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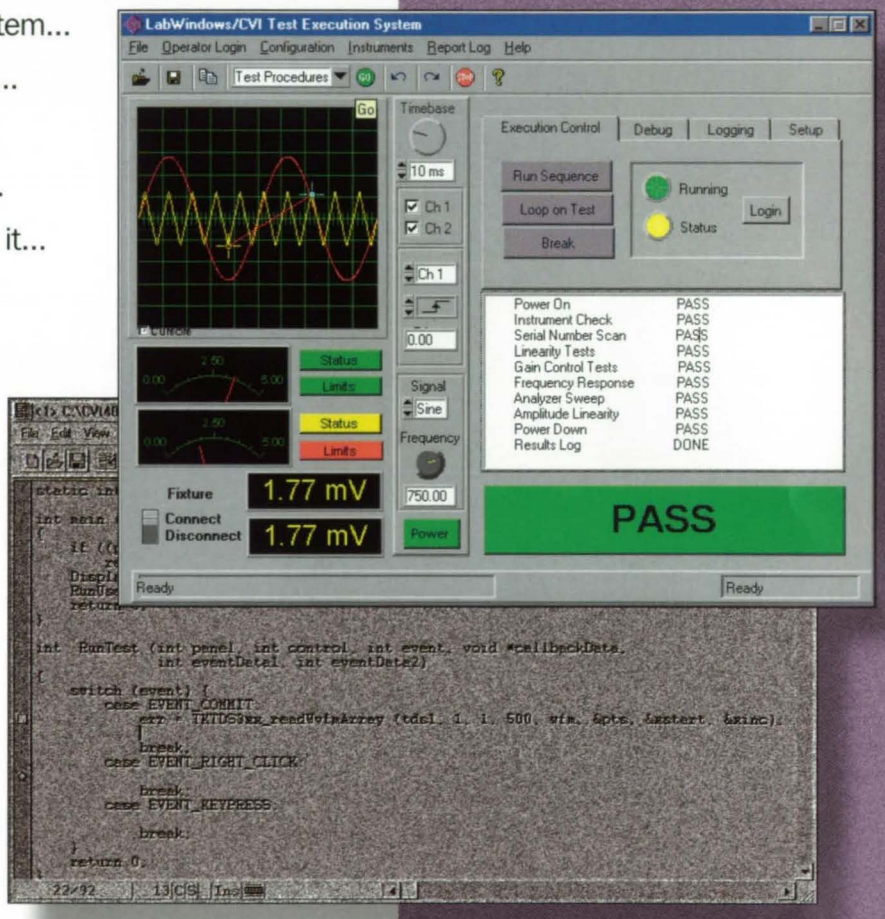

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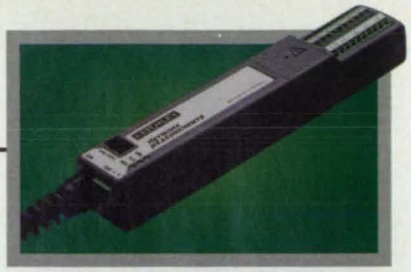

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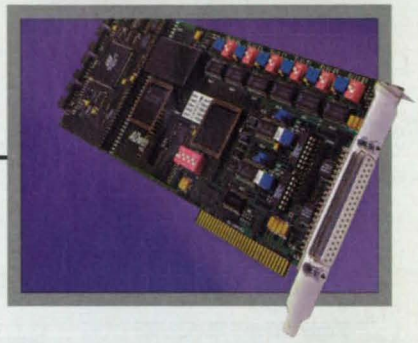

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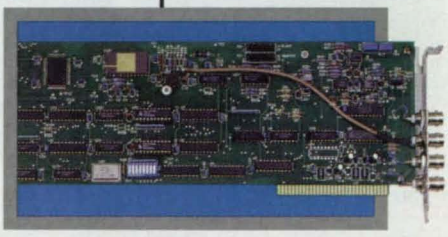

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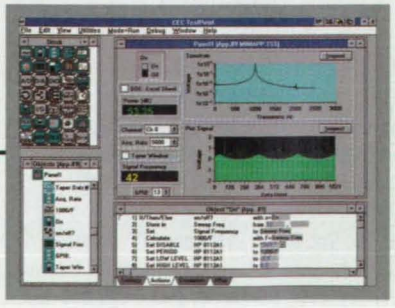

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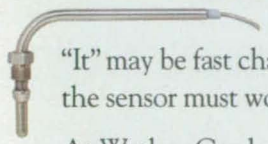

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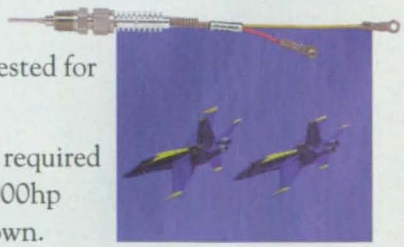

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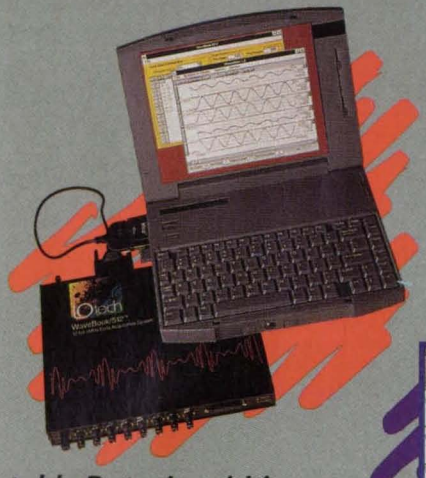

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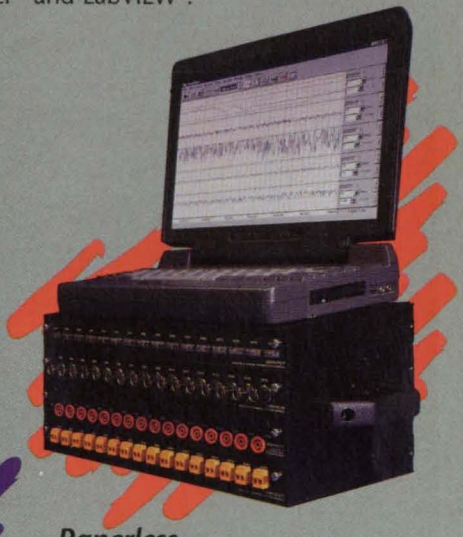

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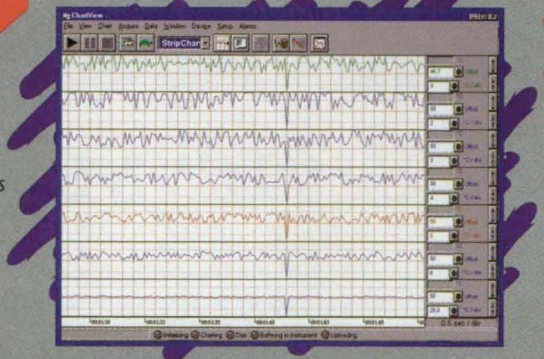

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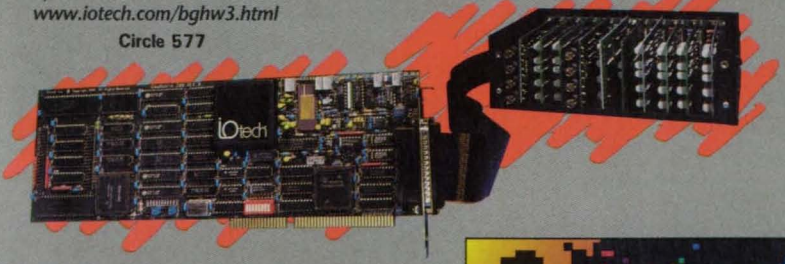

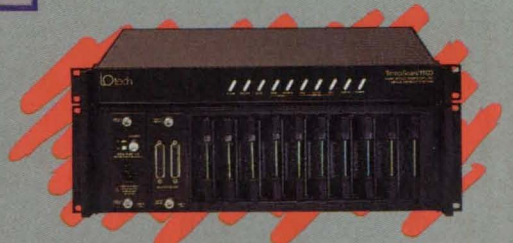

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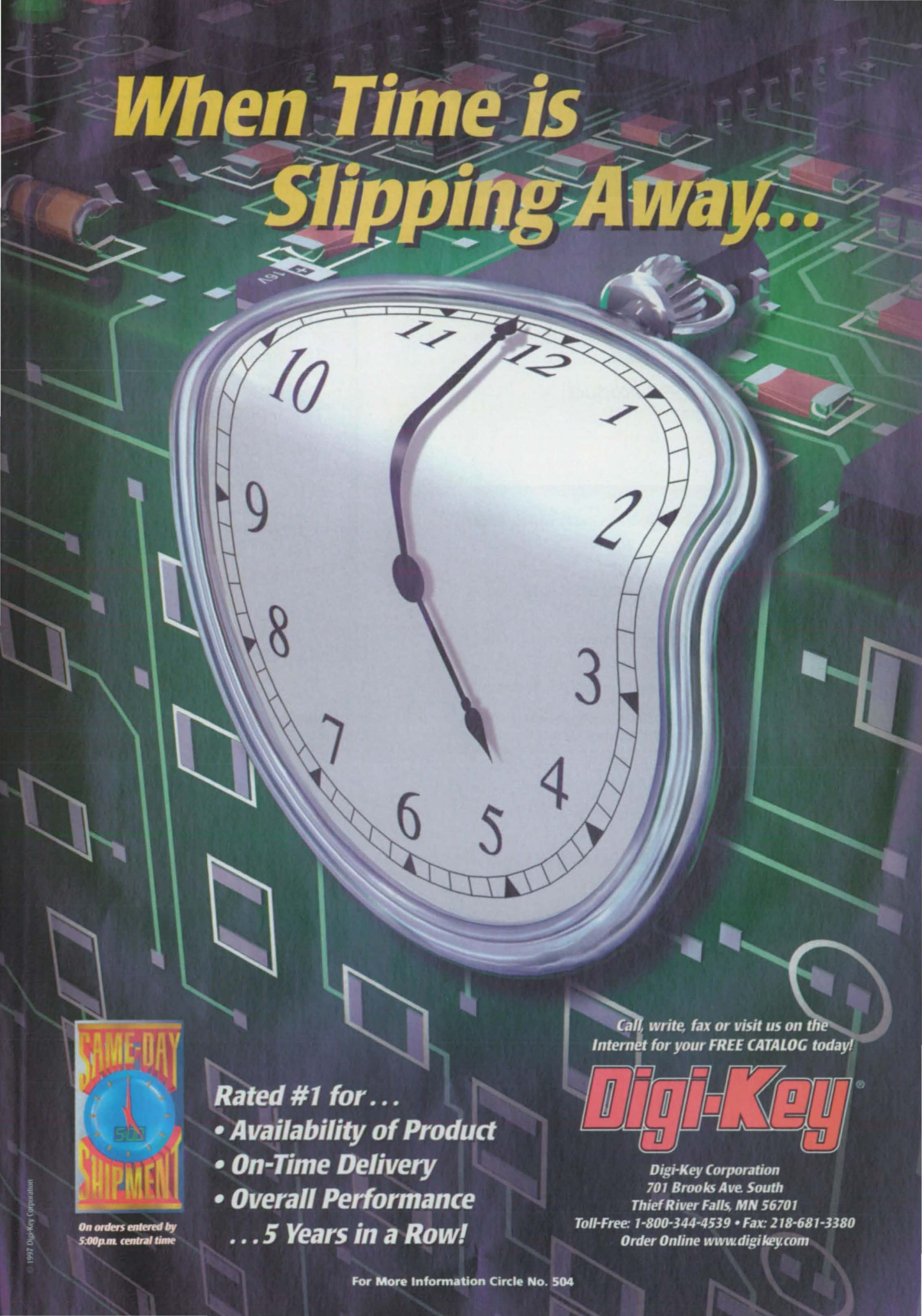
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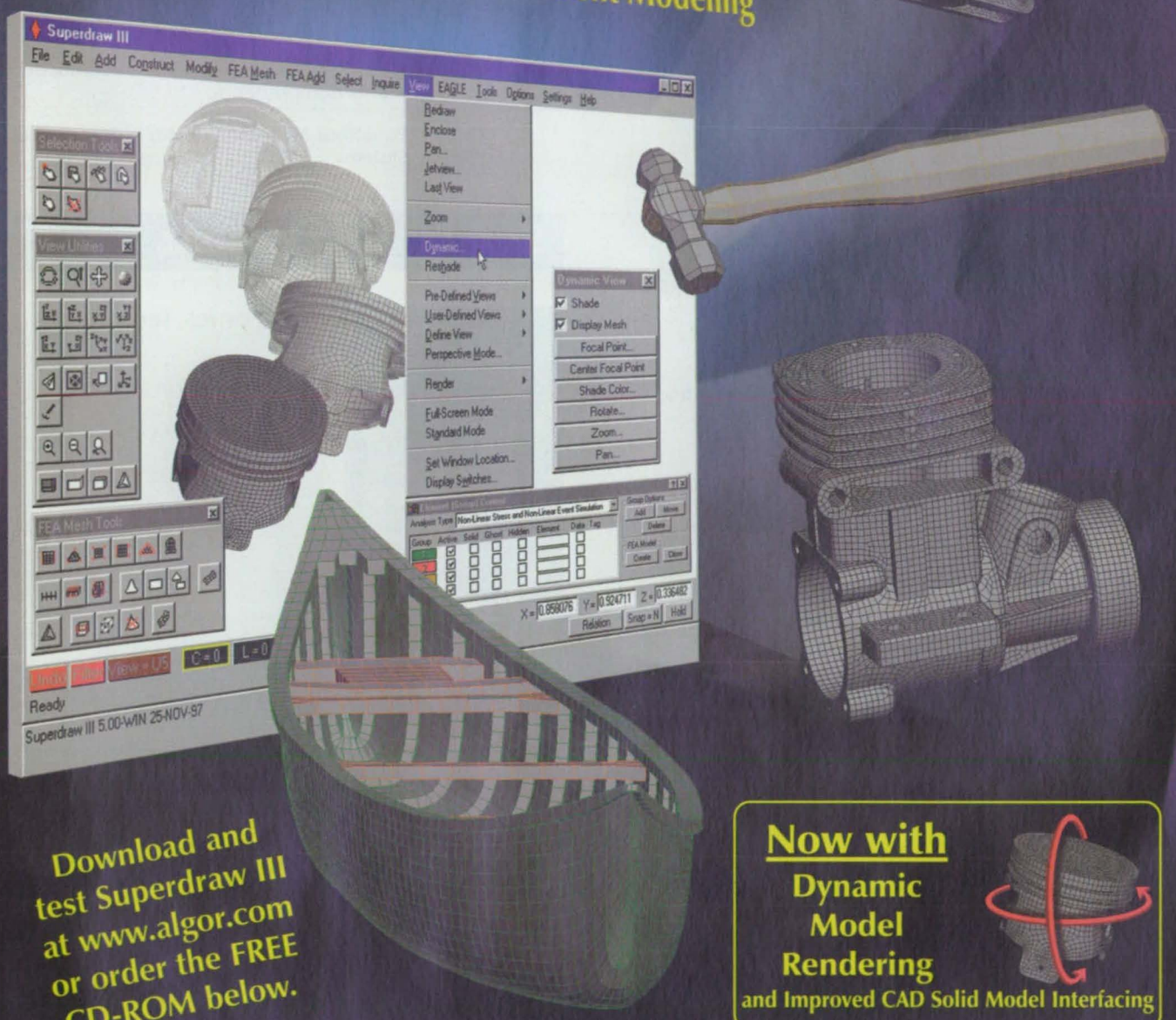

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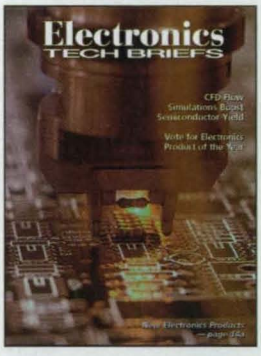

Electronics Tech Briefs

Follows page 80 in selected editions only.

On the cover:

This month's issue features Special Coverage of Sensors and Data Acquisition, beginning on page 40. Included are NASA's latest advances in both areas, as well as new proximity, pressure, and orientation sensors, and data acquisition boards, systems, and software. Personal Daq™ from IOtech, Cleveland, OH, is the first full-featured PC-based data acquisition module that fully utilizes the Universal Serial Bus (USB). The portable system provides a single-cable connection to the PC, with no battery or power cables needed. Learn more about Personal Daq™, the Product of the Month, in UpFront on page 16.

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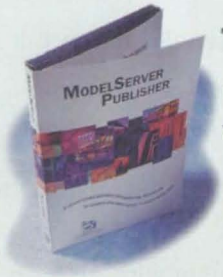

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Wavetable stereo sound with speakers
Microsoft® IntelliMouse™
Microsoft Windows NT® Workstation
5-year/3-year Micron Power™ limited warranty

$4,699
Bus. Lease $149/mo.

POWERDIGM XSU

Dual Intel 300MHz Pentium II processors
Samurai chip set
128MB ECC SDRAM
Iomega 1GB Jaz SCSI drive
Fire GL 4000 15MB 3DRAM/16MB CDRAM
4GB Ultra-Wide SCSI-3 hard drive
21" Hitachi SuperScan CM801 (20" display) .26dp monitor
Supports dual processors
Supports IDE Ultra ATA and multiple Ultra-Wide SCSI-3 hard drives
512KB pipeline burst cache, flash BIOS
Memory upgradable to 1GB ECC SDRAM
3Com Fast EtherNet 10/100 PCI network adapter
12/20X variable speed SCSI CD-ROM drive
Optional support for dual monitors
DMI, software and hardware management support
Iomega Jaz SCSI drive with 1GB removable cartridge
Wavetable stereo sound with speakers
Microsoft IntelliMouse
Microsoft Windows NT Workstation
5-year/3-year Micron Power limited warranty

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Bus. Lease $263/mo.

MMX™ intel inside pentium® II processor

MICRON POWER WARRANTY

- 5-year limited warranty on microprocessor and main memory
- 3-year limited parts-only system warranty (1-year for TransPort VLs)
- 1-, 2- or 3-year optional on-site service agreement for Micron desktop and server systems
- 30 days of free Micron-supplied software support for Micron desktop systems; 3 optional network operating system incident resolutions included for Micron server systems
- 30-day money back policy
- 24-hour technical support

The foregoing is subject to and qualified by Micron's standard limited warranties and terms and conditions of sale. Terms and conditions of sale may vary for specific configurations. Copies of the limited warranties may be obtained on our Web site or by calling Micron.

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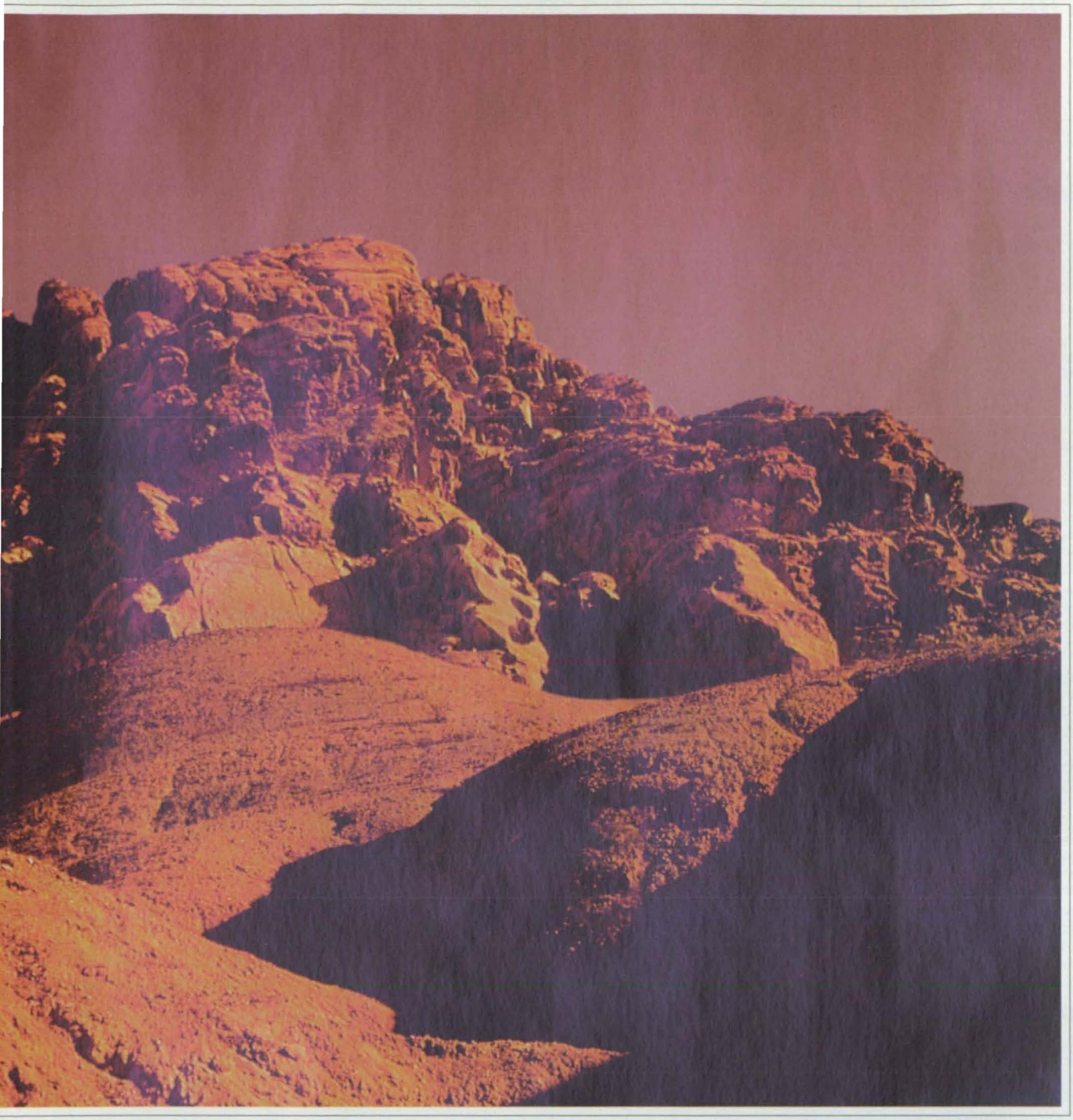

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For More Information Circle No. 540

NASA Commercial Technology Team

NASA's R&D efforts produce a robust supply of promising technologies with applications in many industries. A key mechanism in identifying commercial applications for this technology is NASA's national network of commercial technology organizations. The network includes ten NASA field centers, six Regional Technology Transfer Centers (RTTCs), the National Technology Transfer Center (NTTC), business support organizations, and a full tie-in with the Federal Laboratory Consortium (FLC) for Technology Transfer. Call (206) 683-1005 for the FLC coordinator in your area.

NASA's Technology Sources

If you need further information about new technologies presented in *NASA Tech Briefs*, request the Technical Support Package (TSP) indicated at the end of the brief. If a TSP is not available, the Commercial Technology Office at the NASA field center that sponsored the research can provide you with additional information and, if applicable, refer you to the innovator(s). These centers are the source of all NASA-developed technology.

Ames Research Center
Selected technological strengths: Fluid Dynamics; Life Sciences; Earth and Atmospheric Sciences; Information, Communications, and Intelligent Systems; Human Factors.
Bruce Webbon
(650) 604-6646
bwebbon@mail.arc.nasa.gov

Dryden Flight Research Center
Selected technological strengths: Aerodynamics; Aeronautics Flight Testing; Aeropropulsion; Flight Systems; Thermal Testing; Integrated Systems Test and Validation.
Lee Duke
(805) 258-3802
duke@louie.dfrf.nasa.gov

Goddard Space Flight Center
Selected technological strengths: Earth and Planetary Science Missions; LIDAR; Cryogenic Systems; Tracking; Telemetry; Command.
George Alcorn
(301) 286-5810
galcorn@gsfc.nasa.gov

Jet Propulsion Laboratory
Selected technological strengths: Near/Deep-Space Mission Engineering; Microspacecraft; Space Communications; Information Systems; Remote Sensing; Robotics.
Merle McKenzie
(818) 354-2577
merle.mckenzie@ccmail.jpl.nasa.gov

Johnson Space Center
Selected technological strengths: Artificial Intelligence and Human Computer Interface; Life Sciences; Human Space Flight Operations; Avionics; Sensors; Communications.
Hank Davis
(713) 483-0474
hdavis@gp101.jsc.nasa.gov

Kennedy Space Center
Selected technological strengths: Environmental Monitoring; Sensors; Corrosion Protection; Bio-Sciences; Process Modeling; Work Planning/Control; Meteorology.
Gale Allen
(407) 867-6626
galeallen-1@ksc.nasa.gov

Langley Research Center
Selected technological strengths: Aerodynamics; Flight Systems; Materials; Structures; Sensors; Measurements; Information Sciences.
Dr. Joseph S. Heyman
(804) 864-6006
j.s.heyman@larc.nasa.gov

Lewis Research Center
Selected technological strengths: Aeropropulsion; Communications; Energy Technology; High Temperature Materials Research.
Ann Heyward
(216) 433-3484
cto@lerc.nasa.gov

Marshall Space Flight Center
Selected technological strengths: Materials; Manufacturing; Nondestructive Evaluation; Biotechnology; Space Propulsion; Controls and Dynamics; Structures; Microgravity Processing.
Sally Little
(205) 544-4266
sally.little@msfc.nasa.gov

Stennis Space Center
Selected technological strengths: Propulsion Systems; Test/Monitoring; Remote Sensing; Nonintrusive Instrumentation.
Kirk Sharp
(601) 688-1929
ksharp@ssc.nasa.gov

NASA-Sponsored Commercial Technology Organizations

These organizations were established to provide rapid access to NASA and other federal R&D and foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory Consortium. To reach the Regional Technology Transfer Center nearest you, call (800) 472-6785.

