July 1999

Vol. 23 No. 7

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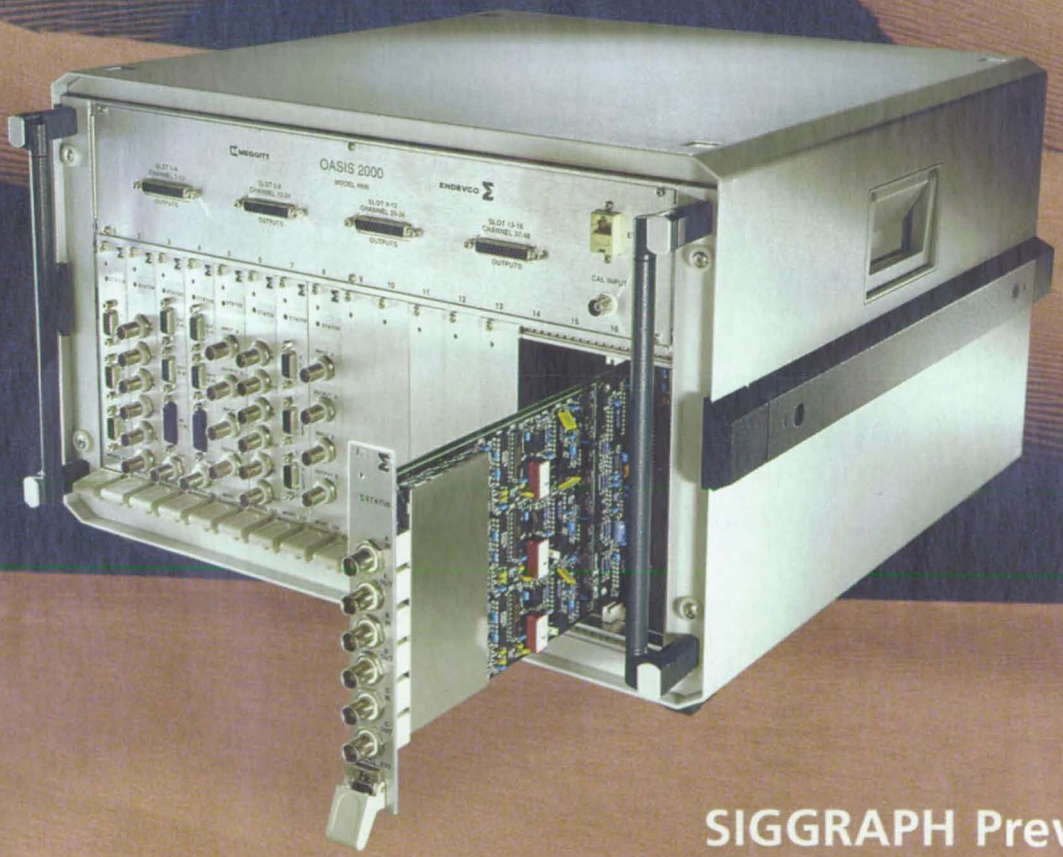

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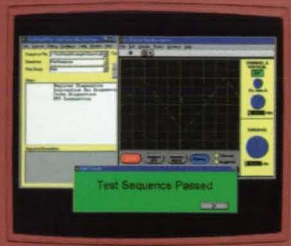

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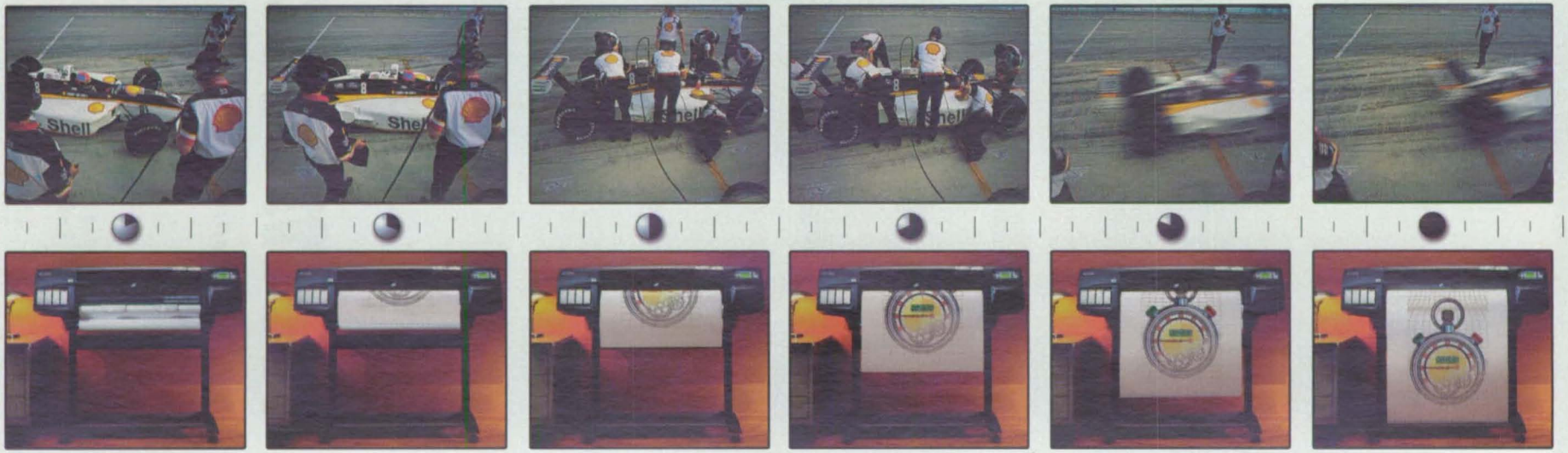

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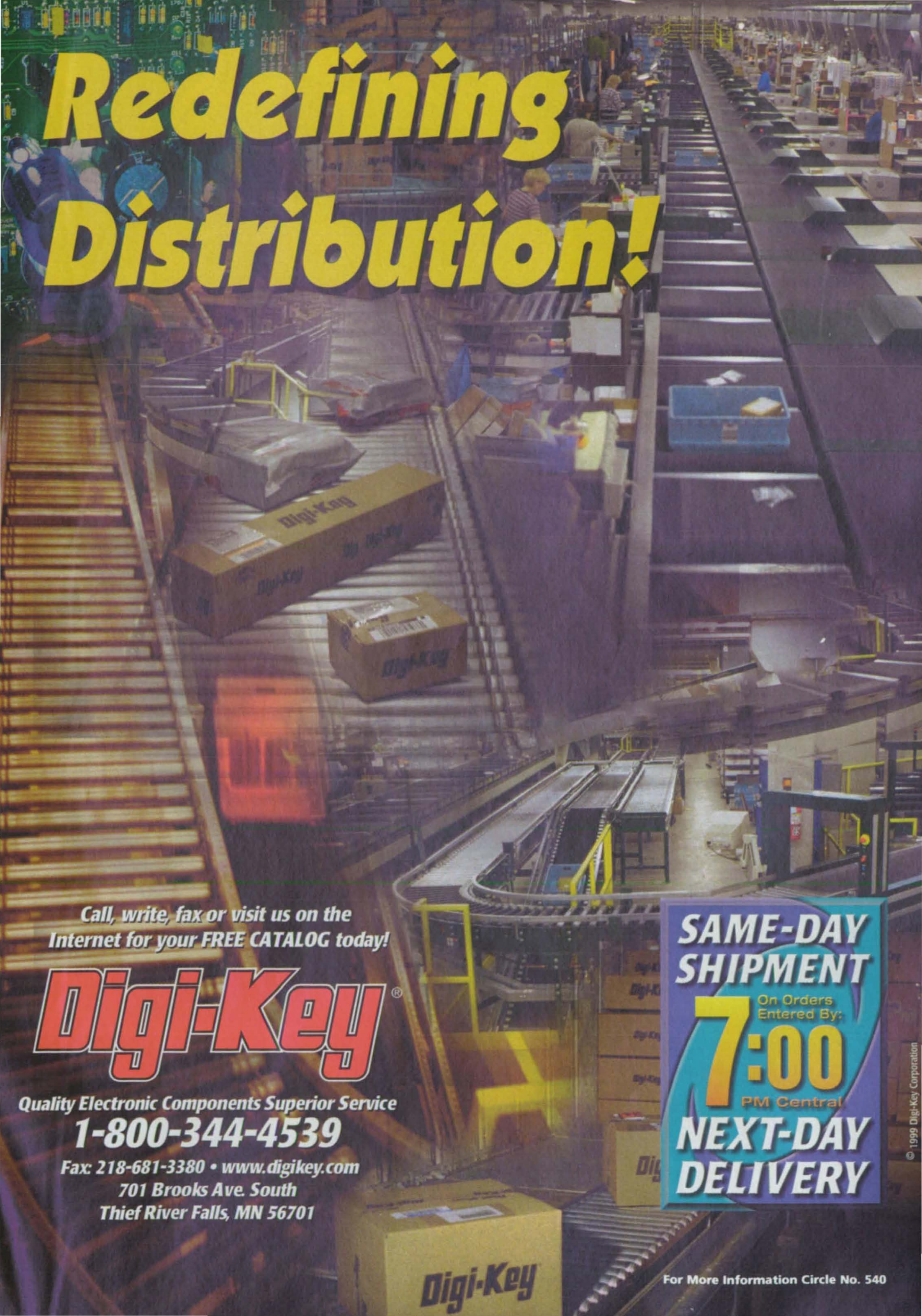
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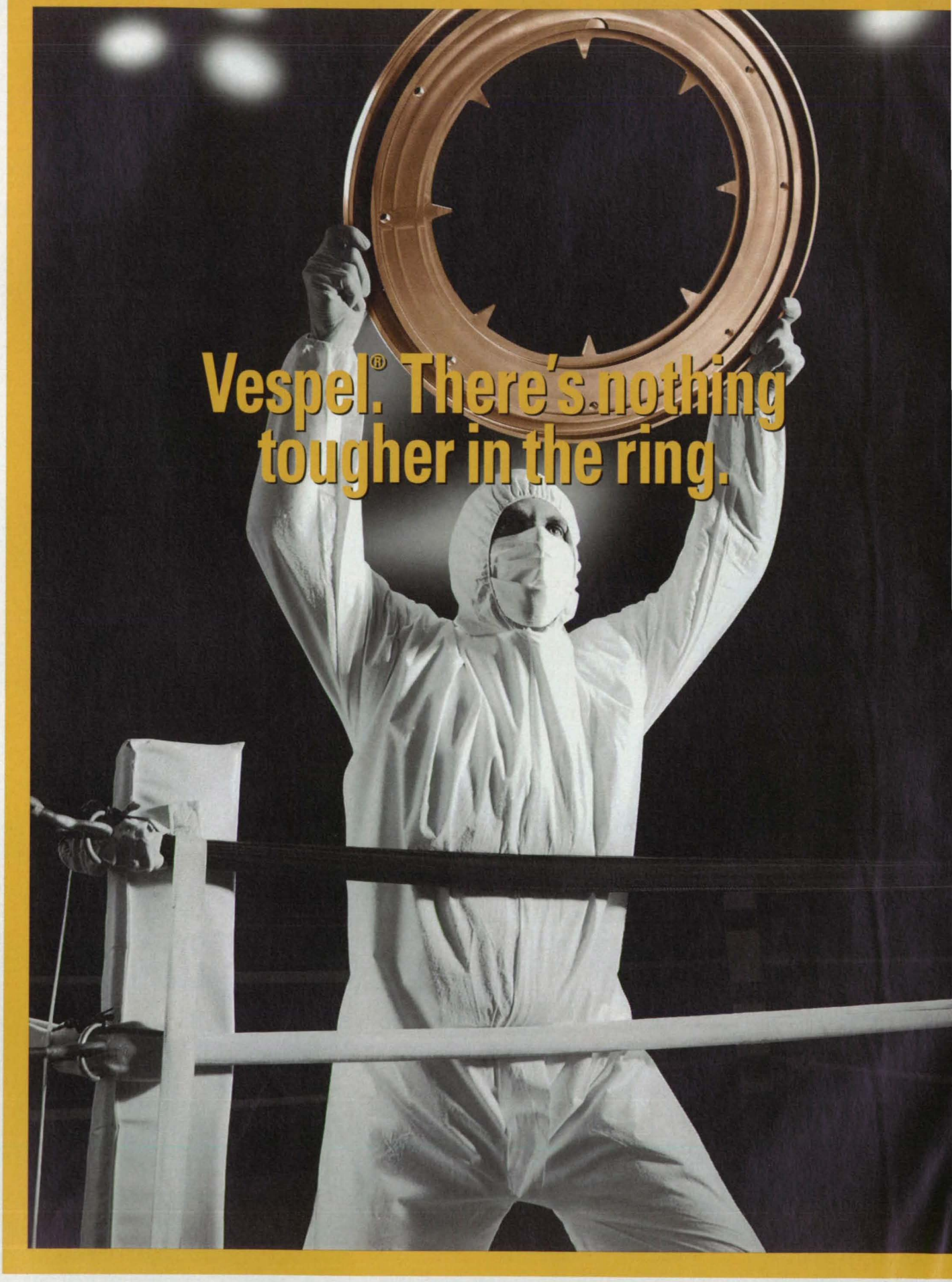
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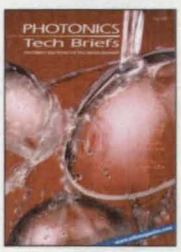
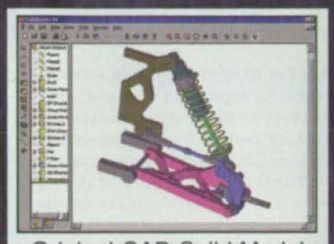
SPECIAL SUPPLEMENT



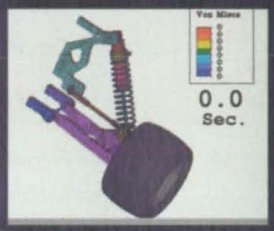
NEW Mechanical Event Simulation with Kinematic Elements

Dynamic stresses are shown on the spring. Other suspension components are modeled with a damper element and kinematic elements for faster processing.



Original CAD Solid Model from SolidWorks.

See Dynamic Stresses During the Event at www.algor.com



CAD Solid Model Assemblies to Mechanical Event Simulations and Faster Stress Analyses with Algor's New Kinematic Elements

Algor's Release 12 introduces 2- and 3-D kinematic elements, which produce massive speed gains in processing for a Mechanical Event Simulation or static stress analysis. Kinematic elements can be used in place of regular (flexible) elements when an area of the model is relatively rigid when compared with regions of stress interest. Kinematic elements can be constrained or loaded with force, traction, pressure or gravity. Because these elements have mass and can transmit forces, they can produce motion and stress in flexible elements. Engineers, therefore, can import CAD solid models or assemblies and specify which parts are to be modeled as kinematic or flexible elements, as appropriate. This means that for the first time engineers can run a virtual experiment on complete CAD solid models or assemblies using Mechanical Event Simulation on desktop computers.

Kinematic elements can interact with impact walls and other parts of an assembly made of kinematic or other element types. Engineers can set up test runs of Mechanical Event Simulations by modeling the entire assembly with kinematic elements and processing for motion only. This means the engineer can study the motion of the event to see if it works prior to adding regular (flexible) elements for the detailed stress analysis.

Kinematic elements can dramatically speed up processing runs for regular linear static stress analysis when significant parts of the model are relatively rigid.

Download and try a **FREE** Limited-time Trial Version of Algor's Release 12 Software Featuring Mechanical Event Simulation at:
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For More Information Circle No. 514

Contents *continued*

PRODUCT OF THE MONTH

Endevco's OASIS 2000 sensor interface system combines hardware options and application software.

16

ON THE COVER

Sensors Expo, held in May in Baltimore, was the occasion for several new product introductions, including our Product of the Month, the OASIS 2000 sensor interface system from Endevco Corp., San Juan Capistrano, CA. The computer-controlled measurement instrumentation front-end provides users with an interface to a data acquisition system for a variety of sensors, including strain gauges, piezoelectric pressure sensors, and accelerometers. For more information on OASIS 2000, see UpFront on page 16.

(Image courtesy of Endevco Corp.)

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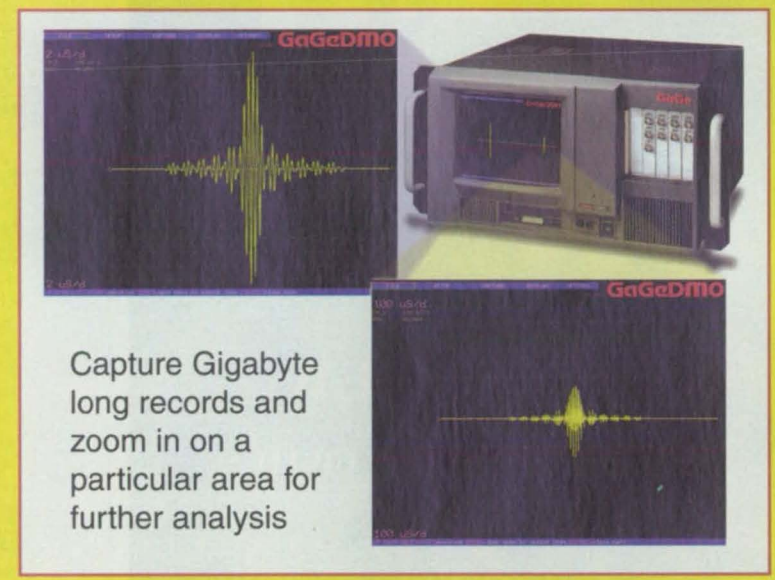

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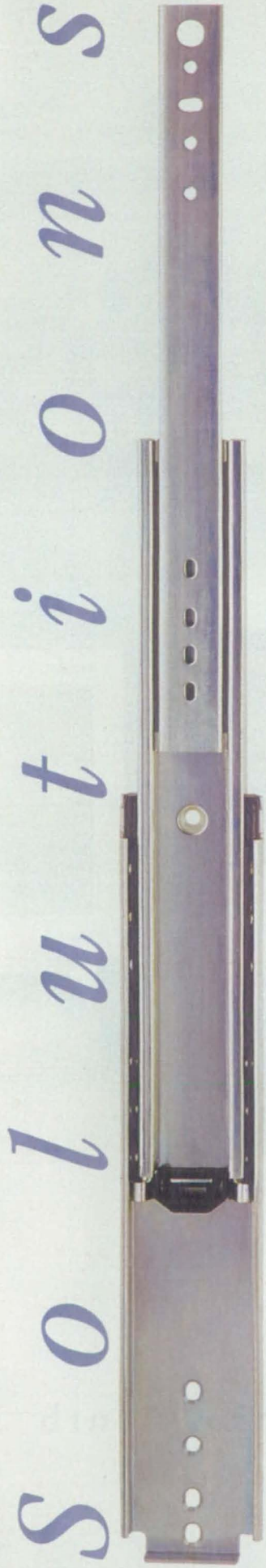

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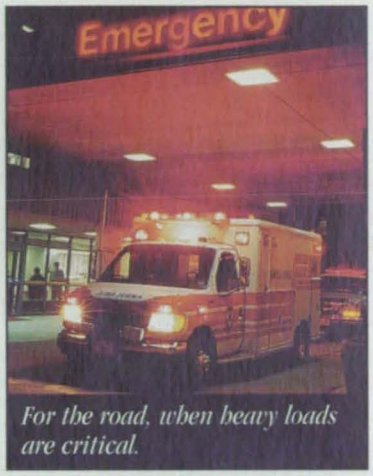

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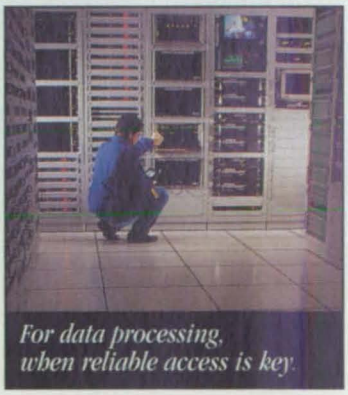

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galcorn@gsfc.nasa.gov

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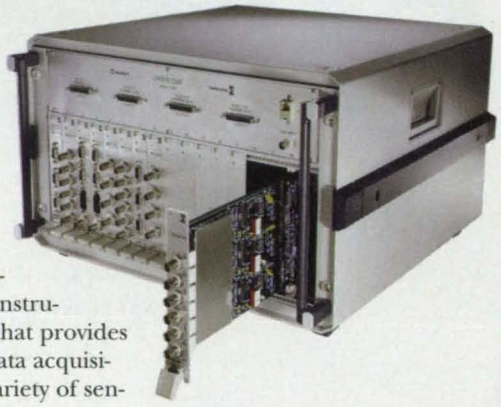

Endevco Corp., San Juan Capistrano, CA, has introduced the OASIS 2000 sensor interface system, a computer-controlled, multi-channel measurement instrumentation system that provides an interface to a data acquisition system for a variety of sensors, including strain gauges, pressure sensors, and accelerometers. The system is comprised of the Models 428, 433, 436, and 482 cards, all of which mount into a 16-slot Model 4990 EIA 19" rack. The Model 428 is a 2-channel piezoelectric/ISOTRON® card; the 433 is a 3-channel piezoelectric/ISOTRON® card; the 436 is a 3-channel DC differential card; and the 482 is an 8-channel SmartModal™ card. Windows 95/98/NT system software features a graphical user interface to record system configurations, and built-in error checking for duplicate entries.

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- Finally, the web site has been graphically redesigned to make it easier to navigate and find what you need. Let us know how you like it.

NASA and SGI Take Control

In order to fight the growing number of airline accidents and reduce airport gridlock, SGI (Mountain View, CA) has installed a high-performance Onyx2® workstation to power what NASA says is the world's first full-scale virtual reality air traffic control tower. Located at NASA's Ames Research Center (Moffett Field, CA), NASA's virtual tower is an accurate approximation of real air traffic control towers found in America's largest airports, including Chicago's O'Hare, Dallas/Fort Worth, and Atlanta's Hartsfield.

"With runway accidents growing 15 percent a year and passenger traffic expected to double by 2015, this facility allows airports to widen the safety envelope and push the capacity envelope," said Yuri Gawdiak, project manager for NASA's Aviation Safety Program. "Controllers, pilots, and airline operators can test air and runway scenarios without the risks of trying it live."

The two-story, 5,130-square-foot facility uses the SGI workstation to process 3D graphics, imaging, and video data in real time. Using data sources such as satellite imagery, digitized photographs, and architectural data, the system can portray any airport in the world in realistic, 360-degree, high-resolution virtual reality through the tower's 12 tempered-glass windows.

NASA's virtual airport tower allows air traffic controllers to move around as they would in a real tower. Computer-generated images simulate weather conditions, seasons, time of day, and the movement of up to 200 aircraft and ground vehicles. The top floor of the tower is a 24-foot diameter tower cab that

supports 12 air traffic control positions. The lower floor can house up to 8 ramp control and airport operators, and up to 13 "virtual" pilots to support the airport simulation.

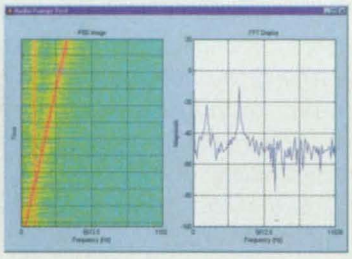
"We can determine if changing traffic patterns in arrival and departure corridors under certain weather conditions could increase safety," said Nancy Dorighi, deputy project manager for the virtual airport tower at NASA. "We can also use the simulator's panoramic IMAX® theater-style view of airport terrain to optimize the deployment of emergency vehicles and communications systems."

For more information on the virtual airport tower, visit the web site at: http://sdtf.arc.nasa.gov/sdtf

NEW
DATA ACQUISITION TOOLBOX NOW AVAILABLE

Now you can acquire data directly into MATLAB.

The new MATLAB® Data Acquisition Toolbox makes it easy to acquire data directly into MATLAB. This new toolbox allows you to communicate with a variety of data acquisition devices, including plug-in boards from National Instruments, Hewlett Packard VXI hardware, and PC sound cards. Acquire, analyze, visualize, and model from within the familiar, industry-standard MATLAB technical computing environment.



The new MATLAB Data Acquisition Toolbox lets you read data directly from acquisition hardware into MATLAB for analysis.

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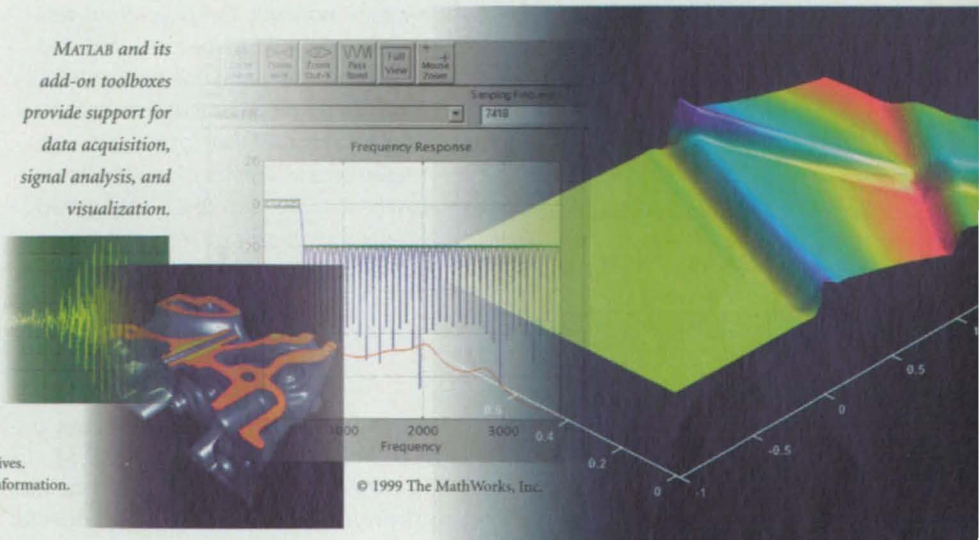

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Reader Forum

Reader Forum is devoted to the thoughts, concerns, questions, and comments of our readers. If you have a comment, a question regarding a specific technical problem, or an answer to a question that appeared in a recent issue, send your letter to the address below.

I often see supplements in NASA Tech Briefs *focusing on photonics and electronics. I do not receive the supplements in my issue. How can I get them?*

D.L. Sivco
Bell Labs Lucent Technologies
New Providence, NJ

(***Editor's Note:*** *We publish, as part of* NASA Tech Briefs, *market focus supplements called* Photonics Tech Briefs *and* Electronics Tech Briefs, *both of which are distributed to readers who indicate on their subscription forms that they are involved in those industries. However, now you can access these two supplements on-line at the following web sites:* **ptbmagazine.com** *for* Photonics Tech Briefs; **etbmagazine.com** *for* Electronics Tech Briefs.)

Your April issue featured a tech brief entitled, "Liquid-Circulation System Keeps Aircrew Members Cool" (DRC-98-86, p. 41) from Dryden Flight Research Center. I found this technology quite interesting. My son was a Dallas police officer for 13 years. He would start a shift in comfort, wearing a bulletproof vest in an air-conditioned car. After answering a few calls, however, the bulletproof vest would cause him to become hot and sweaty, or wet and clammy. NASA Dryden could get a faster and more thorough evaluation of their system if it were installed on a trial group of police officers anywhere in the "Sun Belt." They would also need some sort of liner that would wick away the moisture from the officers' bodies. If mass-producing such a system would make it economical for police forces, it would create a far larger market than the military.

Gene Trower
O'Fallon, MO

The use of a self-calibrated, multifunction sensor can reduce significantly the production and maintenance costs of engineering systems. For example, a microprocessor-based sensor that uses the same probe, but different software, to detect ice on a surface, measure fuel level, detect viscosity degradation, and measure acidity of hydraulic lines, will reduce the costs of producing and maintaining fuel, de-icing, and hydraulic systems. Our firm has developed a proof-of-concept for such a sensor, and we are looking for sources to produce and market the sensor. Any help would be appreciated.

Dr. Josef Maatuk
Max Em Engineering
Los Angeles, CA
310-652-1434

I am interested in purchasing a small sheet of tungsten for an enameling kiln. I own a wholesale/manufacturing jewelry shop, and this would be helpful since enamel does not stick to tungsten. Any information on where to purchase tungsten sheet would be appreciated.

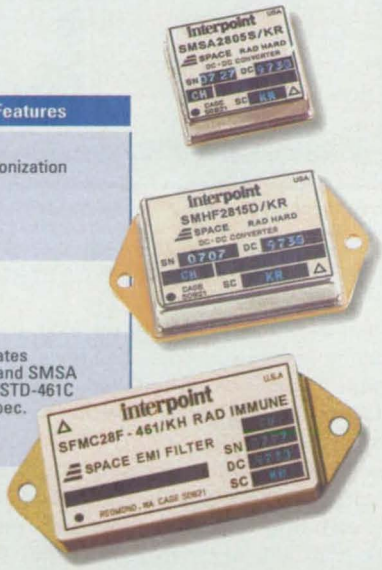
Mark Kane
mkane@swbell.net

Post your letters to **Reader Forum** on-line at: **www.nasatech.com** or send to: Editor, *NASA Tech Briefs*, 317 Madison Ave., New York, NY 10017; Fax: 212-986-7864. Please include your name, company (if applicable), address, and phone number or e-mail address.

DC/DC Converters for Space Applications

Model	Output	Output (volts)	Size - inches (mm)	Screening Options	Features
Converter SMHF	Power 15 Watts	3.3, 5, 12 or 15 single 12 or 15 dual	1.460 x 1.130 x 0.330 (37.08 x 28.70 x 8.38) Flanged (shown) 2.005 x 1.130 x 0.330 (50.93 x 28.70 x 8.38)	Class H* or K* Rad hard - 3 levels	Inhibit Synchronization
Converter SMSA	Power 5 Watts	5, 12 or 15 single 12 or 15 dual	1.075 x 10.75 x 0.270 (27.31 x 27.31 x 6.86)	Class H* or K* Rad hard - 3 levels	Inhibit
Filter SFMC	Throughput Current 2.7 Amps		2.110 x 1.115 x 0.400 (53.59 x 28.32 x 10.16) Flanged (shown) 2.910 x 1.115 x 0.400 (73.91 x 28.32 x 10.16)	Class H* or K* Rad hard - 2 levels	Attenuates SMHF and SMSA to MIL-STD-461C CE03 spec.

* Per MIL-PRF-38534



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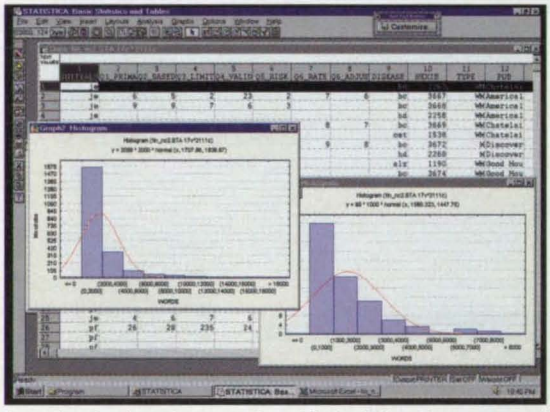
High-End Stats in a Friendly Package

Statistica 5.5

Steven S. Ross

Statistica, the high-end statistics package from StatSoft, has long been known for its clean interface and its impressive graphics output. The 1999 update, Version 5.5, offers more of the same, along with better file-handling capabilities (even HTML output) and new products for industrial settings, especially industrial quality control.

But first, a question: Does the typical engineer need a super-high-end package such as Statistica, Systat, or SAS? It depends on how you work. The review copy came just as I was getting ready to analyze data from a big project for the National Council on Aging (NCOA). NCOA wants to know why older women fear breast cancer far more than heart disease, even though heart disease is three times more likely to kill them. To help answer that question, I had built a database of 11,500 articles and had hired students to content-code 1,300 of them. The result: Two large data sets. The bigger one, consisting of all the articles, included publication date, type of publication, word count, and disease discussed (breast and lung cancer, heart disease, osteoporosis, Alzheimer's). The smaller data set, of coded articles, included that information plus answers to six sets of questions.

