.1 million units shipped in the fourth quarter of 1979. Prices for first-quarter shipments were in the $5.00 to $5.25 range. However, recent price quotes for 16K RAMS have fallen into the $4.00 to $4.75 range.

64K dynamic RAMS are still in a sampling mode with first-quarter shipments in the range of 21,000 units, and prices generally in the $100 to $125 range.

Worldwide shipments of 4K dynamic MOS RAMS continued to decline in the first quarter of 1980, dropping about 21 percent to an estimated 11.5 million units. Volume prices are about $2.00.

4K static NMOS RAM shipments increased in the first quarter of 1980 to an estimated 14.1 million units. Lead times for most of the slow 4K statics are now less than 10 weeks and prices have declined to about $3.25. Worldwide shipments of the 2147 fast 4K static RAM increased by about 34 percent to an estimated 1.8 million units in the first quarter of 1980 and lead times are generally well under 10 weeks. Prices in the first quarter for the fast statics were about $10. Worldwide shipments of 4K CMOS static RAMS increased about 30 percent to 2.5 million units in the first quarter of 1980.

First-quarter shipments of 8K EPROMS were an estimated 4.5 million units, down about 11 percent from an estimated 5.1 million units in the fourth quarter of 1979. Shipments of the 16K EPROM increased by about 20 percent to an estimated 5.3 million units. Prices have continued to soften and are currently about $15. The 32K EPROM is available in limited quantities; an estimated 320 thousand units were shipped in the first quarter of 1980 at prices in the range of $45 to $60. This product is receiving increased attention with 7 suppliers either sampling or shipping products.

DYNAMIC MOS RAMS

16K RAMS

Table 1 presents DATAQUEST estimates of worldwide shipments of 16K dynamic MOS RAMS in the first quarter of 1980. Worldwide shipments were an estimated 37.3 million units, up about 37.7 percent over the 27.1 million units shipped in the fourth quarter of 1979. These estimates include the 2-chip hybrids shipped to IBM on the Caribou program.

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During the first quarter of 1980 demand was still quite strong and prices remained relatively stable in the $5.00 to $5.25 range. However, starting in March the supply and demand outlook for 16K dynamic RAMS began to change markedly. A greater supply of 16K RAMS is now available as the result of more wafer starts by some suppliers as well as better yields at most suppliers. Concurrently, there has been a slightly diminished demand as the result of some cancellations and stretch-outs—primarily from IBM.

As a result of this increased supply and diminished demand, the 16K RAM was removed from most suppliers' allocation lists, and lead times are now less than 12 weeks. Some suppliers have 50,000 units available in as little as 4 weeks. Consequently, prices of slow (250 nanosecond) plastic devices are now being quoted at about $4.00. However, the majority of the second-quarter shipments will still go out at prices closer to $5 since most of the large commitments have been made on long-term purchase agreements. It is the only incremental or newly booked business for the second and third quarters that will go out at these lower prices. Furthermore, there is still about a $1.00 spread between the slower parts (250 ns) and the fast parts (under 125 ns). If a user requires a side-brazed ceramic package, the premium over a plastic package is $3.50 to $5.00 because of the high gold content.

<u>32K RAMS</u>

Of all suppliers of 16K RAMS, Mostek is still the only one in the merchant market with a 32K dynamic RAM hybrid device. This 2-chip device is gaining some popularity, and Mostek shipped an estimated 220,000 devices in the first quarter of 1980 at prices around $14.00.

<u>64K RAMS</u>

Table 2 presents DATAQUEST estimates of worldwide shipments of 64K dynamic MOS RAMS. Worldwide shipments in the first quarter of 1980 were an estimated 21 thousand units, up about 31.3 percent over shipments in the fourth quarter of 1979. This market is still in a sampling mode with six suppliers sampling or shipping prototype quantities during the first quarter. Others are expected to enter the market over the coming quarters. Up until now most MOS memory suppliers have been extremely limited in new wafer starts that could be dedicated to the 64K RAM. With the increased supply and weakening demand in the 16K dynamic MOS market, more suppliers should be able to devote more wafer starts to the 64K dynamic RAM. Please note that our estimate for shipments by Fujitsu for 1979 have been revised upward. Although these parts were the two power supply parts (+7v, -2.5v), Fujitsu has recently begun sampling a 5-volt only device.

Prices on 64K RAMS in relatively low quantities are still in the $100 to $125 range. These prices should fall about $70 range by the fourth quarter of 1980.

<u>4K RAMS</u>

Worldwide shipments of 4K dynamic MOS RAMS continued to decline in the first quarter of 1980 (Table 3). Worldwide shipments were down an estimated 21.2 percent to about 11.5 million units. Some suppliers have stopped taking orders for this product and are only shipping against the existing backlog. This phenomenon is normal as suppliers are de-emphasizing the product and beginning to put emphasis into the 64K RAMS. Lead times for this product still remain in the 12-to-18 week time frame as a result of this diminished supply. Prices in the first quarter were about $2.00 and are continuing at that level in the second quarter.

STATIC MOS RAMS

4K RAMS

Table 4 presents DATAQUEST estimates of worldwide shipments of slow 4K NMOS static RAMS. Total shipments in the first calendar quarter were up about 9 percent over the fourth calendar quarter of 1979. The 1K x 4 device shipped an estimated 8.5 million units, up about 11 percent over the fourth quarter. The 4K x 1 device shipped an estimated 3.6 million units, which is up 2.6 percent over the fourth quarter.

Lead times for most of the 4K slow statics are under 10 weeks and prices for slow plastic parts are down in the $3.00 to $3.50 range. The faster devices in CERDIP packages command prices in the $4.00 to $4.50 range.

Shipments of fast 4K NMOS static RAMS in the first quarter were up about 34 percent to an estimated 1.8 million units (Table 5). This total includes an estimated 125,000 units shipped by Intel of the 2148 (1K x 4) fast static RAM. As a result of the increased number of suppliers, lead times have shrunk to less than 10 weeks and prices for second and third quarter deliveries are now under $10.

Shipments of 4K CMOS static RAMS in the first quarter of 1980 were an estimated 2.5 million units, up about 30.5 percent over the 4th quarter of 1979 (Table 6). The 1K x 4 devices were up about 32.7 percent to 1.7 million units, whereas the 4K x 1 devices were up about 26.2 percent to 800 thousand units. Lead times for these devices are still generally longer than 20 weeks, and prices for second and third quarter delivery remain relatively strong in the $12 to $14 range.

MOS EPROMS

8K MOS EPROMS

Worldwide shipments of 8K EPROMS continue to decline in the first quarter of 1980 (Table 7). They were down an estimated 11.4 percent to 4.5 million units. Most prices for this device for second-quarter delivery are in the $5.00 to $5.50 range. Some suppliers, including Intel, National Semiconductor, and Texas Instruments, are shipping a partial 16K EPROM as an 8K 5-volt only EPROM labeled as a 2758. These shipments are still a relatively small percentage of total shipments and are not included in the above table.

16K EPROMS

Shipments of 16K EPROMS continue to increase in the first quarter of 1980 to an estimated 5.3 million units, which is up about 19.5 percent over the fourth quarter of 1979 (Table 8). Prices are generally in the $14 to $16 range in the second quarter of 1980, with lead times in the 12-to 18-week range. There is some price pressure in this market as more suppliers come into the market.

32K EPROMS

Worldwide shipments of the 32K EPROM were up about 68.4 percent to an estimated 320 thousand units in the first quarter of 1980 (Table 9). At present there are 7 suppliers in this market and prices in the second quarter are generally in the $45 to $60 range.

64K EPROM

Texas Instruments is the only supplier sampling the 64K EPROM and it shipped fewer than 1,000 units during the first quarter of 1980.

Daniel L. Klesken
Lane Mason

TABLE 1
ESTIMATED WORLDWIDE SHIPMENTS OF 16K DYNAMIC MOS RAMS
(THOUSANDS OF UNITS)

COMPANY	1978 YEAR	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 YEAR	1980 1ST QTR
AMD	S	S	5	10	50	65	300
FAIRCHILD	465	300	400	500	700	1,900	800
FUJITSU	2,000	1,100	1,300	1,600	2,500	6,500	3,000
HITACHI	1,210	800	1,400	2,200	2,700	7,100	3,200
INTEL	2,400	600	700	950	1,000	3,250	1,150
INTERSIL	S	S	5	5	0	10	0
ITT	203	200	300	600	600	1,700	750
MATSUSHITA	0	0	0	0	0	0	5
MITSUBISHI	100	100	200	400	550	1,250	700
MOSTEK	4,900	2,400	3,600	4,800	6,000	16,800	7,400
MOTOROLA	1,750	700	1,200	1,000	1,800	4,700	3,000
NATIONAL	287	250	450	1,000	1,500	3,200	3,500
NEC	3,850	1,700	2,200	3,200	4,200	11,300	6,100
SGS ATES	0	0	0	0	3	3	10
SIEMENS	85	100	150	250	375	875	600
SIGNETICS	140	75	40	50	10	175	0
TEXAS INSTRUMENTS	3,150	1,800	2,200	1,800	3,200	9,000	4,200
TOSHIBA	285	225	550	900	1,800	3,475	2,500
ZILOG	60	20	50	50	70	190	50
TOTAL	20,885	10,370	14,750	19,315	27,058	71,493	37,265
PERCENT CHANGE FROM PREVIOUS QUARTER		28.2	42.2	30.9	40.1		37.7

SOURCE: DATAQUEST, INC.

TABLE 2
ESTIMATED WORLDWIDE SHIPMENTS OF 64K DYNAMIC MOS RAMS
(THOUSANDS OF UNITS)

COMPANY	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 YEAR	1980 1ST QTR
FUJITSU	3.0	5.0	7.0	9.0	24.0	10.0
HITACHI	0.0	0.0	0.0	S	S	S
MITSUBISHI	0.0	0.0	0.0	S	S	S
MOTOROLA	S	1.0	3.0	6.0	10.0	10.0
TEXAS INSTRUMENTS	S	0.4	1.0	1.0	2.4	1.0
TOSHIBA	0.0	0.0	0.0	0.0	0.0	S
TOTAL	3.0	6.4	11.0	16.0	36.4	21.0
PERCENT CHANGE FROM PREVIOUS QUARTER		113.3	71.9	45.5		31.3

SOURCE: DATAQUEST, INC.

TABLE 3
ESTIMATED WORLDWIDE SHIPMENTS OF 4K DYNAMIC MOS RAMS
(THOUSANDS OF UNITS)

COMPANY	1978 YEAR	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 YEAR	1980 1ST QTR
AMD	6,600	2,600	3,000	3,000	1,600	10,200	1,300
FAIRCHILD	900	0	0	0	0	0	0
FUJITSU	1,900	200	200	200	150	750	100
HITACHI	1,780	350	200	200	100	850	100
INTEL	11,000	1,700	1,700	1,500	1,200	6,100	900
INTERSIL	450	100	100	300	500	1,000	600
ITT	1,600	1,100	1,300	1,300	1,500	5,200	1,400
MOSTEK	17,000	3,800	3,300	3,400	3,600	14,100	2,500
MOTOROLA	5,700	1,500	1,150	1,800	2,000	6,450	1,700
NATIONAL	5,600	2,000	2,400	2,000	1,500	7,900	1,500
NEC	6,150	1,350	1,900	1,300	1,000	5,550	400
SGS ATES	360	150	175	200	225	750	300
SIGNETICS	1,150	300	100	50	10	460	0
TEXAS INSTRUMENTS	16,700	3,600	3,200	2,700	1,200	10,700	700
TOTAL	76,890	18,750	18,725	17,950	14,585	70,010	11,500
PERCENT CHANGE FROM PREVIOUS QUARTER		(4.0)	(0.1)	(4.1)	(18.7)		(21.2)

SOURCE: DATAQUEST, INC.

TABLE 4
ESTIMATED WORLDWIDE SHIPMENTS OF SLOW 4K NMOS STATIC RAMS
(THOUSANDS OF UNITS)

	1979						1980	
	3RD QUARTER		4TH QUARTER		YEAR		1ST QUARTER	
COMPANY	1K×4	4K×1	1K×4	4K×1	1K×4	4K×1	1K×4	4K×1
AMD	330	140	420	220	1,175	465	350	200
AMI	95	0	50	0	250	0	5	0
EMM	700	650	700	700	2,600	2,450	800	800
FAIRCHILD	300	0	400	0	850	0	450	0
FUJITSU	250	0	100	0	580	0	50	0
HITACHI	450	0	450	0	1,800	0	450	0
INTEL	850	100	800	200	2,650	1,300	800	250
INTERSIL	250	150	200	250	880	630	500	250
MATSUSHITA	50	0	75	0	145	0	75	0
MITSUBISHI	200	0	200	0	800	0	180	60
MOS TECHNOLOGY	100	0	175	0	305	0	175	0
MOSTEK	0	900	0	1,000	0	2,950	0	750
MOTOROLA	450	30	300	50	1,340	130	425	75
NATIONAL	900	200	1,100	400	3,430	910	1,200	600
NEC	800	400	1,000	300	2,800	1,750	1,350	270
SYNERTEK	900	0	1,000	0	3,060	0	1,000	0
TEXAS INSTRUMENTS	550	450	350	350	1,900	1,800	350	350
TOSHIBA	300	0	350	0	1,010	0	350	0
ZILOG	0	150	0	45	0	415	0	0
TOTAL	7,475	3,170	7,670	3,515	25,575	12,800	8,510	3,605
PERCENT CHANGE FROM PREVIOUS QUARTER	28.1	(3.2)	2.6	10.9			11.0	2.6

SOURCE: DATAQUEST, INC.

TABLE 5
ESTIMATED WORLDWIDE SHIPMENTS OF FAST 4K NMOS STATIC RAMS
(THOUSANDS OF UNITS)

COMPANY	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 YEAR	1980 1ST QTR
AMD	0	0	0	0	0	S
AMI	5	10	5	5	25	0
FUJITSU	0	0	15	60	75	150
HITACHI	0	0	0	0	0	0
INTEL	800	1,200	650	900	3,550	1,125
INTERSIL	0	0	3	20	23	35
MOSTEK	0	0	0	0	0	S
MOTOROLA	0	10	20	50	80	70
NATIONAL	0	10	25	65	100	200
NEC	25	70	250	250	595	200
TEXAS INSTRUMENTS	0	0	0	5	5	30
TOSHIBA	0	0	0	15	15	25
TOTAL	830	1,300	968	1,370	4,468	1,835
PERCENT CHANGE FROM PREVIOUS QUARTER		56.6	(25.5)	41.5		33.9

SOURCE: DATAQUEST, INC.

TABLE 6
ESTIMATED WORLDWIDE SHIPMENTS OF 4K CMOS STATIC RAMS
(THOUSANDS OF UNITS)

	1979						1980	
	3RD QUARTER		4TH QUARTER		YEAR		1ST QUARTER	
COMPANY	1K×4	4K×1	1K×4	4K×1	1K×4	4K×1	1K×4	4K×1
FUJITSU	0	0	S	S	S	S	30	30
HARRIS	100	100	125	125	290	270	150	150
HITACHI	0	325	0	400	0	950	50	500
MITSUBISHI	35	0	55	0	90	0	60	0
MOTOROLA	0	0	S	0	S	0	0	0
NATIONAL	0	0	5	5	5	5	15	15
NEC	450	0	500	0	1,320	0	650	0
RCA	125	0	100	0	355	0	150	0
TOSHIBA	500	100	500	100	1,625	275	600	100
TOTAL	1,210	525	1,285	630	3,685	1,500	1,705	795
PERCENT CHANGE FROM PREVIOUS QUARTER	44.0	105.9	6.2	20.0			32.7	26.2

SOURCE: DATAQUEST, INC.

TABLE 7
ESTIMATED WORLDWIDE SHIPMENTS OF 8K EPROMS
(THOUSANDS OF UNITS)

COMPANY	1978 YEAR	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 YEAR	1980 1ST QTR
AMD	485	600	700	700	500	2,500	600
ELECTRONIC ARRAYS	200	75	100	125	35	335	0
FAIRCHILD	280	160	200	350	600	1,310	750
FUJITSU	280	70	50	50	50	220	50
INTEL	3,400	1,100	1,400	1,400	1,100	5,000	700
MITSUBISHI	S	10	15	25	40	90	60
MOTOROLA	1,020	700	750	1,000	1,000	3,450	500
NATIONAL	1,250	600	800	800	900	3,100	1,000
SIGNETICS	280	0	0	0	0	0	0
TEXAS INSTRUMENTS	2,100	800	800	800	800	3,200	800
TOSHIBA	40	50	100	100	50	300	35
TOTAL	9,335	4,165	4,915	5,350	5,075	19,505	4,495
PERCENT CHANGE FROM PREVIOUS QUARTER		23.6	18.0	8.9	(5.1)		(11.4)

SOURCE: DATAQUEST, INC.

TABLE 8
ESTIMATED WORLDWIDE SHIPMENTS OF 16K EPROMS
(THOUSANDS OF UNITS)

COMPANY	1978 YEAR	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 YEAR	1980 1ST QTR
AMD	0	0	S	5	10	15	25
FAIRCHILD	0	0	0	0	S	S	30
FUJITSU	5	70	200	300	300	870	350
HITACHI	35	125	200	350	500	1,175	700
INTEL	1,350	550	750	800	900	3,000	950
MITSUBISHI	S	10	20	50	90	170	210
MOSTEK	25	90	150	250	350	840	275
MOTOROLA	100	160	150	160	200	670	250
NATIONAL	S	5	50	80	120	255	250
SYNERTEK	0	0	0	0	S	S	S
TEXAS INSTRUMENTS	850	400	900	1,100	1,800	4,200	2,000
TOSHIBA	5	25	50	90	200	365	300
TOTAL	2,370	1,435	2,470	3,185	4,470	11,560	5,340
PERCENT CHANGE FROM PREVIOUS QUARTER		58.6	72.1	28.9	40.3		19.5

SOURCE: DATAQUEST, INC.

TABLE 9
ESTIMATED WORLDWIDE SHIPMENTS OF 32K EPROMS
(THOUSANDS OF UNITS)

COMPANY	1979 1ST QTR	1979 2ND QTR	1979 3RD QTR	1979 4TH QTR	1979 YEAR	1980 1ST QTR
FUJITSU	0	0	0	S	S	S
HITACHI	0	0	0	S	S	S
INTEL	5	30	50	100	185	165
MITSUBISHI	0	0	0	S	S	S
MOTOROLA	0	0	0	S	S	5
NATIONAL	0	0	0	0	0	S
TEXAS INSTRUMENTS	10	35	60	90	195	150
TOTAL	15	65	110	190	380	320
PERCENT CHANGE FROM PREVIOUS QUARTER		333.3	69.2	72.7		68.4

SOURCE: DATAQUEST, INC.

DATAQUEST RESEARCH NEWSLETTER
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MANUFACTURING MODEL

DATAQUEST's Semiconductor Industry Service has just published a comprehensive manufacturing model. This report of over one hundred pages is a complete revision of Section 3 of the Semiconductor Industry Service notebook and replaces earlier material published in 1975 and 1977.

TECHNOLOGY AND EQUIPMENT

Wafer fabrication technology continues to evolve, and the interplay of equipment technology, device technology, plant layout and design, site selection, cost, and personnel management becomes increasingly complex. The trend toward greater device complexity and larger die size has been spurred on by lowered defect densities. As device geometries approach the 2-micron level and below, processing, environmental and equipment technologies must be carefully coordinated.

Of the many process technologies, photolithography has been one of the key factors in determining the pace of Very Large Scale Integration (VLSI) design and manufacture. The trend is away from contact printing toward proximity and projection printing.

Dry etching techniques are being developed as a necessary concomitant of projection printing in order to etch fine patterns in a variety of materials.

Deposition of materials is becoming more sophisticated with the addition of sputtering and plasma deposition to the tried-and-true electron beam and chemical vapor deposition technologies.

Ion implantation techniques have kept pace to achieve, quickly and inexpensively, control of impurity concentrations and junction depths.

Although complex and expensive, with increasing delivery times, wafer fabrication equipment is proving to be cost effective. The equipment is increasingly

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controlled electronically (by the integrated circuits it is used to fabricate). The result is greater automation, control, and reproducibility of results, as well as lower defect levels due to lower operator/wafer interfacing.

The clean room facilities in 1980 are geared toward Class 100 rating and better rather than toward the Class 1000 rating that was acceptable until 1978.

Deionized (DI) water is being elaborately treated and tested to meet the new clean standards. The water is pretreated through activated carbon and diatomaceous earth filters before it goes through reverse osmosis and deionization stages.

Four-inch diameter wafers are expected to be the standard during the mid-1980s; larger wafers may be used for many standard memory lines. Thus, for a facility processing 10,000 wafers out per four-week period with manufacturing costs of \$40 to \$80 per wafer and gross revenues of \$300 to \$600 per wafer, at least \$3.0 million dollars per period can be realized.

At the same time, equipment purchases for today's use must nevertheless be chosen for eventual upgrading to handle five-inch, and even six-inch diameter wafers, as long as the particular technology will not be obsolete by the time of the upgrading. It is also possible to adapt machines to suit other products. With the high capital cost of some equipment, care must be taken to obtain maximum utilization of such equipment while it is in service.

PLANT LAYOUT AND DESIGN

Several factors determine the way in which a particular plant is laid out. Cleanliness for VLSI production is influencing what portion of the equipment remains in the clean room. Only the loading end of diffusion furnaces are being allowed in the clean room. The heat and dust generating portions are being separated from the clean room by a fire wall. The same is true for ion implanters and the trend will be continued for other equipment where appropriate.

Servicing of equipment and work stations in old facility designs meant frequent ingress of personnel into the clean room to deliver bottles of chemicals, replace furnace tubes, and repair plumbing. New layouts obviate the necessity for these entries by pumping chemicals (except photoresist) to other points of use. Plumbing can be done outside the clean room if a service corridor rings the fabrication area. Furnace tubes can be pulled and replaced behind the fire wall and outside the clean room. If gases are pumped overhead through a crawl space, gas lines can often be serviced in these crawl spaces without need for entry into the clean room.

Philosophies of equipment design have shifted toward single wafer and in-line processing and wafer handling, away from the purely batch-type handling. Thus, there is greater interplay between different processing areas (as opposed to the almost strict quarantine that existed before) as long as cleanliness is maintained, material flow facilitated, and cross-contamination avoided. New demands for material accountability have made production control supervision the heart of the entire operation and this fact has also affected the overall plant layout. Increased usage of computers and terminals will make this approach even more effective.

AUTOMATION

Perhaps the most persistent and pervasive trend is that towards automatic sequencing of events within a given piece of equipment. Also popular is the drive toward computer automation of the entire fabrication area for control, reproducibility, data collection, and analysis. The benefits to be reaped are legion and include:

- Less wafer handling
- Process monitoring and control
- Correct process sequencing
- Proper routing of material
- System self-diagnostics and self-correction
- Data collection for off-line processing
- Elimination of paper work
- Material accountability (especially useful since lot sizes vary for different operations in the manufacturing process)

Equipment manufacturers are following the trend toward automated equipment, some with micro- and minicomputers. Some automation now exists in the areas of diffusion/oxidation, physical and chemical vapor deposition, ion implantation, masking, alignment, mask making, mask inspection, testing, plasma etching, DI water, and environment monitoring.

Variables which constitute the particular process at the factory level are sensed and measured. The supervisory element compares the measured data against set values and adjusts the system to initiate or shut down the process. Communication and display terminals are at the floor or factory level and through them data are transmitted to the highest level, the management computer.

Exciting as it is, the prospect of a fully computerized, semiconductor manufacturing facility is not foreseen before the mid- to late-1980s, even though an experimental automated line has been constructed at Texas Instruments and automated production lines are used by several captive manufacturers. The determining element is, of course, equipment development. Much of the equipment today is being "updated" by adding microprocessors for sequencing. However, very few pieces of equipment are designed around computer control with adequate supporting software. More and more companies have placed computer terminals in their manufacturing areas but these terminals are almost always to handle data rather than direct and control manufacturing processes.

The development cycle for very sophisticated equipment can range from two to five years. Delivery times of equipment costing above $200,000 often range from nine to eighteen months. Development costs are often high too, as is the rate of obsolescence. Consequently, only the wealthiest semiconductor manufacturers can undertake their own development programs toward full computerization of the factory. The rest must wait for market forces to react.

Batch processing will probably never disappear in the foreseeable future. However, more and more equipment manufacturers are offering cassette-to-cassette wafer systems to eliminate tweezer handling. Tweezers are a well-known cause of damaged patterns, silicon particle generation, and wafer defects. In properly controlled equipment, each wafer is subject to almost the same set of process parameters.

STAFFING

The cumulative effects of the recessions of 1970 and 1974 are now evident in the acute shortage of trained engineering staff. The trend of decreased enrollment in engineering colleges since these recessionary periods has not been reversed at rates compatible with industry growth. For those engineers who remained, it has become a sellers' market. In Santa Clara (Silicon) Valley, California, unemployment at 4.7 percent in September 1979 was at a five-year low, unparalled anywhere in the country. At the lower end of the wage scale, turnover rates ranged from 50 to 100 percent among operators. Although mothers of young children have rejoined the work force, the industry still faces severe labor shortages while professional personnel are being wooed by "headhunters" and by print, skywriting, radio, and television ads. Incentives and bounties are offered to staff already in place to ensure successful recruiting.

Housing costs, already prohibitive for engineering staff, are even more prohibitive for operators (see "Site Selection"). Commuting is only a partial solution to the problem of staffing expanding operations. The trend, therefore, has been to relocate new operations in more favorable labor markets, all other things being equal.

WAFER FABRICATION GUIDELINES

Certain guidelines became apparent as U.S. merchant and captive semiconductor manufacturers were surveyed to develop the costs to be used in this model. A summary of these guidelines follows.

Direct labor in most wafer fabrication areas correlates well with the number of wafers out (assuming adequate wafer fabrication yields) and with the number of mask layers; the product of these two factors is approximately 250. In other words, if an 8-layer device were being manufactured, each worker should account for approximately 31 wafers out per week.

Supervision of direct labor typically runs 15 to 20 percent of direct labor hours and, because of higher pay rates, 36 to 48 percent of direct labor dollars.

Allocated labor accounts for all indirects in the wafer fabriction area. This category includes process sustaining engineers, product engineers, quality control and quality assurance, production control, and equipment maintenance. Allocated labor is the largest labor category and may run from 180 to 280 percent of direct labor cost.

We found in our survey a few cases where older processes are in production and little technological change is taking place; in these cases, allocated labor costs were much lower.

Typically, the wafer fabrication area floor space depends on the wafer start capacity required. Our model assumes approximately 12,000 wafer starts per period (there are 13 four-week periods per year) and has approximately 12,000 square feet of wafer fabrication area and 12,000 square feet of area for testing and office space. Thus, the wafer fabrication area required is approximately 1 square foot per wafer start.

The construction costs for these facilities are substantial, particularly in wafer fabrication areas. An analysis of company annual reports suggests that the semiconductor industry spends about 25 percent of its capital on facilities and 75 percent on equipment. Our model shows higher facilities expenditures on a percentage basis because all construction is new; as the equipment ages, it is to be expected that new equipment will be purchased before the facilities become obsolete. This phenomenon accounts for the lower ratio in mature companies.

In our N-channel RAM wafer fabrication model, total capital expenditures for facilities and equipment are:

	Cost	Percent
Facilities:	$ 3,832,300	38%
Equipment	6,364,950	62
	$10,197,250	100%

The facilities expenditure includes both wafer fabrication and office space and is divided as follows:

	Cost	Cost Per Sq.Ft.
Fab Area (12,160 sq.ft.)	$3,319,300	$273
Offices and Test (12,840 sq.ft.)	513,000	$ 40
	$3,832,300	

In the table above, the costs per square foot are in addition to the cost of the basic building shell. In our model, it is assumed that the land and building shell are leased at a cost of $1.00 per square foot per month. If land were purchased and a building constructed, additional costs of $40 to $85 per square foot would be incurred. The variation in these figures depends on the price of the land; it may vary from $40,000 to $400,000 per acre or more.

MODEL COSTS

Our 1980 cost model is based on an MOS 16K DRAM, fabricated using a 6-layer process that does not employ silicon nitride. Other companies may use an 8-layer process. Basic assumptions are listed below:

Technology

- 16K DRAM, MOS N-channel
- 6-layer double-poly process
- 5-micron geometry
- 140 mil x 140 mil chip size (= 20,000 mil^2)
- 16-pin DIP plastic package
- 4-inch diameter silicon wafer
- 1:1 projection aligners (UV)
- Negative photoresist
- Wet etching
- Plasma ashing of photoresist

Production

- Two full shifts per day (skeleton graveyard shift mainly for maintenance)
- Seven hours effective work per shift
- Five day week = 20 days per period
- 12.5 productive periods per year
- 25 percent benefit package including shift premiums
- Minimum throughput at any step = 60 wafers per hour
- 10,000 wafers out per period
- Productivity at approximately 42 wafers out per operator per week (6 layers)
- All assembly operations offshore

Yields

- Cumulative Fab yield - 85%
- E-Sort (16K DRAM) - 16%
- Assembly yield - 90%
- Final test yield - 80%

Facilities

- Building rented as shell at $1.00 per sq.ft. per calendar month
- Space rented = 25,000 sq.ft.
- Minimum of 15 percent inflation rate on construction, materials, and equipment
- All facilities and services supplied from scratch
- All design services contracted to outside engineering firms
- All chemicals (except photoresist) to be pumped into the fab area from storage tanks to points of use
- Masking can accommodate up to 10 projection aligners
- Diffusion can accommodate 20 furnaces
- Fab area = 12,160 sq. ft; E-Sort, Test, Offices = 12,840 sq.ft. total

Equipment

- Highly automated operation
- Convertible for use on 5-inch diameter substrates
- Equipment will be used eventually on 2- to 3-micron gates and shallow junctions (less than 1.0 micron)
- Need filled for data collection and information management to facilitate trend analysis

Volume-sensitive wafer making costs appear in Table 1, a summary of wafer making costs appears in Table 2, and a summary of equipment costs in Table 3. The fixed monthly costs of Table 2 include building rent, sewage, electric power, gas, and depreciation of buildings and equipment.

Howard Z. Bogert

Table 1

VARIABLE (VOLUME-SENSITIVE) COSTS
(Data Gathered From Company Surveys)

Wafer Fab (75% Cumulative Yield)		
Materials:		
- Silicon	$13.33	
- Masks	0.25	
- Chemicals	3.00	
- Indirect Materials	2.25	
- Gases	2.00	
- DI Water	0.10	
Cost per Wafer Out		$20.93
Labor:		
- Direct (Adjusted for 6-layer Process)	$ 5.75	
- Indirect	2.59	
- Allocated	13.53	
Cost per Wafer Out		$21.87

Source: DATAQUEST, Inc.
June 1980

Table 2

COST PER WAFER OUT

		Cost		Percent
Fixed Monthly Costs		$18.04		29%
Fab Materials		20.93		35
Fab Labor:				
Direct	$ 5.75		9.5%	
Indirect	2.59		4.3	
Allocated	13.53		22.2	
Subtotal		21.87		36
Total		$60.84		100%

Source: DATAQUEST, Inc.
June 1980

Table 3

EQUIPMENT COSTS: N-CHANNEL MODEL

	Capital Cost	Percent of Total
Diffusion Area	$1,339,450	21.0%
Masking Area	2,283,300	35.9
Deposition Area	1,039,700	16.3
Fab Support and Test Areas	1,287,900	20.3
Backside Processing	414,600	6.5
Grand Total (6½% Tax Included)	$6,364,950	100.0%

Source: DATAQUEST, Inc.
June 1980

DATAQUEST RESEARCH NEWSLETTER
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UPDATE ON INTEL

SUMMARY

Intel is in the process of making a major shift in the value-added component of its product base, away from semiconductor manufacturing and into design, software, and systems integration. This strategy will make Intel more of a true microcomputer company and less of a commodity semiconductor supplier.

The basic core of its strategy is to make a standardized operating system available on a chip. The investment required to accomplish this goal is huge—DATAQUEST estimates the development costs to be in the order of $100 million, a portion of which has already been expended by the Company.

The key to this program is its execution—if the Company is successful in bringing these products to market, then the investment should prove highly successful. If the integration is not successful, demand will not be as great and Intel will have lost some momentum over its competition.

DATAQUEST projects a 34 percent gain in revenues at Intel in 1980 to $880 million. Despite the potential margin pressure of a weakening in semiconductor demand in the second half, we believe that margins will closely approximate last year's and that earnings will increase by 30 percent to $4.65 per share.

MARGIN ANALYSIS

During 1979, Intel not only maintained, but increased its historically high profit margins, as forecasted by DATAQUEST in its newsletter of December 20, 1978. Intel's ability to maintain its margins was aided by the price stability brought on by a very strong demand for semiconductors.

In 1980, DATAQUEST perceives some weakening of the rate of growth of semiconductor demand in the general industry. Intel will also face increased competition in certain of their high-margin product areas, such as the 2147 fast 4K static RAM, the 2732 EPROM, and the 8048 microprocessor. This competition will

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cause some pressure on margins, but DATAQUEST believes that margins can remain at about the present level through 1980. Intel has developed several product areas which should provide excellent margins and afford some protection from the competitive environment:

- The new high-speed, HMOS II static RAMs.
- The new high-speed EPROMs
- The new EEPROMs
- The 8086 microprocessor family
- Five-volt dynamic RAMs
- Microcomputer board products
- The new high performance microprocessor products
- Microprocessor and microcomputer support products—peripherals, software, and development systems

The microprocessor products are inherently less competitive than some of the high-volume commodity products such as standard memory products. We believe these product areas and their increasing percentage of revenues at Intel will offset the decline in margins from specific memory products. The 8086 and 8085 microprocessor families still are essentially free of intense price competition. Additionally, the support products in the total package pricing of microprocessor and microcomputer related products promise excellent margins. Many of these products can be priced on a value-added basis rather than a cost basis. Intel still has processing advantages over most of its competitors. The new HMOS II memory devices are coming into production even as the original HMOS devices are just beginning to see effective competition. It is our belief that Intel still is a low-cost producer for standard products. If the current heavy demand slackens, we believe that Intel can significantly increase yields and reduce costs.

Additionally, the exceedingly strong market in 1979 has allowed Intel to spend very large amounts for research and development and other costs in developing a rapidly growing corporation. Since some of those costs are discretionary, they can be somewhat reduced if necessary. Secondly, those costs should begin to bear fruit in revenue and profit in 1980 and beyond. These factors give Intel a measure of protection from an uncertain market environment.