Joseph Allen
National Technology Transfer Center
(800) 678-6882

Ken Dozier
Far-West Technology Transfer Center
University of Southern California
(213) 743-2353

Dr. William Gasko
Center for Technology Commercialization
Massachusetts Technology Park
(508) 870-0042

J. Ronald Thornton
Southern Technology Applications Center
University of Florida
(904) 462-3913

Gary Sera
Mid-Continent Technology Transfer Center
Texas A&M University
(409) 845-8762

Lani S. Hummel
Mid-Atlantic Technology Applications Center
University of Pittsburgh
(412) 383-2500

Chris Coburn
Great Lakes Industrial Technology Transfer Center
Battelle Memorial Institute
(216) 734-0094

NASA ON-LINE: Go to NASA's Commercial Technology Network (CTN) on the World Wide Web at **http://nctn.hq.nasa.gov** to search NASA technology resources, find commercialization opportunities, and learn about NASA's national network of programs, organizations, and services dedicated to technology transfer and commercialization.

NASA Program Offices

At NASA Headquarters there are seven major program offices that develop and oversee technology projects of potential interest to industry. The street address for these strategic business units is: NASA Headquarters, 300 E St. SW, Washington, DC 20546.

Carl Ray
Small Business Innovation Research Program (SBIR) & Small Business Technology Transfer Program (STTR)
(202) 358-4652
cray@mail.hq.nasa.gov

Dr. Robert Norwood
Office of Aeronautics and Space Transportation Technology (Code R)
(202) 358-2320
rnorwood@mail.hq.nasa.gov

Philip Hodge
Office of Space Flight (Code M)
(202) 358-1417
phodge@osfms1.hq.nasa.gov

Gerald Johnson
Office of Aeronautics (Code R)
(202) 358-4711
g_johnson@aeromail.hq.nasa.gov

Bill Smith
Office of Space Sciences (Code S)
(202) 358-2473
wsmith@sm.ms.ossa.hq.nasa.gov

Bert Hansen
Office of Microgravity Science Applications (Code U)
(202) 358-1958
bhansen@gm.olmsa.hq.nasa.gov

Granville Paules
Office of Mission to Planet Earth (Code Y)
(202) 358-0706
gpaules@mtpe.hq.nasa.gov

NASA's Business Facilitators

NASA has established several organizations whose objectives are to establish joint sponsored research agreements and incubate small start-up companies with significant business promise.

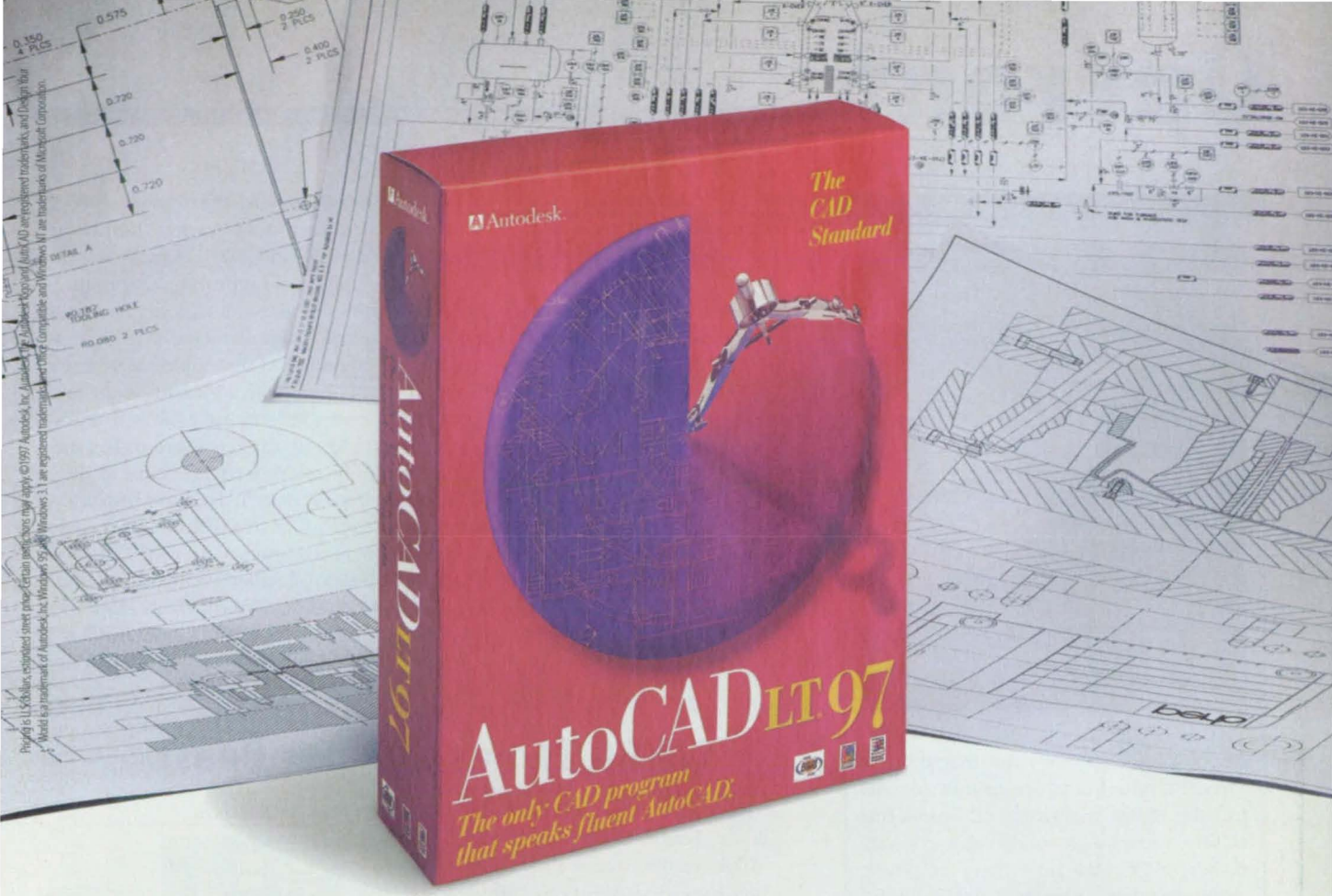
Dr. Jill Fabricant
Johnson Technology Commercialization Center
Houston, TX
(713) 335-1250

Wayne P. Zeman
Lewis Incubator for Technology
Cleveland, OH
(216) 586-3888

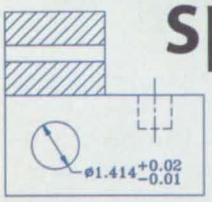
Joe Boeddeker
Ames Technology Commercialization Center
San Jose, CA
(408) 557-6700

Dan Morrison
Mississippi Enterprise for Technology
Stennis Space Center, MS
(800) 746-4699

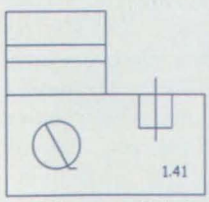
If you are interested in information, applications, and services relating to satellite and aerial data for Earth resources, contact: Dr. Stan Morain, **Earth Analysis Center,** (505) 277-3622. For software developed with NASA funding, contact the **Computer Software Management and Information Center (COSMIC)** at phone: (706) 542-3265; Fax: (706) 542-4807; E-mail: http://www.cosmic.uga.edu or service@cosmic.uga.edu.



The *only* CAD program that speaks fluent AutoCAD.



Since AutoCAD LT uses the same native .DWG drawing file format as AutoCAD, any drawing you read or write with AutoCAD LT is the same as with AutoCAD. Every time.



Other CAD programs modify drawings as they read and write the AutoCAD .DWG file format, causing imprecise measurements, missing elements, changed text and incorrect line types.

100% AutoCAD DWG PURE

AutoCAD® is the universal language of design — the world CAD leader. And there's only one CAD program that's truly compatible: AutoCAD® LT 97. Now AutoCAD LT 97 is compatible with other leading standards, including Microsoft® Office 97.

The Essence of AutoCAD.

Perfect for designers or projects that do not require full-blown AutoCAD capabilities, AutoCAD LT 97 works as a drafting tool for preliminary sketches, detail drawings or final designs. And now it's even easier. In addition to complete Internet tools, our new Content Explorer™ allows you to drag and drop existing blocks and drawings.

Best of all, AutoCAD LT 97 lets you share files, worry-free, with more than 2 million AutoCAD and AutoCAD LT users worldwide — from colleagues to clients to contractors.

100% Full R14 Compatibility.

AutoCAD LT 97 is compatible with every version of AutoCAD, including R14. Other CAD programs claim to read and write AutoCAD's native DWG drawing file format. And that can be risky because you could end up with drawing errors. Since AutoCAD and AutoCAD LT 97 use the same DWG file format, you can share files easily — without errors. No lost line types, changed dimensions or jumbled fonts. No long waits for loading or saving. And, most importantly, no miscommunication of ideas.

AutoCAD LT 97 is available for an ESP of $489 at software retailers and authorized Autodesk dealers. Call 1-800-225-1076 and ask for DemoPak A574 or visit us on the Web at www.autodesk.com/a574. Then get ready to speak the universal language of design. Fluently.

See your local software reseller or call 1-800-225-1076 for upgrade information or DemoPak A574.

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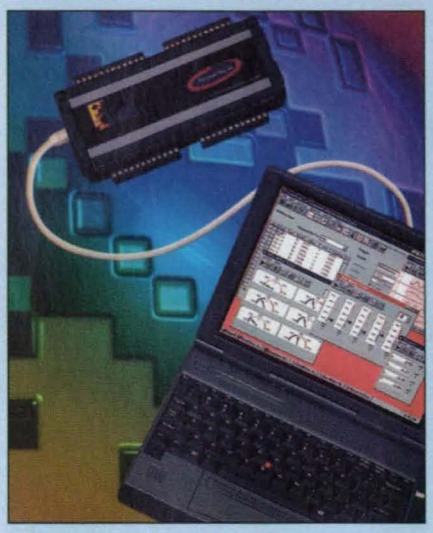
Product of the Month



IOtech, Cleveland, OH, has introduced Personal Daq™, the first full-featured PC-based data acquisition systems to fully utilize the Universal Serial Bus (USB), providing a single-cable connection to a PC with no battery or power cables required. The Personal Daq/55™ data acquisition system offers 22-bit A/D resolution, 10 single-ended or 5 differential analog or thermocouple input channels, 16 programmable ranges, 500V optical isolation, 8 digital I/O lines, and 2 frequency/pulse input channels. The Personal Daq/56 offers twice as many input channels and digital I/O lines. A PDQ™ Expansion Module can be snapped on to the Personal Daq for additional channel capacity. Both models are a compact 7" long and can be located up to five meters from the PC, allowing them to reside close to the point of measurement. DaqView™ Out-of-the-Box™ graphical display and data acquisition software is included for easy system configuration and set-up. The Personal Daq/55 is priced below $700; the 56 model is priced at about $1,000.

For More Information Circle No. 790

DON'T FORGET! ...

... to vote for 1997 Readers' Choice Product of the Year. The deadline has been extended to **January 30** for casting your vote. All voters will be entered automatically in a random drawing to win valuable prizes! See page 35 for details.

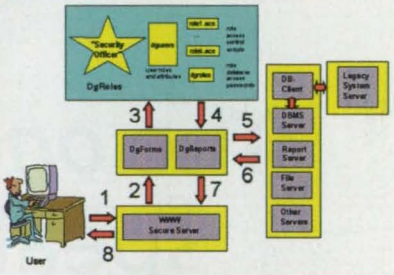
Seeking Solutions

NASA's Office of Life and Microgravity Science and Applications (OLMSA) and the Juvenile Diabetes Foundation (JDF) are soliciting new technologies that would improve existing methods of measuring individuals' levels of blood glucose, hormone, and other physiological analytes without blood sampling. Both agencies have acknowledged a mutual interest in promoting research and development of a non-invasive or minimally invasive method of biochemical measurement to be used in both a spacecraft environment and a clinical setting. A workshop planned for April 1998 will identify the more promising technologies and explore opportunities for public/private partnerships in developing and marketing those technologies. Research Triangle Institute of North Carolina is supporting both agencies in this technology transfer. Interested researchers can visit the project's web site at: http://www.rti.org/technology/nasa-jdf. The site includes a detailed problem statement and a form for submission of technology responses.

For more information, contact Dan Winfield of Research Triangle Institute at 919-541-6431 or e-mail: winfield@rti.org

NASA Tames a Paper Beast

Data Flow Architecture



Researchers at NASA's Goddard Space Flight Center in Greenbelt, MD have developed a software tool that uses the Internet to completely eliminate the paperwork necessary to document and manage complex, widely distributed processes. Led by Dr. Barry E. Jacobs of Goddard's National Space Science Data Center, the team that developed the tool — called Electronic Handbooks (EHBs) — worked in partnership with REI Systems of Vienna, VA under the Small Business Innovation Research (SBIR) program.

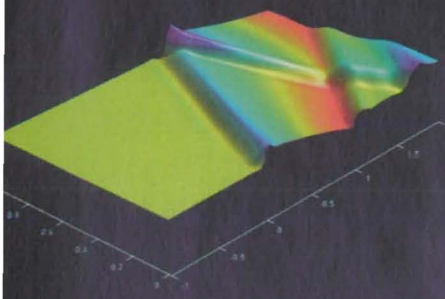
"Over the past two years, we have applied Electronic Handbooks to the entire SBIR process at NASA. This effort, which manages roughly 35 percent of all of NASA's new contracts, is the largest, end-to-end, completely electronic Internet use in the Federal Government to date," said Jacobs.

"With EHBs, we can achieve roughly a one-third reduction in the time required to process 2,500 SBIR proposals, while simultaneously achieving a $300,000 operational cost reduction," according to Paul Mexcur, NASA's SBIR program manager at Goddard.

Users do not need formal training, and only require a microcomputer with Internet access. When an EHB is implemented, file server resources are identified and allocated. The method has led to interest from other functions in NASA, including the Education Program, Patents Management, and Mission Management segments.

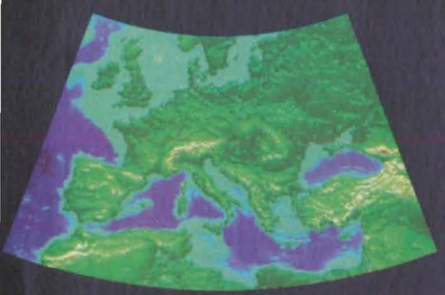
Jacobs said that NASA is working with Old Dominion University to implement EHBs in graduate programs management, including admissions, coursework, and doctoral research. "We expect interest from commercial areas as well, as firms seek to exploit the advantages of the Internet," Jacobs added. Wayne Hudson, chief of Goddard's Technology Commercialization Office, predicted that with potential use in "insurance, medical, legal, tax, and many other applications, this technology has the potential to totally restructure the way all these processes are done."

For more information on EHBs, contact Bill Steigerwald of NASA Goddard at 301-286-0039 or e-mail Bill at william.a.steigerwald.1@gsfc.nasa.gov



Technical Graphics

MATLAB 5 lets you visualize physical phenomena like this shock wave propagating in a fluid.



Mapping

The new MATLAB Mapping Toolbox can be applied to environmental, oceanographic, and defense applications.

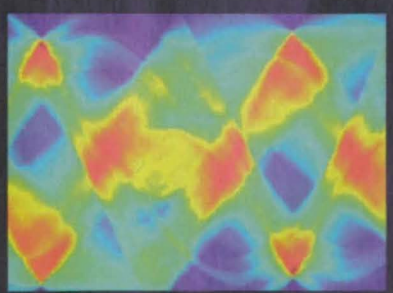


Image Processing

This Radon transform of a spine X-ray illustrates one of the many uses of the Image Processing Toolbox.

Now see what you think.

New MATLAB 5, now with advanced visualization and a complete language for application development.

New Visualization Power

Now you can quickly create more informative and revealing 2-D and 3-D graphics directly in MATLAB 5. Gain insights into complex systems using capabilities like lighting and shading, camera control and texture mapping. Efficient new algorithms make even irregularly-sampled data display faster and easier.

Application Development

A host of language and data management enhancements make algorithm and application development fast and intuitive.

We added:

- visual debugger/editor
- function performance profiler
- point-and-click GUI builder
- object-oriented programming

Multidimensional Arrays and Structures

Now the MATLAB matrix computing language supports multidimensional arrays and user-definable multitype data structures. MATLAB 5 includes a full set of functions for manipulating and analyzing multidimensional data, and even visualizing 3-D slices.

New Toolboxes

Companion toolboxes offer application-specific graph types, analysis functions, and interactive interfaces. New and updated toolboxes include:

- NEW Mapping Toolbox
- UPDATE Image Processing Toolbox
- UPDATE Signal Processing Toolbox
- UPDATE Control System Toolbox

See how MATLAB 5 can work for you. Call for your free copy of the MATLAB 5 Special Edition Newsletter.

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For More Information Circle No. 508

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.

Through NASA Tech Briefs, *we are finding sources of components and techniques to develop a line of wildlife telemetry products to track water fowl, song birds, reptiles, and amphibians. Thank you.*

Robert V. Allen, President
Micro International
Nashville, TN
rvamii@bellsouth.net

We are looking for assistance in obtaining information on manufacturers of special thin-wall tubes made of stainless steel, copper/nickel, and other materials to meet MIL-SPECs. Thank you for any assistance.

Jack Botts
Square D
Missouri Plant

I am looking for prices, specs, and brochures from manufacturers of diskette duplicating devices. I need to replicate IBM-format PC 3.5" diskettes, 40 to 300 per hour, text only, on a regular basis. Thank you for any assistance.

G.W. Jones, Owner
Allende Del Rio Productions
Las Cruces, NM

The November 1997 Reader Forum included a request from Dr. John Morrison on where to locate an electronic slope sensor. Lucas Sensing Systems of Phoenix, AZ, manufactures the AccuStar® II dual-axis clinometer that measures level, angle, and tilt.

Jacob Klein, President
K&C Metal Brazing Engineers
Southfield, MI

*(**Editor's Note:** Thanks for the suggestion, Jack. Lucas Sensing Systems can be contacted at 800-545-3243; Fax: 602-582-3520.)*

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.

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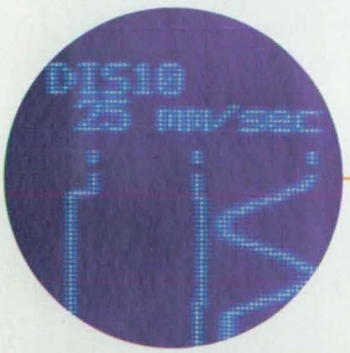

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The all-new Dash 10 lets you receive up to 30 waveform channels (DC to 25 kHz), see the data in real time on the bright high-speed vacuum fluorescent monitor, record with laser quality fidelity, and *at the same time* capture the data for playback and analysis. Now you can do all this on a truly portable package powered by internal battery or AC. The Dash 10 comes with a powerful software package, has a floppy disk for updates and data archiving, plus RS-232 and GPIB.

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Astro-Med, Inc.®

Astro-Med Industrial Park, West Warwick, Rhode Island 02893
Phone: (401) 828-4000 • Toll-Free (800) 343-4039 • Fax: (401) 822-2430
In Canada Telephone 1-800-565-2216

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For More Information Write In No. 558

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The reasons to use Vespel® polyimide parts and shapes keep piling up. And not just because they stand up to heat, friction, pressure and aggressive environments – with minimal or no lubrication. Manufacturers are finding that Vespel® parts in a wide range of applications can really trim the bottom line. That's because the reliability and long life of Vespel® parts can make them the most cost-effective choice for general applications in the long term.

If your applications require parts that can withstand extreme temperatures (cryogenic to 550 F), Vespel® should be your first choice. Vespel® should also be considered for parts that rub together, if metal parts are too noisy, or if fluid flow needs to be controlled.

Superior performance and reliability aren't the only ways Vespel® can save you money. Often, you can consolidate two or more existing parts in one Vespel® piece.

Seal Rings.

In the assembly of automobile transmissions, and farm and construction equipment, Vespel® seal rings reduce costs by replacing expensive metal rings, which can fracture or deform during assembly. They also reduce warranty costs by producing a better seal.

Bushings.

In aircraft engine vanes, Vespel® bushings withstand high-frequency vibration dithering and offer excellent stability and lubricity at extreme temperatures. They also reduce assembly time.

Thrust Devices.

The automotive industry counts on Vespel® thrust devices because they reduce friction, extend component life and can be easily molded. What's more, the variety of Vespel® grades allows manufacturers to specify the properties they need most.

Insulators.

In plasma-arc cutting torches, Vespel® insulators provide superior strength and durability at high temperatures up to 550 F, lasting up to six times longer than fragile ceramic insulators.

Thrust Washers.

In construction equipment transmissions, Vespel® thrust washers reduce costs and manufacturing time by eliminating the need for secondary machining. Vespel® washers also withstand high pressure and exhibit minimal wear with limited or no lubrication.

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Supermarkets are cooling foods more efficiently with discus compressors, featuring components made of Vespel®. Vespel® not only reduces energy and noise levels, but it also offers excellent wear resistance. The Vespel® part is expected to operate for 15 years without failure.

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Polyimide Parts and Shapes

For More Information Circle No. 529

Do you think about NASA when you tee off for an afternoon of golf, or when you set out on a leisurely bike ride? And does NASA come to mind when you dive into your pool or go grocery shopping? These are just a few of the myriad ways NASA touches our lives every day.

The National Aeronautics and Space Administration began operations on October 1, 1958. Congress indicated in NASA's original charter that it must share with U.S. industry any commercially promising technology developed in the course of research and development. In 1962 — to refute charges that Apollo expenditures would serve only the space program — Administrator James E. Webb created NASA's technology utilization program. Its goal was to identify and disseminate space technology that could be adapted for civilian applications.

NASA publications spread the word on innovative technology and seven regional technology transfer centers were established. During its first 40 years, 30,000 "aerospace spinoffs" have been identified — secondary applications of space technology that affect our daily lives. About 2,000 new applications are emerging every year. New products have ranged from solid-state electronics, to smoke alarms, to sports equipment, to patient-monitoring systems. As the 21st century approaches and NASA reaches even further into space, the transfer of space technology promises continued improvements to life on Earth.

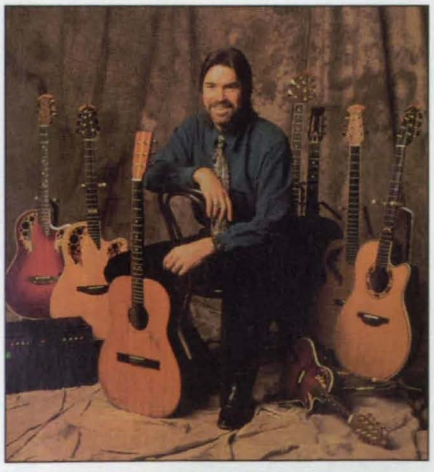
In each issue this year, *NASA Tech Briefs* will look back at a sampling of the most successsful of these spinoff technologies, and take a look at new commercial applications of NASA technology that are bolstering American business today. Each month, we'll highlight a specific area in which NASA technology has been used to create products that we depend on — from computers, to medical and healthcare advances, to manufacturing and environmental protection, and this month's focus, Consumer Products.

The following success stories and spinoff technologies in apparel, sports equipment, entertainment, food, and home products may make you think of NASA the next time you reach for your sunglasses or slalom down a ski slope.

1960s

Music to Our Ears

Kaman Aerospace Company was started by Charles H. Kaman, an aerospace engineer who began producing helicopters of his own design. His machines soon propelled the company into one of the nation's top helicopter manufacturers, and won large Department of Defense contracts. But a recession in the 1960s caused Kaman to diversify the company into other areas. So, as an accomplished guitarist, Kaman decided to turn to musical instruments, and used aerospace technology to improve the sound quality of acoustic guitars.