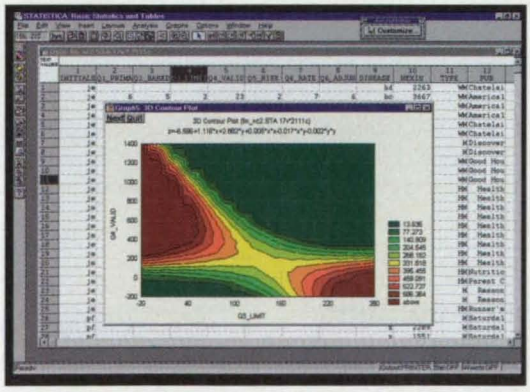


Even the simple tasks are easier with Statistica. Here, a normal histogram is plotted. In the second version (right), the program was told to optimize the case intervals. We could have used other histogram schemes, such as the Weibull.

This study, and most engineering studies as well, requires only basic statistical functions — crosstabs, ANOVA, histograms, and maybe a regression or two. And like most people, I tend to find a good package and stick with it. My current enduring friendships are with Pinpoint (an old survey program from Longman's Publishing), SPSS 6.0 (yes, SPSS is up to version 9, but who's counting?), and statistical routines I've written for use inside spreadsheets.

Could I come up to speed quickly enough with Statistica to use it for this project? And had my data been collected in a way that Statistica could handle?

First, I had to normalize the coding by ten different people — nine students and myself. Each had coded at least 100 articles. The coding questions started very specific and ended with a general "how would you rate the article on a scale of 0 to 10" question. A quick check of the average answers showed surprisingly small deviation from the average of all coders. The coder-to-coder averages were off by no more than about two points on the scale. I wanted to adjust each coder's scores by adding or subtracting an integer to get close to the average. Could I do that transform "legally?" Would I have to use fractional adjustment values? Pinpoint offers no help here. SPSS 6.0 was confusing.



Statistica is famous for gorgeous contour plots — a common sight in journal articles.

Searching Statistica for tests I rarely or never use let me check my methods with ease. My transform would work as long as I stayed away from doing any regression analysis on this question. The sophistication of high-end stats packages does count!

Statistica also can convert numeric fields to character fields, if you haven't figured out how to do that in your raw data. (My raw data was in Excel 97, which would normally treat the field as numeric. The Excel trick, which you don't need with Statistica: Save as a comma-separated variable file, with a blank row as the first record of "live" data.)

The accumulation of these tricks makes it tough to contemplate changing statistical software. But it is clear to me that I want to get to know Statistica better. A lot better. I have a new friend.

What about you? The full package goes for $1,095. But you may want to spend your money a different way. There's a "Quick Statistica" version with all basic statistical methods and more, along with all the great graph options of the full package. It's only $495. Then go for the Process Analysis or Design of Experiments add-on ($495 each) to get as much industrial statistics as most people need. There's also a Quality Control Charts free-standing program that works with Statistica or the add-ons (but doesn't require them) for $695. Have trouble designing experiments in the first place? StatSoft offers a free-standing Power Analysis package for $495. There are also enterprise-wide solutions for process control and "mining" old data. A development library comes with the full program. Use it to build your own functions for specialized tasks in Visual C++, Visual BASIC, FORTRAN, or Statistica BASIC.

You can reach StatSoft at 2300 E. 14th Street, Tulsa, OK 74104; Tel: 918-749-1119; Fax: 918-749-2217; www.statsoft.com.

Steven S. Ross is associate professor of journalism at Columbia University, New York, NY. He has authored three commercial software packages, including a units conversion program and an engineering calculations program.

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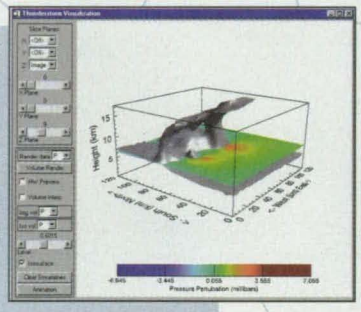
SIGGRAPH 99: Connecting With Technology

The Los Angeles Convention Center will be home to SIGGRAPH 99, the 26th International Conference on Computer Graphics and Interactive Techniques, from August 8-13. Technologies that enabled some of the most significant achievements of the century — including the World Wide Web, advanced telecommunications, medical imaging, engineering design tools, and virtual reality — will be on display at the SIGGRAPH 99 Exhibition, which runs from August 10-12.

In addition to the hundreds of companies that will be exhibiting innovative computer graphics and interactive technologies — some of which are described on the following pages — SIGGRAPH 99 will feature a comprehensive conference program covering tracks such as Modeling, Rendering, and Interactive Techniques. For more information on SIGGRAPH 99, visit the web site at www.siggraph.org/s99/.

Booth 403



Interactive Data Language (IDL) data analysis and visualization software from Research Systems, Boulder, CO, allows users to analyze data from tests, experiments, or images, as well as to write applications for others to use. Features include object-oriented programming, advanced image processing, interactive 2D and 3D graphics, volume visualization, integrated mathematics and statistics, flexible data I/O, a cross-platform GUI toolkit, and program linking tools. **Circle No. 755**

Booth 1101

PHANTOM Desktop technology from SensAble Technologies, Cambridge, MA, allows engineers and other 3D professionals to utilize the power of touch to shape their designs and interact with 3D digital data in applications such as product visualization and simulation, molecular modeling, and seismic data analysis. Currently available for Windows NT and SGI workstations, the PHANTOM Desktop device features ergonomic engineering, a parallel port interface for ease of installation, and a compact footprint. **Circle No. 764**

Booth 2361

Solid Modeling Solutions, Bellevue, WA, in conjunction with HarmonyWare, offers IGES/SMLib™ translation software for translating IGES data formats into and out of SMLib. It allows reading and writing of IGES files, interfacing with the geometry kernel of SMLib. The software is suited for use in CAD applications. **Circle No. 758**

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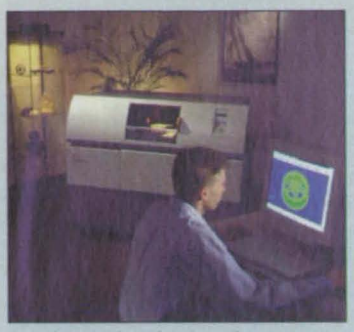
Booth 937

3Scan™ version 1.0 3D object scanner from Geometrix, Santa Clara, CA, enables users to generate fully textured 3D models of objects in minutes. It does not require users to stitch together textures and geometry obtained from multiple scans to reconstruct the complete object. The scanner replaces proprietary scanning hardware with a computer-controlled digital camera that takes multiple images of an object as it rotates on a turntable. From the images, the system software extracts the complete 3D geometry of the object and creates textures that are mapped onto the geometry. The resulting model can be output in a variety of file formats. **Circle No. 757**



Booth 501

3D Systems Corp., Valencia, CA, has introduced the ThermoJet Solid Object Printer, a parts printer that turns computer images into physical 3D objects. Users creating mechanical parts with CAD software can send the file to the printer over an ordinary office network. Within hours, the printer produces a sample in a plastic-like material that the designer can evaluate. The system also enables users to detect flaws immediately. Files can be sent over any network, including the Internet, making the machine a 3D "fax" to send models anywhere. **Circle No. 759**

Booth 1936

Charles River Media, Rockland, MA, publishes books and software tools for computing professionals. Titles include "Form-Z Modeling for Digital Visual Effects and Animation" by David Rindner. The form-Z modeling software has a full range of surface and solid modeling capabilities. The book covers all topics of design, including production workflow, layering strategies, surface constructions, character modeling, and integration of form-Z with other environments. A companion CD-ROM includes demos of form-Z, RenderZone, and other related software. Tutorials and examples guide users through fine points of form-Z in order to maximize the capabilities of the software. **Circle No. 763**

Booth 2211

The VIVID 700 non-contact 3D portable color digitizing system from Minolta Corp., Ramsey, NJ, converts objects into 3D coordinates and color texture data for input into a workstation. Designed for computer graphics, virtual reality, industrial design, and rapid prototyping, the system eliminates the need for tape and pen-type sensors when digitizing objects. 3D data can be acquired in the same way as when photographing an object. Zoom and autofocus functions can be used to define the target object. Software included with the system enables users to select specific points on the target object to be viewed, modified, modeled, or scaled. The system segments an object into 200 x 200 range points and into a 400 x 400-point color image in 0.6 second. An ATA-PC card enables the system to operate without a workstation. **Circle No. 760**

Booth 2258

Western Scientific, San Diego, CA, offers the InFusionX3 workstation/server that features up to four Pentium III Xeon processors, and the ability to run Red Hat Linux, Windows NT, and Windows 98 on one machine. Also available will be the Tempest-RAID, a RAID solution for users requiring speed and fault tolerance in a compact, desktop RAID system. **Circle No. 761**

Booth 2434

ShadowBox PC-based automatic 3D scanner from CamSys, Troy, NY, uses natural light, a CCD camera, and a motorized turntable to generate fully textured 3D models from physical objects. The system features accuracy of 10-50 microns, and generates surfaces using proprietary technology. Object scanning typically is completed within 15 to 60 seconds, and the surface is generated within 20 seconds to two minutes, depending on resolution and details desired. The scanner features triangle decimation capabilities for manipulation of the final surface display. Data can be exported directly to applications such as Windows, Alias | Wavefront, and 3D StudioMAX. Objects as small as one cubic centimeter or as large as 50 centimeters in diameter can be modeled within system tolerances. **Circle No. 762**

Booth 1910

Xenofex 1.0 special effects software from Alien Skin Software, Raleigh, NC, includes 16 special effects for use with Photoshop and other graphics programs. The software allows users to create realistic natural phenomena, and features distortion filters such as Flag, which provides realistic 3D rendering of rippling surfaces. Also included are effects such as Rounded Rectangle and Stamper. A user-friendly interface and 160 presets are included. **Circle No. 776**

Booth 529

FibreSTORE RAID systems from Ciprico, Plymouth, MN, offer end-to-end Fibre Channel storage solutions, combining the company's FibreSTORE JBOD disk arrays with single or dual FibreSTORE RAID controllers. The system's 100-MB-per-second host interface provides maximum Fibre Channel bandwidth to support applications running under ordinary file systems. RAID systems encompassing from 5 to more than 100 disks with multiple terabytes of storage capacity can be created. Up to 16 independent five- or nine-disk storage volumes can be defined within a single RAID system. The systems include redundant drives, power supplies, cooling fans, and controllers that can be serviced without system interruption. The controllers and disk enclosures feature local point-of-use displays, indicators, and keypads. **Circle No. 778**

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Suspension Devices for Vibration Testing of Structures

A simple, inexpensive support includes a noncircular cam, a torsion spring, and a cable to replace more complex supports used in vibration testing of space structures. Earlier supports did not present the full dynamic conditions of outer space.
(See page 34.)

Seven-Element Circularly Polarized Patch Antenna

Because of the recent allocation of commercial communication frequencies around 2.4 GHz, the antenna developed originally for this frequency for satellite communications may find applications in cellular phone and mobile communication systems.
(See page 44.)

Fabricating Diamond Membranes Using Reactive-Ion Etching

An improved, faster process involves chemical vapor deposition of diamond onto a silicon substrate, followed by conventional photolithography and subsequent reactive-ion etching to remove part of the substrate.
(See page 48.)

Metal-Surfaced Ceramic Insulating Blankets

Flexible thermal-insulation blankets made of ceramic fibers can be protected against weather and handling by attaching thin metal face sheets. The metal sheets protect the ceramics against flow-induced stresses and reduce aerodynamic drag.
(See page 49.)

Portable Device for Chemical Fixation of a Biological Sample

The device is mechanically resilient, small, and easy to use and is thus well suited for field and laboratory.
(See page 55.)

Wicks for Initiating Hydroponic Growth

A material developed for space suits is found to be useful in making wicks to support seedlings and to carry water and nutrients to them during hydroponic growth. Another promising application is in wick-based evaporators and humidifiers.
(See page 55.)

MMIC Converters for K- and Ka-Band Communications

Monolithic microwave integrated-circuit (MMIC) frequency converters have been developed for use in satellite- and ground-based communications at frequencies from about 18 to 30 GHz. These and similar converters are expected to be in big demand in the next few years.
(See page 59.)

Determining Superconductor Inhomogeneity at Room Temperature

A new technique for determining inhomogeneities in high-critical-temperature superconductors involves scanning a small eddy-current probe over a flat surface of the specimen at room temperature while monitoring the inductance of the probe. Earlier methods relied on cryogenic apparatus.
(See page 63.)

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Resin Technology Group, LLC (RTG), a wholly-owned subsidiary of Loctite Corp., Hartford, CT, manufactures epoxy, urethane, acrylate, light cure, and hybrid technology adhesives for industrial bonding applications. In November 1998, RTG was selected by Thiokol Propulsion, Brigham City, UT, to supply replacement adhesives for Space Shuttle Reusable Solid Rocket Motor (RSRM) nozzle bonding applications. Thiokol Propulsion, a division of Cordant Technologies, is the NASA contractor that manufactures the RSRMs, formerly known as solid rocket boosters.

Two solid rocket motors used during launches provide 80 percent of the thrust needed to lift the shuttle from Earth and propel it into orbit. During their two-minute flight, the rocket motors travel 25 miles into Earth's atmosphere, reaching a speed of over 3,000 miles per hour. Once solid propellant burn is completed, the solid rocket motors separate from the shuttle and descend back to Earth. With the help of several parachutes to slow them down, the rocket motors splash aft-end down into the sea at approximately 60 miles per hour. The rocket motors are then recovered and returned to the Thiokol facility for postflight assessment, refurbishment, and reuse.

Each solid rocket motor is comprised of four sections: one forward, two center, and one aft, which includes the nozzle assembly. Each RSRM is approximately 12 feet in diameter and 126 feet tall, weighing 1.2 million pounds.

Since 1974, Thiokol has been using high-strength epoxy adhesives to secure the phenolic rings to the steel or aluminum housings of the nozzle. The phenolic rings provide thermal protection and structural support to the nozzle, while the metal housings provide structural support. Bonding of the nozzle assembly is critical to the safety of the shuttle, as failure of the phenolic-to-metal bond could result in the possible failure of the solid rocket motor and of the flight itself.

The thermal shock and vibration experienced during handling and transportation of the RSRM units present as much

TIGA 321 epoxy adhesive is used to secure the phenolic ring to the nozzle housing on the shuttle's solid rocket motor.

or more of a problem to the nozzle adhesive system as do stresses experienced during the actual space shuttle launch. The new adhesive needed to offer a minimum tensile strength of 7,000 psi, a fracture toughness of 20 in-lbs/square inch, and a working life of at least 3 hours. In addition, the new adhesive formulation had to be safer to handle, non-toxic, and less prone to obsolescence. TIGA 321 displayed tensile strengths exceeding 9,500 psi and average fracture toughness values of 32.0 in-lbs/square inch. The first use of TIGA 321 is planned for STS-91, scheduled for launch in July 2002. To meet this launch schedule, nozzle bonding will begin in August of 2000.

For More Information Circle No. 744

Flowmeter Used in NASA's Hypersonic Plane

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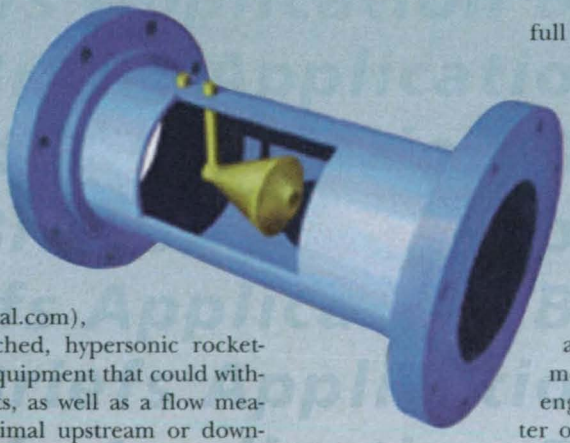

Orbital Sciences Corp. (www.orbital.com), designers of NASA's X-34 air-launched, hypersonic rocketplane, required flow measurement equipment that could withstand highly combustible propellants, as well as a flow measurement device that required minimal upstream or downstream pipe lengths. The equipment also had to repeatedly endure extreme acceleration, sub-freezing temperatures of cryogenic liquid, and severe vibration during launch.

The V-Cone® flowmeter had been used previously by NASA on several other projects. The flowmeter's design allows for full conditioning and mixing of the flow prior to measurement, and it installs virtually anywhere in a system. Six V-Cones were purchased by Orbital, and three were used in each of their two X-34 launch vehicles. They are used in both the launching and vehicle return phases.

The propellants used in the X-34 are a mixture of liquid oxygen and kerosene. Precise measurements are used to shut down the engine and estimate the vehicle's center of gravity for flight control. One V-Cone measures the kerosene; the other two measure the liquid oxygen.

Orbital plans to use the flowmeter in all X-34s they produce for NASA's Reusable Launch Vehicle (RLV) program.

For More Information Circle No. 745

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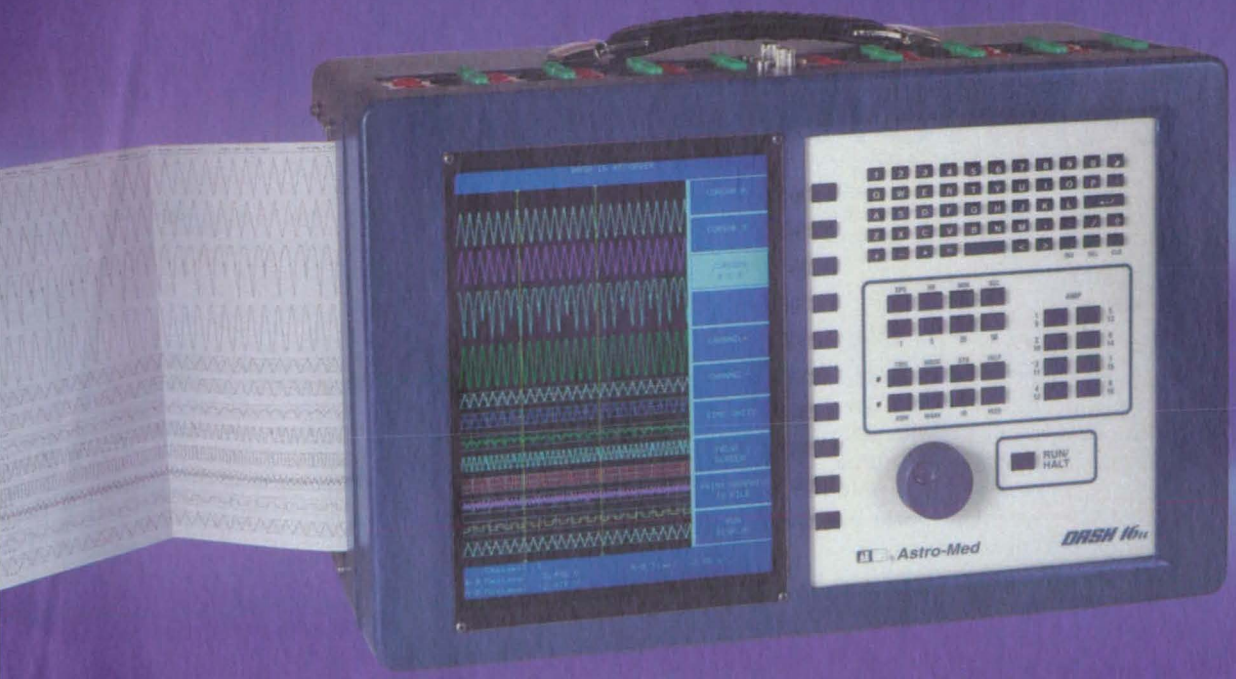

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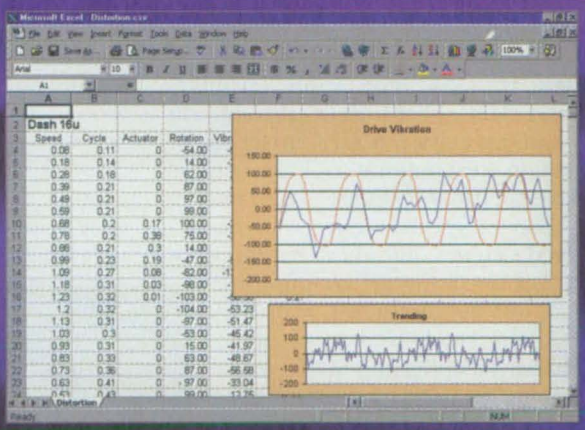

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For More Information Circle No. 560

Technology Forecast

This month's technology forecast for the test and measurement industry is contributed by David Patricy, Vice President and General Manager of the Instrument Business of Keithley Instruments, Cleveland, OH. David shares his views on the changing options in test and measurement platforms.

The convergence of new technologies and measurement needs has triggered an evolution in the design of test and measurement (T&M) platforms. For many years, commercial development of T&M systems was driven by the needs of the R&D community. As more and more high-tech products enter consumer markets, the greatest demand for sophisticated T&M systems has shifted to production applications. In these environments, pressure to produce more at lower cost largely determines test system attributes and the speed at which designs evolve.

While production T&M may not need sensitivity and accuracy quite as high as R&D applications, production often has higher throughput requirements. Also, most production test engineers want application-specific solutions; an economical way of getting these is to use PC-based systems. Still, these systems must be capable of quickly adapting to new test requirements brought about by rapid product change. Further complicating matters is a growing demand for more open T&M system architectures and web enabled systems to allow data sharing throughout the enterprise.

These are the major demands propelling change in PC-based production test architectures. The two most common ones are:

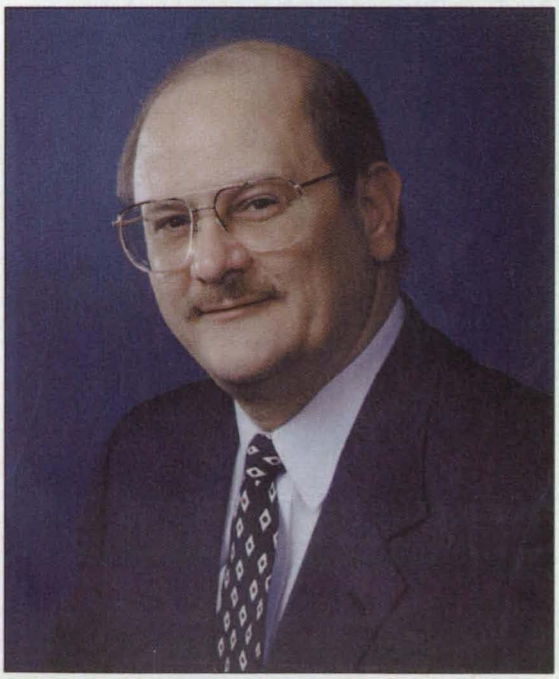
- Systems using PC plug-in boards
- Standard hardware modules and instruments connected to a PC.

Some features will change more dramatically than others.

Exploiting New Test Platforms

Plug-in board systems. Probably, the biggest change will occur in these systems. The driving force appears to be a shift in data bus technology envisioned by Intel and others. To further shrink the size of PCs and increase processing speed — with or without faster clock speeds — a slotless computing environment is envisioned. Connection to the outside world has not been fully defined, but could be some form of internal bus extension, USB data bus, IEEE-1394 (Firewire) connection, Ethernet, or other high-bandwidth bus.

With no slots, PC plug-in cards would disappear, replaced by external modules or card chassis. To adapt to the new bus configuration and take full advantage of higher bandwidth, the design of cards and modules may also have to change. However, the software giants are working on ways of minimizing this with such things as Virtual Interface Architecture and Jini technology to complement Java and ActiveX controls. Such technology strongly appeals to test engineers who must minimize production outages due to system redesigns.



David Patricy, Vice President and General Manager of the Instrument Business of Keithley Instruments.

For these reasons, a shift to slotless computers (when available) is likely to be slow in production facilities. Witness the fact that there is still a brisk market in ISA plug-in cards, even though PCI cards have been widely available for the past couple of years. The philosophy of "if it ain't broke, don't fix it" can be very powerful when a production line hums along with minimal problems. Still, a test system developer considering a plug-in card design should also think about the slow disappearance of PCs that accept these cards. Such a platform will probably be more difficult to implement as time goes on.

Standard hardware modules and instruments connected to a PC. These systems also are controlled by PCs and application-specific software. However, they use external benchtop instruments and related hardware modules to get higher sensitivity, accuracy, and other features not available with limited PC card real estate. These standard building blocks provide an economical way to create a customized system that more closely fits specific needs of a production line. Also, the DMMs and switching systems typically used in this type of platform can be reused when test requirements change. You won't have to worry about PC slots disappearing since these devices are already external.

Firewire, The Web, and More

The most obvious change to expect in future instruments and external data acquisition modules is addition of more types of data communication interface, such as USB, Firewire, and Ethernet. Currently, the prevalent interfaces are IEEE-488 and RS-232, which have significant speed limitations. The change will be welcomed by test system developers, particularly those who have tried implementing test and mea-

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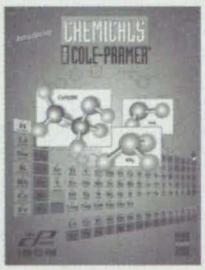

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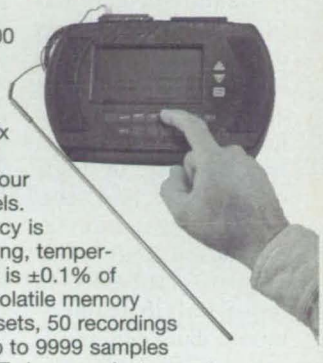

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surement over Ethernet. This is nothing like plug-and-play, often requiring what seems to be cryptic, arcane command language and hassling with PC interrupts to avoid hardware conflicts.

Under USB and Firewire, things should get a lot easier. True plug-and-play should become a reality for test instruments, much as it has for conventional PC peripherals such as printers. A Firewire interface on instruments and the PC, slotless or not, will be very attractive because of high bandwidth and the shared communication bus. A draft of the Firewire (IEEE-1394) industrial instrumentation data communication protocol is moving closer to acceptance, spurred on by the 1394 Trade Association Industrial Instrumentation Work Group. This could happen as early as the third quarter of 1999.

Even more dramatic will be the appearance of web-enabled instruments, probably based on embedded Windows CE platforms. These should start to appear within the next 12 months. The driving force behind these designs is the desire of different enterprise departments to exploit production test data to reduce costs and increase productivity. Sharing such data across secure intranet connections will become commonplace as TCP/IP protocols are embedded in test equipment with high bandwidth communication interfaces.

> ***"A test system developer considering a plug-in card design should also think about the slow disappearance of PCs that accept these cards."***

Consider what these instruments and resulting test systems bring to a manufacturer faced with large-scale validation testing. For example, new automotive designs must validate a large number of components and assemblies before they are approved for production. To accelerate the process, large batches of sample devices are tested simultaneously in environmental chambers spread across different engineering and development departments. Networked test systems and databases greatly facilitate the selection of compatible components. Authorized personnel can do detailed analysis on data from any chamber at any time, and take action if any device starts to exhibit reliability problems. There is no need to wait for a batch processed report to be generated. Similarly, test limits can be modified easily via the network, if appropriate. All of this helps shorten the product development cycle and time to market.

For more information, contact the author at Keithley Instruments, 28775 Aurora Rd., Cleveland, OH 44139-1891; Tel: 440-248-0400 or 800-552-1115; www.keithley.com.

July 1999

PHOTONICS Tech Briefs

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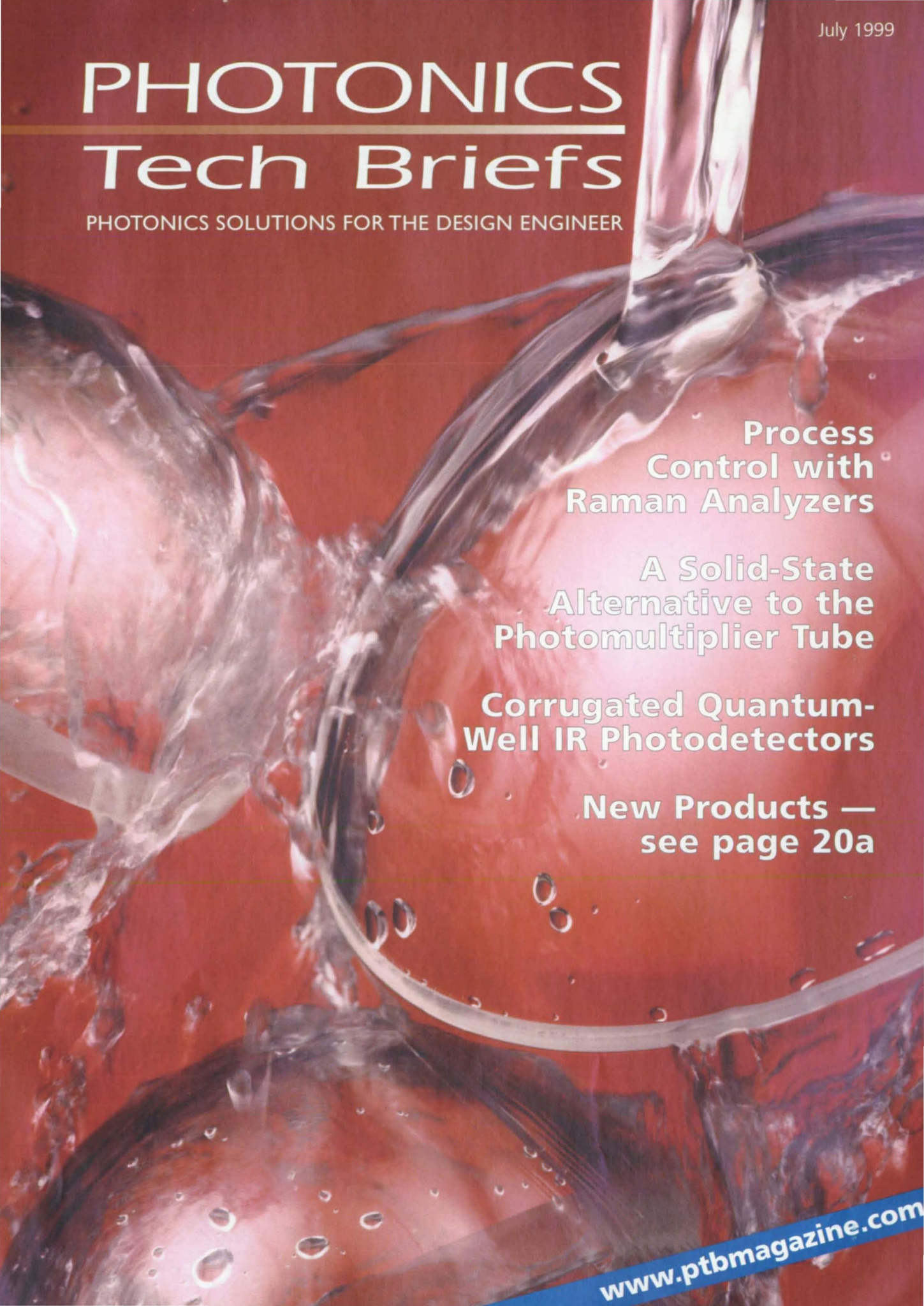

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New Products — see page 20a

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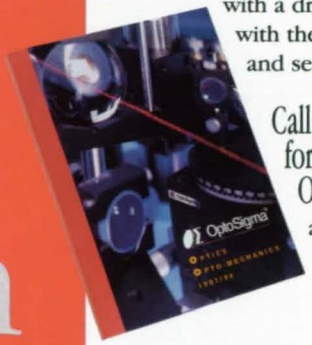

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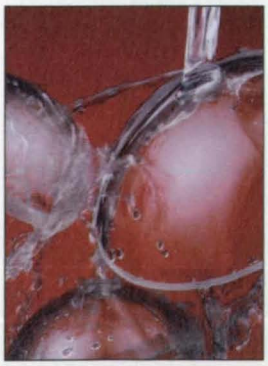

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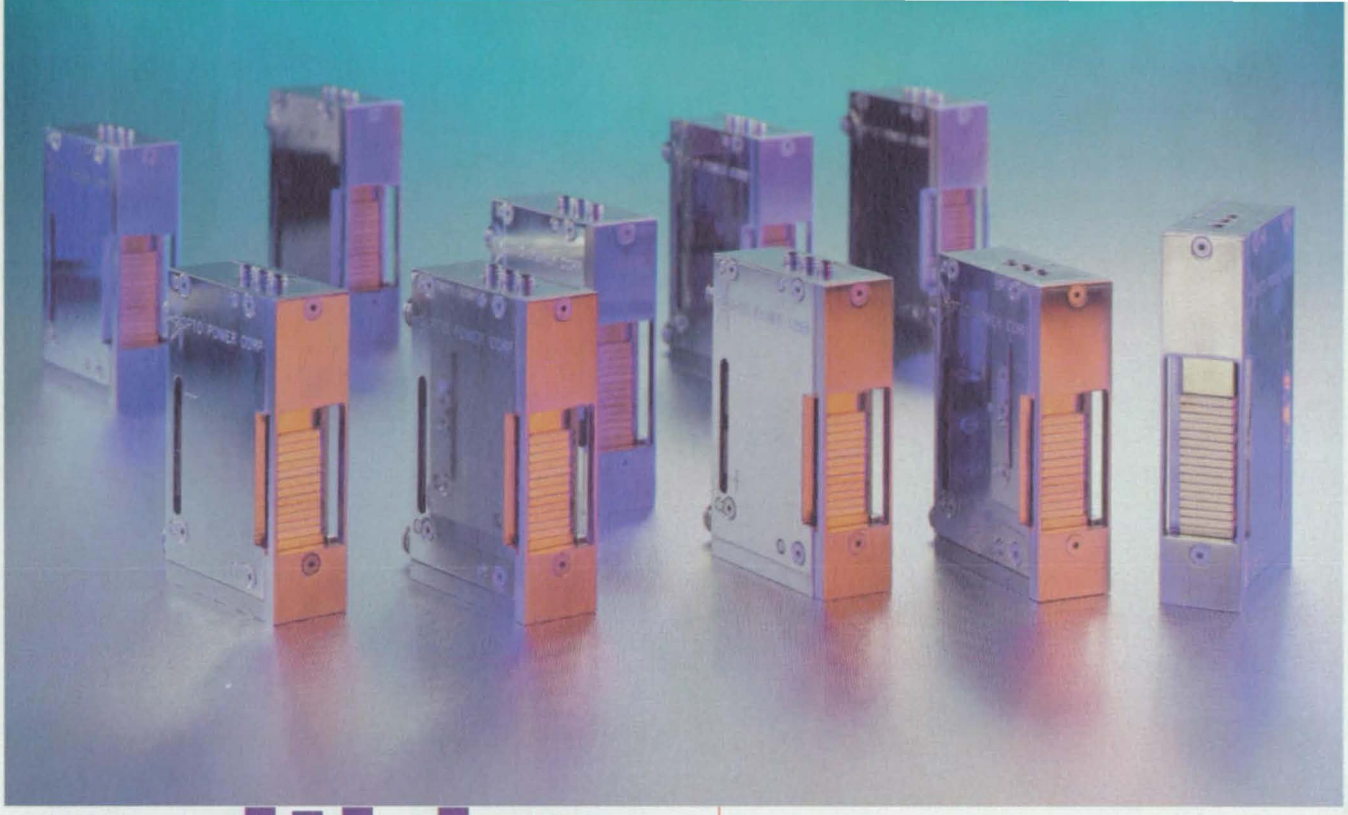

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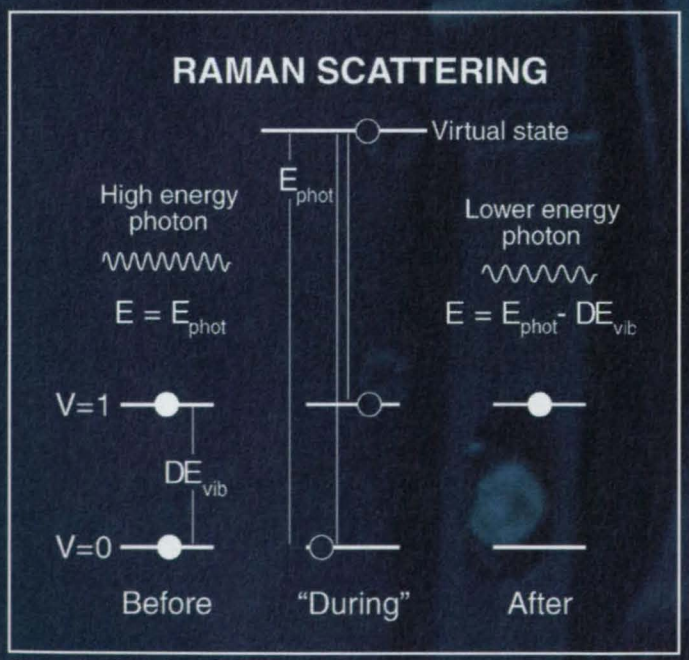

Figure 1. Like infrared absorption, Raman spectroscopy is usually used to probe signature vibration resonances of molecules. In the case of Raman, though, only part of the original photon energy is absorbed, leaving a lower-energy photon.