First quarter sales increased 52 percent to $205 million and pretax margins rose slightly to 22.5 percent. We expect sequential sales growth of at least 5 percent in the second quarter and a 34 percent increase in full year revenues to $880 million, as shown in Table 1. DATAQUEST estimates that so far in the second quarter the component book-to-bill ratio is in the range of 1.2. Of the major divisions, the two fastest growing are Microcomputer Components (50 percent) and Microcomputer Systems (35 percent).

Table 1

Intel Corporation

ESTIMATED REVENUES 1977-79
(Millions of Dollars)

	1977	1978	1979	1980 Estimate
Memory Components Division	$ 84	$132	$203	$235
Components	69	97	143	195
IBM Contract	-	5	20	-
OEM - Memory Systems Operation	15	30	40	40
Special Products Division	93	123	170	$210
Total Memory Components Group	$177	$255	$373	$445
Microcomputer Components Division	$ 38	$ 75	$154	$230
Microcomputer Systems Division	52	75	148	200
Commercial Systems Division	22	20	30	55
Service			*	15
End User		20	20	12
CSD-Austin (MRI)	-	-	10	18
Solid-State Disk	-	-	-	10
Microma Division	17	0	0	
Intel Magnetics	0	0	1	5
Intracompany	(23)	(24)	(43)	(55)
Total Company Revenues	$283	$401	$663	$880
Percent change from previous year	25.2%	41.7%	65.3%	32.7%

*Service revenues were estimated at $8 million for 1979 but these revenues were not credited to CSD in that year.

Source: DATAQUEST, Inc.
May 1980

Assuming only a slight decline in profit margins this year, we believe that earnings can increase by 30 percent to $4.65 per share.

MICROCOMPUTER COMPONENTS DIVISION AND MICROCOMPUTER SYSTEMS DIVISION

Since the activities of these divisions are so closely related, we are electing to deal with them together in our discussion of microcomputers and microprocessors. However, separate estimates of their revenues are given in Table 1. The Microcomputer Divisions are probably in the fastest growing area currently in Intel. This area is the focal point for some major changes in corporate direction.

Strategy

Reflecting its new slogan, "Intel Sells Solutions," Intel is putting major emphasis on its future in microprocessors and microcomputers. The basic points of this strategy are:

- Move from commodity components to high-margin quasi proprietary microprocessor systems
- Be a "Full Service" microcomputer company, offering processors, peripheral devices, software products, development systems, board products, etc.
- Sell solutions in addition to hardware
- Capture revenue at the system, rather than the chip level, with increased non-semiconductor product, including design, software, etc.
- Utilize current and future high margins to support extensive R&D to outdistance competition

Intel's current strategy is both a corporate strategy and an attempt to meet competition in the microprocessor area. Central to this strategy is a multi-faceted development program in Intel which arose from concern with some basic problems in the microprocessor area. These problems are:

- Increased competition from the new 16-bit microprocessors—the 68000 and Z8000, for example, the loss of the Olivetti business to the Z8000
- The tremendous costs being incurred in software and systems development by people applying the new, powerful 16-bit microprocessors
- The need to recoup development costs for these very complex devices
- The long lead time, often exceeding two years, from product inception to final design and software application of a microprocessor-based system

Meeting these problems has resulted in a coherent future microprocessor strategy for Intel, which includes:

- Going to higher level building blocks for semiconductor systems
- Expanding the value added from basic semiconductor manufacture into systems design and software
- Moving toward bringing some of that software back to the chip level

The 68000 microprocessor made by Motorola and the Z8000 microprocessor made by AMD and Zilog are regarded as competitive to the 8086 16-bit microprocessor, especially if only the CPU chip is considered. Such comparisons are somewhat unfair: the 8086 has been in production for a considerable time and, therefore, it is natural that newer devices should have some technical edge. More importantly, these complex microprocessors are not stand-alone devices. Their performance in any given application is aided by other peripheral chips, the applications software, etc. For many applications, the speed or cost of system design is as important as final cost. This is essentially true of applications where quantity production is limited. Thus, for many applications, these products do not compete as individual chips, but within the environment of a set of chips and support material.

Intel's approach to this situation is to invest heavily in the development of these complex systems, including all phases of support products as well as the new microprocessors themselves. This approach has been well publicized by the Company as a pre-emptive strike against the 68000 and the Z8000. By pre-product announcement, they hope to delay and stop the movement of the potential customers to these competing products. The addition of "coprocessors" to a basic microprocessor greatly enhances the power of the system in some applications. Peripheral devices, such as the 8089 I/O processor, the 8087 math chip, and others, such as the DMA memory controllers, peripheral device controllers, amd SDLCs, are highly complex chips, and, in some cases, significantly more complex than the 8086. They are microprocessors optimized to do special functions quickly and efficiently.

Telecommunications and Automotive Operations

This newly formed operation reports to the Microcomputer Components Division. Sales volume in 1979 was small but has tremendous growth potential.

In telecommunications, Intel has introduced the 2910 Codec, the 2912 filter, and the 2920 analog microprocessor. DATAQUEST estimates that Intel has invested $1.5 to $2 million in advanced test equipment to help get this business started. In automotive, Intel is working on a large 16-bit microprocessor program for Ford, and DATAQUEST believes that Intel is very active in this field overseas. It is DATAQUEST's perception that Intel has changed its attitude to the automotive market after opting not to pursue General Motors' business and having General Motors accept the decision and award substantial amounts of business to Intel's competitors.

Table 2

Intel Corporation

ANTICIPATED 1980 MICROPROCESSOR PRODUCT INTRODUCTION

I. 3 Microprocessor Systems

- 16-bit Microprocessor (iAPX 186)
  - Enhanced 8086, with support chips integrated
  - Enhanced instruction set
- 16/32-bit Microprocessor (iAPX 286)
  - 32-bit internal
  - Some operating system integration (into hardware)
  - Memory management
  - High performance cluster controller
- 32-bit Microprocessor (iAPX 432)
  - "Micromainframe"
  - High-level on chip language integration (on chip!)
  - Object oriented
  - Will support transparent multiprocessing
  - Multilingual
  - New architecture (memory-driven processing)

II. Peripheral Processors

- 8087 - Numeric Processor
  - 64-bit floating point math processor
  - Compatible with all languages, hardware and software transparency
  - 68 Numeric Processor
- 8089 - I/O processor
- Support Chips
  - SDLC, UART
  - Memory Controller
  - Error Correction Chip
  - Floppy Disk Controller
  - Timer/Counter

Table 2 (Continued)

Intel Corporation

1980 MICROPROCESSOR PRODUCT INTRODUCTION

III. Software

- Intel Standard Languages:
  - Systems Programming Languages
    - ASM/86
    - PL/M/86
    - PASCAL/86
  - Applications Oriented Languages
    - PASCAL/86
    - BASIC (to be introduced in 1981)
    - FORTRAN/86
    - COBOL (to be introduced in 1981)
- Operating System Software (iRMX 86) "Real Time Multi-Tasking Executive"
  - Executive (23K bytes)
  - I/O Control (40K bytes)

IV. Development Aids

- Disk file sharing system
- Multi-station microprocessor development systems
- Mainframe link for distributed development

Source: Intel Corporation and
DATAQUEST, Inc.
May 1980

The range of products planned by Intel to meet its strategy goals is outlined in Table 2. Their overall impact is impressive. They could significantly increase the computing power possible with microprocessors. Some basic comments are in order:

- The investment required is extremely large. DATAQUEST estimates that ultimate costs will be in the order of $100 million.

- The concept of a standardized product is implied, i.e., moving the component mentality into the computer systems area. This is a questionable strategy, but one which DATAQUEST believes appropriate to many applications. The movement to standardized operating systems is reminiscent of the move to standardized logic designs in the early 1960s. At that time the movement was highly resisted by the computer companies; however, the benefits in economy, convenience, and design time ultimately became overwhelming. Intel has the opportunity of being the first to set the initial standards, and, if successful, the Company could realize a powerful, long-term competitive advantage.

- The overall Intel strategy is highly application dependent. DATAQUEST believes that this strategy could be successful for a large percentage of applications, but that it will not exclude other microprocessors from gaining market acceptance in certain other applications.

- Intel is clearly moving the value-added component of its product base away from semiconductor manufacturing and into design, software, and systems integration. Essentially, in this area they will be more and more a microcomputer company and less a commodity semiconductor company. Insofar as this trend deviates from past strengths, it is potentially hazardous.

- The general architectural approach taken by Intel generates neither high praise nor scorn from computer manufacturers. The inference is that the approach is one of several acceptable possibilities.

What is important is that Intel executes this product development. If the Company is successful in bringing these products to the market, then the investment should prove highly successful. If there are significant product problems and the integration of these products is less successful than desired, then this will affect market demand. Detailed estimates of the revenues of the Microcomputer Components Division are given in Table 3.

Table 3

Intel Corporation

ESTIMATED MICROCOMPUTER COMPONENTS
DIVISION REVENUES - 1979

Product	Units (Thousands)	Average Price	Drag* Factor	Estimated Revenues (Millions of $)
4004	120	$ 4.50	2	$ 1.6
8008	65	$ 5.50	3	1.4
8080A	780	$ 5.00	5	23.4
8048/8021/8035	1700	$ 6.95	0	11.8
8049/8022	230	$12.00	0	2.8
8748	300	$75.00	0	22.5
8085	1085	$ 8.00	5	52.1
8086	75	$80.00	3	24.0
Other	-	-	-	14.4
Total				$154.0

*The drag factor is used to make allowance for the peripheral chips required for a microprocessor application. Revenues = Average Price x Units x (Drag Factor +1).

Source: DATAQUEST, Inc.
May 1980

MEMORY COMPONENTS GROUP

The Memory Components Group consists of the Memory Components Division, the Special Products Division, and Intel Magnetics. The Memory Components Division makes standard dynamic and static RAMs. Additionally, the OEM board memory products group reports to this division. The Special Product Division manufactures special products such as EPROMs, EEPROMs, bipolar memory, and various other components. DATAQUEST estimates of 1978 and 1979 revenues for these divisions are given in Tables 4 and 5.

Table 4

Intel Corporation

MEMORY COMPONENTS GROUP
ESTIMATED 1978 REVENUES

Memory Type	Major Product	Units (Millions)	Average Price	Estimated Revenues (Millions of $)
MEMORY COMPONENTS DIVISION				
Dynamic RAMs				
1K	1103	3.90	$ 2.05	$ 8.0
4K	2107,2104	11.60	$ 2.20	25.5
16K	2116, 2117	3.30	$ 9.60	31.7
High Speed RAMs				
1K	2115	2.80	$ 2.45	6.9
4K	2147	1.20	$18.00	21.6
CCD Memory	2416	0.40	$ 4.80	1.9
Other				1.7
Total Division				$ 97.3
SPECIAL PRODUCTS DIVISION				
Static RAMs				
1K	2101	9.60	$ 1.35	$ 13.0
4K	2114	2.60	$ 5.50	14.3
EPROMs				
2K	1702	1.20	$ 3.50	4.2
8K	2708	3.20	$ 7.00	22.4
16K	2716	1.45	$18.50	26.8
ROMs				17.0
Bipolar				17.0
CMOS, Memory, Peripheral, Other				8.0
Total Division				$122.7
Total Memory Components Group				$220.0

Source: DATAQUEST, Inc.
May 1980

Table 5

Intel Corporation

MEMORY COMPONENTS GROUP
ESTIMATED 1979 REVENUES

Memory Type	Major Product	Units (Millions)	Average Price	Estimated Revenues (Millions of $)
MEMORY COMPONENTS DIVISION				
Dynamic RAMs				
1K	1103	2.00	$ 2.10	$ 4.2
4K	2107, 2104	6.10	$ 2.35	14.3
16K	2116, 2117	3.25	$ 7.50	24.4
High Speed RAMs				
1K	2115	3.00	$ 3.0	9.0
4K	2147	3.65	$18.50	67.5
Static RAMs				
1K	2101	-	-	-
4K	2114	3.95	$ 4.20	16.6
CCD Memory	2416	-	-	-
Other				7.0
Total Division				$143.0
SPECIAL PRODUCTS DIVISION				
EPROMs				
2K	1702	1.20	$ 3.75	4.50
8K	2708	5.00	$ 5.75	28.8
16K	2716	3.00	$24.00	72.0
32K	2732	0.18	$55.00	9.9
ROMs				13.0
Bipolar				22.0
Telecommunications				5.0
CMOS, Memory, Peripheral, Other				14.8
Total Division				$170.0
Total Memory Components Group				$313.0

Source: DATAQUEST, Inc.
May 1980

Memory Components Division

In 1979, Intel pulled back from active competition in many product areas. In particular, they withdrew from the market for 1K dynamic RAMs, and especially from widespread competition in the 4K and 16K dynamic RAM markets. In making this decision, Intel did not have a major choice. Because of capacity limitations, they had to make the decision to supply these standard components or to supply other products for which they were primarily sole source, such as the high-speed static RAMs and EPROMs. For those products, Intel's customers did not have alternate potential sources of supply. The withdrawing of products from the market was not widely applauded by some of Intel's customers. Rightly or wrongly, it was perceived that the products that Intel maintained in production were higher margin items. Nevertheless, the move marked a major turning point for a company that once was the dominant supplier of semiconductor memory.

Recently, Intel has been emphasizing the single voltage supply (5-volt) 16K RAM. For this product they had been the sole supplier, but other suppliers have recently begun to sample the device. The product fits nicely with Intel's line of microprocessors, such as the 8085 which also operates on a single supply. In 1980, we believe Intel will introduce a 64K dynamic RAM. Introduction of 64K RAMs has been delayed by the exceptionally strong memory market. It is our belief that this situation has allowed Intel to redesign its product and improve its process. If Intel's capacity begins to approach its demand, wafer capacity will be allocated to this product. As capacity becomes more available, we expect Intel to take a more aggressive position in standard memory products.

In 1979, Intel was virtually a sole source of fast 4K static RAMs. Its 2147 RAM is beginning to undergo serious competitive pressure; companies second-sourcing the device include Fujitsu, Motorola, National Semiconductor, and NEC, and other companies are expected to enter volume production. Competing devices now include devices from several Japanese companies, including Hitachi. The HMOS II process will allow significantly faster devices to be produced. With new products, such as a 16K static RAM which is expected to begin production in 1980, Intel has a competitive edge. However, in 1980, we anticipate only 16 percent growth over 1979 in the Memory Components Division.

Special Products Division

The Special Products Division has a mixed future in 1980. It is faced with the likelihood of significant price declines for its 16K and 32K EPROMs. These devices are entering a period of increased competition and supply from an essentially monopolistic position. On the other hand, this division has several new, exciting products:

- <u>16K EEPROM</u>. This device is an electrically eraseable PROM (EEPROM) which can used as a potential replacement for the 2716 EPROM. Intel developed both a new process—HMOS-E—and a new cell structure—Flotox—for this product. This product signals Intel's entry in to the nonvolatile memory (NVM) market, which has tremendous potential, but has not been fully realized due to lack of proper product and high cost. EEPROMs are now manufactured by General Instrument, Hitachi, National Cash Register (for captive use only), and Nitron.

The current market is small; primarily consumer products. Industrial applications, including POS terminals, telecommunications, office equipment, and others are just beginning to emerge.

- 2732A Fast EPROM. This new EPROM is designed to operate at speeds compatible with the faster, newer microprocessors. Based on a new version of Intel's processing technology, this device is approximately half the size of the previous 2732 chip. It promises ultimately to have superior price-performance to any EPROM now in the market.

- 2764 EPROM. This new 64K EPROM was described at the ISSCC in February. It will be sampled this year although its active development will be a function of capacity constraint.

- 16K Bipolar PROM. Intel's competitive position in the bipolar PROM market has taken second place to its overall microprocessor strategy. Nevertheless, Intel is one of only two companies in production of 16K PROMs. This product has the possibility of greatly expanded revenue.

Intel Magnetics

Intel Magnetics now reports to the Memory Components Group. In March 1979, they introduced a 1 megabit bubble memory board. Sales have not grown as fast as was anticipated due in part to the lack of support peripherals from Intel. Sales by Intel Magnetics in 1979 were $1 million and are expected to be about $5 million in 1980.

At the recent SEMICON West exhibition, DATAQUEST learned from several test houses that interest in bubble memory testers is substantial and growing. There appears to be a lot of activity in Japan and Europe. This bodes well for Intel as well as for other manufacturers.

COMMERCIAL SYSTEMS DIVISION (CSD)

The Commercial Systems Division has been undergoing some major changes prior to the more rapid growth expected in 1980 and beyond. The OEM Memory Systems Operations was transferred to the Memory Components Division. This transfer underscored the reality that these board products are significantly closer in nature to components than to systems.

It is DATAQUEST's perception that the CSD is moving strongly toward areas related to data base management. This move will incorporate the products and systems expertise of Intel with the software and systems expertise of MRI Systems which was acquired by Intel early in 1979. This general strategy should become more apparent in 1980 with the expected introduction of a data base package for the 16-bit microcomputers.

Solid State Disk

The solid state disk has had some product problems which have delayed its general volume manufacture. It is DATAQUEST's understanding that the initial systems have been removed from beta sites for changes and improvements relating to speed and micro-coding. Nevertheless, the 3805 solid state disk is an exciting new product which has gained considerable attention. Although we believe that 1980 demand could be as high as 50 systems at about $300,000 each, or $15 million, Intel may not be able to meet this demand; therefore, we estimate revenues for 1980 to be $10 million. In 1981, revenues could be as high as $50 million.

CSD-Austin (MRI)

Although MRI still produces and sells its original products, it is now giving more attention to the development of data base management system for Intel microcomputers. DATAQUEST believes that MRI will have revenues of approximately $18 million in 1980.

End-User Memory

The end-user IBM compatible memory revenues are solely lease income from existing installations. DATAQUEST estimates revenues in 1980 will be about $12 million.

Product Service

The Commercial Systems Division also services development systems and memory systems. In 1979, revenues were approximately $8 million and are expected to almost double in 1980 to about $15 million. This potential growth underscores the increasing revenues derived by the Company from development systems and microcomputer-related products. Development systems are sold by the Microcomputer Systems Division.

FACILITIES AND CAPITAL EXPENDITURES

Capital expenditures of Intel in 1979 were about $97 million. We believe it was the only major semiconductor company to reduce spending last year. This reduction resulted primarily from problems arising because of delayed equipment deliveries and a high level of capital spending in 1978. In short, Intel was limited by how fast they could spend money rather than by a reduction of plans.

In 1980, Intel plans capital expenditures in the order of $150 million. Plans includes major wafer fabrication expansion in Santa Clara, California, and Chandler, Arizona. Additionally, design facilities will be expanded in Japan and Israel. The design group in Japan is now very small, and will probably become operational in 1980. It is DATAQUEST's belief that Intel plans to enter wafer fabrication in Japan at a later date, possibly 1982. In Israel, Intel currently has a design group of about 50 people. We believe that this group will be further expanded in 1980, with the possibility of assembly and wafer fabrication at a later date. Twenty acres of land is under option in Albuquerque, New Mexico, and we believe facility construction will begin in 1980. Currently under construction is expansion of the Microcomputer Systems Division in Hillsboro, Oregon. Wafer fabrication expansion is also underway in Livermore, California, doubling that facility's capacity. When that is completed, the semiconductor wafer fabrication capacity of Santa Clara, Livermore, and Oregon will be approximately equal. A list of Intel facilities is given in Table 6.

Table 6

INTEL FACILITIES[1]

Plant Location	Square Footage	Activity
Mountain View, CA	22K	Fab I - Upgraded in 1979
Santa Clara, CA, No. 1	78K	Fab II - Upgraded in 1979
Livermore, CA	50K	Fab III
Aloha, OR, No. 1	60K	Fab IV
Aloha, OR, No. 2	80K	Fab V
Chandler, AZ	100K	Fab VI - Production 1980
Livermore, CA, No. 2	50K	Production early 1981
Japan		Design 1980
Japan		Wafer Production 1982
Israel		Design 1979
Albuquerque, NM		Land Purchased
Penang, Malaysia		Assembly
Manila, Philippines		Assembly
Barbados		Assembly Expansion, 1979-80
Santa Clara, CA, No. 4	180K	Headquarters for Microcomputer Components Division, Corporate Offices
Hillsborough, OR, No. 1 (under construction)	382K	Microcomputer Systems Division
Deer Valley, AZ	163K	Headquarters of the Commercial Systems Division, Completed 1979

[1]Not a complete list

Source: DATAQUEST, Inc.
May 1980

Shortages of labor and equipment, and limits on the rate at which wafer fabrication facilities can be constructed or expanded are problems that Intel may face in common with all semiconductor manufacturers. However, for the reasons explained in this newsletter, DATAQUEST remains optimistic about Intel's future both long and short term.

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GATE ARRAYS AND OTHER SEMICUSTOM LOGIC

INTRODUCTION AND HISTORY

Standardized semiconductor circuits are becoming increasingly complex. The driving cost behind this phenomenon is economic; as more transistors are added to a VLSI device, the production cost per transistor is reduced. Unfortunately, not all complex circuit functions can be performed with standardized circuits. Custom designed circuits offer one alternative, but design costs are so high that this approach is only suitable for those circuits which are produced in very high volume. The semiconductor industry has now developed (or redeveloped) several techiques which offer a compromise between the two alternatives of custom design and standard product. Generally, these techniques have lower design costs than custom circuits and higher production costs than standard circuits. We refer to these circuits in general as semicustom circuits.

Gate arrays have been offered by the integrated circuit industry since the mid-1960s with little economic success. Arrays and other interconnect customizable integrated circuits were offered in the mid-1960s—TI's Master Slice flip-flops were probably the first offered. Fairchild's Micromatrix of 1967 was one of the earliest commercial array devices; it contained 32 gates. Near the end of the 1960s, TI developed a Discretionary Routed Array in which the interconnections were fabricated after the wafer had been tested to identify inoperative cells. Raytheon, in conjunction with its missile systems activities, offered and used TTL gate arrays of 30 to 300 gate complexity.

Former Lack of Acceptance

By the mid-1970s, all of the significant commercial programs, except Raytheon's, had been curtailed because of economic considerations. Specific reasons included:

- Large die sizes caused the circuits to be too expensive for high-volume applications.
- Complexity was too low to replace enough SSI/MSI to effect significant cost or size reductions.
- Prices of SSI/MSI were falling very rapidly.

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- Developmental resources could be applied to memories and microprocessors for significantly better return on investment.

- Custom and semicustom developments require close customer interfacing which was generally viewed as opposed to the traditional role of the semiconductor supplier.

Current Resurgence

The incentives for semicustom logic—reduction of development lead-time and cost—have changed little. What has changed is circuit density and system constraints. There is now great interest in gate arrays as a solution to semicustom VLSI in non-microprocessor applications as a result of five major events:

- Increased circuit density
- Improved cost savings in design and manufacture
- Easier implementation
- Introduction of sub-nanosecond ECL
- IBM adaptation of gate arrays for implementation of its 4300 series computers

Chip densities are increasing such that one chip represents all of the random logic associated with computing machines of substantial complexity. The opportunities for standard (catalog) logic functions are increasingly precluded as each chip represents a machine model; production volumes are likewise limited. Thus, integration of control functions seems destined to be implemented with highly-customized, low-volume devices. Value is perceived as the ability to achieve system design security, to reduce cost by reducing the size of the electronic package, to reduce lead times, and to reduce logistic problems by making a complete product mix available with only a few part numbers. Previously, SSI/MSI implementations were generally more cost effective than array solutions.

A significant additional parameter is introduced in high-performance ECL arrays—high-level integration is necessary to preserve the low propagation delays.

SEMICUSTOM LOGIC APPROACHES

The major approaches to semicustom logic include:

- Gate Arrays
- Field-Programmable Logic
- Standard Cells

The above approaches are compared to full custom and to SSI/MSI solutions in Table 1.

Table 1

COMPARISON OF VARIOUS DESIGN APPROACHES

Approach	Relative Design Cost	Typical Gate Count
Full Custom	100%	3,000-5,000
Standard-Cell Custom	60%	1,500-3,500
Gate Arrays	10%	300-1,500
Field-Programmable Logic	1%	30-90
SSI/MSI	0%	8-10

Source: DATAQUEST, Inc.
April 1980

New processes and circuit designs are becoming increasingly popular. Generally, traditional TTL is being abandoned in favor of lower power solutions such as I^2L, ISL (Integrated Schottky Logic) and CMOS. Interconnection parasitics are reduced to very low levels when the interconnections are on-chip; therefore, performance in the low nanoseconds can be maintained without recourse to more power-consuming logic circuits such as Schottky TTL. To effect TTL compatibility at high speeds, we expect that the basic TTL array will be ECL with TTL input/output translations.

Gate Arrays

Gate arrays are those integrated circuits which contain a standardized array of logic gates interconnected by a customized metal interconnect pattern.

Gate arrays promise to enjoy a significant share of the semicustom logic market; however, the support in CAD equipment (especially software) represents a tremendous investment. The investment becomes prohibitive for most users when one adds the direct write-on-wafer E-beam (Electron-beam) equipment required to provide the turnaround deemed necessary by the electronic equipment manufacturers. Arrays are offered in a variety of processes.

Gate Arrays in High-Performance ECL

High-density gate arrays were first introduced in conjunction with the high-performance ECL families characterized by Fairchild's F100K. In these families, the gate array is utilized to effect designs with a reasonable amount of front-end lead time and cost; however, the prime incentive for its use is not the reduction of circuit development costs, but its impact on performance.

Gate propagation delay in modern ECL arrays is approximately 600 picoseconds and decreasing. SSI/MSI ECL implementations have special problems because package-to-package interconnections of less than one inch are nearly impossible to effect; in fact, one-inch interconnections will connect only adjacent packages. Since a one-inch interconnection has a delay of about 100 picoseconds or more, it is apparent that propagation delays in the interconnect quickly approach, or even exceed, the delays within the gates. If, however, the gate interconnections can be effected on an LSI/VLSI chip, the interconnection length is a few hundredths of an inch, resulting in interconnect delays which are small compared to the gate delays. In this manner, the effectiveness of the very fast gate is maintained.

Gate Array Status At IBM

IBM is utilizing its substantial expertise in software, Computer-Aided Design (CAD) techniques, direct-write E-beam, and packaging to realize a significant advantage over its computer competitors through very rapid gate array design times. IBM has three automated quick turnaround fab lines in East Fishkill, New York. These lines are used to etch the variable interconnect patterns on IBM's 750 gate TTL array. All other layers of the device are produced by more conventional means. Industry sources say that the time required between entry of a logic diagram into the system and receipt of tested, packaged parts may vary from eight hours to two weeks.

Automation and direct E-beam exposure of wafers are used to improve turnaround time. Automation improves the turnaround time because all the wafer-processing equipment is interconnected. For this reason, there is no waiting time between one process step and the next. In a conventional process, these waiting times may exceed the process time by a factor of ten. E-beam exposure of wafers improves turnaround because it eliminates the delays associated with maskmaking.

Each of these lines can process at least ten wafers an hour. Thus, it is conceivable that 30 new array designs could be generated every hour on the three lines.

Field-Programmable Logic

The field-programmable logic array (FPLA), its descendents, and especially the PAL, are expected by DATAQUEST to play key roles in satisfying the demand for customized high-density circuits. These devices are programmed by the user in much the same way a bipolar PROM is programmed. They offer an alternative to smaller companies that cannot afford the programming costs for gate arrays. They are typically served through the distribution channel. Interviews with even first-tier systems houses reveal that some systems have already been prototyped with as much as one-half of the random logic functions being implemented with field-programmable devices. We think the outstanding feature of field programmable logic is that it cuts the major bottleneck of other semicustom logic solutions—front-end lead times—to virtually zero.

Programmable Array Logic

PAL (Programmable Array Logic) is expected to play a very major role in this market and probably will be the major vehicle used by third-tier and distributor-supported customers. PAL devices are less versatile than full FPLA devices, but more economical and easier to implement into designs. The PAL series was originated by Monolithic Memories and is being second-sourced by National Semiconductor and Raytheon. The PAL family is a series of 16 devices which can be programmed through the fusible link method like a bipolar PROM. It is said that these 16 devices can be programmed to duplicate the functions of 250 different MSI devices.

Standard Cells

At least one manufacturer, Signetics, offers a cell solution to the custom/semicustom offerings. Signetics' Composite Cell Logic (CCL) offers a library of predesigned logic cells which the device designer may choose, place, and interconnect. DATAQUEST believes this approach will be successful as an alternative to fully customized logic rather than a competitor for fast turnaround semicustom logic. CCL can utilize inventoried wafers to a limited degree only; a given customer would be well advised to use one cell pattern (at least very few) and as many interconnect patterns as necessary. This restriction would provide faster design time than for a fully customized design with more flexibility than a gate array.

Role of Programmable Memories

PROMs and EPROMs, although technically memories, contribute significantly to solutions for the elimination of conventional SSI/MSI in the control areas. Both allow major portions of the control to be reduced to a series of "words" stored in a control memory.

THE MARKET FOR GATE ARRAYS AND SEMICUSTOM LOGIC

We estimate that the market is virtually undeveloped; present merchant sales are approximately $50 million. Both users and manufacturers are presently in a state of "tire kicking" while they ascertain how to properly use and support this new entity. The major gate array manufacturers and their respective estimated revenues and design experience are shown in Table 2; their technologies are shown in Table 3. By 1985, the worldwide market potential for semicustom logic (gate arrays, ROMS, PLAs, PAL, etc.) is estimated to be up to one-third of the projections for bipolar digital devices. Currently, most suppliers report sales growth rates in the range of 50 to 100 percent or more. We believe that it is not presently possible to forecast market shares by approach because the approaches are too dependent on support strategy decisions which must yet be made. DATAQUEST estimates that the per-gate prices of gate arrays will decline by a factor of approximately four from 1980 to 1985. Specific forecasts are shown in Tables 4, 5, and 6.

Captive gate array manufacturing presently constitutes the major production. The major captive gate array manufacturers are listed in alphabetical order in Table 7.

Table 2

SEMICONDUCTOR MANUFACTURERS OFFERING GATE ARRAYS

(Millions of Dollars)

Manufacturer	Estimated 1979 Gate Array Revenue	Estimated Design Options Completed to Date
Applied Microcircuits	\$ 0.2	2
AMI	(Product currently in development)	
California Devices	0.5	20
Dionics	-	10
Exar	4.0	70
Fairchild	2.5	70
Ferranti	4.0	250
Fujitsu	4.0	40
Interdesign	10.0	300
International Microcircuits	4.0	500
Master Logic	0.5	20
Motorola	6.5	175
Plessey	0.2	5
RCA	10.0	70
RTC	0.0	5
Siemens	.5	20
Signetics	2.0	10
Texas Instruments	N/A[1]	N/A
Total	\$48.9	1,567

[1]N/A = Not Available

Source: DATAQUEST, Inc.
April 1980

Table 3

GATE ARRAY TECHNOLOGY

Manufacturer	Process(es)	Gate Count Available
Applied Microcircuits	ECL, TTL, CMOS	120-1120
California Devices	CMOS	50-800
Dionics	I^2L	200-400
Exar	I^2L	200-400
Fairchild	ECL, I^3L	70-168, 4000
Ferranti	Bipolar	200-1,000
Fujitsu	TTL, CMOS	200-500, 2,000
Interdesign	NMOS, CMOS	100-400
International Microcircuits	CMOS	50-5,000
Master Logic	CMOS	100-500
Motorola	ECL, TTL	150-1,500
Plessey	ECL	N/A[1]
RCA	CMOS, SOS	180-650
RTC	ECL, ISL	168, 1100
Siemens	ECL	180-1,500
Signetics	ISL, I^2L	1,100, 2,000
Texas Instruments	N/A[1]	N/A

[1] N/A = Not Available

Source: DATAQUEST, Inc.
April 1980

Table 4

ESTIMATED GATE ARRAY SELLING PRICES

(Dollars)

	1980	1981	1982	1983	1984	1985
CMOS, I^2L	$ 6.00	$ 7.10	$ 8.60	$11.00	$13.50	$ 15.00
T^2L	$ 8.00	$ 9.40	$11.00	$13.00	$15.30	$ 18.00
ECL	$99.00	$92.00	$94.00	$96.00	$98.00	$100.00

Source: DATAQUEST, Inc.
April 1980

Table 5

ESTIMATED AVERAGE GATE ARRAY GATE COUNT

	1980	1981	1982	1983	1984	1985
CMOS, I^2L	300	475	750	1,200	1,900	3,000
T^2L	200	300	450	700	1,000	1,500
ECL	150	250	425	700	1,200	2,000

Source: DATAQUEST, Inc.
April 1980

Table 6

ESTIMATED AVERAGE GATE ARRAY PRICE PER GATE
(Cents)

	1980	1981	1982	1983	1984	1985
CMOS, I^2L	2.0	1.5	1.2	0.9	0.7	0.5
T^2L	4.0	3.1	2.4	1.9	1.5	1.2
ECL	60.0	37.0	22.0	13.7	8.2	5.0
SSI/MSI	5.0	5.1	5.2	5.3	5.3	5.3

Source: DATAQUEST, Inc.
April 1980

Table 7

CAPTIVE GATE ARRAY MANUFACTURERS

Manufacturer
Amdahl
Burroughs
Digital Equipment Corp.
Honeywell
IBM
Sperry Univac
Storage Technology
Western Electric

Estimated total designs completed - 3,000
Estimated total value manufactured in 1979 - $60 million

Source: DATAQUEST, Inc.
April 1980

Second Sourcing

The use of VLSI for random logic will likely have a strong impact on semiconductor revenues. We estimate that by 1985, logic suppliers will supply fewer circuit packages of each type at approximately one-fourth of the present cost per gate function. This development could aggravate the second source problem as some users are expected to have difficulty satisfying the minimum quantity criterion of even one supplier. Sometimes the customer will own the interconnect tooling and so will be free to change suppliers for production quantities, provided there is more than one vendor manufacturing a compatible device. The present trend of semiconductor manufacturers towards decentralization of their wafer fabrication facilities protects the customer in the event of total loss from fire or other disaster.

PACKAGING IMPLICATIONS

Gate array implementations in VLSI technology promise to require packages with very large lead counts and an unwieldy amount of die periphery committed to bonding pads. IBM has solved this problem through the use of its highly developed solder bump technology which seems capable of accommodating more than a hundred interconnections. The solder bump technology eliminates the die periphery problem because contacts can be distributed throughout the die. The independent packaging industry has not yet learned how to make successful package solutions with more than 168 pins, and most electronic equipment manufacturers have difficulty handling any package that does not use the DIP (Dual In Line Package) format. DIP packages as a practical matter are limited to 68 pins or less. Leadless carriers alleviate some of the problems, i.e., size and lead length, but are still limited by the pad periphery problem.