C.W. "Bill" Kaman, II, is president of Kaman Music Corp. and son of founder Charles Kaman. The original Ovation Roundback guitar (center) is shown with some of the company's more current instruments.

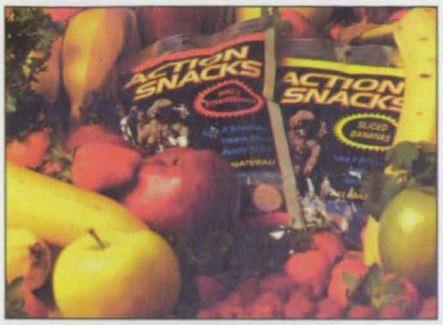
Helicopter design requires eliminating vibration; guitar builders try to incorporate vibration into their design. NASA, the military, and Kaman's own company had spent years studying how to eliminate vibration. Kaman took that knowledge, reversed it, and applied it to enhance vibration, creating a guitar with superior sound.

After two years of vibration analysis, Kaman produced a bowl-like guitar that provided a rich, constant tone throughout the guitar's range. But since wooden guitars can crack, Kaman again borrowed from aerospace research on composite materials and chose fiberglass for the guitar's surface. He incorporated aircraft manufacturing techniques such as the use of jigs and fixtures to assemble the guitar. The result was the Ovation® Roundback guitar, which was an instant success.

Kaman formed a subsidiary company, Ovation Instruments, and produced guitars for professional entertainers. Cost-effective manufacturing improvements allowed him to move into lower-priced fields, making Ovation guitars one of the top acoustic guitar manufacturers. Ovation Instruments is now part of a multinational manufacturing and distribution entity known as Kaman Music Corp. (KMC), headquartered in Bloomfield, CT. Its four manufacturing divisions, three distribution divisions, and international marketing group enjoy combined annual sales of $100 million.

Snack Foods from Space

During the 1960s, as the duration of manned space flights and the number of astronauts increased, NASA sought ways to provide meals that were appetizing and nutritious, while being easily prepared and low in weight. One technique that came out of a series of research contracts with food processing companies was freeze-drying, in which water is extracted from foods by dehydration at very low temperatures. Freeze-drying of freshly cooked food locks in flavor. The cooked food is then sealed in special pouches that block out moisture and oxygen, the principal causes of food deterioration. The food can then be stored for long periods without refrigeration.

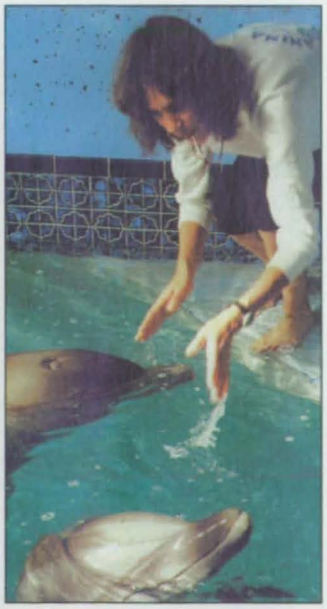


One of the companies that has successfully commercialized this technology is Action Products International Inc. (APII), which focuses on a special market niche: freeze-dried snack food, including the first freeze-dried ice cream. APII offers 22 varieties of Action Snacks™ and Adventure Foods, among them yogurt, apples, sliced bananas, whole strawberries, french fries and, the newest and most popular, cheese pizza. These foods are cooked, then quickly frozen to -40°F. Slow heating in a vacuum chamber removes moisture by turning ice crystals formed by the process to vapor. APII says the final product retains 98 percent of the nutritional value of the fresh-food equivalent and weighs only 20 percent of what it did in its original form.

Action Snacks are sold at 11 NASA facilities, in addition to many museum, planetarium, and corporate employee shops. The company also exports its products to Europe and Asia, and enjoys sales of several million dollars a year.

Pure and Simple

NASA's Johnson Space Center conducted a research program in the 1960s aimed at developing a small, lightweight water purifier that would require no astronaut monitoring and minimal power in order to supply pure drinking water for the Apollo crews for up to two weeks. An electrolytic silver ion generator slightly larger than a pack of cigarettes and weighing less than ten ounces was designed.



Mounted in various locations in the potable water supply on the Apollo — and then on later spacecraft — the units dispersed silver ion concentrations of 100 to 300 parts per billion to eliminate the bacteria in the water within hours.

In the decades since its invention, several companies have acquired NASA licenses to commercialize the technology in water management systems. Clearwater Pool Technologies of Largo, FL, uses silver/copper ionization to purify water in the Marine Science Center dolphin and turtle pools. The ClearWater Pool Purifier consists of a microcomputer that monitors water conditions; a pair of metallic electrodes; and a rheostat controller.

The company also produces systems for cleaning spas, hot tubs, water recycling systems, systems for bacteria and algae control in ponds, hospital water purification systems, and drinking water purification systems in Latin America and the Caribbean.

1970s

If the Boot Fits ...

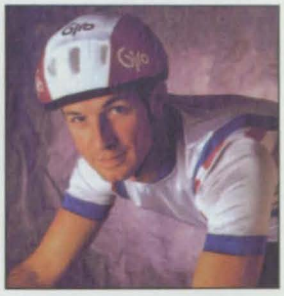
Comfort Products Ltd. of Aspen, CO, a footwear design and development firm, adapted astronaut protective clothing technology to the design of ski boots in the 1970s. The company used heating element circuitry that kept Apollo astronauts warm to create rechargeable foot-warming devices that were built-in to ski boots at the manufacturing stage.

Two decades later, the company again applied NASA technology to ski boots. Working with Raichle Molitor USA, Comfort Products developed the Raichle Flexon ski boot concept that adapts the accordion-like corrugations of a space suit joint. Raichle uses Flexon technology in a number of its ski and snowboarding boots. The Flexon system consists of a chambered bladder filled with tiny hollow ceramic spheres sewn into the inner boot. The spheres adapt to the contours of the wearer's foot, providing a custom fit.

1980s

A Cyclist's Dream

Industrial designer and cyclist Jim Gentes formed Giro Sport Design in Soquel, CA, to design and manufacture a cool, lightweight, aerodynamic bike helmet. The result was the Giro Prolight, which was designed with airfoil technology developed during World War II by NASA's predecessor, NACA, to reduce drag on fighter planes.



Jim Gentes wearing the Giro Prolight helmet.

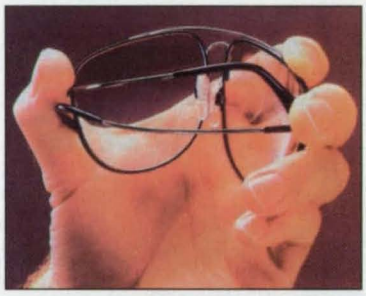
Aerodynamicist Raymond M. Hicks of NASA's Ames Research Center helped Gentes adapt the technology to the helmet design, incorporating vents in the front and back to let air flow through.

Introduced in 1986, the helmet was the first in a line of Giro models, which include the Aerohead, Hammerhead, and the Air Attack. Gentes' friend and world-class cyclist Greg LeMond wore the Air Attack when he won the 1989 Tour de France.

Shape Shifting

Shape Memory Effect (SME) is the ability of certain metal alloys to change from one shape to another when subjected to a temperature change, a direct result of a transformation of the alloy's crystal structure. Developed in the 1960s, NASA renewed interest in SME in the 1980s. Memry Corporation, Norwalk, CT, has been working on SME alloys for advanced composite structures and space station applications since 1985, and has spun off a line of products for home use.

Memry has produced, through its NASA contracts, a number of alloys in sheet, wire, rod, and tube forms. Adapting their expertise in shape memory behavior and characterization, Memry Technologies, a subsidiary of Memry Corp., applies SME alloys to produce MEMRYSAFE® and ULTRAVALVE™. MEMRYSAFE products provide protection against scalding in the home by instantly restricting water flow in the shower, bath, and sink before reaching scalding temperatures. ULTRAVALVE is a computer-controlled bath and shower valve that allows the user to select a preferred bathing temperature, which is maintained by an automatic electronic control and is confirmed by a digital readout.



Another company, Marchon® Eyewear of Melville, NY, has applied memory metal technology to produce a version of the material in a "smart" eyeglass frame that remembers its shape and its wearer's fit. Frames made with Flexon™ snap back to their original shape, even after being bent in half or twisted like a pretzel.

Bringing Up Baby

Commercially available infant formula benefited from NASA-sponsored research exploring the potential of algae as a recycling agent for long-duration space travel. A nutritional enrichment ingredient, an algae-based, vegetable-like oil known as Formulaid®, was developed and is manufactured by Martek Biosciences Corporation of Columbia, MD, a pioneer in the commercialization of products based on microalgae. The company's founders and principal scientists acquired their knowledge in this area by working on the NASA program.

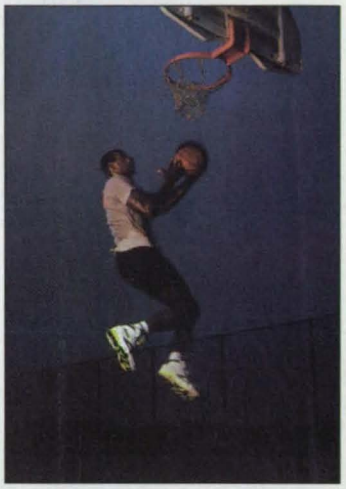
The dietary value of Formulaid, Martek's leading product, stems from two essential polyunsaturated fatty acids known as DHA and ARA. Many researchers believe that these substances, found in human milk but not in most infant formulas, are associated with infant mental and visual development.

Formulaid and other Martek products originated in a NASA program of the early 1980s called Closed Environment Life Support System. Under contract to NASA, scientists at Martin Marietta Laboratories of Baltimore experimented with the use of microalgae as a food supply, a source of oxygen, and a catalyst for waste disposal on manned missions. When Martin Marietta dropped out of the program, several of its scientists left the company to seek commercial opportunities for their expertise in deriving compounds from algae and plants.

Now staffed by some 60 scientists, Martek has a number of patented products, of which Formulaid is the "flagship." In 1994, the year Martek was granted a U.S. patent for it, the company signed an agreement with Nutricia, a leading European nutritional product manufacturer, whereby Formulaid was to be added to Nutricia's infant formula for sale in Europe.

Shoes Don't Fail Me Now

Using space technology, athletic footwear manufacturer AVIA Group International of Portland, OR, created a major shoe advancement in the late 1980s. A subsidiary of Reebok International, AVIA sought to eliminate the unwanted compression that occurs in athletic shoes, causing a loss of cushioning. The company contracted with Al Gross of Lunar Tech in Aspen, CO, to design a shoe that would retain shock-absorption and flexibility over a longer lifetime.



National Basketball Association star Clyde Drexler puts the AVIA Compression Chamber shoes through a workout.

Gross worked on the design of the Apollo astronauts' space suits, and became lead engineer at ILC Industries in Dover, DE, which designs and manufactures all of NASA's space suits. Gross eliminated foam materials from the shoe's midsole, replacing them with a fatigue-free mechanical system — a rigid/flexible system similar to a pressurized space suit.

The resulting AVIA Compression Chamber™ midsole was introduced to the market in 1990.

1990s

From Plastic to Parkas

Working with researchers at NASA's Ames Research Center, S.D. Miller & Associates of Flagstaff, AZ, developed a honeycomb structure that is more efficient than fibers for insulation. Through a Small Business Innovation Research (SBIR) grant, S.D. Miller created a lightweight plastic insulation for blankets and clothing that keeps the wearer warm, even when it gets wet. The insulation is non-allergenic and dries five times faster than wool, the company says.

S.D. Miller has manufactured rescue blankets using the plastic insulation, which is made of recycled plastic milk jugs. Red Cross chapters and ambulance companies are evaluating the blankets for use.

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You Can See Clearly Now

The Ray-Ban® Survivors® Collection of sunglasses from Bausch & Lomb, Rochester, NY, features DiamondHard® technology, which coats the lenses with a film of diamond-like carbon (DLC) that makes them ten times more scratch-resistant than conventional glass lenses, and reduces surface friction to lessen water spotting.

The film coatings, supplied by Diamonex Optical Products Group of Allentown, PA, employ a modified version of a dual ion beam bonding process developed by NASA's Lewis Research Center. The direct ion deposition coating technology was licensed to Air Products & Chemicals of Allentown, from which Diamonex Optical was spun-off.

Biomedical Optics Company of America, North Hollywood, CA, manufactures the Eagle 475 polarized sunglasses, which are a second-generation NASA spinoff. The company developed the Eagle 475 from a NASA-derived technology used in the 1980s as the basis for the Suntiger line of sunlight-filtering lenses. In 1991, Biomedical Optics acquired the rights to Suntiger coating processes and further developed the lenses into the Eagle 475, which absorbs 100 percent of the photowavelengths that are hazardous to the eyes, including ultraviolet and blue light.

NASA Helps Kirby Clean Up

A Space Act Agreement between NASA's Lewis Research Center and Kirby, a vacuum cleaner manufacturer in Cleveland, OH, has resulted in a commercial vacuum line that employs NASA technology. The company was interested in evaluating their 1994 home care system, the Kirby G4™, the results of which contributed to the design of the new G5™ and future models. Kirby enlisted the help of NASA Lewis to better understand particle flow behavior and vibration.

The Kirby G5 incorporates design enhancements made with assistance from NASA's Lewis Research Center.

Using Lewis equipment and technical expertise, Kirby constructed a new blade design from a polymer that was then configured for a substantial reduction in centrifugal force. The new blade was 300 to 400 percent stronger than the previous one, and a 75 percent noise-level reduction in certain frequencies was achieved.

The relationship between Kirby and Lewis continues today, with the two collaborating on improving airflow traits in various nozzle designs to optimize nozzle performance in removing embedded dirt.

Golfers Are Having A (Better) Ball

NASA aerodynamics technology helped create what Wilson Sporting Goods of Humboldt, TN, calls "the most symmetrical ball surface available." The Ultra® 500 Series golf ball has 500 dimples arranged in a pattern of 60 spherical triangles. The research that led to the dimple pattern was conducted by Robert T. Thurman, a principal engineer of aerodynamics for Wilson. Thurman gained experience in aerodynamics with Martin Marietta Manned Space Systems of New Orleans, LA, where he analyzed airloads on the space shuttle.

With Wilson, he analyzed air loads on airborne golf balls and their effects on the ball's trajectory. The Ultra 500 balls have dimples of three different sizes, shapes, and depth, with each dimple mathematically positioned for the best effect.

Racers Keep Their Cool

The same type of thermal insulation used to shield the space shuttle on re-entry is being used by NASCAR race teams to keep drivers cooler. Temperatures in race car cockpits can exceed 150°F due to the extreme heat transferred into the driver's compartment through the engine firewall, transmission tunnel, and floor.

Former NASCAR driver Bobby Allison's idea to use NASA's blanket insulation in NASCAR cars has resulted in the formation of a new company, Bobby Allison Technologies. The company has introduced insulating materials manufactured by Energy "Q" International of Fort Worth, TX, into car racing. The first tests using flexible insulation were conducted in 1995 in a Ford Thunderbird driven by Rusty Wallace. The engine compartment and exhaust system were fitted with the insulation, which lowered the driver compartment temperatures by up to 90°F.

The first vehicle equipped with the Energy Q insulation and radiant barrier material were conducted in May 1997 in a car driven by Doug Reid. Instruments indicated that temperatures were lowered in the driver compartment by more than 100°F. Chrysler Corporation has picked up on the insulation technology, and may incorporate a radiant barrier exhaust heat reflector made by Engineered Thermal Systems of St. Johnsbury, VT, in a new model of the Dodge Viper.

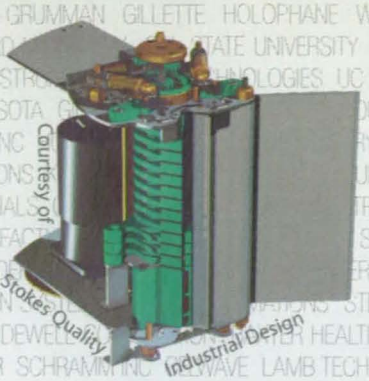
Looking Ahead ...

- NASA's Lewis Research Center has formed a partnership with the Ben Hogan Company to introduce NASA technology to golfing products. Ben Hogan engineers have already collaborated with Lewis researchers to measure spin rates of experimental golf balls at the Imaging Technology Center at Lewis. The imaging data acquired has been used to design a new golf ball that will be introduced this year. Other products are being developed with the help of NASA Lewis.

- Toy manufacturer Hasbro, Inc. of Pawtucket, RI, has partnered with NASA's Langley Research Center to develop a line of foam glider planes that children can fly without having knowledge of aerodynamics. The Aero Nerf® gliders had to be designed to fly on the basis of their shape, and propulsion had to come from the toss of a hand. Langley engineers provided Hasbro with a tutorial on the physics of flying gliders, including where to place the wings, how to shape the foam, and the correct tail angle. Four types of gliders are now available in toy stores nationwide; additions to the Aero Nerf® line are expected.

Next Month:

NASA Innovations Used In Computer Hardware and Information Technologies



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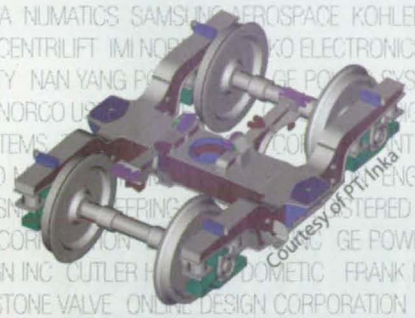

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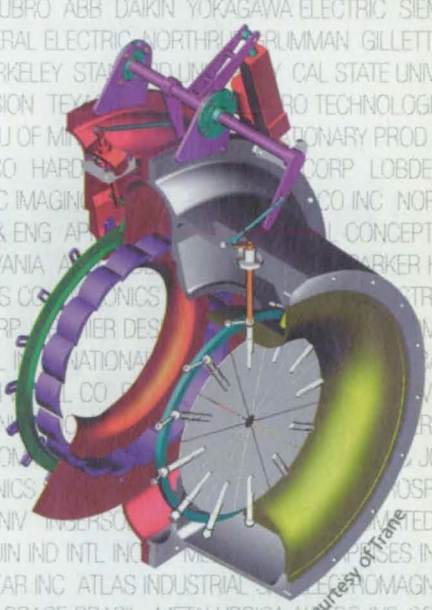

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Booth 522

Corrosion-resistant hinges and fasteners will be displayed by **Craftech Industries, Hudson, NY.** Included are eye bolts, clevis hangers, beam clamps, self-leveling foot, handles, and hinges. Corrosion-resistant hinges are available in 30% glass fiber Isoplast™, polycarbonate, and 40% glass-filled polypropylene in a variety of colors. The assembly hinges are available in 1-1/2" wide by 1-3/4" long, and 2" wide by 2-1/2" long sizes. The hinges are designed for applications requiring chemical resistance and strength.

For More Information Circle No. 752

Booth 506

Polaris Plastics, Rancho Dominguez, CA, will exhibit the Ding Ring™ vinyl bellows guard that wraps around bellows flexible tube sections that are most prone to handling damage. The vinyl straps wrap around the middle of the tube and fasten with Velcro strips; they can adjust to a variety of diameters. The wraps can be opened briefly for inspection and processing without requiring repackaging. Ding Rings also can be used to protect heavy objects such as polished shafts and worm gears from accidental scratches. Routing symbols and handling instructions can be silk-screened directly on the wrap for resorting operations. Standard sizes for tubing from 1" in diameter are available.

For More Information Circle No. 756

PACIFIC DESIGN ENGINEERING show

Booth 331

Fenner Drives, Manheim, PA, will exhibit a new line of custom-molded dual durometer belts, which provide frictional properties for push, pull, or conveying applications. The homogeneously molded belts are available unsupported or supported with high or low modulus reinforcements. Urethanes ranging from 35 A to 90 A can be molded into Fenatrak Multi-V, flat, timing, and special profile belts. The firm also provides prequalification, analysis of materials, and belt design.

For More Information Circle No. 762

Booth 275

Intergraph Corp., Huntsville, AL, will demonstrate Solid Edge™ Version 4 mechanical assembly, part modeling, and drawing software, which includes expanded part modeling using helical features, 3D sweep, and advanced blending. Other enhancements include animation of underconstrained assemblies, access of data using a new viewer and web-enabled OLE server, and enhanced data translation to and from AutoCAD and MicroStation. The feature-based solid modeling software is fully compatible with Microsoft Office 97, and implements Microsoft's OLE for Design and Modeling Geometry and Topology specifications.

For More Information Circle No. 757

Booth 144

ConsenSys Software Corp., San Jose, CA, will exhibit RapidPDM product development management systems, including ConsenSys. The systems are designed for manufacturers operating in environments of rapid product change. ConsenSys automates document control and revisions, product release and change management (ECOs), and product structure management (BOMs) throughout the manufacturing process. The systems' set-up method speeds implementation time, typically to one to three months. ConsenSys runs on Windows 3.1/95/NT, is available with an embedded SQL database, and supports Oracle 7. ConsenSys WebLinc provides secure access to information managed by ConsenSys over an intranet or across the Internet.

For More Information Circle No. 760

Booth 742

Teckbon-NC electrically conductive adhesive will be displayed by **Tecknit, Cranford, NJ.** The nickel-coated graphite particle-filled silicone RTV is ready to use without mixing. It produces a bond that cures at room temperature; the bond or seal is flexible, waterproof, and conductive. The adhesive meets temperature requirements from -55°C through 200°C. A variety of conductive adhesives filled with silver, silver-plated copper, silver-plated aluminum, and nickel particles also is available.

For More Information Circle No. 755

Booth 725

Dayton Rogers Manufacturing Co., Minneapolis, MN, will offer copies of its 40-page guide on metal stamping design. Design principles relate to tolerance, blank size and layout, holes and openings, contour and relationship to forms, and position and heights of forms. Also included are specifications and characteristics of formed and drawn parts, limits of burrs and flatness, dimensioning practice for turret press, press brake and laser, and charts on related subjects.

For More Information Circle No. 751

NASA Tech Briefs is proud to be the Official Sponsor of the Pacific Design Engineering Show, which will be held at the Anaheim Convention Center in Anaheim, CA, from January 20-22, 1998. Produced by Canon Communications LLC, the show is the West Coast's most comprehensive product and services exhibition for design engineering and manufacturing professionals, featuring more than 1,100 suppliers in three exhibit halls covering 153,000 square feet.

As an added feature, special product pavilions will highlight Design Software and Rapid Prototyping, Electronics, International Markets, and Packaging. Here are some of the cutting-edge OEM products and services you'll see at the show.

Booth 412

Metapor F100 AL air-permeable tooling material will be on display by **PORTEC-North America, a division of NEST Technologies, Studio City, CA.** The microporous aluminum material is steam- and water-permeable, and is made of 70 to 90% aluminum powder and 10 to 30% epoxy resin. Designed for applications requiring consistent permeability such as in vacuum– or pressure-related processes, the material is available in 20" x 20" square slabs in thicknesses from 1/2" to 12". It can be joined with adhesives and can be used to make inserts for production aluminum molds.

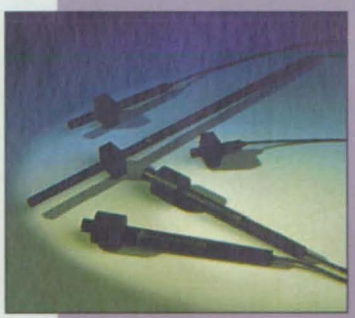
For More Information Circle No. 763

Booth 328

Conductive formulations for electrophotography and other imaging-related applications will be displayed by **Winfield Industries, Buffalo, NY.** Custom formulations are developed with the use of proprietary chemical additives in a liquid-cast process, resulting in a specific and homogeneous level of conductivity. Consistent charge response and electrical stability over a range of environmental conditions is provided. The company also formulates and molds liquid-cast elastomer parts that feature shock absorption, abrasion and tear resistance, and resilience. Capabilities include incorporating UHMW materials into a urethane matrix to reduce friction in sliding applications, Microcellular urethane foams, high-tolerance sheets for blade applications, squeegee materials, and thermally conductive silicones.

For More Information Circle No. 761

Booth 500



The AQLT and AQMLT linear potentiometers will be displayed by **Data Instruments, Acton, MA.** The units incorporate conductive plastic technology called MystR®. An external actuator is magnetically coupled to the position feedback element, and a waterproof sensor housing is included. The position transducers are designed for applications requiring absolute position sensing in wet and washdown areas or in-tank level sensing. The AQMLT has a 0.375" diameter body with available lengths from 0.5" to 12". The AQLT has a 0.50" diameter body with available lengths from 6" to 40". Custom lengths also are available.