Many industries critically depend on the ability to make in-process chemical composition measurements of both end products and intermediates. Typical examples of this range from determining the crystallinity of polymer sheets to measuring gasoline octane. Such quantitative monitoring not only allows manufacturers to optimize production processes, but can provide direct feedback to ensure key parameters remain at specified values.

Continued on page 8a

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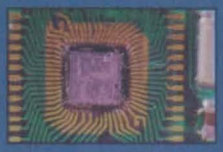

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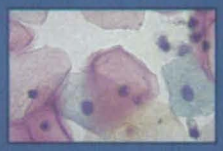

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Unfortunately, most of these measurements have traditionally entailed off-line analysis of captured samples in a plant's analytical laboratory. The most widely used techniques involve GC (gas chromatography) and HPLC (high-pressure liquid chromatography). These may require overall measurement times of up to one hour, which can have a huge cost impact on a process. Indeed, the holy grail of process monitoring has always been real-time, in-situ measurements. With recent advances in photonic technology, Raman spectroscopy is uniquely able to finally deliver this. As a result, surprisingly, industrial Raman instrumentation is now one of the fastest-growing areas of analytical instrumentation, already in use at such giants as Dow Corning, ICI, DuPont, Monsanto, Akzo Nobel, Exxon, and British Petroleum.

Raman Spectroscopy

Raman scattering was first discovered in 1928 but for many years enjoyed only limited popularity as a laboratory tool for physical chemists. In Raman scattering, a high-energy photon causes vibrational excitation of a molecule; the photon is essentially re-emitted with its energy reduced by this vibrational energy quantum (see Figure 1). If Raman-scattered light is dispersed in a spectrometer, it is seen to consist of spectral peaks and lines that are shifted from the original wavelength by characteristic amounts.

In order to ensure sharp spectra, it is important that the exciting light be monochromatic. Given that Raman is a low-probability effect, the excitation source must also be very bright, so that there is sufficient returned signal. Together, these requirements make the laser an ideal Raman excitation source. In theory, this laser can be at any arbitrary fixed wavelength, but in practice certain spectral regions are preferred.*

Raman offers a number of advantages for on-line process control over other spectroscopic techniques, such as FTIR (Fourier transform infrared absorption) and NIR (near-infrared absorption). For example, Raman provides clean, easily resolved spectral features that can be readily related to composition. Raman can be performed using visible light, which can be transmitted through low-cost glass fibers, allowing for remote measurements in a plant. Also, by relying on backscattered Raman, the sampling setup can be very simple. Using a simple imaging lens or microscope objective, noncontact measurements can be made through glass windows and bottles, for example. Packaged pharmaceuticals can even be analyzed in plastic blister packs. Furthermore, even dilute solutes in aqueous solutions can be detected because water itself produces only a weak Raman response.

Turnkey Rugged Spectrometers

Given these advantages, why did it take over 60 years for Raman to finally begin gaining acceptance for direct process control? The answer is very simple. The evolution of photonic technology has recently enabled a revolution in the way practical Raman is implemented, in terms of both performance and ease of use.

In the past, Raman required an expensive and bulky water-cooled laser. A large triple monochromator was used to scan the spectrum and separate the weak Raman signal from scattered laser light. The entire setup would fill a large optical table, consume lots of electrical power and water, and require constant skilled realignment.

The past ten years, however, have seen the maturation of three key technologies: compact, solid-state visible and near-infrared lasers for excitation, highly efficient holographic notch filters to remove scattered laser light, and cooled, low-noise CCD detectors to enable simultaneous detection of the entire Raman spectrum. Together, these enabled Raman spectrometers to be

*Shorter visible wavelengths give more intense signals, because Raman intensity scales with (photon energy)^4. Near-infrared excitation is used with samples where visible Raman could be obscured by sample fluorescence.

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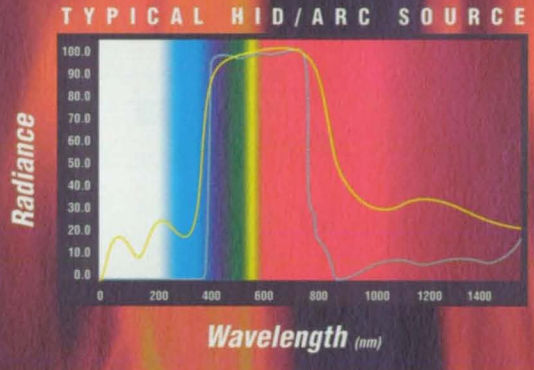

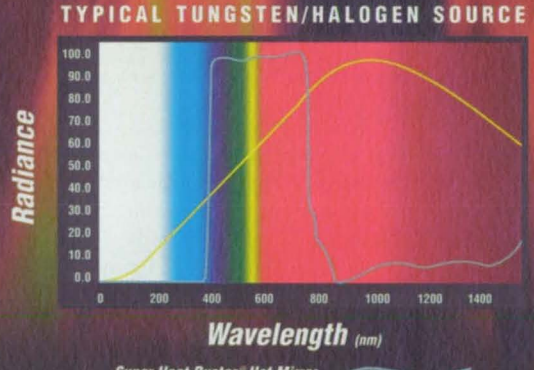

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No other hot mirror on the market can withstand the heat from your lighting system like the ***Super HeatBuster®*** from ***Deposition Sciences, Inc.*** Long after competitors' products have crashed and burned, the Super HeatBuster® keeps on taking the heat. The single-sided coating features extended infrared reflection, out to 1550nm, full UV blocking, and heat capacity up to ***550°C*** without failure. Super HeatBuster: one of a family of heat management products from DSI, longtime innovators in thin film coatings for industrial lighting and other commercial uses.

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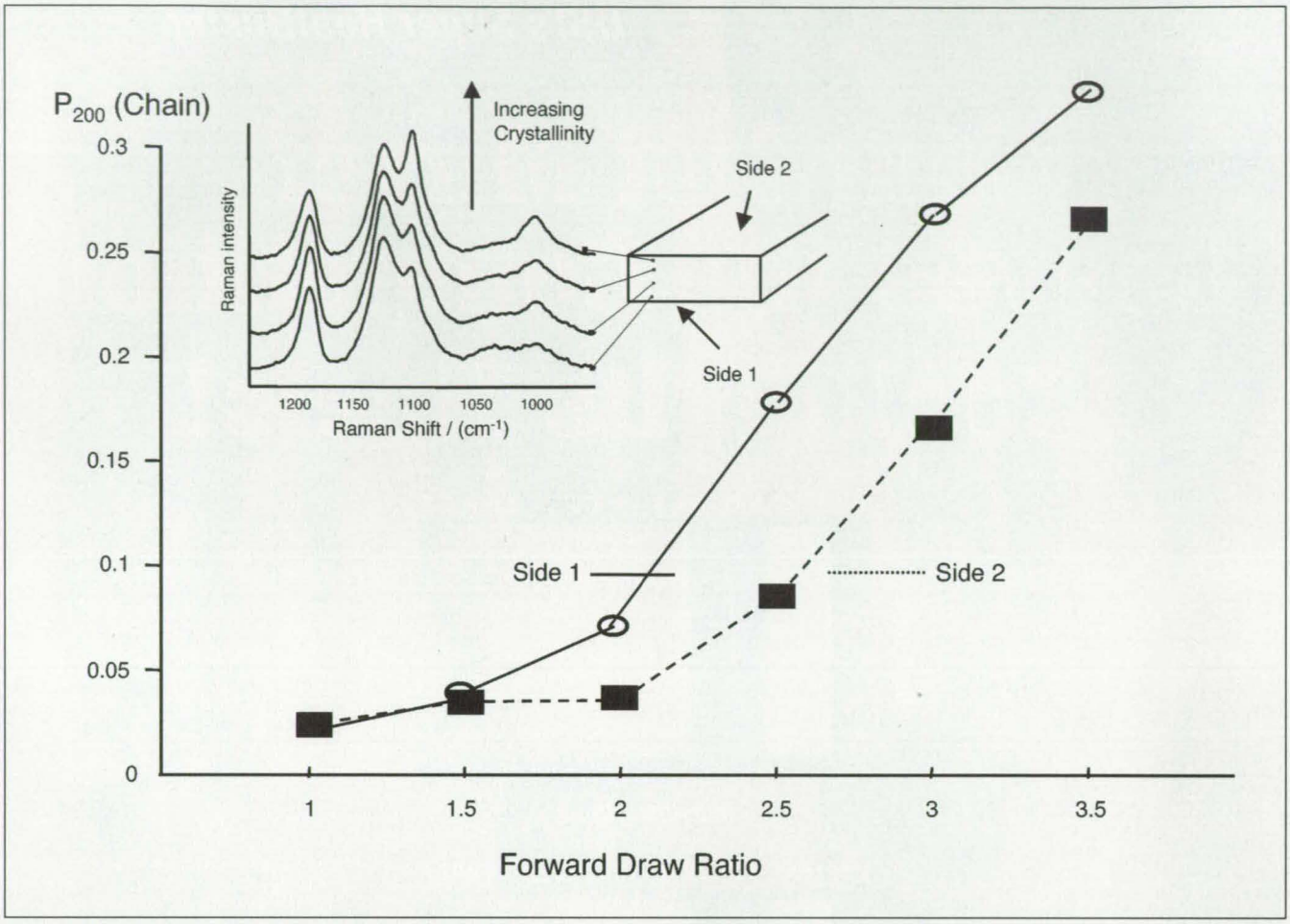


Figure 2. Variation in polymer-chain orientation as a function of draw ratio in a PET film. Both the orientation and crystallinity vary through the film. Surprisingly, these gradients are in opposite directions. Data courtesy of ICI.

packaged as turnkey benchtop instruments that are small, rugged, and simple to operate. Just as important, the combination of efficient elimination of laser scatter and low-noise detection enables these instruments to detect materials down to the parts-per-million level. In addition, because these spectrometers are all-solid-state, with no moving parts, they can also be packaged in industrial NEMA configurations as on-line process analyzers. The photo at the head of this article shows a typical example: the Kaiser HoloProbe. One of the most important features of these fiber-coupled analyzers is the incorporation of a rugged multichannel fiber sequencer, which allows the software to sample up to eight different points in a plant on demand.

Applications: Improving PET Products at ICI

Raman is now being used both to improve processes as well as to monitor and control in real time. As with any new process monitoring/control technique, the first step is to use Raman in the lab to understand precisely how the data relates to product composition and quality factors. For many years ICI has conducted this type of research at its Wilton Research Centre (Middlesborough, UK), for example on PET poly(ethylene terephthalate). This is one of the most important polyestermer materials, used to make everything from textiles to soft-drink bottles and touch keyboards.

The mechanical properties of PET products are strongly dependent on the morphology of the PET material. This includes the extent of crystallinity and the degree to which the polymer chains are aligned in a particular axis or plane. These are ultimately determined by production parameters such as melt temperature, draw speed, cooling rate, etc. In blow-molded products, for example, local PET morphology can vary

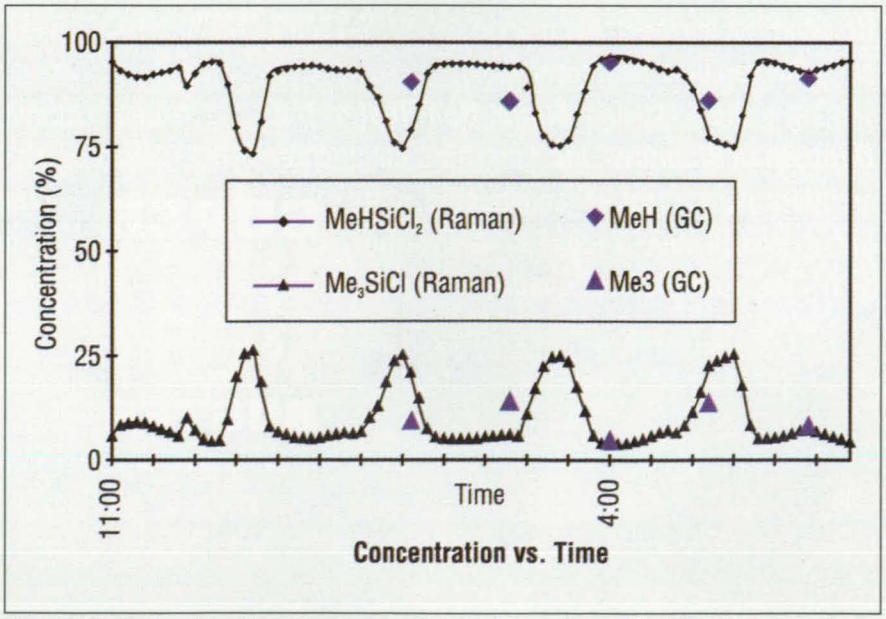


Figure 3. The Raman data at Dow Corning revealed a system oscillation that GC had been too slow to discern. Data courtesy of Dow Corning.

greatly throughout the product, an article by Neil Everall, a business research associate at ICI, explains. It has been known for some time that polymer crystallinity and orientation could be measured from the intensity of key spectral peaks, and that orientation could be deduced by measuring spectral intensity as a function of laser and signal polarization.

ICI has taken this a step further by incorporating spatial resolution into these measurements. Specifically, they have used a polarized confocal Raman microscope (Kaiser HoloProbe) to independently measure orientation and crystallinity from a range of PET film samples. As expected, ICI could follow the variation in chain orientation as a function of draw ratio. In addition they detected spatial gradients in both crystallinity and orientation through the thickness of the film (see Figure 2). Very surprisingly, these observed gradients were in opposite directions.

Monitoring Chlorosilane Production at Dow Corning

An application that has already proved its value in the on-line manufacturing environment is the use of Raman to monitor chlorosilane production at Dow Corning. Methylchlorosilanes (MexSiCly) are important intermediates in the industrial production of silicones. The problem is that these are generated by the catalytic reaction of silicon and chloromethane, which produces a mixture of chlorosilanes and methylchlorosilanes. These must then be separated and purified by sequential distillation. Since separation is costly in terms of both time and energy, it should be monitored in real time to maximize plant efficiency.

Until recently, the intermediate and final process streams in this separation were monitored by extracting hot chlorosilane samples from the process streams and using GC analysis in the laboratory. This extraction was less than simple because the hot chlorosilanes react with moisture in the air, producing corrosive HCl. Furthermore, overall sampling and analysis times were as long as 50 minutes.

Then a group led by Ronda Grosse and Elmer D. Lipp at Dow Corning's Process Research Department showed that a single Raman analyzer can replace several GC instruments. More importantly, it can make true on-line measurements with acquisition times as short as 20 seconds. Also, the measurement can be made through a window in the process stream, thereby avoiding air contact with the sample. The power of Raman's ability to make real-time measurements is demonstrated in Figure 3. This data from one of Dow Corning's pilot plant-separation columns shows a fast cycling, which the slower sampling of GC had never detected. This revelation was a significant factor in convincing the production engineers to adopt Raman in the plant. Another advantage noted by the Dow group is overall economics. Explains Grosse, "While GC instruments can be relatively inexpensive, the fact is that Raman doesn't require the expensive consumables associated with GC [pure carrier gases, replacement columns and septa]. In addition, by using a multichannel Raman analyzer (Kaiser HoloProbe), we replace four GC instruments with a single Raman instrument."

Conclusion

For many years, Raman spectroscopy remained a relatively minor laboratory technique. Now the convergence of several important photonic technologies has enabled Raman instrumentation to be packaged as a compact, cost-effective turnkey system. As more engineers come to realize the value and power of Raman, it will continue to gain prominence in such diverse fields as pharmaceuticals, petrochemicals, polymers, biotechnology, and environmental monitoring.

For more information, contact the authors of this article, Michael J. Pelletier, Senior Scientist, and Will K. Kowalchyk, Applications Scientist, Kaiser Optical Systems, Spectroscopy Products, Ann Arbor, MI. E-mail: will@kosi.com.

A Solid-State Alternative to the Vacuum Photomultiplier Tube

A cooled, large-area avalanche photodiode has been developed for flow cytometry and other low-light applications that require high quantum efficiency.

Advanced Photonix Inc., Camarillo, California

There are a number of important OEM photonic applications based on the detection of low incident light levels, including flow cytometry, PET (positron emission tomography) imaging, and applied spectroscopy. In flow cytometry, a blood sample is first treated with fluorescently labeled antibodies, which preferentially adhere to different cell types. As the cells flow through the instrument in a single-file fashion, a focused laser beam excites fluorescence. The various antibody labels each have emission peaks at different points in the visible spectrum, which are separated by dichroic optical filters and detected with photodetectors. This allows several different cell types to be simultaneously counted. In this brief a novel cooled, solid-state photodetector designed to detect low light levels in flow cytometry and other applications is described.

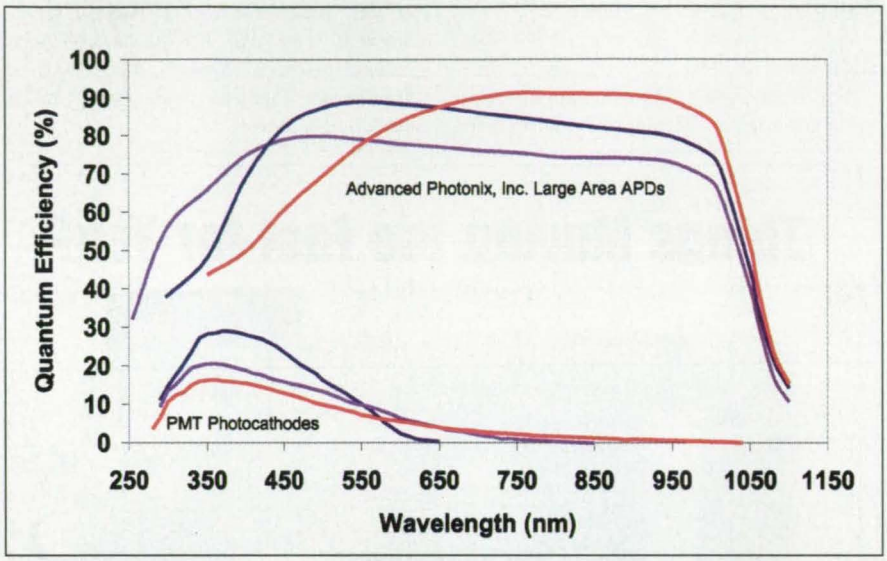
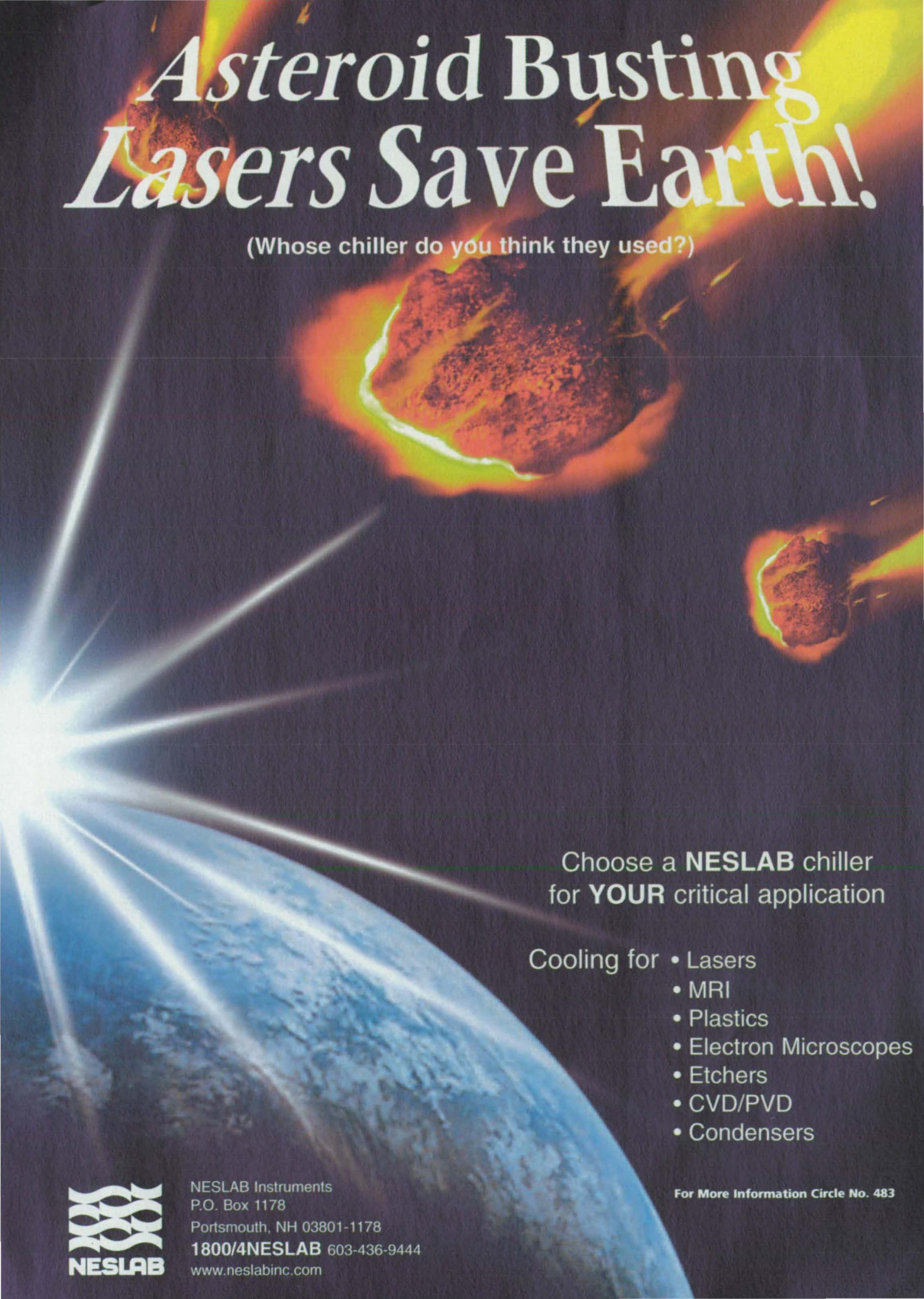


Figure 1. Comparison of the **Quantum Efficiency** of the LAAPD and typical PMT types.

The photomultiplier tube (PMT) has long been used as the detector of choice in this application. However, this detector has a number of limitations. For example, the quantum efficiency (QE) of available PMTs is only 1-10% at 670 nm, which limits the signal-to-noise ratio of the instrument and its ability to accurately distinguish fluorescent cells with the new probes.

Silicon photodiodes, on the other hand, can have high quantum efficien-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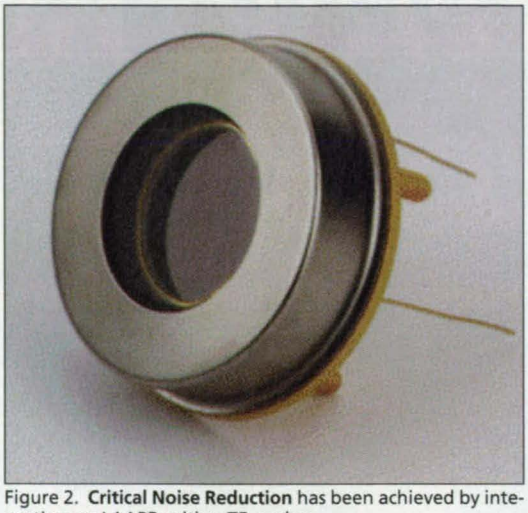


Figure 2. **Critical Noise Reduction** has been achieved by integrating an LAAPD with a TE cooler.

cies (>80%) throughout the visible and near-IR. But with no internal gain, the silicon PIN photodiode is ill-suited to detecting low photon fluxes.

The Large-Area Avalanche Photodiode (LAAPD) combines the advantages of both detector types. Originally developed by Advanced Photonix engineers for high-energy physics applications, the LAAPD offers the ideal combination of extended spectral range and high QE (see Figure 1) with substantial internal gain. In an avalanche photodiode, an incoming photon creates an electron-hole pair. The combination of low-defect transmutation-doped silicon and a patented beveled-edge architecture allows a large-area device to be fabricated that can withstand applied voltages up to 2 kV without breakdown. This large reverse field causes electrons to accelerate through the doped silicon toward the device's cathode, producing an avalanche of electrons by collisional ionization. Each initial photoelectron typically results in several hundred electrons reaching the cathode. In theory, an internal gain factor of several hundred is more than sufficient to support flow cytometry and other traditional PMT applications. And with active areas as large as 16 mm in diameter, the LAAPD can replace the PMT in instruments such as flow cytometers without requiring any optical redesign.

There are several major advantages to replacing vacuum-tube technology with a solid-state alternative. Compared to the glass-enclosed PMT, the LAAPD is much smaller and orders of magnitude more rugged. The LAAPD also offers a much greater dynamic range, with a linear response over 106. In contrast the dynamic range of the typical PMT is limited to 104, principally because of charge-cloud build-up at the anode. Continuous current draw by the voltage divider circuit is another disadvantage of the PMT in instruments, such as PET scanners, that use a number of these devices. This current is eventually converted to resistive heat. Conversely, the only current flowing through an LAAPD circuit is the photocurrent — the signal.

High QE is the biggest advantage of the LAAPD in flow cytometry. In this application, a gain of several hundred is sufficient to amplify typical signals above the noise floor of subsequent electronics. Once this noise floor has been exceeded, a more important consideration is the probability of converting an incident photon into a detected charge carrier–the quantum efficiency. Simply stated, if a photon doesn't produce a photoelectron, how much that photoelectron is amplified is irrelevant.

In a typical PMT, only 10-25% of incident photons generate photoelectrons at the photocathode, and even this efficiency is achieved over only a narrow spectral range. But in a LAAPD, the QE can be as high as 90% in the visible light spectrum (see Figure 1).

The other important consideration in low-light applications such as flow cytometry is noise from the detector itself. Both PMTs and LAAPDs benefit from active cooling. In the case of the LAAPD, lowering the temperature reduces the dark current (and hence dark noise) due to thermally generated charge carriers, and also increases the gain for a given bias. But unlike the bulky PMT, the compact LAAPD can be cooled by integration of just a tiny thermoelectric cooler. Figure 2 shows the final format that has been developed for the flow cytometry application: both the LAAPD and its cooler are completely contained in a modified TO can.

To summarize, the photomultiplier had long been the only detector choice for low-light applications. As we learn how to tailor the solid-state LAAPD alternative to important applications, Advanced Photonix expects it to displace the PMT, just as surely as the transistor replaced the vacuum tube in the world of electronics.

This work was done by a team of engineers at **Advanced Photonix Inc.**, *Camarillo, CA, including Marek Szawlowski. For more information, contact Brock Koren at (805) 987-0146: fax (805) 484-9935: e-mail: bkoren@advancedphotonix.com; www.advancedphotonix.com.*

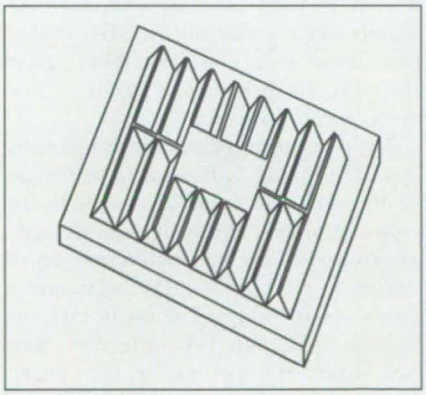
Corrugated Quantum-Well Infrared Photodetector Arrays

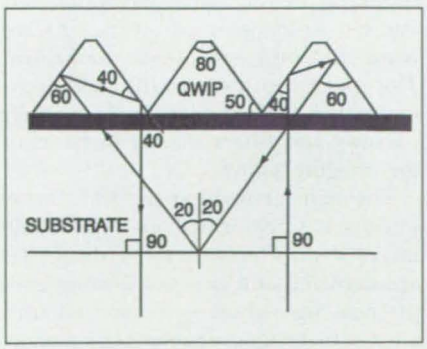
Corrugated light coupling scheme greatly advances quantum-well infrared technology.