TESTING

Generation of the test programs is a task which can approach, or even exceed, the cost of chip design. To effect fast turnaround of a new design, the CAD software must generate the test vectors from the input logic equations. Few effective commercial programs are yet in existence, so most test routines are developed by an engineer. The mainframe computer industry has demonstrated that the computer time required to generate a test routine will grow with increasing chip density unless some form of on-chip test aid is incorporated. Significant controversy exists around the question of increasing test complexity. Some users believe the problem grows as the square of the complexity; others think that it will grow as the square root.

On-chip aids include IBM's Level Sensitive Scan Design (LSSD) and Univac's Scan Set. It seems obvious that future generations of gate arrays and other commercial logic must incorporate one of these techniques. The scan design techniques, in essence, provide a method of testing lower complexities by determining internal inputs and output states.

RESOURCE REQUIREMENTS

Application of suitable developmental resources to device implementation is the major factor in the successful implementation of VLSI in random logic. DATAQUEST believes that design turnaround time and the ability to absorb large numbers of designs are the overriding factors for successful custom and semicustom programs. Major computer manufacturers feel that a turnaround of six weeks or less from Pattern

* Generator tape to samples is the maximum time period acceptable if their design-cycle time is to be competitive. Rework cycle requirements are set at two weeks. Response time at this level has been demonstrated by at least one vendor; however, most vendors expect turnaround time for original and rework cycles to be about three months. Routine responses of six weeks or less are expected to require very sophisticated CAD software and either direct write-on-wafer with E-beam or dedicated quick turnaround maskmaking.

Capital expenditures for a gate array manufacturing area can be smaller than for a semiconductor plant. This is possible because it is necessary to perform only interlayer deposition, metal deposition, and etch; the other wafer manufacturing steps are performed elsewhere. The requisite partially completed wafers can either be purchased from another company or made by another division of the same company. DATAQUEST believes the capital expenditure for such a facility is between one and two million dollars. This does not include maskmaking equipment, direct-write E-beam equipment, or CAD development.

Separation of the custom portion of the gate array manufacturing process is, we believe, necessary to insure that the proper emphasis is placed on achieving a capacity to execute many designs in the shortest possible time. Gate array customization is a service business and is likely to prosper best if somewhat isolated from the typical manufacturing-oriented semiconductor company. Several smaller companies have now developed, or are developing, a metal-etch capability.

Engineering talent grows increasingly scarce and there is little reason to expect the situation to improve. The need for more engineers is increasing as technological innovations enhance our life styles and become part of our way of life. The percentage of engineers as a fraction of total annual college graduates is now less than half what it was in 1950. Therefore, in spite of a doubling of the number of annual college graduates, the number of engineering graduates has remained relatively constant. Department of Commerce statistics are shown in Table 8.

Table 8

ENGINEERING GRADUATES FROM U.S. COLLEGES AND UNIVERSITIES

Year	Engineering Graduates	Percent of Total Graduates
1950	58,000	11.6%
1960	46,000	9.5%
1970	64,000	5.9%
1975	65,000	5.0%

Source: U.S. Department of Commerce

Howard Z. Bogert

DATAQUEST RESEARCH NEWSLETTER
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SIS: 2.12

THE FCC MAKES A LANDMARK DEREGULATION DECISION

(Docket 20828 - April 7, 1980)

SUMMARY

The United States has a 45 percent share of the $250 billion world market for computer and communications services and equipment. Into this market, the U.S. Federal Communications Commission has thrown a double blockbuster.

Effective in March 1982, the FCC proposes that:

- AT&T, the world's largest utility, will be allowed to enter the data processing market through an arm's-length subsidiary.
- U.S. business and residence telephone subscribers will purchase or lease in an open competitive market all of the estimated $10 to $15 billion worth of voice and data terminal equipment located on their premises.

INTRODUCTION

The FCC was expected to take major deregulatory action in the area of computers and communications in its final decision on the second computer inquiry. However, the deregulation of all terminal equipment on customer premises in the same decision makes its action doubly significant, and gives the decision twice the potential impact of landmark decisions such as Carterfone.

The full text of the Order is not expected for at least another week from the date of this writing. DATAQUEST, nevertheless, is providing at the earliest possible time this analysis of the important issues involved.

BACKGROUND

The FCC's Order of April 7, 1980, attempts to resolve two controversial issues with which it has been dealing for over a decade. These are:

- The deregulation of voice and data terminal equipment situated on customers' premises. The first major move in this direction was the Carterfone decision of 1968, which permitted equipment not owned by the operating telephone companies to be interconnected to the nationwide telephone network.

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- The regulation or deregulation of data communications and data processing services. This issue had first been dealt with by the FCC Computer Inquiry of 1966/67 in which two major ongoing concerns were addressed:

  —That a regulated common carrier (particularly AT&T) could subsidize data processing services with its monopoly telecommunications services

  —That computer companies (particularly IBM) could sell communications services as part of a data processing package not subject to regulation

This most recent decision of the FCC Commissioners is a broad one of major impact. However, the scope of the decision is sweeping, and we believe that the FCC will be involved in challenges, modifications, and clarifications of this Order for at least the next two to three years.

THE FCC DECISION

The FCC has released the following abstract of its actions.

- Common Carrier Network Services

  —Defined all network services as either basic services (limited to the common carrier offering of transmission capacity for the movement of information) or enhanced services (combines basic services with computer processing applications which provide additional, different, or restructured information).

  —Deregulated enhanced services and held that only basic transmission services were subject to regulation under Title II of the Communications Act.

- Carrier-Provided Customer Premises Equipment (CPE)

  —Accorded uniform regulatory treatment to all carrier-provided CPE and made no distinction between various types of CPE.

  —Required a carrier's offering of terminal equipment and related costs to be unbundled (separated) from its basic services and detariffed, and provided a transition period until March 1, 1982, for the orderly deregulation of CPE.

  —A Federal-State Joint Board is to be convened to determine whether adjustments in other exchange plant allocations are warranted.

- Carrier Provision of Enhanced Services and CPE

  —Eliminated current rules requiring "maximum separation" of a carrier's regulated services from its unregulated data processing services, except for carriers under direct or common control of the AT&T and GTE. Thus, all other carriers are no longer required to offer enhanced services through a separate subsidiary.

—Carriers under direct or common control of AT&T and GTE may provide enhanced services only through a separate corporate entity on a resale basis. The resale subsidiary must acquire all its transmission capacity from a carrier pursuant to tariff.

—Carriers under direct or indirect common control of AT&T and GTE may not market, install, service, or maintain CPE except through a separate subsidiary. The CPE subsidiary may not provide transmission equipment. However, CPE may be offered through the resale subsidiary in conjunction with enhanced services. Waivers of this rule for operation in sparsely populated rural areas will be entertained.

—Stated that AT&T is not foreclosed from providing enhanced services for CPE under the terms of the 1956 AT&T Consent Decree.

COMMENTS ON THE DECISION

We interpret and summarize the FCC Order to consist of three major items to be effective by March 1982.

- Terminal equipment, i.e., equipment located at customers' premises, will no longer be provided under operating telephone company tariffs. Before the (1968) Carterfone decision, all such equipment was provided, owned, and tariffed by the telephone companies only. After the Carterfone decision, the business or residential subscriber had the option of using:

  —tariffed equipment,

  —equipment he had purchased himself, or

  —equipment leased to him by a third party.

This latest decision removes the first of these options, but probably allows the telephone companies to lease equipment to their subscribers as a competitively priced, non-tariffed item. The equipment covered under this ruling includes: telephones, key systems, PBXs, data modems, and acoustic couplers.

- AT&T may enter the market for data communications and data processing products and services, and GTE may remain in this market. AT&T has, up till now, been barred by its 1956 Consent Decree from engaging in any business other than common carrier communications.

- The two largest operating telephone companies, AT&T (1979 revenues $45.4 billion) and GTE (1979 revenues $9.96 billion) must each set up separate "arm's-length" subsidiaries to conduct their sales to either of the markets described above, i.e., the terminal market and the data communications/processing services market. Other independent operating telephone companies (e.g., Central Telephone and United Telecommunications) are already in one or both markets through subsidiaries which are not "arm's-length." These companies may continue to operate in this manner, or to sell in these markets directly.

In 1974, the Justice Department filed a second antitrust suit against AT&T. The new suit was based on the contention that FCC decisions, in the six years prior to 1974, had opened up new areas to competition and had created conditions that made the continuance of an integrated Bell System no longer legal, nor in the public interest. This suit is still being litigated.

We believe that a major objective of the FCC is to extricate itself from situations in which it must make judgmental categorizations based on technology and/or technical applications. However, the issue of what are basic carrier services and what are enhanced communication services is not readily comprehensible to the layman and can be controversial for the expert. It is not our intention to cover this complex question in this newsletter. However, we anticipate that in this area the FCC may still be faced with difficult distinctions often rooted in the shifting sands of innovative electronic technology.

In DATAQUEST's judgment, another so-far-unstated objective of the FCC is based on national priorities. If AT&T continues to be barred from becoming a full "information utility," the United States may be alone among industrialized countries in restraining its largest national reserve of communications expertise (e.g., Bell Labs) from contributing to the future of the information society.

OUTSTANDING QUESTIONS:

The broad scope of the decisions gives rise to numerous questions for which we provide DATAQUEST's responses. We believe that some of the more significant questions are as follows:

- Does deregulation imply that the FCC will no longer have authority over the equipment and services deregulated?

We interpret the term "deregulation" in this context of the FCC decision to imply:

—Non-tariffing, i.e., prices are set by the marketplace, not by the regulatory authority

—Relaxed conditions of market entry and participation

The Congress has given the FCC regulatory authority in these areas, and the Courts have affirmed it. We do not believe that the FCC can relinquish its authority or that it desires to do so. Type approval of terminal equipment, for example, will still be required. We also do not expect any near-term action by the Congress or the Courts to take away the FCC's authority over these areas.

- Are the terms "basic services" and "enhanced services," which are used by the FCC, clearly defined in the technical or trade literature of the communications and/or computer industry?

The FCC states that all network services are either basic or enhanced and deregulates those which are enhanced. We believe that in due course the FCC will provide more complete definitions and/or guidelines than it has so far. However, we do not find these to be definitive terms in the usage of either the communications or computer industries.

- Do the service offerings of carriers which operate value added networks (VANs) become deregulated? Tymnet, ITT, and Graphnet are providing enhanced ("value-added") services of this kind, but their operations are not large enough to constitute dominant market forces. DATAQUEST believes that these services will now qualify for deregulation.

- Will the Bell System's Advanced Communications System (ACS) (if and when it is re-introduced) be a regulated common carrier service? Or will it be an enhanced data communications/processing service offered by AT&T's unregulated subsidiary?

We believe that the answer to this question will depend to a large extent on the features of ACS when it is re-introduced, but that it will most likely qualify for deregulation.

- Will GTE be required to operate its Telenet public data network subsidiary - also a VAN - as a deregulated "arm's-length" subsidiary?

GTE acquired Telenet for two million shares (approximately $58 million) in 1979. We expect that Telenet and probably other planned services of GTE's new Communications Network Sytems Group (e.g., "GTE Viewdata") will become offerings of the deregulated subsidiary.

- Will non-communications companies such as IBM, Xerox, or Exxon be allowed to enter the enhanced data communications services market and operate non-regulated public data networks similar to, or more advanced than, Telenet for example?

DATAQUEST believes that the Order will allow them to enter this unregulated market as long as they offer sufficient "enhancement" beyond the transportation (common carrier) function. We anticipate that Xerox's XTEN, for example, would qualify.

- Will Western Electric be allowed to manufacture equipment for sale to the public through an unregulated arm's-length Bell System marketing entity?

The 1956 Consent Decree appears to restrict Western Electric to the manufacture of equipment for sale to the Bell System only (other than D.O.D. work). Western Electric's manufacturing capacity is approximately ten times the size of any other telecommunications equipment manufacturer's U.S. plant. The resultant economies of scale provide Western with the potential for major competitive advantages. We anticipate that Western will, therefore, be "handicapped" in some still undetermined way in its sales outside the Bell System.

- Will those operations of AT&T and GTE which manufacture terminal equipment be required to become parts of the arm's-length subsidiaries of those companies?

Their manufacturing competitors will presumably contend that the potential for subsidy from these companies' monopoly common carrier services exists if full separation is not effected. We believe that this issue will be a difficult one to resolve, particularly for AT&T, but that, in the long run, those manufacturing operations will become separated.

- Does this Order change the regulatory status of the specialized common carriers (SCCs), eg., MCI, SPCC?

We interpret this Order as having no serious impact on the SCCs. Their services will remain regulated. They could previously offer data processing services through unregulated subsidiaries. Apparently they can now offer such services directly without a separate subsidiary. However, in order to avoid potential conflicts with state regulators, they would probably use separate subsidiaries if and when they do offer enhanced services.

- Does this Order deregulate the services of the SBS partnership (IBM, COMSAT-General and Aetna)?

The Services to be offered are technologically innovative. Nevertheless, we believe that they are predominantly services "offering transmission capacity for the movement of information" which the FCC regards as subject to basic common carrier regulation.

LEGAL ROADBLOCKS:

The courts have played a major and increasing role in the resolution of issues arising from FCC decisions on deregulation and the introduction of competition. Those who oppose this latest FCC Order can attack it through the courts in some of the several ways listed below:

- The FCC decision appears to be inconsistent with AT&T's 1956 Consent Decree in at least two areas:

  —AT&T will be allowed to offer non-common-carrier services.

  —Western Electric will be allowed to sell equipment outside the Bell System.

- The unregulated sales and/or manufacturing subsidiaries of AT&T (and perhaps GTE) would become sufficiently large that they could be construed to dominate the markets in which they operate.

- Arm's-length separation of major portions of Western Electric and possibly Bell Telephone Laboratories means the fragmentation of a major national resource (the integrated Bell System) and is not in the public interest.

- Adequate studies of the economic impacts of this Order have not been made, and it should not be implemented until satisfactory studies have been completed.

- The March 1982 deadline is too short for an orderly transition of this magnitude; several more years should be allotted.

- The 1934 Communications Act gives the FCC jurisdiction to regulate, but not to deregulate.

The potential litigants in such challenges cover a wide spectrum including:

- The Justice Department
- State Public Service Commissions
- Industry associations, e.g., Computer and Communications Industry Association (CCIA), U.S. Independent Telephone Association, North American Telephone Association (NATA), representing Interconnect companies
- Companies offering telecommunications and data communications services and equipment

THE OUTLOOK

To a large extent, the question of whether the FCC's decision will be sustained and implemented depends upon the support and actions of other government organizations, including the Justice Department, NTIA, as well as the White House and the House and Senate:

Questions relating to the 1956 Consent Decree are undoubtedly of most immediate concern to the Justice Department which was a party to that decree. Although the Justice Department has not announced its position, in view of its present antitrust suit against AT&T, the department is expected to take a posture that may range from caution to outright opposition and legal challenges.

In recent correspondence to the House Committee on Interstate and Foreign Commerce, the Department of Justice objected to vacating the 1956 Consent Decree. The letter also advocated divestiture of Western Electric and Bell Laboratories and represented arm's-length subsidiaries of AT&T to be imperfect substitutes that would not be effective in restraining anti-competitive behavior.

We believe that the Justice Department will show some independence of other organizations within the executive branch, most of which we consider to be favorably inclined toward the FCC decision.

The NTIA is judged to be in favor of the FCC's Order and its director, Henry Geller, is reported to have been acting in a liaison role between Congress, the FCC, and the administration.

Based upon its attitude toward regulation in general and its recent support of pending congressional telecommunications deregulation measures in particular, we believe that the White House will support the FCC action.

Congress has not been successful in its efforts to rewrite the 1934 Communications Act. Both the Senate and the House version of the proposed bills stress, to varying degrees, deregulation and broader participation in the computer/communications industry. Representative Lionel Van Deerlin, the chairman of the House Communications Subcommittee, has been frustrated in his attempts over the last four years in securing passage of a Communications Act rewrite bill. The latest version to reach the floor has once again run into opposition to certain details and has virtually no chance of passage during the current year. The bill's proposed measures largely follow those contained in the FCC Order. Thus, we expect that Congressman Van Deerlin would support the FCC's action as a means to accomplish similar ends.

Senator Howard Cannon, chairman of the Senate Commerce Committee, and Senator Ernest Hollings, chairman of the Communications Subcommittee, have been somewhat non-committal, and DATAQUEST anticipates that they will not oppose the FCC's Order.

In the past, challenges to FCC decisions on the basis of insufficient evidentiary information or unresolved economic impact have not been successful. Similarly, the Justice Department's recent suit contesting the FCC's approval of Satellite Business Systems on antitrust grounds has not been effective. In view of these and other precedents set in the recent history of the Interconnect and SCC activities and the anticipated largely supportive attitudes of other cognizant government organizations, DATAQUEST expects that the FCC's Order will be carried out without undue delay.

IMPACTS AND IMPLICATIONS

Because the FCC Order is so broad in scope, it is expected to have impact upon a wide range of markets and their participants.

Voice Terminal Equipment

Deregulation of these products which include telephones, PBXs, and other voice station equipment, implies major restructuring of the market and present tariffs.

Telephone companies are allowed to earn a return on their investments, which is under the control of the FCC and state public utility commissions. The companies derive further income from a pool of toll revenues, which are allocated in part on the basis of investments in customers' station equipment. For the telephone industry in total, these revenues amount to about $5 billion annually, or approximately $4.80 per month per subscriber. Removing customer premises equipment from the telphone companies' rate base would have a significant impact upon their revenues, and will undoubtedly require some readjustments in the tariff structure if local rates are to remain unaffected.

We would expect that all present and future equipment market participants, including the AT&T and GTE unregulated subsidiaries, would act quickly to establish a posture in the newly created markets. At stake is a market that DATAQUEST estimates will be over $6 billion at the retail level in 1982 when the FCC Order is intended to become effective.

Whereas the business segment of the market has been served to a growing extent for a number of years by the Interconnect suppliers, the residential market for telephones has been dominated by the telephone companies which provided the instrument as part of the service and at bundled tariff rates. The FCC

Order requires the outright sale of telephone instruments, so that a large retail market would be created with opportunities for new market entrants.

The Interconnect market which serves the business community with PBXs and key telephone systems would also be affected immediately. The unregulated subsidiaries of AT&T and GTE will compete in direct sales of PBSs and KTS systems with Interconnect vendors who previously were the only non-tariff sources for purchase of this equipment. The fact that all equipment will now be supplied on a non-tariff basis will tend to put all vendors on an equal footing.

Besides the present AT&T and GTE manufacturing subsidiaries (Western Electric and GTE-Automatic Electric), a large number of other companies are involved in this market, and include:

- Northern Telecom
- Stromberg-Carlson (General Dynamics)
- Rolm
- NEC
- ITT
- OKI

Data Communications Equipment

The market for data network interface equipment, which in 1982 is estimated to reach about $600 million, has been much less dominated by the telephone industry than the voice terminal markets, and deregulation would have a lesser immediate impact. In the long term, as Bell and GTE assert their presence through the unregulated subsidiaries, we should expect a very competitive climate to develop, particularly in the much larger and broader market for data communications equipment, including terminals.

A very large number of data communications equipment suppliers participate in this market, including:

- IBM
- DEC
- Motorola/Codex
- General Datacom
- Anderson-Jacobsen

Data Communications Services

The distinction between regulated and unregulated data communications services will undoubtedly require clarification and will probably also be subject to further controversy. We would expect to see the market participants, especially potential new ones, take a cautious posture until a clearer understanding is reached of what constitutes service enhancement.

Present and future participants in this market include:

- GTE-Telenet
- Tymnet
- SPCC
- SBS
- ITT
- Xerox (XTEN)

Data Processing Services

The FCC decision permits the smaller telephone companies and the AT&T and GTE subsidiaries to offer unregulated data processing services. This is an area in which no precedents exist in this country. In Europe and Japan, the PTTs are moving or are poised to move in the direction of becoming full-fledged "information utilities" that in time will offer a range of data bank and data processing services. The FCC Order appears to have prepared the grounds for similar activities in the U.S.A.

Current market participants include computer teleprocessing and data base service companies, such as:

- CDC/SBC
- General Electric
- ADP
- Computer Services Corporation

Semiconductor Industry

The semiconductor industry is now selling more than $500 million in components annually to the U.S. telecommunications manufacturers. Participants in the industry have so far elected not to pursue vertical integration into the telecommunications equipment market as they have in the computer market. With a market approaching 20 million units a year in 1982 for new and replacement telephones, and with increasing semiconductor content, we anticipate that one or more major semiconductor manufacturers will have decided to pursue vertical integration into this market by the March 1982 deadline.

Courtesy of DATAQUEST's Telecommunication Industry Service
Martin W. Fletcher
Victor Krueger

DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

Vol. II - No. 4 April 18, 1980

This letter is a condensation of recent newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific newsletters should be directed to the author. A list of recent DATAQUEST Research Newsletters appears at the end of this letter.

SEMICONDUCTORS

The turn has come.

There is now enough corroborating evidence from users, distributors, and manufacturers to confirm the fact that the balancing of supply and demand, which we had been anticipating for some time, is finally occurring. Parts that were previously very hard to get are now becoming more readily available, lead times are coming down, selective instances of price weakness have occurred (such as 16K RAMS in Europe), and backlogs are shifting more towards longer term contracts than short-term delivery items. All of these are clear signs of softening.

We would expect to see some reductions in user inventories over the next few months because of high interest rates and greater uncertainty about end demand. We should emphasize, however, that we do not believe inventory levels are at excessive rates and any liquidation that does occur should be brief in duration and moderate in extent. In fact, a recent check of mainframe companies indicates that production schedules will meet or slightly exceed the projections made three months ago.

We are not painting a negative scenario. Rather, supply and demand are acting much as we forecasted they would in projecting a 20 percent increase in industry shipments in 1980. A number of compensating factors will start to assert themselves once the softness continues for a short time:

- There is a tremendous opportunity for the semiconductor manufacturers to reduce costs and get more efficient once industry conditions moderate sufficiently for the frantic pace of activity that has been present for the last year or more to subside somewhat. For example, removing some third shifts will actually reduce unit component costs.

- As more silicon is freed up, producers will shift more towards making 64K RAMs and other parts that consume large amounts of silicon.

- It is very possible that, for a variety of reasons, the Japanese may lose market share when supply becomes more generally available.

The single most important factor in our forecast for this year is unit demand. In our forecast of a moderate recession, we assume that unit demand will continue to increase at very strong rates, acting as a buffer against any sharp deterioration in price. In this scenario, reductions in costs will almost match those of price, and as a result, industry profit margins should decline only modestly in 1980. Only if we have a severe enough recession to markedly affect unit semiconductor demand, which is presently not the DATAQUEST forecast, will the industry be badly hit.

SMALL COMPUTERS

A recently completed survey of Four-Phase System customers yielded two pieces of data that we think are worth expanding on: first, that the users were very satisfied with the Four-Phase equipment; second, that the great bulk of them are utilizing the equipment almost exclusively for shared processor data entry.

The case that the company makes is that its products are multifunction in use (word processing, data input, COBOL processing, file management). Our survey indicates that Four-Phase has a ways to go before completely achieving that goal. The difference is important: the growth rate for data entry devices is, by our estimates, 15-20 percent per year; the growth in true multifunction office products probably twice that.

Four-Phase is a company in transition. It needs to make improvements in its word processing software and possibly in operating system compatibility before truly being able to expand the applications and use of its products into the office automation area. Unfortunately, it picked a difficult economic year to make the transition. Earnings this year are hard to predict (and probably not that meaningful anyway). Our guess is $2.00 per share versus $3.25 per share last year.

The news from last week's Datapoint meeting was very favorable. Orders are still very strong, the lease/sales mix is not shifting, lead times that were stretching out a bit on the low end are now back to where the company wants them (8-12 weeks, for the most part) and the stable of new products already introduced seems very full.

In retrospect, Datapoint has gone through a major transition in the past 15 months that has been masked by continued strong earnings growth. The company's sales force had to learn to sell the new ARC systems, which were larger than prior product offerings and had a longer selling cycle. As a result, DATAQUEST would estimate that unit shipments of Datapoint's high-end products grew by no more than 20 percent in calendar 1979. Offsetting this relatively modest increase, however, was extremely rapid growth in sales of low-end terminals into the very small computer market. The direct sales force now seems well up the learning curve and can probably start accelerating their productivity, which positions Datapoint very well as we head into unchartered economic waters.

Two potential weak spots should be noted: the company's contract with its foreign distributor, TRW, will not be renewed after its expiration in 1983. Management expects a lower relative rate of growth in its foreign business because of the less than optimal marketing arrangement and this area is one that should be watched closely. The recently announced letters of intent to acquire Inforex and its foreign sales and service organization may be the start of a solution to the overseas marketing problem. Second, the low end of the market, which has been very important to Datapoint, could be susceptible in a downturn. In the aggregate, however, we remain positive on the company's fundamentals. We project earnings of $3.90 per share in the July 1980 fiscal year, up 33 percent and a 22 percent rate of growth to $4.75 in fiscal 1981, even allowing for a recession.

Data General is expected to announce its long awaited 32-bit computer before the National Computer Conference (May 19-23). The introduction of this product should be very positive for the company's order and shipment position in 1981, although start-up expenses might cause a slight drain on fourth-quarter earnings. We project 1980 earnings at $5.50 and believe 1981 could reach or exceed $6.80 with volume shipments of the new machine. A 32-bit machine will provide upward growth to DGN's current customers as well as allow the company to compete in a new market segment from which they have previously been blocked by DEC, Perkin-Elmer, Prime, and SEL.

INSTRUMENTATION

Instrument business generally remains good, but the first signs of the inevitable slowing in orders appear to be sporadically cropping up. We sense that the rate of order growth at Hewlett-Packard will not be nearly as great in the second quarter as it was in the first. We do not detect any order softening at Tektronix, but it is probably only a matter of time; the company has been expecting its order rate to start dropping for two years now.

The decline in third-quarter earnings at Tektronix was the first such drop in eight years. Managements' indication that two of the major problems that have been restricting the company's shipments (poor yields on storage tubes and general manufacturing inefficiencies) have been solved suggests that the worst is behind the company. However, don't expect any big rebound in the fourth quarter. For one thing, last year's 31 percent tax rate in the last period makes comparisons difficult. For another, one major factor is still depressing margins: the company's LIFO inventory policies are continuing to squeeze margins, and relief in terms of higher prices will not be felt until the first quarter of fiscal 1981. Given these factors, we would not be surprised to see a flat fourth quarter, which would put full year earnings in the $4.50-$4.55 range.

The good news, however, is that the factors working against Tektronix in this fiscal year could well work for them next. The company will enter fiscal 1981 with very high backlogs and if we experience only a modest recession, we believe that incoming order growth could easily justify sales growth of over 20 percent. Conversely, if (as appears more likely) we experience a more severe recession and Tektronix and other companies' order rates are more severely affected, the company still has a high backlog to partly offset any softening. More importantly, in these conditions, it is likely that both inflation and short-term interest rates would moderate significantly. Both of these occurrances would benefit Tektronix. We would estimate that the use of LIFO accounting will negatively affect earnings comparisons in fiscal 1980 by more than 25¢ per share and this same negative impact may not be present next year. By our estimates, every one percent change in short-term interest rates means about 3¢ a share to Tektronix. A decline in interest rates would therefore have a meaningfully positive impact on comparisons in fiscal 1981.

The net of things is that we are reasonably confident that Tektronix can have very strong earnings comparisons in fiscal 1981. Our estimated earnings range is $5.30-5.50 per share. If the economy only weakens modestly, the company will generate the growth through a large increase in shipments. In a deeper recession, the financial factors noted above will aid comparisons.

PAPER AND FOREST PRODUCTS

Demand remains surprisingly good for most paper products, but everyone expects deterioration to start in the very near future. The 11 percent price increase in linerboard that was instituted in February by some companies has been followed by almost every major producer, but since most manufacturers are integrated, the key determinant is the ability to raise box prices. At this juncture, we would anticipate that only about half of the linerboard price increase will be passed along in the second quarter.

Production remains at high rates in linerboard, but the momentum now appears to be heading downward. We would forecast a $275 linerboard price realization by the end of the year vs. $285 at the end of the second quarter and believe that it could bottom at $250-260 per ton sometime in mid-1981. This pricing scenario would indicate no great catastrophe on the brown paper side of things over the next two years. However, as previously noted, we believe that operating rates could deteriorate dramatically in white paper. In any event, we do not anticipate any improvement in the paper industry fundamentals until late 1981, which means to us that it is too early to get interested in the group, particularly since things haven't really started to deteriorate fundamentally as yet.

The one positive thing that could be said about the forest products industry is that at least one does not have to wait for fundamentals to collapse. By our calculations, southern plywood prices in April were 21 percent below their 1979 average, western plywood prices were 25 percent below last year, and Douglas fir prices were a whopping 39 percent lower than 1979. Approximately 25 percent of the softwood plywood industry is presently shut down and the plants that are operating were running at 79 percent utilization rates in early April, which in total means that the industry is operating at only 59 percent of total capacity. This would indicate that more closedowns are likely in the near future.

Everyone is now losing money on converting, the housing outlook for the remainder of this year is bleak, and there are almost no positive signs on the horizon. All of which is somewhat encouraging to us, since that is usually the time that stocks bottom out.

CAPITAL EQUIPMENT

As might be expected, the current high level of interest rates is having a very negative impact on demand for both construction and farm machinery. Retail farm tractor sales declined by 29 percent in March and are down 19 percent thus far this year. It now appears that sales for the full year may decline by 10-15 percent, versus our last published forecast (Feb. 1, 1980) of a 2 percent decline. Sales next year are very difficult to project at this time, but our best guess would be for flat to slightly higher levels of retail demand in 1981 from the low levels expected this year.

The present industry slump has positive longer term implications for the stronger competitors in the farm machinery field. There is significantly higher dependence on the manufacturers to finance end-user leasing and purchases as well as dealer inventories. One could reasonably make the case that the current industry downturn is an important longer term plus for Deere in that International Harvester has been severely injured by the combination of lower retail sales, its lengthy strike, and the disadvantages of a weakened financial condition. Nearer term, however, the ability of Deere to exceed the $4.90 per share fully diluted that it earned in 1979 seems open to considerable question.

We remain fairly optimistic about the earnings outlook at Caterpillar this year, as we still believe that primary earnings can exceed $7.00 per share. We expect to see a very good second quarter at Caterpillar, reflecting increases in physical volume to fill up its dealer pipelines that were depleted by the strike last year. However, we expect 1981 to be a difficult comparison year for Caterpillar.

In terms of new products from Caterpillar, we expect to see a new hydrostatic-driver crawler loader introduced to its dealers by June, an upgrade to its rubber-tired loader line introduced in September, and important improvements on its high-end crawler tractors to be made in October. It remains our belief that some time in 1981, Caterpillar will enter the high end of the four-wheel drive farm tractor market.

COPYING AND DUPLICATING

The Xerox Retail Markets Division expansion that we speculated about in our last Portfolio letter has now been publicly confirmed by the company. As we indicated, the first six stores will be in Dallas and Denver, and if the trial stores go well and are profitable, the pace of new store openings will be very rapid. We believe Xerox is still testing different store layouts, methods of merchandising, etc. and has not yet decided upon the final configuration to be used in all stores.

The one addition to the product offerings in the stores that we did not anticipate was a new, very low-priced ($1,195) Xerox copier, the 550. The 550 is a modified 660, so it uses old technology, but should be replaced by a new low-end machine (more expensive, but much more reliable) within 12 months.

The major potential negative for Xerox in this venture is its lack of experience in the retail environment. Tandy, for example, has been successful by hiring young aggressive store managers and offering them highly incentivized pay packages. Xerox has not traditionally had to attract this type of employee and the transition in terms of staffing the stores will not be inconsequential.

The major positive is service. Xerox has a highly trained service organization in place. If it can integrate a level of service on products sold by the retail stores without upsetting its service cost structure, it will have an important competitive advantage. Additionally, this approach will hopefully be a very cost-effective way of selling low-end copiers.

Win or lose on this venture (and we still lean towards win), it shows a new level of aggressiveness at Xerox that was not present before Dave Kearns took over as president. This change, in itself, is an important plus for the company.

Michael R. Weisberg

RECENT NEWSLETTERS OF NOTE

Semiconductors	
1. General Industry Update	04/11/80
2. U.S. Semiconductor Manufacturers Capital Spending 1979-80	04/01/80
3. Update on Motorola	03/18/80
4. International Solid State Circuits Conference 1980	03/17/80
Small Computers	
1. Personal Computer Market Update	04/10/80
2. 1979 World Market Estimates Class II, III & IV General Purpose Minicomputers	03/26/80
3. Small Computer Suppliers' Terms and Conditions Update	03/11/80
4. General Purpose Minicomputer Market Still Strong in 1979	03/11/80
Instrumentation	
1. Electronic Counter Product Review	03/25/80
2. Digital Voltmeter/Multimeter Market	03/21/80
3. ATE 1979 Market Overview	03/21/80
4. Hewlett-Packard Company Annual Meeting-Feb. 26, 1980	03/06/80
5. Circuit Board Tester Product Review	03/03/80
Paper and Forest Products	
1. Uncoated Free Sheet: Profit Decline Possible from Mid-1980 through 1985	03/25/80
Capital Equipment	
1. Caterpillar Tractor Company Update	04/02/80
2. Potential Impact of Changes in Housing Patterns on Machinery Demand	03/15/80
Copying & Duplicating	
1. Xerox Cuts Quantity Purchase Prices on Low-end Copiers, Announces Additional Price Plans for 8200 and 9500, and Raises Supply Prices	04/03/80
2. Xerox's New Retail Markets Division Offers Model 550 Through the Mail	04/01/80
3. Konishiroku Introduces New Copiers and Expands Marketing	03/31/80
4. Notes on Xerox	03/20/80
5. SCM Out of Copier Business	03/13/80
6. Pitney Bowes Reports 1979 Results	03/13/80
Word Processing	
1. Analysis of the Xerox 860 Information Processing System	03/24/80
2. Wang Announces Large Lease and Maintenance Increases	03/24/80

DATAQUEST RESEARCH NEWSLETTER
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GENERAL INDUSTRY UPDATE

SUMMARY

Imminent Slowdown Expected

DATAQUEST expects a marked slowing in U.S. semiconductor consumption growth during the balance of 1980. While bookings in the semiconductor industry have remained strong through March, many of the early signs are visible that indicate supply is catching up with demand. Book-to-bill ratios should be affected imminently, reflecting both the increasing rates of shipments and a leveling out of demand. We forecast U.S. semiconductor consumption for 1980 to show a growth of 19.8 percent over 1979. This percentage is somewhat misleading because the semiconductor industry entered 1980 significantly above average shipment levels for 1979. U.S. semiconductor consumption in 1979 grew approximately 37 percent over 1978.