For More Information Circle No. 759

We'll Change YOUR Perception About CORK!

If you've taken cork or rubber/cork gaskets and seals for granted, it's time to change your attitude. After all, those thin slices of shaped cork are a phenomenon of nature. You see, cork has 200,000,000 cells per cubic inch, and more than half of those cells are air! This unique structure enables the engineers at GTS to create an incredible array of products, from gaskets in the automotive industry to insulation material for the space shuttle.

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For More Information Circle No. 403

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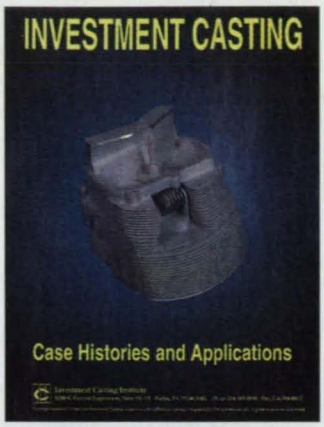
For More Information Circle No. 404

PACIFIC DESIGN ENGINEERING Show



Booth 235

Investment Casting Institute, Dallas, TX, will provide details on the investment casting process for design engineers and purchasers of metal components. The trade association represents investment casting manufacturers worldwide, and will feature examples of the investment casting process. Case studies illustrate how investment castings can eliminate or reduce machining, welding, fabrication, or other metalworking processes. Also provided will be a list of investment casting manufacturers with alloys cast and casting size parameters, and brochures describing the process and its design capabilities.

For More Information Circle No. 764

Booth 230

Phillips Plastics Corp., Prescott, WI, will display a line of stereolithography molds, which are made with a process similar to building stereolithography parts. The molds, however, are reinforced to withstand injection molding conditions for up to 50 or more cycles. The parts produced can be used to verify part design and functionality in specified materials such as polycarbonate, ABS, polypropylene, and polystyrene.

For More Information Circle No. 753

Booth 209

ITOCHU Canada, Montreal, Quebec, Canada, offers Fuji Prescale thin film with a layer of microencapsulated color forming material and color developing material. When pressure is applied to the film, a red color forms in varying density according to the amount of pressure and pressure distribution. The film can be used alone for visual inspection of pressure conditions, allowing users to perform pressure measurements without special training. The film is available in five types from 28 PSI to 18500 PSI. Also on display will be the Prescale Densitometer and Pressure Reader for more precise analysis of Prescale film.

For More Information Circle No. 754

Rubbercraft & Alloy Die Casting Sanders Industries Companies

Rubbercraft Corporation and Alloy Die Casting are sister corporations that combine sales and engineering capabilities to provide one-stop shopping for a customer's die casting and seal requirements. Each company has years of experience in the creation of their own products, and combined they can provide completed subassemblies at a lower installed cost to their customers.

Core Businesses

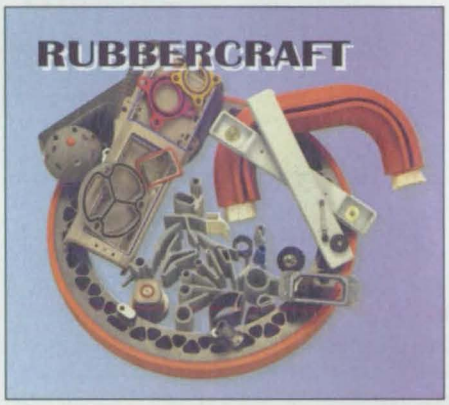
Rubbercraft Corporation: Rubbercraft Corporation designs, develops, and manufactures precision elastomeric seal products used in the aerospace, telecommunications, and medical industries. The company's capabilities include precision molded elastomers (both with option of metal & fabric impregnation or Teflon skin), extrusions, conductive elastomers for EMI and RFI shielding. The company offers laboratory and chemical testing capabilities as well as a complete tool and die shop. As an added benefit, Rubbercraft Corporation offers an extensive inventory of standard extrusion dies and gasket molds, which considerably lowers cost of production.

The company, which operates from its facility in Gardena, CA, has over 60 years of unmatched expertise in engineering and designing products that meet rigid commercial aerospace, medical, and MIL specs.

Alloy Die Casting: Alloy Die Casting produces large, small, and complex die castings using aluminum and zinc/aluminum alloys. Customer-furnished or jointly-developed designs and products are produced to meet applicable military, medical, commercial, and automotive specs. The company can furnish castings up to 300 square inches in surface area with tolerances up to ±0.001 inch. The Garden Grove, CA-based company has the capability to bond rubber/elastomer components to castings to create a completed part. They also can cast-in-place metal inserts. In addition, Alloy Die Casting offers complete engineering support, custom tool design and fabrication, and complete turnkey finishing including CNC machine shop capability.

Joint Capabilities Lower Customer's "Total Installed Cost"

Combining both company's advanced technologies allows for complete custom-engineered solutions using extruded or molded elastomers mated to aluminum components. This capability allows the company to produce completely finished products for their customers at a lower cost than that of the competition.



Materials used for these capabilities include:

Rubbercraft:

- Fluorocarbon
  Viton®
  Fluorel®
- Butyl
- Conductive Elastomers
- Custom Compounds
- EPDM/EPT
- Epichlorohydrin
- Flourosilicone
- Hypalon
- Natural Rubber
- Neoprene
- Nitrile
- SBR
- Silicone
- Silicone Sponge
- Sponge
- Urethane

Alloy Die Casting:

- Aluminum Alloys (380, 390, 356, etc.)
- Zinc/Aluminum Alloys

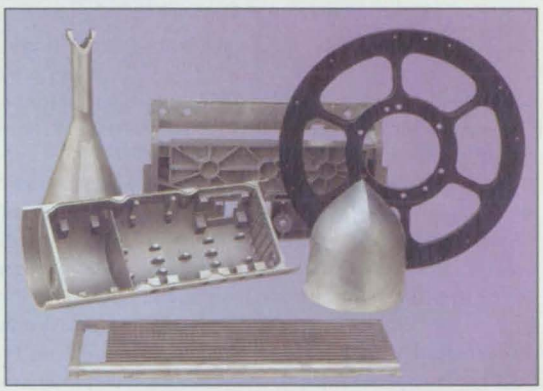
Products/Markets

Primary markets and selected examples include:

- Aviation/Aerospace
- Industrial
- Military/Defense
- Telecommunications
  - Industrial
  - Electronics
  - Medical Equipment

Key Executives

- Mike Cassidy, Chief Financial Officer
- Leigh Munsell, Sr. Vice President Sales & Marketing
- Tim Shanahan, Vice President Marketing
- Kim Sanders, Vice President Customer Relations



Rubbercraft Corporation
15627 S. Broadway
Gardena, CA 90248
Tel: 310-328-5402
Fax: 310-618-1832
www.rubbercraftcorp.com

For More Information Circle No. 684

Alloy Die Casting
6550 Caballero Blvd.
Buena Park, CA 90220
Tel: 714-521-9800
Fax: 714-521-5510
www.alloydie.com

For More Information Circle No. 685

Data Instruments Inc.

Data Instruments is a multinational corporation with five major business units centered around such core areas as electronic sensors, transducers, and controls.

- Transducer Products Group: Position-sensing transducers and potentiometers, and stainless steel pressure transducers
- Advanced Silicon Group: Silicon-based micromachined pressure sensors
- Critical Fluids Group: Pressure measurement products for high-purity fluids used in electronics fabrication
- Detector™ safety light curtains for machine guarding
- Wintriss® Controls Group: Press automation, die protection, and safety controls for metal stamping.

Data Instruments' corporate headquarters in Acton, MA.

Historical Background

Data Instruments is an employee-owned company with some 500 employees, subsidiaries in Europe and Japan, and a global network of sales and service representatives. It was among the first U.S. companies to achieve ISO 9001 certification, the strictest of the ISO standards. Although Data Instruments was officially incorporated back in 1977, our lineage dates back at least 50 years. It's a pedigree that includes the industry pioneers who created and perfected the technology as we know it. Our ranks include individuals recognized throughout the industry for their contributions to the state of the art (some have been with us for 40 years or more). Our original patents date back 50 years.

When we started making transducers, each was hand-crafted at a cost that limited their use to aerospace or military applications. Since then, we've introduced design innovations and manufacturing refinements that allow us to meet the most demanding requirements at a fraction of their former cost. Today, we produce hundreds of thousands of high-quality transducers a year in our ISO-9001-certified manufacturing facilities in Acton, MA and Sunnyvale, CA. Millions currently are performing in continuous-duty applications around the globe. Typically they outlast the systems they support.

Position-Sensing Transducers

Our linear and rotary position-sensing transducers include a wide range of contact and noncontact position sensors employing both potentiometric and inductive technologies. Standard stroke lengths range from 0.5 to 60 inches. Our linear potentiometers are rated intrinsically safe. They're also CE-rated. Our potentiometers are a cost-saving, space-saving alternative to LVDT and magnetorestrictive devices. For example, DC Hydrastar® has the largest usable body-to-stroke-length ratio of any noncontact, in-cylinder position sensor available. DI position transducers offer a choice of high-level DC, current, or voltage output.

Stainless Steel Pressure Transducers

The unique design of our stainless steel pressure transducers has elevated quality and reliability well beyond accepted standards. Our bonded semiconductor strain-gauge technology and stainless steel diaphragms withstand the harshest conditions, including corrosive media. Laser-trimmed and tested, they are fully calibrated and temperature-compensated to assure long-term reliability and accurate performance. DI stainless steel pressure transducers can survive more than 160 million full-pressure cycles and still retain their rated accuracy. They are available in gauge, absolute, sealed, and differential models for pressure ranges from 0-5 to 0-20,000 psi.

Micromachined Silicon Pressure Sensors

DI's silicon-based micromachined pressure sensors are low-cost miniature sensors with ranges from 1" H_20 to 150 psi. Small enough to mount directly on printed circuit boards, they're ideal for applications ranging from OEM medical and environmental instrumentation to respirators, cleanrooms, and HVAC equipment. The Sursense™ models employ proprietary DSC (Dynamic Self Compensation) technology for very low pressure ranges of 0-1, 0-5, 0-10, 0-20, and 0-30" H_20. They can be mounted in any position, because they're not position-sensitive. DSC also eliminates offset errors due to long-term drift.

Detector Safety Light Curtains

Detector light curtains prevent injury by shielding operators and passersby from machine hazards with a harmless and invisible curtain of infrared light beams. Any intrusion signals the machine to stop. Our light curtains have been protecting people for over 25 years. With tens of thousands installed, we're the acknowledged leader in industries known for having some of the world's toughest safety standards.

Global Network

With our global distribution network and technical centers in Germany, France, and Japan, you can expect applications assistance, on-time delivery, and in-depth support virtually anywhere in the world.

Data Instruments Inc.
100 Discovery Way
Acton, MA 01720
Tel: 800-333-3282
Fax: 978-263-0630
www.datainstruments.com

For More Information Circle No. 692

Craftech® Industries, Inc. manufactures standard and custom plastic fasteners, components, handles, hinges, pipe hangers, structural hardware, tools, and shapes for the semiconductor equipment manufacturing, electronics, aerospace, computer, and commercial markets. In-house capabilities include CNC and screw machining, die cutting, custom mold making, and horizontal and vertical injection molding, as well as encapsulated and insert molding. Plastic materials offered for chemical resistance, high temperature performance, non-conductivity, tensile strength, and conductive properties include Kynar®, PCTFE, Polypropylene, PVC, Isoplast® and 80 other plastics.

Call 800-833-5130 or 518-828-5001; www.craftechind.com

For More Information Circle No. 681

Rapid Product Development Services

ARRK Creative Network Corporation will take your new product from design to creation. As the most experienced professionals in the industry, ARRK provides the best technical expertise available, responding quickly and decisively to your production needs, whether you need one simple prototype or a complicated series of products. ARRK's capabilities include rapid prototyping, CAD/CAM machining, fabricated prototypes, vacupressure molding, aluminum castings, pre-production injection molding, and model making.

ARRK Creative Network Corporation, 8880 Rehco Road, Bldg. A, San Diego, CA 92121; Tel: 619-552-1587; Fax: 619-552-8231; e-mail: info@arrk.com; http://www.arrk.com

For More Information Circle No. 687

When your objective is a PCB prototype ready for assembly, LPKF Systems can help. Our full line of circuit board plotters utilizes many different board materials, and our tool motor speeds range from a constant 20,000 RPM to variable/programmable speeds up to 60,000 RPM. Our new PROTOMAT 91s/vs combines high speed (up to 60,000 RPM) and programmability to make possible the milling of fine-pitch structures as small as 4 mils in printed circuit boards. All LPKF Prototyping Systems have optional automated thru-hole plating capability. See us create PCBs at the MDM Show in Booth 167.

LPKF Cad/Cam Systems, 6180 SW Arctic Dr., Beaverton, OR 97005; Tel: 503-643-0604.

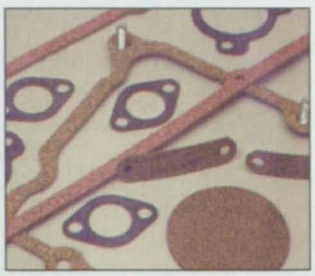
For More Information Circle No. 690

Pressure & Flow Automation Made Easy!

Tescom introduces the UI3000 Digital User Interface designed to accommodate directly with an ER 3000U Electropneumatic PID Controller. The UI3000 Main Menu screen provides a convenient means of optimizing the ER3000 PID tuning parameters or programming the ER with a profile of steps, ramps, and dwells. Other screens display the setpoint and feedback either graphically or digitally. Add a Tescom regulator to precisely control pressures of gases or liquids from vacuum to 15,000 PSIG and flows from 0.02 to 45 C_v.

Tescom Corporation, 12616 Industrial Blvd., Elk River, MN 55330-2491; Tel: 612-441-6330; Fax: 612-241-3224.

For More Information Circle No. 688



We'll Change YOUR Perception About CORK!

Since 1946, GTS has been producing sealing systems and gaskets designed and manufactured by using rubber, cork, and cork/rubber materials. Applications include automotive, aerospace, appliance, electrical, gas, and industrial. Prime manufacturing facilities are located in the United States and Europe.

Demitri Fardelos, Sales Manager, GTS, 26112 110th St., Trevor, WI 53179; Tel: 800-558-3206 or 414-862-2311; Fax: 414-862-2500.

For More Information Circle No. 691

High-Quality Vacuum Cast Rapid Prototypes

MCP Systems is a pioneer and leader in rapid prototyping technology to serve a wide range of industrial new product applications — automotive, consumer product, aerospace, electrical, and electronic. The company specializes in vacuum casting technology as the best solution for meeting the speed, resin choice, and part quality criteria necessary to support aggressive new product development efforts. MCP Systems sells complete vacuum casting systems and consumables, and offers a full-training customer support program. A color brochure is available detailing the company's extensive capabilities and experience.

MCP Systems, 511 Commerce Drive, Fairfield, CT 06432; Tel: 203-367-7761; Fax: 203-368-4787.

For More Information Circle No. 689

Ciba Specialty Chemicals Corp.

Ren Shape™ Work Boards

Ciba's line of Ren Shape™ board materials is designed to meet the diverse tooling, modeling, prototyping, and fabricating requirements across a broad range of industries. The board materials are used for building styling models, master models and prototypes, fixturing and duplicating aids, foundry patterns, metalforming dies, nickel electroplating mandrels, composite lay-up tools, and many other uses.

Ciba Specialty Chemicals Corporation, Performance Polymers, 4917 Dawn Ave., E. Lansing, MI 48823; Tel: 800-955-5509; Fax: 517-351-6255.

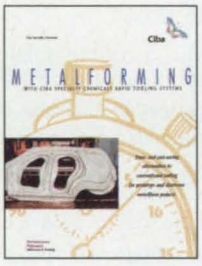
For More Information Circle No. 694

Rapid Tooling for Rapid Manufacturing

Advanced rapid manufacturing methods that reduce product-to-market lead times are described in a new eight-page brochure. The literature discusses products used for master model production via SLA or CNC-machining, casting of multiple prototypes in silicone rubber molds (focusing on Parts In Minutes™ Polyurethanes), and polyurethanes and epoxy tooling systems for initial and short-run part production.

Ciba Specialty Chemicals Corporation, Performance Polymers, 4917 Dawn Ave., E. Lansing, MI 48823; Tel: 800-955-5509; Fax: 517-351-6255.

For More Information Circle No. 695



Metalforming Tooling Systems

Described in a 12-page brochure are our polyurethane board and casting systems that can reduce lead times and costs for metalform tooling. Ren Shape™ 5166 machinable polyurethane board and RP 6479-A/B casting polyurethane exhibit the impact strength, wear resistance, and compressive strength needed for forming draw dies, stretch forms, and hydroform tooling used in short-run or prototype metalforming projects.

Ciba Specialty Chemicals Corporation, Performance Polymers, 4917 Dawn Ave., E. Lansing, MI 48823; Tel: 800-955-5509; Fax: 517-351-6255.

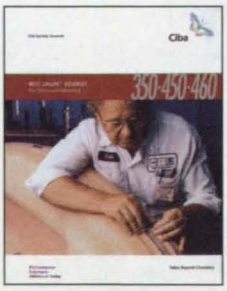
For More Information Circle No. 696

High-Performance Adhesives

Ciba Specialty Chemicals' Araldite® 2000 adhesives for repair, maintenance, and assembly are featured in a new brochure. The epoxies and polyurethanes offer properties such as fast setting, heat/chemical resistance, strength, and flexibility. Araldite® adhesives bond metals, plastics, ceramics, and rubber, as well as other materials. They are available in 50 or 200 ml cartridges and quart cans.

Ciba Specialty Chemicals Corporation, Performance Polymers, 4917 Dawn Ave., E. Lansing, MI 48823; Tel: 800-955-5509; Fax: 517-351-6255.

For More Information Circle No. 697

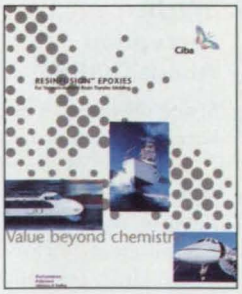


Styling and Modeling Boards

Ren Shape™ 350, 450, and 460 boards are described in this four-page brochure. These products are used by designers that require grain-free styling and modeling materials that produce high quality, dimensionally accurate models and patterns, either by hand carving or CNC milling.

Ciba Specialty Chemicals Corporation, Performance Polymers, 4917 Dawn Ave., E. Lansing, MI 48823; Tel: 800-955-5509; Fax: 517-351-6255.

For More Information Circle No. 698



Resinfusion™ Epoxies

Our new Resinfusion™ epoxies used by composite manufacturers in the VARTM (Vacuum Assisted Resin Transfer Molding) process is explained in the literature package. The material offers good dimensional stability and excellent cured properties to support the production of high-quality composite parts and tooling. The VARTM process is also described.

Ciba Specialty Chemicals Corporation, Performance Polymers, 4917 Dawn Ave., E. Lansing, MI 48823; Tel: 800-955-5509; Fax: 517-351-6255.

For More Information Circle No. 699

IT'S NOT TOO LATE!

To Cast Your Vote for

TECH BRIEFS

Third Annual Readers' Choice Awards

In last month's issue, *NASA Tech Briefs* readers were invited to vote for Product of the Year — the one product among those highlighted throughout the year that our readers feel was the most significant new product introduced for the engineering community in 1997.

We have extended the deadline for submitting ballots to January 30, 1998.

In addition, all ballots received by the deadline will qualify for a random drawing, from which three Grand Prize winners will be selected.

Grand Prizes include:

★ SolidWorks 97Plus 3D mechanical design software from SolidWorks Corp. of Concord, MA. Designed in 1995 as the first Windows-native 3D mechanical design system for mainstream engineers, this version is the fourth release and features more than 160 enhancements, including more than 65 improvements in detailing and drawing. Users also can add Internet hyperlinks directly to parts, drawings, or assemblies.

★ The FW7000 Series laptop workstation from FieldWorks, Eden Prairie, MN. The rugged computer is the only clamshell portable with ISA and PCI slots, and is equipped for data acquisition, imaging, and testing. It can withstand 100 Gs of operating shock, temperature extremes from –22° F to 122° F, and resists liquids, dirt/dust, and electromagnetic interference.

You can cast your vote in one of three ways:

- Visit the *NASA Tech Briefs* web site at www.nasatech.com and indicate your choice on the Product of the Year ballot;
- Complete the ballot below and fax it to 212-986-7864; or
- Mail it to: Product of the Year, *NASA Tech Briefs*, 317 Madison Ave., New York, NY 10017.

Your completed ballot must be received by January 30, 1998, for your vote to be counted.

The Readers' Choice Award winners will be announced in the March 1998 issue.

1997 *NASA Tech Briefs* Readers' Choice Product of the Year Ballot

Name: _____

Company: _____

Address: _____

City: _____

State: _____ Zip: _____

Phone: _____ Fax: _____

E-mail: _____

For detailed descriptions of the nominated products, see page 19 of the December 1997 issue of *NASA Tech Briefs*.

CHECK ONLY ONE BOX

- ❑ **January:** Racal Recorders - Racal-Heim DATaRec A60 instrumentation recorder
- ❑ **February:** The MathWorks - MATLAB 5 technical computing software
- ❑ **March:** Gage Applied Sciences - CompuScope 8500/PCI data-acquisition system
- ❑ **April:** National Instruments - DAQ Instruments instrumentation computer interfaces
- ❑ **May:** Baystate Technologies - CADKEY® 97 mechanical CAD software
- ❑ **June:** Keyence Corp. of America - CV Series compact machine vision system
- ❑ **July:** SoftSource - Vdraft™ AutoCAD-based CAD software
- ❑ **August:** Polytel Computer Products Corp. - DraftPAD programmable touchpad for CAD applications
- ❑ **September:** Hewlett-Packard - Infinium family of oscilloscopes
- ❑ **October:** Manufacturing and Consulting Services - Anvil Express™ CADD/CAM software
- ❑ **November:** Cad.Lab - Eureka Gold 97 mechanical CAD software
- ❑ **December:** Invention Machine Corp. - IM-Phenomenon™ problem-solving software

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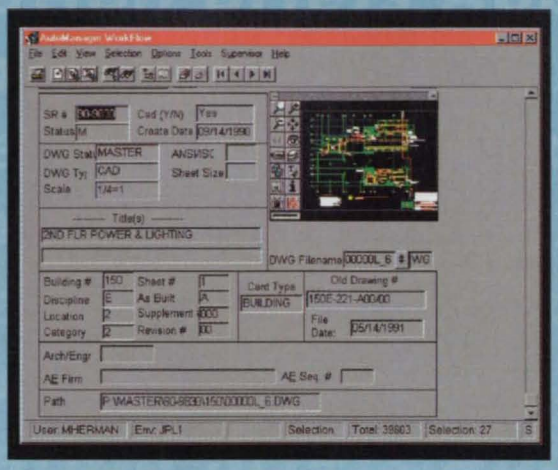


NASA's Jet Propulsion Laboratory (JPL), Pasadena, CA, has no trouble navigating to other planets. But when it came time to navigate through its own documents, it needed help. The Facilities Division at JPL, which is responsible for the design, construction, and maintenance of all JPL facilities, spent five years making it easier to navigate through the 200 buildings that comprise JPL, as well as improving the Division's library of drawings used to plan new construction and modify existing structures.

A document management system had to be selected to maintain the 29,000 drawings and 120,000 aperture cards that had been accumulated over the past 50 years. The Division chose AutoManager WorkFlow. The Division handles about 1,500 service requests each year and takes about 600 calls a week that require research through documents. Using Navigator, the software's hierarchical file manager, users can search for files by date, description, project, or sheet number.

Because JPL is a NASA facility, it must answer to government auditors who monitor facility renovations. The software ensures an accurate revision history for every drawing by guarding against unauthorized changes. An online catalog for drawings and a reference library for project documents will be created soon. Those files will be linked by project numbers and names, making it easy to locate information.

According to Linda Kyle, group leader of Facilities Document Control at JPL, the software "streamlines our processes by creating a central archive that is available to everyone who needs access." Other divisions, through a lab-wide network, will be able to view JPL databases, saving time throughout the organization

For More Information Circle No. 749

NASA Monitors Antarctica With Mapping System

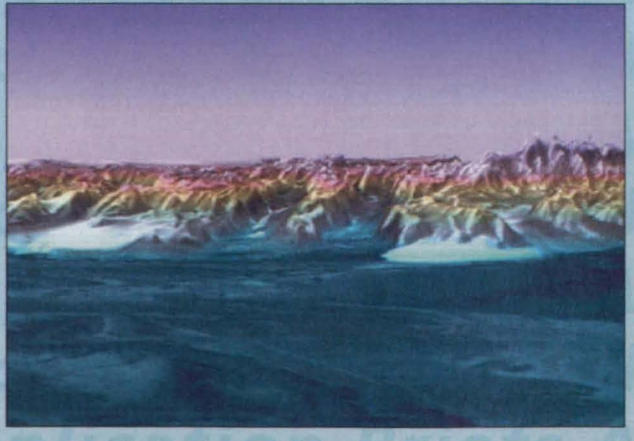
Radarsat Antarctica Mapping System
Vexcel Corp.
Boulder, CO
303-583-0222
www.vexcel.com

Developed as part of the Mars Pathfinder Program by Vexcel, the Radarsat Antarctica Mapping System has been used by the Byrd Polar Research Center (BPRC) of Ohio State University and NASA to produce the first image mosaic of the entire continent. The system processed the thousands of images required to cover the Antarctic land mass, which is nearly as large as North America. According to Dr. Kenneth C. Jezek of BPRC, "monitoring Antarctica is crucial to global change since 70% of the planet's fresh water is locked up in Antarctica's ice sheets."