Army Research Laboratory, Adelphi, Maryland

Corrugated quantum-well infrared photodetector (C-QWIPs) arrays are sensitive and high-resolution thermal imaging devices. They are not only suitable for a wide range of conventional military, scientific, and commercial applications but also offer new imaging capabilities, such as remote temperature sensing and polarization-sensitive detection. The C-QWIP arrays are easy to manufacture in large quantities and at a low cost. The new detector architecture thus greatly improves the quantum-well infrared technology.

Quantum-well infrared detectors emerge as a good candidate for imaging in the mid- and long-wavelength ranges. Based on the matured III-V material technology, QWIP arrays can be produced in high-resolution formats and be made to be sensitive in different wavelengths without affecting the material quality. Palm-sized cameras and cameras with noise-equivalent temperature differences less than 10 mK are commercially available. Basic mid-wave/long-wave and long-wave/very-long-wave QWIP dual-band cameras have also been demonstrated. This trend shows that the QWIP technology is maturing rapidly, and is expected to expand its market share in the near future.





The **3D Perspective** of a C-QWIP pixel element (top); the **Side View** of a C-QWIP (bottom) and the ray diagram of normal incident light.

Despite these promising developments, the production of QWIP arrays is not straightforward. A QWIP can only absorb light traveling at an oblique angle, and thus needs an additional light-coupling mechanism to sense normal incident light in the staring format. The conventional approach of using gratings at the top of detectors for light diffraction has several shortcomings. Diffraction is less efficient for small detector pixels, which limits the array's spatial resolution. Each grating design is only effective for a particular wavelength, not for broadband detection or dual-band detection. The fine features in the grating design require stringent electron-beam lithography, which greatly limits the production throughput and drives up costs. A better light-coupling scheme is thus needed. *Continued*

As shown in the figure, a C-QWIP uses total internal reflection to redirect light inside a detector. Using a special chemical etching technique, an array of V-grooves with slanted sidewalls can be etched into the detector's active volume. The unetched center island in the figure is reserved for contact bonding. The normal incident light reflects at these angled sidewalls and travels at a large oblique angle, allowing for efficient infrared absorption. Based on reflection rather than diffraction, the corrugated coupling scheme is both pixel-sized and wavelength-independent. These two important attributes improve the sensitivity of a typical array by an order of magnitude.

The new scheme is also particularly suitable for broadband detection and dual-band detection, the latter required for precision temperature sensing. A composite detector consisting of two C-QWIPs with their corrugations oriented in orthogonal directions can be used for polarization detection, further enhancing the detection capability. Since the corrugations are created during the detector's pixel separation, no extra processing steps or grating material layers are needed for the creation of these corrugations. The problems and restrictions associated with the grating approach can be completely eliminated. The production of C-QWIP arrays is thus extremely simple and of low cost. With the improved sensitivity and capability, the employment of the corrugated light coupling scheme greatly advances the quantum-well infrared technology.

This work was done by K.K. Choi at the **Army Research Laboratory**. *Inquiries concerning rights for the commercial use of this invention should be addressed to Ms. Norma Cammarata, ARL, 2800 Powder Mill Rd., AMSRL-CS-TT, Adelphi, MD 20783-1197; (301) 394-2952; fax: (301) 394-5818; e-mail: norma@arl.mil.*

Camera Images Hydrogen Fires in Three Wavelength Bands

The camera filters and processing can be customized for other multispectral imaging applications.

Stennis Space Center, Mississippi

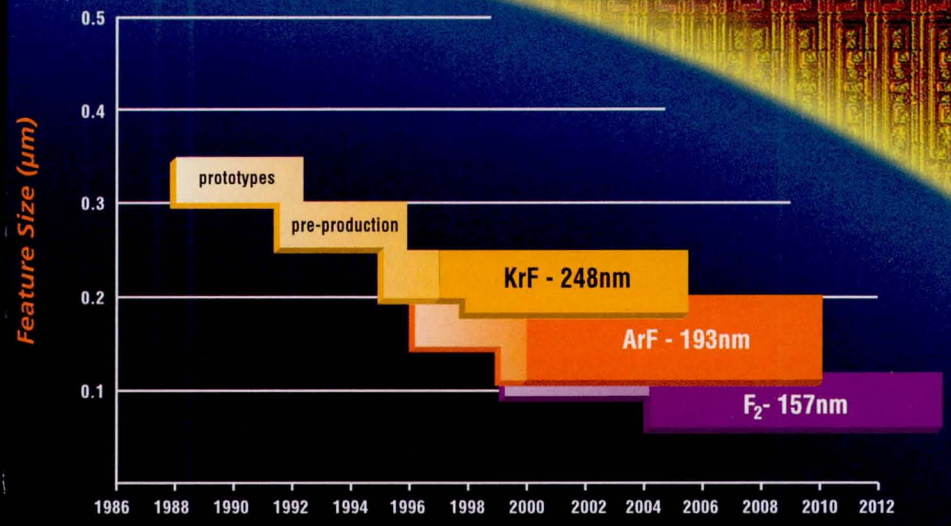
A special-purpose multispectral video camera has been designed to provide an enhanced capability for viewing hydrogen fires. Hydrogen fires do not emit sufficient visible light to be seen by the unaided human eye, but they do emit strongly at other wavelengths — especially in the infrared and near-infrared portions of the spectrum. Therefore, like some other video cameras developed previously for the same purpose, this camera is designed to respond to infrared light emitted by hot water molecules in hydrogen flames. Going beyond previous designs, this camera provides a combination of imaging in three wavelength bands and processing of the three images, all for the purposes of (1) reducing spurious responses to background light and solar radiation, and (2) synthesizing an image of a hydrogen flame overlaid on an ordinary visible-light image of the scene that contains the flame.

The camera includes custom optics similar to the color-separation prisms found in broadcast video cameras, but operating in different spectral regions. Instead of separating the red-green-blue light, this camera separates the incoming light into visible and two infrared channels. The incoming light is first focused by a commercial electronic news gathering (ENG) motorized zoom lens assembly, then passed through the prism to separate it into three spectral images.

The operation of the camera is illustrated in Figure 1. Incoming light passes through the zoom lens and beam-splitting prism. The visible wavelengths are routed to the color charge-coupled device (CCD) to acquire a standard color video image. The near infrared light is split into two different channels, one to image wavelengths corresponding to the flame emissions and another to image a near-infrared wave band that omits the flame emissions. The spectral content of the light arriving at the CCD sensors is selected by narrow-band filters placed in front of the imaging arrays.

The light arriving at the CCD array sensors is transformed into electronic image data. The outputs of the CCDs are digitized and processed using proprietary algorithms programmed into an Altera programmable logic device. The background infrared (IR) image is then subtracted from the flame IR

157nm Extends Optical Lithography One Step(per) Further



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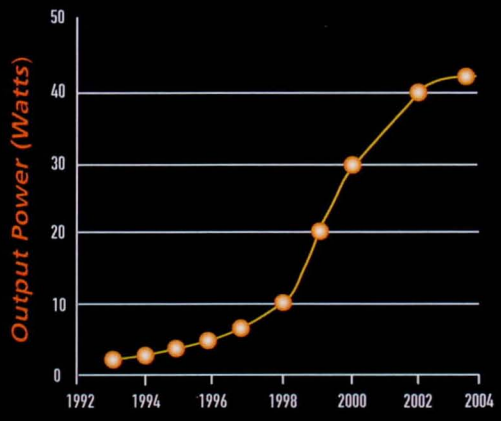

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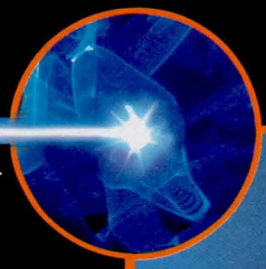

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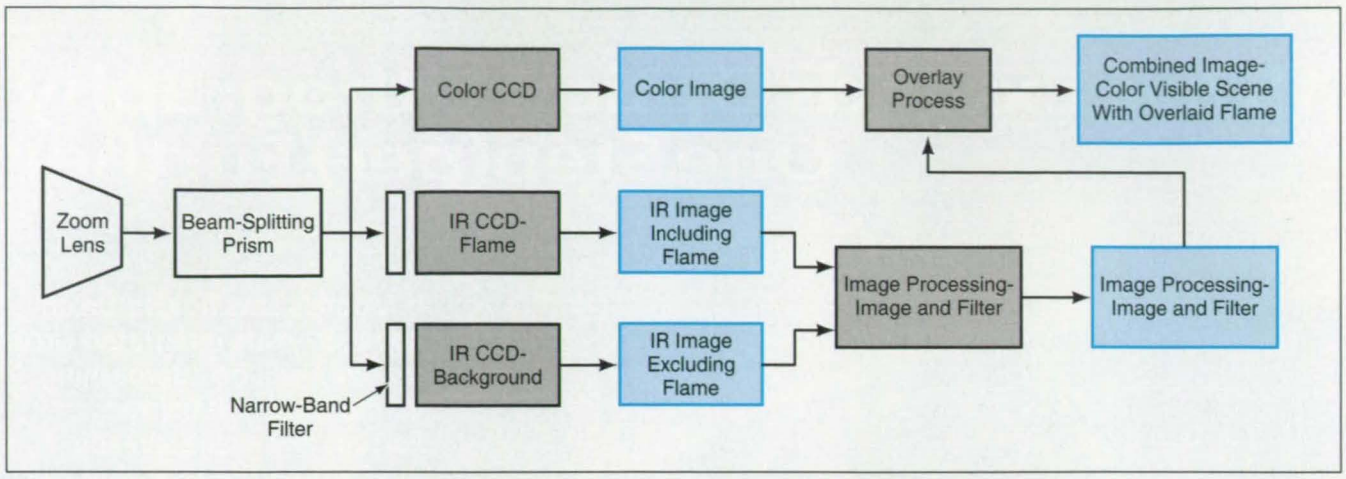


Figure 1. A **Multispectral Camera** represented here by a block diagram uses filtering and thresholding algorithms to produce a visible image of a typically transparent hydrogen fire.

image. Filtering and thresholding algorithms isolate the flame pixels. The resultant isolated flame image is superimposed on the visible image, producing a red overlay on the visible image, denoting the location and size of the hydrogen flames. A digital-to-video encoder provides a standard NTSC (National Television Systems Committee) and S-video output. Multiple modes provide output of the color, flame IR, background IR, or overlay image. Figure 2 shows the overlay mode image with the flame represented in red. The inset shows a standard color video image for comparison. An additional output mode cycles among color, flame IR, and overlay images at a fixed interval. User control of the output mode is available via remote-control input or a switch on the rear of the camera.

With an eye towards other types of future application, the camera was designed with a number of features to accommodate customized filtering and image processing. Alignment features built into each array channel allow image registration of the three images to less than one pixel accuracy. This allows the camera to be easily realigned after disassembly for filter replacement. The camera optical mounts are fabricated from low-expansion alloys to minimize temperature sensitivity. The onboard image processing is implemented with a programmable logic device that can be customized for special applications. Future versions of the camera will provide digital output from the three CCD arrays to provide a direct interface to computer systems for additional image processing.

This work was done by David B. Duncan, Greg Leeson, and Sherwood Kantor of Duncan Technologies, Inc., for **Stennis Space Center**.

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

David B. Duncan
Duncan Technologies, Inc.
11824 Kemper Road
Auburn, CA 95603

Refer to SSC-00056, volume and number of this NASA Tech Briefs *issue, and the page number.*

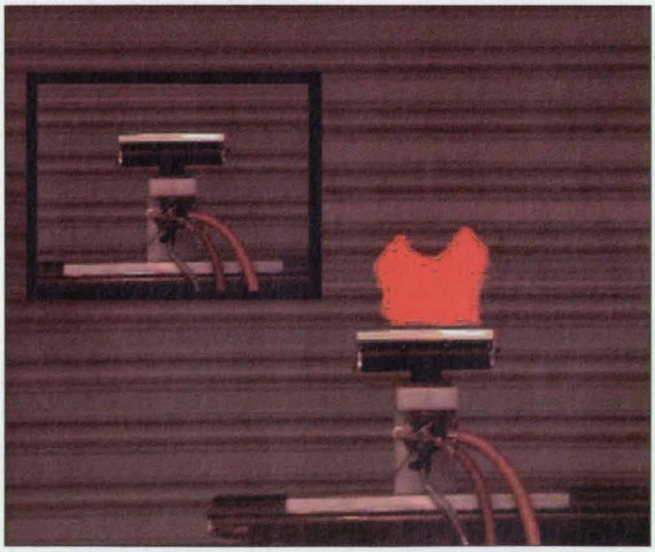
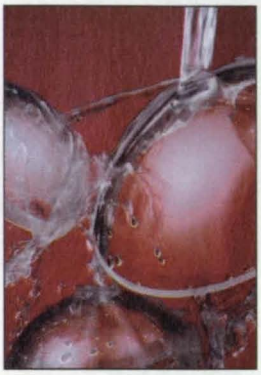


Figure 2. The **Processed Image of a Hydrogen Flame** is superimposed in red against the background, making it clearly visible, whereas the standard color video image of the same scene in the inset does not reveal the flame.

NEW PRODUCTS

PRODUCT OF THE MONTH



Optical Domes for Sensors

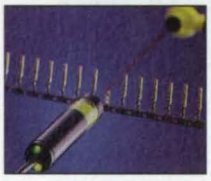
Meller Optics, Providence, RI, offers high-precision optical domes for protecting sensors and detectors from water, chemicals, moving particles, debris, and corrosive materials while extending their viewing angle. Manufactured to specifications on a 5-axis Opticam SX spherical machining center, the domes can be fabricated from sapphire, quartz, glass, ZnSe, fused silica, and silicon. The domes feature included angles to 160° and can be fabricated in sizes up to 4 in. outside diameter. They exhibit <25 microns wall thickness variation, <1 fringe/in. surface accuracy (at 633 nm), and finishes up to 20-10 scratch/dig.

For More Information Circle No. 765

Carbon Dioxide Slab Laser

Cincinnati Incorporated, Cincinnati, OH, introduces a carbon dioxide slab laser option for its cutting centers. The slab design eliminates the need for gas circulation systems, and the maintenance they require, in the typical rod laser configuration. The company says that gas consumption is lower and routine maintenance intervals are reduced to 30 percent of that of a conventional resonator.

For More Information Circle No. 767



Laser Emitter for Sensing

Banner Engineering, Minneapolis, MN, announces the M12 laser emitter, which it calls a high-precision low-power IEC Class 2 device designed for the most exacting sensing applications. The company says the M12 combines the easy alignment of a visible light beam with the increased sensing range of a laser diode light source. The collimated 670-nm red beam is 2 mm (0.08") in diameter, with a divergence of less than 1 milliradian. Banner says the M12 is useful for sensing small objects and profiles typical of the semiconductor industry.

For More Information Circle No. 770

Microfocus Laser Diode Line Generator

Lasiris Inc., Saint-Laurent, PQ, Canada, says its MFL series of laser products can produce lines as thin as 9 microns at precise working distances, for applications where the utmost accuracy and precision are required. They use Lasiris's patented uniform line-generator optics. The company says that it can deliver a wide range of standard and custom models with exceptional thermal stability and ESD protection. The line has a protected integrated laser diode driver.

For More Information Circle No. 768

CW Diode-Pumped Nd:YVO_4 Laser

Spectra-Physics, Mountain View, CA, says that the BL-106C 5.5-W continuous-wave diode-pumped Nd:YVO_4 laser offers the highest output power available from a package that measures 2.1 x 2.3 x 7.0 in. In addition to the 5.5-W version, which has M_2 beam quality of <1.1, a model with 8.5 W of CW multimode output (M_2 <3) is available. Both have 1.06-micron near-IR output. The lasers are guaranteed to run for a year without any limit on the number of operating hours, a result, the company says, of its patented FC*bar*™ technology.

For More Information Circle No 771

Laser Photoelectric Sensor

Keyence Corp., Woodcliff Lake, NJ, says of its LX2-V laser throughbeam sensor that it uses a parallel beam, not diffused light, to detect minute differences in target size, with 5-μ resolution at distances up to 300 mm. The LX2-V controller incorporates a built-in two-color digital display with 11-mm-high characters. Four sensor beamwidths, from 1 mm to 30 mm, are available. An autoscaling feature can be set up to display measurements in such units as percentage, voltage, mm, or inch.

For More Information Circle No. 774

Laser Rotary Encoder

Canon U.S.A.'s Semiconductor Division, Lake Success, NY, announces the R1Ō and R1L, the latest additions to its extensive decoder line. The company says the systems have a resolution of 81,000 square waves per revolution, the equivalent of 16 arcsec for each pulse. Maximum rotation is 5000 rpm, with starting torque of <9 g. A 780-nm semiconductor laser powers both units. Signal output is digital with the open collector output circuit of the R1Ō and the balanced line driver output circuit of the R1L. The company recommends the encoders for motion control machine tools, calibration equipment, and lens-grinding equipment.

For More Information Circle No. 766

Dye Lasers for Simultaneous UV/VIS

New from Laser Science Inc., Franklin, MA, is a series of dye lasers comprising the DUO-210, DUO-220, and DUO-221 models. Optically pumping a dye in the DUO laser with Laser Science's VSL-337ND-S nitrogen laser produces pulsed visible light. Dye solutions in cuvettes are exchanged reproducibly, giving researchers access to laser output from 360 nm in the visible to 950 nm in the near-IR. The series has dual beam-exit ports for dye and nitrogen output, so the user can choose the dye output, reflect out the unaltered nitrogen beam at 337, or insert a beamsplitter for simultaneous UV and visible output.

For More Information Circle No. 769

Portable Thermal Imaging System

Land Infrared, Bristol, PA, offers the FTI 6T thermal imaging system that combines digital processing and focal plane array detector technology. The result, the company says, is continuous real-time radiometric imaging from -5 to 3600 °F (-20 to 2000 °C). The cart-transportable sensor can be controlled from a remote keyboard or a computer keyboard. The FTI 6T provides unlimited image storage on PCMCIA cards, and Land says that the LIPS T software's Report Writer facility produces and prints color thermal reports in minutes. Thermal analysis modes include points, areas, isotherms, histograms, profiles, and alarm thresholds.

For More Information Circle No. 772

Triple Detector Array

Viscotek, Houston, TX, makes available what it calls the first integrated triple detector array. The Model 300 TDA's triple detection, according to the company, sets the standard for gel permeation chromatography and size exclusion chromatography, and is the preferred method for characterizing natural and synthetic polymers. The device employs a differential refractometer concentration detector, a four-capillary viscometer, and a light-scattering detector acting in concert.

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441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460
461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480
481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500
501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520
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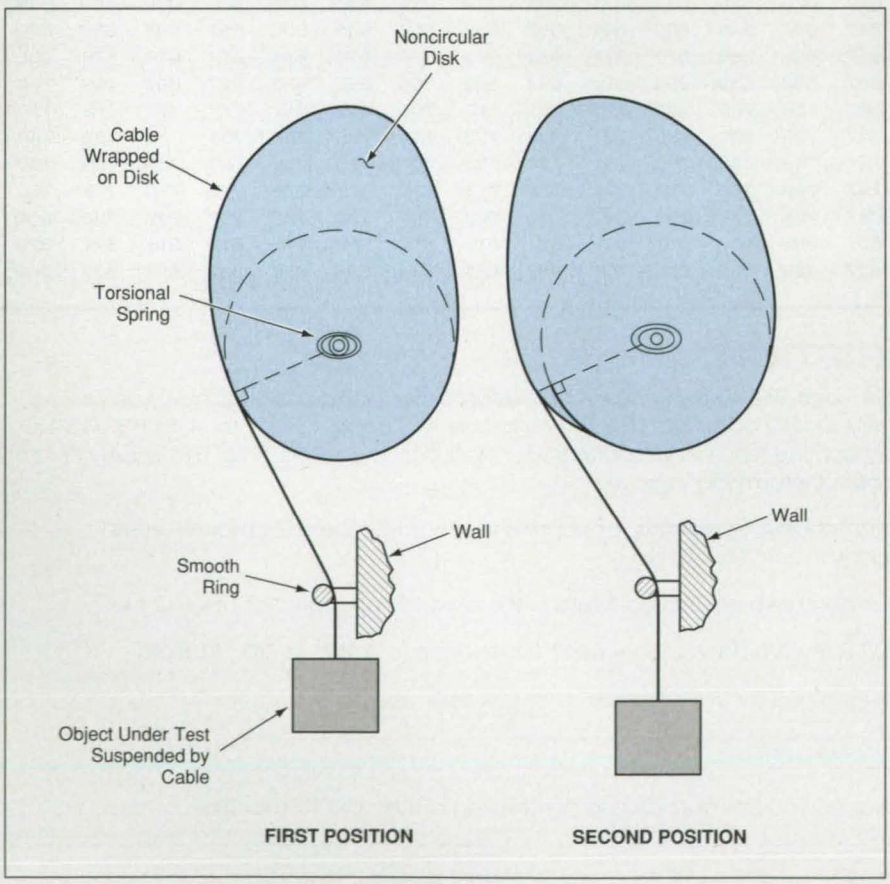
Suspension Devices for Vibration Testing of Structures

Springs, cables, and noncircular cams suspend objects in static equilibrium.

Langley Research Center, Hampton, Virginia

Space structures in general experience free-free vibrational boundary conditions that are not readily replicable on the ground. To conduct vibration tests of such structures on Earth, special devices must be used to support the weight of the structures without introducing any constraining forces that impose boundary conditions that detract from the simulation of the desired free-free boundary conditions in outer space. Previous supports all have certain disadvantages. For example, long cables entail very tall ceilings and generate undesirable pendulum effects, the masses of air pads incorporated into a suspended structure can distort the dynamical characteristics of the structure, pneumatic/electric devices are usually highly complex, and springs are limited by small domains of operation (strokes). To overcome these difficulties, a simple and inexpensive support was designed that includes a noncircular cam, a torsion spring, and a cable.

As shown in the figure, a thin cable is wrapped around the circumference of the noncircular disk. This cable passes through the smooth ring and extends downward to suspend the object under test. To prevent the cable from driving the disk and unwinding, a torsional spring is attached to the disk. The cam has a special profile designed in conjunction with the load it is to suspend and with the stiffness of the torsional spring. The torsional spring loads the cam as the cam rotates so that the torque exerted by the spring about the axis of rotation of the cam is exactly counterbalanced by the weight of the object under test.



The **Increase in Torque of the Torsional Spring** when the object moves to the second position is balanced by an increase in the moment arm on the noncircular disk, keeping the object in static equilibrium at any height.

In this concept, the profile of the disk is designed such that for any given displacement of the object under test from its original static-equilibrium position, its new position is also one of static equilibrium. This imitates what happens in outer space: any object displaced from one position of static equilibrium to another position remains in static equilibrium in its new position.

This device also simulates the behavior of the object under test when it is subjected to an impulse. When a given velocity is imparted to the object, it continues to travel at that same velocity over a considerable range. The velocity remains constant because the tension in the cable remains constant and equal to the weight of the object, so that no net driving force is exerted on the article throughout its entire range of motion. This condition simulates the motion of an object in outer space.

This suspension system is simple and inexpensive to construct. The setup is very compact, precluding the need for high ceilings or large platforms. The range of motion for the object under test can be large, providing considerably longer times for the experimental collection of data. In addition, the inertia of the system is small and therefore does not appreciably modify the dynamical characteristics of the test article. Besides the obvious applications of this system in the aerospace field, it could be applied to many everyday problems in which objects must be balanced vertically by use of systems of relatively low mass and friction.

This work was done by Meng-Sang Chew and Li-Farn Yang of Old Dominion University, and Jer-Nan Juang of **Langley Research Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category.*

This invention has been patented by NASA (U.S. Patent No. 5,207,110). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Langley Research Center; (804) 864-3521. Refer to LAR-14272.

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For More Information Circle No. 562

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For More Information Circle No. 564

MODEL 4475 ISOTRON® Power Supply

This portable 10-channel power supply, designed to work with ISOTRON transducers, features spring terminals for quick and reliable input connections, and uses an external DC power source. The unit supplies 4.7 mA to the ISOTRON and has a bandwidth of 0.2 Hz to 50 kHz. Outputs are provided through both BNC and DB-15 connectors. LED indicators display operating status. The unit weighs 2.5 lbs and is ideal for on-vehicle testing.
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MODEL 133 PE/ISOTRON® Signal Conditioner

This three-channel signal conditioner can be operated manually or by computer, using the standard RS-232 port and optional application software. It has a built-in 4-pole Butterworth high-pass filter with optional corner frequencies. Bandwidth is 100 kHz with gain range programmable from 0 to 1000. Meets filter requirements of J211 and ISO 6487. The 5.57" x 2.52" x 2" unit weighs 4 lbs.
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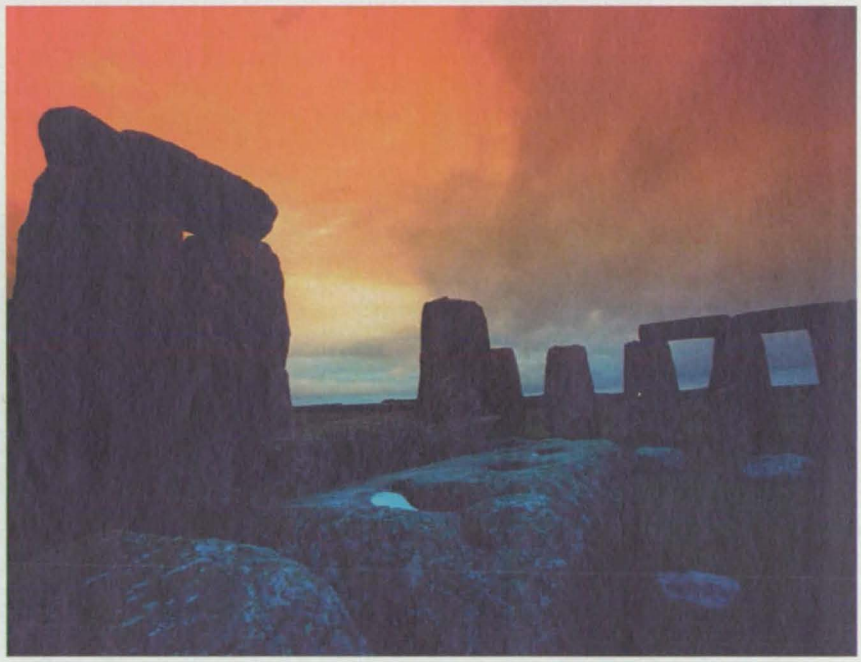

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For More Information Circle No. 567

Pistol-Grip Torque-Measuring Power Tool

Features include compactness and improved control of torque.

Goddard Space Flight Center, Greenbelt, Maryland

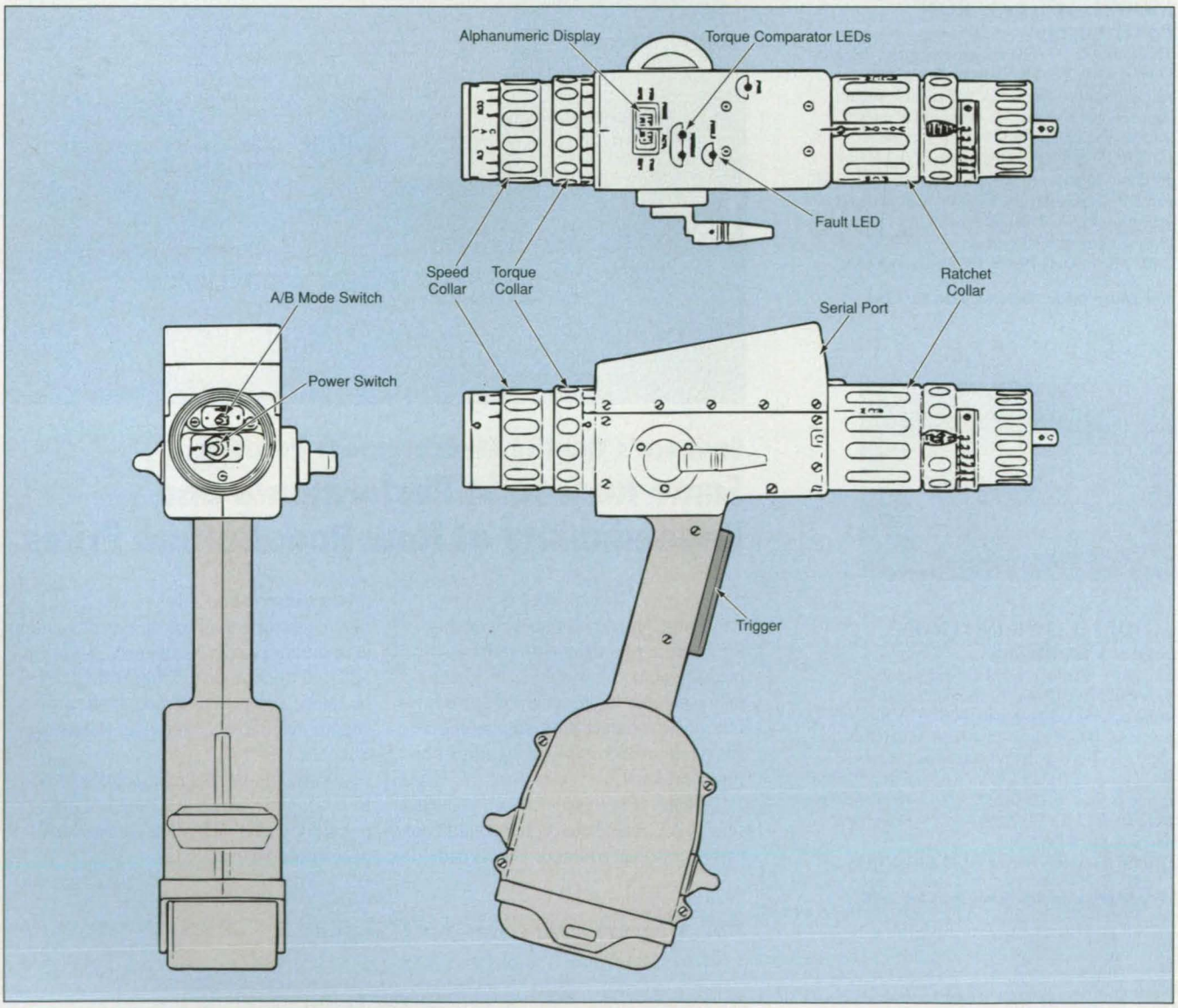
The figure shows one aspect of the exterior appearance of a pistol-grip torque-measuring power tool. The tool is a self-contained, computer controlled, 3/8-in. (≈9.5-mm) drive pistol-grip style tool. The tool is intended for use in assembly operations in which application of precise torques to fasteners is critical to safety. In comparison with controlled-torque industrial and commercial power tools now in use, the tool offers advantages of small volume and more precise control of torque. It can also be operated under battery power, with battery life extended relative to battery lives of similar commercial power tools.

The tool is capable of generating torques up to 25 lb-ft (34 N-m) and operating at speeds up to 60 revolutions/min. Numerous torque, speed, and turn count limits can be programmed into the tool through the tool's serial port. The tool is 14.17 long by 15.18 in. high (36.0 by 38.6 cm), with battery, and 2.75 in. (7.0 cm) wide.

Whereas currently available controlled-torque power tools feature open-loop servocontrol with poor torque-control accuracy, the tool includes a computer-based closed-loop servocontrol system that is programmed via software. The tool provides excellent torque-control accuracy. For each significant torque application event, the tool records data in its nonvolatile memory. Each datum characterizes the maximum applied torque and angle rotated after a threshold torque is reached. The data may be downloaded to a separate computer to ascertain the quality of the torque application and to diagnose the condition of the tool.

This work was done by Paul W. Richards, Ken Wagner, Robyn King, and Chan Park of **Goddard Space Flight Center**; *Carl Konkel, Chris Smith, Joe Rosol, and Leland VanAllen of Orbital Sciences Corp.; and Lee Brown, Randy Frey, and Mike Garrah of Swales. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category.*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center; (301) 286-7351. Refer to GSC-13706.



This **Pistol-Grip Power Tool** resembles other pistol-grip power tools in some respects, but is smaller and provides better control over applied torques.

Apparatus for Testing Vacuum Torsional Dampers

Variations in torque can be measured under realistic operating conditions.