The future outlook is formed by several strong opposing forces, including:

- A flat U.S. economy, with a pessimistic future outlook
- Tremendous unit demand for semiconductors
- Recent caution by manufacturers of equipment using semiconductors
- High semiconductor prices and other market imbalances from the accelerated 1978 and 1979 industry growth

Behind the strength in the semiconductor industry is an extremely flat economy that now appears to be worsening; the hyperinflation cannot be reduced without economic consequences. Even so, special factors mitigate the effect on the semiconductor industry, and DATAQUEST expects it to continue to outperform the economy by a considerable margin. A temporary demand leveling (not a downturn) is expected to result from price adjustments, inventory reduction, cancellation of double orders, and reduced backlogs and lead times.

The probability of a severe recession and the consequent effect on semiconductor demand is increasing. Extreme caution is advisable.

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RECENT ECONOMIC TRENDS

The U.S. economy has a very severe problem—hyperinflation. Movements by the government to solve this problem have not yet had the anticipated effect on the economy. No solution will come easily. Throughout 1979 and the first few months of 1980, the general U.S. economy has been relatively stagnant. While there has been slight growth in the GNP, industrial production has remained essentially flat. However, either a prolonged downturn or a short, sharp downturn in the economy is currently considered likely by economists. The possibilities of deep recession are becoming increasingly probable. Furthermore, forecasting is unreliable: there is no recent historic precedent for today's situation. Obviously, energy, inflation, and foreign affairs problems make the world situation very tentative. Outside the United States, higher energy prices have already impacted the economic outlook for Europe and Japan, resulting in increased inflation and slower economic growth.

The following recent economic developments are noteworthy:

- Hyperinflation is now a reality. Currently, the prime bank interest rate in the United States is at the banana republic level of 20 percent.
- High rates of inflation have appeared in Europe and Japan during the first quarter of 1980. In the past, this has led to strong economic measures by most of these countries to combat inflation, resulting in slower economic growth.
- The United States has experienced severe problems with foreign affairs, compounded by military weakness. These problems are not new, but the increased perception of them is a significant development.
- Government leadership has been inactive, indecisive, and impotent.
- The gross national product grew at an annual rate of about 2.1 percent in the fourth quarter of 1979, following a growth of about 3.1 percent in the third quarter. This growth was unexpected. Most forecasters expect real GNP to be level or down in the first half of 1980. Increasingly, the second half of 1980 looks less promising with an economic recovery put off beyond this year.
- Industrial production has continued to remain essentially level, although it rose moderately in December, January, and February.
- The index of leading indicators has continued to decline at a moderate pace. This pattern would indicate an economic downturn, but that has not yet occurred. Indirect effects of inflation possibly are distorting this index.
- Money supply has continued to remain volatile. It has grown 9.0 percent in the last year and may grow at more rapid rates in the near future. The need of the federal government to finance itself indicates that money supply growth will continue.
- Capital expenditures for business equipment have remained relatively strong, especially for electronics.

- Real disposable income of most consumers has severely declined since January due to increased taxes and increasing prices. Consumer prices have been rising at an 18 percent annual rate (1.4 percent per month) this year.

The economy is already in a slowdown, with some areas such as automobiles and housing showing very poor performance. The very high interest rates will begin rapidly to affect more areas. Currently, the economy is skewed, with some areas weak and others strong. We expect that as the economy moves into a downturn from its current limbo all areas of the economy will gradually be affected. This sequence has occurred in the past, and there is no reason to expect any difference this time around. However, as the economy adjusts to new levels of prices, industries less affected by inflation are bound to show relatively better performance.

SEMICONDUCTOR INDUSTRY TRENDS

U.S. semiconductor consumption has continued to rise at remarkable rates despite the lackluster U.S. economy. U.S. semiconductor demand for the fourth quarter of 1979 rose an estimated 12.3 percent over the third quarter. This strong semiconductor demand reflects general strength in all areas of electronics to date, and relatively stable pricing for semiconductor devices. Through the first quarter of 1980 book-to-bill ratios have remained in the range significantly above 1.1 to 1.

Nevertheless, DATAQUEST believes supply is catching up with demand. Some of the very early signs appear to be emerging:

- Fewer devices appear to be on the critical shopping list of major corporations.
- Smaller companies are now receiving parts with greater ease than in late 1979.
- Lead times for product shipment appear to be dropping.
- A larger percentage of the backlog of semiconductor manufacturers now have extended delivery times.
- Prices appear to be weakening in some product areas such as memory.
- Some application areas such as consumer are showing order weakness. Specifically, we have seen some price weakness in 16K RAMs beginning outside the United States and spreading internally; LSTTL devices appear to be increasingly available, with new supply coming from several areas, including Japan, and capacity increases among U.S. manufacturers.

U.S. semiconductor consumption is significantly outperforming its historical relationship to the economy. If past relationships had remained true, a significant softening of semiconductor demand would have occurred in mid-1979, but it did not occur. This continuing demand is due to several special factors which DATAQUEST has enunciated many times before:

- The indirect effects of inflation. The declining prices of electronics make them increasingly popular in industrial and consumer markets. General industry capital expenditures have not been particularly strong, but expenditures for electronics have far outpaced other areas. The cumulative effects of inflation are a very positive aspect of semiconductor demand and are without historical precedent.

- New markets—such as automotive and telecommunications.
- Increased purchases of semiconductors from U.S. manufacturers for overseas delivery.
- A movement to electronic use by electromechanical and mechanical equipment manufacturers.
- Elastic demand in some markets such as EDP.
- Increasing purchases of electronics for military applications.
- Increased purchases of semiconductors from the merchant market by captive manufacturers, especially IBM, General Motors, and Western Electric.

In surveying market applications for semiconductors, DATAQUEST is struck by the extremely strong future unit demand for semiconductors, particularly for LSI and VLSI devices. It is awesome: massive amounts of wafer fab capacity will be needed. For example: 1) The demand in 1980 for 16K dynamic RAMs—one part—is expected to be three times that of 1979—the production equivalent of over 10 new wafer fabrication modules, 2) The automotive industry is making a major change to microprocessor controlled engines and digital radios. Worldwide, this development will increase semiconductor consumption up to a billion dollars in the future. A major increment will come in 1980. These new applications are a change in product and are, therefore, independent of the economy, 3) The microprocessor revolution has finally occurred: major areas of industry are converting mechanical and electromechanical equipment to electronic control.

On a more sobering side, semiconductor prices have remained relatively stable over the past 15 months. While cost/price imbalances are not at 1974 levels, many products have not seen normal price attrition. Furthermore, it is DATAQUEST's perception that semiconductor manufacturing cost did not fall at normal rates in 1979. Other imbalances have begun to appear, including out-of-mix production, a slowing of new product introductions, and some increases in inventory.

General caution in the electronics industry is at a very high level. The unbridled optimism of 1973 and 1969 are not in evidence. Thus business practices have not been excessive. It is our perception that although inventory levels are rising, they are not at severe levels. The current cost of money is encouraging management at all industry levels to keep inventory under reasonable control.

A further check on market deterioration is the present lack of excess capacity in the semiconductor industry, which provides a cushion to a demand softening. Many, if not most, companies are operating above comfortable capacity, using third shifts, foregoing product and process development wafer starts, reducing relative production of engineering or wafer intensive products, etc. The ability of the U.S. semiconductor industry to expand capacity is increasingly constrained by lack of engineering personnel both for captive and merchant manufacturers alike. The major business structure of the industry has been undergoing change. The number of very large users of semiconductors is rapidly increasing while the number of merchant suppliers is declining. In addition, major multinational corporations are acquiring more and more merchant suppliers, including Fairchild and Mostek which were purchased in 1979. What effect this trend may have on their willingness to actively supply the merchant market is speculative, although no short-term changes are foreseen.

SEMICONDUCTOR INDUSTRY FORECAST

Table 1 gives our estimate for U.S. semiconductor consumption in dollars. We believe that semiconductor consumption in 1980 will show an increase of about 19.8 percent over 1979. In 1979, U.S. semiconductor consumption increased approximately 37.1 percent over 1978. This figure not only includes shipments by U.S. manufacturers to the United States, but a major net increase in exports to the U.S. from Japan. DATAQUEST expects continued growth in semiconductor demand in 1981, although given the very high degree of economic uncertainty a useful forecast is not possible.

Our current estimates for U.S. semiconductor consumption by calendar quarter are shown in Table 2. We expect significantly slower growth this year than in 1979, with average quarterly growth dropping to the level of 2 to 3 percent.

This forecast reflects the consequences of several powerful forces—poor U.S. economic performance, those special factors causing strong unit demand, and a rebound from the excesses and imbalances of two very strong years. Essentially, price weakness and a correction of other imbalances resulting from the strength over the last two years will cause slower revenue growth even though unit demand will be strong.

Semiconductor demand will always have a close tie to the economy, but currently other factors are allowing the industry to outperform its historical relationships to the economy. Even so, as the performance of the economy weakens, so will the rate of demand growth. We do not expect semiconductor industry demand to show a sharp downturn, as in 1975, but instead to show relatively slow growth for a period of time.

The effects of inflation on semiconductor revenues are difficult to determine. In the past, there has been no measurable effect of inflation on semiconductor costs, prices, or revenues. That should be modified in 1980. Those device areas that have a major material content, such as SSI integrated circuits and discrete devices, will show some pass-through of material cost. In particular, the soaring price of gold should impact semiconductor revenue. Hyperinflation is now affecting all areas to some extent. While engineering salaries have increased tremendously, it is DATAQUEST's perception that they have not been matched by the pay of hourly workers. Incoming pay for workers in the semiconductor industry has not kept pace with other areas, and with other industries or jobs, especially in Silicon Valley. Thus we expect cost for direct labor to increase rapidly over the next few years.

The long-term secular demand factors in the industry remain extremely positive. DATAQUEST expects the current supply/demand imbalance to moderate temporarily, but to become even more pronounced when the world economy improves. Increases in capacity are limited by the high cost of wafer fabrication facilities, the high technical content of VLSI products and the increasing difficulties encountered in their manufacture, shortages of labor, and other factors. These considerations would argue for moderate capacity increases over time.

Three things could blunt this optimistic scenario: unbridled capacity increases; irresponsible (i.e., not cost-based) pricing; and restricted market access by companies, industries, or nations. The participation in the semiconductor industry by national interests and multinational corporations poses a concern: they have unlimited financial resources. Diligence must be maintained to ensure that they act legally, fairly, responsibly, and with reserve.

Frederick L. Zieber

Table 1

ESTIMATED U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1978	1979	Percent Increase 1978-79	1980	Percent Increase 1979-80
Discrete Devices	$1,019	$1,246	22.3%	$1,368	9.8%
Integrated Circuits	2,304	3,310	43.7%	4,088	23.5%
Total	$3,323	$4,556	37.1%	$5,456	19.8%

Source: DATAQUEST, Inc.
April 1980

Table 2

ESTIMATED QUARTERLY U.S. SEMICONDUCTOR CONSUMPTION
(Millions of Dollars)

	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.	1979 4th Qtr.	1979 Total Year
Discrete Devices	$ 285	$ 321	$ 314	$ 326	$1,246
Integrated Circuits	685	789	852	984	3,310
Total	$ 970	$1,110	$1,166	$1,310	$4,556
Percent Change From Previous Quarter	4.4%	14.4%	5.0%	12.3%	
Percent Change From Previous Year	32.0%	35.0%	39.3%	41.0%	37.1%

	1980 1st Qtr.	1980 2nd Qtr.	1980 3rd Qtr.	1980 4th Qtr.	1980 Total Year
Discrete Devices	$ 331	$ 345	$ 343	$ 349	$1,368
Integrated Circuits	987	1,026	1,019	1,056	4,088
Total	$1,318	$1,371	$1,362	$1,405	$5,456
Percent Change From Previous Quarter	0.6%	4.0%	(0.7%)	3.2%	
Percent Change From Previous Year	35.9%	23.5%	16.8%	7.3%	19.8%

Source: DATAQUEST, Inc.
April 1980

DATAQUEST RESEARCH NEWSLETTER
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U.S. SEMICONDUCTOR MANUFACTURERS
CAPITAL SPENDING 1979—1980

Capital spending plans for 1980 by merchant semiconductor manufacturers show that manufacturers plan to continue spending at a high level—more than 20 percent over 1979 levels. They regret that they were not ready for the record-breaking 1979 season and they look with confidence beyond any softening in 1980 to a strong market in the future.

Occasional component shortages from the merchant market, or concerns about possible shortages, have motivated several captive manufacturers to buy outright, build from the ground up, or expand existing semiconductor manufacturing capacity as a means of protecting their critical component supplies. These captive manufacturers are expected to spend heavily in the coming year, accounting for an estimated 30 percent of total equipment purchases in 1980.

Major semiconductor manufacturing equipment continues to be increasingly expensive and, to quote one industry source, "lead times now exceed any conceivable downturn." Several companies would have spent more in 1979 if they could have obtained equipment and those purchases will now have to wait until 1980 or later. Long equipment lead times would probably have a moderating effect on any tendency of the industry to bring too much capacity on line too soon.

Estimated capital spending for facility (which includes land, building, facility improvements, and hook-ups) and equipment for 1979 and 1980 is summarized in Tables 1 and 2.

It should be kept in mind that "proposed spending," often made public at the beginning of the fiscal year, is not necessarily committed money: Intel underspent by 20 percent their early-year pronouncements. Nor, as recent history tells us, is actual spending limited to proposed spending: in 1979 alone, Mostek overspent early-year plans by 40 percent and Motorola by 33 percent. Manufacturers have means available of reducing capital commitments, should economic events take a drastic turn for the worse—witness the events of 1974-1975 when industry capital spending was halved because of excess capacity. Similarly, as the last two years indicate, additional investment money is readily available should market prospects appear to be better than previously expected.

WHAT HAPPENED IN 1979--

U.S. manufacturers were unprepared for a banner year in 1979. Virtually all had been slow to add capacity after the 1975 recession and found themselves capacity-limited throughout the entire year. Equipment and facilities costs have continued to rise, as a result of general price increases of purchased materials and labor as well as

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Table 1

ESTIMATED U.S. SEMICONDUCTOR MANUFACTURERS
1979 CAPITAL SPENDING
(Millions of Dollars)

	Merchants	Captives	Total
Facility	$ 355	$150	$ 505
Equipment	710	295	1,005
Total	$1,065	$445	$1,510

Source: DATAQUEST, Inc.
March 1980

Table 2

ESTIMATED U.S. SEMICONDUCTOR MANUFACTURERS
1980 CAPITAL SPENDING PLANS
(Millions of Dollars)

	Merchants	Captives	Total
Facility	$ 440	$185	$ 625
Equipment	880	370	1,250
Total	$1,320	$555	$1,875

Source: DATAQUEST, Inc.
March 1980

the increasing technical content of the equipment. Coupled with this rise has been the ongoing trend to larger, more fab-intensive chips, requiring more equipment dollars per unit of output. Lead times to bring new capacity on line have lengthened to the point that a new facility's contribution to billings is now often more than two years after the decision to build. These factors have all contributed to the capacity-demand difficulty, and reduced the industry's ability to respond to heavy demand.

Spending forecasts early in 1979 also had implicit in them the specter of economic recession late in that year, and were cautious so as to avoid a repeat performance of 1974-1975's capacity excess and attendant price competition to hold markets. That dire view has gradually given way to one expecting only a period of sluggish economic activity (and welcome relief) coupled with long-term optimism.

PROSPECTS FOR 1980 AND BEYOND--

As semiconductor bookings have shown continuing strength, so capital spending plans for 1980 continue to build for a growing market. Year-long short supplies and uncommonly firm prices have compelled component manufacturers to expand as rapidly as possible, and component users to commit to manufacturing their own key components or to investigate the possibility of doing so.

There is also a growing consensus of those inside and outside the industry that semiconductor devices will play a critical role in the economics of the 80s and beyond. This view has tentatively convinced corporate planners that the right place to focus is the remainder of the decade, beyond any possible economic difficulties in 1980.

U.S. MERCHANT MANUFACTURERS

Virtually every U.S.-based merchant manufacturer expanded or announced significant capacity expansion plans in 1979, most of which will run into 1980 and beyond. Table 3 summarizes DATAQUEST's estimated company capital expenditures for semiconductor facility and equipment for 1978, 1979, and planned for 1980.

If these capital expenditure amounts are compared with U.S. semiconductor factory shipments, it is apparent that the 1979 ratios, at greater than 15 percent of sales, are well above the historical average of about 11 percent of sales, and far above the low for the 1970s of about 7 percent of sales in 1975. If merchant capital expenditures for 1980 reach planned levels, they will be nearly 16 percent of 1980's forecast U.S. companies' factory shipments. These ratios indicate not only increasing capital intensity in the industry, but also a timing problem. Today's catch-up capacity expansion has been brought on by a slow post-recession recovery and phenomenal 1979 industry growth. Furthermore, lengthening lead times to get the facility up and running have stretched out the building cycle. Manufacturers need a longer head start than formerly and can't wait until 1982 to add 1983's capacity.

Texas Instruments

Texas Instruments reported 1979 capital expenditures for the entire Components Group of $230 million. Of this, an estimated $190 million was spent on the semiconductor portions of that group's PP&E additions. TI has filed with the SEC for $200 million worth of debentures, some of which will be used for capital expenditures as well as retirement of short-term debt and increase of their working capital.

Table 3

ESTIMATED U.S. MERCHANT MANUFACTURERS CAPITAL SPENDING (SEMICONDUCTORS ONLY)
(Millions of Dollars)

	1978	1979	1980
Texas Instruments	$115	$ 190	$ 190
Motorola	72	159	200
National	49	70	90
Intel	85	82	125
AMD	22	42	65
Fairchild	23	58	70
Mostek	19	42	85
Signetics	40	50	80
Other U.S. Companies	255	372	415
Total Merchant	$680	$1,065	$1,320

Source: DATAQUEST, Inc.
March 1980

Motorola

Motorola corporate raised their 1979 estimate in mid-year and reported $265 million for the year. Of this, $159 million went to the Semiconductor Group, primarily in Austin, TX, and Mesa and Tempe, AZ. For 1980, the corporate capital budget is expected to be about $325 million and the Semiconductor Group should account for about $200 million.

National Semiconductor

National continues to expand its wafer fab capacity in Salt Lake City, UT, and Greenoch, Scotland. In October 1979, it also announced plans to build in Vancouver, WA. This plant is expected to be in production in late 1981, and to expand to full capacity in 1984.

Intel

The final tally for Intel's 1979 capital expenditures was $97 million, with about $82 million spent for semiconductor operations. After corporate spending of $104 million in 1978, Intel was exceptional in that its capital expenditures in 1979 declined both in dollars and as a percentage of its sales. Total corporate expenditures for 1980 are planned for the $150 million range, with its Phoenix, AZ, facilities getting the largest share, followed by the Livermore, CA, and Aloha, OR, facilities. Some capital is also budgeted for assembly facilities offshore.

AMD

AMD recently placed $24 million in long-term notes with four insurance companies, and plans to spend about $80 million in fiscal year 1981 (ending March 31) with a variety of expansion plans in Santa Clara, CA, and their newest operating facility in Austin, TX.

Fairchild

Since a principle motivation of Schlumberger in purchasing Fairchild last year was to gain a foothold to a high-technology industry, we expect a change in corporate philosophy with respect to capital spending. Fairchild underestimated the growth potential of the market in 1978-1979, and this fact likely contributed to their loss of market shares during that period. Now under Schlumberger, corporate capital expenditures in 1979 were reported at $73 million, with an estimated $58 million for the semiconductor group. Fairchild will likely have access to adequate capital in the 1980s to grow the business as fast as the market will allow.

Mostek

Mostek's capital expenditures for 1979 are estimated to have been about $42 million, after its spending plans were raised twice in mid-year. Now, having a $200 million line of credit at 10 percent available from United Technologies, Mostek will likely accelerate its building plans for Carrollton, TX, (Fab 5), Colorado Springs, CO, (Fabs 6 and 7), and Dublin, Ireland, (Fabs 8 and 9).

Signetics

In 1979, Signetics spent about $50 million on capital equipment and facilities and plans to spend about $80 million in 1980. This will include new bipolar facilities in Santa Clara, CA; significant expansion of facilities in Orem, UT; and its R&D Center now in the initial building stages in Sunnyvale, CA.

Other companies that have announced new wafer fab locations are:

International Rectifier

IR has broken ground for a new fab facility in El Segundo, CA, to manufacture its new Hexfet power transistors. This facility is expected to be producing in the first quarter of 1981.

Zilog

Zilog has begun producing wafers at their new fab module in Nampa, ID, near Boise. Construction is scheduled to begin in 1981 on a second module at the same location. Total capital expenditure for the modules is expected to be in the neighborhood of $40 million by the end of 1982.

Synertek

Synertek will break ground this spring for its new fab facility in Santa Cruz, CA, with the expectation that it will contribute to billings in the second half of 1981. It has also announced a $7 million assembly plant to be built this year in Thailand.

Harris

Harris Semiconductor announced a $25 million expansion of its Palm Bay, FL, manufacturing facility, and expansion of its assembly facilities in Kuala Lumpur, Malaysia.

U.S. CAPTIVE MANUFACTURERS

In the past, DATAQUEST has focussed its attention primarily on merchant semiconductor suppliers. However, from the viewpoint of a materials or equipment supplier to the industry, merchant manufacturers are indistinguishable from captive manufacturers: both captives and merchants constitute a part of the market for fab, assembly, and test equipment.

Secondly, the development of the captive semiconductor manufacturing market has begun to have significant impact on the size and characteristics of the merchant market. IBM's need for $120 million in 16K RAMs from the merchant market cannot be ignored, and neither can IBM's decision to enlarge its own in-house manufacturing capacity and maintain its relative independence from the merchant market.

Of 23 major semiconductor users listed in DATAQUEST Research Newsletter Major Semiconductor Users (19 December 1979), only Olivetti is known to have no semiconductor manufacturing capability whatsoever. Of 17 firms expected to purchase at least $100 million of semiconductor components in 1981, 12 are known or thought to be adding significant semiconductor manufacturing capacity themselves.

Captive semiconductor manufacturing could result in a significant erosion of the growth potential of the merchant market by the mid-eighties. Historically, captives have made what was not available from a merchant supplier, and only IBM and Western Electric have attempted to produce all their internal needs—standard plus custom parts. From 1979 to 1982, dramatic increases in purchases by major users (e.g., GM, IBM) have added and will probably continue to add a significant adjunct to a broad base of semiconductor users. Make-or-buy decisions by these major users in succeeding years will determine to what extent these "new markets" will remain the province of merchant suppliers, or whether they will be drawn inside the user firm. The capability of these large purchasers to supply their own needs should be monitored carefully in any strategic assessment of long-term merchant market potential.

With these developments in mind, we have decided to incorporate a brief discusssion of capital spending plans by major captive manufacturers side-by-side with those of merchant manufacturers.

The capital spending by captive manufacturers for semiconductor capacity is difficult to ascertain. It is estimated that about 30 percent of semiconductor manufacturing, assembly and test equipment sales go to captive manufacturers. Their facility and equipment purchases are probably growing as fast as those by merchant manufacturers. Spending by captive merchants therefore adds about $555 million for 1980 to the total market for semiconductor facilities and equipment.

Below are listed several of the major building commitments by captive manufacturers made during 1979 which will contribute to the heavy demand for semiconductor manufacturing and test equipment for 1980 and 1981.

Northern Telecom

In August 1979, Northern Telecom, Ltd. announced plans to begin building a $33 million dollar LSI fab facility in Rancho Bernardo, CA, which is expected to be producing components early in 1981.

Burroughs

Burroughs Corporation broke ground in November 1979 for their second MOS facility, also located in Rancho Bernardo with their existing bipolar and MOS lines. The expected cost is between $15 and $20 million.

General Motors

Expansion of Delco's manufacturing capacity is now taking place, and will more than double their semiconductor production capacity by 1983, but merchant market purchases of semiconductors will increase more than three times over the same period. Further significant increases of their in-house capability over the following three to five years would be entirely consistent with GM's make-it-yourself philosophy.

IBM

IBM has committed immense amounts of money for capital equipment in 1978 and 1979 and expects to do so in 1980 as well. They set up a $1.5 billion line of credit with 37 banks in July 1979, sold a $1 billion bond offering in September 1979, and borrowed $300 million in December 1979 from the Saudi Arabian Monetary Agency.

Their semiconductor component purchases from the merchant market rose to an estimated $175 million in 1979, and will probably be between $250 and $300 million in 1980.

IBM has made, and will continue to make, very large investments in semiconductor plant and equipment in the next few years. Principal expansions are a large fab line in Austin, TX; expansion of their Burlington, VT, facility where the 64K RAM is made; and continuing capacity increases in East Fishkill, NY, for MOS and bipolar products.

NCR

NCR, whose earnings were impacted in 1979 by both external and in-house chip shortages, continues to expand both its Colorado Springs and Ft. Collins, CO, operations, with still further capacity planned for San Diego, CA.

Digital Equipment Corp.

DEC has recently added capacity in Hudson, MA, to supply some of their internal MOS needs.

Mainframe manufacturers CDC, Honeywell, and Sperry-Univac, as well as Storage Technology Corp., have all announced semiconductor manufacturing additions or expansions for 1980-1981.

CONCLUSIONS

Two very clear trends are apparent in these industry capital spending plans. Semiconductor companies are optimistic about the long-term future of their industry, and captive manufacturers are continuing to match, if not exceed, merchants brick for brick, aligner for aligner, wafer for wafer in their own expansion plans. Capitives see that semiconductors will play an increasingly crucial role in their products, and they want to reduce their dependence on merchant suppliers for these critical components.

Lane Mason
Frederick L. Zieber

DATAQUEST RESEARCH NEWSLETTER
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SIS Code: Volume III, 8.06 Motorola

UPDATE ON MOTOROLA

SUMMARY

DATAQUEST projects an 18 percent revenue increase in 1980 for Motorola to $3.21 billion and a 16 percent gain in earnings to $6.05 per share. Motorola's ability to achieve this forecasted earnings gain in the light of current economic conditions should have a positive effect on investor perception of this company.

The Semiconductor Group faces a particularly challenging year. It has made very strong progress with its 68000 16-bit microprocessor, but must meet its schedules on peripheral and support chips if it is to establish a strong position in this market. At the same time, Motorola must maintain impetus in its memory business; the 64K RAM is a keystone product in this effort. The group must also provide for a ramp up in shipments to General Motors.

Meeting these challenges will sweep Motorola into the billion dollar class as a semiconductor producer and firmly establish this group as one of the major semiconductor forces in the world.

DATAQUEST forecasts a somewhat below average year in revenues and growth for the Communications Group. The Communications Group continues to maintain its dominant market position in both pagers and two-way communications systems. The start up problems experienced in late 1978 and early 1979 at its Fossil Creek, Texas plant have been largely resolved. DATAQUEST feels that the historic margins of the Communications Group have not been consistent with the margins generated by other technologically dominant electronic firms.

Automotive Products continues to be the troubled division at Motorola. This group lost over $16 million in 1979. The group continues to suffer from both product mix and margin problems. DATAQUEST does not forecast a rapid profit turn around in 1980.

Government Electronics Division (GED) had an excellent booking and revenues year in 1979 and is poised to become the fastest growing Motorola entity in 1980, both in sales and earnings growth.

Codex, which includes Universal Data Systems (UDS), grew in excess of 40 percent in 1979 achieving margins well above corporate average, despite making substantial technical investments in products of the future.

Motorola had a productive international year. Among its accomplishments overseas were the setting up of a semiconductor joint venture with a French Government entity (EFCIS); the establishment of an automotive lab in Japan; negotiating an agreement to sell advanced pagers to NTT in Japan (Motorola has previously had minimal market penetration in Japan in this product line).

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While preparing this update DATAQUEST was impressed by the pervasive use of solid state technology throughout the Company.

REVENUE AND PROFIT ANALYSIS

Our estimate of revenues and operating profits for each of Motorola's major groups are shown in Tables 1 and 2. These estimates assume a 1.5 percent decline in real gross national product this year. Specific comments regarding our estimates are as follows:

- We believe that the Semiconductor Group can continue to gain market share in both discrete and integrated circuits this year. We believe that both areas improved margins in 1979 and that additional increases in profitability can accrue in the future. Our estimate of flat operating margins from this group in 1980 is, therefore, conservative and makes some allowance for economic uncertainties.

- One could reasonably make the case for a good turn-around in Automotive Products profitability. Given the uncertain automobile environment, however, and the likelihood of losses from this operation in the first half, we would prefer to be conservative and assume losses this year about in line with those experienced in 1979, despite the likelihood of improving results from Angers.

- Our forecast of 13 percent revenue growth and flat operating margins from Communications appears a mid-range forecast in terms of the variances that may occur in 1980.

- The biggest swing factor in profits may well be in the "Other Products" category. The constituents of this swing are as follows:

  - Elimination of losses from the recently closed watch module and LCD operations: in addition to the $10 million published write-off we estimate that there was a $15 million operating loss.

  - Motorola is phasing out its Topsil operation. The losses incurred here in 1979 will not be repeated.

  - DATAQUEST forecasts that Government Electronics will have a dramatic improvement in profits.

  - Codex is expected to maintain its margins on a revenue growth of 36 percent.

- A sharp increase in interest expense should negate the improvement in operating profit margins that we envision.

Table 1 gives data published by Motorola for 1978 and 1979 with DATAQUEST projections of group divisions' revenues and corporate earnings for 1980.

Table 1

MOTOROLA[1]

(Millions of Dollars)

	Sales & Revenues 1978	Operating Profits 1978	Sales & Revenues 1979	Operating Profits 1979	Estimated Sales & Revenues 1980	Estimated Operating Profits 1980
Communications Products[2]	$ 964.9	$111.1	$1,127.2	$148.5	$1,270.0	$165.0
Semiconductor Products	718.1	107.3	992.3	172.0	1,250.0	213.0
Automotive Products[3]	205.4	9.5	203.0	(16.4)	210.0	(15.0)
Other Products[4]	376.4	41.5	452.2	33.7	550.0	54.0
Adjustments & Eliminations	(45.1)	.3	(61.1)	(3.2)	(70.0)	(4.0)
Industry Totals	$2,219.7	$269.7	$2,713.8	$334.6	$3,210.0	$413.0
General Corporate Expenses		(21.7)		(28.9)		(36.0)
Interest Expense		(27.5)		(36.1)		(58.0)
Special Charge				(10.3)		0
Earnings Before Income Taxes		$220.5		$259.3		$319.0
Tax Rate		43.2%		40.5%		40.3%
Net Income		$125.2		$154.3		$190.0
Average Shares (Millions)		31.0		31.1		31.3
Earnings Per Share		$ 4.04		$ 5.21[5]		$ 6.05

[1]Note: FASB #14 reporting by Motorola does not conform to its organizational structure.

[2]Includes the Communications Group; does not include Codex.

[3]Includes the Automotive Products Division and the Angers operation; does not include Autovox or Display Systems (both of which report to Carl Lindholm, of the Automotive and Display Systems Group).

[4]Includes Government Electronics, Codex, Autovox, Display Systems, and miscellaneous units.

[5]Before special charge.

Source: DATAQUEST, Inc.
March 1980

Table 2 is a DATAQUEST estimate of revenues for which Motorola does not provide a breakdown.

Table 2

ESTIMATED OTHER PRODUCTS

(Millions of Dollars)

	1978	1979	1980
Government Electronics	$140	$180	$250
Codex	75	110	150
Autovox	50	55	60
Display Systems	55	60	60
Watch Modules, LCD	20	17	0
Miscellaneous	36	30	30
Total	$376	$452	$550

Source: DATAQUEST, Inc.
March 1980

CAPITAL EXPENDITURE

DATAQUEST's estimates of Motorola's capital expenditure are as follows:

Table 3

MOTOROLA CAPITAL EXPENDITURES BY GROUP
(Millions of Dollars)

	1977	1978	1979	Estimated 1980
Semiconductor	$ 53.1	$ 72.1	$160	$200
Communications	55.4	45.6	60	70
Automotive	9.7	13.0	10	15
Other	10.2	15.7	35	40
Total	$128.4	$146.4	$265	$325

Source: Motorola Annual Reports
DATAQUEST Estimates

SEMICONDUCTOR GROUP

Operating profits increased 60 percent in 1979 to $172 million from $107 million on a revenue increase of 38 percent. DATAQUEST estimates that the Integrated Circuits Division grew 50 percent to $500 million in 1979 and that MOS shipments gained over 80 percent. Motorola was the second fastest growing MOS supplier last year following National Semiconductor and is now the number three supplier after Intel and Texas Instruments.

Other highlights of the group last year include:

- Introduction and market acceptance of 68000
- Introduction and shipment of 64K RAM
- Organization of Office of the General Manager
- Establishment of a joint venture in France with EFCIS

- Initial shipment ramp to General Motors of both General Motors Control Module (GMCM) and 6802

- Twenty-two percent increase in discrete shipments and a substantial quality upgrade. In 1979 the Discrete Division continued its excellent progress toward being the dominant discrete supplier in the world.

- Elimination of some small or non-mainline business such as crystal and LCD products, Topsil, and some old IC logic products

Despite the uncertain economic climate this year, the biggest challenges to Motorola Semiconductor are internal. The group needs peripheral and support chips to support the 68000 and must also upgrade its memory product line (fast 4K and 16K statics, and 64K RAMs) while at the same time ramping up shipments to serve General Motors. The challenge of accomplishing all of these goals and still maintaining profit margins is a difficult one, but we believe that management is up to the task.

In this regard, two other points should be noted:

- As more and more highly sophisticated and very expensive wafer fabrication facilities are being built, Motorola is encountering the same personnel shortages that have plagued the rest of the industry. This problem could lead to profit and/or expansion limitations.

- Motorola, as well as the rest of the semiconductor industry, needs to become adept at working in an inflationary economy. This industry has grown on a learning curve of reduced prices in the face of an average 5 percent inflation. Our current inflation rate and the skyrocketing prices of precious metals pose special problems short-term.