The three-week mission required the Radarsat satellite to be rotated from its normally right-looking position to a left-looking mode. The maneuver allowed the satellite's synthetic aperture radar (SAR) to completely map the continent, including for the first time, the South Pole region. The 25-meter-resolution mosaic spans approximately 150 km.

Since changes in the polar ice caps are constant, NASA plans a second mapping mission of Antarctica in 1999. The data will be used in comparison with the original map to chart changes in the ice sheets and glacier fields. The Antarctic Mapping Mission also includes stereo collections of the mountainous regions, allowing construction of 3D models for geologic studies, and interferometric collections of the glacier regions for estimation of the glacier ice motion.

This perspective view of the coastal region of Antarctica looks from McMurdo Sound southwest towards the Blue Glacier (on the left) and the Ferrar Glacier. The tall mountains to the right are part of the Olympus Range, extending approximately one mile above the coast.



For More Information Circle No. 750

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(703) 330-1199 • (703) 330-1722 Fax

SEWP II - NAS5-32898

For More Information Circle No. 516

Commercialization Opportunities

Signal-Conditioning Electronics for Discrete Capacitive Sensors

A newly developed instrument uses the resistance to alternating current running through a device to measure the variances in capacitance. The instrument is used to measure the presence or absence of dielectric material between the plates of a capacitor.
(See page 40.)

Integrated Thin-Film Fluorescence Sensor

A sensory element has been designed for a miniature instrument for measuring the concentration of atomic or molecular species that exhibit fluorescence at certain wavelengths. Applications could be as diverse as medical and biological immunoassay and monitoring pollutant gases in engine exhausts.
(See page 40.)

Proximity Measurement of Pressure and Temperature

Inexpensive, high-performance, optically coupled temperature and strain gauges are proposed that would be impervious to mechanical shocks and consume only femtowatts of power. Unlike electrically coupled sensors, the proposed sensors would be immune to electromagnetic interference at suboptical frequencies.
(See page 48.)

VLSI Neural Processors Based on Optimization Neural Networks

Very-large-scale integrated (VLSI) neural processors are being developed to perform a variety of computation-intensive tasks. Their role would be in maximizing the return of useful scientific information from future multiple-sensor spacecraft and in robotic and other systems requiring "smart" sensors.
(See page 58.)

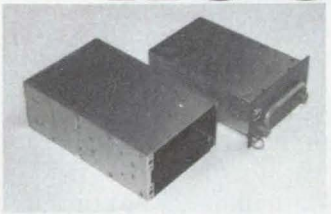
Black-Body Evaporator Unit for a Point-Focus Solar Collector

A solar heating system features an improved absorber/evaporator unit that exploits geometry to achieve an absorption characteristic approximating that of a black body. The system can be used to boil water or another liquid, dry aqueous hazardous wastes, distill pure solvent from spent solvent, purify water by distillation, and generate steam.
(See page 62.)

Sputter Deposition of Pure and Fluoropolymer-Filled Al_2O_3

Nonreactive ion-beam sputtering can be used to deposit a transparent film of aluminum oxide on a polycarbonate, silicon, or fused-silica substrate. The goal of these experiments is to develop effective films to protect polymeric windows, such as in automobiles and aircraft, against oxidation and abrasion and to enhance their ability to shed water.
(See page 68.)

RUGGEDTRONICS



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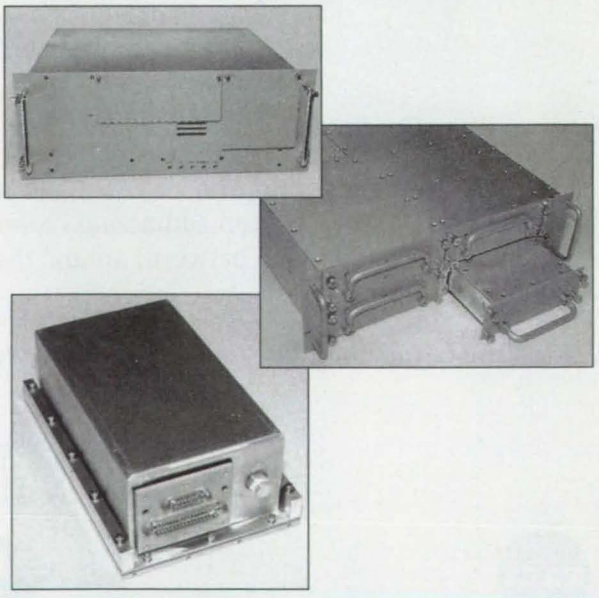

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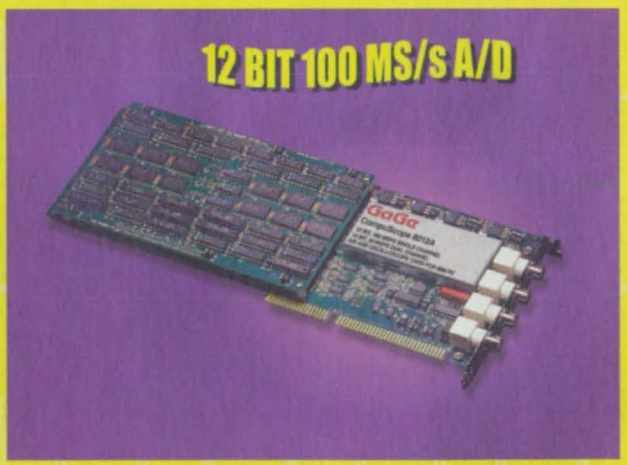

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For More Information Circle No. 509

Signal-Conditioning Electronics for Discrete Capacitive Sensors

The effects of stray capacitance are nullified with a parallel resonant circuit.

Marshall Space Flight Center, Alabama

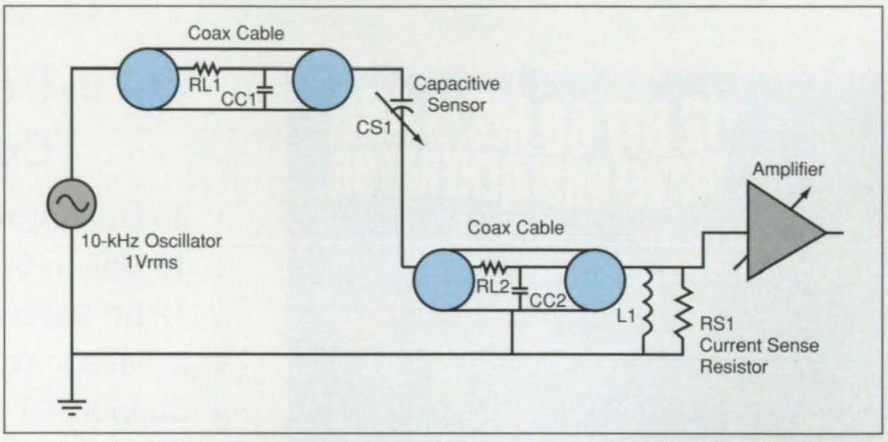
A newly developed instrument, designed at Marshall Space Flight Center, uses the resistance to alternating current running through a device to measure the variances in capacitance. Engineers use this device to detect the presence or absence of dielectric material between the plates of a capacitor.

Previously, instruments were designed to measure one or more quantities (amplitude, frequency, or phase) that make up an alternating current waveform. However, these instruments were plagued by stray capacitance, solder traces and connectors.

This device allows engineers to apply Ohm's law to make an impedance measurement of the sensor by knowing the voltage across the sensor and the current running through the sensor.

An inductive circuit is in parallel with the stray capacitance from the sensor cable, connectors, and solder traces on the printed circuit board within this device. This unique design puts the inductor and stray capacitance [including the cable capacitance at the end of a 300- to 400-ft (90- to 120-m) cable] in a parallel resonant circuit that completely nullifies the effects of stray capacitance. Because stray capacitances no longer have any affect on the measurement system, the circuit is said to be tune.

The signal conditioning electronics for this instrument are shown in the abbreviated schematic diagram below. The sensor is excited by a 1-V (rms) sine wave that is operated at 10 kHz. The signal is then sent through a coaxial cable to the capacitive sensor. (The coaxial cable shields the signal from any outside disturbance.) The signal at the sensor is again picked off from another coaxial cable to the right of the sensor and sent to the instrument in a series across the resistor. The current sense resistor prevents the current flow across the sensor from loading down the signal. The resulting signal is then fed to an amplifier.



This abbreviated schematic diagram shows the **Major Functional Parts of the Signal-Conditioning Electronics** for discrete capacitive sensors.

The amplified signal is fed to a comparator circuit. If the voltage on the non-inverting terminal of the comparator exceeds the trip voltage setting on the inverting terminal, the output of the comparator goes high, turning the transistor ON, indicating that the capacitive plates are covered by the dielectric material. An OFF transistor reading indicates the sensor is no longer exposed to the dielectric material.

This work was done by Randal S. McNichol of **Marshall Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Circuits category,* ***or circle no. 143*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

MFS-31195

Integrated Thin-Film Fluorescence Sensor

This device senses fluorescence at a wavelength characteristic of a substance to be detected.

Lewis Research Center, Cleveland, Ohio

An integrated thin-film device has been designed to constitute the sensory element of a miniature instrument for measuring the concentration of an atomic or molecular species that exhibits fluorescence at specified excitation and emission wavelengths. The device combines a fluorescence-emission method with a detection method to detect fluorescence emitted by those atoms or molecules of interest that are situated within a short distance of one surface of the device. Applications could be as diverse as medical and biological immunoassay and monitoring pollutant gases in engine exhausts.

The device comprises multiple corrugated thin film layers (see figure). The corrugations are characterized by a peak-to-valley depth of about 500 Å and a spatial period of about 1 μm. The function of the corrugations is explained below.

The layer in contact with the atmosphere or other medium that contains the fluorescent material to be detected is a dielectric waveguide with a thickness of the order of 2,000 Å. The thickness is chosen so that the waveguide supports the desired electromagnetic-field modes at the specified fluorescence excitation and emission wavelengths. The electric-field profiles of these modes are evanescent; that is, outside the waveguide layer,

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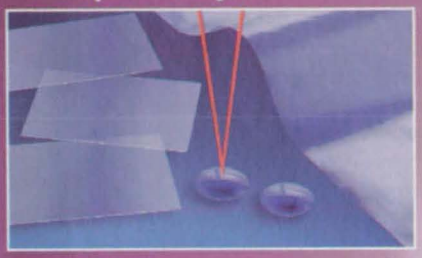
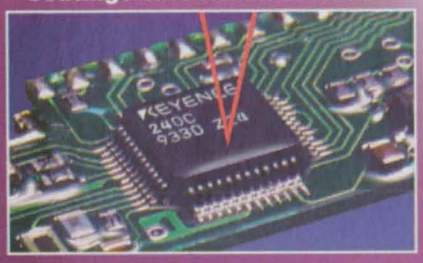


A single LT sensor head traces the curves of contact lenses and measures the thickness of glass and plastic (poly) film.

▶ Thickness of Conformal Coatings on Colored Surfaces



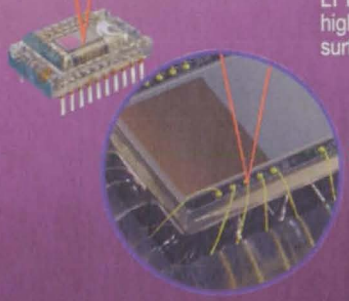
LT accuracy is unaffected by surface color, luster, texture and even wet surfaces.

▶ Depth of Metal Stampings and Scorings on Rough Surfaces

Scoring depths of 100 -150 μm are accurately measured by the new LT.

▶ Flatness and Profiles of Mirrored Surfaces

LT measurement of height and profiles of highly mirrored surfaces is unaffected by surface reflections.



▶ Height of Very Small Objects

The height of 20-μm diameter IC leads with reflective surfaces is easily measured using confocal technology.

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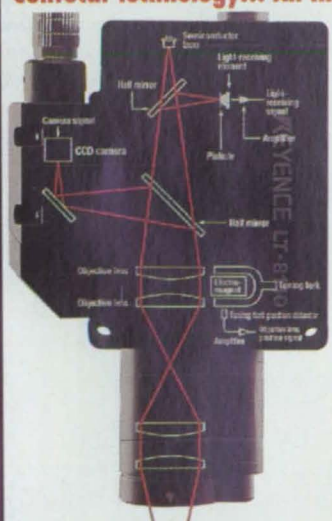

A laser beam passes through a lens coupled to a vibrating tuning fork which moves the beam in and out of focus.

The beam reflects off the target through a system of mirrors and converges on a pinhole aperture. It passes through the aperture onto a photodiode only when perfectly focused.

The vertical position of the fork is then used to calculate the distance to the target's surface.

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For More Information Circle No. 511

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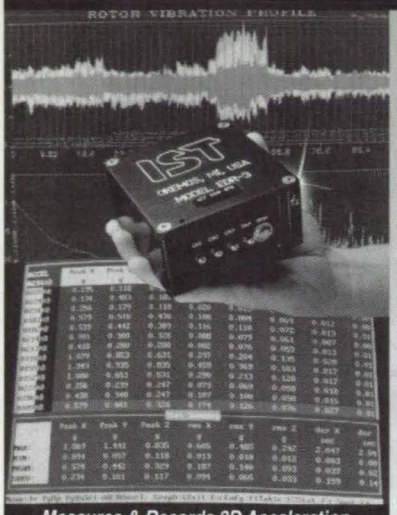

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For More Information Circle No. 407

the electric-field amplitudes decrease monotonically with distance from the layer.

Optical excitation is supplied by radiation from an external source to fluorescent atoms or molecules near the surface. The resulting emission from the fluorescent atoms or molecules is coupled into the waveguide via evanescent wave modes; thus, the device opens a radiative-decay channel for fluorescence.

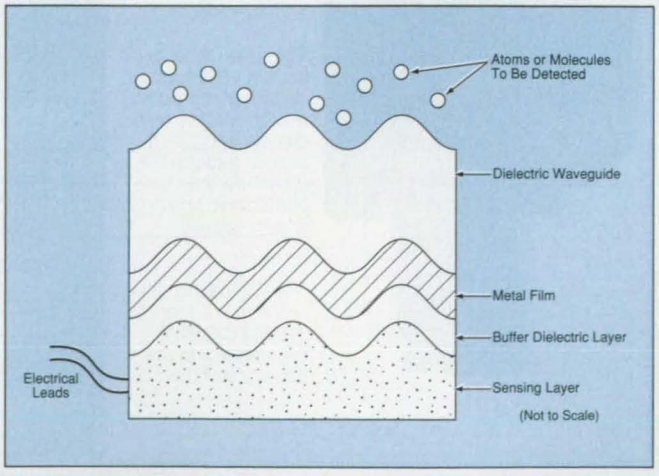
Below the dielectric waveguide is a metal film. Below the metal film is a dielectric buffer layer made of a material different from that of the waveguide layer. Among the electromagnetic-field modes supported by the thin-film geometry are surface plasmons, supported at the dielectric/metal interface. The amplitudes of these modes decay with increasing depth into the metal. The thickness of the metal layer is about 500 Å — enough to render the metal opaque to photons but not enough to prevent overlap of plasmon fields on opposite surfaces.

In this asymmetric dielectric/metal/dielectric configuration, the corrugation enables matching of the momenta of surface plasmons that have equal wavelength and are localized on opposite sides of the metal film. As a result, over a narrow range of wavelengths, there is cross-coupling between surface plasmons on opposite sides, with consequent generation of lower-surface plasmons. The narrow range of wavelengths is determined by the corrugation periodicity and can be chosen by design to contain the fluorescence emission wavelength of interest. Thus, optical energy at the fluorescence emission wavelength is transmitted through the film, which otherwise remains opaque to photons and thus to most background light.

Below the buffer layer is a sensing layer, which can be a semiconductor p/n junction or other electronic device that exhibits a measurable change in voltage, current, or resistance when it absorbs energy from plasmons. The buffer dielectric layer is thin enough to allow penetration of the surface plasmon electric fields into the sensing layer. Optionally, one can dispense with the buffer dielectric layer, in which case the sensing layer also serves partly as the lower dielectric layer.

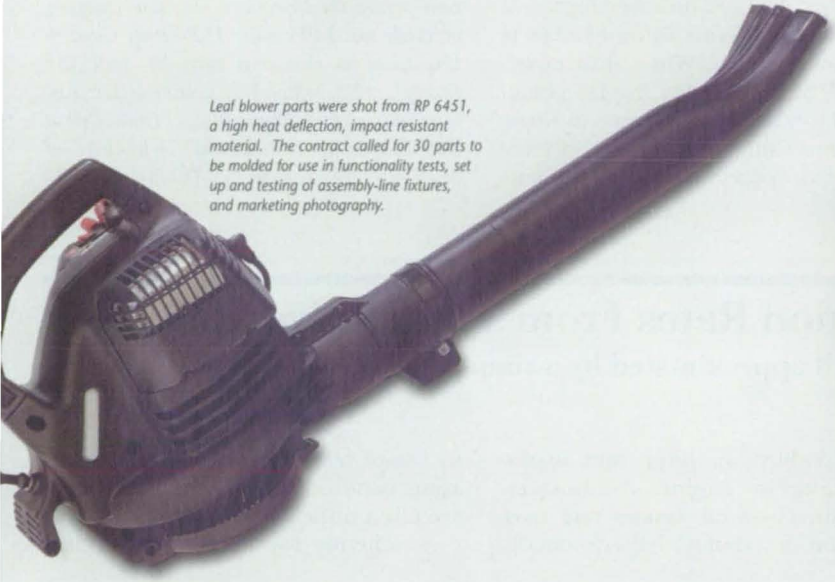
This work was done by Margaret L. Tuma of **Lewis Research Center** *and Russell W. Gruhlke of Ohio Aerospace Institute. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 157*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16368.



The **Corrugated Dielectric and Metal Layers** of this device are designed to exploit evanescent-wave coupling and cross-coupling of surface plasmons so that fluorescent emission from nearby atoms or molecules to be detected is coupled to the sensing layer, while light at other wavelengths is not coupled to the sensing layer.

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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For More Information Circle No. 512

Virtual-Reality Platform-Independent Software for Access to Mars Data

NASA's Jet Propulsion Laboratory, Pasadena, California

The Virtual Reality Mars Atlas User Interface (VR-MAUI) provides an atlaslike interface for access to Mars data. This access is provided via the World Wide Web, using JAVA. Within VR-MAUI, images are organized as maps. These maps provide a natural coordinate system, which defines feature locations. VR-MAUI is used to (1) examine, process, display, and analyze variable-resolution images of Mars and (2) interactively create VRML models of the Martian surface. VR-MAUI provides a point-and-click interface for selecting a specific location on Mars. Users identify locations by image features, pixel coordinates, or map coordinates. Data can be displayed in the forms of text, maps, still images, movies, and VRML models.

The current version of VR-MAUI provides an interface to Viking and Mars Pathfinder data. Future versions will provide similar access to other objects in the solar system. When fully developed, VR-MAUI will (1) display planetary surfaces and atmospheres in three dimensions using VRM and (2) display and analyze spacecraft and instrument data during flight operations.

This program was written by Raymond J. Bambery, Eric M. DeJong, Steven R. Levoe, and Myche McAuley 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 Computer Software category,* ***or circle no. 149*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge). This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20173.*

Calculating Chemical-Reaction Rates From Thermodynamic Data

Gas-phase chemical-kinetic rates are well approximated by a simple equation.

Lewis Research Center, Cleveland, Ohio

Kinetic rate data are needed to design all chemical processes. Specifically, they are needed to determine such things as ignition delay times, combustion times, and explosion limits in engine combustors. Previously, chemical kinetic rate data have been determined experimentally by use of reactors at the desired operating conditions. However, such data are often difficult to obtain.

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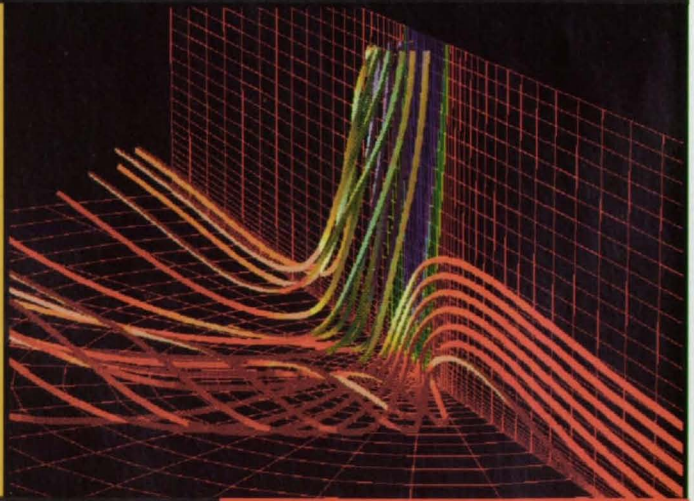

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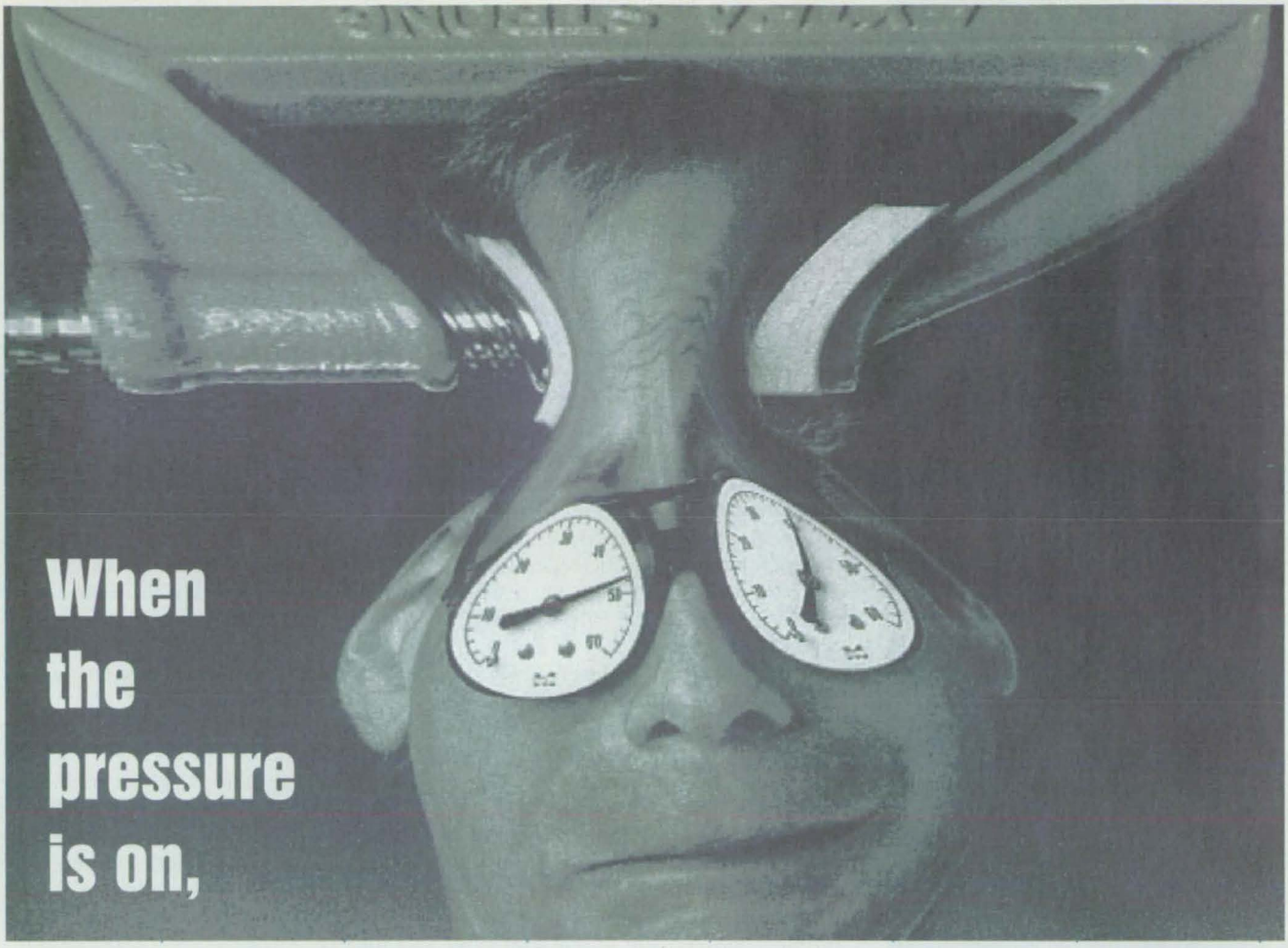

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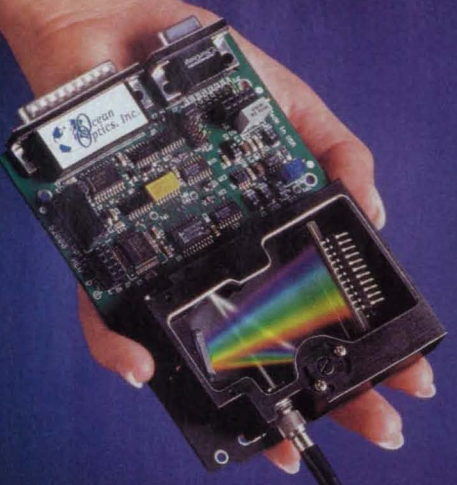

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For More Information Circle No. 409

kinetic rates to thermodynamic-property data has been developed. The scheme is based on the discovery that the rate, r, of a chemical reaction is related to the Gibbs gradient with respect to the extent of conversion, X, by

$$r = D\left[\exp\left(\frac{-1}{RT}\frac{\partial G}{\partial X}\right) - 1\right],$$

where the single constant D is used for all reactions, R is the universal gas constant, T is the absolute temperature, and G is the Gibbs energy. Using this equation, the chemical rate constants for each reaction can be related to the equilibrium constant for that reaction, and the net chemical rate can be predicted.