Goddard Space Flight Center, Greenbelt, Maryland

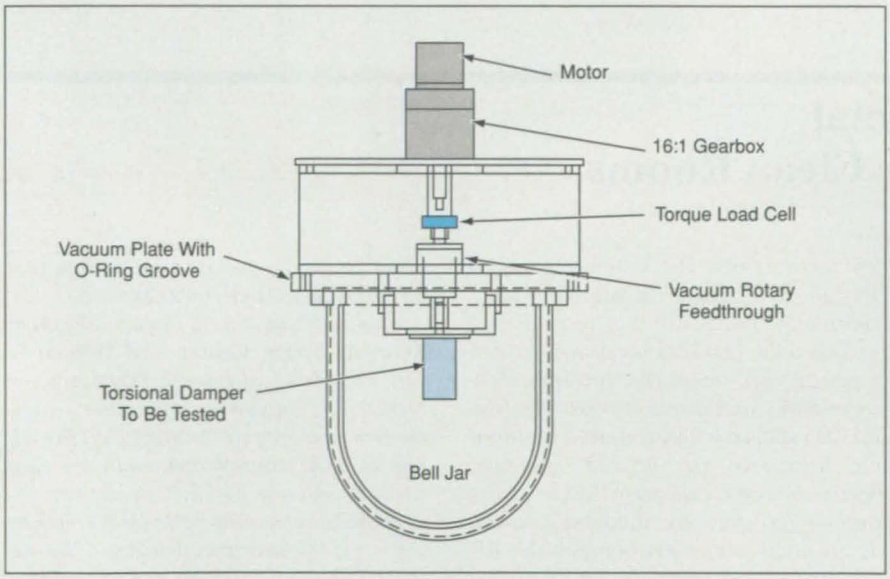
A laboratory apparatus called a "vacuum damper investigation and performance evaluation robot" ("V-DIAPER") affords capabilities for vacuum dynamic testing of torsional dampers. The apparatus was developed for original use in testing torsional dampers (rotary viscous dampers) that are destined to operate, in vacuum, as parts of rotary solar-panel-deployment and antenna-deployment mechanisms on spacecraft. The V-DIAPER can also be used to perform vacuum dynamic testing of torsional dampers designed for terrestrial use in vacuum or in air.

In the original application, for which the V-DIAPER was developed, each damper contains a paddle that, in operation, is rotated through a highly viscous liquid in a chamber. By virtue of the rotation, the liquid is forced through an orifice from the advancing side to the retreating side of the paddle; this action contributes a major portion of the damping torque. The flow of the viscous liquid in the clearance between the paddle and the chamber walls also contributes some damping torque. When the damper is placed in a vacuum, bubbles can form in the damping liquid. The bubbles cause local decreases in viscosity and thus intermittent sharp decreases in damping torque during rotation. The V-DIAPER was designed to facilitate investigation of the effects of the bubbles under realistic vacuum operating conditions.

The V-DIAPER (see figure) includes a motor and gearbox for rotary actuation of a damper under test. The damper is mounted inside a vacuum bell jar. The motor and gearbox are mounted outside the vacuum bell jar, and the output shaft of the gearbox is connected to the damper via a torque load cell and a vacuum rotary feedthrough. The load cell provides measurements of the time-varying responsive damping torque, so that decreases in damping torque associated with incidence of bubbles and the recovery of damping torque after passage of bubbles can be studied in detail. Optionally, an x-ray camera can be used for visual observation of bubbles.

In the original application, the V-DIAPER was not used only to investigate the effects of bubbles; it was also used to confirm the effectiveness of corrective measures that were undertaken in an effort to eliminate bubbles. These measures consisted mostly of improvements in the techniques for filling and sealing the dampers.

This work was done by Brian Ottens and Alphonso Stewart of **Goddard Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category.*
GSC-14093



A Torsional Damper Is Actuated in a Vacuum while its responsive damping torque is measured by a load cell. Optionally, an x-ray camera (not shown) can be used to view bubbles in the liquid inside the damper.

Redundant Fiber-Optic Transceivers for Remote Testing

Data can be transmitted at rates up to 125 Mb/s over long distances.

Stennis Space Center, Mississippi

Redundant fiber-optic transceivers have been incorporated into the High Speed Data Acquisition System (HSDAS) at Stennis Space Center, where they are used to communicate data acquired by remotely located instrumentation during tests of spacecraft engines. These and similar transceivers could also prove useful in other situations in which there are requirements for acquiring data at safe distances from instrumentation located in hostile or potentially dangerous environments.

A primary consideration in the design of these transceivers is to separate the analog-to-digital conversion hardware from the data recording device.The analog signals from a test stand could be transmitted to a safe location over long copper cables, but the signals on the cables can become corrupted through pickup of electromagnetic noise from the environment. Another approach would be to avoid long cables by tape-recording the analog signals on the test stand and subsequently transporting the tapes to a safe location for processing. This method would require extra time to digitize the data after tests. Analog-to-digital conversion on the test stand, digital transmission, and recording at a remote location make it possible to avoid both the degradation of analog electrical signals over long cables and the delays incurred through post-test digitization.

With these transceivers, the analog instrumentation outputs are digitized and preprocessed on the test stand and then recorded remotely on a commercially available high-speed data recorder. Previously, the digitizer was connected to the recorder through a 75-Ω coaxial cable that could be no longer than 50 m. The electrical output of the recorder — a modified TAXI (Transparent Asynchronous Transmit/Receive Interface) signal containing a stream of digital data at a rate of 125 Mb/s — is fed through a standard duplex coaxial interface to the first of two fiber-optic transceivers. In the first transceiver, the electrical signal is converted to an optical one, then transmitted over one of two duplex fiber-optic links to the second transceiver, which is in a safe location far from the test stand. The fiber-optic link can be as long as 25 km — much longer than the coaxial cable. In the second transceiver, the optical signal is converted back to the original electrical signal and this data is then stored on the high-speed data recorder.

Fiber-Optic Transceivers like this one are used in pairs to transmit digital signals from remote test locations at rates up to 125 Mb/s. Whereas the maximum usable length of a coaxial cable for transmission of analog signals in the original application is 50 m, the maximum length of a fiber-optic digital link in the same application is 25 km.

Each transceiver (see figure) contains two fiber-optic transmitters and two fiber-optic receivers. Under either manual or automatic control, electronic switching circuitry in the transceivers selects the transmitter/receiver pair that generates the best received signal. The redundancy of transmitters and receivers also helps to prevent communication errors that could arise from defects in the fiber-optic links.

This work was done by Joey V. Kirkpatrick of **Stennis Space Center** *and Francis Grosz, Jr., Kenny Lannes, and David Maniscalco of Omni Technologies, Inc.*

This invention is owned by NASA, and a patent application has been filed. Omni Technologies, Inc., has an exclusive license for this technology. All inquiries should to addressed to: Omni Technologies, Inc., Attn: Sean Griffin, 7412 Lake Shore Drive, New Orleans, LA 70124, Tel No: (504)288-8211. Refer to SSC-00052.

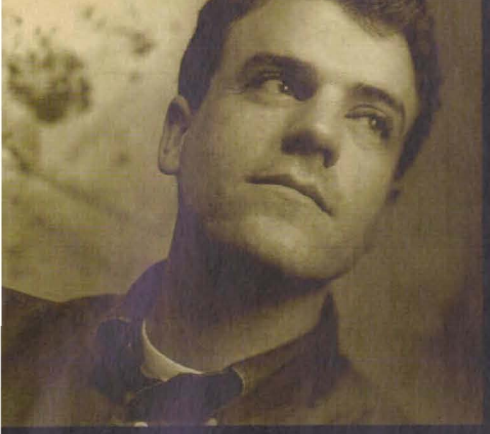
Integrated Environmental Monitoring System for Clean Rooms

John F. Kennedy Space Center, Florida

A system of electronic monitoring equipment under central computer control records and displays the readouts of environmental-quality instrumentation in clean rooms in the Space Station Processing Facility at Kennedy Space Center. The instruments include airborne-particle counters, temperature, humidity and pressure sensors, and detectors of ammonia and other gases. The monitoring system is readily configurable and expandable; it was developed to replace a system that was based on obsolescent computers and could not accommodate new instruments. The system includes a central data station, assembled from commercial hardware, that receives and records data, provides local and remote graphical user interfaces, provides security features, and prints reports. The central data station is connected to monitoring locations via RS-422 standard electronic communication links. At the monitoring locations, modular converters are used to convert between the RS-422 format and other digital or analog data formats, which include the RS-232 and 0-to-5-volt formats. This is done in order to accommodate instruments that output data in these formats.

This work was done by Paul A. Mogan of **Kennedy Space Center** *and William L. Gill formerly of McDonnell Douglas Space Station Co. For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Electronic Components and Systems category.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Technology Programs and Commercialization Office, Kennedy Space Center, (407) 867-6373. Refer to KSC-12044.



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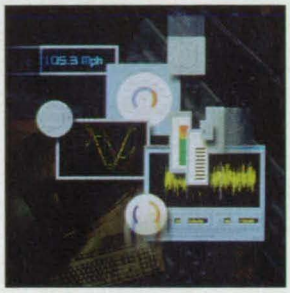
For More Information Circle No. 555



Keithley Instruments, Cleveland, OH, offers XControls **test program development software**, a library of software components that enables programmers to shorten development time in test and data acquisition applications. The suite contains 18 compact, 32-bit ActiveX controls for Windows 95/98/NT for test applications using Visual C/C++, Visual Basic, Delphi, or other development tools that are ActiveX containers.

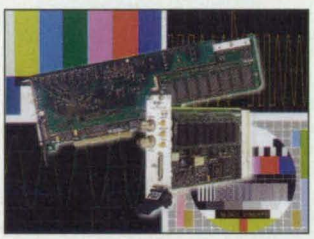
Using the software, a programmer can insert GUI controls in the form of graphs, analog meters, digital displays, lighted annunciator panels, selector knobs and dials, start/stop buttons, and toggle switches. Components include XMeter, which enables users to display data as a simulated analog meter; XSlider, which allows users to input and display a numeric data between two limit values using a linear slider; and XMMTimer, which implements a hardware-controlled timer with pre-assigned interrupt independent of the system.

For More Information Circle No. 721

The EL-SYSB AC/DC and DC/DC benchtop **power supply test systems** from ELTEST, Mansfield, MA, are available in three versions: EL-DCSYSB for testing DC/DC and VRM power supplies; EL-ACSYSB for AC/DC power supplies; and the EL-ADSYSB for a combination of both. The systems include Powerwin® software for AC/DC, DC/DC, and VRM testing; rackmountable industrial PC with keyboard-mouse and 17" SVGA monitor; power supply measurement board; load controller board; programmable DC source and/or GPIB programmable AC source; and test manifold fixturing.

The manifolds integrate the electronic loads and offer various cooling options/power levels. The Powerwin software is Windows 95-based virtual instrument software that includes a library of industry-standard test functions, providing real-time graphic presentation of captured waveforms. Any individual test selected from the library shows the test limits, guard-band margins, measured values, and optional graphic plot on the parameter being measured.

For More Information Circle No. 722



National Instruments, Austin, TX, offers three **computer-based signal generators:** the NI 5431, NI 5411, and NI 5401 signal sources that deliver analog stimulus for network analysis, video signal testing, automotive testing waveforms, and serial signals for the test and diagnostics of serial communications links. The NI 5431 for PCI and PXI™/CompactPCI computers is an analog and digital video signal generator that features a sampling frequency of 20 MHz.

The NI 5411 is an arbitrary waveform generator for PCI, PXI/CompactPCI, and ISA computers that includes all the functionality of arbitrary waveform generators, sweep generators, and function generators. It features one output channel, 12-bit vertical resolution, and 16-bit digital pattern output. The NI 5401 is a DDS-based function generator for PCI and PXI/CompactPCI computers that can generate repetitive signals, such as sine, square, triangular, and limited arbitrary with a minimum frequency of 9.31 MHz.

For More Information Circle No. 724

Lake Shore Cryotronics, Westerville, OH, has introduced the Model 218 **temperature monitor**, an eight-channel monitor that reads up to eight diode or resistance temperature sensors twice each second. The monitor displays all eight channels continuously in Kelvin, Celsius, volts, or ohms. The monitor supports diodes, Platinum RTDs, and Negative Temperature Coefficient (NTC) resistor sensors. There are two versions of the monitor: the Model 218S and 218E. Both have the same sensor reading and display capabilities.

Available with the monitor are two computer interfaces: IEEE-488 and serial. Simple computer programs can collect readings from all eight channels at the full update rate. The monitor features alarms and two analog voltage outputs. Eight relays can be used with the alarm setpoints in latching mode for error detection or in nonlatching mode for on/off control. A printer capability gives a hard copy of readings when a computer is not being used to record data.

For More Information Circle No. 723

The Model 785 Multi-Range **pressure standard** from Paroscientific, Redmond, WA, performs a variety of pressure measurements for calibration, testing, and transfer standard applications. The pressure instrument features either one or two Digiquartz® absolute and gauge pressure transducers. Multi-ranging allows each transducer to replace three separate transducers.

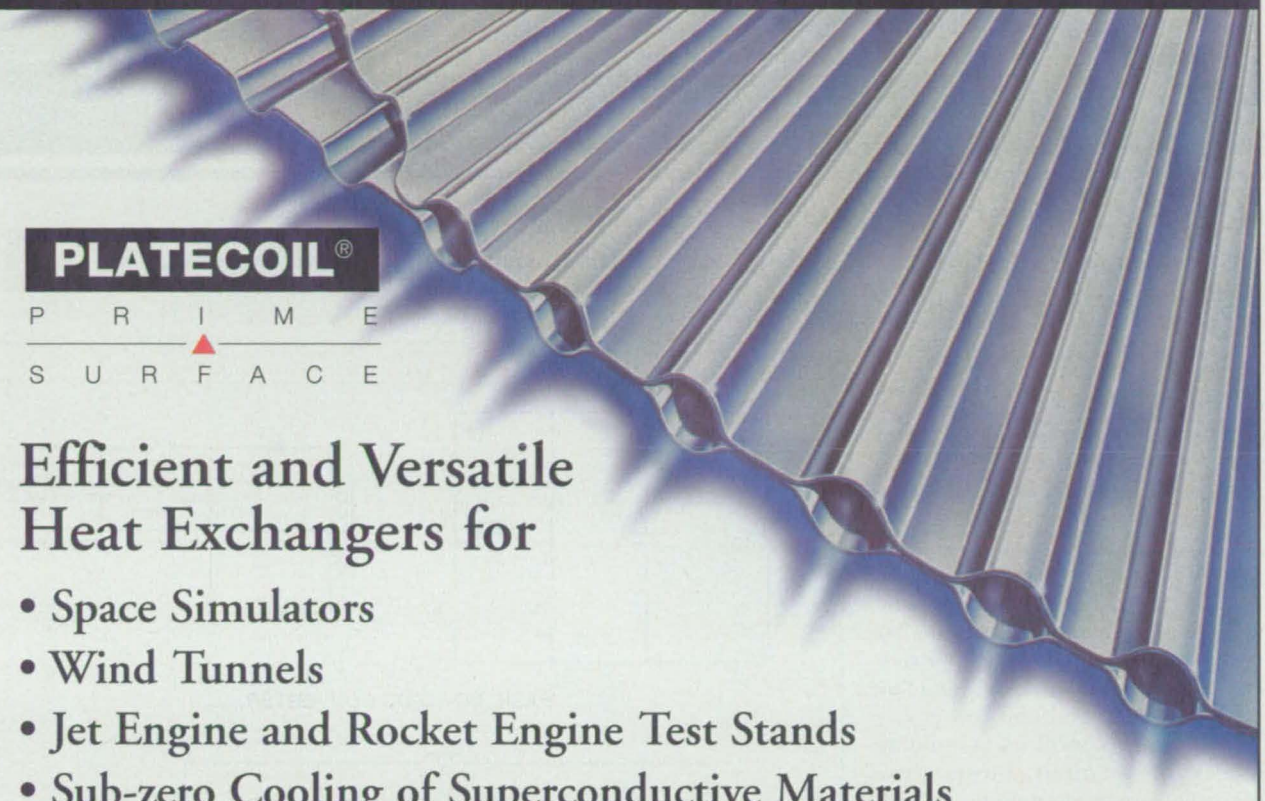
Resolution of better than 0.0001% and typical accuracy of 0.01% can be achieved in difficult environmental conditions. The instrument features push-button selection between measurement modes. A front-panel keyboard is used for local configuration and customized set-up. An automated zeroing function allows users to operate in either gauge or absolute measurement mode.

For More Information Circle No. 725

Raytek Corp., Santa Cruz, CA, has introduced the MiniTemp™ pocket-sized **infrared non-contact thermometer** for monitoring of climate control systems, electrical panels, automotive components, cooling systems, water temperature, and duct efficiency. The thermometer is powered by a 9-volt battery, and is available with an accessory package that includes a wrist strap and case.

The unit measures temperatures up to 6 feet away within the range of -18° to 260°C (0 to 500°F). Features include C or F temperature selectable switch, backlight, low battery indicator, automatic off, and a seven-second hold on the display after trigger release. Two models are available: the MT2 and the MT4, which has laser sighting for accurate aiming.

For More Information Circle No. 726



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Series-Connected Boost Regulators

Dc-to-dc converters serve as building blocks of modular electric-power systems.

John H. Glenn Research Center, Cleveland, Ohio

A series-connected boost regulator (SCBR) is, as its name suggests, an electronic circuit for boosting a power-supply voltage to a higher and regulated value. The distinguishing feature of an SCBR is an interconnection topology in which one utilizes the input/output dc-isolating quality of a dc-to-dc converter. (Other, similar terms that have been used to denote an SCBR include "series-connected converter," "series-connected boost converter," and "series-connected boost unit.")

SCBRs were conceived as building blocks of relatively inexpensive, modular power-management-and-distribution (PMAD) systems for future spacecraft. Potential terrestrial applications for the SCBR concept include output regulators and storage-battery chargers for solar photovoltaic arrays.

The top part of Figure 1 is a simplified schematic diagram of a typical dc-to-dc power converter, showing how dc isolation between the input and output sides is achieved by use of transformer coupling. The bottom part of Figure 1 illustrates the utilization of the same dc-to-dc converter in a basic SCBR, in which one connects the input "hot" terminal to the output return ("cold") terminal; in effect, the input and output are connected in series, so that their voltages add to yield a higher overall output voltage.

An important advantage afforded by an SCBR is the ability to use a dc-to-dc converter to regulate more power than it is rated to handle by itself, at an overall efficiency greater than that of the dc-to-dc converter by itself. Figure 2 illustrates the example of an SCBR that supplies a regulated potential of 28 Vdc to a load of 2.8 Ω (thus supplying a load current of 10 A). In this example, the available power-supply potential is 20 Vdc (unregulated), and one uses a dc-to-dc converter as a boost regulator to increase the load potential to the desired regulated 28 Vdc.

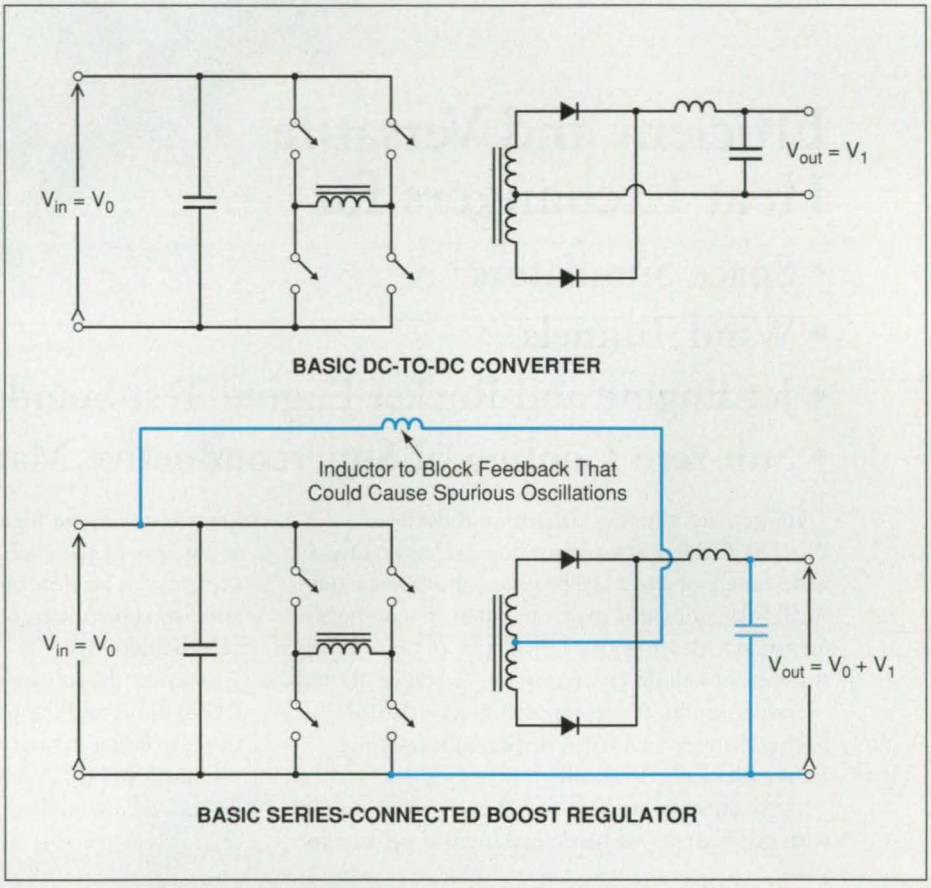

Figure 1. **A Basic SCBR Is Formed** by connecting the "hot" terminal on the input side of a dc-to-dc converter to the return ("cold") terminal on its output side.

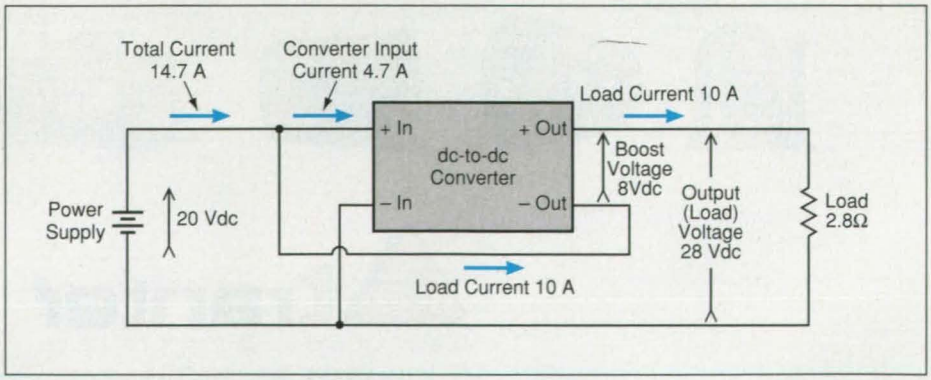

Figure 2. **Power Is Delivered** from a 20-V power supply to a 2.8-Ω load via an 8-V-output dc-to-dc converter connected and operated as a boost regulator.

The dc-to-dc converter considered by itself is rated to put out a current of 10 A at a potential of 8 Vdc (thus, an output power of 80 W) while drawing an input current of 4.7 A at the supply potential of 20 Vdc (thus, an input power of 94 W). Under these conditions, its efficiency (output power ÷ input power) is about 85 percent.

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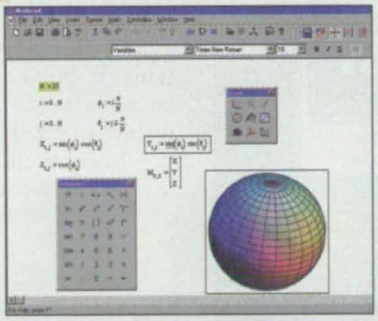

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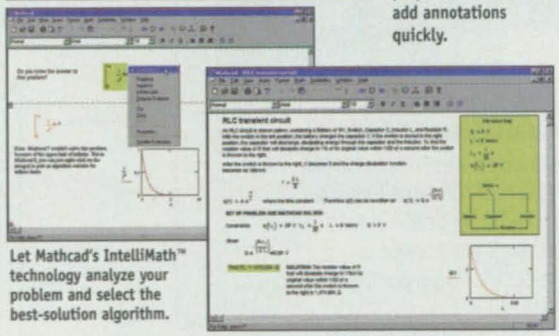

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For More Information Circle No. 550

However, the dc-to-dc converter does not operate by itself. With respect to the load current, it is connected in series with the 20-Vdc power supply. As a consequence, it processes only a fraction of the total regulated power of 280 W delivered to the load; this is the sense in which the dc-to-dc converter can be regarded as regulating more power than it is rated to handle by itself.

The current drawn from the 20-Vdc power supply in this example is 14.7 A, comprising the load current of 10 A and the 4.7-A input current for the dc-to-dc converter. The total power consumed is thus $20 \times 14.7 = 294$ W. Then the overall efficiency (regulated output power ÷ total power consumed) is about 95 percent, which is greater than the efficiency of the dc-to-dc converter considered by itself.

SCBRs can be built at relatively low cost because dc-to-dc converters are commercially available and relatively inexpensive. A basic SCBR can be used by itself or in combination with other building blocks (including other SCBRs). Other advantages of SCBRs include high power densities, adaptability to positive-ground power systems, and capabilities for high degrees of fault tolerance.

This work was done by Raymond F. Beach and Robert Button of **Glenn Research Center** *and Andy Brush of Sverdrup Technolgy, Inc. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

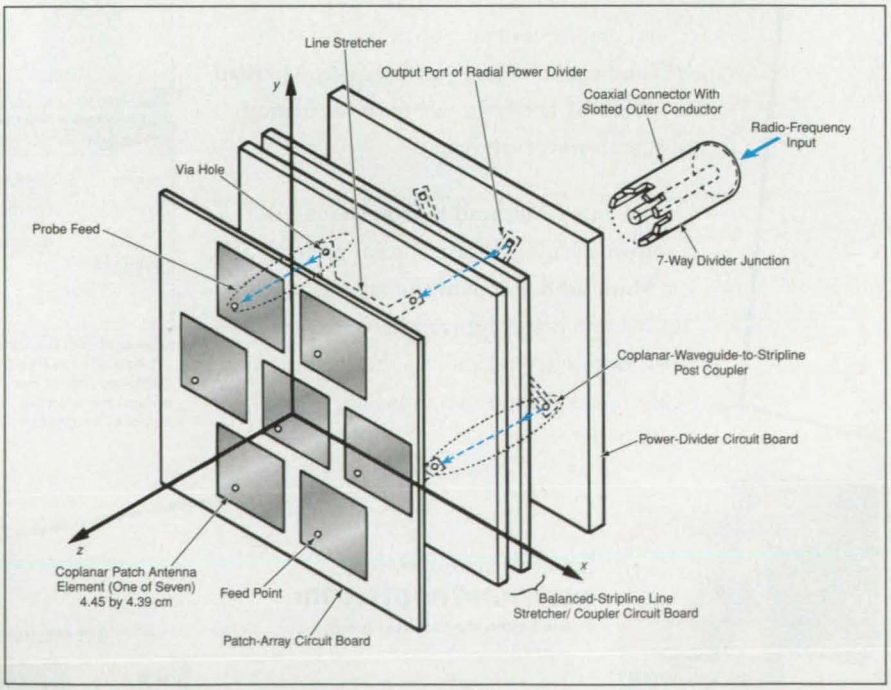
Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-15918.

Seven-Element Circularly Polarized Patch Antenna

Commercial terrestrial applications have recently been found for a spacecraft antenna.

John H. Glenn Research Center, Cleveland, Ohio

A seven-element microstrip patch antenna is designed to operate with circular polarization and high gain at a frequency of 2.2875 GHz. The antenna was developed in the early 1990s as a potential replacement for a helical antenna aboard the Advanced Tracking and Data Relay Satellite. Recently, the Federal Communications Commission allocated frequencies around 2.4 GHz for commercial communication systems. The present antenna is well suited for these



This **Seven-Element Patch Antenna** generates a circularly polarized beam with high gain. Its characteristics are well matched with requirements for commercial communication systems that operate at frequencies around 2.4 GHz.

systems, not only because it provides high gain in the desired frequency range, but also because like other patch antennas, it is lightweight, can be fabricated easily, can be mounted with a low profile, and is inexpensive. In addition, its circular polarization is especially advantageous in cellular-telephone and mobile communications, in that circular polarization can mitigate multipath fading, which is severe in urban environments.

The seven patch antenna elements are arranged in a hexagonal pattern (see figure). The patches are fed in equal amplitude and phase by a multilayer feed network that consists largely of coplanar-waveguide (CPW) and balanced stripline components fabricated at low cost by printed-circuit techniques.

Radio-frequency power from a transmitter is fed to the antenna through a coaxial cable that terminates in a coaxial connector. The coaxial connector is orthogonal to the plane of a seven-way radial CPW power divider. The inner conductor of the coaxial connector meets the junction formed by the middle strip conductors of the CPWs. The outer conductor of the coaxial connector is slotted and meets the ground-plane conductors of the CPW.

Each of the seven output ports of the power divider is connected, via a post coupler, to one of the ports of a balanced stripline line stretcher, which equalizes the signal-propagation path lengths to the seven patch antenna elements. Each port of the line stretcher is connected to one of the patch antenna elements by a post coupler that also serves as a probe feed.

The measured on-axis axial ratio (that is, the ratio between axes of the polarization ellipse) is 1.5 dB; in other words, the polarization is nearly circular as intended. The measured beam widths are 36° in two orthogonal meridional planes, and the gain of the antenna as determined from the beam widths is 13 dB. The measured return loss at the coaxial connector is more than 15 dB at the design frequency.

This work was done by R. Q. Lee of **Glenn Research Center**, *G.R. Lindamood of the University of Akron, and R. N. Simons of Sverdrup Technology, Inc. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16713.

For More Information Circle No. 408

Automating Work-Time and Attendance Recording on an Intranet

Money is saved through reduction in processing time and prevention of errors.

Goddard Space Flight Center, Greenbelt, Maryland

The OMNI time and attendance system is a workstation software system for automated, centralized recording of work time and attendance, and for flexible scheduling of work by employees in an organization. The OMNI system makes it unnecessary to perform the time-consuming and error-prone tasks of preparing, copying, transporting, or in any other way using or handling paper time cards or other paper records.

Unlike most commercial intranet client/server "groupware" designed for paperless office operations, the OMNI software is not difficult to learn, is not loaded with extra "features" that most organizations do not need, and is compatible with a variety of computers and operating systems. The OMNI software was developed, from the start, to take advantage of popular Web-browser programs (Netscape, Mosaic, and Internet Explorer) installed in many computer workstations.

The OMNI time and attendance software comprises approximately 20 computer scripts in Practical Expression and Report Language (PERL). These scripts run on a Unix workstation that supports a World Wide Web (WWW) server. Preferences can be changed by use of scripts. Administrators can use other scripts to gain access to and to change pertinent information. Supervisors can run still other scripts to obtain summary data and reports.

Employees log into the OMNI system from remote computer terminals and identify themselves to the system by selecting their names and entering passwords. The system responds to each employee by displaying, in a time-card format (see figure), the employee's work-time information as of the most recent previous entry. (This information is recorded in a database maintained by the system.) The employee can update the information by changing job order numbers (referenced by names) and/or numbers of hours worked. The employee can also enter such information as requests for leave and flexible work schedules.

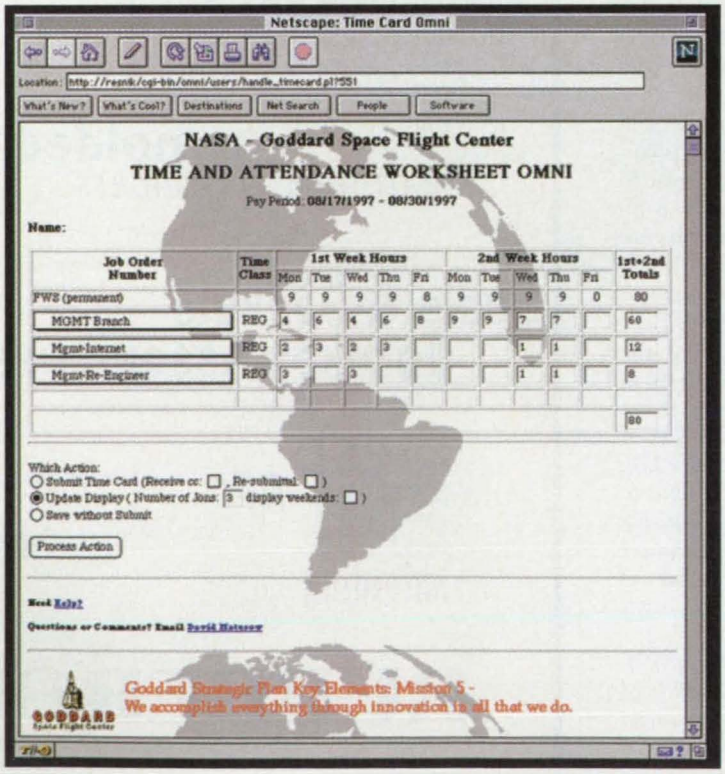
When the employee has finished updating the time-card information, the employee can save the information with or without submitting it for official recording by the system. When the employee submits the information to the system, several things happen:

- The system records the information in the database for retrieval next time.
- By electronic mail, the system sends the electronic equivalent of the employee's time card to a time keeper.