Motorola presently has very strong momentum in almost all product areas and we believe it likely that the Company will gain market share in both integrated circuits and discretes this year.

Table 4 represents DATAQUEST's estimates of semiconductor group revenues for 1977 through 1980.

Table 4

MOTOROLA

ESTIMATED SALES OF SEMICONDUCTOR GROUP

(Millions of Dollars)

	1977	1978	1979	1980
IC	$227	$329	$500	$ 680
Discrete & Opto	315	351	419	470
Total Semiconductor	542	680	919	1,150
Microsystems	18	25	41	70
Memory Systems	2	7	7	10
Other	14	33	20	20
Total	$582	$718	$992	$1,250

Note: Detail for 1977-1979 is available in Appendix B, March 1980.

Source: DATAQUEST, Inc.
March 1980

There are three divisions in the Semiconductor Group: Integrated Circuits, Discrete Products, and International. Each division will be discussed separately.

Integrated Circuits Division

Microprocessor

The 68000 microprocessor was well received last year although some customers appear to be holding back somewhat awaiting peripherals and other support chips on schedule. For complete acceptance, such peripherals as a memory management unit, direct memory access controller, bus arbitration module, and 16-bit parallel interface adapter will be needed as well as adequate software support. Motorola has assembled an impressive array of multi-national second sources—EFCIS, Rockwell, and Hitachi. It is DATAQUEST's belief that discussions are being held with another large manufacturer outside the United States.

DATAQUEST anticipates fierce competition among 16-bit microprocessor manufacturers in 1980. Motorola's lack of peripherals has not gone unnoticed by Intel.

Memory

Motorola has broadened its lines of memories and taken a leadership position in development and production of the 64K dynamic MOS RAM. DATAQUEST estimates total memory component shipments exceeded $95 million for MOS and $18 million for bipolar.

CMOS

Motorola introduced its 14406 and 14407 Codex-decoder coders and 14414 filter in 1979. A second source agreement, made in December 1979 with RCA, will greatly enhance acceptance of these products. In development are a subscriber loop interface circuit, a time slot assignment circuit, another filter, and an 8x1 time slot interchange circuit. These parts are CMOS logic compatible. DATAQUEST estimates that Motorola's CMOS sales increased 50 percent to $115-$125 million in 1979, giving Motorola the leading market position in this technology.

Memory Systems

This business had experienced difficulty in its initial phase. The minicomputer add-in memory business has not grown as expected; however, custom memories have booked well. There is a lag between booking and shipment. DATAQUEST expects this group to ship $10 million in 1980.

Microsystems

A new marketing organization, reporting directly to the World Marketing Director has been set up to market microcomputer development systems, computers on a board, subsystems, and memory systems. DATAQUEST anticipates shipments from this group to be approximately $85 million in 1980.

In 1979, the $40 million of microsystems sales was divided roughly evenly between Europe and the United States. Further, approximately two-thirds of this $40 million was for microcomputer development systems and the balance was for boards.

The subsystem area consists of a product mix of input/output modules, solid state switches, and switching power supplies which has been developed by the Discrete Products Division, but is being market by the Integrated Circuits Division and will be covered in this part of the newsletter.

We understand that Motorola has a joint venture with Tandy and Western Union to develop a data communication system for farmers. From his home, the farmer can tie into the county agricultural agency computer to get data on such subjects as weather, fertilizing, and crop rotation.

The EXORmacs will be introduced within the next 60 days. This is the Microprocessor Development System (MDS) that will be used with the 68000. The average selling price will be approximately $30,000. It is DATAQUEST's feeling that $7 to $10 million of these can be shipped in the calendar year 1980, if they can be manufactured. The EXORciser, Motorola's original MDS system, is being updated from EXORciser II to EXORciser III. We understand the change simply means the inclusion of a faster clock and some other refinements.

The Microsystems Group is also selling the EXORterm in conjunction with Codex. The EXORterm is a smart terminal and can be used with the EXORciser, and when it is, it is called EXORciser 50. When the EXORterm is used with the EXORciser in a terminal complete with CRT, it has applications for software development. Another product that was developed in Europe is the EXORset 30, which is a 6809 based development system and is an excellent cost effective MDS vehicle for the low end of the market.

We also anticipate a large effort in computers on the board with the 68000, these products are known as KDM modules.

Discrete Products Division

This division grew 18 percent in 1979 versus a world market growth of 9 percent. The growth in discrete by the major suppliers is increasingly being concentrated in the hands of Motorola and the Japanese. DATAQUEST believes that Motorola's continued aggressiveness in the discrete area will benefit the Company since there is a continuous drag business of discrete with ICs in all applications.

In brief conversations with a number of customers of Motorola, DATAQUEST has the impression that the quality program instituted well over a year ago by the General Manager of the Division is having substantial payoffs with Motorola's discrete customers. DATAQUEST believes that this attention to quality, which includes having the Reliability Manager report to the Division Manager, will enable Motorola to compete effectively with the Japanese for this market as the years go on.

DATAQUEST understands further that in some cases capital equipment which has a good useful life, but which has had to be replaced for technological purposes, has been transferred from the IC Division to the Discrete Division. This type of equipment utilization has substantial positive profit ramifications.

The details of product development are somewhat difficult to procure, but it is DATAQUEST's opinion that Motorola continues to emphasize automation on its TO 92 line (the division is the largest supplier for auto and consumer tuning diodes, and has essentially become an industry sole source for rectifiers and rectifier buttons; it is emphasizing RF power especially in the module area). DATAQUEST estimates that Motorola's RF transistor business is growing rapidly and could reach $50 to $60 million in 1980.

International

One of the notable achievements last year in this third operating division was the joint venture between EFCIS and Motorola to manufacture NMOS in France. It is our opinion that Motorola will become a dominant supplier to both the French commercial and military market as a result of this, and that there will be a substantial fall out to other parts of Motorola's business such as pagers and two-way data communications.

International has plants in East Kilbride, Scotland and Toulouse, France; both plants have undergone substantial expansion. Between exports and direct shipments, International accounts for about 40 percent of the division's sales dollars. The International Division has made very successful and extensive use of European distributors. DATAQUEST estimates that the sales through European distribution are approximately 40 percent.

Capacity

The Semiconductor Group is headquartered in Phoenix, Arizona with facilities in Phoenix, Mesa, and Tempe, Arizona; Austin, Texas; France; Germany; Scotland; Hong Kong; Japan; Korea; Malaysia; and Mexico.

There are two MOS modules in Austin, Texas, one for CMOS and one for NMOS. Each module is capable of 10,000 wafer starts per week. The module in Tempe, Arizona produces HMOS wafers for the 64K dynamic RAM. There are also two MOS modules in Tempe, Arizona.

Motorola wafer fabrication facilities outside the United States include 270,000 square feet in East Kilbride, Scotland for the manufacture of CMOS and NMOS wafers, and power discrete and linear IC lines in Toulouse, France.

The facilities in Hong Kong, Korea, and Malaysia are used for assembly and the facility in Munich, Germany is for bipolar test.

Motorola has now converted most of its wafer fab lines to four-inch wafers and plans considerable expansion of its wafer fab facilities in 1980-81. Capital expenditure in the Semiconductor Products Group in 1980 is expected to be approximately $200 million.

A new bipolar line is planned to begin operation in Mesa in mid-1980 and an MOS facility for later in the year. Two more wafer fabrication modules are being built in Austin, Texas. Expansion is also planned for Phoenix, Arizona in 1981.

The Company, which already has a design facility in Japan, is seeking a manufacturing site in Japan, intended to produce circuits for the Japanese automotive industry.

COMMUNICATIONS GROUP

Communications Group operating profits increased 33 percent in 1979 on a 17 percent gain in sales, as a recovery was made from the margin difficulties experienced in 1979. The manufacturing problems at Fossil Creek and Fort Lauderdale appear to be behind the Company.

DATAQUEST believes that the Communications Group derives substantial product benefits because of the corporate semiconductor capability as represented by MICARL and the Semiconductor Group. DATAQUEST also estimates that Motorola has 800 independent service stations and 50 Company service facilities in place; we believe this capability to be a very powerful marketing tool.

This group is organized into the following entities:

- Portable Products Division
- Mobile Products Division
- Communications Fixed Products Division (formerly Communications Products Division)

- Communications Systems Division

- Communications Distribution Division

- International

Portable Products Division

This division was formed in 1979 as part of the split from Communications Products Division. The Division Manager is Mort Topfer. DATAQUEST estimates that this division has well over 50 percent market share in its available market.

DATAQUEST understands that, as discussed at the Motorola stockholder meeting last summer, the Portable Products Division has a signed agreement to supply pagers to NTT in Japan. These pagers incorporate many advanced technological features such as a CMOS microprocessor; we understand that future design changes can be made by replacing the ROM. This capabilty will have a substantial effect on this product's market share in both Japan and the United States. The initial order is for 150 pagers.

DATAQUEST estimates that the Portable Products Division sales were about $250 million in 1979.

Mobile Products Division

This division is a second spin out from the former Communications Product Division. Mobile basically covers applications that are non-marine between a station area and moving entity or between two moving entities.

We estimate the volume in this group was about $250 million in 1979.

Substantial product activity has been underway in this group—some of the activity that DATAQUEST perceives is as follows:

- For many years the standard two-way set was MICOR. It is our understanding that Motorola is replacing MICOR, which operates at a lower frequency, with an 800 MHz set of radios, the SYNTOR and the SYNTOR X. These units make extensive use of microprocessors, frequency synthesizers, and ROMs for feature customization. These two units bracket the costs and the features that used to be supplied by MICOR. We understand that MICOR will continue to be offered as a product for some period of time. DATAQUEST believes that having these two sets in the higher frequency can expand Motorola's customer base.

- Maxar—It is DATAQUEST's feeling that the Maxar is as much a philosophy as a product. Basically, it is defined as a low-cost radio for under-dash installation. It is our feeling that Maxar is the area where the most cost effective technical and manufacturing breakthroughs are applied. The next version of Maxar known as Maxar II will be operating at 800 MHz and will again use such advances as microprocessor frequency synthesizers.

- The High Capacity Mobile Telephone System (HCMTS), which is a product in the 900 MHz spectrum, is still under test at the FCC.

- The Motorola cellular system which has been in test in the Washington-Baltimore area is expected to commence full service in 1981-82. The FCC, in beginning the regulatory process leading to final rules for cellular systems, is addressing a number of major questions.

- We also understand that an Electronic Mobile Exchange (EMX) is being developed by this group. It is designed to get the user to the first available transmission channel as quickly as possible. This application is another example of Motorola's use of advanced solid state technology. Motorola has obtained two large orders for this sytem, one from Austria and one from Pacific Telephone and Telegraph.

Communications Fixed Products Division

This division is the progenitor of the two previous divisions. The product line residue is basically the fixed apparatus and the equipment at base stations consisting of the base station itself, consoles, and other point-to-point communications equipment. We estimate the volume for this group last year to be approximately $175 million. Once again, the pervasiveness of semiconductors is shown in that the equipment currently offered by this group has a smaller configuration accompanied by higher wattage.

Communications Systems Division

All the previous product divisions focused on voice communications, an area in which Motorola has a dominant position. We understand that the charter of the Communications Systems Division is to achieve that dominance in data communications. Data communications represents a substantial potential for Motorola. We estimate Communication Systems Division volume at approximately $150 million. We understand that they are working on programs such as vehicular tracking, which is a monitoring system for commercial transportation systems.

We also understand that they are working with utility companies looking at such concerns as load management. This system would control power input to houses, using such features as selective cut-off to water-heaters, refrigerators, and air-conditioners, and the ability to charge varying rates for power according to the time of use.

We understand that this group is also working with some of the telephone companies in custom work in the digital synthesizing area. Common carrier mobile radios are also the responsibility of this division.

Communications Distribution Division

This division is the marketing area for the group. In addition to the hardware sales realized by the other divisions, this division billed an estimated $125 million in service revenues in 1979. This business is typically low-margin and high return on net assets (RONA).

International Division

This division has its own product development group to design and market equipment to foreign standards. The division has facilities in Germany, South Africa, Israel, Canada, Scotland, and Mexico. DATAQUEST estimates that the international activity will have revenues of about $200 million in 1980.

Manufacturing

As indicated in past Motorola releases and our previous newsletters, the Communication Group suffered from start up cost and manufacturing problems at its Fossil Creek facility. It is DATAQUEST's opinion that the Fossil Creek facility is fully operational, and highly automated in both manufacturing and warehousing. We understand that there is a four-story Kenway automated warehouse which picks work in process as needed by lot and brings it to the line. We also understand that the Fort Lauderdale facility has had all of its functions combined and now reports as a total manufacturing facility to Mort Topfer. As publicly released, Motorola has acquired a property in Boynton Beach, Florida for future expansion of communications.

AUTOMOTIVE AND DISPLAY SYSTEMS

Last year was another difficult one for the Automotive and Display Systems Group. This Group ran at a loss in excess of $16 million in 1979. At the annual shareholders meeting last summer, the Company predicted a loss for the Group. At this meeting, Carl Lindholm, General Manager of Automotive and Display Systems, dealt with responsiblities for the following groups:

- Automotive Products Division
    - a) Electronic Systems
    - b) Entertainment
    - c) Industrial Controls
    - d) International
- Angers Operations
- Display Systems
- Autovox

Automotive and Display Systems Group includes the Angers operation in France but does not include Autovox. Autovox does, however, report to Carl Lindholm of Automotive and Display Systems Group.

The Automotive and Display Systems Group has been working with a combination of problems some of which DATAQUEST perceives are the following:

- The automotive market was generally soft in 1979.
- Entertainment business especially car radio, classically an area of strength for Motorola, has been very weak the last several years. Motorola still has a business in this area which DATAQUEST estimates to be about $25 million; however Ford's move to inhouse manufacture radios has resulted in lost business of about $25 million compared with revenues several years ago.
- Display systems appears to have both margin and market share problems.

This group is the profit trouble spot in Motorola Corporate. We believe that the problems have been identified and that a substantial amount of corporate energy is being focused on this group.

Automotive Products Division

APD has penetrated Ford very heavily. It is DATAQUEST's estimate that in 1979 about 40 percent of APD sales were to Ford in these areas: pressure sensors, engine control modules, ignition systems, EEC III modules, radios, and remote CBs.

Electronic Systems

DATAQUEST estimates that Motorola shipped between 150,000 and 250,000 EEC III units at $125 each in 1979. These units were used for the high end cars. Motorola has also shipped a motor control unit using an Intel 8048 which we believe markets for about $40 a unit. It is our estimate that APD supplied about 500,000 MCUs to Ford.

APD has opened an automotive lab in Japan and is, DATAQUEST believes, working very hard on an engine control unit for a major Japanese car manufacturer.

Substantial marketing and application effort is being devoted to heavy equipment manufacturers such as Deere; focusing on instrument panels, two-way communication systems, and microprocessor controls.

Industrial Controls

The industrial systems program, which consists mainly of two microwave oven control programs, generated an estimated $5 to $10 million in 1979; this revenue could grow in 1980.

International

We believe that Motorola is making good progress in Europe. We perceive increasing penetration in Volkswagen with alternators; extensive development work with Weber in electronic control modules; and very close development work with Peugeot and Fiat.

Automotive Products Europe has recently hired Mr. Gerhardt Schulmyer as General Manager. He comes from Sony, Europe, and is well regarded. In addition, the new General Manager of the Automotive Parts Division, Mr. Levy Katzir, is also well regarded.

Angers

The Angers operation has been a drag on Motorola's profits since the operation was acquired in 1974. It is DATAQUEST's understanding that pricing on alternators for the European market was very aggressive initially in order to get market share and the Angers operation is just now catching up to its costs with its princing. We look for Angers to make a contribution next year after breaking even in 1979.

This group continues to have problems with product mix (entertainment), slow automobile sales, and Ford market share problems. Nevertheless, DATAQUEST has seen indications that the future for this group might be brighter than it appears.

The Automotive Products Group represents a substantial profit improvement program for the corporation. It is DATAQUEST's opinion that it will take longer than this one year, 1980, to complete the transition from a heavy commitment to entertainment to the business of the future—under the hood. Given an uncertain automotive climate, we do not expect much improvement in losses this year.

GOVERNMENT ELECTRONICS DIVISION

The Government Electronics Division participates in four markets: Communications,—approximately 40 percent of sales; Radar—35 percent of sales; Tactical and Electronics Missiles combined, 25 percent of sales. It is DATAQUEST's perception that this division which in the past has operated under constraints related to percent of sales per contract and percent sales to a given agency has had these restraints lifted. The bookings activity in 1979 was extremely good. The major accomplishment was obtaining the contract for the Stand Out Target Acquisition System (SOTAS). SOTAS mounts a surveillance radar system on a United Technology Sikorsky Blackhawk helicopter and relays target data in real time to command post ground stations. Motorola won this award in fierce competition with General Dynamics Electronics. This contract is for $56 million initially. DATAQUEST believes that this is the largest single contract the group has ever received. Production potential is extremely high—between $500 million and $1 billion. Other awards this year include DAMA (Demand Assignment Multiple Access System) which works in conjunction with the Galileo Satellite. Motorola has continued its excellent penetration with the National Security Agency (NSA). Motorola is now one of the preferred suppliers to NSA.

DATAQUEST estimates that this division grew from $140 million to $180 million in 1979. Our estimate for 1980 sales is $250 million, a growth of approximately 39 percent.

The strains of accelerated growth depressed margins in 1979 under 10 percent pretax, but we expect a recovery in margins this year.

As mentioned in a previous DATAQUEST newsletter, this division has set up a production group called the Specialized Production Center, designed to bid on military contracts in which the technological content is minimal and has been reduced to routine production practice. The production line concept will receive its test under fire this year with the FMU 110 Fuse and an Army Fuse contract running on this line. DATAQUEST estimates that as much as 10 percent of division sales will run through this line this year.

The division is adding 300,000 square feet of space in Tempe, Arizona, when completed, the facility will total 1.25 million square feet. Radar and Tactical groups will go to Tempe. It is our understanding that this group is looking for still another site for future expansion.

The encryption device originally designed by MICARL and marketed by GED, is now being marketed by Codex. This is another example of the synergy that exists with the use of MICARL to provide technical uniqueness in limited quantities and high ASP type black box business.

CODEX

This subsidiary consists of Codex, UDS, (both recent acquisitions), and a small intelligent terminal operation in Phoenix and reports directly to the President of the Company. This group made a heavy investment in technical development in 1979 and still achieved margins 10 percent NPAT. The charter of this group is total data communciations systems from computer to man-computer interface—(specifically excluding the computer). Sales in 1979 are estimated at $108 million, with Codex responsible for approximately $90 million and UDS for approximately $18 million. UDS works in the low speed end of the modem product spectrum. Codex margins declined somewhat in 1979, reflecting heavy Research and Development investment. We would anticipate flat margins in 1980.

Codex works on high speed modems (4,000 to 9,000 baud range) and a variety of specialty data communications equipment such as data concentrators, pre-processors, and channel selectors. Codex has established Codex/West to market the Motorola SPG developed EXORterm terminal and to interface with Motorola Integrated Circuit Advanced Research Laboratory (MICARL). MICARL developed chips are beginning to appear in Codex equipment.

MICARL

Throughout this newsletter we have repeatedly mentioned Motorola Integrated Circuit Advanced Research Laboratory (MICARL). We believe that MICARL processes in excess of 200 custom chips per year. It has been an effective solution to the problem that affects most equipment manufacturers: the timely design and fabrication of solid-state chips that have a high value-added and technological content in a finished system, but require an extremely limited production run, in some cases as small as one hundred wafers.

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INTERNATIONAL SOLID STATE CIRCUITS CONFERENCE 1980

SUMMARY

The International Solid State Circuits Conference (ISSCC) is the premier high technology conference of the year for the semiconductor industry. This year, the conference was held in San Francisco from February 13 to 15. Next year, it will go to the East Coast, but will be in New York City rather than in the traditional East Coast site of Philadelphia. This site change is necessitated by the burgeoning conference attendance; there were 3,000 attendees this year, up from 2,000 the previous year.

ELECTRONICS IN THE 80s

Once again, the tenor of the conference was set in the keynote speech delivered this year by Mr. J. Fred Bucy, President of Texas Instruments. He discussed the increasing growth rate of the industry and the challenges for U.S. companies to maintain their share of the world market.

Mr. Bucy estimated that by 1990 worldwide semiconductor markets would grow from the 1979 total of $11 billion to the range of $60 to $80 billion; he projected that 40 percent of that total would be MOS memory. In order to grow to that level, the worldwide industry will have to add between $50 and $70 billion of additional manufacturing capacity. U.S. companies alone will have to add at least 60 percent of this capacity to maintain their share of world markets—$30 to $40 billion of new capacity. This increased capital spending in the 1980 decade is up significantly from the $5 to $6 billion of capital spending by U.S. based companies in the 1970s. This productive capacity will be difficult to add not only because it is larger in absolute magnitude but also because more capital investment is required to generate an additional dollar of revenue.

Mr. Bucy emphasized that the U.S. economic system encourages high debt and low capital formation; therefore, it is not presently structured to encourage this level of investment. He mentioned that, as a result, 49 company acquisitions have been made in the U.S. semiconductor industry, 18 of these by foreign firms. Mr. Bucy also discussed two other challenges to U.S. industry: its ability to develop the managerial capabilities to handle this growth and the electronic industry's capability to use the potential of semiconductor technology.

OVERVIEW OF THE TECHNICAL PAPERS

The country of origin for technical papers at ISSCC shows an interesting trend inasmuch as it indicates the level of R&D within that country. Table 1 shows this data for the technical papers, exclusive of the panel discussions. U.S. presence has declined from 76 percent in 1978 to 68 percent in 1980, whereas the Japanese presence increased from 14 to 25 percent over the three years.

Table 1

COUNTRY OF ORIGIN FOR TECHNICAL PAPERS AT ISSCC

Country	1978	1979	1980
United States	76%	65%	68%
Japan	14	21	25
Europe	10	14	7
	100%	100%	100%
Total Technical Papers (Exclusive of Panel Sessions)	94	97	90

Source: DATAQUEST, Inc.
March 1980

Among U.S. papers, Intel's paper on a 16K bit electrically erasable nonvolatile read only memory was well received (session 12.6). Intel erases this memory with a 20 volt pulse across 200 angstroms of oxide, surely an excellent oxide. TI's 64K RAM paper generated interest (session 17.6) and IBM's paper on an automated wafer production area (session 16.1) described their direct E-beam personalization of gate arrays. This facility handles one hundred more bipolar chip part numbers per year than comparable facilities did five years ago.

Many of the technical papers from Japan were indicative of the long-range research going on in Japan. They tended to look two to five years into the future whereas many of the U.S. papers were looking at the next one to three year time frame. The Japanese papers (session 2) covering imaging sensors for color TV cameras were particularly good as were the papers on 256K RAMs by NEC-Toshiba Information Systems and NTT Musashino Electrical Communication Laboratory (session 17).

It should be noted that the two Japanese papers on 256K dynamic MOS RAMs indicated a high level of R&D activity in Japan as well as the increasing pressure to "publish or perish." However, in light of the fact that the worldwide semiconductor industry shipped less than 20,000 64K dynamic RAMs in 1979 it is clear that the 256K RAM is still a couple of years away from serious sampling. Nevertheless, the two papers from Japan did indicate that they have a very good technical ability in advanced state-of-the-art products.

Table 2 indicates the number of papers within various categories which have been presented over the last three years.

Howard Z. Bogert
Daniel L. Kiesken

Table 2

PAPER COUNT BY APPLICATION AREA AT ISSCC

Topical Area	1978	1979	1980
Analog Circuits and Applications	28	24	15
Digital Circuits and Applications	19	11	24
Semiconductor Memory	15	21	16
Combined Digital and Analog	12	13	10
Design Aids, Processing, and Manufacturing	7	11	11
CCDs and Imaging	7	7	6
Telecommunications	6	6	8
Gate Arrays	-	4	-
Total	94	97	90

Source: DATAQUEST, Inc.
March 1980

DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

Vol. II - No. 3 March 14, 1980

This letter is a condensation of recent newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific newsletters should be directed to the author. A list of recent DATAQUEST Research Newsletters appears at the end of this letter.

COPYING AND DUPLICATING

Xerox's recent announcement of its intention to establish a Retail Markets Division was made in a relatively low-key fashion, but we believe that this move may be very significant for the company longer term.

Within the next two months, DATAQUEST expects Xerox to establish three to six company-owned retail stores in Dallas, Denver, and Minneapolis. These stores would begin selling a line of office equipment including low-end Xerox copiers along with non-Xerox manufactured typewriters and dictation equipment. Ultimately, we believe that the product line will be expanded to include supplies for a wider range of Xerox and other manufacturers' copiers, an electronic typewriter directly competitive with the IBM 70 and 75 that Xerox could announce mid-year, a new low-end copier likely to be introduced within the next twelve months, and standalone word processing systems. The product line might also include small business computers and home computers

If the initial three city test market proves successful, we believe that Xerox will move very aggressively to expand this retail store network nationwide, with as many as 100 stores possible within twelve months and 600 stores by the end of 1982. Robert Rieser, formerly Vice President of Marketing and a leading candidate for more senior management positions, was put in charge of the operation. This indicates to us that the company has big plans for the retail enterprise.

Considering the costs of leases, leasehold improvements, inventories, staffing, training, and advertising, the financial commitment required for starting this operation will be enormous. If the pilot stores prove successful and a rapid expansion is started, we estimate that pretax losses from this division will run between $10 and $20 million in both 1980 and 1981. As a result, we are shaving our 1980 earnings estimates from $7.50 to $7.40 per share. The division could turn profitable by 1982 and potentially generate significant profits by 1983. Conversely, an unsuccessful effort would mean stores closings, more red ink, and more red faces.

DATAQUEST believes that the concept of retail stores makes a lot of sense. We envision Xerox becoming a one-stop office equipment supermarket that can fulfill almost all needs of a small business. In addition, by selling the low-end copiers on a retail basis, Xerox frees its direct sales force to concentrate on the more lucrative mid- and high-range products, where the marketing cost are better absorbed by a higher average selling price.

Although the risks of this venture are certainly significant, we think they are far outweighed by the potential rewards. More good news on Xerox in the Word Processing section.

WORD PROCESSING

It looks to us as if 1980 may be the year in which the big players finally get serious about the word processing business.

Under the direction of Don Massaro, we sense that Xerox's office products division (OPD), which encompasses word processing, has started to generate more momentum. Most of the initial software problems that have plagued the 850 word processors are now resolved and we believe that a very aggressive marketing effort on the 850 and the new 860 product is paying off in a marked pickup in new orders. Xerox's word processing revenues could jump as much as 70 percent in 1980 to almost $200 million and although the division will lose money this year, we believe that the losses will be down considerably from the levels of 1979.

The long-term key for Xerox in the word processing market is the success of ETHERNET, its intra-office communications network. We do not believe that all of the pieces of ETHERNET are ready as of yet, but the pieces that we have become aware of look extremely well thought out and promising. It remains our belief that Xerox can finally obtain profitability in word processing in 1981. That success would dramatically change investor's attitudes about top management's capability and direction.

At the same time, it appears that IBM is readying a noteworthy product for the word processing business as well. Likely to be introduced in the third quarter of 1980, the product should be IBM's first real entrance into the CRT standalone sector of the market. We expect that the new machines will have very good communications capabilities with other IBM office and computer products. The real key to the success of this machine will be pricing and software support. We will not be sure of those details until after the equipment's introduction. Initial indications however are that pricing may be very aggressive and that user interface will be emphasized.

Do we think that these stronger efforts by Xerox and IBM will have a significant negative impact on the well entrenched companies in the word processing business? - NO. Do we think that they very well could impact some of the less well-positioned companies? - YES.

SEMICONDUCTORS

As we have been predicting, we are starting to see clear signs that supply is catching up with demand for certain semiconductor parts. We should note however, that conditions are still very tight in 16K RAMs, bipolar PROMs, low power Schottky, and microcomputers and are likely to remain so for almost all of 1980. In short, business is still very good. In fact, we are raising our forecast of U.S. semiconductor consumption growth for 1980 from 14 percent to 20 percent. This altered forecast does not reflect any change in our economic outlook, but rather the fact that sales in the fourth quarter of last year significantly exceeded our preliminary estimates. This means that the run rate entering 1980 is at a higher level and therefore year-to-year growth should be higher. In addition, overall orders during the first two months of 1980 remained strong.

Our present thinking is that the rate of gain in year-to-year sales will approximate 35 percent in the first quarter of this year and then decelerate down to a 7 percent rate of year-to-year growth in the fourth quarter, before starting to gradually improve during 1981. As we have stated before, the major question mark is pricing; we remain convinced that unit demand will remain fairly strong this year.

A few comments about the Japanese seem in order since there appears to be increasing concern about their penetration into various sectors of the semiconductor industry. First, in 1979, the Japanese semiconductor manufacturers lost market share in every single product category (bipolar, MOS, linear, discrete), primarily as a result of losing their dominance of the Asian consumer products markets. Second, a good portion of the business the Japanese have received in the United States in the last year has been overflow business that the U.S. suppliers could not meet, which is a healthy development. We do not want to minimize the potential impact of the Japanese, particularly with their ability to spend large amounts of money in development and product reliability assurance without commensurate economic return, as well as the support that the companies get from the Japanese government. We do not want to over-emphasize the risk either.

The turnaround in Motorola's semiconductor operation has been predicted and documented by our staff for the last three years, but unfortunately the rest of the company has not been able to support the turnaround that the semiconductor group affected. We understand that our $6.05 per share earnings estimate for Motorola this year is high by Wall Street standards. Frankly, we were somewhat hard pressed to keep the numbers down that low and have factored a reasonable degree of conservatism into our forecast (i.e., no improvement in the large losses incurred last year by automotive products).

Motorola's 16-bit microprocessor, the 68000, is an extremely strong product offering. The company faces a tremendous challenge this year to introduce the necessary support chips to take advantage of the product's potential. If Motorola can accomplish this goal and also show good earning gains in what is likely to be a tough economic year, we think investors' perceptions of the company can change radically.

PAPER AND FOREST PRODUCTS

The surprising strength of the U.S. economy thus far in 1980 has translated into generally strong levels of demand for almost all paper products. In addition, the companies in general have been able to raise prices at a more rapid rate than cost. All of which means that industry profitability should be very strong in the first quarter of 1980 and probably in the second quarter as well. Despite these glad tidings, however, we have become somewhat more pessimistic about the intermediate term outlook since our last writing.

We are more and more convinced that while the recession this year may not be a very steep one, the recovery is likely to be very moderate as well. Our official DATAQUEST forecast is for a 1.5 percent decline in real GNP in 1980 followed by a 1.5 percent increase in 1981. In this scenario, paper industry pretax profits would likely decline by about 10 percent in the third quarter of this year and by 20 percent or more in the fourth quarter of 1980 and first half of 1981, before recovering somewhat late next year. A further unsettling note is that we now feel that there is clear evidence of overbuilding in wholesale inventories of white paper in particular, and probably of almost all paper grades. This overload will obviously work to the industry's disadvantage late this year.

The one saving grace for the paper industry in 1980 may be the possibility of strikes in eastern Canada. Labor contracts for the entire eastern Canadian paper industry will expire in the fall and the initial reports are that the gap between management and labor is fairly wide. A prolonged strike in Canada this year could bail out the U.S. producers much the same as it did in 1975.

As noted in previous Portfolio Letters, we have particular concern about the white paper sector of the industry. We foresee relative imbalances between supply and demand continuing off and on through 1985 and believe that the peak year of profitability in this sector of the industry until 1985 may be achieved in the first half of 1980. Conversely, while 1980 and 1981 will not be banner years in brown paper, we remain convinced that over the ensuing years, brown paper supply and demand will be relatively tight and will work to the benefit of the producers.

Our attitude about the relative weightings of the different sectors of this industry remains the same: a de-emphasis on companies with high white paper exposure (Boise Cascade, Hammermill Paper) and an emphasis on companies with high brown paper exposure (Union Camp). Our overall view of the industry over the next 18 months, however, is somewhat more pessimistic because of the likelihood of a slower recovery next year. We think it is reasonable to expect the forest products companies to lead the recovery. With this in mind, we would particularly point to one forest products concern, Champion International, that is particularly interesting because it has a relatively good exposure to brown paper.

INSTRUMENTATION

Several instrument companies have recently cited the problems brought on by the present high rate of inflation, namely that with relatively long backlogs, these companies have found it difficult to raise prices fast enough to offset rising costs, particularly since most companies use LIFO accounting.

We have few words of wisdom to add on this subject other than to project when these problems should abate for each of the companies involved. Hewlett-Packard was hurt by high component costs as early as the fall of 1979 and has been steadily raising prices throughout fiscal 1980. Prices are already up an average of more than 3.5 percent this year; we would anticipate that another 1.0-1.5 percent price increase scheduled for May 1 will be moved up by a month. In general, we believe that cost pressures are actually becoming somewhat less of a problem at Hewlett Packard because of the relatively early steps it took to raise prices. We would anticipate that sequential profit margin would improve in the second fiscal quarter and continue to move higher during the balance of fiscal 1980.

The problem is somewhat more significant for Tektronix because of manufacturing problems that are holding up shipments. This slowdown could cost the company $10-15 million in revenues in the present quarter. This problem has the additional negative effect of stretching out backlogs, which means that price increases take longer to be reflected in revenues. We do not expect any improvement in margins at Tektronix until the first quarter of fiscal 1981 (August) and our $4.70-$4.80 per share estimate for fiscal 1980 implies only slight improvement in earnings during the final two quarters of this year.

Teradyne's backlogs in certain semiconductor tester products are stretched out over six months and the lag before the company can raise prices on products that flow into sales will definitely constrain margins during most of 1980. This consideration is factored into our $3.30 per share earnings estimate for this year. GenRad, which is working off of backlogs that generally do not exceed three months, is experiencing fewer problems in this regard.

SMALL COMPUTERS

Our final estimates indicate that the U.S. based general purpose minicomputer (GPMC) market grew by 29.8 percent to $5.0 billion in 1979. The increase in unit shipments was only 16 percent, a clear indication that sales of peripherals and add-ons as well as service revenues greatly exceeded the growth in new system sales. Two small companies, Tandem Computer and Prime Computer, were standout performers with revenue gains of 133 percent and 51 percent respectively. Among the larger participants, IBM, Honeywell, and Hewlett-Packard also gained market share. Data General held about constant and Digital Equipment lost about one percentage point in share.