Ordinarily, energy levels from the thermodynamic data are used to calculate equilibrium compositions and not dynamic rates. The equilibrium condition for a given reaction is a balance between the forward and reverse rates for that reaction. When the system of reacting species is not in equilibrium, G is at a value higher than its minimum, and the rate is related to the difference between the actual and minimum values.

Data on the heat capacities, standard-state enthalpies, and Gibbs energies under equilibrium conditions were previously calculated for 1,130 chemical species and tabulated. These data can now be used for each chemical-reaction step to determine its rate. Using the present method, kinetic rates that have not yet been determined can be computed, enabling prediction of alternative chemical processes.

For comparison of experimental data with predictions by the present thermodynamic method, the Lewis General Chemical Kinetics and Sensitivity Analysis (LSENS) computer code was modified to incorporate the present method. The method was tested on the H/Br system with excellent results. In a similar test on the H/O system, the deviation between the predictions and the experimental data was greater for the present method than for the classical method. However, the disadvantage of the greater deviation in the present method may be offset by the advantage that one can use only the single constant D for all reactions, whereas in the classical method, one must use at least two constants (the preexponential factor and the activation energy) for each reaction to describe a given chemical system.

It will be necessary to demonstrate the present method on other chemical systems. One difficulty lies in the inclusion of small quantities of intermediate species, the properties of which may not yet have been tabulated. However, thermodynamic properties can be accurately estimated, given molecular structures. More work is being done to test the limits of the present thermodynamic method for kinetics. When completely verified, this method will have a widespread effect on the chemical industry.

This work was done by C. John Marek of **Lewis Research Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 176*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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NASA's Jet Propulsion Laboratory, Pasadena, California

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For More Information Circle No. 517

storage and retrieval system excludes occasional users or management from easily accessing data products. Therefore, a simple access to data products has been developed based on the web browser paradigm.

Typically, a single host tracks data products using a commercial relational data-base management system (RDBMS) or custom file-based data base. With this type of (DBMS) data base management system, only references to products and fixed-file descriptors are allowed for data storage and retrieval. For this reason, a viewable data dictionary coupled with standard and familiar search tools were used to remove these limitations.

This innovative technology is a Search Engine System for Scientific Data Formats. It exists as several government off-the-shelf software (GOTS) and commercial off-the-shelf software (COTS) products, integrated to form a single, logical host for a distributed search tool.

This state-of-the-art search engine has been running on a developmental web site. Here, the webmaster designates an SDF directory, which is the repository for SDF files. The SDF directory is input to a translator program, which runs automatically with the webmaster's user name and privileges. The translator program extracts certain data, such as variables, attributes, file descriptions, time stamp, and a uniform resource locator (URL) for each SDF found in the tree below the specific directory. It then converts this data to a Hypertext Markup Language (HTML) document. The time stamp is used to update the HTML document if an SDF file changes. The system periodically submits new or changed URL's to commercial search engines. This system also allows nontext search extensions.

The capability to search the data dictionary of SDF's is a key innovation. Users who are unfamiliar with a library's structure are able to gain access to that structure, allowing them judge a data product's value.

The union of a WAN DBMS to SDF's is a second innovation. The WAN DBMS interfaces various search engines to the internally self-describing SDFs. This allows remote users to search SDF's using data element names, types, and values.

Simplified access to complex data bases lets users explore data intuitively. This enhances the value of the data by increasing their usefulness to the scientific community.

This work was done by John T. Robinson and Steven Pham of SARA, Inc., Electronics and Information Systems Business Area, for **NASA's Jet Propulsion Laboratory.** *For further information, contact John Robinson, SARA, Inc., 15262 Pipeline Lane, Huntington Beach, CA 92649-1136, Telephone: (714) 373-5509.*

NPO-30036

Proximity Measurement of Pressure and Temperature

Electrical contact would not be necessary for interrogating submillimeter resonant microbeams.

NASA's Jet Propulsion Laboratory, Pasadena, California

Inexpensive, high-performance, optically coupled temperature and strain gauges based on a combination of advanced optoelectronic and microelectromechanical concepts have been proposed. The sensors would contain vibrating beams with submillimeter dimensions, made primarily of silicon by microfabrication techniques. The beams would be designed so that (1) their resonance frequencies would vary with strain and temperature, respectively, and (2) their vibrations would be both excited and measured by use of light. The sensors would be impervious to mechanical shocks, would have masses in the microgram range, and would consume only femtowatts of power. Unlike electrically coupled sensors, the proposed sensors would be immune to (and would not generate) electromagnetic interference at suboptical frequencies.

These sensors were conceived for original application in measuring strains and temperatures on a canister that would be sealed pyrotechnically on Mars to bring a sample of the Martian atmosphere back to Earth. The strain measurements would be converted to readings of the pressure of the enclosed gas sample. In that application, there is a requirement for noninvasiveness; one must not create a potential leak by penetrating the canister to insert instrumentation for monitoring the enclosed gas. There is also a requirement to be able to separate the canister from, and connect the canister to, different instrumentation systems without having to make and break sensor electrical contacts. The same features that make the proposed sensors attractive for the original application also make these sensors attractive for terrestrial applications for monitoring temperatures and strains in sealed gas containers and in other structures.

A sensor of this type would include either a cantilever or a double-pinned microbeam in a polycrystalline silicon vacuum enclosure. The sensor would include an integral photodiode, and in the presence of optical excitation, the electrical output of the photodiode would cause bending of the beam via electrostatic attraction. The vibrations would give rise to modulation of the incident light reflected from the beam. Optical excitation and readout would be accomplished via an optical fiber, which could be terminated in the sensor body or, if necessary, at a distance of as much as a few millimeters.

A double-pinned microbeam would be particularly suitable for measuring axial strain; if a sensor containing such a microbeam were intimately coupled to, and suitably oriented on, a structural member, the stress in the member would alter the tension in the beam, thereby altering its resonance frequency. A cantilever microbeam would be well suited for measuring temperature; the coefficient of thermal expansion of a bimorph coating can be made to differ from that of silicon, so that thermally induced stress in the beam would change its resonance frequency. Moreover, with a typical resonance quality factor (Q) of about 10^5 and power dissipation of about 10^{-15} W, a cantilever-microbeam temperature sensor would not thermally contaminate its environment.

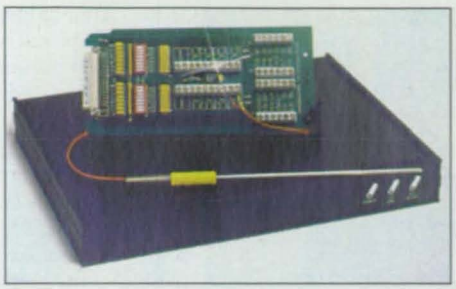
This work was done by Frank Hartley of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 172*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

NPO-20223

Keithley Instruments, Cleveland, OH, has introduced the SmartLink™ KNM-DCV12 miniature **data acquisition instruments** that deliver up to 30,000 readings per second with up to 16-bit resolution. It accepts up to eight single-ended, four differential, or two four-wire analog inputs. Users can mix signals from various sensors to obtain voltage, ohm, RTD, thermistor, pressure, flow, and weight transducer, and digital signals from the same unit.

Measuring 1.1 x 1.3 x 6.7", they can be connected to a remote computer via a data network or cabled to a local computer for setup and debug. Applications include production testing; transient analysis; vibration studies; frequency, event, and pulse width analysis; and high-speed data acquisition. The instruments are supported by various data acquisition or test and measurement software packages such as LabVIEW® and Testpoint™, and interface with Windows-based application software.

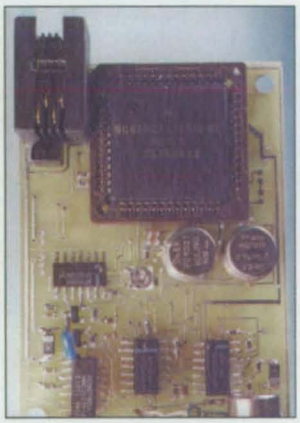
For More Information Circle No. 741



Omega Engineering, Stamford, CT, offers the OMB-Tempbook-66 **data acquisition system** that adds voltage and thermocouple measurement capability to notebook PCs for portable test applications. It provides 12-bit 100 KHz data acquisition and data transfer to a PC via an enhanced parallel port interface or PCMCIA link.

The unit can connect to a standard parallel port with slightly slower transfer rates. It features a built-in analog capability that allows measurement of eight differential or 16 single-ended channels. Input types include millivolt signals, voltage signals, and direct thermocouple input without additional signal conditioning. An optional rechargeable battery pack is available for portability.

For More Information Circle No. 742



MicroStrain, Burlington, VT, has announced the 3DM miniature, self-contained, solid-state **orientation sensor** that incorporates three magnetometers and three accelerometers to calculate pitch, roll, and yaw angles relative to the Earth's magnetic and gravitational fields. The three orientation angles are output in digital RS232 or optional multi-drop RS485. It can also be programmed to provide raw accelerometer and magnetometer data in true physical units.

The sensor can measure angles from 0 to 360 degrees on the pitch axis, and -70 to +70 degrees on the roll axis. The yaw output is compensated for errors due to pitch and roll using embedded algorithms. Applications include sold-state compassing, robotics, virtual reality, well drilling, and biomedical applications.

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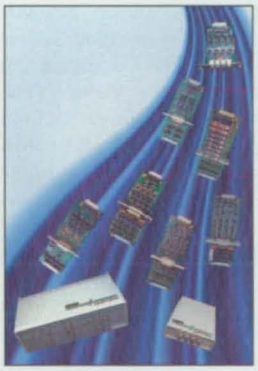


Quatech, Akron, OH, has introduced the SignalPro™ Series of **signal-conditioning boards** that utilize data acquisition hardware and software to enable use of a desktop or laptop computer to directly monitor process, transducer, and sensor input signals. The boards are designed to work with the DAQ-1200 lien of desktop data acquisition adapters, and with the company's PCMCIA data acquisition products.

The series consists of board-level signal conditioning modules for strain gauges, RTDs, universal current/voltage/high-voltage sensors, low/high/band-pass filters, simultaneous sample filter cards, thermocouples, accelerometers, and a multipurpose card for 5B modules. The cards are housed in a 19" rack-mount unit that holds up to 14 modules, a half-rack with seven modules, or as a portable unit with one module. All components are software-programmable and include a universal software driver.

For More Information Circle No. 735

The KM Series 210 **pressure transducers** from Patriot Sensors & Controls Corp., Simi Valley, CA, feature microprocessor-controlled, digitally-corrected output. The on-board microprocessor automatically compensates for non-linearity and thermal sensor errors, and offers accuracies of better than ±0.5% over the temperature range from -40°C to 125°C.

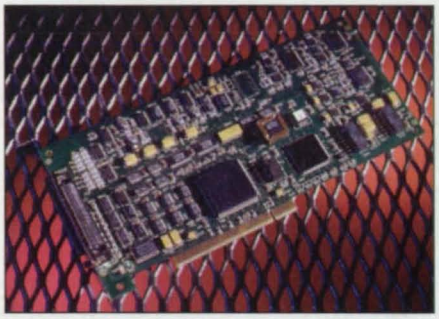
Using Silicon-on-Sapphire (SOS) sensing technology, the series features a 1" x 4" package made of 17-4PH stainless steel and titanium and offers burst pressure capabilities of up to 20 times the operating pressure. The transducers operate with a variety of voltage outputs ranging from 0 to 5, to 1 to 11 VDC and voltage inputs of 10 to 40 VDC. They can withstand 10 Gs, peak to peak, and can be used in flow computers, machine control, and chemical processing applications.

For More Information Circle No. 736

Cell-Stack **data acquisition system controller** from So-Mat Corp., Champaign, IL, allows engineers to use cellular phones, satellites, or wireless Ethernet connections to set up, monitor, and control field data acquisition systems. The self-contained, Windows-based controller can manage remote communication, control data acquisition devices, perform remote analysis, and archive and transfer remote data.

The unit's hardware box is built around a notebook PC enclosed in an aluminum box weighing 8.5 pounds. It features a Pentium processor with 16 MB RAM and 700 MB hard disk. It also features a cellular phone modem, backup battery charging circuit, and on/off circuitry.

For More Information Circle No. 737



Data Translation, Marlboro, MA, offers the DT300 Series PCI **data acquisition boards** that consists of four 12-bit boards capable of achieving sampling rates from 150 KS/s to 333 KS/s. They are compatible with software-development programs such as LabVIEW® and HP VEE™. The boards share a common architecture, register map, connector, accessories, and software.

The boards feature a 1024-location channel gain list that enables users to acquire data from channels in non-sequential order and with different gains. Two optional 12-bit analog outputs with software-selectable ranges are available. The boards also include two custom-designed ASICs — one for the PCI interface and one for counter/timer capabilities.

For More Information Circle No. 746

Measurement Specialties, Fairfield, NJ, offers the MSP-430 hostile-media **pressure sensor** for pressure measurement in the 0 to 25,000 psi range. Fabricated from a single piece of 17-4PH stainless steel, the sensor has no internal O-rings or welds, and no silicone oil-filled cavities. Microfused micromachined silicon strain gage technology makes it impervious to most physical and electrical hostile-media environments.

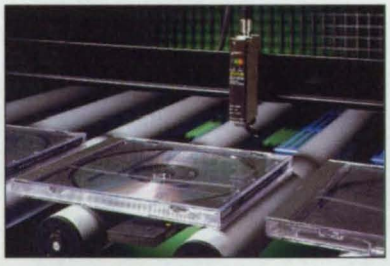
Accuracy is ±0.5% full-scale output; output signal is 0.5-4.5 VDC; overpressure is 1.5x rated pressure; and burst pressure is 2x rated pressure. The sensor measures 2" in length and 1.25" in diameter and uses an M18x1.5-mm male pressure port. Standard operating temperature range is -40 to 85°C.

For More Information Circle No. 739

ACQuire AP **portable data acquisition system** from Gould Instrument Systems, Valley View, OH, features built-in acquisition and analysis software. It allows for 16 input channels, dual sample rates, external sample rate, real-time continuous hard copy, and the ability to mark multiple events. The system includes 5B signal conditioner module, ACQuire Data Acquisition Software, and View II Analysis & Data Manipulation Software.

Features include acquisition rates to 50,000 samples per second continuous to disk, up to 100% pre-trigger, real-time thermal array hard copy running at speeds to 100 mm per second, and integrated playback and analysis.

For More Information Circle No. 745



The E2J **capacitive proximity sensor** from Omron Electronics, Schaumburg, IL, features a separate amplifier and flat sensing head joined by a flexible one-meter robotic cable for non-metallic and metallic sensing applications. A sensitivity setting on the amplifier allows fine-tuning for applications involving vibration and variations in target materials. The separate amplifier allows remote mounting of the detection head in space-confined areas.

Sensing heads are 0.22" thick and are available in two sizes: the 0.79 x 1.18" size has an adjustable sensing range from 4 to 10 mm; the 1.18 x 1.57" size has an adjustable sensing range from 8 to 20 mm. Optional extension cables are available in 1-meter and 2-meter lengths, allowing the sensor head to be mounted up to 3 meters away from the amplifier.

For More Information Circle No. 740

Transducer Techniques, Temecula, CA, has introduced the SSM and DSM Series stud-mount **load cells**. The SSM is designed to be surface-mounted with the load applied through the mounting stud; the DSM is mounted with a stud at each end for in-line mounting. Each can be used in tension and/or compression applications, and is sealed for protection against harsh environments.

The sensors are manufactured of heat-treated 17-4ph stainless steel, and the sensing element incorporates bonded foil strain gages. Ranges are available from 50 pounds to 10,000 pounds. They are supplied with a Certificate of Calibration traceable to N.I.S.T.

For More Information Circle No. 744

The DLN and DLS **load cells** from Sensotec, Columbus, OH, deliver 1% accuracy, weigh less than 1.5 ounces, and have frequency response to 40 KHz. The load cells feature an operating temperature range from 20 to 300°F and overload limits to 200% full scale. The Model DLN has a thickness of 0.19" and is available in compression-only ranges to 1,000 pounds. It requires a through-bolt mount and comes with three feet of coaxial cable with a 10-32 connector.

The DLS is designed for capacities to 10,000 pounds and measures impact forces and dynamic loads that have high static preloads. The model is 0.43" thick and also is a bolt-mount.

For More Information Circle No. 743

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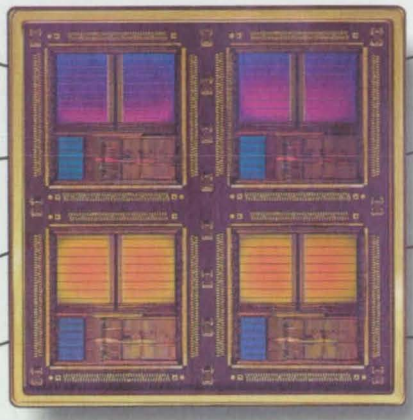

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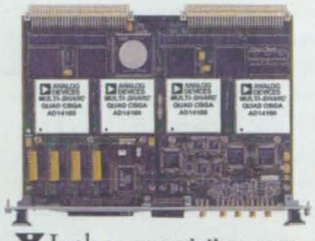

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Polyimide Passivation for Making High-T_c Josephson Junctions

Smaller spreads in critical currents and resistances are achieved.

NASA's Jet Propulsion Laboratory, Pasadena, California

Passivation by coating with OCG285 (or equivalent) polyimide at critical steps of fabrication has been found to enhance the quality of tapered edges in high-critical-temperature (high-T_c) superconductor/normal-conductor/superconductor (SNS) Josephson junctions. In comparison with Josephson junctions that are nominally identical except for having been fabricated without such passivation, those fabricated with polyimide passivation exhibit cleaner and smoother edges and, consequently, smaller differences among the resistances and critical currents of individual junctions.

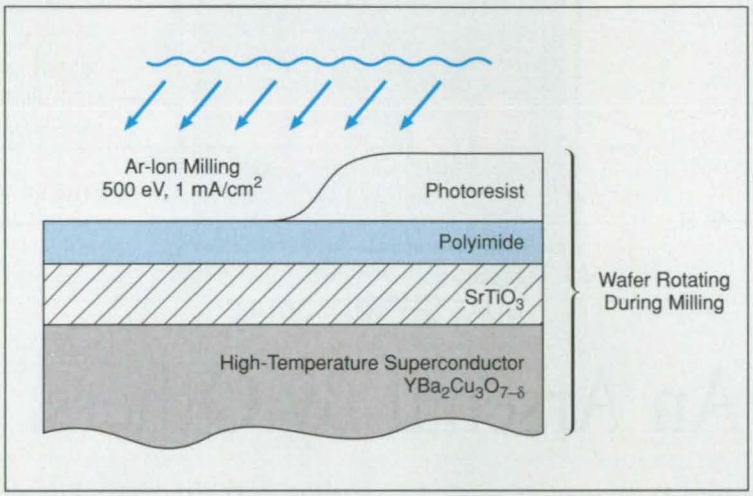

Figure 1. The **Formation of a Tapered Edge** on a high-temperature superconductor during the fabrication of an SNS Josephson junction is accomplished by ion milling through a patterned photoresist mask. The incorporation of the polyimide layer enhances the quality of the tapered edge formed in this process.

The formation of clean, smooth, tapered edges on films of high-T_c superconductors (primarily $YBa_2Cu_3O_{7-\delta}$) and on related epitaxial insulating films (e.g., $SrTiO_3$) is an essential part of the fabrication of SNS Josephson junctions and similar devices. The tapered edges are needed for the subsequent deposition of layers that are free of defects. In typical current practice, the edges are formed by ion milling through photoresist masks that have been patterned onto the high-T_c superconducting and overlying insulating films. This processing exposes the superconducting films to the photoresist patterning, which often leaves minute amounts of residues that degrade the quality of subsequently deposited high-T_c superconducting films. In addition, the exposure of the photoresist and superconducting films to the ion-milling process can lead to further degradation of the superconductor films and edges.

Figure 1 shows one aspect of the formation of a tapered edge in a process that incorporates the polyimide passivation step. Coating with the polyimide before patterning and ion milling protects the underlying high-temperature superconductor from the developer and photoresist. The polyimide layer also protects the photoresist against ion-milling-induced changes that degrade the superconducting film and edges.

The polyimide-passivation technique has been tested in the fabrication of multiple SNS edge Josephson junctions on chips. $YBa_2Cu_3O_{7-\delta}$ followed by $SrTiO_3$ was deposited on (100) $LaAlO_3$ wafers. The $SrTiO_3$ layers were patterned with reflowed photoresist masks, then rotated during argon-ion milling without cooling. The Josephson junctions were then completed by the deposition of $YBa_2Cu_{2.79}Co_{0.21}O_{7-\delta}$ as the normal conductor followed by $YLa_{0.005}Ba_2Cu_3O_{7-\delta}$ superconducting counterelectrodes. The current-vs.-voltage characteristics of junctions fabricated with and without polyimide passivation were measured at a temperature of 60 K. Plotted in Figure 2 are the spreads in the critical current densities and quantities proportional to normal resistivities calculated from the measurements. The results show that in all cases except one, the variability among devices was decreased by use of polyimide passivation. In the one exceptional case in which a chip made with polyimide passivation exhibited a 74-percent spread in critical current, the SNS devices on the chip were just beginning to show a critical current as the temperature decreased to the measurement temperature; at a temperature of 50 K, the spread in critical current for this chip was 24 percent.

This work was done by Jeffrey Barner and Henry LeDuc of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Electronic Components and Circuits category,* ***or circle no. 106*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*

NPO-20164

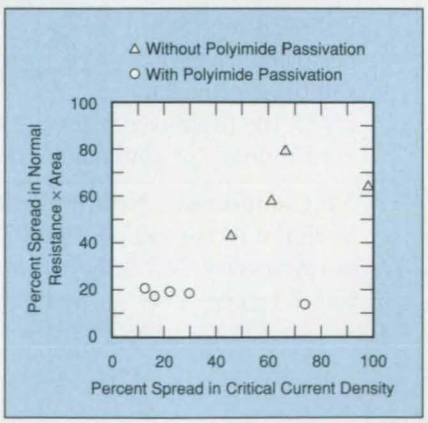

Figure 2. The **Spreads in Resistance and Critical Current** for sample SNS Josephson junctions fabricated without and with polyimide were calculated from current-vs.-voltage measurements. The percent spread on each axis is defined as 100 × (the standard deviation ÷ the mean).