Once the electronic equivalents of time cards from all employees have been received and approved, the information from the databases is printed on time-card stock paper and sent to a payroll-processing system.

Anyone familiar with the World Wide Web can use the OMNI system. Moreover, because the OMNI system runs on an ordinary WWW server on an intranet, it is easily useable in many areas. The performance of the OMNI system for an organization is limited only by the design of the organization's intranet.

In an organization that has a high employee-to-supervisor ratio, the automation of administrative processes by use of OMNI software on an intranet is a quick and inexpensive way to save time across the workplace. For example, in an application to the former Flight Dynamics Systems Branch at Goddard Space Flight Center, the cost of implementing the OMNI system was less than one person-month of effort. Once the OMNI system was in operation, the amount of time spent processing time-card information became 10 minutes per pay period, whereas it took 10 hours per pay period to process time cards in the former paper system. An additional benefit afforded by the OMNI system is an on-line database that can be used to store and track project expenditures by employee; this makes it easier for supervisors to satisfy staffing requirements and to make accurate estimates of future expenditures by project.



This **Example of a Time-Card Entry Page** was generated in the OMNI system and displayed by use of Netscape.

This work was done by David Matusow and Joe Sparmo of **Goddard Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

GSC-13973

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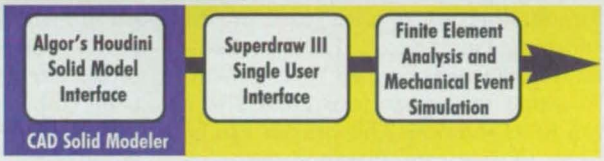

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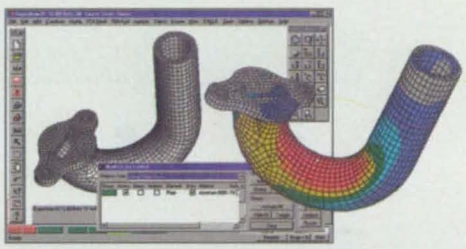

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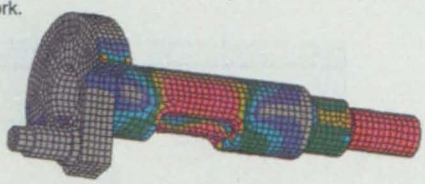

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Fabricating Diamond Membranes Using Reactive-Ion Etching

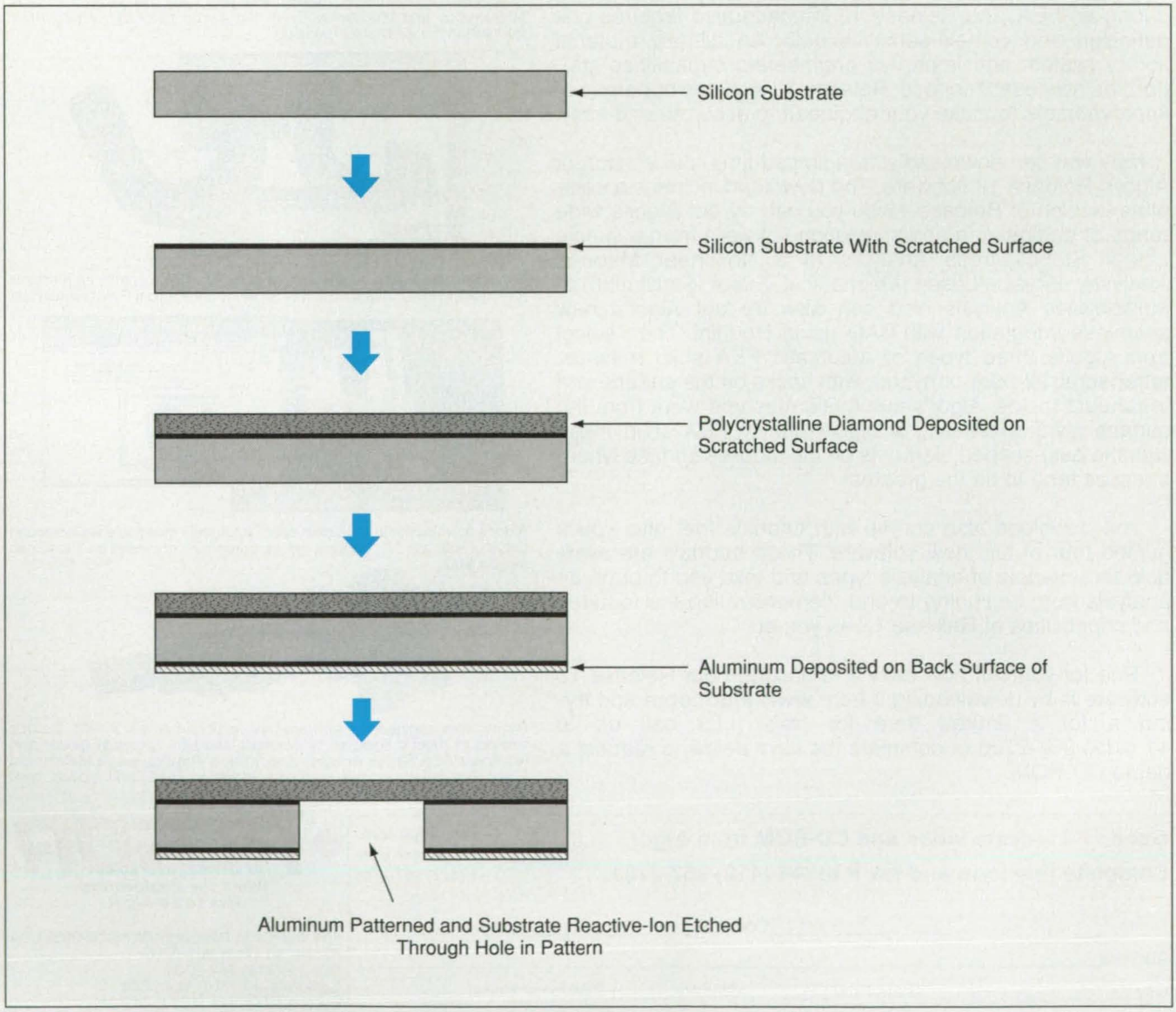
The rate of dry etching of silicon is more than 3 times that of hot KOH.

NASA's Jet Propulsion Laboratory, Pasadena, California

A process for the fabrication of a polycrystalline diamond membrane involves chemical vapor deposition (CVD) of diamond onto a silicon substrate, followed by conventional photolithography and subsequent reactive-ion etching to remove part of the substrate (see figure). This process is an improvement over an older process in which the substrate is etched in a hot KOH solution. This process can be used to fabricate diamond polycrystalline membranes as parts of microelectromechanical sensors.

The starting substrate is a mirror-smooth (100)-oriented single-crystal silicon wafer with n or p doping to a resistivity <20 Ω·cm. To increase the density of nucleation sites for diamond and thereby make it possible to obtain a pinhole-free diamond deposit, the front (top in the figure) surface of the substrate is scratched by use of diamond paste. A polycrystalline diamond film is grown on the scratched surface by CVD from a flowing mixture or methane and hydrogen, typically at a total pressure of 45 torr (6 kPa) and a substrate temperature of 950 °C.

After deposition of diamond to the required thickness, aluminum is deposited on the back (bottom in the figure) surface of the substrate by electron-beam evaporation. The aluminum film is patterned photolithographically, then etched by a commercial solution con-



The **Processing Sequence** is depicted here schematically in terms of the status of the workpiece at various stages.

taining phosphoric and acetic acids, thereby forming a mask to define the areas to be protected from, and exposed to, reactive ion etching. Next, reactive-ion etching is effected by use of a radio-frequency-induced SF_6 plasma.

In an experiment, the rate of reactive-ion etching was found to be about 3.6 μm per minute; in contrast, the rate of etching in hot KOH is about 1 μm per minute. It was also found that reactive-ion etching undercut the masked portion of the substrate at a rate of about 3.5 μm per minute. The diamond membrane exposed by etching of the substrate was found to be in a state of compressive stress.

This work was done by Rajeshuni Ramesham of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category.*
NPO-20477

Metal-Surfaced Ceramic Insulating Blankets

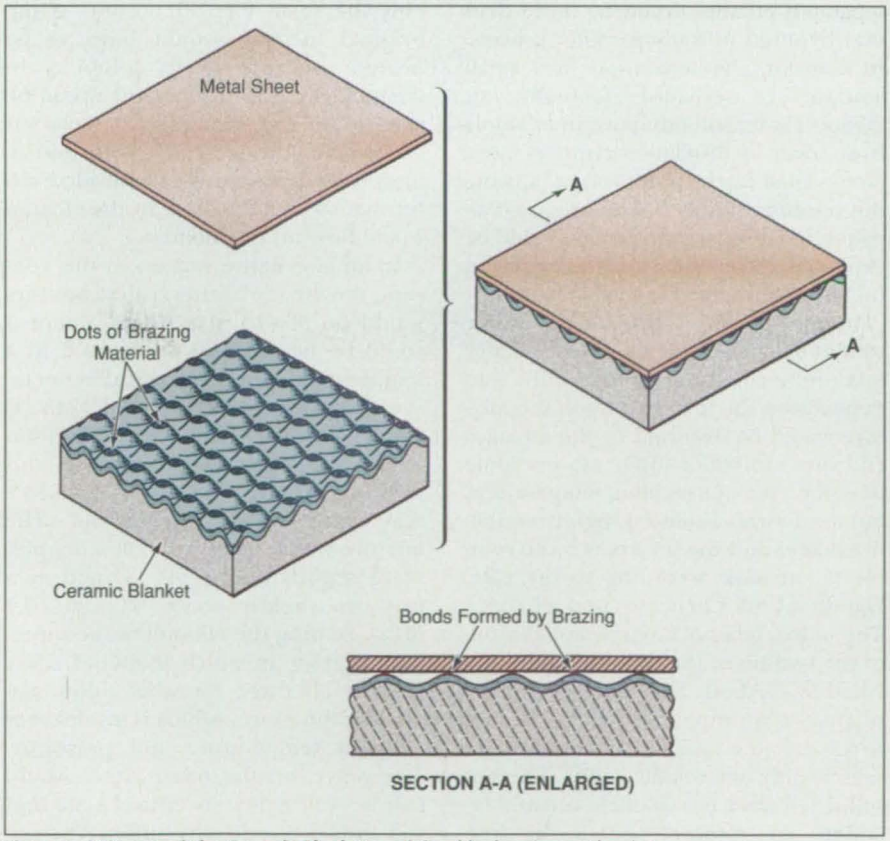
Metal foils are attached to ceramic blankets by brazing at multiple locations.

Ames Research Center, Moffett Field, California

Flexible thermal-insulation blankets made of ceramic fibers can be protected against weather and handling by attaching thin metal face sheets. In applications in which the blankets are exposed to gas flows, the face sheets also afford protection against flow-induced stresses and help reduce aerodynamic drag by providing smoother flow surfaces.

Typically, a metal sheet to be attached to a ceramic blanket has a thickness of 5 mils (≈0.13 mm) or less and is made of titanium, aluminum, chromium, niobium, or alloys of these elements. The blanket can be made of fibers of silica, aluminoborosilicate, silicon carbide, and/or other ceramic materials. Optionally, in preparation for attachment of the metal sheet, the ceramic fabric on the attachment surface of the blanket can be precoated with a thin layer of nickel to improve its bonding properties.

Small dots of a metal or ceramic brazing material are placed on the attach-



The **Metal Sheet and the Ceramic Blanket** are joined by brazing at the dots.

ment surface of the blanket (see figure). Preferably, the dots are between 1/8 and 1/4 in. (about 3 to 6 mm) square and positioned either randomly or in a regular pattern at intervals of about 1 in. (≈2.5 cm). The metal or ceramic brazing material can be any of several commercial formulations that both wet the ceramic fabric and form metallic bonds with the metal sheet when heated to the brazing temperature. Suitable ceramic brazing materials include ceramic-precursor adhesives based on silica, alumina, and/or zirconia. Suitable metal brazing materials include copper/silver, copper/gold, and copper/silver/gold alloys that contain titanium and/or vanadium as wetting agents.

The metal sheet is placed over the dots, then the resulting sandwich is heated to a temperature of about 1,800 °F (about 980 °C) in a reducing atmosphere or in a vacuum to effect brazing. Finally, the sandwich is cooled to room temperature, leaving the metal sheet strongly bonded to the blanket at the dots.

This work was done by Daniel J. Rasky, Paul M. Sawko, Paul Kolodziej, and Demetrius A. Kourtides of for **Ames Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category.*

This invention has been patented by NASA (U.S. Patent No. 5,744,252). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Ames Research Center; (650) 604-5104. Refer to ARC-11989.

Separating Ethanol From Water Via Differential Solubility

Alcohol for combustion could be purified more economically.

Langley Research Center, Hampton, Virginia

The differential solubility of sulfur in ethanol and water could be exploited to separate ethanol from water. The energy that could be produced by burning the separated ethanol would be more than that required in the separation process. In contrast, the separation of a small amount of ethanol (actually an ethanol/water solution poor in ethanol) from water by distillation requires more energy than can be produced by burning the resulting distillate. The proposed alcohol/water separation process could be exploited industrially to produce clean fuel from fermented vegetable matter.

In one version of this concept, sulfur would be added to an ethanol/water mixture: a slight amount of sulfur that depends on the temperature of the mixture would be dissolved by the ethanol. (All three forms of sulfur are insoluble in water, even at its boiling temperature, but the a form of sulfur is slightly soluble in ethanol and the b form is more soluble in ethanol, according to the CRC Handbook of Chemistry and Physics.) The sulfur/ethanol mixture would settle to the bottom of the container, where it could be bled off. This small part of the original mixture could then be heated to separate the volatile ethanol from the significantly less volatile sulfur. The hot sulfur left after the distillation could be added to another batch of the ethanol/water mixture.

In comparison with the energy consumed in the conventional distillation process, a significant amount of energy would be saved in this process because only the small bled-off portion of the original mixture would have to be heated. Because of its solubility in ethanol, the b form of sulfur would be used when the separation process was carried out at room temperature and atmospheric pressure. Finely divided sulfur that was not dissolved by the ethanol would float on the mixture.

In an alternative version of this concept, the ethanol/water/sulfur mixture would be placed in a retort, where it could be heated and pressurized to a temperature above the critical temperature and pressure of ethanol [243 °C and 63 atm (6.4 MPa), respectively] but below the critical temperature and pressure of water [374.1 °C and 218.3 atm (22.12 MPa), respectively]. The mixture would be retorted at a temperature slightly above 243 °C and at a pressure slightly above 63 atm (6.4 MPa), putting the ethanol in the supercritical state, in which it should easily dissolve all three forms of sulfur (including the γ form, which is insoluble at ambient temperature and pressure). The water, on the other hand, would still be well below its critical state and still should not dissolve sulfur. The sulfur/ethanol mixture would settle to the

bottom of the retort, where it could be piped away under pressure and at high temperature. The sulfur/ethanol mixture would then be expanded to a lower temperature and pressure at which not as much sulfur could be dissolved in the ethanol and at which ethanol would partially separate from the mixture. Further heating of the remaining mixture at a pressure of 1 atm (0.1 MPa) would separate most of the remaining ethanol and sulfur. The sulfur could be reused, and the high-pressure hot water could be used to cook more mash to be fermented or to preheat a charge going to another retort.

This second version is probably the most suitable for an industrial process, and could be aided by the addition of a centrifuge to separate the initial two-phase mixture. The role of sulfur in both versions could be played by another substance. However, the low toxicity and very low vapor pressure of sulfur at the boiling temperature of ethanol appear to make it the best candidate.

This work was done by Renaldo V. Jenkins of **Langley Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category.*
LAR-14894

Separating Ethanol From Water Via Differential Miscibility

Alcohol for combustion could be purified more economically.

Langley Research Center, Hampton, Virginia

The differential miscibility of castor oil in ethanol and water would be exploited to separate ethanol from water, according to a proposal. Burning the separated ethanol would produce more energy than would be consumed in the separation process. In contrast, the separation of a small amount of ethanol (actually an ethanol/water solution poor in ethanol) from water by the conventional process of distillation requires more energy than can be produced by burning the resulting distillate. As in the process described in the preceding article, "Separating Ethanol From Water Via Differential Solubility" (LAR-14894), the proposed alcohol/water separation process could be exploited industrially to produce clean fuel from fermented vegetable matter.

In one version of this process, castor oil would be added to an ethanol/water solution. The ethanol would mix freely with castor oil, which is insoluble in water. The resulting ethanol/castor-oil phase, which would contain less than 1 percent water, would collect as the top layer, the bottom layer being the remainder of the ethanol/water solution somewhat depleted in ethanol. Heating this two-layer mixture to a temperature slightly below the boiling temperature of ethanol (78.5 °C) would cause the partial pressure of ethanol above the top layer to be much greater than the partial pressure of either castor oil or water. This vapor-phase ethanol could be condensed in a relatively pure state.

Although heating an isolated ethanol/water solution like that in the bottom layer would normally raise the vapor pressure of both ethanol and water above the solution, this would not be the case in the presence of the top castor-oil/ethanol layer for the following reasons: The amount of water that could dissolve in the top castor-oil/ethanol layer would increase only slightly upon heating. On the other hand, ethanol could readily cross the interface between the two layers and enter the top layer. As long as the total mix was kept at a temperature below the boiling temperature of ethanol (thereby preventing agitation of the layers by boiling), the diffusion of water through the castor-oil/ethanol phase would be inhibited.

In an alternative version of this concept, the upper castor-oil/ethanol layer would be skimmed off and heated to obtain the ethanol. Once the ethanol was driven off, the castor oil could be returned to an ethanol/water solution to dissolve more ethanol to repeat the process. This concept could readily lend itself to a continuous process. Substances other than castor oil (one of its components perhaps, or another substance) could be used in this process or to extract other compounds from other mixtures by using this upper-of-two-phases vaporization technique.

This work was done by Renaldo V. Jenkins of **Langley Research Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category.*
LAR-14895

Durability Studies on the F-15B Flight-Test Fixture

X-33 and space-shuttle insulation specimens were tested by use of similar hardware.

Dryden Flight Research Center, Edwards, California

NASA's F-15B #836 is a two-seat version of the F-15, which is a high-performance, supersonic, all-weather fighter airplane. The F-15B is used as a test-bed aircraft for a wide variety of flight experiments. In support of this use, a flight-test fixture (FTF) (see Figure 1) was developed to provide a space for flight experiments in a region with known aerodynamic conditions.

The FTF has been flown in many flight experiments during the past several years and can be modified to satisfy a variety of research requirements. For example, the X-33 project requested assistance in exposing specimens to shear and impinging shock loads for validation and flight qualification of the X-33 thermal-protection-system (TPS) materials in a flight environment. X-33 TPS materials for this experiment ranged from metallic panel materials (supplied by BF Goodrich) to a variety of advanced flexible reusable surface insulation (AFRSI) specimens supplied by NASA Ames Research Center. Transition seals and flight-test instrumentation islands were also incorporated into the specimens to demonstrate the durability of these components. Some of the specimens were thermally cycled in an arc-jet tunnel prior to flight test in order to simulate thermal loads expected on the X-33 vehicle.

The two forward left side panels on the FTF were replaced by a large carrier plate in order to simplify the installation of the various TPS specimens and thereby enable quick changes in configuration between research flights. Specimens were installed in the various quadrants of the carrier plate (see upper part of Figure 2), depending on the desired configuration for each flight. Forward specimens were generally used to look at the effects of shock-impingement loads previously identified at forward locations at transonic speeds. Specimens in the aft locations were used to document the effects of shear loads.

Six configurations were flight-tested at a maximum mach number of 1.4 and dynamic pressures as high as 790 lb/ft^2 (37.8 kPa). Flight tests were conducted at altitudes as low as 5,000 ft (1.5 km) to obtain the higher shear loads and as high as 35,000 ft (10.7 km) for supersonic testing. Surface pressures were obtained to document flow conditions and loads on the specimens. In addition, in-flight video and detailed pre- and post-flight photos were used to document the conditions of all specimens. This highly successful flight-test series was completed in May 1998 as part of the overall flight qualification of the X-33 TPS.

Figure 1. The **Flight-Test Fixture** is a fully instrumented test article mounted on the centerline of the lower fuselage of an F-15B airplane. The fixture is 107 in. (2.72 m) long, 32 in. (0.81 m) high, and 8 in. (20 cm) wide, with a 12-in. (30.5-cm) elliptical nose section.

Figure 2. **Specimens of Exposed Materials** from the X-33 launch vehicle and the external tank of the space shuttle were mounted on the carrier plate of the flight-test fixture.

Several months later, the Shuttle External Tank Project from Marshall Space Flight Center saw the results of the X-33 test and requested use of the same carrier plate to expose specimens of the shuttle external tank insulation to a simulated shuttle launch environment at speeds up to mach 1.5 and altitudes up to 60,000 ft (18.3 km) Six specimens were flown to simulate the thrust-panel rib structure and foam where the shuttle solid rocket boosters are attached to external tank. Several types of foam insulation configurations and rib orientations (see lower part of Figure 2) were tested by use of similar instrumentation and video documentation. This flight-test series was successfully completed in less than two weeks in January 1999.

The X-33 and Shuttle External Tank Projects were both able to gain significant benefits from the flight-test results obtained by use of the F-15B FTF with a carrier plate as a research platform. Flight results were obtained quickly and efficiently and provided valuable data toward flight qualification with an increased understanding of the durability of the tested materials in flight environments.

This work was done by David Richwine, Craig Stephens, Kirsten Carpenter, Michelle Greslik, and David McAllister of **Dryden Flight Research Center.** *No further documentation is available.*

DRC-99-11

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NASA Developing Crew-Return Vehicle

The spacecraft equivalent of a lifeboat will be available to astronauts.

Dryden Flight Research Center, Edwards, California

Up a creek without a paddle? Not if you're an International Space Station astronaut with a CRV. That's short for Crew Return Vehicle, and it's being developed following an innovative approach in the X-38 program. The CRV will perform three specific roles:

- A lifeboat if the space station becomes uninhabitable;
- An ambulance if a crewmember becomes sick or injured; and
- A way home if the space shuttle is un available.

NASA photo by Jeff Doughty

The **X-38 CRV** is shown here under the wing of a B-52 airplane.

The CRV is a 30-ft (9.1-m) long spacecraft that will be moored on the station and will carry up to seven crewmembers safely back to Earth. Designed to replace the three-person Soyuz vehicle used in early space-station operations, it is completely autonomous, can carry the entire station crew, has significant cross-range capability, and can make ground-based, low-speed, soft landings at predefined sites around the world by use of a large parafoil.

In response to Administrator Dan Goldin's challenge to build a new spacecraft to transport humans in a better, faster, cheaper way, engineers at NASA's Johnson Space Center conceived the X-38 program to solve the technical issues associated with the development of the CRV. The X-38 program relies on a series of low-cost, unpiloted development vehicles to perform flight demonstrations of innovations to be incorporated into the CRV. Paramount among the innovations is the parafoil and its control mechanisms. The proper selection of innovations makes it possible to build and test the prototype CRV quickly; as a result, the experience needed for designing and building the CRV can be gained early in the development cycle. A total of five vehicles will be used to test various parts of the eventual CRV mission.

The first of the X-38 vehicles successfully made its maiden flight in March 1998 at Dryden Flight Research Center. Launched from Dryden's venerable B-52 mother ship at an altitude of 23,000 ft (7 km), the vehicle known as V131 deployed a drogue parachute and parafoil on cue and glided to a soft landing on the Precision Impact Range Area at Edwards Air Force Base. The flight marked the first time a parafoil of this size (larger than the B-52 wing area) had been deployed from an aerodynamic-lifting-body aircraft. Although some minor problems were encountered, the test demonstrated the feasibility of the parafoil concept.

Like the familiar wedding couplet — "Something old, something new" — the X-38 blends proven technology with state-of-the-art technology. The basic lifting body shape is derived from the X-24A program tested at Dryden in the 1960s and 1970s. Data on re-entry aerodynamics and heating were recovered from flights in the X-23 program undertaken by the Air Force in the mid-1960s. Flight-proven components from the space shuttle have been used to reduce risk wherever possible. Conversely, the parafoil, electromechanical flight surface actuators, and fiber-optic systems are all examples of emerging technology being used to augment CRV capabilities. The use of the parafoil provides a low-speed, soft-landing capability without the need for a pilot or a prepared runway. Unlike traditional hydraulic actuators, the electromechanical actuators afford a leak-free, non-freezing capability for the intended three-year stay of the CRV at the station.

To increase the likelihood of a successful X-38 program, the Johnson Space Center X-38 team has enlisted several partners. In addition to providing the B-52 launch capability, Dryden has assisted with flight controls and flush air-data systems advice, and general flight-test and range-safety expertise. Pioneer Aerospace Corporation has led the development of the parafoil, and the Army has provided test facilities at Yuma Proving Ground. In an example of an international cooperative effort, the European Space Agency and the German National Space Agency will provide several components for the first space flight of the X-38, to be launched from the Space Shuttle in November 2000.

Ideally, the CRV will never be used for a real emergency. However, the recent problems with the Mir space station illustrate the need for a way home, just in case. The CRV will be there for astronauts in case they need it.

This work was done by John F. Muratore of Johnson Space Center and Christopher J. Nagy of **Dryden Flight Research Center.** *DRC-98-90*

Portable Device for Chemical Fixation of a Biological Sample

John F. Kennedy Space Center, Florida

The Kennedy Space Center (KSC) fixation tube is a device for chemical fixation of a biological sample. It is mechanically resilient, small, and easy to use, and is thus well suited to use in the field as well as in the laboratory. Because typical chemical fixatives are extremely hazardous to humans, the device is also designed to contain its fixative solution within a triply-redundantly sealed environment. The device includes a main tube, sample tube, expansion plug, base plug, and top-plug/plunger assembly. Prior to use, the fixative solution is contained at the bottom of the main tube, below the expansion plug. The sample is placed in the sample tube, which is then inserted in the main tube and sealed in the main tube by inserting the top plug. Next, the plunger is used to (1) actuate a mechanism that loosens the seals on the expansion plug, then (2) push the sample tube down against the sample plug, thereby pushing the sample into the fixative solution.

This work was done by Howard William Wells of the Bionetics Corp. and Mark Best of Vector CAD Services for **Kennedy Space Center.**

Inquiries concerning rights for the commercial use of this invention should be addressed to the Technology Programs and Commercialization Office, Kennedy Space Center, (407) 867-6373. Refer to KSC-11993.

Wicks for Initiating Hydroponic Growth

These wicks can be reused.

Lyndon B. Johnson Space Center, Houston, Texas

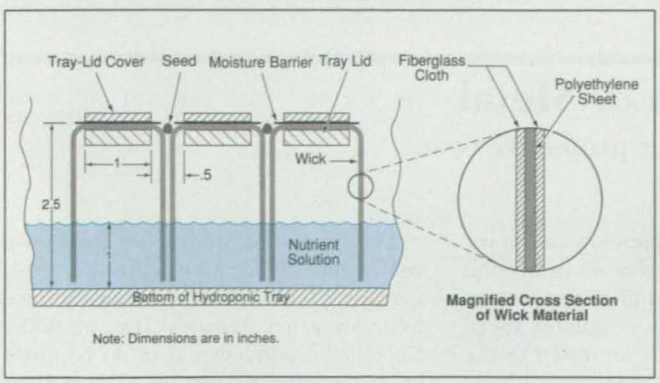
A material developed for space suits has been found useful in a completely different application: making wicks to support seedlings and to carry water and nutrients to them during the initial stages of hydroponic growth. A modified version of the wick material may also prove useful in wick-based evaporators and humidifiers.

The wick material consists of a middle layer of polyethylene sandwiched between layers of woven glass fibers. The layers are fused together by heating and pressing. Sheets of the material are bent into U-shaped wicks, which are positioned with the tips immersed in an aqueous nutrient solution (see figure). The wick material is chemically inert with respect to the nutrient solution.

Seeds are nested between adjacent wicks. The hydrophilic nature of the fibers and their tight weave ensures wicking of moisture and nutrients to the seeds and, eventually, to the roots. The wicks support roots in the sense that root hairs can cling to the glass fabric, but the tight weave resists penetration by the roots. Seedlings can therefore be removed with little or no damage to the roots, and wicks can be reused.

This work was done by Daniel J. Barta of **Johnson Space Center** *and Robert W. Spanarkel of Lockheed Engineering and Sciences Co. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Bio-Medical category.*

MSC-22539



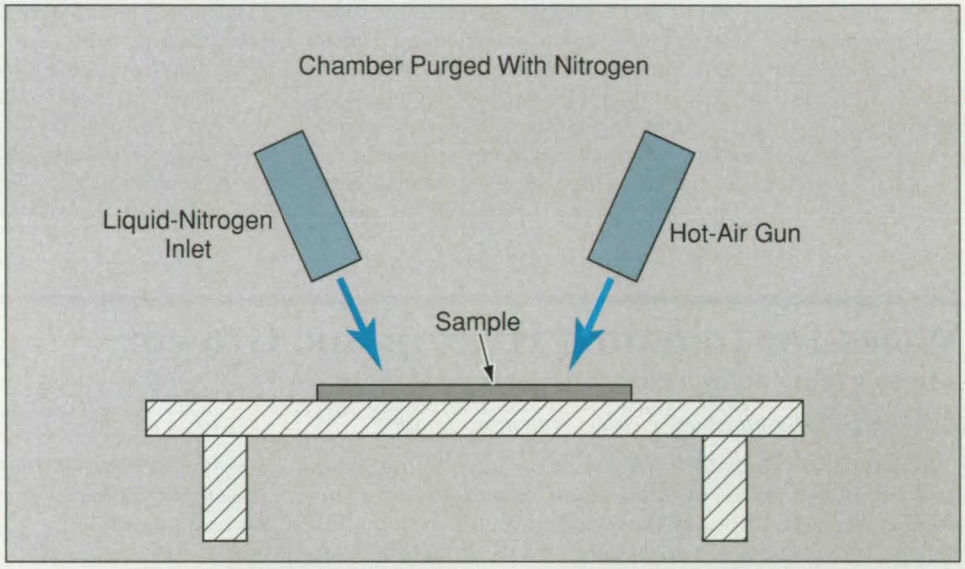
Wicks Made of a Laminated Material support and nourish seedlings over a hydroponic tray.

Rapid Thermal-Cycle Life Testing of Thin Films

The thermal-cycle time is only 20 seconds.

Goddard Space Flight Center, Greenbelt, Maryland

An automated heating/cooling laboratory apparatus enables the accelerated thermal-cycle life testing of thin-film samples and other small material samples. In the original application for which the apparatus was constructed, the thin-film samples are candidates for use as components of thermal-insulation blankets, and there is a requirement to subject the samples to at least 20,000 thermal cycles between the temperatures of +50 and –100 °C. Without the present apparatus, it would be necessary to test the samples in an environmental chamber that takes about 30 minutes to complete a thermal cycle and would therefore take more than a year to complete 20,000 cycles. In contrast, the present apparatus operates with a thermal-cycle time of 15 to 20 seconds, making it possible to complete the 20,000 cycles in less than five days.



Samples Are Alternately Cooled and Heated by liquid nitrogen and electrically heated nitrogen, respectively, under automatic timing control.