Despite the increasing economic uncertainties, we are inclined to increase our growth forecast for the GPMC market from 25 percent to a 25-30 percent range in 1980. This alteration does not reflect a change in fundamentals, but rather one in pricing. IBM recently raised prices by an average 7 percent across most of its product line, Digital Equipment has announced price increases ranging from 5-15 percent, and Datapoint has just raised prices (for the first time in its 11-year history) an average of 4 percent on purchases and 8 percent on leases. We would expect selective price increases from Data General and Hewlett-Packard in the near future, as the industry adapts to a more inflationary environment. We hesitate to become more optimistic about increases in growth rates that are purely a function of pricing, but we are encouraged by the recent moves in that they increase the likelihood that the industry can maintain profit margins this year.

Michael R. Weisberg

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DATAQUEST RESEARCH NEWSLETTER
A Subsidiary of A.C. Nielsen Co. INCORPORATED

SIS Code: Vol. I, 2.8.7

AN UPDATE: AUTOMOTIVE SEMICONDUCTOR MARKET

In December 1978, DATAQUEST's Semiconductor Industry Service published a Service Section and a Research Newsletter on the market opportunities for semiconductor devices in automobiles. This newsletter updates subscribers on this important market segment.

Government-mandated systems for fuel economy, exhaust emissions, and safety are expected to remain the major incentive for production of electronic systems for several years. However, feature items are being incorporated more quickly than DATAQUEST anticipated; for example, Ford is offering electronic door locks on several of its 1980 models.

Our revised forecast of semiconductor consumption (Table 1) for U.S. and Canadian cars is 40 percent higher than our forecast of a year ago. There are 3 major reasons for the increase:

- General Motors is equipping nearly all of its 1980 models with electronic engine controls; in 1978, we estimated that incorporation on this scale would not occur until model year 1981.
- Semiconductor content in the systems is higher than expected because the systems are more complex than expected and unit prices did not fall as projected.
- More feature systems are being offered than were expected.

Note that we are revising our forecast for model year 1980 only; the assumptions and predictions for future years still appear to be valid.

In Table 2, we show some representative equipment installed in 1979 model cars as reported by Ward's Automotive Reports. In general, DATAQUEST's forecasts of December 1978 compare very favorably with these reported actuals. Use of the V-8 engine has declined dramatically as we expected; the rapidly rising price of fuel is expected to cause the decline to continue even more rapidly. Buick has already cast its last V-8 engine. The 4-cylinder engine is gaining popularity faster than we expected and sales of this engine appear to be limited only by production capacity. Waiting times for some 4-cylinder models is reported to be 13-14 months. Dealers report that the typical car buyer's perception is that 8 cylinders are required for performance and 4 cylinders are required for economy; surprisingly, the 6-cylinder engine, which really offers both, has little inherent demand.

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Diesel engine sales are limited somewhat by availability. Even without the planned 260 cubic inch diesel, General Motors' diesel sales now surpass the sales volume of all of the imported diesel automobiles. GM is now offering the diesel engine in other divisions, so sales are expected to continue growing; however, its engine has not yet gained certification for sale in California for 1980 models. Since the popularity was highest in California, this is expected to have significant negative impact on diesel market penetration.

Cruise Control is still largely non-electronic; in 1979, only Ford (all lines) and Cadillac used electronic solutions. Delayed windshield wipers and digital clocks are not electronic in all cases, but we expect that they will soon be converted. The higher than originally expected use of electronic catalytic-converter controls in 1979 was primarily due to GM's acceleration of electronic programs.

The electronic dashboard promises to be the major area for feature distinction. Trip Computer and Message Center functions are expected to be integrated further with the traditional instrument cluster functions. Diagnostic functions and warning devices are expected to take advantage of animation capabilities of LCD displays. Audible warnings and messages are expected to abandon buzzer and chimes in favor of speech synthesizer-generated messages.

Table 3 presents DATAQUEST's estimates of the 1980 model year procurements by the domestic automobile manufacturers and the market shares of the semiconductor suppliers. By winning major supply contracts at General Motors, Texas Instruments is now estimated to be the number two supplier to the domestic automobile industry.

The impact of the impending recession on the accuracy of the auto industry's forecasts for automobile production is viewed as the most significant factor affecting the accuracy of our forecasts. We expect that any further loss of market share by Chrysler will tend to decrease the total market for semiconductors as Chrysler's implementations tend to be higher in integrated circuit content than those of GM and Ford and, further, to shift some of the North American automobile market to Japan and Western Europe.

We expect that in the future Delco Electronics will build a smaller percent share of GM's semiconductor requirements. Toshiba, a significant microprocessor supplier for model year 1979, is estimated to be participating at a considerably smaller market share in 1980. American Microsystems, Inc. (AMI) is moving into a position of significance as an automotive supplier. Although several AMI programs were curtailed when the company's VMOS process was withdrawn, AMI is expected to become a significant supplier to the European market through its affiliation with Robert Bosch GmbH.

In addition to their semiconductor sales, Motorola and Fairchild are significant suppliers of electronic assemblies. We estimate that Motorola's 1979 sales of automotive electronic modules were about $100 million and Fairchild's 1979 sales, principally electronic ignition modules were about $25 million. Motorola's sales of automobile radios are not included in the above estimates.

Table 4 presents DATAQUEST's estimate of the component unit volumes required for U.S. domestic car production in model year 1980. This estimate includes the components supplied by module manufacturers.

Willard T. Booth
Daniel L. Klesken

Table 1

ESTIMATED SEMICONDUCTOR COMPONENT VALUE IN FACTORY INSTALLATIONS BY MODEL YEAR IN FREE WORLD VEHICLES

(Millions of Dollars)

Model Year	1978	1979	1980	1981	1982	1985
Total Free World	$243	$270	$450	$640	$820	$980
United States & Canada	$126	$143	$280	$450	$610	$700
United States	$111	$126	$255	$410	$540	$620
Canada	$ 15	$ 17	$ 25	$ 40	$ 70	$ 80
Japan	$ 41	$ 46	$ 70	$ 80	$ 90	$110
Western Europe	$ 76	$ 81	$100	$110	$120	$170

Source: DATAQUEST, Inc.
February 1980

Table 2

SELECTED 1979 EQUIPMENT INSTALLATION RATES
U.S. DOMESTIC CARS

(Percent of Total Production)

8-Cylinder Engines	
Gasoline	56.4%
Diesel	2.2%
6-Cylinder Engines	23.8%
4-Cylinder Engines	17.6%
Cruise Control	
Electronic	6.0%
Other	31.1%
Digital Clocks	20.5%
Delayed Windshield Wipers	25.7%
Tachometer	9.2%
Burgler Alarm	1.0%
Headlamp Timing	4.5%
Trip Computer	0.1%
All-Electronic Radio	1.3%
Electronic Engine Controls	
Fuel Injection	2.5%
Spark Advance	14.9%
Catalytic Converter Control	3.7%
Climate Control	9.8%

Source: Ward's Automotive Reports
January 28, 1980

Table 3

ESTIMATED SEMICONDUCTOR COMPONENT PROCUREMENTS
FOR MODEL YEAR 1980

(Millions of Dollars)

	GM	Ford	Chrysler	Total
Motorola	$ 90	$12	$ 8	$110
Texas Instruments	30	14	6	50
Delco Electronics	40	-	-	40
National Semiconductor	20	1	5	26
RCA	5	-	12	17
Signetics	10	2	1	13
Intel	-	10	-	10
Fairchild	5	2	-	7
AMI	-	4	1	5
Toshiba	-	2	-	2
Total	$200	$47	$33	$280

Source: DATAQUEST, Inc.
February 1980

Table 4

ESTIMATED COMPONENT REQUIREMENTS
OF U.S. DOMESTIC CARS FOR
MODEL YEAR 1980 BY TECHNOLOGY

(Millions of Units)

			$
Integrated Circuits	190		510
Bipolar	85	x4	340
NMOS	15	x 2 =	30
PMOS	10	x2 =	20
CMOS	80	x 1.5 =	120
Discrete Devices	360	x0.25 =	90
Transistors	175		
Diodes	185		
			$600
Passive Devices	3,100		
Resistors	1,700		
Capacitors	1,400		

Source: DATAQUEST, Inc.
February 1980

DATAQUEST RESEARCH NEWSLETTER
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MOS MICROPROCESSOR SHIPMENTS

SUMMARY

In the fourth quarter of 1979, worldwide shipments of MOS microprocessors were an estimated 26.3 million units, up about 20 percent over estimated third quarter 1979 shipments, and up about 216 percent over the fourth quarter of 1978. Worldwide shipments for the year 1979 were an estimated 75.1 million units, up a dramatic 193 percent over an estimated 25.6 million units shipped in 1978.

In the fourth quarter, 4-bit microprocessors represented about 67 percent of the total shipments with estimated shipments of 17.7 million units, up about 20 percent over the third quarter of 1979. Eight-bit microprocessors had estimated shipments of 8.4 million units, representing about 32 percent of the total. Sixteen-bit products, with estimated shipments of 203,000 units, represented about 1 percent of the fourth quarter 1979 totals.

Figure 1 demonstrates the continued dramatic growth in quarterly microprocessor shipments. Quarter-to-quarter growth of total microprocessor shipments has exceeded 20 percent for each of the four quarters in 1979. The rapid growth of the 4-bit and 8-bit single-chip microcomputers is also easily seen in this figure; microcomputer shipments represented about 82 percent of the fourth quarter shipments, compared to 81 percent in the third quarter.

Demand for single-chip microcomputers remains strong in this first quarter of 1980. Lead times for these ROM-based devices are generally in excess of twenty weeks, and prices have remained firm. Lead times on some microprocessors have shortened to under five weeks, and prices have declined slightly.

QUARTERLY MICROPROCESSOR SHIPMENTS

DATAQUEST estimates of worldwide microprocessor CPU shipments for the fourth quarter of 1979 are presented in Table 1. Our estimated shipments refer to microprocessor CPU chips only and do not include I/O or peripheral chips. Total microprocessor shipments in the fourth quarter of 1979 were an estimated 26.3 million units, up about 20 percent over the third quarter of 1979 and up about 216 percent over the fourth quarter of 1978.

Total shipments of MOS microprocessors for 1979 were an estimated 75.1 million units, up about 193 percent over an estimated 25.6 million units shipped in 1978 and up dramatically over the estimated 8.4 million units shipped in 1977.

DATAQUEST has been tracking MOS microprocessor shipments since our first newsletter on the subject in September 1976, and Figure 2 is a plot of estimated worldwide shipments of MOS microprocessors for the years 1975 through 1979. These shipments have increased dramatically from an estimated 1.1 million units in 1975 to an estimated 75.1 million units in 1979. The compound annual growth rate between 1975 and 1979 has been a remarkable 188 percent. This figure indicates almost a tripling of shipments every year. Such a growth rate cannot continue forever, but we do expect to see a doubling of total unit shipments in 1980.

Table 2 presents DATAQUEST's estimate of worldwide shipments of 4-bit, single-chip microcomputers. In the fourth quarter of 1979, estimated shipments of 4-bit bit microcomputers were 17.7 million units, up about 20 percent over estimated third quarter shipments of 14.7 million units. In 1979 an estimated 50.2 million 4-bit microcomputers were shipped, up dramatically over an estimated 16.0 million units in 1978.

Table 3 presents DATAQUEST's estimates of worldwide shipments of 8-bit microcomputers. In the fourth quarter of 1979, an estimated 3.9 million units of the 8-bit microcomputers were shipped, up 32 percent over an estimated 2.9 million units in the third quarter of 1979. For the year 1979, 8-bit microcomputers totalled 9.8 million units, up sharply from an estimated 1.4 million units in 1978. In this first quarter of 1980, the demand for single-chip microcomputers continues to be very strong. It appears that all the major users of microcomputers, including the toy and games, automobile, instrument, and terminal manufacturers, have expanded their requirements for single-chip microcomputers in 1980. Lead times are still generally beyond twenty weeks for these ROM-based products and prices remain relatively firm in this first quarter of 1980. The 8-bit microcomputers are generally in the $7.00 to $9.00 range for first and second quarter deliveries. However, some very high volumes (200,000 units) have been quoted as low as $5.00.

4-BIT MICROPROCESSORS

Table 4 presents DATAQUEST's estimates of worldwide shipments of 4-bit microprocessors. In the fourth quarter of 1979, shipments of these products were for an estimated 17.7 million units, up about 20 percent over third quarter of 1979. For the year 1979, total 4-bit microprocessor shipments were an estimated 50.4 million units, up from 16.3 million units in 1978.

In this first quarter of 1980, pricing on the 4-bit microcomputers generally remains firm in the $1.50 to $3.50 range for large volume purchases. However, some of the newer devices on the market are not quite as low priced: for example, the S2000 family is generally priced in the $4.00 to $6.00 range for 10,000 unit quantities, whereas the 141000, a CMOS product, is priced in the $7.00 to $9.00 range. Several of the 4-bit microcomputer families contain 10 to 20 distinct products differing in memory size, package size, and technology. Prices for devices at the high end of the family are often two or three times the prices of devices at the low end of the line.

8-BIT MICROPROCESSORS

Worldwide shipments of 8-bit microprocessors in the fourth quarter of 1979 were an estimated 8.4 million units, up about 20 percent, over estimated third quarter shipments and up about 211 percent over estimated fourth quarter 1978 shipments (see Table 5). Eight-bit single-chip microcomputers are playing an increasingly important role in the overall 8-bit market. Over the four quarters of 1979, 8-bit microcomputers increased their share of the total 8-bit products from 30 percent in the first quarter, to 39 percent in the second quarter, 42 percent in the third quarter, and 46 percent in the fourth quarter.

Mature 8-bit microprocessors scheduled for delivery in the first half of 1980 are currently priced in the $3.75 to $6.50 range. These prices have fallen slightly from those of late 1979 and reflect some softness in the microprocessor market. Lead times in the various 8-bit microprocessor families are generally less than five weeks.

12- AND 16-BIT MICROPROCESSORS

Table 6 presents estimates of worldwide shipments of 12- and 16-bit microprocessors. Shipments of 12-bit microprocessors were an estimated 12,000 units in the fourth quarter, the same as the third quarter total. This market still has not moved significantly and is not expected to ever be a major microprocessor market.

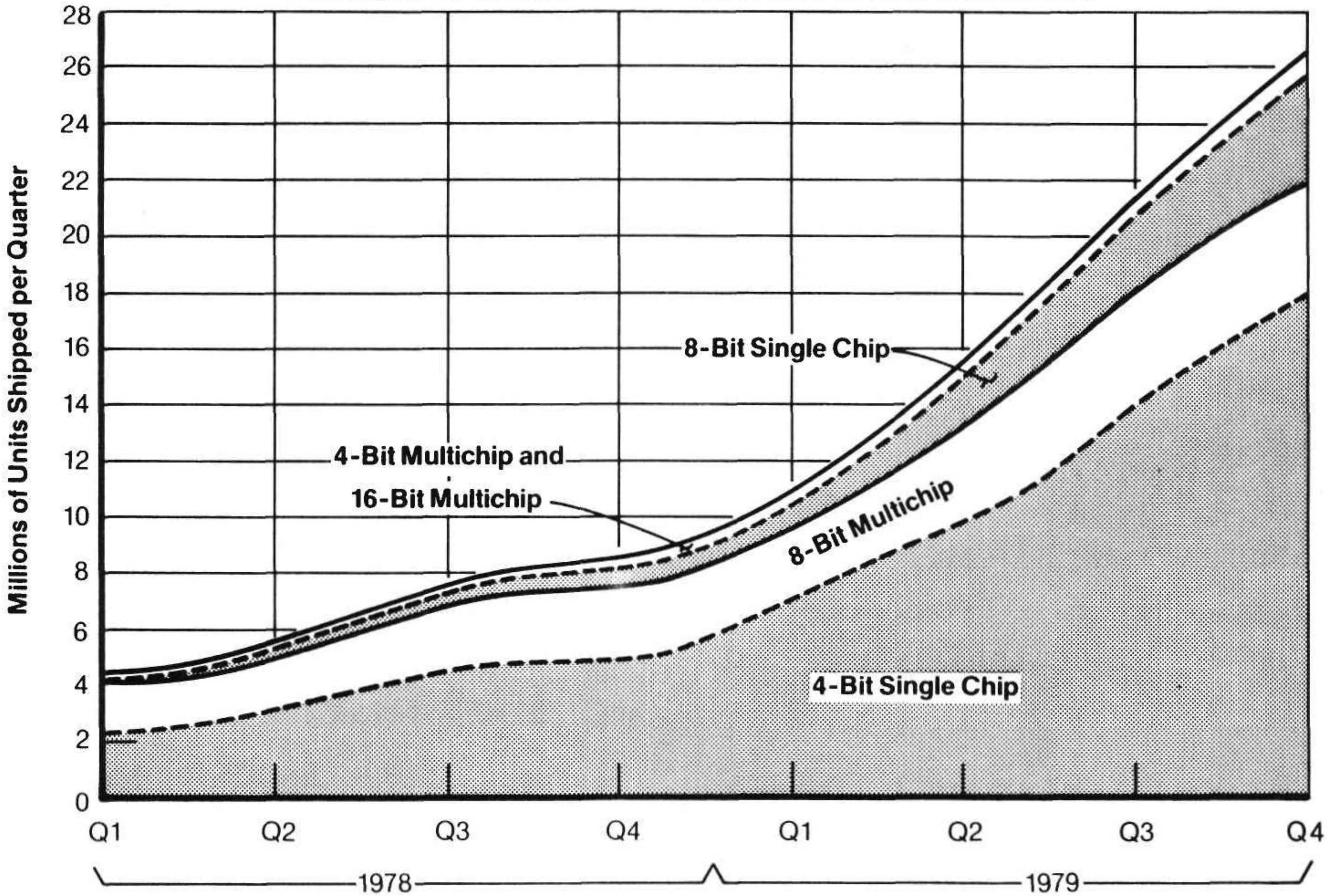
Worldwide shipments of 16-bit microprocessors in the fourth quarter of 1979 were an estimated 203,000 units, up about 27 percent over estimated third quarter 1979 shipments of 160,000 units and up 92 percent over estimated fourth quarter 1978 shipments. For 1979, total 16-bit microprocessor shipments were an estimated 625,000 units.

Current pricing on most 16-bit microprocessors has remained relatively stable since fourth quarter of 1979. The TMS-9980 is currently available for about $12.00 in large volumes, whereas the TMS-9900 is priced in the range of $20.00 to $25.00. The newer 16-bit products, such as the 8086, are priced in the $60.00 to $90.00 range whereas the Z8000 and 68000 are currently priced in the $150.00 to $250.00 range. These prices are expected to decline over the coming quarters as shipments increase.

Daniel L. Klesken
Lane Mason

Figure 1

ESTIMATED WORLDWIDE MICROPROCESSOR SHIPMENTS



Source: DATAQUEST, Inc.

Table 1

ESTIMATED WORLDWIDE SHIPMENTS OF MOS MICROPROCESSORS
(Thousands of Units)

Company	Microprocessor	Bits	MOS Process	1978 4th Qtr.	1978 Total	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.	1979 4th Qtr.	1979 Total
AMD	8080A	8	N	125	435	135	325	335	285	1,080
	8085	8	N	5	5	15	40	75	70	200
	8048	8	N	0	0	S[1]	S	3	20	23
	Z8000	16	N	0	0	0	S	S	S	S
AMI	S2000	4	N	12	29	50	300	675	400	1,425
	6800	8	N	35	130	35	30	30	40	135
	6802/6808	8	N	0	0	S	10	10	30	50
	9900	16	N	0	0	0	0	S	5	5
EFCIS	6800	8	N	0	0	8	10	12	15	45
Fairchild	F8	8	N	200	630	150	200	275	260	885
	3870	8	N	10	23	40	50	120	300	510
	6800	8	N	30	90	35	35	40	40	150
	6802/6808	8	N	S	S	S	S	15	30	45
General Instrument	PIC-1650	8	N	175	450	300	950	1,250	1,600	4,100
	CP-1600	16	N	15	60	15	20	20	25	80
Harris	6100	12	C	7	22	7	7	7	7	28
Hitachi	HMCS-40	4	P&C	120	410	130	150	175	200	655
	6800	8	N	25	70	50	100	125	150	425
Hughes	1802	8	C	12	35	12	14	18	22	66
Intel	4004	4	P	35	159	35	32	28	25	120
	8008	8	P	22	103	20	18	15	12	65
	8080A	8	N	190	705	190	200	210	180	780
	8048/8021	8	N	170	480	210	300	450	550	1,510
	8049/8022	8	N	10	10	20	40	70	100	230
	8748	8	N	25	30	50	75	75	100	300
	8085	8	N	125	350	175	260	300	350	1,085
	8086	16	N	13	24	13	15	19	25	72
Intersil	6100	12	C	4	15	4	4	5	5	18
Matsushita	MN1400	4	N,P&C	N/A[2]	N/A	500	800	1,400	1,700	4,400
MOS Technology	6500	8	N	60	225	65	70	80	90	305
Mostek	F8	8	N	45	160	90	125	125	130	470
	Z80	8	N	80	260	100	120	125	170	515
	3870	8	N	205	350	260	300	425	485	1,470
Motorola	141000	4	C	15	20	30	75	90	90	285
	6800	8	N	160	570	165	175	215	205	760
	6801/6803	8	N	0	0	0	S	3	10	13
	6802/6808	8	N	90	180	150	240	275	325	990
	6805	8	N	0	0	0	0	S	3	3
	6809	8	N	0	0	S	2	8	10	20
	3870	8	N	40	70	80	125	125	170	500
	68000	16	N	0	0	0	0	S	3	3
National	COPS	4	N&C	850	2,325	900	1,100	1,500	2,100	5,600
	4004	4	P	30	130	30	26	20	15	91
	IMP	4	P	20	80	18	15	15	15	63
	8080A	8	N	100	375	150	175	220	240	785
	8048	8	N	0	0	0	0	0	S	S
	8049	8	N	0	0	0	0	S	10	10
	8050	8	N	0	0	0	0	0	S	S
	8070	8	N	0	0	0	0	0	S	S
	SC/MP	8	N	100	335	100	140	160	175	575
	PACE	16	N	25	86	25	25	25	25	100
NEC	COM-4	4	N,P&C	600	1,500	1,100	1,300	2,300	3,100	7,800
	8080A	8	N	60	305	65	90	105	100	360
	8048/8049	8	N	15	15	25	160	350	450	985
	8085	8	N	25	30	55	75	120	150	400
	Z80	8	N	25	30	80	80	60	40	260
	768	16	N	0	0	S	S	S	S	S
RCA	1802	8	C	90	325	115	115	125	135	490
Rockwell	PPS-4	4	P	650	2,275	600	1,100	1,100	1,100	3,900
	6500	8	N	60	595	50	60	60	60	230
	6500/1	8	N	0	0	0	S	3	5	8
Siemens	8080A	8	N	0	0	3	10	25	40	78
	8085	8	N	0	0	0	S	5	10	15
Signetics	2650	8	N	45	125	45	90	110	110	355
	8048	8	N	S	S	15	30	60	75	180
Solid State Scientific	1802	8	C	10	22	10	11	12	10	43
Synertek	6500	8	N	70	680	100	120	280	300	800
Texas Instruments	TMS 1000	4	P&C	3,200	9,400	4,200	5,400	7,500	9,000	26,100
	TMS 8080A	8	N	35	135	32	25	18	5	80
	TMS 9900	16	N	53	185	68	80	92	105	345
	TMS 9940	16	N	0	0	0	S	S	5	5
Thomson - CSF	6800	8	N	7	25	0	0	0	0	0
Zilog	Z8	8	N	0	0	0	S	S	S	S
	Z80	8	N	210	550	195	250	425	700	1,570
	Z8000	16	N	0	0	0	1	4	10	15
Total Microprocessors				8,340	25,628	11,120	15,695	21,922	26,327	75,064
Percent change from previous quarter						33%	41%	40%	20%	

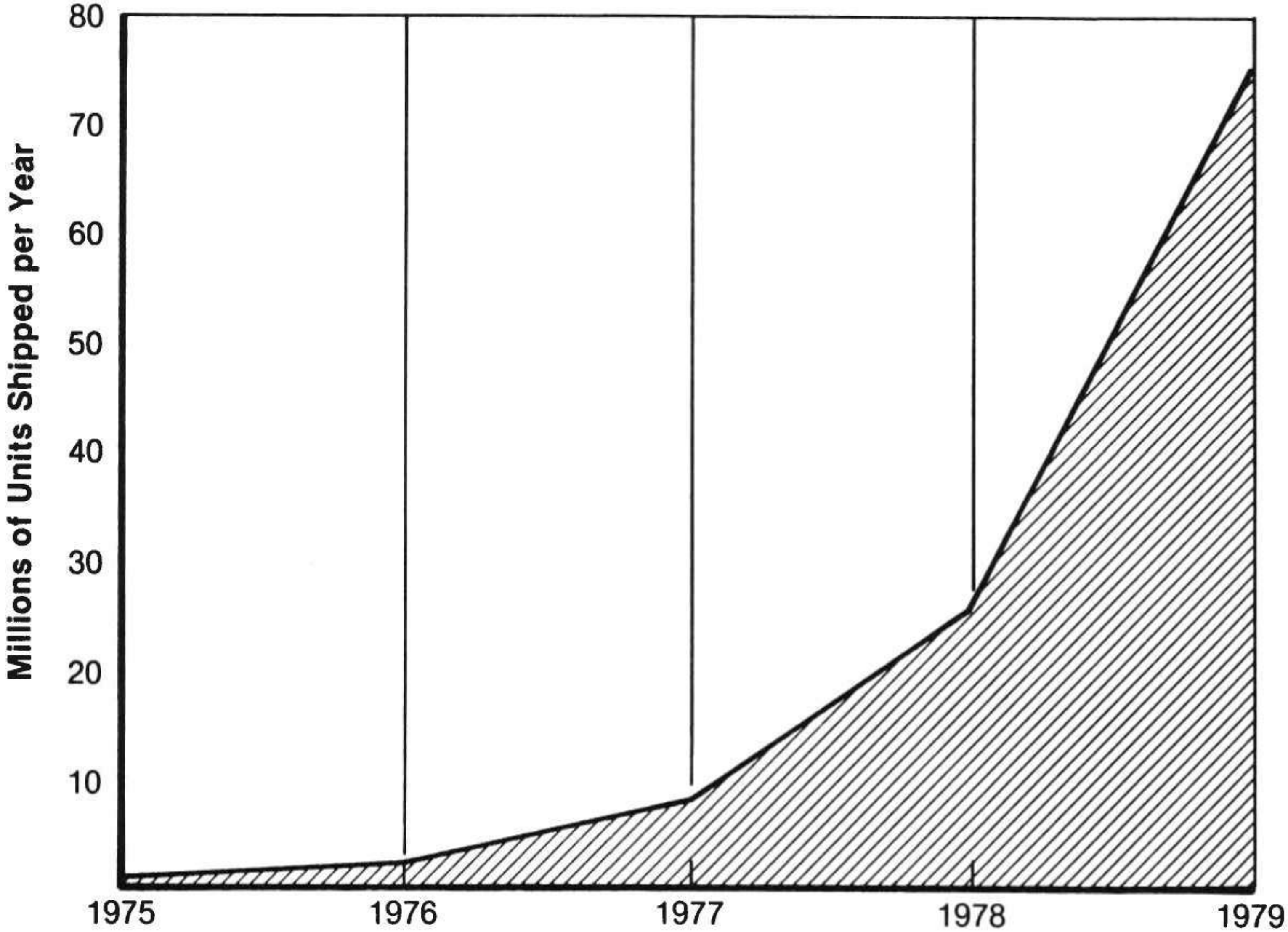
[1]S = Sampling

[2]N/A = Not Available

Source: DATAQUEST, Inc.
February 1980

Figure 2

ESTIMATED WORLDWIDE MICROPROCESSOR SHIPMENTS



Source: DATAQUEST, Inc.

Table 2

ESTIMATED WORLDWIDE SHIPMENTS OF 4-BIT SINGLE-CHIP MICROCOMPUTERS

(Thousands of Units)

		1978		1979				
Company	Microcomputer	4th Qtr.	1978 Total	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1979 Total
AMI	S2000	12	29	50	300	675	400	1,425
Hitachi	HMCS-40	120	410	130	150	175	200	655
Matsushita	MN1400	N/A[1]	N/A	500	800	1,400	1,700	4,400
Motorola	141000	15	20	30	75	90	90	285
National	COPS	850	2,325	900	1,100	1,500	2,100	5,600
NEC	COM-4	600	1,500	1,100	1,300	2,300	3,100	7,800
Rockwell	PPS-4	650	2,275	600	1,100	1,100	1,100	3,900
Texas Instruments	TMS1000	3,200	9,400	4,200	5,400	7,500	9,000	26,100
Total		5,447	15,959	7,510	10,225	14,740	17,690	50,165
Change from previous quarter				38%	36%	44%	20%	

[1]N/A = Not Available

Source: DATAQUEST, Inc.
February 1980

Table 3

ESTIMATED WORLDWIDE SHIPMENTS OF 8-BIT SINGLE-CHIP MICROCOMPUTERS

(Thousands of Units)

		1978		1979				
Company	Microcomputer	4th Qtr.	1978 Total	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1979 Total
AMD	8048	0	0	S[1]	S	3	20	23
Fairchild	3870	10	23	40	50	120	300	510
General Instrument	PIC-1650	175	450	300	950	1,250	1,600	4,100
Intel	8048/8021	170	480	210	300	450	550	1,510
	8049/8022	10	10	20	40	70	100	230
	8748	25	30	50	75	75	100	300
Mostek	3870	205	350	260	300	425	485	1,470
Motorola	6801	0	0	0	S	3	10	13
	6805	0	0	0	0	S	3	3
	3870	40	70	80	125	125	170	500
National	8048	0	0	0	0	0	S	S
	8049	0	0	0	0	S	10	10
	8050	0	0	0	0	0	S	S
	8070	0	0	0	0	0	S	S
NEC	8048/8049	15	15	25	160	350	450	985
Rockwell	6500/1	0	0	S	S	3	5	8
Signetics	8048	S	S	15	30	60	75	180
Zilog	Z8	0	0	0	S	S	S	S
Total		650	1,428	1,000	2,030	2,934	3,878	9,842
Change from previous quarter				54%	103%	46%	32%	

[1]S = Sampling

Source: DATAQUEST, Inc.
February 1980

Table 4

ESTIMATED WORLDWIDE SHIPMENTS OF 4-BIT MICROPROCESSORS

(Thousands of Units)

Company	Microprocessor	1978 4th Qtr.	1978 Total	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.	1979 4th Qtr.	1979 Total
AMI	S2000	12	29	50	300	675	400	1,425
Hitachi	HMCS-40	120	410	130	150	175	200	655
Intel	4004	35	159	35	32	28	25	120
Matsushita	MN1400	N/A[1]	N/A	500	800	1,400	1,700	4,400
Motorola	141000	15	20	30	75	90	90	285
National	COPS	850	2,325	900	1,100	1,500	2,100	5,600
	4004	30	130	30	26	20	15	91
	IMP	20	80	18	15	15	15	63
NEC	COM-4	600	1,500	1,100	1,300	2,300	3,100	7,800
Rockwell	PPS-4	650	2,275	600	1,100	1,100	1,100	3,900
Texas Instruments	TMS 1000	3,200	9,400	4,200	5,400	7,500	9,000	26,100
Total		5,532	16,328	7,593	10,298	14,803	17,745	50,439
Percent change from previous quarter				37%	36%	44%	20%	

[1] N/A = Not Available

Source: DATAQUEST, Inc.
February 1980

Table 5

ESTIMATED WORLDWIDE SHIPMENTS OF 8-BIT MICROPROCESSORS

(Thousands of Units)

		1978		1979				
Company	Microprocessor	4th Qtr.	1978 Total	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1979 Total
AMD	8080A	125	435	135	325	335	285	1,080
	8085	5	5	15	40	75	70	200
	8048	0	0	S	S	3	20	23
AMI	6800	35	130	35	30	30	40	135
	6802/6808	0	0	S	10	10	30	50
EFCIS	6800	0	0	8	10	12	15	45
Fairchild	F8	200	630	150	200	275	260	885
	3870	10	23	40	50	120	300	510
	6800	30	90	35	35	40	40	150
	6802/6808	S	S	0	S	15	30	45
General Instrument	PIC-1650	175	450	300	950	1,250	1,600	4,100
Hitachi	6800	25	70	50	100	125	150	425
Hughes	1802	12	35	12	14	18	22	66
Intel	8008	22	103	20	18	15	12	65
	8080A	190	705	190	200	210	180	780
	8048/8021	170	480	210	300	450	550	1,510
	8049/8022	10	10	20	40	70	100	230
	8748	25	30	50	75	75	100	300
	8085	125	350	175	260	300	350	1,085
MOS Technology	6500	60	225	65	70	80	90	305
Mostek	F8	45	160	90	125	125	130	470
	Z80	80	260	100	120	125	170	515
	3870	205	350	260	300	425	485	1,470
Motorola	6800	160	570	165	175	215	205	760
	6801/6803	0	0	0	S	3	10	13
	6802/6808	90	180	150	240	275	325	990
	6805	0	0	0	0	S	3	3
	6809	0	0	S	2	8	10	20
	3870	40	70	80	125	125	170	500
National	8080A	100	375	150	175	220	240	785
	8048	0	0	0	0	0	S	S
	8049	0	0	0	0	S	10	10
	8050	0	0	0	0	0	S	S
	8070	0	0	0	0	0	S	S
	SC/MP	100	335	100	140	160	175	575
NEC	8080A	60	305	65	90	105	100	360
	8048/8049	15	15	25	160	350	450	985
	8085	25	30	55	75	120	150	400
	Z80	25	30	80	80	60	40	260
RCA	1802	90	325	115	115	125	135	490
Rockwell	6500	60	595	50	60	60	60	230
	6500/1	0	0	0	S	3	5	8
Siemens	8080A	0	0	3	10	25	40	78
	8085	0	0	0	S	5	10	15
Signetics	2650	45	125	45	90	110	110	355
	8048	S	S	15	30	60	75	180
Solid State Scientific	1802	10	22	10	11	12	10	43
Synertek	6500	70	680	100	120	280	300	800
Texas Instruments	TMS 8080A	35	135	32	25	18	5	80
Thomson - CSF	6800	7	25	0	0	0	0	0
Zilog	Z8	0	0	0	S	S	S	S
	Z80	210	550	195	250	425	700	1,570
Total		2,691	8,908	3,395	5,245	6,947	8,367	23,954
Percent change from previous quarter	..			26%	54%	32%	20%	

[1]S = Sampling

Source: DATAQUEST, Inc.
February 1980

Table 6

ESTIMATED WORLDWIDE SHIPMENTS OF 12-BIT AND 16-BIT MICROPROCESSORS

(Thousands of Units)

12-Bit Products		1978		1979				
Company	Microprocessor	4th Qtr.	1978 Total	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1979 Total
Harris	6100	7	22	7	7	7	7	28
Intersil	6100	4	15	4	4	5	5	18
Total		11	37	11	11	12	12	46
Percent change from previous quarter				0%	0%	9%	0%	

16-Bit Products		1978		1979				
Company	Microprocessor	4th Qtr.	1978 Total	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	1979 Total
AMD	Z8000	0	0	0	S[1]	S	S	S
AMI	9900	0	0	0	0	S	5	5
General Instrument	CP-1600	15	60	15	20	20	25	80
Intel	8086	13	24	13	15	19	25	72
Motorola	68000	0	0	0	0	S	3	3
National	PACE	25	86	25	25	25	25	100
NEC	768	0	0	S	S	S	S	S
Texas Instruments	TMS 9900	53	185	68	80	92	105	345
	TMS 9940	0	0	0	S	S	5	5
Zilog	Z8000	0	0	0	1	4	10	15
Total		106	355	121	141	160	203	625
Percent change from previous quarter				14%	17%	13%	27%	

[1] S = Sampling

Source: DATAQUEST, Inc.
February 1980

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DYNAMIC AND STATIC MOS RAM AND EPROM SHIPMENTS

SUMMARY

In the fourth quarter of 1979, worldwide shipments of 16K dynamic MOS RAMs increased to an estimated 26 million units, up about 38 percent over an estimated 18.9 million units shipped in the third quarter of 1979. The total for the year 1979 was an estimated 69.7 million units, up about 236 percent over the 20.8 million units shipped in 1978. Demand for these devices still exceeds available supply with prices currently in the $5.25 to $5.75 range for plastic packages. CERDIP packages command a $0.25 to $0.50 price premium over plastic.