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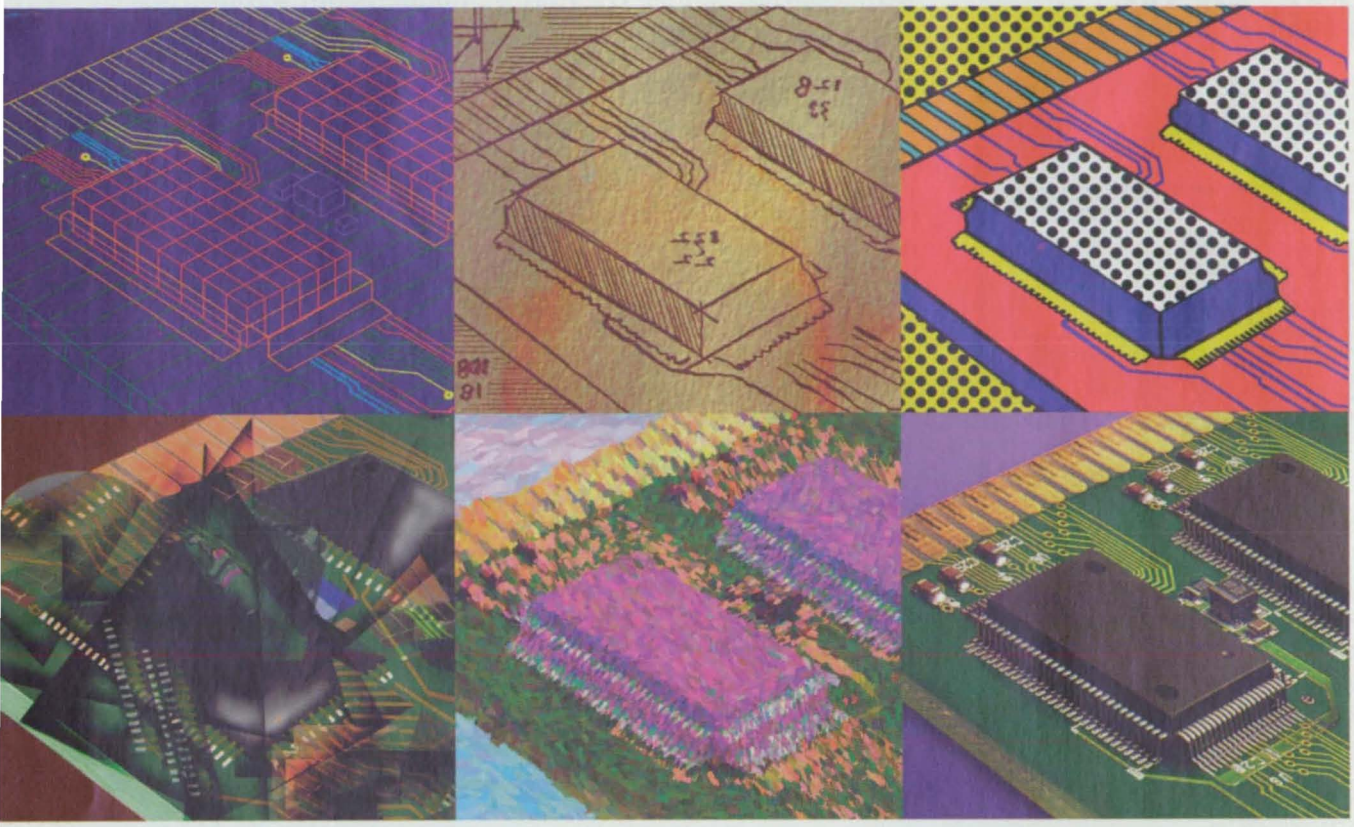

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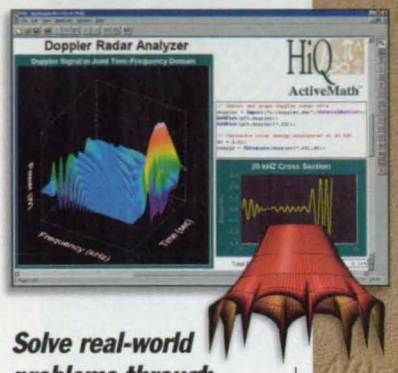

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Phase-Synchronized Enhancement Method for Engine Diagnostics

This technique transforms instantaneous phase signals into discrete signals for better engine-health monitoring and fault analysis.

Marshall Space Flight Center, Alabama

A diagnostic signal-analysis technique, called the Phase Synchronized Enhancement Method (PSEM), has been developed. This method allows NASA engineers to retrieve any unique defect signatures and trends associated with different failure modes and unusual phenomena experienced during Space Shuttle main engine (SSME) testing.

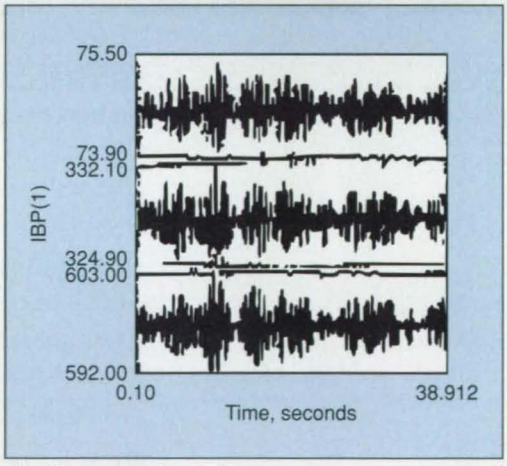
Previous diagnostic studies using the Generalized Hyper-Coherence method have shown that the frequency of the shaft rotational component (sync) of a high-speed SSME turbopump is fluctuating around a center frequency during steady-state operation. These studies further showed the Power Spectral Density (PSD) to be exhibiting a discrete peak, indicative of strong stationarity.

Machinery failure detection has always been a significant technical challenge for NASA's propulsion technology engineers. A reliable engine-health-monitoring system can prevent catastrophic failures and lower costly downtime due to false alarms. PSEM can provide valuable signal-enhancement capability during engine-health monitoring and diagnostics and improve the safety and reliability of NASA's advanced propulsion systems.

This method of analysis uses the microfrequency variation phenomenon to improve all the sync-related components in a signal. PSEM forces the narrowband spectral component of sync into a pure-tone discrete component with a constant frequency by transforming its instantaneous phase signal into an equivalent "realignment" time. When the realignment time is corrected, the original sync component will become discrete, generating a highly desirable effect on the entire signal where all the other sync-related components (sync harmonics, cage, ball spin, outer ball pass, and inner ball pass) will automatically become discrete. The resulting discrete signal provides better PSD resolution, which improves engine diagnostic evaluation.

A vibration signal in a rotor system is modeled as an FM signal with multiple spectral components at different carrier frequencies. The instantaneous frequency and instantaneous phase information of each component is recovered using several digital frequency-demodulation methods, such as complex demodulation techniques and the phase-lock-loop method. During steady-state operation of most machinery systems, the instantaneous frequency of sync tends to fluctuate about a center frequency and is not a constant frequency. Since the amplitude of such frequency variation could be much smaller than the bandwidth with PSD analysis, the sync spectral component still appears as a very discrete peak in its PSD.

This technique has potential for commercial application outside NASA's propulsion area. For example, PSEM will greatly increase the PSD resolution during quality-control checks on spindle motors during production and reduce the man-hours needed for system monitoring and diagnostics.



This illustration shows the **Instantaneous Frequency** of sync (N), inner ball pass (IBP), and the 8th harmonic of sync (8N). PSEM algorithm forces the frequency of sync from this periodic variation into a constant frequency, generating a highly desirable effect on the entire signal.

This work was done by Jen-Yi Jong of AI Signal Research, Inc., for the **Marshall Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Circuits category,* ***or circle no. 109*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*
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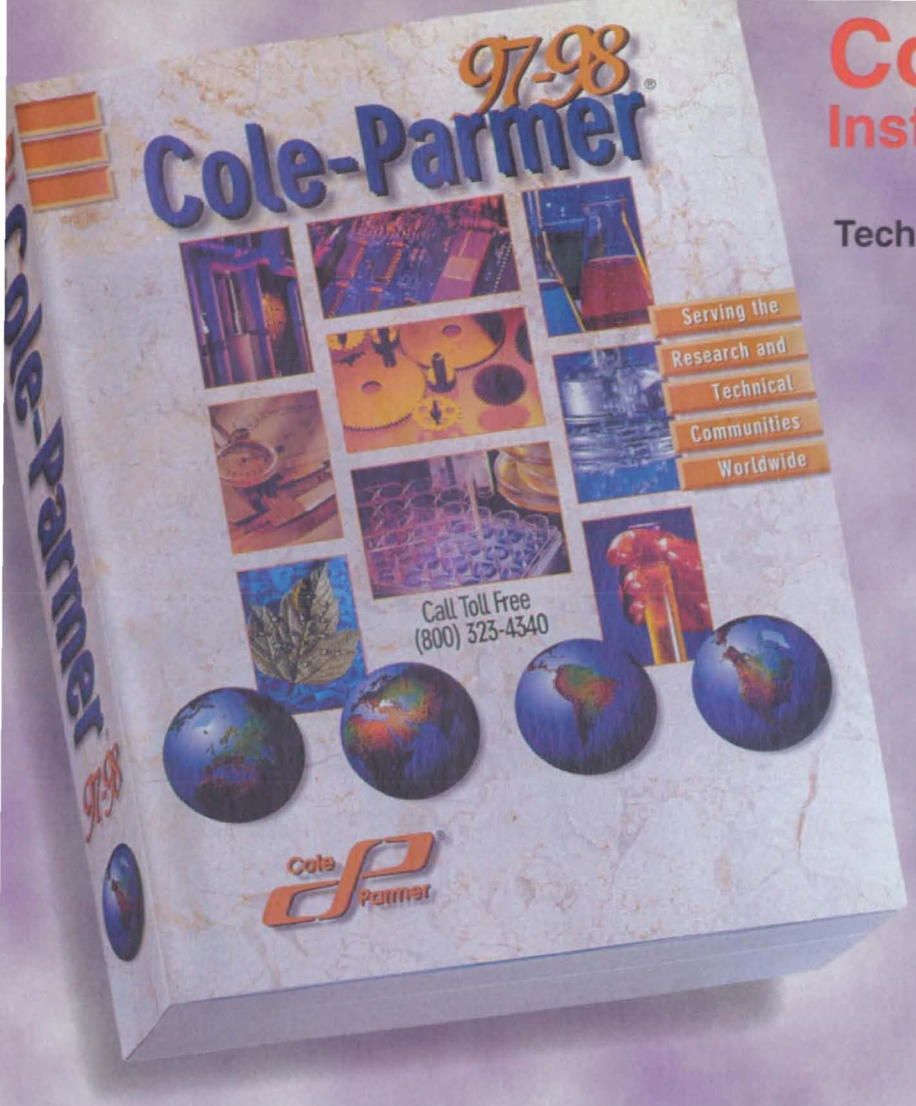

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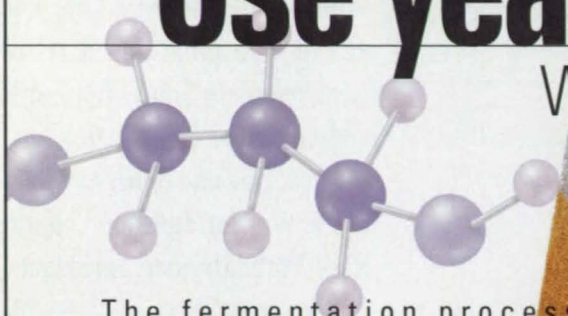

Yeast, grain and water can be used to make really fine beer. Or, for that matter, really fine trimethylene glycol.

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into other molecules?

doing it for 4,000 years.

The transformation of sugars into alcohol by microscopic organisms has been known for a very long time. But only since the advent of genetic engineering is it feasible to think about harnessing the sophistication of biological systems to create molecules that are difficult to synthesize by traditional chemical methods.

For example, the polymer polytrimethylene terephthalate (3GT) has enhanced properties as compared to traditional polyester (2GT). Yet commercialization has been slow to come because of the high cost of making trimethylene glycol (3G), one of 3GT's monomers.

Working the bugs in

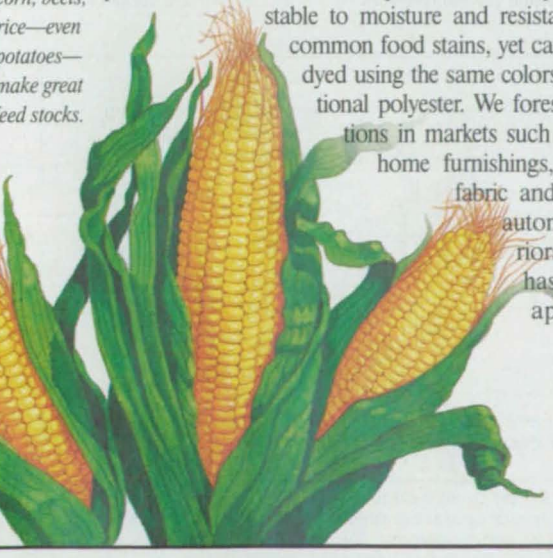
The secret to producing 3G can be found in the cellular machinery of certain unrelated microorganisms. Some naturally occurring yeasts convert sugar to glycerol, while a few bacteria can change glycerol to 3G. The rub is that no single natural organism has been able to do both.

Through recombinant DNA technology, an alliance of scientists from DuPont and Genencor International has created a single microorganism with all of the enzymes required to turn sugar into 3G. This breakthrough is opening the door to low-cost, environmentally sound, large-scale production of 3G. The eventual cost of 3G by this process is expected to approach that of ethylene glycol (2G).

is no longer necessary o start with a barrel of l to produce chemicals. Corn, beets, rice—even potatoes—make great eed stocks.

A polymer for your thoughts

The 3GT polymer produced using our biosynthesized monomer has properties that exceed those of normal polyester. It is resilient and can be molded or extruded into fibers. The fibers are heat-settable and can be stretched at least 15 percent and recover without permanent "creep." They are stable to moisture and resistant to most common food stains, yet can be readily dyed using the same colors as conventional polyester. We foresee applications in markets such as apparel, home furnishings, upholstery fabric and carpet for automobile interiors. Even 3G has numerous applications.



Comfortable, easy-care apparel may soon be made with fibers spun from chemicals that have been fermented from sugar.

By combining it with various organic acids, polyols can be made as precursors to polyurethane elastomers and synthetic leathers.

A break for the environment

The 3G fermentation process requires no heavy metals, petroleum or toxic chemicals. In fact, the primary material comes from agriculture—glucose from cornstarch. Rather than releasing carbon dioxide to the atmosphere, the process actually captures it because corn absorbs CO_2 as it grows. All liquid effluent is easily and harmlessly biodegradable. What's more, 3GT can readily undergo methanolysis, a process that reduces polyesters to their original monomers. Post-consumer polyesters can thus be repolymerized and recycled indefinitely.

Can you play a role?

Throughout DuPont's history, many of our biggest contributions have come to market through collaboration with other companies. Development of 3GT could involve partnering with companies active in traditional polymer processing, separations technologies, recombinant DNA techniques, corn wet-milling and fermentation. If you possess these skills, or have ideas for end-use applications, we'd like to hear from you. Fax us on company letterhead with an indication of your interests to: DuPont, Dept. NT, 302-695-7615. Please limit your correspondence to nonproprietary, public-domain information only.

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VLSI Neural Processors Based on Optimization Neural Networks

Computational performances could be greatly enhanced.

NASA's Jet Propulsion Laboratory, Pasadena, California

Compact analog/digital electronic data processors of a novel type are based on the concept of the optimization cellular neural network (OCNN) and are implemented in very-large-scale integrated (VLSI) circuitry. These VLSI neural processors are being developed to perform a variety of computation-intensive tasks in maximizing the return of useful scientific information from future multiple-sensor microspacecraft, given such considerations as synergy among multiple sensors, limits on the power and bandwidth available for transmission of data, and the need to recognize significant data in the absence of prior explicit instructions. The OCNN concept also has obvious potential for terrestrial "smart"-sensor and other data-reduction applications.

The OCNN concept is founded on the concept of the cellular neural network (CNN), which is a recursive neural network that comprises a multidimensional array of mainly identical artificial neural cells, wherein (1) each cell is a dynamic subsystem with continuous state variables and (2) each cell is connected to only the few other cells that lie within a specified radius (see Figure 1). Since its original publication in 1988, the concept of the CNN has evolved rapidly and now provides a unified theoretical framework for such computation-intensive applications as signal processing and optimization. The CNN concept provides the architecture for a locally connected, massively parallel computing system with simple synaptic operators — very suitable for VLSI implementation in real-time, high-speed applications. The behavior of a CNN depends on the computing model, network topology, and coefficient template; the behavior in a given application depends primarily on the coefficients of the template (synaptic weights, threshold values, and boundary conditions) and the procedure for applying them.

An OCNN is designed to perform programmable functions for fine-grained processing with annealing control to enhance the quality of the output. Going beyond the basic CNN concept, the OCNN concept incorporates a hardware-based annealing method, according to which the annealing function is embedded in the network. The annealing function is a parallel version of fast mean-field annealing in analog networks, and is highly efficient in finding globally optimal solutions. Whereas synaptic weights in a basic CNN are fixed, those in an OCNN are made digitally programmable to accommodate applications in which predetermined operators are needed.

Other important features of the OCNN concept can be described with reference to the example of a typical intended application, in which a VLSI

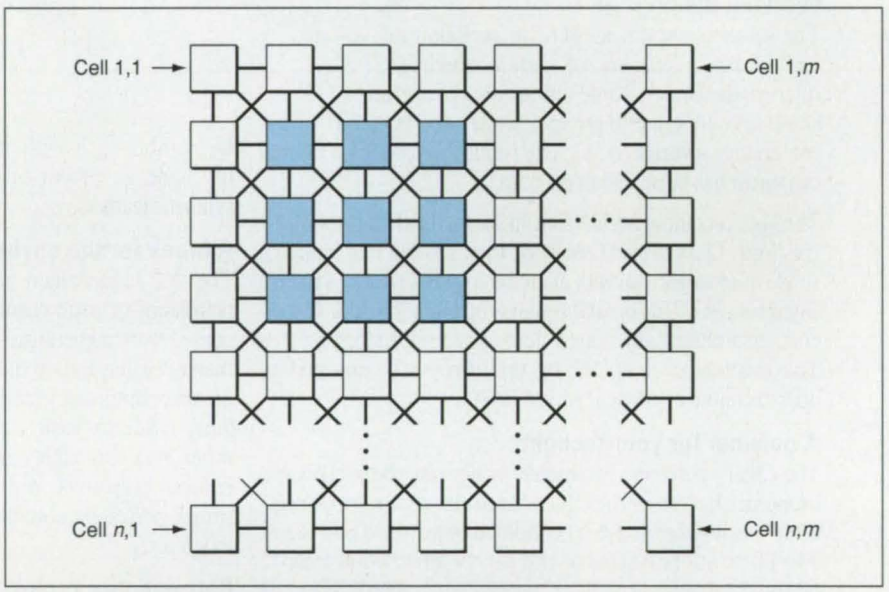

Figure 1. A **Typical *n*-by-*m* Rectangular Cellular Neural Network** contains cells that are connected to their nearest neighbors only.

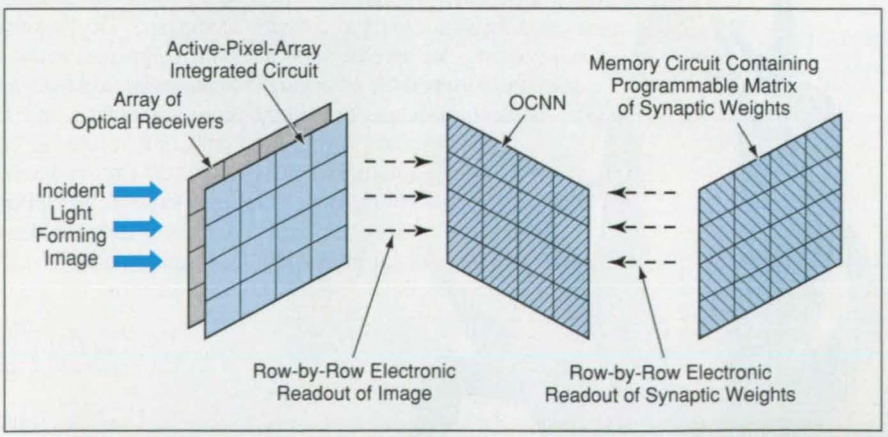

Figure 2. A **"Smart" Optoelectronic Image Sensor** could include an OCNN sandwiched between a planar array of optical receivers and a planar array of optical transmitters, along with circuitry that would implement a programmable synaptic-weight matrix memory. This combination of optics and electronics would afford fast processing of sensory information within the sensor package.

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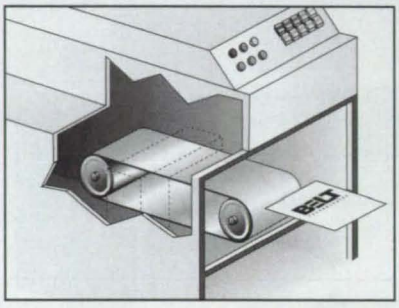

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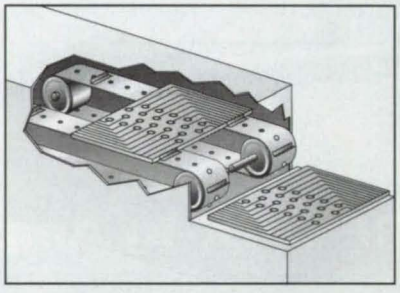

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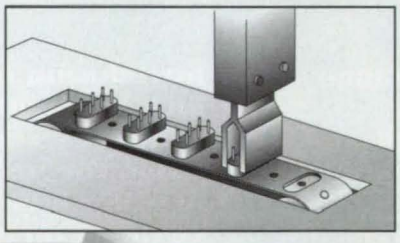

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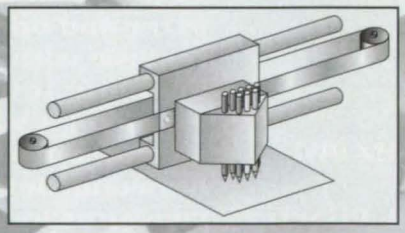

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OCNN processor would receive input from an image-sensing array of photodetectors and would perform such image-data-processing functions as detecting edges or detecting motion. If a basic CNN were to be used in this application, then each pixel would be represented by one neuron. In an OCNN, every pixel could be represented by multiple neurons, that, collectively, would constitute a hyperneuron and would execute the maximum evolution function for selecting among various profiles or exploiting data synergy. For instance, in an OCNN designed to detect motion, every image pixel would be represented by multiple, mutually exclusive neurons in a hyperneuron for velocity selection. Only the winning neuron within each hyperneuron would remain active, while the others would be turned off. The operation of the neural network would be terminated when the energy function of the network reached a minimum. To improve the global interconnections and the input and output of image data with external circuitry beyond those of a basic CNN, an OCNN could be integrated with optical receivers and transmitters (see Figure 2)

VLSI neural processors of this type would likely also prove useful in terrestrial robotic systems and in other systems in which there are requirements for "smart" sensor subsystems and/or high-performance on-board computing for optimization, autonomous control, and/or reduction of data. Preliminary studies have shown that the OCNN concept offers the potential for orders-of-magnitude improvements in performance in onboard computation for autonomous control and reduction of data from multiple sensors.