The apparatus includes a hot-air gun and a liquid-nitrogen inlet mounted above and aimed at the samples. All of the aforementioned components are located in a chamber purged with nitrogen (see figure). A solid-state relay is used to control the opening and closing of an electrically actuated valve that controls the flow of liquid nitrogen through the inlet. Another solid-state relay is used to turn the hot-air gun on and off. (Because the gun is located in the nitrogen-purged chamber, it actually blows hot nitrogen, not hot air, when it is turned on.) The samples are taped and clamped to a fixture. Thermocouples are attached to the fixture and to one of the samples for monitoring test temperatures.

The solid-state relays are toggled by an amplified 1-volt rectangular-wave signal that establishes the timing of the cooling and heating periods of the thermal cycle. When the signal is 1 V, the liquid-nitrogen valve is opened and the hot-air gun is turned off. When the signal is 0 V, the liquid-nitrogen valve is closed and the hot-air gun is turned on. The duty cycle of the rectangular wave is adjusted to obtain the required thermal cycle; for example, in initial experiments, the liquid-nitrogen valve was opened during about 38 percent of the thermal cycle and the hot-air gun was on during the remaining 62 percent of the cycle.

This work was done by Charles Powers and Bruno Munoz of **Goddard Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*

GSC-13974

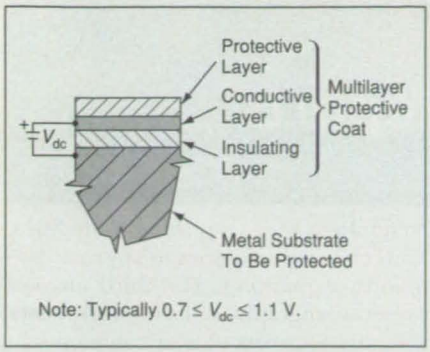
Low-Current Cathodic Protection of Metal

The anode would be incorporated into a multilayer protective coat.

Langley Research Center, Hampton, Virginia

A proposed extension of the impressed-current method of cathodic protection of metal against corrosion in wet environments would reduce the current and power needed. The proposal involves (1) the application of a special multilayer coat to the metal part to be protected and (2) the use of a small dc power supply that operates at a precisely chosen low output potential. The effectiveness of protection should justify the costs of power sources and coatings in many situations: metal structures that could be protected by the extended method include ships, automobiles, bridges, metal buildings, radio towers, pipelines, and storage tanks.

The proposed multilayer protective coat would include an electrically insulating layer in contact with the metal surface to be protected. The next layer would be electrically conductive; it could be made of conductive plastic or carbon-filled paint, for example. If the conductive layer were not sufficiently durable to withstand



The **Metal Substrate Would Be Maintained Cathodic** with respect to the conductive layer in the protective coat.

prolonged exposure to the anticipated environment, a third protective layer could be added. The conductive layer would be connected to the positive terminal of the dc power supply, while the metal to be protected would be connected to the negative terminal (see figure).

If there were no cracks or pinholes in the multilayer coat, then when the power supply was first turned on, current would flow initially by virtue of the capacitance between the metal substrate and the conductive layer. Once the capacitor was charged to the output potential of the power supply, the current would fall to a negligible value, and only a static electric field would be maintained. As cracks or pinholes formed during deterioration of the outer layers, water and oxygen would come in contact with the metal substrate. By keeping the metal substrate negative (cathodic) relative to the conducting layer, a protective shield of hydrogen ions would be made to form on the exposed parts of the metal substrate, thereby inhibiting electrochemical reactions in the pinholes and cracks.

To protect effectively against corrosion, in the presence of water, the output potential of the power supply must be greater than the corrosion-induced potential of the metal substrate. For example, the potential for iron to corrode to common rust is 0.44 V. At the same time, the supply voltage should be less than the minimum voltage to electrolyze water (1.229 V), so that the impressed current could be kept much smaller than it would be if electrolysis were occurring. On the basis of previous experience with sacrificial anodes of zinc (which has an oxidation potential of 0.76 V), it appears that a suitable potential to protect steel without consuming excessive current in electrolysis would lie between 0.7 and 1.1 V.

This work was done by Leonard M. Weinstein of **Langley Research Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category. LAR-15069*

Books & Reports

Documents on Flight Software for the SAMPEX Spacecraft

A collection of four documents contains information on various aspects of the flight software of the Solar Anomalous and Magnetospheric Particle Explorer (SAMPEX) spacecraft. The first document is part of a longer paper that presents design requirements for the software; the information in this part includes an introduction to the SAMPEX project and a brief description of the Small Explorer Data System (SEDS) — the onboard data-processing system utilizing the software. The second document is a completed form for submittal of the software to NASA's now-discontinued Computer Software Management and Information Center (COSMIC). The third document — apparently an attachment to the COSMIC form — is an outline that briefly describes the purpose, capabilities, and characteristics of the software. The fourth document is a complete paper that describes the software in somewhat more detail: The paper includes a brief historical introduction; an overview of the structure and functions of the software in relation to the SEDS hardware; and discussions of the impact, innovative aspects, and utility of the software.

This work was done by Ray Whitley, R. Hollenhorst, Chuck Clagett, Gil Colon, Jim Watzin, Bruce Savadkin, Mike Blau, Alan Cudmore, Todd Miller, and John Ong of **Goddard Space Flight Center** *and John Allen and Jerry Hengemihle of Daedalian Systems Corp. To obtain a copy of the collection of documents, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Information Sciences category. GSC-13665*

Development of Gear Technology and Theory of Gearing

A NASA Reference Publication discusses gear technology from mathematical and historical perspectives. Following a preface containing historical and philosophical observations, the first of three chapters presents mathematical details of the theory of gearing, including recent developments attributable to the author and others. The second chapter discusses the development of gear geometry and technology, with emphasis on modifications of gear geometries to improve conditions of meshing. The third chapter presents biographies of inventors, scientists, and founders of gear companies in order to credit the contributions made by previous innovators and to combine the separate pieces of the history of gear technology and the theory of gearing.

This work was done by Faydor L. Litvin of the University of Illinois at Chicago for **Glenn Research Center.** *To obtain a copy of the publication, "Development of Gear Technology and Theory of Gearing," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category.*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16702.

Mars Ascent Propulsion System

A report presents an overview of continuing efforts to develop an advanced propulsion system for a spacecraft that would ascend from Mars to bring samples to Earth. The system is required to be smaller and to weigh and cost less, in comparison with a conventionally designed system of equal capability. The development efforts include research on several topics, including the following, which are discussed in the report: (1) warm-gas pressurization subsystems for pushing liquid propellants from supply tanks to engines, (2) lightweight, high-performance rocket engines that burn propellant fluids supplied at temperatures below 0°C, (3) lightweight tanks for propellants and pressurants, and (4) lightweight flow-control components. Finally, the report describes the latest version of the system, which features a two-stage design with pyrotechnic separation.

This work was done by Carl Guernsey, Barry Nakanzo, Hartwell Long, and Andre Yavrouian of Caltech for **NASA's Jet Propulsion Laboratory.** *To obtain a copy of the report, "Advanced Storable Propulsion Technologies for Low-Cost Mars Sample Return," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category. NPO-20428*

MMIC Converters for K- and Ka-Band Communications

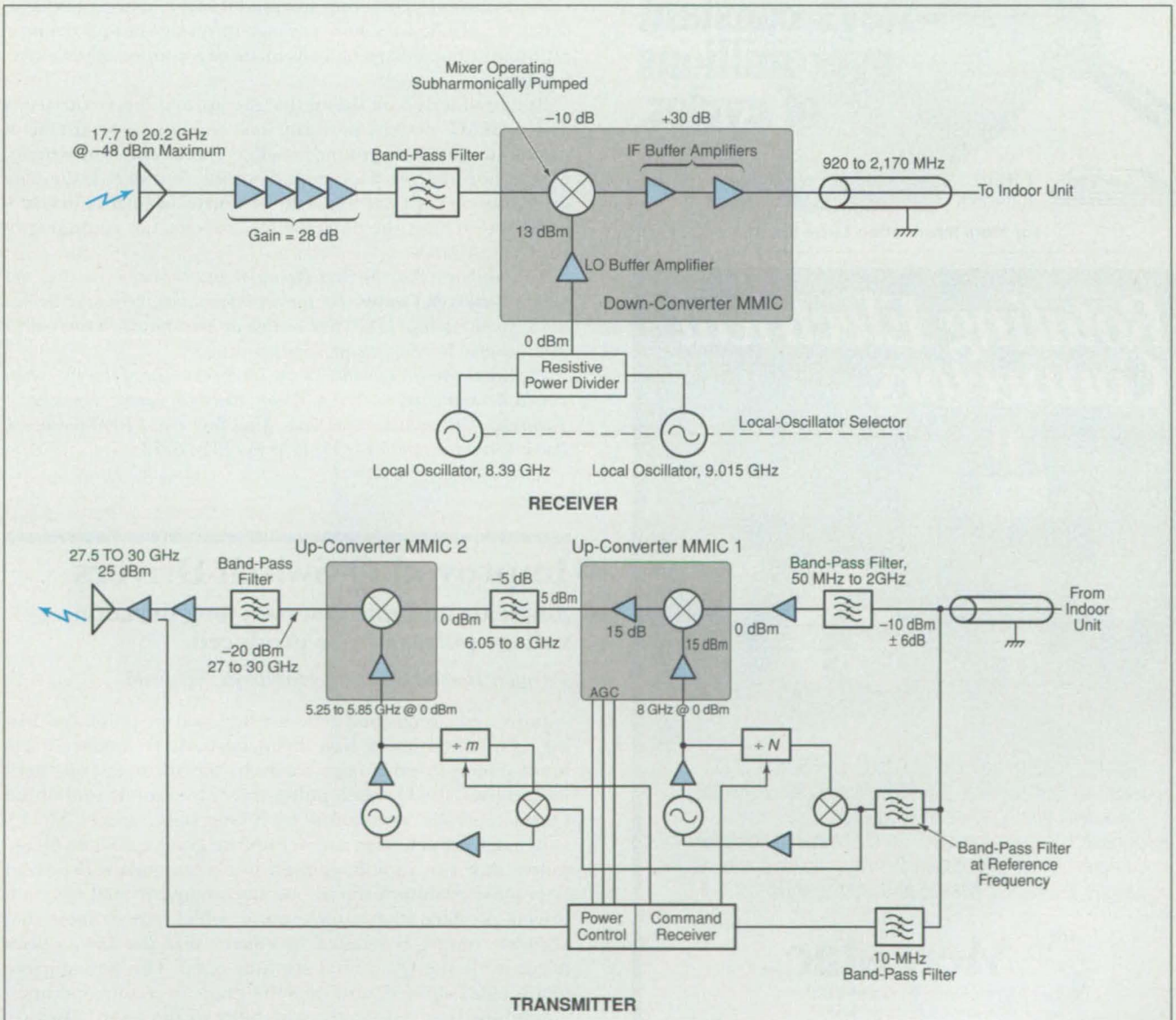
Prototypes show promise for high performance and mass-producibility at low cost.

John H. Glenn Research Center, Cleveland, Ohio

Monolithic microwave integrated-circuit (MMIC) frequency converters have been developed for use in satellite- and ground-based communications (see figure) at frequencies from about 18 to about 30 GHz. These and similar converters can be expected to exert significant effects on the sizes, costs, and performances of terminals for the next generation of K- and Ka-band communication systems. The rapid increase in the number of such systems is expected to give rise to a demand for tens of millions of frequency converters during the next few years.

The emphasis in this development program was on low cost, and the technical approach involved reliance on well-established design practices and mature, commercially available processes for fabrication of MMIC chips. The practices and processes selected were those of GaAs metal/semiconductor field-effect transistors (MESFETs) with 1/2-μm design rules.

The converters are capable of operation as both up- and down-converters, and are passive in the sense that external local oscillators (LOs) must be provided. Some of the converters are designed for



The **Transmitter and Receiver** at a ground station of a typical ground/satellite communication system would be contained in an outdoor unit mounted adjacent to the antenna. The receiver and transmitter would contain converters of the type developed in this program.

use with subharmonic LOs, taking advantage of the decrease in cost and increase in availability of oscillators with decreasing frequency.

Some of the converters contain integrated buffer amplifiers for the LO and intermediate-frequency (IF) signals of several gigahertz, as in the example of Figure 1. However, a fundamental limitation on the range of operating frequencies of 1/2-μm MESFET amplifiers precluded the integration, into the converters, of radio-frequency (RF) amplifiers operating at frequencies from 20 to 30 GHz. As a first step in an effort to overcome this limitation, the developers fabricated a set of advanced MMICs for converters and amplifiers, using an acceptor-doped high-electron-mobility transistor (p-HEMT) design and process. It is anticipated that as the p-HEMT art matures, p-HEMT devices will offer a potential to manufacture inexpensive, highly integrated chips.

The performance of an MMIC chip can be altered by its surroundings. Factors that can affect performance include box resonances, coupling to walls, and transmission-line effects on bonding wires. Therefore, considerable attention was given to packaging. Two alternatives to conventional MMIC packaging were considered: One involved the use of a low-temperature cofired ceramic. The other involved a ball-grid-array package, which is a leadless ceramic package in surface-mount configuration with noncollapsing balls made of a copper/silver eutectic alloy.

Results of tests have shown that the up- and down-converters and p-HEMT devices perform well enough to be useful in ground terminals of ground/satellite communication systems. Of the two low-cost packaging concepts considered, the ball-grid-array concept was found to be worthy of further development and to offer the potential for cost-effective packaging of converter MMICs.

This work was done by Paul Blount of Hittite Microwave Corp. for **Glenn Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16752.

Improved Q-Switch Drivers

Single or multiple fast-rise, long-duration voltage pulses can be produced.

Langley Research Center, Hampton, Virginia

Improved circuits that generate high-voltage pulses for driving Q-switched lasers have been devised. To extract maximum energy from a laser cavity in the form of consistent laser pulses, the Q-switch pulses must rise rapidly so that the Q-switch is fully open before each laser pulse occurs. The Q-switch drivers placed in use heretofore generate high-voltage pulses that rise rapidly enough to accommodate the short laser-pulse-evolution times, but many conventional Q-switch drivers produce high-voltage pulses which are so short that accurate timing is needed to ensure that the laser pulses occur while the Q-switches are fully open. The timing problem is compounded, and thus the range of usable operating conditions reduced, by the variability of the laser-pulse-evolution time with variations in the storage and loss of laser-pumping energy.

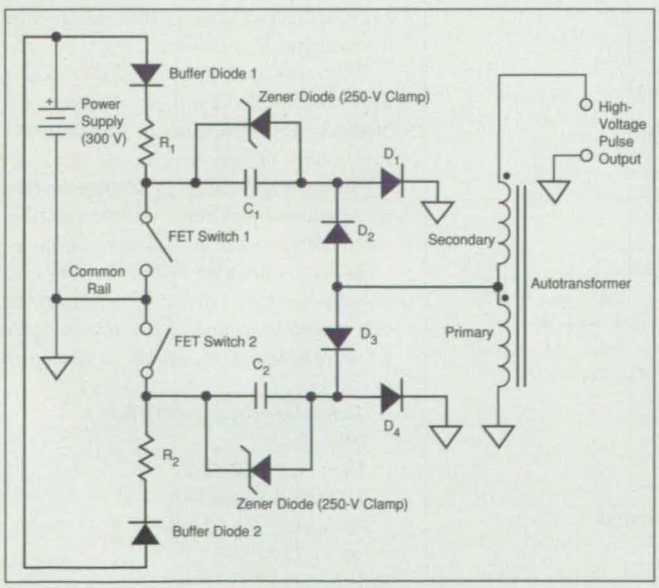
The improved Q-switch drivers provide fast-rising, nearly square high-voltage pulses that last long enough (typically about 300 ns) to accommodate a wider range of laser-pulse-evolution times, thereby making timing much less critical and enabling lasers to function more reliably and at higher efficiency over wider ranges of operating conditions. In addition, the improved circuits can generate multiple high-voltage pulses in rapid succession.

A driver circuit of this type generates a high-voltage pulse by discharging a capacitor through a step-up autotransformer designed specifically for the required pulse operation. Long-duration pulses are achieved by selection of a toroidal ferrite transformer core that has a relative magnetic permeability of 3,000, by choice of the dimensions of the core, and by optimizing the numbers of turns (at a turns ratio of 8) and configurations of the primary and secondary windings.

The figure is a simplified schematic diagram of the charging and discharging circuits in an improved Q-switch driver that can generate two pulses in rapid succession. Capacitors C_1 and C_2 are charged from a power supply (typically +300 V); to promote consistent charging from shot to shot and to shorten the charging time, the voltage on each of these capacitors is clamped, by a zener diode, at a value (typically 250 V) less than that of the power supply. Diodes D_2 and D_3 are part of an energy-steering network through which both C_1 and C_2 are connected to the single autotransformer and through which either capacitor can be discharged into the transformer without discharging the other. Diodes D_1 and D_4 act as clippers, preventing overshoot and suppressing ringing to make the output pulses more nearly square.

Single- or dual-pulse operation can be selected by use of control logic circuitry (not shown). The discharge path of each capacitor passes through a field-effect-transistor (FET) switch, which initiates discharge by connecting the positively charged terminal of the capacitor to the common power-supply rail (in essence, ground). To speed the charging of the input capacitance of the FET and thereby make the discharge pulse rise rapidly, the turn-on pulse is supplied to the gate of each FET through a dedicated low-impedance, transformer-coupled input circuit.

This work was done by Norman P. Barnes of **Langley Research Center** *and Charles Nichols of Hughes STX Corp. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*
LAR-14803



Either Capacitor Can Be Discharged into the transformer without discharging the other. They can be discharged in rapid succession to produce two rapid-rise, long-duration Q-switch pulses.

Improved Successive-Approximation ADCs With Charge Balancing

Charge balancing is effected by single self-cascoded inverters.

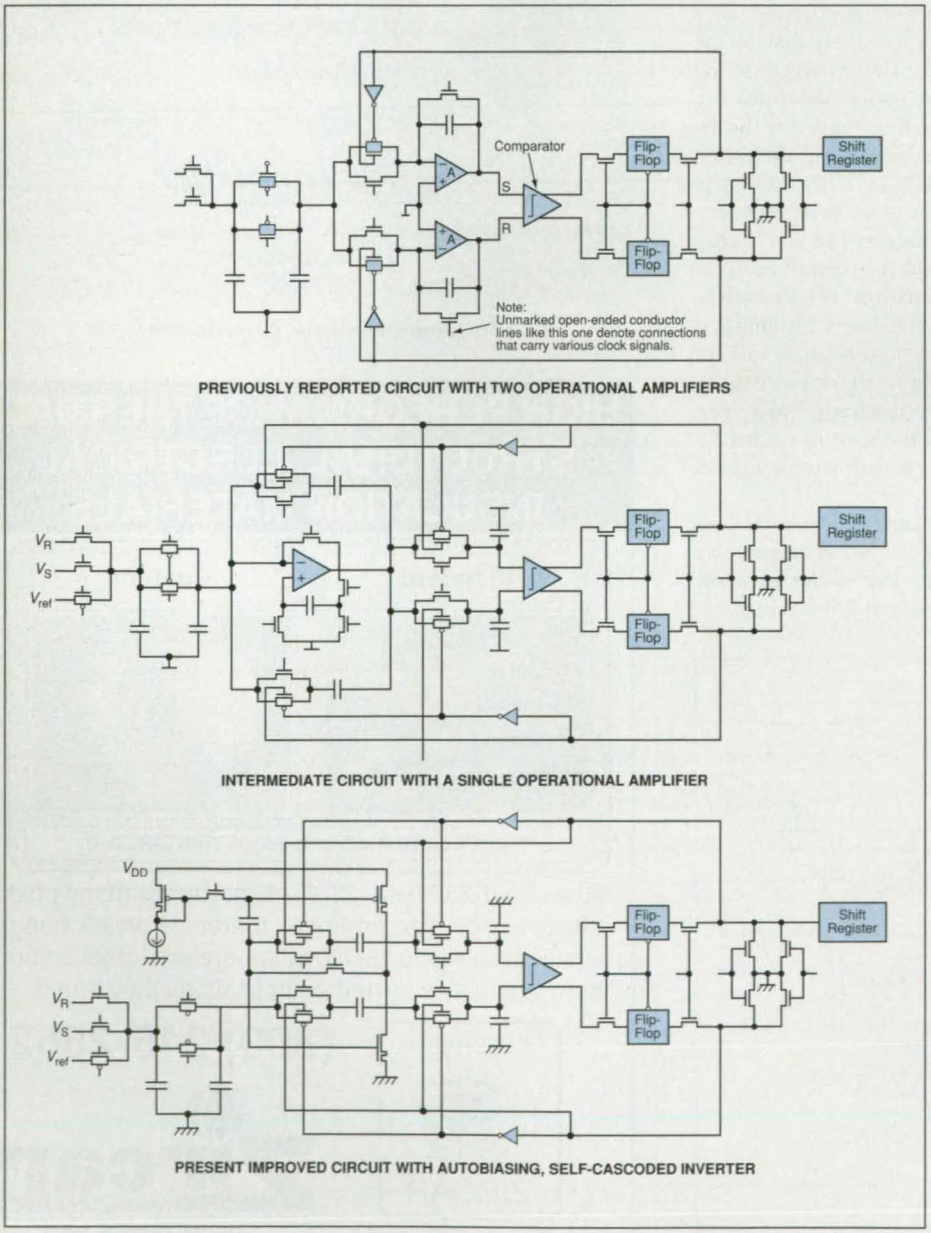
NASA's Jet Propulsion Laboratory, Pasadena, California

Improved successive-approximation analog-to-digital converter (ADC) circuits are undergoing development for eventual incorporation into focal-plane arrays of photodetectors. These circuits are derived from, and offer advantages over, the ones described in "Successive-Approximation ADCs With Charge Balancing" (NPO-19784), *NASA Tech Briefs*, Vol. 21, No. 5 (May 1997), page 47.

The top part of the figure shows a circuit of the previously reported type. The circuit implements successive-approximation analog-to-digital conversion according to a charge-balancing approach, in which the reset (R) and signal (S) branches of the circuit accumulate successively halved increments of reference charge in an attempt to balance the charges in the two branches. The circuit includes two high-gain charge-integrating operational amplifiers, the components of which must be closely matched to achieve accuracy in conversion. To achieve close matching, it is necessary to make the transistors in the amplifiers larger and to use dc bias currents larger than one would otherwise be inclined to do; as a consequence, the size and power consumption of the circuit are increased, making it more difficult to integrate the circuit into a high-performance focal-plane array of photodetector readout circuits.

The middle part of the figure shows a circuit at an intermediate stage of development, in which a single operational amplifier (instead of two high-gain operational amplifiers) is used to integrate charges on both the R and S branches during nonoverlapping clock phases. Sharing of the same operational amplifier by both branches results in perfect matching of dc gain and dc offset, and in a large reduction of a component of ADC error associated with dc gain. However, the error caused by the matched dc offset is not necessarily small when the dc gain is low, which it can well be in some designs.

It turns out that the offset effect can be eliminated by replacing the single operational amplifier with a single autobiasing inverter. A dc gain of 40 dB is sufficient for 8-bit accuracy, and gain greater than 40 dB can be achieved via self-cascoding of the inverter transistors. The bottom part of the figure illustrates the resulting improved ADC circuit. In comparison with a circuit of the previously reported type, a circuit of the present type can be made to operate at the same rate and the same level of accuracy while occupying less space and consuming less power.



The **Present Improved ADC** with a single simple inverter is derived from a previously reported charge-balancing ADC with two charge-integrating operational amplifiers via an intermediate version with one operational amplifier.

This work was done by Zhimin Zhou and Bedabrata Pain of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to

Technology Reporting Office
JPL
Mail Stop 122-116
4800 Oak Grove Drive
Pasadena, CA 91109
(818) 354-2240

Refer to NPO-19979, volume and number of this NASA Tech Briefs *issue, and the page number.*

Determining Superconductor Inhomogeneity at Room Temperature

Eddy-current scans reveal inhomogeneities of resistivity, which is related to T_C.

Marshall Space Flight Center, Alabama

A technique for determining inhomogeneities in a specimen of a high-critical-temperature superconductor involves scanning a small eddy-current probe over a flat surface of the specimen at room temperature while monitoring the inductance of the probe. In contrast, older techniques for obtaining the same or similar information involve cooling the specimen below its superconducting-transition critical temperature (T_C), with attendant difficulty and cost of operating a cryogenic apparatus.

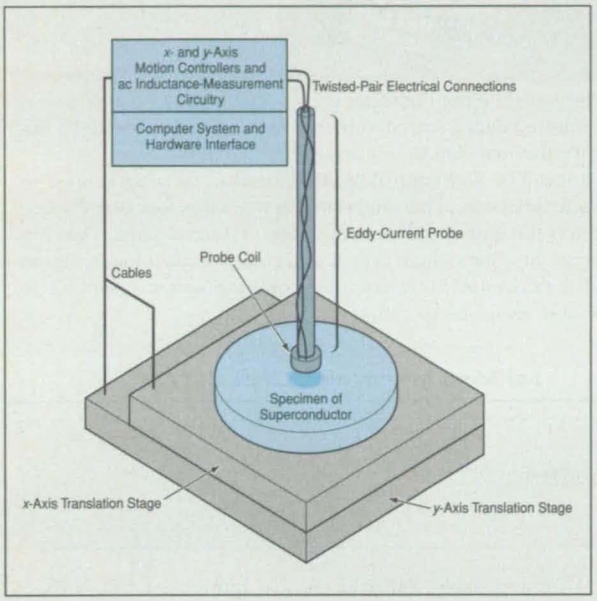


Figure 1. **A Flat Specimen of a High-T_C Superconductor** is translated under an eddy-current probe to obtain local probe-inductance measurements at the intersections of a rectangular grid.

The present technique is based on the following two concepts:

1. The inductance of a test coil placed near a highly electrically conductive object increases with increasing electrical resistivity of the object.
2. Previous measurements on conventional low-T_C superconductors have revealed correlations between their T_Cs and normal resistivity ratios. High-T_C superconductors are assumed to behave similarly.

Applying these concepts to a specimen of a high-T_C superconductor, one can infer inhomogeneities (specifically, spatial variations of T_C, including intergrain contacts and structural defects) from spatial variations of room-temperature resistivity and thus from spatial variations of the inductance of an eddy-current probe scanned over the specimen.

Figure 1 schematically depicts an apparatus for implementing the technique. An eddy-current probe is held stationary just above the flat surface of a high-T_C specimen, which is mounted on a horizontal two-dimensional (x,y)-translation table. Stepping motors controlled by a computer actuate the translation stages to move the specimen to commanded x,y positions. By use of a variable-frequency inductance/capacitance/resistance meter, the coil is excited at a frequency (typically about 10 MHz) chosen to obtain the best signal-to-noise ratio and the inductance of the coil is measured. This measurement is repeated at regular increments (typically 0.5 mm) of x and y to obtain a map of eddy-current-probe inductance on a rectangular grid that spans the specimen surface. The inductance data at the grid points can be used to synthesize a gray-scale or false-color image of inhomogeneity in the specimen (see Figure 2).

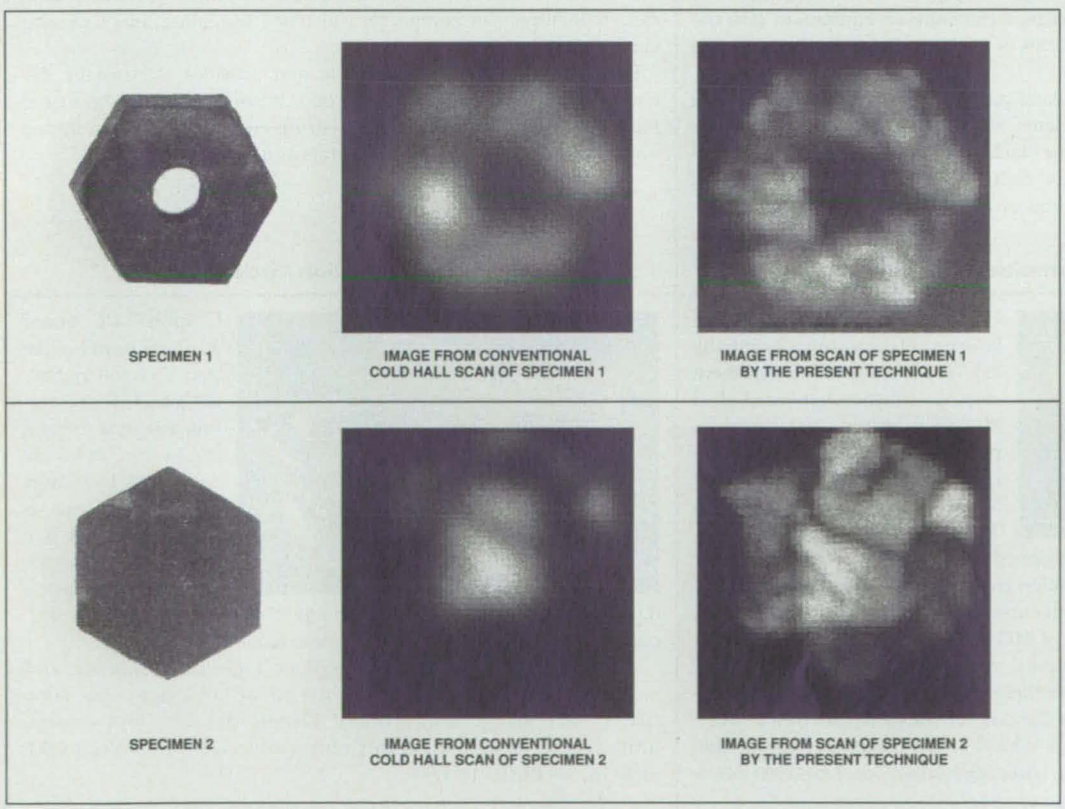


Figure 2. **Images of Inhomogeneities** in two high-T_C-superconductor specimens were synthesized from Hall-probe scans at low temperature and from room-temperature scans by the present technique. A qualitative correlation between the two images for each specimen is apparent.

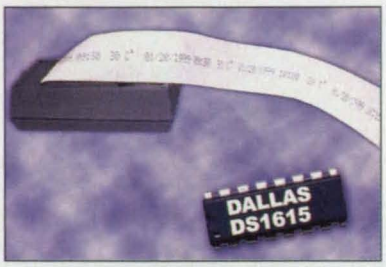
This work was done by Robert C. Sisk and Palmer N. Peters of **Marshall Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center; (256) 544-0021. Refer to MFS-31249.

Hewlett-Packard, Palo Alto, CA, has introduced the HP 4072A **semiconductor test system** for process verification of next-generation CMOS (Complementary Metal Oxide Semiconductor) integrated circuits at high throughput. The parametric system also provides Flash memory-testing capability, rapid wafer level reliability (WLR) assessment, and ring-oscillator measurements.

The system's 60-MHz @ -3dB high-frequency matrix provides flexibility for pulse-signal routing. An integrated pulse switch built into the test head allows design engineers to toggle between write and erase functions without controller intervention. When combined with a spectrum analyzer, the system can measure frequencies of hundreds of megahertz.

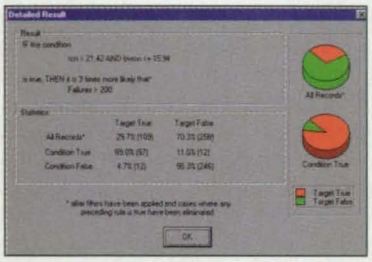
For More Information Circle No. 727



Dallas Semiconductor, Dallas, TX, offers the DS1615 **one-chip instrument** for measuring temperature integrity and variability over time. The chip integrates a Y2K-compatible real-time clock, digital thermometer, control logic, serial interface, and nonvolatile memory that can record 2,048 consecutive temperatures. Collected data is stored in both a traditional data log and a histogram for thermal distribution analysis.

Only a few RTC and control registers need to be programmed to begin data collection. The single-chip device takes less board space and reduces the testing and inventory costs of discrete parts. The chip can operate in a standalone system as a complete data logger; in an embedded environment, it does not consume system resources to monitor and record temperature.

For More Information Circle No. 728



Q-YIELD 4.0 **semiconductor yield improvement software** from Quadrillion Corp., Kanata, ON, Canada, solves production problems, regardless of data file size, using artificial intelligence coupled with statistics. Each analysis automatically produces a report at the touch of a button. Other features include support for high-level data types such as parametric measurements or equipment IDs, the ability to run analyses in batches or individually, and command line interface for rapid analysis.