The availability of 64K dynamic MOS RAMs is still quite limited; in the fourth quarter, five suppliers shipped an estimated 9,500 units. Total shipments for the year 1979 were an estimated 16,300 units. Prices for these small quantity shipments are in the range of $100 to $150.

Worldwide shipments of 4K dynamic MOS RAMs declined sharply to an estimated 14.4 million units, down about 19 percent from an estimated 17.8 million units in the third quarter of 1979. Total shipments for the year 1979 were an estimated 69.3 million units, just slightly less than the 69.7 million 16K dynamic MOS RAMs shipped in 1979. Prices remained firm in the $2.00 range with some quotes as high as $2.50.

Fourth quarter shipments of slow 4K NMOS static RAMs reached an estimated 11.0 million units up about 5 percent over estimated third quarter 1979 shipments. Shipments of fast 4K NMOS static RAMs were an estimated 1.4 million units, up from an estimated 968,000 units in the third quarter, but just slightly above second quarter shipments of 1.3 million units. Shipments of 4K CMOS static RAMs increased to an estimated 2.0 million units in the fourth quarter of 1979, up about 15 percent from an estimated 1.7 million units shipped in the third quarter of 1979. Availability of slow and fast NMOS as well as CMOS static 4K RAMs has improved since our last DATAQUEST Research Newsletter dated 16 November 1979. Lead times for most of these products are under eight weeks.

Fourth quarter shipments of 8K EPROMs declined to an estimated 5.0 million units, down about 5 percent from an estimated 5.3 million units in the third quarter. Prices are in the $5.25 to $5.50 range with lead times under 4 weeks. Worldwide shipments of 16K EPROMs were up sharply to an estimated 4.9 million units, which is up about 46 percent over an estimated 3.3 million units shipped in the third quarter of 1979. Prices for the 2716 devices have softened as more supply has become available. Prices currently range from $16.00 to $20.00 for plastic parts. These devices are now available on most distributor shelves. Fourth quarter shipments of 32K EPROMs from five different suppliers were estimated to be 190,000 units.

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DYNAMIC MOS RAMS

16K RAMs

DATAQUEST estimates of worldwide 16K dynamic MOS RAM shipments are presented in Table 1. We estimate that the merchant market suppliers of this device shipped an estimated 26.0 million units in the fourth quarter of 1979. This is up about 38 percent over an estimated 18.7 million units in the third quarter of 1979 and up a dramatic 223 percent over an estimated 8.0 million units shipped in the fourth quarter of 1978.

These estimates also include 16K chips which were shipped in two-chip hybrid packages as 32K dynamic RAMs to IBM and other users. Two types of hybrid packages currently exist. One is the so-called piggy-back version with one dual-in-line package riding on top of another. The other is the so-called camel-back version with two small chip carriers, each containing a 16K chip on top of an 18-pin ceramic side-brazed package.

Currently, demand for 16K dynamic RAMs is extremely strong. DATAQUEST has conducted an informal survey of 16K RAM demand for 1980 and has found the demand to be approximately 205 million units, whereas currently projected supply is about 175 million units. This disparity explains why most suppliers of 16K RAMs are essentially fully committed for 1980.

Current prices of 16K RAMs are in the $5.25 to $5.75 range for plastic packages and $0.25 to $.50 higher for CERDIP packages. The recent dramatic increase in the price of gold has resulted in a gold adder for ceramic side-brazed packages of $1.00 to $2.00 on top of the $1.00 to $3.00 premium that this package already had over the plastic package.

The European market for 16K RAMs has softened since the third quarter of 1979 as several Japanese suppliers have been very aggressively marketing large quantities of 16K RAMs at very competitive prices. Key customers in Europe are able to receive 50,000 devices in 4 to 6 weeks. In Europe, high volume pricing on plastic parts is in the $5.50 range, whereas the overall average selling price for plastic is closer to $6.00.

The rapid growth of unit shipments of 16K dynamic RAMs is graphically illustrated in Figure 1. Also shown in that figure is the market share of the U.S., Japanese, and European companies.

32K RAMS

Mostek remains the only supplier shipping 32K dynamic RAMs into the merchant market. The company shipped an estimated 100,000 units in the fourth quarter with prices in the $16.00 to $18.00 range. Intel, Motorola, and Texas Instruments are not actively marketing their 32K piggy-back hybrids into the market. Instead, they are shipping them directly to IBM. These shipments are included in the overall estimates for the companies in Table 1.

64K RAMS

At year end 1979, there were five suppliers sampling 64K RAMs: Fujitsu, Hitachi, Mitsubishi, Motorola, and Texas Instruments. Estimated shipments of these suppliers are presented in Table 2. In the fourth quarter, they shipped an estimated

9,500 units, up from 5,000 units in the third quarter. For the year 1979, an estimated 16,300 units were shipped. The current suppliers are finding the 64K RAM an extremely difficult device to manufacture; hence, the limited shipments and the absence of additional suppliers.

4K RAMS

DATAQUEST estimates of 4K dynamic MOS RAMs shipments are presented in Table 3. In the fourth quarter of 1979, worldwide shipments declined sharply to an estimated 14.4 million units, down about 19 percent from an estimated 17.8 million units shipped in the third quarter. This was the first dramatic decline in quarterly shipments after relatively small declines (less than 4 percent) in each of the previous four quarters. Most suppliers have de-emphasised this product because they are limited in wafer-start capacity and are shifting that capacity to the 16K dynamic RAMs, 64K dynamic RAMs, and other memory products. Prices remain firm in the $2.00 range, with some as high as $2.50. Lead times have shortened somewhat to range between 12 and 16 weeks.

STATIC MOS RAMS

4K RAMS

Table 4 presents DATAQUEST estimates of slow 4K NMOS static RAM shipments in the fourth quarter of 1979. Merchant market suppliers shipped an estimated 11.0 million units, which is up about 5 percent over an estimated 10.4 million units shipped in the third quarter of 1979. In the fourth quarter of 1979 the suppliers shipped an estimated 7.5 million 1Kx4 static RAMs and an estimated 3.5 million 4Kx1 static RAMs. The 1Kx4 type represented 68 percent of the total, compared to 70 percent of the third quarter total. Prices for these slow 4K static devices have softened to the $3.50 range. Currently lead times have shrunk to about 2 to 8 weeks and the parts are generally available off distributor shelves.

Table 5 presents DATAQUEST estimates of worldwide shipments of fast 4K NMOS static RAMs. In the fourth quarter, an estimated 1.4 million units were shipped, up about 42 percent over an estimated 968,000 units shipped in the third quarter. Note that Intel's shipments in the fourth quarter include an estimated 60,000 2148 (1Kx4) devices. Prices for these products softened late in 1979 and in the first quarter 1980 as the number of supplies increased to eleven, up sharply from four in the first quarter of 1979. Some quotes have been as low as $12.00, but most pricing is in the $15.00 range. The large number of suppliers and the more limited number of sockets for 2147s has shortened lead times to under eight weeks.

Table 6 presents our estimates of 4K CMOS static RAM shipments. In the fourth quarter an estimated 2.0 million units were shipped, up about 15 percent from an estimated 1.7 million units shipped in the third quarter. Lead times are under ten weeks, with prices in the $10.00 to $13.00 range for shipments in the first and second quarter of 1980.

8K RAMS

EMM and Mostek remain the only suppliers shipping static 8K RAMs. EMM continues to sample its 1Kx8 device, while Mostek shipped an estimated 150,000 1Kx8 slow NMOS static RAMs in the fourth quarter of 1979. Prices for these devices are currently in the $10.00 to $12.00 range.

16K RAMS

The first of the 16K CMOS static RAMs were sampled in the fourth quarter of 1979 by Toshiba. Additional suppliers are expected in the coming quarters.

EPROMS

8K EPROMS

Table 7 presents DATAQUEST's estimated worldwide shipments of 8K EPROMs. In the fourth quarter of 1979, an estimated 50 million units were shipped, down about 5 percent from an estimated 5.3 million units in the third quarter. Prices have declined slightly from the fourth quarter and are in the $5.25 to $5.75 range. Lead times have shortened significantly to under four weeks from the suppliers and immediate availability off the distributors' shelves.

16K EPROMS

Table 8 presents our estimates of worldwide shipments of 16K EPROMs. An estimated 4.9 million units were shipped in the fourth quarter of 1979, up from an estimated 3.3 million units shipped in the third quarter of 1979. As availability of these devices has improved in the fourth quarter and into the first quarter of 1980, prices have softened and are now in the $15.00 to $20.00 range. Lead times have shrunk to under four weeks for most suppliers and immediate availability off most distributors' shelves.

32K EPROMS

Table 9 presents our estimates of worldwide shipments of 32K EPROMs. Fourth quarter shipments of 190,000 units are up from an estimated 110,000 units in the third quarter. Prices are in the $50.00 to $75.00 range for the limited quantities being shipped.

64K EPROMS

The first of the 64K EPROMs were sampled in the fourth quarter of 1979. Texas Instruments sampled its 2564 EPROM in a 28-pin package. Prices for these initial small quantities are in the $200.00 range.

Daniel L. Klesken
Lane Mason

Table 1

ESTIMATED WORLDWIDE SHIPMENTS OF 16K DYNAMIC MOS RAMS[1]
(Thousands of Units)

Company	1978 4th Qtr.	1978 Year	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.	1979 4th Qtr.	1979 Year
AMD	S[2]	S[2]	S	5	10	50	65
Fairchild	200	465	300	400	500	700	1,900
Fujitsu	900	2,000	1,100	1,300	1,600	2,000	6,000
Hitachi	500	1,210	800	1,400	2,200	2,700	7,100
Intel[3]	900	2,400	600	700	950	1,000	3,250
Intersil	S	S	S	5	5	0	10
ITT	100	203	200	300	600	600	1,700
Matsushita	0	0	0	0	S	S	S
Mostek	1,800	4,900	2,400	3,600	4,800	6,000	16,800
Motorola	500	1,750	700	1,200	1,000	1,800	4,700
National	150	287	250	450	1,000	1,500	3,200
NEC	1,300	3,850	1,700	2,200	3,200	4,200	11,300
Siemens	40	85	100	150	250	375	875
Signetics	80	140	75	40	50	10	175
Texas Instruments	1,400	3,150	1,800	2,200	1,800	3,200	9,000
Toshiba	150	285	225	550	900	1,800	3,475
Zilog	20	60	20	50	50	70	190
Total	8,040	20,785	10,270	14,550	18,915	26,005	69,740
Percent Change From Previous Quarter	35.1%		27.7%	41.7%	30.0%	37.5%	

[1] Includes merchant market and internal shipments

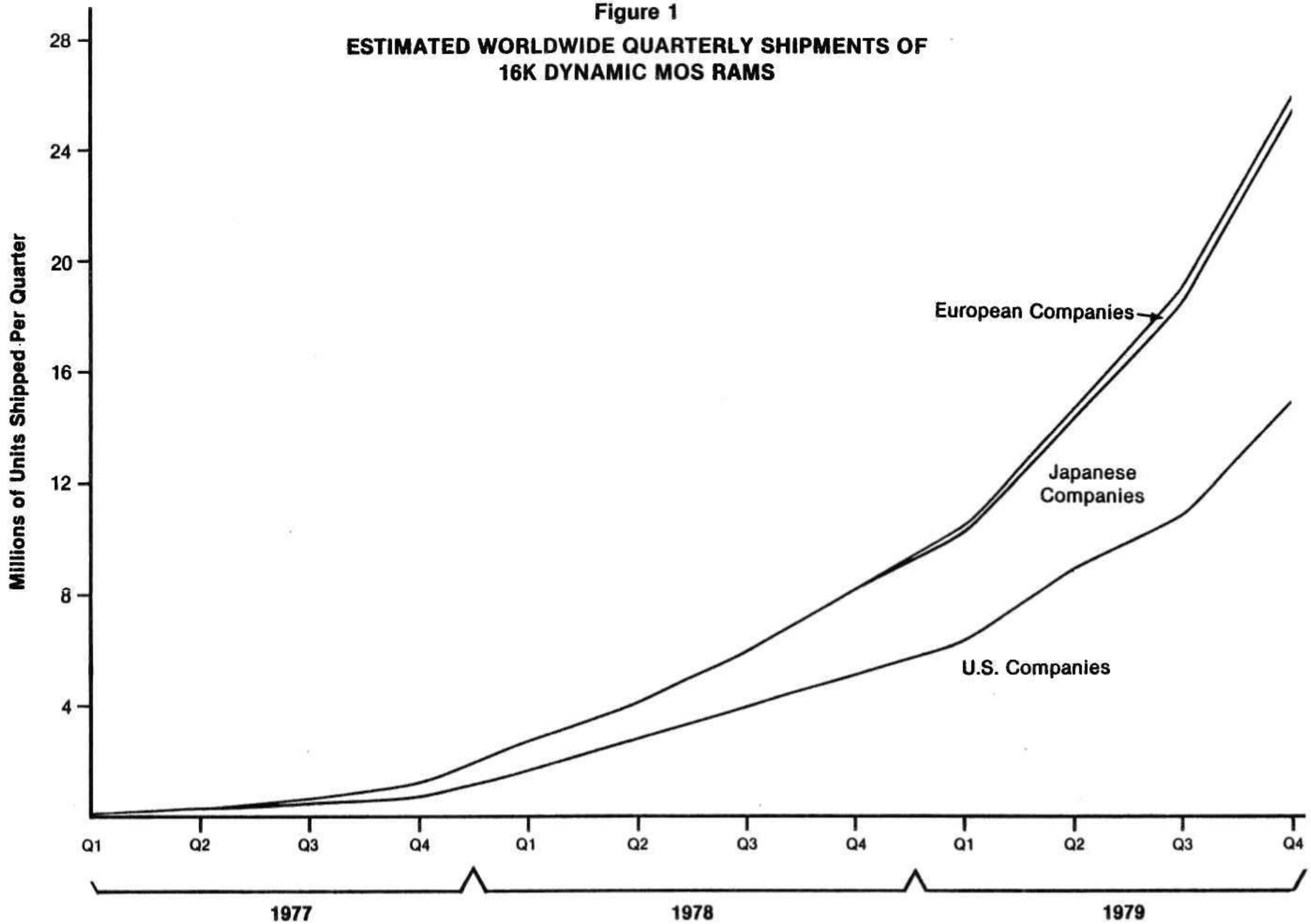
[2] Indicates sampling

[3] Includes an estimated 50,000 5-volt only parts in the third quarter and an estimated 80,000 5-volt only parts in the fourth quarter of 1979

Source: DATAQUEST, Inc.
February 1980

Figure 1

ESTIMATED WORLDWIDE QUARTERLY SHIPMENTS OF
16K DYNAMIC MOS RAMS



Source: DATAQUEST, Inc.

Table 2

ESTIMATED WORLDWIDE SHIPMENTS OF 64K DYNAMIC MOS RAMS
(Thousands of Units)

Company	1979 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year
Fujitsu[1]	S[2]	0.4	1.0	2.5	3.9
Hitachi	0	0	S	S	S
Mitsubishi	0	0	0	S	S
Motorola	S	1.0	3.0	6.0	10.0
Texas Instruments	S	0.4	1.0	1.0	2.4
Total	S	1.8	5.0	9.5	16.3

[1]Shipping devices using +7 and -2 Volt power supply.
Other suppliers shipping 5-volt only devices

[2]Indicates sampling

Source: DATAQUEST, Inc.
February 1980

Table 3

ESTIMATED WORLDWIDE SHIPMENTS OF 4K DYNAMIC MOS RAMS[1]
(Thousands of Units)

Company	1978 4th Qtr.	1978 Year	1979 1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year
AMD	2,200	6,600	2,600	3,000	3,000	1,600	10,200
Fairchild	0	900	0	0	0	0	0
Fujitsu	300	1,900	200	200	200	150	750
Hitachi	450	1,780	350	200	200	100	850
Intel	2,300	11,000	1,700	1,700	1,500	1,200	6,100
Intersil	100	450	100	100	300	500	1,000
ITT	800	1,600	1,100	1,300	1,300	1,500	5,200
Mostek	4,200	17,000	3,800	3,300	3,400	3,600	14,100
Motorola	1,900	5,700	1,500	1,150	1,800	2,000	6,450
National	1,700	5,600	2,000	2,400	2,000	1,500	7,900
NEC	1,350	6,150	1,350	1,900	1,300	1,000	5,550
Signetics	300	1,150	300	100	50	10	460
Texas Instruments	3,800	16,700	3,600	3,200	2,700	1,200	10,700
Total	19,400	76,530	18,600	18,550	17,750	14,360	69,260
Percent Change From Previous Quarter	(0.5%)		(4.1%)	(0.3%)	(4.3%)	(19.1%)	

[1]Includes merchant market and internal shipments

Source: DATAQUEST, Inc.
February 1980

Table 4

ESTIMATED 1979 WORLDWIDE SHIPMENTS OF SLOW 4K NMOS STATIC RAMS
(Thousands of Units)

Company	1st Quarter 1Kx4	1st Quarter 4Kx1	2nd Quarter 1Kx4	2nd Quarter 4Kx1	3rd Quarter 1Kx4	3rd Quarter 4Kx1	4th Quarter 1Kx4	4th Quarter 4Kx1	Year 1Kx4	Year 4Kx1
AMD	150	30	275	75	330	140	420	220	1,175	465
AMI	50	0	55	0	95	0	50	0	250	0
EMM	600	500	600	600	700	650	700	700	2,600	2,450
Fairchild	50	0	100	0	300	0	400	0	850	0
Fujitsu	80	0	150	0	250	0	100	0	580	0
Hitachi	450	0	450	0	450	0	450	0	1,800	0
Intel	400	400	600	600	850	100	800	200	2,650	1,300
Intersil	200	100	230	130	250	150	200	250	880	630
Matsushita	0	0	20	0	50	0	75	0	145	0
MOS Technology	5	0	25	0	100	0	175	0	305	0
Mostek	0	450	0	600	0	900	0	1,000	0	2,950
Motorola	270	30	320	20	450	30	300	50	1,340	130
National	530	120	900	190	900	200	1,100	400	3,430	910
NEC	400	600	600	450	800	400	1,000	300	2,800	1,750
Synertek	560	0	600	0	900	0	1,000	0	3,060	0
Texas Instruments	500	500	500	500	550	450	350	350	1,900	1,800
Toshiba	150	0	210	0	300	0	350	0	1,010	0
Zilog	0	110	0	110	0	150	0	45	0	415
Total	4,395	2,840	5,635	3,275	7,275	3,170	7,470	3,515	24,775	12,800
Percent Change From Previous Quarter			28.2%	15.3%	29.1%	(3.2%)	2.7%	10.9%		

Source: DATAQUEST, Inc.
February 1980

Table 5

ESTIMATED 1979 WORLDWIDE SHIPMENTS OF FAST 4K NMOS STATIC RAMS
(Thousands of Units)

	1979				
Company	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year
AMI	5	10	5	5	25
Fujitsu	0	S[1]	15	60	75
Hitachi	0	0	S	S	S
Intel[2]	800	1,200	650	900	3,550
Intersil	0	0	3	20	23
Mostek	0	0	0	S	S
Motorola	S	10	20	50	80
National	0	10	25	65	100
NEC	25	70	250	250	595
Texas Instruments	0	0	0	5	5
Toshiba	0	0	S	15	15
Total	830	1,300	968	1,370	4,468
Percent Change From Previous Quarter		56.6%	(25.5%)	41.5%	

[1]Indicates Sampling

[2]Includes an estimated 25,000 2148 (1Kx4) devices in 3rd quarter and 60,000 2148 devices in 4th quarter

Source: DATAQUEST, Inc.
February 1980

Table 6

ESTIMATED 1979 WORLDWIDE SHIPMENTS OF 4K CMOS STATIC RAMS
(Thousands of Units)

	1st Quarter		2nd Quarter		3rd Quarter		4th Quarter		Year	
	1Kx4	4Kx1	1Kx4	4Kx1	1Kx4	4Kx1	1Kx4	4Kx1	1Kx4	4Kx1
Harris	25	15	40	30	100	100	125	125	290	270
Hitachi[1]	0	50	0	175	0	325	0	500	0	1,050
Motorola	0	0	0	0	S[2]	0	S	0	S	0
National	0	0	0	0	S	S	5	5	5	5
NEC	100	0	270	0	450	0	500	0	1,320	0
RCA	50	0	80	0	125	0	100	0	355	0
Toshiba	175	25	450	50	500	100	500	100	1,625	275
Total	350	90	840	255	1,175	525	1,230	730	3,595	
Percent Change From Previous Quarter			140%	183%	40%	106%	5%	39%		

[1]Includes 25,000 6147 Fast CMOS Static RAMs in 2nd quarter, 100,000 in 3rd quarter, and 225,000 in 4th quarter

[2]Indicates sampling

Source: DATAQUEST, Inc.
February 1980

Table 7

ESTIMATED WORLDWIDE SHIPMENTS OF 8K EPROMS[1]
(Thousands of Units)

Company	1978 4th Qtr.	1978 Year	1979 1st Qtr.	1979 2nd Qtr.	1979 3rd Qtr.	1979 4th Qtr.	1979 Year
AMD	340	485	600	700	700	500	2,500
Electronic Arrays	60	200	75	100	125	35	335
Fairchild	120	280	160	200	350	600	1,310
Fujitsu	70	280	70	50	50	50	220
Intel	1,000	3,400	1,100	1,400	1,400	1,100	5,000
Motorola	400	1,020	700	750	1,000	1,000	3,450
National	500	1,250	600	800	800	900	3,100
Signetics	50	280	0	0	0	0	0
Texas Instruments	800	2,100	800	800	800	800	3,200
Toshiba	30	40	50	100	100	50	300
Total	3,370	9,335	4,155	4,900	5,325	5,035	19,415
Percent Change From Previous Quarter	56.0%		23.3%	17.9%	8.7%	(5.4%)	

[1]Includes merchant market and internal shipments

Source: DATAQUEST, Inc.
February 1980

Table 8

ESTIMATED WORLDWIDE SHIPMENTS OF 16K EPROMS[1]
(Thousands of Units)

	1978		1979				
Company	4th Qtr.	Year	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year
AMD	0	0	0	0	5	10	15
Fairchild	0	0	S[2]	S	S	S	S
Fujitsu	5	5	70	200	300	300	870
Hitachi	30	35	125	200	350	500	1,175
Intel	450	1,350	550	750	1,000	1,400	3,700
Mostek	25	25	90	150	250	350	840
Motorola[3]	90	100	160	150	160	200	670
National	S	S	5	50	80	120	255
Synertek	0	0	0	0	0	0	S
Texas Instruments[4]	300	850	400	900	1,100	1,800	4,200
Toshiba	5	5	25	50	90	200	365
Total	905	2,370	1,425	2,450	3,335	4,880	12,090
Percent Change From Previous Quarter	94.6%		57.5%	71.9%	36.1%	46.3%	

[1]Includes merchant market and internal shipments

[2]Indicates sampling

[3]Includes some parts having a 5-volt only power supply:
3rd quarter 1979: 10 percent
4th quarter 1979: 33 percent

[4]Includes some parts having a 5-volt only power supply:
1st quarter 1979: 40 percent
2nd quarter 1979: 50 percent
3rd quarter 1979: 60 percent
4th quarter 1979: 60 percent

Source: DATAQUEST, Inc.
February 1980

Table 9

ESTIMATED WORLDWIDE SHIPMENTS OF 32K EPROMS
(Thousands of Units)

	1979				
Company	1st Qtr.	2nd Qtr.	3rd Qtr.	4th Qtr.	Year
Fujitsu	0	0	0	S[1]	S
Hitachi	0	0	S	S	S
Intel	5	30	50	100	185
Motorola	0	0	0	S	S
Texas Instruments	10	35	60	90	195
Total	15	65	110	190	380

[1]Indicates Sampling

Source: DATAQUEST, Inc.
February 1980

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THE CURRENT RECESSION IMPLICATIONS AND PROSPECTS

On January 15, 1980, DATAQUEST was honored to present Dr. Ezra Solomon, Dean Witter Professor of Finance at the Stanford Graduate School of Business, as a speaker at its Small Computer Industry Service Conference. Dr. Solomon's speech on the current economic situation was so well received by conference attendees that we decided to make it available to our Semiconductor Industry Service clients.

Dr. Solomon is Dean Witter Professor of Finance, Stanford Graduate School of Business, and a former member of the President's Council of Economic Advisers. He lectures and consults extensively in the field of financial management and managerial economics. Dr. Solomon is an author of many articles and a number of books, including The Theory of Financial Management and The Anxious Economy. He serves as Consulting Editor for Prentice-Hall, Inc. and is a member of the Editorial Board of the Journal of Finance. Dr. Solomon serves as Consulting Economist for Wertheim & Co., Inc. and is a Director of Kaiser Aluminum and Chemical Corporation., Encyclopedia Britannica, Inc., United Financial Corporation, Foremost-McKesson, Inc., and Capital Preservation Fund. Prior to his appointment as Dean Witter Professor of Finance, Dr. Solomon was the founding director of the Ford Foundation International Center for the Advancement of Management Education at Stanford University. He was previously Professor of Finance at the University of Chicago. Dr. Solomon received his Ph.D. in Finance from the University of Chicago under a fellowship for overseas graduate study which he earned in his native Burma.

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THE CURRENT RECESSION-IMPLICATIONS AND PROSPECTS
by
DR. EZRA SOLOMON

Before discussing the economic outlook, I'd like to share my favorite cartoon which has to do with computers: Two economists are in a dark basement. One is saying to the other, "This forecasting business is getting more difficult," and the other guy says, "Yes, especially if it involves the future."

FORECASTING PROBLEMS

The story is really not as whimsical as it might sound. Economists indulge in two kinds of forecasts. One is the conditional forecasts and we are pretty good at this: if you do this, then that will happen. For example, if you expand the money supply too fast you get inflation, if you control the price of some product below its equalibrium level you get shortages. The other kind of forecasting is more in the realm of prophecy. Here we are not very good. I rank economists half way between weathermen and astrologers. We are right only when our little trick works, and the trick is simply to project past patterns into the future. When these patterns break down, we are wrong. Forecasts made a year ago turn out to be dramatically wrong for 1979; a lot of new unexpected cards are in the deck now. Nevertheless there is a very high demand for this kind of prophecy, even when it is wrong; the amount of prophesying has increased significantly.

First of all, the computer-based econometric models can spew out four or five forecasts at a time, you don't get one forecast anymore, you get four or five scenarios and you pick. Another reason, of course, is that the government, which used to be very reticent about making forecasts in the last year or so, has been very candid indeed. The official forecast of the recession has been altered frequently. There is a great deal of uncertainty; for example, Mr. G. William Miller told us in October that the recession was half over, and other people are suggesting it hasn't yet begun. In a technical sense, I think Mr. Miller might turn out to be right. The National Bureau of Economic Research decides when the recession begins, and a year or so from now they will probably tell us that March of '79 was the peak of that last long wave of expansion. It is a funny sort of situation, very similar to that of 1973-75. But let's look at the other half of Mr. Miller's forecast. If he is technically right, and we are half way through by now, it is a little misleading—the worst half may be yet to come.

As I say, the analogy of 1973-75 is in many ways quite powerful. The same thing happened then. The peak (we are now told) was November 1973, but for three quarters after that the economy was moving rather sideways. Indeed, industrial production in the middle of 1974 was higher than it had been at the peak. This time around we are seeing gross national product running a little higher than it ran in the peak at the first quarter of the year, even though industrial production hasn't quite reached the March levels. I think it was about September 1974 that the Secretary of Commerce said, "What recession are you talking about? The economy is just waffling sidewise"—the best thing that came out of Washington that year. It was waffling sidewise in

September but starting in October of 1974 it went into a free fall, and for six months we had what ended up as the sharpest recession since the 1930s.

INFLATION

That is a similarity, but here are basic differences. In 1974 businessmen, deceived by inflation—the first peace time inflation we have had in our history—were pursuing an inventory policy in which they were buying from each other. When they woke up in September of 1974 and found out they were not selling to the ultimate customer, they began to cut production levels very, very sharply. I call it a unique time in history. It was the only time when purchasing agents were taking salesmen out to lunch.

This time around, there have been two basic changes, both affecting the consumer. These changes have kept U.S. activity at a high plateau. The first was a change in the ground rules by which the housing market gets its finance mortage power. In the past whenever interest rates rose significantly above the fixed levels of 5 or 5 1/2 percent that the thrift institutions could pay to borrow money from individuals, people disintermediated. That is, some smart people withdrew their funds for 5 1/2 percent deposit and put it in the money market. This disintemedation would cause a drying up of mortgage money, and the housing market would collapse. This process has happened in every single downturn since World War II. However, just as it was about to happen in June 1978 the rules changed. Thrift institutions could now compete in the open market for funds with treasury bill plus certificates and so on. This extended the housing boom deep into 1979 by at least a full year. I will explain in a moment why I don't think it can continue.

The second major change was in the attitude and behavior of the American consumer. We have been surveying the consumer fairly carefully since about 1950 and right up to '74 his response to these questions was always what I like to refer to as the Protestant ethic or Protestant rationality. Until 1974, whenever it was believed that inflation was going to accelerate a little—2 to 4 percent or 3 to 5 percent— the consumer thought it was a bad time to splurge. In other words, if inflation was going to get worse, the consumer also believed it was a bad time to buy cars, homes, and other big ticket items. The logic was that staples were going to cost a lot more, so it was no time to splurge on things that could be deferred. Starting in 1974 a small fraction of the respondents began to adopt what I call the Brazilian attitude towards inflation - if you think prices are going to rise, this a good time to buy before the rise gets worse. By 1979 we were all behaving like this. So consumer borrowing broke all records. Consumers borrowed $50 billion net on just short-term consumer credit. In addition to this record borrowing there was another record amount of borrowing in the mortgage market, where people were refinancing their homes in order to splurge. As a result, what we call the net saving rate, the ratio of net saving of all savers and borrowers combined to total disposable income, has broken all records on the low side. In the last quarter in 1979 it was running 3 percent per annum. We have heard in the past that American saving is low relative to other national saving. The Japanese save about 22 percent of their disposable income, the Germans about 10 - 15 percent, even the British 10 - 15 percent, and the Americans' 6 percent was regarded as low; now it is running 3 percent.

Why this behavior? Because inflation is not neutral with respect to the relationship between the rewards of saving and the pains of borrowing. It could be neutral in a world with no taxes, but progressive income taxes make all the difference.

We think interest rates are high, when in fact they really are the lowest they have ever been in history. In terms of aftertax, and after-inflation interest rate, they have been running negative all through 1979. It is beginning to look positive now. We are all in very high tax brackets partly because of inflation, partly because of affluence, and partly because of double incomes. Nevertheless, for someone in the 40 - 50 percent marginal tax bracket, borrowing at 12 percent only costs 6 to 7 percent. On the other hand, saving and earning 12 percent doesn't give them 12 at all, it gives them 6 or 7 percent after inflation, that is, about minus 6 or 7 percent, because inflation has been running 13 percent.

In short as a society we have developed a set of ideas, regulations, and taxes which fit the world of the 1930s, not the world of the 1970s and 1980s. By that I mean in the 1930s for the first time economists developed the idea that saving may not be a virtue. Prior to that it was obvious to the old orthodoxy that saving was a virtue and borrowing a bit of a vice, and a big vice for the federal government, meaning government deficits were bad things. However, in a world of unemployment and deflation the economist Keynes suggested that the opposite might be true. The saver is not doing anybody a favor, he is merely disemploying his neighbor; borrowing might be a virtue, and it is okay for the government in such times to itself be a borrower and run a deficit. These ideas, which were the old heresies, became the new orthodoxies of the 1960s, and we have so changed our tax system that you might say that we are literally punishing the saver every time he saves and rewarding the borrower every time he borrows and a rational people is responding to an irrational government. Simple as that!

THE CURRENT SCENARIO

While these two changes in the mortgage markets and the consumer markets maintained the strength of total demand deep into 1979, even the fundamentals were beginning to weaken. We never have an economy moving smoothly upwards without interruption—imbalances develop. One imbalance that has developed is that the rate of inflation itself is chewing into real incomes so that real per-employee income has not been rising after taxes for the last 12 months. It is lower now than it was then. Gradually this must affect the consumer. Secondly, the attempt to allow the thrift institutions to compete in the money market ran into other irrationalities like usury ceilings on the rate at which they could lend. In about 20 states they can't lend at more than a certain 10 or 9 percent, or whatever it is. They have been changing the usury ceilings, but they still exist, so that this competition became increasingly joyless. The mutual savings banks, in the east particularly, began to see their profit margins squeezed as they were beginning to pay 12 and 13 percent to borrow money and lending at 10. You and I know they can't make it up in the volume. Very quickly in the last few months we have seen high interest rates begin to grab so that housing starts have fallen off sharply and the expectation is that housing will go into a recession in 1980 without a doubt. It will not be as severe as the 1973-75 housing recession. For one thing the excess of building in 1972-73 was enormous compared to this period. Conventional houses were being built then at the rate of 2.4 million per year, and this time around at the peak it was 2.1 million. Mobile homes then were being sold at the rate of 600,000 a year, and this time around it was 300,000 a year. The same excesses did not build up this time. Nonetheless we will see a dip from 2.1 million housing starts in 1978, starting in 1979 we'll be down to 1.75, and I am expecting in 1980 to be down to about 1.4 million. At the worst quarter, it could be as low as 1.2 million. Last time housing starts fell below one million for several months. Housing is now a big sector of the economy. Secondly, the sharp rise in the price of homes, especially in California, will continue, but it is not going to be as sharp and dramatic as it has been in the last two or three years. Twenty or 21 percent per annum steadily adds a lot to the equity people own in homes and therefore to their willingness and their ability to borrow. This steady increase is no longer guaranteed, and therefore I don't see that same source of bullishness for the average house owner.

The intermediaries, the banks and finance companies that lend to consumers, are finding that these consumer credit loans are no longer as lucrative as they used to be. The standard rate on consumer loans runs about 18 percent per annum; when the cost of money is 8 or 9 percent, 18 percent looks good even though there might to be a 5 or 6 percent default of some kind. With the prime rate at 15 percent, and the effective cost of money at around 15 percent, 18 percent no longer looks so good. So the willingness of the intermediary who puts money at the consumer's disposal has diminshed greatly. The automobile market, which is the primary debt finance consumer item, has begun to decline. Car sales last year totaled 10.6 million; the most optimistic forecast, made early in the year by GM, predicted 11.6 million. We are off quite a bit. This year the figure is going to be about 9.6 million, including imports. This is a sharp fall in cars; production has been cut severely by all domestic manufacturers. So we are likely to see pains in that market.

Cars and houses are the very typical items that cause a recession. I think other items are going to hold up rather well, so there is not going to be a sharp recession of the kind we had in 1973-75. In that recession from peak to the trough, real gross national product fell about 6 percent. This time around the decline should be about only 3 percent from the peak, which was probably the third quarter of 1979 in terms of gross national product, to the trough, which will be about next summer. It will probably be about as severe as the 1957-58 recession, a middlesized one. Unemployment will unquestionably rise; by the end of this year around election time, the unemployment rate will probably be pushing 8 percent. However I don't think it is going to create the same kind of excitement it created in the '50s and '60s, because the other problem in society will remain, and that is the more important one in my opinion—inflation.

Inflation from December to December both on the producer price index, previously the old wholesale price index, and the consumer price index, has been running about 12.6 percent over a 12 - month span. It has been considerably higher over a shorter span—about 13.5 in the consumer price index. This rate of inflation is worse than we suffered in 1974 in terms of consumer price index but not as bad in terms of the wholesale price index, which in 1974 jumped 20 percent in this country and much more elsewhere. Will that come down? How will government react to this joint problem of recession with inflation? Nevertheless, more important than the recession itself, is the recovery from the recession on the other side.

In a nutshell I expect it is going to be a slow recovery. We will remain in fairly recessed conditions without the major bounce-back that we typically get, partly sponsored by government action in the interests of getting inflation rates down and, hence, getting interest rates down a little. This is a dangerous guess to make in an election year. Just as soon as things begin to look bad there will be a drumbeat for some stimulus from government and business as usual. But I think the world has changed, and what I want to suggest is that somewhere in 1973 the post war period ended. The only people who didn't realize it were those in Washington. By the end of a period I mean that you go through a sort of sluggish watershed for a while until a whole new set of ideas and objectives begin to become national policy. World War II was a major watershed that ended the pre-WWII policies, and attitudes; we got a much more pro-growth, big government, let's-step-on-the-accelerator attitude which worked beautifully in the 50s, worked beautifully in the 60s, and gave us the best growth we have ever had in our history. However, we overdid it and we got into trouble, so that about 1973 three things converged which ended the period. One was the onset of very high rates of peace time inflation. The second was the quantum jump in the price of oil—a fourfold jump then and a subsequent doubling, and oil is a major input in an industrial society. The third item was the collapse of the system of fixed exchange rates and the move to a so-called free floating rate, which the Swiss accuse us of using as a euphemism for free sinking rates. The dollar has been taking a bad beating.

PRODUCTIVITY

Why do these three factors make such a difference? Most powerfully because they interact. But let's sort it out, and let me be an economist for a minute and say supply and demand—you have to say supply and demand once a month to retain your union card as an economist. Look at the supply side. Very simple, and straightforward. The Industrial Revolution, and especially the postwar manifestation of the Industrial Revolution, with its enormous increase in productivity per employee has been due essentially to the substitution of oil for sweat. We were diseconomizing on one factor of production—oil, embodied in the form of machines because it was cheap and plentiful and getting cheaper in real terms. We were therefore conserving this precious fact of production, human sweat, and getting ourselves large increases in productivity for a unit of sweat; that is the way I like to look at it. That is what the Industrial Revolution is all about, but now all of a sudden oil is no longer plentiful, or cheap, and it is certainly not going to get cheaper. It is getting more and more expensive by the year and getting scarcer by the year. We can't do very much, and for the last three or four years U.S. productivity has not really been rising at all, it has been static. The consequences of this are a little frightening, because the only source of a rise in average standards of life must be average product per person; there is no other source for a rising standard of life in the material sense. So from the supply side, the world has a difficult problem. As a result, growth has slowed significantly all over the world, especially industrial growth since 1973.

From 1948 to 1973 Japan was the growth leader. Their industrial production grew at 13 1/2 percent per annum compound. These are fantastic growth rates that has made Japan a giant economy. However, since 1973, Japanese industrial production has been growing at 1 percent per annum. That is quite a drop. The eight largest economies outside of Japan—I am not talking of the U.S. now but of Europe—grew in the post war period at 5.7 percent per annum compound. This figure is far higher than their history of growth rates. Since 1973 it has been less than 1 percent per annum on industrial production. In the U.S. we also had a slowdown, but much less than elsewhere. We had been growing at about 4 1/2 percent per annum, which is a full 50 percent higher than our historic growth rate, and since 1973 we have slowed down to just under 3 percent per annum. In terms of industrial production we were among the slowest growers in the postwar period; since 1973 we have been the fastest growing nation in terms of industrial production. This leads me to the demand side of the equation.

THE DOLLAR

How did we achieve this production growth? We achieved it because we disregarded the new reality. We bravely barged ahead with expansive policies when the rest of the world was cow-towing to these realities and pursuing much less expansive policies. The reason that this trilogy of economic ills caused the slowdown or change in policy attitudes is simple. For most countries in a free-floating world with high inflation rates and a very high cost of oil, allowing their currencies to slip or fall is a very dangerous thing. The minute the currency slips on the foreign exchange market, the price of oil goes up because it is priced in dollars. Then begins a downward slope because there is an interaction there—the exchange rate slips, the price of oil goes up, inflation gets worse at home, the exchange rate slips further, the price of oil goes up further—it's a ratchet.

Normally expansive countries like Brazil and the UK had to adopt relatively go-slow policy. They and other countries did so in 1977. The Germans did it automatically—they were so scared of inflation that they adopted a relatively go-slow policy. So all of us together bounced out of the '75 recession; by the end of '76 the recovery began to peter out. When the recovery petered out elsewhere they let it; they were content with zero growth in '77, in some cases mini-recessions in '77 and '78, but not the U.S. We decided we were different; we had a new administration, the Carter administration, and we stepped on the gas. So 1977 and 1978 were a super years for the U.S., at least for the U.S. economy and for U.S. employees, but it was a terrible year for the U.S. financial markets and the U.S. dollar. The dollar began to slip. We were immune from the usual restraints, discipline as it is called, normally imposed on a normal country because in a sense we were not a normal country in 1977; we now are. The reason we were not normal is that oil is denominated in our currency, so when the U.S. dollar falls against the Swiss Franc it makes no difference in the price of oil. We pay no price for this—we think.

The second difference, and probably more important, is that another country that suffers a large deficit in its balances with the world has to go to the credit market to borrow money. You have to go hat in hand, the bankers tell you to behave, and you darn well better behave. Behave means slow down, cut out your fiscal stimulus, stop expanding your money supplies, etc. Well the U.S. is again different from the rest of the world. We don't have to go and get credit when we run a deficit; it's automatic, we write on the cuff. We are the only nation that could be running a trade deficit of $45 billion a year, a tremendous sum, in early '78 and laugh about it. The Secretary of the Treasury said, well, next year is going to be even worse. It is a policy of benign neglect.

Fundamentally we come to yet another difference which existed, and no longer exists: the world financial community could not discipline the U.S. Not for political or military reasons, although that matters, but simply for economic reasons. The ultimate sanction against a country like the UK, Brazil, Japan, or Peru, which refuses to cow-tow to international banks is that they get no more credit and no more imports. Without imports they die, because they are either dependent on food or dependent on parts; they are not self-sufficient economies. The U.S. except for oil, is essentially self-sufficient. As badly as we have behaved, can you imagine the Japanese saying to us, behave yourselves, you Americans, or no more Toyotas. Three day holiday and rejoicing in Detroit! Fundamentally we were different and we behaved differently. In other words, we said we are the locomotive we are going to charge ahead, we are going to lead the world back into full employment and fast growth and never mind anyone else. Well we couldn't do it for long, because we suddenly woke up and realized that the falling dollar does have consequences for us. The price of other imports if not of oil goes up very rapidly. There is a threat that oil might get repriced in some other currency and it is a very real threat. There is one group of nations that can say to us now, you pay in real money or else no imports, and that would hurt.

So these changes began to dawn in Washington and we had two major actions over the last four quarters or so. First was Halloween day 1978, when we abandoned the policy of benign neglect. We said mia culpa, we too are going to behave like a sensible nation, and we are going to worry about the exchange value of the dollar. This meant raising interest rates, being competitive, etc. It didn't work too well. It worked for a while—the dollar gained significantly, especially against the Yen, but it didn't work for long. The money supply again got out of hand. On October 6, when we had the so-called Saturday night special, Mr. Volper, then the new chairman of the Fed said "I am really going to tighten money, I'm not going to fiddle around." The essential difference between the way policy had been conducted prior to October 6th and since then is that prior to October 6th the government always worried more about what was happening to the interest rate and how to control the rate at which that would rise. When there was tightening, it wasn't sufficient for the pressures that existed. The reason we are trying to control the interest rate again is a populist reason, high interest rates are "bad". We have always believed so in this country. Presidents have always hated high interest rates and a populist Southern president really hated them very badly. That is why he threw Arthur Burns out, because Burns was worried about inflation and tried to tighten money early in the game, and that is why every time Burns' successor did anything to tighten money there was an adverse reaction from the White House.

Since October 6th however, that has changed and it is with the support of the President completely. Will it work? Yes, I think it will. Tight money is one reason some of the exuberance on the demand side is disappearing. I think it is one reason Congress is at least talking about doing something to reduce the amount of fiscal stimulus, which is very strong. We have been running deficits every year in boom period which was never what deficit financing was meant to do. For a recession, yes, but for a boom, no. It just inflames the situation. I think inflation has been given the highest priority among our various objectives. The question is, how long will this last? Last time around we brought inflation down from 13 percent. In the last 12 months of the Ford administration it was down to 4.8 percent, and then it rose again. I don't think Mr. Carter will make the same mistake. It is politically unpolular today to say," I am going to inflate". Everybody is against it.

BEYOND 1980

Do we have the staying power? If we do, the picture I see beyond 1980 is for much slower total economic growth, down to below 3 percent per annum on the long range track as compared to 4 1/2 percent. The same is true for Europe and for Japan. The whole western world is going to have to grow more slowly. In the process it will adapt to the energy shortage by curbing the growth of demand for energy and making some sort of transition to non-energy intensive forms of production. If we do that, the rate of inflation should come down gradually. I think it will be down to 9 or 10 percent by December from 13 percent and it can continue in 1981. I expect it will come down dramatically, because it is the year after the recession that you get the great results. If we get it down to the 4 to 5 percent range by the middle 80s, the problem is over in some sense. If we are impatient and we listen to the voices that say go for the accelerator, I think this country is going to be in deep trouble. The only way you can go for the accelerator and preserve a modicum of sensible economic results is to slap on the whole paraphernalia of controls. The only person I can tell who might lead us in that direction is Mr. Kennedy. He would have the inclination and guts to try that; it is terribly wrong, but you don't have to be smart to be gutsy. More than wage and price control, we would have to have foreign exchange controls, credit controls, and many others. I hope we don't go down the road of trying to reconcile very fast growth in a non-inflationary world. It can't be done. I hope we take the more judicious path of slowing down. I think the majority opinion is to follow the latter path.

THE ROLE OF INFORMATION TECHNOLOGY

I have sounded fairly pessimistic but let me end with an optimistic note, which has very much to do with your industry. Energy remains the pressing problem of the 80s. We are still heavily dependent on imported oil, more than ever before. The ratio of imported oil to total energy is the highest it has ever been in spite of the big jump in price. Everybody thinks that the solution of how to get rid of this dependence on foreign oil is to find a literal substitute such as coal and uranium. They are the two obvious ones, and therefore the ones we have turned our backs on in this society—and looking to crazy things like solar, which may do something by 1995 but can't do very much now. Conservation, yes, but that means slow growth. I think some of this solution will come with finding a literal substitute for oil. It is more likely to come more from a shift in aggregate demand by the American people toward new products that don't require energy, and there is a new process and a new product right in our midst which is big enough, in my opinion—the microprocessor. It is big enough, plentiful enough, and versatile enough to be thought of as a factor of production. Let me restate what I was saying here. We have sweat, we have oil, and a third factor which used to be something called brains. However, brains were even scarcer and more expensive than oil so we had to conserve on them too. Now there is this extension of the brain which is very cheap and getting cheaper and very plentiful and getting more plentiful and getting small. It can do a whole lot of things. If we can grow to love the products of this new electronic revolution as much as we grew to love the products of the industrial revolution, the future is very bright. We have this factor of production, we have this ability to generate goods and services, communications and applications we don't dream of yet. I say we will grow to love these things like we grew to love the car and the machine. The transition in the '80s is going to be in this direction. This is a major way of curing the energy shortage problem, in addition to doing all the things the government says it is going to do.

But on this energy question, nothing the government has done so far gives me any heart. They have made all the possible mistakes they could make and they continue to make them, and the only thing that gives me any comfort at all is what Winston Churchill once said about the United States: "You can count on the U.S. to do the right thing after it has tried every wrong thing possible."

DATAQUEST SECURITIES, INC. PORTFOLIO LETTER

Vol. II - No. 2 February 1, 1980

This letter is a condensation of recent newsletters and internal thinking from the industry research groups at DATAQUEST, Inc. Requests for amplification of our thoughts or for specific newletters should be directed to the author. A list of recent DATAQUEST Research Newletters appears at the end of this letter.

CAPITAL EQUIPMENT

In our most recent Portfolio Letter, we outlined a fairly optimistic scenario for farm equipment purchases over the next year. However, a major assumption in our forecast was that the United States would export large amounts of grains; the recent embargo by President Carter has obviously changed this situation. Our concerns relate less to 1980 than they do to the 2-3 year impact of the embargo.

During 1980, we believe that the Federal Government will be able to sustain reasonably high levels of grain prices through support programs. Longer term, however, we doubt whether these programs can have the same positive impact. If other grain growing nations are able to boost output enough to attract the Soviets as customers and maintain total worldwide demand for grains, then the longer term impact on farm prices and therefore machinery sales may not be significant. However, if due to lack of grain the Soviets have to slaughter their livestock herds, then we could be looking at a longer term reduction in Soviet grain needs. Were this to occur, we believe it would result in a secular decline in the demand for farm machinery.

DATAQUEST estimates that every 1 percent of change in farm cash receipts precipitates a 1-1/2 percent change in farm machinery sales. That effect should be magnified somewhat in 1980 because of emotion surrounding the embargo issue. If the embargo continues, DATAQUEST foresees the possibility that retail tractor sales could decline 2 percent in 1980 and drop another 8-11 percent in 1981 to a level of about 125,000 units. Because grain farmers tend to buy larger tractors, the impact on revenues would be magnified somewhat.

We have been forecasting $5.50 a share in earnings for Deere in fiscal 1980, and we are not changing our forecast. The company should benefit from low dealer inventories and the continuation of the strike at Harvester. However, given a decline in retail sales in 1981 as well as in 1980, it would appear very possible to us that Deere could have lower earnings in fiscal 1981. Once the strike at International Harvester ends, the company should be able to ramp shipments up fairly rapidly to restock dealer inventories. Longer term, however, a weak market for farm machinery would be even more a problem at IH than at Deere, since IH needs a strong farm market in order to accomplish its corporate goals of permanently higher levels of profitability.

INSTRUMENTS

Instrument demand in general remains very strong. The forecasts that we have made for the Test and Measurement (T&M) and Automated Test Equipment (ATE) markets assumed a moderate recession in 1980 and softening in demand. In the T&M area (which includes ATE) we have been forecasting 13 percent industry growth. Although orders have definitely slowed from last year's rates, we would estimate present order growth to still be close to 20 percent. In ATE, orders are now running over 30 percent ahead of 1979 orders, far higher than our 16 percent growth forecast for the full year. We are not changing our estimates at present, but we want to point out that backlogs are high, and unless order growth decelerates by the end of the first quarter, our growth forecasts will have to be raised.

We commented last year that very strong product development efforts at Hewlett-Packard should allow the company to gain T&M market share in 1980 and probably 1981. Apparently that is exactly what is taking place. It appears that instrument order growth at H-P is presently running over 20 percent, and we believe that the company will exceed the industry order growth rate in 1980 by 5-6 percentage points. Our overall 1980 forecast for Hewlett-Packard is for order growth of 27 percent, sales growth of 31 percent, and earnings of $4.60 per share versus $3.43 per share in 1979. If these seem like abnormally high numbers in a "recession" year, we should point out that it is likely that first quarter orders at Hewlett-Packard will exceed $800 million and our 27 percent order growth forecast for the full year implies no sequential growth from the first quarter level. Even more importantly, our forecast implies a further expansion of backlogs at Hewlett-Packard this year, which would allow the company to enter fiscal 1981 with a very high backlog position, increasing the likelihood that fiscal 1981 would be another year where sales and earnings gains exceed 20 percent at the company.

One further point regarding all of the instrument companies should be made. Almost all of the companies have complained about high component costs and the negative impact these costs are having on profit margins. If and when instrument demand does slow down somewhat, it is likely that demand for other high technology products may moderate as well. To the extent that this slowdown results in a lesser rate of demand growth for semiconductors and some errosion in semiconductor pricing, this situation could have a very beneficial effect on the profit margins of users, particularly since almost all companies have begun raising prices in anticipation of continued tightness in semiconductor pricing. The same argument could also be made for the computer industry.

SEMICONDUCTORS

If any of you were surprised when Intel indicated that a certain amount of price cutting was going on in Europe, you shouldn't have been. We indicated back in October of last year (Vol. I, No. 6) that selected price cutting was taking place in the European market by the Japanese in an attempt to gain market share. For the most part, the Japanese are focusing on 16K dynamic RAMs, but price cutting tends to spread from one device to others. For example, it is possible for a large European user to get 50,000 or more 16K RAMs in 4-6 weeks from various Japanese suppliers. The equivalent delivery time in the United States would be well in excess of six months.

Do not make the mistake, however, of thinking that the European situation is that bad or that it is a harbinger of what will happen in the United States. For one thing, basic demand in Europe is not as strong right now as it is domestically. More importantly, the Japanese are buying their way into the European market where they do not have a significant market share. By and large, the Japanese have, in our opinion, about as high a market share in key product areas in the United States as they are likely to get without major changes in buying habits by large U.S. customers. We do believe that sometime in the first quarter of calendar 1980, supply and demand will come somewhat into balance and that it will stay that way throughout most of 1980. This should allow prices to drop at a moderate rate during the year. However, basic demand appears just too strong to support any significant price degradation. We still are maintaining our 13-14 percent growth forecast for domestic consumption in 1980 and, if anything, we are getting more optimistic about the outlook for this year.

Longer term, we are more and more convinced that a basic shortage in semiconductor parts will once again emerge in 1981 and beyond. This has important implications for 1980 as well as beyond. Let us assure you that large buyers of semiconductors are very concerned about availability of parts over the next 3-5 years. As such, they are less likely to be aggressive in pricing when any softness does develop during the course of 1980, since they are interested in maintaining good relations with the large suppliers. In this regard, it is noteworthy that Hewlett-Packard, which has sited components costs as one of the major depressants of profit margins, has already raised prices in fiscal 1980 by twice as much as they had in all of fiscal 1979.

One final point needs emphasizing. Despite the very high profits of the industry, the companies are operating inefficiently. There are large numbers of new employees who have not yet been effectively worked into the system, and many plants are producing far more wafers than they were designed for. One could reasonably make the case that a period of moderation between supply and demand would be a very valuable long term development for the semiconductor industry, as it would allow the companies an opportunity to get yields up and costs down. We see no compelling reasons to anticipate any meaningful contraction in semiconductor profit margins during 1980.

PAPER & FOREST PRODUCTS

Now that the recession is upon us (?) and paper profits are about to fall off of a cliff, we want to prepare you for a shorter than expected drop, particularly for brown paper.

Everyone knows that brown paper prices get cut dramatically in the latter stages of a recession and that profit margins fall accordingly—except things should be different this time around:

- Operating rates will probably fall in 1980, but limited capacity additions should keep utilization rates around 94 percent in both 1980 and 1981, which would be far from catastrophic.

- Prices are much higher than they were a year ago and we think they are still going higher, not lower, near term—expect an 11 percent increase in linerboard prices in February. Even with prices coming down in the second half of 1980, operating margins should be about flat for the full year (higher first half, lower second) and flat again in 1981 (lower first half, higher second). Beginning in late 1981, the brown paper sector could move towards two or more years of basically sold out conditions and much higher margins.

- Underlying our positive attitude is one basic fact—the brown paper sector is consolidating. Four smaller aggressive companies—Hoerner Waldorf, Inland Container, Hudson Pulp & Paper, and Bodcaw—have been bought by larger concerns within the last three years. Generally, prices would be expected to start dropping rapidly in the second half of 1980. If we are right and they do not drop, there may be more converts to our present minority view—namely that there are long-term opportunities in the brown sector of the paper business.

SMALL COMPUTERS

The feedback from our Small Computer Conference held in January is that growth rates in almost all sectors of the market should moderate only slightly in 1980. We do not expect the industry to be significantly affected by a recession, which is good news not only for the small computer suppliers, but also for their suppliers (i.e., the semiconductor companies). Listed below in Table 1 are our growth forecasts for the various segments of this market over the next two years. Some of our estimates are in revenues and others are in if-sold value. We believe that overall small computer revenue growth was about 26 percent in 1979 and expect 23 percent and 25 percent growth in 1980 and 1981, respectively.

Table 1

ESTIMATED GROWTH OF SMALL COMPUTER INDUSTRY BY SEGMENT

	1978/79	1979/80	1980/81
General Purpose Minicomputers	30%	25%	27%
Very Small Business Computers	114%	67%	43%
Small Business Computers	17%	21%	19%
Larger Business Systems	41%	60%	22%
Processor Based Terminals	22%	23%	23%
Personal Computers	60%	47%	36%

Source: DATAQUEST, Inc.

General purpose minicomputers (major suppliers: Digital Equipment and Data General) should enjoy somewhat lesser growth in 1980, principally because of reduced demand from hardware OEMs. However, as noted in our numbers, the downturn should not be significant and should be bolstered by continued high growth in service revenues. Some acceleration in growth is anticipated in 1981. The rate of growth in this sector may be slowing longer term, but it should remain at very high levels for the next several years.

DATAQUEST defines very small business computers (major products: IBM 5110, Datapoint 1500, and Wang PCS II) to be commercial computers selling in the $5,000-$15,000 price range. This is a small market, totalling only $300 million in 1979, but we expect this to be one of the major growth segments of the small computer market, reaching $1.4 billion by 1984, a compound growth rate of 35 percent.

We define larger business systems to be the products in the $80,000-$200,000 price range. They include the IBM System/38 and 4431, the Hewlett-Packard 3000 Series, the Wang VS Line (the most important part of its computer effort) and most of Prime Computer's products. Our growth forecast for 1980 and 1981 are skewed because of expected initial shipments of the 4331 by IBM in 1980. If one excludes IBM from our data, the other participants should experience growth in the 30-35 percent area in both 1980 and 1981.

Small business computers (price range $15-80,000) have somewhat less potential, both near and longer term, because a high percentage of the first-time users were penetrated in the early and mid-1970s. Major products here are the IBM System/32 and System/34 and the Burroughs B-80 and 90. Personal computers should enjoy rapid growth from a low base. In our view the major commercial opportunity here is in business oriented personal computers sold to larger companies to meet the individual needs of executives and managers. We expect to see increased emphasis on this market by most participants.

WORD PROCESSING

A meeting at our recent Small Computer Conference between our financial clients and the management of Lanier served to point out some of the opportunities and challenges facing the smaller independent word processing suppliers.

Lanier has thus far concentrated exclusively on the stand alone sector of the market, as have CPT and NBI. Despite the probability of a recession, we believe that the stand alone market will grow very significantly in 1980, but that the growth rates will start to moderate somewhat after this year. In addition, the level of competition should increase. This will be a function of both improved product offerings from Xerox and IBM and competition from small business computer suppliers and other mainframe companies who offer word processing capabilities as part of their total package. As an example, the Datapoint 1800 terminal, used as a small business computer, can run the new Dataproducts word processing software.

All of this means that the independents need to expand the scope of their product offerings if they expect to maintain high growth rates. This expansion will likely encompass both some integration with data processing and expansion into the shared resource sector of the market. Both CPT and Lanier have introduced their first clustered terminal systems.

Among the most important criteria for evaluating the potential success of the independent suppliers in adapting to the changes in the market will be the strength and sophistication of their marketing organization, the ability to painlessly integrate whatever data processing capability is necessary, and the excellence of their software in a more competitive environment. In general, we believe that it is important to have a direct sales force that is capable of making the higher level and more sophisticated sell required for clustered terminals.

Regarding Lanier specifically, its new shared resource word processing system offers a lot more software power than its stand alone units and larger storage capability. In particular, it has an equation software package option that, in our opinion, appears superior even to that of NBI. The biggest question we have about the product offering is the larger number of variations in product configuration and the difficulty that a salesperson accustomed to selling stand alone word processors may have in making this type of sale. Lanier plans on having shared systems specialists who will assist the regular salesmen in making a sale and do some direct marketing themselves. We think that these people will be necessary if the product is to succeed. The target at present is for shared systems to contribute 15-20 percent of Lanier's total word processing business by the fourth quarter of calendar 1980. We expect $2.25 per share in earnings at Lanier in the May 1980 fiscal year versus $1.88 in fiscal 1979.

Michael Weisberg

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BOARD-LEVEL MICROCOMPUTERS

SUMMARY

Preliminary estimates indicate that U.S.-based suppliers of board-level microcomputer products had another year of dramatic growth in 1979. Shipments of 8-, 12-, and 16-bit board-level microcomputers totaled an estimated 186,000 units, with associated revenues estimated at $163 million. These figures represent growth rates of over 90 percent in units and approximately 57 percent in revenues for worldwide shipments by U.S. manufacturers. DATAQUEST believes that growth in the coming five years will be less explosive, however, although rates of nearly 40 percent in units and over 25 percent in dollars are expected through 1984. By 1984 the market is expected to approach one million units annually, with revenues of more than $500 million.

Surprisingly, the greatest market growth occurred not in the newer 16-bit products but in the older 8-bit devices. This rather explosive growth, which resulted in a doubling of unit shipments in 1979 over 1978, was the result of the proliferation of a new generation of very low cost products. Competition from a variety of new products costing $200 and less caused average selling prices to decline by nearly one quarter and catapulted several new competitors into significant positions in the 8-bit board-level market. The 12- and 16-bit market also experienced substantial growth in 1979, although the expected penetration of the semiconductor suppliers into a market traditionally dominated by minicomputer suppliers was not as extensive as had been forecast.

8-Bit Board-Level Microcomputers

Table 1 summarizes estimated worldwide unit shipments and revenues of U.S.-based 8-bit board-level microcomputer manufacturers for 1978 and 1979. The unit figures in this table (and all tables in this newsletter) are for CPU boards only while the revenue figures include supplier revenues from all boards and support products shipped by CPU board manufacturers.

In 1979, the 8-bit market grew by more than 100 percent in units and more than 60 percent in revenues. The large discrepancy in these two growth rates was due to a drop of approximately 22 percent in average selling prices. Average price declines were in turn due to the emergence of a new generation of low-cost products in the 8-bit market.

The availability for the first time of board-level products at prices of $200 and less has permitted sales to new markets and customers for which microcomputer products can now be justified based on price alone. The greatest inroads were made by products based on the STD bus and products based on the KIM bus. Pro-Log and

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Mostek emerged as major competitors in the marketplace due to their emphasis on the STD bus, while Rockwell, Synertek, and MOS Technology experienced major gains due to the success of products based upon the KIM bus. These products have proved successful in industrial and instrumentation environments where applications for low-cost, low-performance products abound. European markets and educational markets have also accounted for large volumes of these low-priced products.

Table 1

8-BIT BOARD-LEVEL MICROCOMPUTERS
ESTIMATED WORLDWIDE SHIPMENTS AND REVENUES
U.S.-BASED SUPPLIERS

	Unit Shipments (Thousands)		Revenues (Millions of Dollars)		Share of Revenues	
	1978	1979	1978	1979	1978	1979
Intel	20.0	40.0	$18.5	$32.0	37%	40%
National Semiconductor	5.7	9.8	5.1	7.4	10	9
Pro-Log	2.8	10.0	3.0	6.0	6	7
Motorola	4.2	7.1	5.0	5.5	10	7
Rockwell	1.0	15.0	0.4	5.3	1	7
Zilog	2.4	4.7	2.5	4.3	5	5
Synertek	10.0	15.0	2.5	3.8	5	5
Mostek	1.0	9.0	0.6	3.6	1	4
MOS Technology	10.0	15.0	2.0	3.0	4	4
Others	6.9	7.4	10.4	10.1	21	12
Total	64	133	$ 50	$ 81	100%	100%

Source: DATAQUEST, Inc.

12- and 16-Bit Board-Level Microcomputers

DATAQUEST estimates that in 1979 the 12- and 16-bit board-level microcomputer market grew over 60 percent in units and over 50 percent in revenues, as shown in Table 2. Digital Equipment continued to dominate the market in 1979 and even gained share due to the success of its LSI-11/2 and its new LSI-11/23 products.

Some price erosion occurred in 1979 due to the impact of new higher performance and lower priced products introduced by Computer Automation, Data General, and Digital Equipment during the year. However this price erosion, just over 5 percent, was less than anticipated, primarily because competition from semiconductor suppliers did not occur in 1979 as had been expected. Intel was the only major semiconductor supplier to begin quantity shipments of 16-bit board-level products in 1979. Intel's iSBC 86 became generally available in 1979, but was sold primarily as an upgrade product for 8-bit customers rather than as a product competing directly with the minicomputer suppliers. DATAQUEST believes that as Intel expands this product line, and as Zilog and Motorola enter the market with products based upon the Z-8000 and the 68000, significant competition between these two classes of suppliers will become a reality. These companies are presently emphasizing production of their new

16-bit chip-level products, however, and we do not expect significant emphasis on the 16-bit board market until 1981.

Table 2

12- AND 16-BIT BOARD-LEVEL MICROCOMPUTERS
ESTIMATED WORLDWIDE SHIPMENTS AND REVENUES
U.S.-BASED SUPPLIERS

	Unit Shipments (Thousands)		Revenues (Millions of Dollars)		Share of Revenues	
	1978	1979	1978	1979	1978	1979
Digital Equipment	15.0	30.0	$25.0	$44.0	46%	54%
Texas Instruments	6.0	7.0	8.5	9.8	16	12
Hewlett-Packard	2.0	2.5	8.0	9.8	15	12
Intel	-	1.5	-	3.9	-	5
Data General	2.0	2.5	3.0	3.5	6	4
Computer Automation	1.2	1.5	2.0	2.2	4	3
Others	6.8	8.0	7.5	8.8	13	10
Total	33	53	$ 54	$ 82	100%	100%

Source: DATAQUEST, Inc.

Market Forecasts

Tables 3 and 4 provide updated forecasts for the 8-bit and the 12- and 16-bit board-level microcomputer markets through 1984. In the 8-bit marketplace, we expect that growth will continue to be stimulated by price declines during 1980 and 1981. After 1981 prices should begin to stabilize, and significant growth should continue as these products penetrate a seemingly unlimited variety of new applications in industrial, scientific, and control markets.

The 12- and 16-bit board-level microcomputer market will experience far more significant price declines due to increased competition during 1981 and 1982. We expect price and performance to be key issues in this marketplace during the forecast period, and new standards of power and performance should be set each year as this market develops during the first half of the 1980s.

Grant S. Bushee

Table 3

ESTIMATED WORLDWIDE MARKET FOR 8-BIT BOARD-LEVEL MICROCOMPUTERS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	Compound Annual Growth Rate 1979-1984
Thousands of Annual Units	17	35	64	133	210	300	410	530	660	37.8%
Average System Price (Thousands of Dollars)	$1.0	$0.9	$0.8	$0.6	$0.5	$0.5	$0.5	$0.4	$0.4	(7.0%)
Millions of Dollars	$ 17	$ 32	$ 50	$ 81	$110	$150	$190	$230	$280	28.2%

Source: DATAQUEST, Inc.

Table 4

ESTIMATED WORLDWIDE MARKET FOR 12-BIT AND 16-BIT BOARD-LEVEL MICROCOMPUTERS

	1976	1977	1978	1979	1980	1981	1982	1983	1984	Compound Annual Growth Rate 1979-1984
Thousands of Annual Units	10	22	33	53	80	120	180	240	310	42.4%
Average System Price (Thousands of Dollars)	$1.4	$1.6	$1.6	$1.5	$1.4	$1.2	$1.0	$0.9	$0.8	(12.2%)
Millions of Dollars	$ 14	$ 35	$ 54	$ 82	$110	$145	$180	$215	$250	25.0%

Source: DATAQUEST, Inc.