The software determines which parameters are most likely related to yield fallout; visualizes results, with frequency, line, and scatter plots; prints graphs in color or black and white; conducts more thorough analyses of variables for complex relationships; and features comprehensive on-line help and on-screen manuals.

For More Information Circle No. 729

Olflex® Wire and Cable, Fairfield, NJ, has introduced CRC/CRC-S continuous flex, contamination-free **semiconductor equipment cables** for applications in cleanroom environments. Available in standard unshielded (CRC) and shielded (CRC-S) versions, the cable is halogen-free, does not shed particulates, or outgas harmful chemicals. It features the company's Xelclene® insulating and jacketing compound.

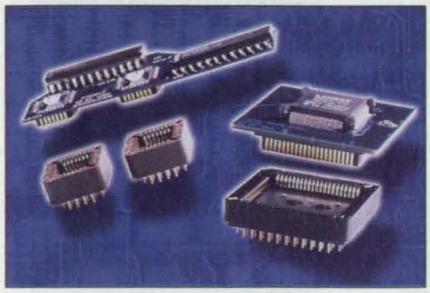
The cable is Class 10 compatible and provides electrostatic discharge (ESD) and EMI/RFI protection. It can be used on automated handling systems, processing and curing equipment, pick-and-place units, industrial drives, and computers and electronics.

For More Information Circle No. 730

Harris Semiconductor, Melbourne, FL, has introduced the HS-4423RH **power management chip**, a radiation-hardened dual MOSFET driver that provides power management for platforms requiring high performance in harsh radiation environments. The chip is an inverting, dual, monolithic MOSFET driver designed to convert transistor to transistor logic (TTL) level signals into high-current output voltages up to 18V.

The chip also provides output current and lower power consumption of about 40 mW for control of MOSFETs in high-frequency applications. The high current outputs minimize power losses in power MOSFETs by charging and discharging the gate capacitance. A low-voltage lockout circuit places the outputs into a tri-state mode when the supply voltage drops below 10V. The chip is suitable for switching power supplies, DC to DC converter applications, and motion/motor control applications.

For More Information Circle No. 731

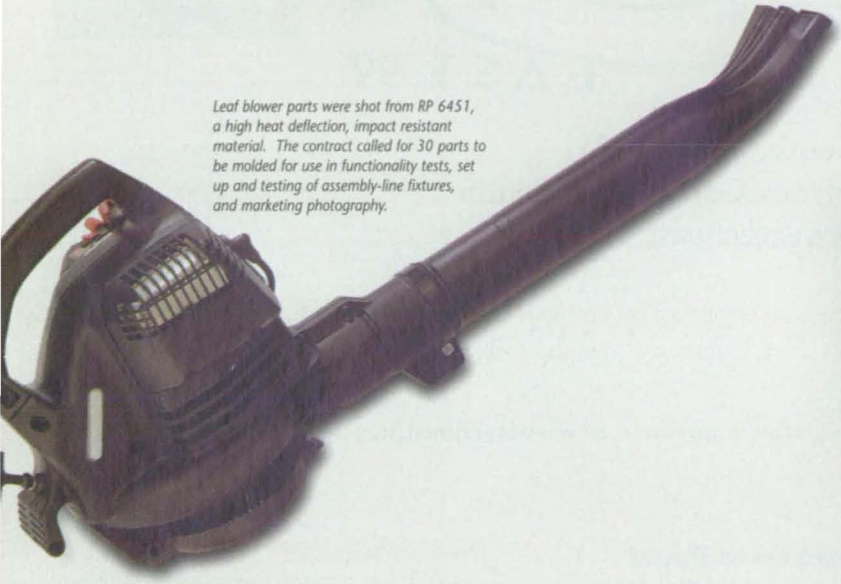


ChipFix™ **PC board adapters** from Emulation Technology, Santa Clara, CA, are custom adapters created for semiconductor users that have large numbers of PC boards with chips that are obsolete or upgraded. By creating a daughter board conversion for any chip upgrade or obsolescence, the user can continue to use existing boards.

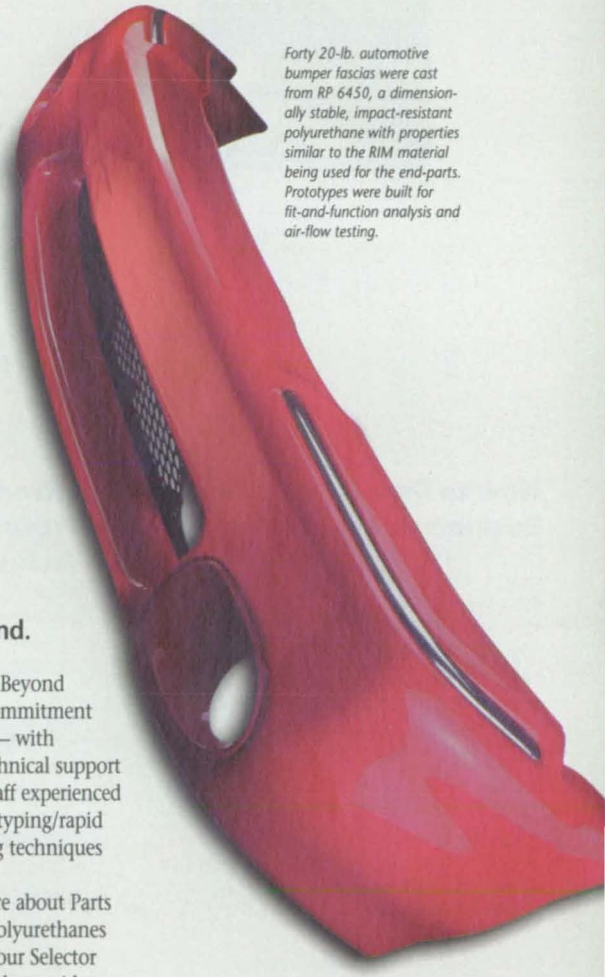
The adapters allow users to replace logic and memory, and enables circuitry and components to be added to the same space, increasing motherboard circuit density. The custom units can be designed for any chip conversion, including QFP to BGA, or PLCC to QFP.

For More Information Circle No. 732

Blood centrifuge covers were produced from RP 6453, chosen for its high heat deflection temperature, good impact resistance and flame retardance. Nearly 1,500 covers were molded in 12 months for installation on centrifuges shipped throughout the world.*



Leaf blower parts were shot from RP 6451, a high heat deflection, impact resistant material. The contract called for 30 parts to be molded for use in functionality tests, set up and testing of assembly-line fixtures, and marketing photography.



Forty 20-lb. automotive bumper fascias were cast from RP 6450, a dimensionally stable, impact-resistant polyurethane with properties similar to the RIM material being used for the end-parts. Prototypes were built for fit-and-function analysis and air-flow testing.

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* *@0.125 inches*

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Value beyond chemistry

For More Information Circle No. 512

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How to Develop a Successful Business or Product

Engineers and other technical professionals are becoming increasingly important as business drivers. Most, however, know few of the skills required to turn a good idea into a successful business. This course will focus on the knowledge, skills, and behaviors needed to "Make it Happen." It will deal primarily with nontechnical issues, as most projects fail due to "people issues."

BENEFITS

You will learn:

- how to recognize an opportunity
- how to sell and market an idea
- how to effectively manage enterprise projects
- how to assemble, motivate, and manage a team
- how to prepare a business plan
- fatal flaws that kill projects
- a roadmap for a successful project.

Most importantly, you will get an understanding of how people really work together, what motivates them, and how the use of simple people skills can make you more efficient and effective.

WHO SHOULD ATTEND

The course will address the needs of both those who run major development projects within an organization (intrepreneurs) and those who want to do it on their own (entrepreneurs).

INSTRUCTOR

Leslie M. Gray, an entrepreneur and engineer, started Airflow Research and Manufacturing Corp. in 1980 to market quiet cooling fans for automobiles; ten years later, when he and his partners sold Airflow to the Robert Bosch Corp., it had grown to $55 million in annual sales. He continues to consult to Bosch while teaching entrepreneurship and serving on the boards of several startup firms.

SC100 $150 prereg/$195 on-site
Mon., Sept. 20: 9:00 am to 12:30 pm

Introduction to Rapid Prototyping and Tooling Technologies

As product design and manufacturing cycles have become more and more compressed, new timesaving tools have emerged to help engineers meet their production challenges. This course will provide an overview of the latest technologies in the areas of rapid prototyping, rapid tooling, and high-speed machining; illustrate practical examples of how these technologies can save time and increase productivity; and discuss which of the technologies make sense for various product design and tooling applications. Topics will include:

- 3D CAD — the starting point
- traditional prototyping vs. rapid prototyping:
- reverse engineering
- rapid prototyping methodologies (Stereolithography, Solid Ground Curing, Laminated Object Manufacturing, Selective Laser Sintering, Fused Deposition Modeling, etc.)
- 3D printing
- rapid desktop and office modelers
- introduction to rapid prototyping applications
- plastic and metal rapid prototyping
- sheet metal fabrication
- high-speed machining vs. rapid prototyping
- RP service bureaus

BENEFITS

In this course you will learn:

- how to slash time and drive down product development costs
- the range of rapid prototyping and tooling technologies available today, how they work, and their cost
- the advantages and limitations of each technology
- which technologies are appropriate for your applications
- new advances on the horizon.

WHO SHOULD ATTEND

Engineers and managers involved in product design, prototyping, and development; individuals involved in making decisions on incorporating rapid prototyping technology into existing design and manufacturing processes; anyone interested in gaining comprehensive knowledge of these emerging technologies.

INSTRUCTOR

A pioneer in the rapid prototyping industry, **Merlin C. Warner** has more than 15 years experience in engineering and manufacturing, and has worked for companies involved in tooling design, rapid prototyping, and rapid manufacturing. He is president of Warner Technologies, Waterford, MI, and is an internationally renowned expert, consultant, and speaker in the field of rapid prototyping, high-speed machining, and their applications.

SC101 $175 prereg/$225 on-site
Mon. Sept. 20: 9:00 am to 1:00 pm

Technology Commercialization Strategies/Finding Niche Markets

Whether your product or service is just an idea, recently patented, emerging or mature, this workshop will help you evaluate the potential opportunities and risks and find the most profitable niche commercial markets.

BENEFITS

You will learn through discussion and brief exercises:

- how to evaluate new product ideas and minimize your risk
- what key factor has the most influence in the acceptance of technology in the commercial marketplace
- the "new" metrics in commercialization success
- specific techniques for targeting your best opportunities

- cost-effective ways to find the commercial value of your product
- how to launch products on tight budgets
- how to prepare a commercialization plan that gets attention.

WHO SHOULD ATTEND

Engineers and other technical professionals, business managers/owners, entrepreneurs and others involved in marketing and selling technologies, products and services.

INSTRUCTOR

William J. Dorman is President of Dorman Associates Inc., Lambertville, NJ. Dorman Associates Inc. is a marketing strategies, management engineering, consulting and research company established in 1976.

SC102 $150 prereg/$195 on-site
Mon., Sept. 20: 1:30 pm to 5:00 pm

Fast and easy online registration: www.techeast.net

Speeding the Innovation Process: How to Improve the Performance of Engineering Systems

This course will review product and process analysis to correctly define and solve product concept design problems. Attendees will examine the resource limitations that impede innovation, how the world's patent collection can be applied to improve product development, and how to predict novel solutions.

BENEFITS

During this course, you will learn:

- how to avoid design mistakes made by other companies
- how to apply the laws and trends that govern engineering systems to your own projects
- how evolutionary practices can predict innovation to be used to improve current systems
- how to use these trends to guarantee success in product design initiatives.

WHO SHOULD ATTEND

Design and R&D engineers, product development managers, leaders of major development projects within organizations

INSTRUCTOR

Dr. Sergei Ikovenko, Director of Training and Services for Boston-based Invention Machine Corp., has conducted more than 300 courses on design innovation and technology optimization. In addition to working with Fortune 500 companies worldwide, Dr. Ikovenko has taught seminars at MIT, Harvard, Carnegie-Mellon, and other leading engineering schools. Dr. Ikovenko has received 76 patents in various field of engineering and authored more than 30 scientific papers.

SC104 $150 prereg/$195 on-site
Tues., Sept. 21: 9:00 am to 12:30 pm

Course registration includes workbook, complimentary tickets for coffee and dessert breaks, and entry to all exhibits. For questions or information on group discount rates, call Melissa Hinnen at (212) 490-3999; melissa@abptuf.org

SBIR as a Business Development Resource: A workshop for SBIR-active and interested firms

With over $1.2 billion in annual funding from TEN federal agencies, the Small Business Innovation Research Program is the largest U.S. source of early-stage technology development financing. Over 9,500 firms have been funded for almost 50,000 projects in every field of endeavor, and some 4,500 new projects are selected each year involving several hundred new firms as well as previous winners.

With strong emphasis on bringing technology to full use-condition, SBIR must now be understood as involving far more than simply having a good idea and getting an award. The scale and scope of federal participation itself has changed in important ways, as has the expectation of what awardees must subsequently address to be judged "successful."

For SBIR awardees and newcomers alike, this all-day, highly interactive, workshop will provide information, analysis, tools and insight into effective SBIR participation and long-term business achievement.

BENEFITS

Featuring leading federal procurement and business development experts, the workshop will cover:

- SBIR's changing dynamics (and the opportunities therein!)
- how the program REALLY works...and making it work for YOU
- effective project design and proposal development
- understanding the government as a customer
- factoring to current (changed) business circumstances
- identifying and valuing technology assets
- critical issues in bringing technology to market-use condition
- tools and strategies for exploiting your technologies

WHO SHOULD ATTEND

Those with a well-established SBIR presence as well as those just getting started will profit from this workshop, as will ANY company seeking to bring technology from lab to market.

- The morning session will address issues highly relevant to both SBIR veterans and newcomers;
- Two afternoon tracks will target, respectively: the practical needs of SBIR involvement, and appropriate and profitable market penetration.

IMPORTANT BONUS

An online interactive roundtable will support post-conference continuing discussion and materials exchange (access included in the workshop fee).

INSTRUCTORS

Ann Eskesen will lead a team of respected, experienced experts from industry, business and government. Since 1983, Ms. Eskesen has been President of Inknowvation Development Institute. She is a dynamic public speaker with a substantial reputation as an SBIR advocate.

SC103 $195 prereg/$245 onsite
Tues., Sept. 21: 8:30 am - 5:00 pm

Marketing For Survival: Creating Opportunities and Solving Problems through the POWER of Marketing

Marketing isn't a choice. We all do it every day. To survive in today's fast-paced world, we need to convince management to support, investors to risk, and customers to buy. As professionals in other disciplines with little time to spare, we need practical, proven marketing tools that get the job done right.

BENEFITS

- **Clarity:** About who our "customers" are and why they buy, fund, and invest
- **Value:** The ability to define the value of our products and services to each customer segment
- **Discipline:** Mental tools that help maintain a focus on satisfying customers in a competitive environment
- **Confidence:** When interacting with our customers, management, and investors
- **Power:** Abilities to use the disciplines and processes of marketing to reach goals and manage change
- **The Book:** "Marketing for Survival"

WHO SHOULD ATTEND

Anyone serving "customers" with technologies, products, services, projects, investment opportunities, or time as employees in professional disciplines

INSTRUCTOR

Dr. Gary Lundquist transitioned from scientist to marketer while converting a service company into an INC 500 software company. He helps high-tech companies and R&D labs nationwide to manage change with marketing. He has marketed technologies, products, and services ranging in price from one hundred to half a billion dollars.

SC105 $150 prereg/$195 on-site
Wed., Sept. 22: 9:00 am to 12:30 pm

Intellectual Property: Protection, Licensing, and Government Technology Transfer Issues

This course will provide an overview of three critical areas of concern when bringing technology to the marketplace: protecting intellectual property; dealing with the government in technology transfer matters; and licensing technology.

BENEFITS

This easy-to-understand course will bring you up to speed on:

- trade secret, patent, copyright, and trademark protection and their relevance to commercializing technology
- the Federal Technology Transfer Act and Cooperative Research & Development Agreements (CRADAs), one of the primary mechanisms for government-industry partnerships and tech transfers
- intellectual property issues when dealing with the government — pitfalls to avoid and proven paths to success
- licensing agreements, in particular the key differences between licensing from the government and from the private sector
- how to determine royalties.

WHO SHOULD ATTEND

Industry, government, and university technology managers; engineers; scientists; and entrepreneurs who want to learn how to effectively protect and license their ideas.

INSTRUCTOR

Jacob N. (Jesse) Erlich, a partner with Perkins, Smith, & Cohen, LLP, specializes in intellectual property matters. Previously, attorney Erlich served as Chief Patent Advisor for the U.S. Air Force. He holds a BS in Mechanical Engineering from Worcester Polytechnic Institute and a Juris Doctor degree from Georgetown Law School. A Past-President of the Boston Patent Law Association, Erlich recently coauthored a book entitled "Technology Development and Transfer — the Transactional and Legal Environment."

SC106 $150 prereg/$195 on-site
Wed: 9:00 am to 12:30 pm

New on DISK

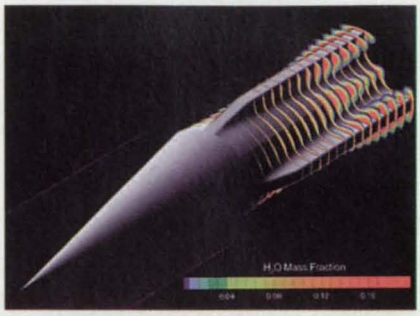
Software-Documentation System

Algor, Inc., Pittsburgh, PA, offers DocuTech, a software-documentation system on CD-ROM, with Release 12 of their FEA software. DocuTech has been redesigned for improved functionality, and contains Algor's software operating and reference documentation, customer application stories, and keystroke-specific tutorials. It uses HTML technology to maintain links between related documents. Features include a new single interface window and technical documentation manuals revised to reflect Release 12's capabilities. DocuTech's search engine allows users to search documentation by chosen categories. **Circle No. 711**

Production Reporting Software

Wonderware Corp., Irvine, CA, offers Industrial Communication's third-party FactorySuite Reporting Tool for use with Wonderware's InTrack resource-management and work-in-progress (WIP) tracking module. FactorySuite is a graphical client program designed to give InTrack users a simple method of analyzing virtually all aspects of their production processes and end products. The FactorySuite Reporting Tool runs in a standalone format and reads information from an InTrack structured query language (SQL) database. Applications include checking product genealogy and WIP information. **Circle No. 718**

Visualization Software

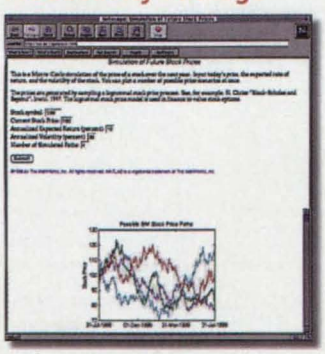


Amtec Engineering, Bellevue, WA, has introduced Tecplot 7.5 visualization software that enables users to transform technical problems into 2D and 3D images, interface with industry-standard data formats, and integrate spreadsheet data into Tecplot grids. The software features the Add-On Developers Kit (ADK), an application programming interface and set of software tools that allows developers to write add-ons directly linked to Tecplot. Applications include post-processing in aerospace, heat transfer, and other disciplines. **Circle No. 713**

MATLAB Web Server

The MathWorks, Natick, MA, offers the MATLAB Web Server, which enables development and distribution of Web-based MATLAB applications. The server allows MATLAB programmers to develop Web-deployable applications from standard MATLAB components. The HTML documents serve as a point-and-click graphical user interface (GUI) for the MATLAB application being deployed. Users do not need to learn MATLAB, and it need not be running on the client machine. Features include tools for processing HTML forms, server-based computing, and interface to MATLAB via standard HTML forms. Applications can generate graphics using MATLAB data-visualization capabilities. **Circle No. 716**

Productivity Package



Technical Professional Suite 8 from MathSoft, Cambridge, MA, is an integrated productivity suite consisting of Mathcad® 8 Professional, Mathcad 8 Treasury, Axum® 6, and Intergraph's Imagination Engineer™ LE. The suite provides engineers and scientists with tools for technical calculation, data analysis, graphing, and CAD drawing. Changes in input data in any one application are incorporated across the entire software suite. The suite also generates publication-quality documents that can be shared via Internet or intranet using built-in Web publishing and browsing capabilities. **Circle No. 715**

Mechanical Design Automation

Parametric Technology Corp., Waltham, MA, has introduced Pro/ENGINEER 2000*i*. This next-generation version of the company's mechanical design automation software includes more than 500 enhancements. It incorporates new functionality and applications for very large assemblies, adaptive process features, design animation, and feature-based production manufacturing tools. It also offers enhanced capabilities for sharing engineering information via the Internet. Behavioral modeling technology enables engineers to explore optimal solutions with a thorough understanding of a design's performance and behavior. **Circle No. 719**

New LITERATURE

Switch Selection Guide

New England Controls, Milford, CT, offers a four-page brochure featuring its complete line of switches. Products include appliance rocker, round rocker, toggle, mini rocker, key, and push-button switches. The Surf 'N Turf line of switches, designed for both marine and land applications, is resistant to vibration, shock, and thermoshock. **Circle No. 733**

Surface Coatings

Thermal Spray Technologies, Sun Prairie, WI, has released a four-page brochure describing application-specific coatings. The company develops and tests coatings for specific surface properties in aerospace, automotive, biomedical, electronic, and other industries. Available coatings provide thermal protection and control, electrical insulation, and resistance to corrosion, abrasion, and oxidation. **Circle No. 736**

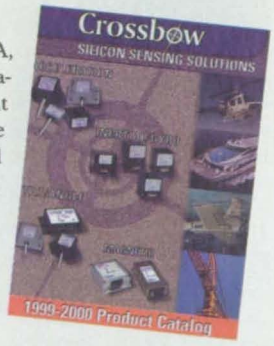
Motors and Switches

A catalog from Haydon Switch & Instrument, Waterbury, CT, describes miniature stepper motors, linear actuators, and sealed switches. Other products include synchronous gear motors, pancake and oscillating motors, and linear/rotary dual-motion actuators. The switches are designed for use in harsh environments associated with aerospace and industrial applications. **Circle No. 735**

Latches and Hardware

The ZOOM™ Interactive Product Selection Guide from Southco, Concordville, PA, is a Windows-based CD-ROM that offers more than 13,000 products, including latches, captive fasteners, hinges, handles, pulls, and drive rivets. The user enters design criteria (panel thickness, thread size, etc.) and ZOOM lists solutions. Other features include product descriptions, a glossary, animated installation tips, and a demo. **Circle No. 734**

Sensor Subsystems

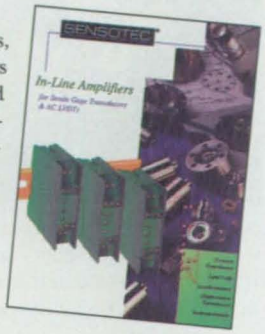


Crossbow Technology, San Jose, CA, has introduced a 60-page 1999-2000 catalog of sensor subsystems, development software, and accessories. Featured are accelerometers, tilt sensors, inertial measurement units, vertical gyroscopes, and magnetic direction and orientation sensors. The catalog also includes X-View and X-Analyze PC-based sensor data acquisition and analysis software. **Circle No. 742**

CompactPCI Products

Schroff North America, Warwick, RI, offers a six-page catalog of CompactPCI products, including handles, front panels, subracks, backplanes, and accessories. New items include fully configured CompactPCI system subracks that integrate the backplane, power supply, drive mounting, and cooling in one package. **Circle No. 737**

In-Line Amplifiers



A brochure from Sensotec, Columbus, OH, describes a series of in-line amplifiers for use with strain gage transducers and AC LVDTs. The 35mm DIN rail-mountable design includes front-accessible electrical connections, and zero and span adjustments. These units provide selectable, regulated DC excitation voltage for the strain gage bridge. Also featured is the Universal Series of user-programmable amplifiers. **Circle No. 738**

New on the MARKET

Video Inspection System

Olympus America, Industrial Products Group, Melville, NY, offers a remote visual inspection system that can be hand-carried. Internal inspections can be performed anywhere in the field, including video internal weldment inspections, which can be made without removing and disassembling the equipment under study. The system consists of an Olympus Series 6 videoscope, an onboard computer, CCU, internal floppy disk drive, light source, and a 6" diagonal LCD monitor. The monitor mounts on the videoscope handle or on a telescoping pole. **Circle No. 743**

Instrumentation Chassis

Geotest, Marvin Test Systems, Santa Ana, CA, has introduced the GT7700 family of PCI/ISA instrumentation chassis. Applications include automatic test equipment (ATE), data acquisition, process control, and scientific research. The standalone unit uses an embedded controller with a 233-MHz (300-MHz optional) Pentium CPU unit, which occupies three of 14 available slots. Its instrumentation section provides four PCI and eight ISA slots. The chassis accommodates up to 11 PCI/ISA instruments and is expandable to 38 PC cards. The platform is designed to provide isolation between the CPU and instruments, and between individual instruments. **Circle No. 702**

Notebook Data Acquisition

The WaveBook/ 512H 1-MHz, 12-bit portable data acquisition system for notebook or desktop PCs is available from IOtech, Cleveland, OH. It connects to a notebook PC via the PC's enhanced parallel port (EPP) or optional PCMCIA card. The base unit offers eight analog input channels and eight digital inputs; it expands to 72 analog input channels via an optional module. The DSP-based design enables definition of any random sequence of channels and associated gains across all 72 potential channels. The system accepts input voltage up 10V and runs on either AC or DC power. It is supported by several signal conditioning options and includes WaveView™ software. **Circle No. 701**

Digital Storage Oscilloscope

The Delta 9500A digital storage oscilloscope from Gould Instrument Systems, Valley View, OH, features a 6.5" VGA color display, 500-MHz bandwidth on all four channels and all attenuator settings, logic and analog triggering capabilities, and a 2-GS/s sample rate. The scope is designed for high-speed testing of digital and power supply designs; and high-speed component, motor drive performance, electrical discharge, and telecom testing. The system incorporates TruTrace®, a patented method of displaying the full waveform detail with variable intensity. Multiple on-screen measurements are assigned to any channel from a list of 43 functions. **Circle No. 704**

Universal Device Programmer

B&K Precision Corp., Placentia, CA, offers the Model 845 Universal Device Programmer with Logic/Memory Test function. The unit, which is used in conjunction with a PC, allows testing of logic and memory chips, as well as programming both standard and low-voltage devices. A built-in power supply operates from either 115 or 230 VAC 50/60 Hz. The programmer uses a parallel interface and works with both desktop and laptop PCs. Applications include research and design, engineering, prototyping, servicing, and manufacturing. **Circle No. 703**

Rotary Position Sensor

Clarostat Sensors and Controls, El Paso, TX, has introduced the Clarostat HRS100 Hall Effect rotary position sensor for automotive, marine, industrial truck, and aircraft position sensing and control. The sensor allows programmable customization of temperature coefficient, offset, and gain control at time of manufacture. This three-terminal, voltage-output device resolves rotation up to 180 degrees and operates at a low supply voltage (about 5 volts). The sensor also has a minimum life of 10 million cycles. Custom electrical functions can be provided by specialized Hall ICs or additional electronics. **Circle No. 700**

New on the MARKET

Component Rack System

Hoffman, Anoka, MN, offers the Open LAN Rack mounting system for 19" and 23" components that supports up to 600 pounds of rack-mounted equipment. It affords easy access to components and provides an alternate mounting solution for patch panels, test instruments, and data and communications equipment. The rack is constructed of lightweight aluminum side rails and cross members. Models are available in 19" or 23" horizontal spacing; the four available heights range from 4 to 8 feet. Vertical mounting-hole spacing complies with ANSI/EIA RS 310-D rack-mounting standards, tapped with 12-24UNC threads. **Circle No. 705**

Equipment Enclosures

The 0140 series of equipment enclosures from Daisy Data, York Haven, PA, is designed for dirty, wet, or wash-down areas. The enclosures accommodate a desktop PC with up to a 21" monitor. Construction with continuous weld seams helps ensure protection in harsh environments. Monitor shelf height is continuously adjustable, allowing correct positioning for monitors of all sizes. A front and rear access door with latches is designed for ease of cleaning. Several optional features are available, including an add-on keyboard drawer. **Circle No. 707**

Graphics Accelerator

Synergy II from ELSA, Santa Clara, CA, is an AGP 4X 2D/3D graphics accelerator designed to enhance entry-level workstation performance. It can be used with professional applications such as AutoCAD, 3D Studio MAX, Microstation, and other CAD/CAE and image processing programs. Utilizing the RIVA TNT2 processing engine, Synergy II is designed to leverage the Pentium III core for high-bandwidth graphics processing, such as geometry transform and lighting acceleration. The graphics controller has a dual-pixel, 32-bit color pipeline with 24-bit Z-buffer, 8-bit stencil buffer, and per-pixel precision. **Circle No. 706**

Portable Field Recorder

The Dash 16u 16-channel data acquisition field recorder from Astro-Med, West Warwick, RI, eliminates the need for signal conditioning or additional front-end filtering. The unit has universal inputs that accept isolated single-ended and differential voltages, thermocouples, pressure transducers, and load cells. Data sample rate is 0.2 to 200 kHz per channel. Features include a 10.4" active color display; real-time, high-resolution 300 dpi chart recording; 16 MB of RAM for data capture, and a built-in 100-MB removable Zip drive. The recorder also includes Windows-based AstroSET™ software to facilitate test setups, and AstroVIEW C™ for data transfer, review, and analysis on a PC. **Circle No. 709**

Editorial Index

Use the phone numbers listed below to obtain more information from the following companies featured editorially in this issue.

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Accuride International Inc.		569	11
Aero Tec Laboratories Inc.	www.atlinc.com	580	58
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Astro-Med, Inc.	www.astro-med.com	560	29
Ciba Specialty Chemicals		512	65
Coherent, Inc., Semiconductor Group	www.diodes.cohr.com	492	1a
Cole-Parmer Instrument Co.	www.coleparmer.com	590-594	31
Continuum	www.continuumlasers.com	544	COV III
CVI Spectral Products	www.cvilaser.com	460	2a
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Exciton Inc.		490	20a
Gage Applied Sciences Inc.	www.gage-applied.com/ad/nasa799.htm	536	9
GE Plastics	www.geplastics.com/nokia	504	21
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The MathWorks, Inc.	**www.mathworks.com/ntba**	**521**	**16A-B, 17**
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Minco Products, Inc.		422	69
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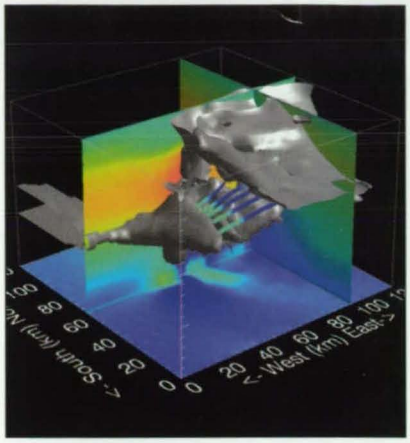

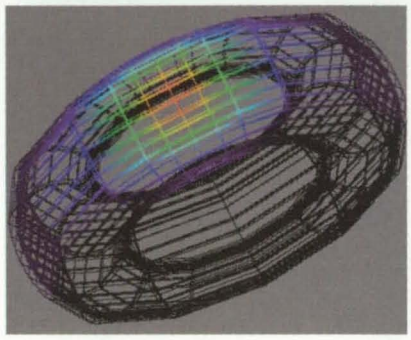

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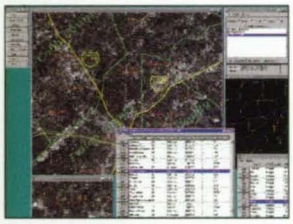
ENVI.



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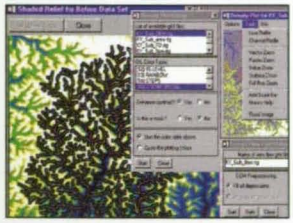

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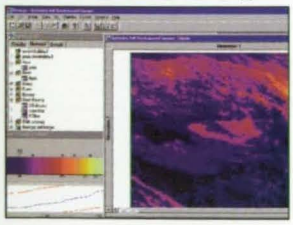

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