This work was done by Wai-Chi Fang, Bing J. Sheu, and James Wall 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 Systems category,* ***or circle no. 113*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*

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Black-Body Evaporator Unit for a Point-Focus Solar Collector

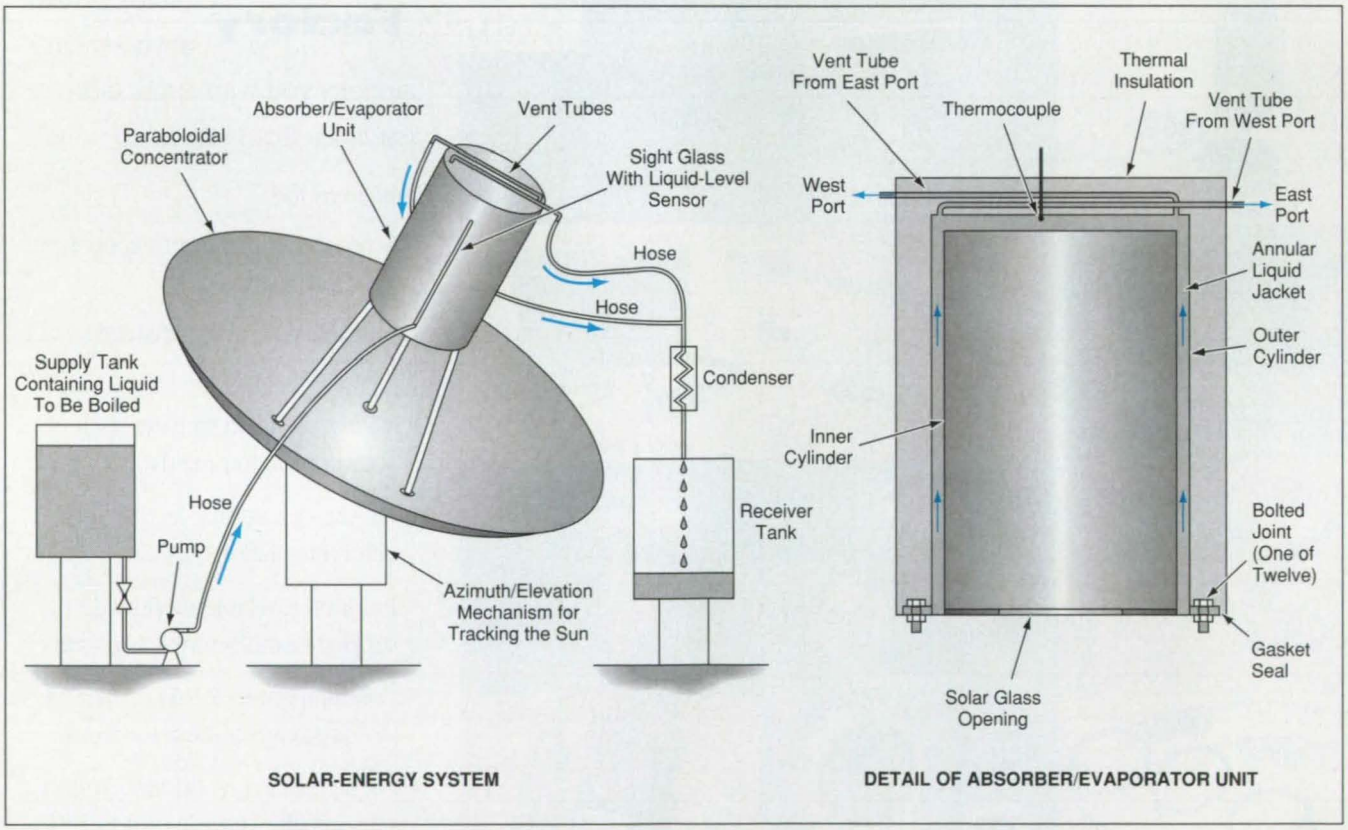
A special coating is not necessary to ensure high solar absorptivity.

John F. Kennedy Space Center, Florida

The figure illustrates a solar thermal energy system for boiling water or another liquid. The system can be used for a variety of purposes that can include drying aqueous hazardous waste, distilling pure solvent from spent solvent, purifying water by distillation, or generating steam. The principal innovative feature of this system is an absorber/evaporator unit, which is designed to absorb radiant solar energy with an effectiveness close to that of an ideal (in the black-body sense) absorber. The design is such that unlike in some other systems, it is not necessary to coat the solar-irradiated surface with a high-solar-absorptivity ("solar black") material to obtain the desired black-body characteristic. The design is also simpler than that of other absorber/evaporator units.

Though the absorber/evaporator unit described here is cylindrical, it could just as well have a spherical, conical, or other convenient shape. The absorber/evaporator unit includes an inner cylinder and a slightly wider outer cylinder, both made of stainless-steel sheet. The inner cylinder acts as the solar-energy absorber for heating the liquid, which is pumped into the narrow annulus between the inner and outer cylinders. The narrow-annulus feature is an important element of the design in that a liquid can be boiled most effectively when confined in a thin layer. The vapor leaves through vent tubes at the top, then flows through vent hoses to the condenser. The vent tubes, the vent hoses, and the outer surface of absorber/evaporator unit (except at the opening) are covered with insulating material.

Concentrated solar radiation enters the absorber/evaporator unit through a solar-glass-covered opening at its lower end. The absorber/evaporator unit is positioned and oriented to face a paraboloidal solar-radiation concentrator; the cylindrical axis of the unit is aligned with the optical axis of the concentrator and the unit is positioned along this axis with the center of the opening at the focal point of the concentrator. Of course, the



This **Solar Heating System** for boiling a liquid features an improved absorber/evaporator unit that exploits geometry to achieve an absorption characteristic approximating that of a black body. The seemingly peculiar arrangement of vent tubes can be understood, upon closer examination, to prevent spillage of liquid when the unit is tilted toward the east or west.

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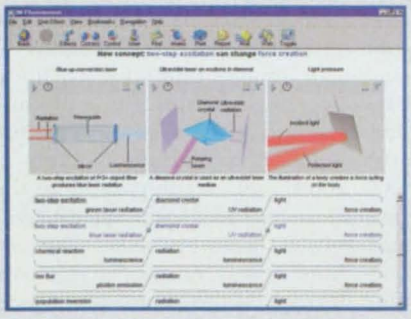

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paraboloidal concentrator must be mounted on an azimuth/elevation tracking mechanism that keeps the concentrator aimed toward the Sun.

This optical arrangement ensures that most or all of the concentrated solar radiation enters the cavity enclosed by the inner cylinder, yet the opening is small enough to provide a relatively small solid angle for the escape of thermal radiation from the cavity. Once solar radiation enters the cavity, some is absorbed immediately, some is absorbed after one or more reflection(s), some is reradiated, and some of the reflected and reradiated energy escapes through the opening. The opening is small enough that the solid angle for the escape of radiation is relatively small; consequently, the incident radiation undergoes multiple cycles of reflection, absorption, and reradiation that convert the radiation field in the cavity into one that approximates a black-body radiation field, even in the absence of a high-absorptivity coating on the absorber surface.

With its thin-wall-shell design and without for a special high-absorptivity coating, the absorber/evaporator unit can be constructed relatively easily. The unit can also be disassembled relatively easily for cleaning and repairs.

This work was done by Feng-Nan Lin, William I. Moore, and Philip D. Stroda of **Kennedy Space Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 160*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
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Adjacent-Pair Imaging Shearography Using Bacteriorhodopsin

John F. Kennedy Space Center, Florida

In a developmental technique of real-time adjacent-pair imaging shearography, a thin film of bacteriorhodopsin is used to record shearograms in argon-laser light for immediate readout in helium/neon-laser light. Unlike conventional silver-halide-based photographic film, bacteriorhodopsin can be used as a real-time recording medium because it yields an image immediately upon exposure and is optically erasable. Bacteriorhodopsin also offers the advantage of resolution as high as 5,000 lines/mm — comparable to the resolutions of silver-halide-based films and much greater than the 80 lines/mm typical of the charge-coupled-device video cameras used heretofore in real-time shearography. Issues to be addressed in subsequent development include the difficulty of recording over a previously recorded image at the recording wavelength, the need for Fourier-transform optics for readout, the need to optimize the optics to realize the full potential for high resolution, and the relative insensitivity of bacteriorhodopsin film (about a tenth of that of silver-halide-based film).

This work was done by Colleen Fitzpatrick of Rice Systems, Inc., for **Kennedy Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 161*** *on the TSP*

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Refer to KSC-11838, volume and number of this NASA Tech Briefs *issue, and the page number.*

A Multicolor Imaging Pyrometer

An imaging pyrometer allows precise spatially resolved temperature measurements over a variable emissivity field.

Physical Sciences Inc., Andover, Massachusetts

Physical Sciences Inc. (PSI) designed, constructed, and delivered a prototype passive imaging pyrometer capable of accurately measuring and controlling the temperature distribution across a specified surface. The device was originally designed, under a NASA SBIR contract (solicitation year 1985) monitored by Jet Propulsion Laboratory, for space application with a material processing acoustic levitation furnace, and thus the software allowed for registration of a surface that was allowed free motion within a defined range.

The multicolor imaging pyrometer was designed specifically to measure temperatures from 900 to 2500 K with spatial resolution of 2 mm. These parameters can be extended and customized for other applications.

Like all pyrometers, this instrument determines the temperature of a material by measuring the emitted radiation. However, unlike most other pyrometers, temperature measurement errors associated with a lack of knowledge about the heated sample's emissivity are minimized by utilizing an optical system that operates at short wavelengths compared to the peak of the blackbody spectrum for the temperature range of interest. In this regime the radiant power increases faster than exponentially with temperature.

Because of this extreme sensitivity to temperature, the emissivity of the source plays a relatively small role in determining the emitted power. The short wavelengths therefore provide more accurate measurements of the temperature than can be made using longer wavelengths, assuming equally poor knowledge of the sample's emissivity. The penalty paid for this accuracy is that the dynamic range of the pyrometer's CCD image detector places rather narrow limits on the range of temperatures that can be measured at a single short wavelength. To cover a broad range of temperature, six wavelengths — each sensitive to a specific temperature range — are provided.

An optical head projects distinct images at all six wavelengths onto the detector concurrently. Computerized data acquisition and analysis enables the user to capture data and store it on

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Absolute accuracy	+/- 25 °C (+/- 50 °F)
Relative accuracy	+/- 15 °C (+/- 30 °F)
Measurement field of view	6° cone
Outputs: Analog	0-10 VDC; 4-20 mA
Digital	RS-232
INSTALLATION:	
Electrical classifications	General purpose
Physical dimensions and weight	1200 × 250 × 180 mm (46 × 9.5 × 7 in.) 18.2 kg (40 lb.)
Port	50 mm (2 in.) port in boiler sidewall

videotape, interactively examine and interpret the data either immediately after capture or upon replay of the videotape, or to automatically analyze the pyrometer's output. In the latter mode, the pyrometer provides a display of the object's temperature distribution in a false color image on a video monitor, a calculation of the temperature distribution's mode value, and a capability to use that value in a feedback loop for controlling the object's temperature.

The pyrometer technology was later extended under a National Science Foundation grant to allow rapid nonintrusive measurement of particulate and gas temperatures in extremely hostile environments. The resulting optical temperature monitor, again employing multiple wavelength measurements, was originally sold commercially as GasTemp®. Following this successful demonstration and commercialization, PSI established a subsidiary to manufacture and enhance the product. It was soon apparent that this company had additional opportunities in the environmental monitoring instrumentation market, and a second optical instrument, the SpectraScan® line, was developed. SpectraScan directly measures trace concentrations of ammonia, hydrogen fluoride, hydrogen sulfide, and other regulated gases in either extractive or open path modes.

As the applications of SpectraScan became clear, the company's name was changed to Spectrum Diagnostix, and the SpectraTemp™ optical temperature monitor was introduced. The Massachusetts Capital Resource Co. and The Venture Capital Fund of New England invested $1.7 million, allowing Spectrum Diagnostix to grow to almost 20 employees. In 1996, Spectrum Diagnostix was sold to PSI's marketing partner, Bovar Western Research, which now manufactures and distributes SpectraTemp™ It provides continuous accurate and reliable temperature monitoring of hot particulate-laden gas streams.

SpectraTemp determines particulate temperature by measuring light emissions from the particulates at three different wavelengths. These are selected to avoid interferences from cool heat-transfer surfaces (*e.g.*, boiler walls). SpectraTemp provides a temperature range of 350 °C (675 °F) to 1600 °C (2900 °F). Its design gives it a unique capability to determine a line-of-sight average temperature all the way across a particulate-laden stream. Automatic calibration, fault detection, and alarms are incorporated into SpectraTemp, and both analog and digital outputs are supplied for interfacing with plant control systems.

SpectraTemp has most commonly been used for monitoring furnace-exit gas temperature in utility and industrial boilers fired by coal, heavy oil, wood, or municipal waste. In these installations, SpectraTemp reduces operating costs by providing better control of furnace-wall blowers and soot blowers, better burner control (tilt and excess air), and superior steam-temperature control.

SpectraTemp can also be used for improved process optimization in other industrial processes where accurate control of the temperature of particulate-laden gas streams is important. Examples of such processes include waste incinerators, cement kilns, and smelters. For more information on SpectraTemp™ contact Norman Stein, Bovar Western Research, (713) 789-1084.

This work was done by **Physical Sciences Inc.** *under a NASA SBIR Contract monitored by* **Jet Propulsion Laboratory.** *Information on customized imaging pyrometers can be provided by George Caledonia, Physical Sciences Inc., 20 New England Business Center, Andover, MA 01810; (978) 689-0003.*

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Sputter Deposition of Pure and Fluoropolymer-Filled Al_2O_3

Transparent coats of Al_2O_3 could protect plastic windows.

Lewis Research Center, Cleveland, Ohio

Experiments have shown that nonreactive ion-beam sputtering can be used to deposit a transparent film of aluminum oxide on a polycarbonate, silicon, or fused-silica substrate. Similar experiments have shown that reactive ion-beam sputtering can be used to form a transparent film of either aluminum oxide alone or else aluminum oxide filled with a few percent of polytetrafluoroethylene (PTFE). The properties of reactively deposited Al_2O_3 films appear to be superior to those of nonreactively deposited Al_2O_3 films with respect to the intended applications, as explained below.

These experiments were conducted as parts of continuing efforts to develop hard, adherent, hydrophobic oxide films to protect polymeric windows (e.g., in automobiles and aircraft) against oxidation and abrasion and to enhance their ability to shed water. Earlier efforts along this line of development were reported in "Deposition of Sapphire by Conversion Coating" (LEW-15638), *NASA Tech Briefs*, Vol. 20, No. 8 (August 1996), page 68.

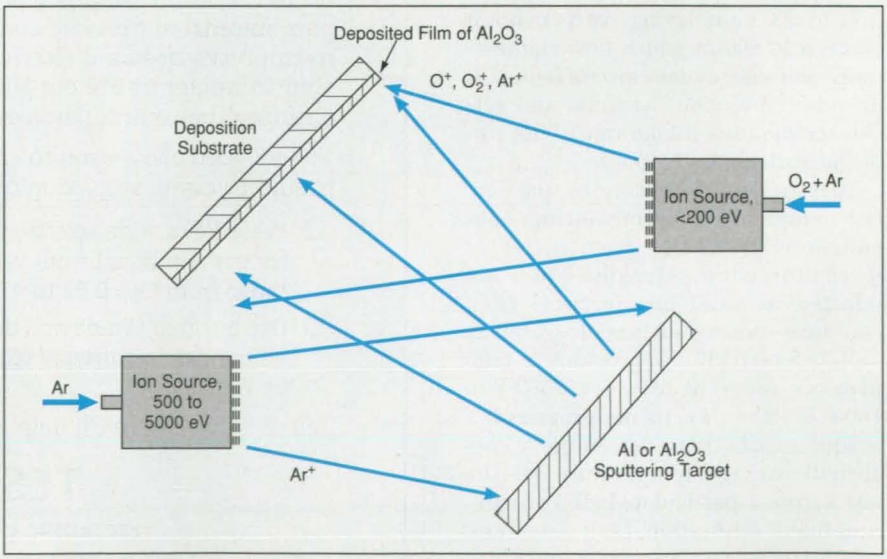
The deposition apparatus (see figure) was housed in a vacuum chamber and contained two ion sources: one that generated a beam of argon ions at a kinetic energy of 1,000 eV and one that generated an oxygen/argon plasma with an ion kinetic energy of about 170 eV. For nonreactive sputter deposition, the argon-ion beam was aimed at an aluminum oxide sputtering target and the oxygen/argon ion source was not used. For reactive sputter deposition, the argon-ion beam was aimed at an aluminum sputtering target, while the oxygen/argon-ion beam was aimed at the deposition substrate. The addition of PTFE during reactive sputtering was accomplished by placing a wedge of PTFE onto the aluminum sputtering target. In one experiment, a film of PTFE (only) was deposited by use of a PTFE (only) sputtering target.

In each case in which a film was deposited on a fused-silica substrate, part of the substrate was masked with tape to provide a datum surface for measurement of the thickness of the deposit by use of a profilometer. Typical thicknesses of Al_2O_3 films ranged from 1,600 to 2,700 Å. A deposit of 92 percent Al_2O_3 and 8 percent PTFE was found to be 3,800 ± 260 Å thick, and a deposit of PTFE alone was found to be 12,300 ± 1,077 Å thick. Water contact angles were also measured on the fused-silica substrates. In cases in which films were deposited on silicon substrates, the intrinsic stresses in the films were determined by measuring the changes in the surface bows of the substrates. Spectral transmissivities of uncoated and coated fused-silica and polycarbonate substrates were measured. Qualitative tests of resistance to abrasion were performed on two types of polycarbonate substrates: uncoated and one reactively coated with Al_2O_3 to a thickness of 12,200 Å.

Stresses were found to be slightly lower in reactively deposited than in nonreactively deposited Al_2O_3 films. Stresses were reduced by incorporation of PTFE. Unexpectedly, films of Al_2O_3 + PTFE were found to be less hydrophobic than are films of Al_2O_3 alone — an effect that might be attributable to the formation of aluminum fluoride. In comparison with nonreactively deposited Al_2O_3, reactively deposited Al_2O_3 proved to be slightly more hydrophobic and more optically transmissive in the ultraviolet. The addition of PTFE exerted little effect on transmittance. The 12,200-Å-thick Al_2O_3 reactively deposited Al_2O_3 films on polycarbonate were found to increase the absolute absorptance by only about 1.8 percent while providing some resistance to abrasion by small particles like those typically encountered during cleaning of windows and lenses. Thus, it appears that reactive ion-beam sputtering of Al_2O_3 is potentially useful as a technique to apply clear, abrasion-resistant films to polymeric windows and possibly other optical components.

This work was done by Sharon K. Rutledge and Bruce A. Banks of **Lewis Research Center** *and Jason Hunt of Ohio Aerospace Institute. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 168*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16424.



The **Argon-Ion Source Was Used** alone for nonreactive deposition of Al_2O_3 from an Al_2O_3 sputtering target or with the oxygen/argon source for reactive deposition of Al_2O_3 from an Al target.

Self-Lubricating Composite Coating for High-Temperature Use

This material offers advantages over a previously developed similar material.

Lewis Research Center, Cleveland, Ohio

PS300 is a self-lubricating solid coating material for use in sliding contacts at temperatures up to 800 °C. PS300 is a composite of metal-bonded chromium oxide with barium fluoride/calcium fluoride eutectic and silver as solid lubricant additives. The "PS" in the name of this and other self-lubricating, high-temperature composite materials that have been reported in *NASA Tech Briefs* signifies that the material is applied to a substrate by plasma spraying of a powder blend of its constituents.

PS300 is similar to a previously developed material of this type, called "PS200." The main difference between the two materials is that instead of metal-bonded chromium oxide, the major constituent of PS200 is metal-bonded chromium carbide (see table). In either material, the major constituent serves as a tough, wear-resistant matrix. The additives provide lubrication by virtue of their low shear strengths: In particular, silver lubricates at low temperatures; at higher temperatures, where silver is too soft to support an appreciable load, the fluoride eutectic phase softens and behaves plastically.

The big disadvantage of PS200 is high cost. The metal-bonded chromium carbide is a highly processed, expensive constituent, and the presence of chromium carbide makes it necessary to resort to costly diamond grinding to polish the coating to the requisite finish prior to use. Moreover, at temperatures above 800 °C in air, the chromium carbide oxidizes, with a resultant increase in friction and loss of resistance to wear.

The metal-bonded chromium oxide in PS300 costs less than does the metal-bonded chromium carbide in PS200. Metal-bonded chromium oxide can be ground and polished by silicon carbide tools, eliminating the need for diamond finishing. Inasmuch as the chromium in PS300 is already in an oxidized state, the coating has potential for better tribological performance in air at high temperatures. Yet another advantage of PS300 over PS200 is that at high temperatures, chromium oxide is a good solid lubricant. Finally, in comparison with PS200, PS300 exhibits less of a tendency to clog spray-gun ports and can thus be plasma-sprayed more easily.

	Constituents and Proportions							
	Metal-Bonded Cr_2O_3*		Metal-Bonded Cr_3C_2**		Ag		BaF_2/CaF_2 Eutectic	
Composite Coating Material	Weight Percent	Volume Percent	Weight Percent	Volume Percent	Weight Percent	Volume Percent	Weight Percent	Volume Percent
PS300	80	80.3			10	5.5	10	14.2
PS200			80	77.1	10	6.4	10	16.5

* By Weight Percent, $80Cr_2O_3$+16Ni+4Cr
** By Weight Percent, $54Cr_3C_2$+28Ni+12Co+2Mo+2Al+1B+1Si

The Compositions of PS300 and PS200 are similar, the major difference lying in the metal-bonded, chromium-based constituent. PS300 offers advantages of lower cost and less difficulty in processing.

PS300 and PS200 have been tested under identical conditions on a pin-on-disk tribometer. In tests at temperatures up to 650 °C in air, the two materials exhibited comparable friction and wear properties.

This work was done by C. DellaCorte and B. J. Edmonds of **Lewis Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 152*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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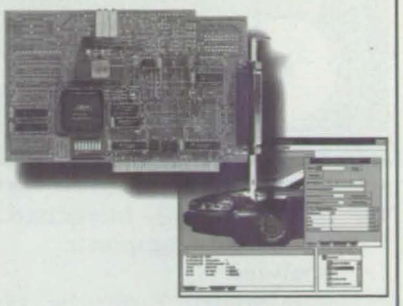

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ICAN/PART — Integrated Particulate Composite Analyzer

The Integrated Particulate Composite Analyzer (ICAN/PART) computer program is a modified version of the Integrated Composite Analyzer (ICAN) program (LEW-15592/LEW-15832), which was developed to conduct analyses of the micromechanics of fiber-reinforced polymer-matrix composite materials. ICAN/PART is a computationally efficient computer code that can be used by engineers in both aerospace and nonaerospace fields to characterize and design particulate-reinforced composite materials. These composites are useful in circumstances in which multi-phased materials are desired but the costs and difficulties of manufacturing continuous-fiber-reinforced composites are too great.

ICAN/PART can compute the effective properties and constituent microstresses of a particulate-reinforced composite as well as of a fiber-reinforced composite that includes a particulate-reinforced matrix material. The user obtains preliminary information on the order of magnitude of stresses that will be found in a given load state. If more-detailed information about the specific stress levels in specific locations of a composite-material object is required, a detailed finite-element model could then be constructed and analyzed.

The manner of using ICAN/PART is very similar to that of the original ICAN code. ICAN/PART includes a provision for a dedicated data bank that enables the user to build a database of properties of commonly used particle and binder materials. The user need only specify code names for constituents. Input includes code names or properties of constituent materials, and factors that reflect the process of fabrication and the geometry of the composite-material object. Output includes the various ply and composite properties, composite structural response, and composite-stress-analysis results with details of failure.

ICAN/PART is written in FORTRAN 77. Two machine versions are available. The UNIX-based version, LEW-16460, has been successfully implemented on a Sun4 SLC computer running SunOS 4.1.3_U1, a Sun4 IPC running Solaris 2.4 (SunOS 5.4), and an SGI Indigo2 computer running IRIX 6.2. The IBM PC-based version, LEW-16484, has been successfully run on a '486 microprocessor running MS-DOS 5.0, a '486 microprocessor running Windows95, and a Pentium microprocessor running Windows95. The code has been successfully compiled under Microsoft's Fortran Powerstation 1.0. A sample executable code is provided. The standard distribution medium for the UNIX-based version is a 3.5-in. (8.89-cm), high-density diskette in UNIX TAR format. The standard distribution medium for the IBM PC version is a 3.5-in. (8.89-cm), high-density diskette in PC format. Alternate distribution media are available on request. ICAN/PART was released to COSMIC in 1997.

This program was written by P. L. N. Murthy and R. K. Goldberg of **Lewis Research Center** *and S. K. Mital of the University of Toledo. For further information on the UNIX version, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Computer Software category,* ***or circle no. 110*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
LEW-16460

For further information on the IBM PC-based version, access the Technical Support Package (TSP) ***free on-line at www.nasatech.com*** *under the Computer Software category,* ***or circle no. 121*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
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Web-Based Software for Coordinating Work

WWWorkflow is a language-driven, data-base-mediated, web-based process mediation system. WWWorkflow leverages on intranet applications and existing information infrastructure services, making it possible to add workflow management features to preexisting information management systems, without the need for significant modifications of those systems. A distinctive feature of WWWorkflow is the careful separation of process mediation from product-data management. WWWorkflow supports many types of workflow and is not focused on any single information structure. WWWorkflow components include a web-based user front-end, a workflow "engine," a workflow data base, and a graphical workflow editor and authoring tool. The web-based user front-end of WWWorkflow allows any user with a web browser to interact with the system. The workflow "engine" contains a workflow language interpreter, as well as an event-driven process mediation service. The workflow data base provides persistence of workflows underway as well as status and historical information for complete reporting. The graphical workflow editor and authoring tool provides both capabilities to produce and edit workflow procedures.

This program was written by Charles Ames, Scott Burleigh, and Stephen Mitchell 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 Computer Software category,* ***or circle no. 127*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge). This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20124.*

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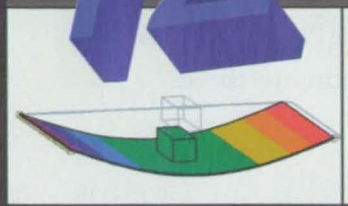
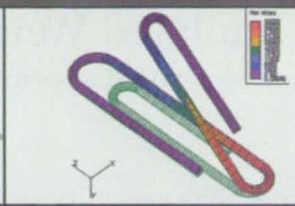
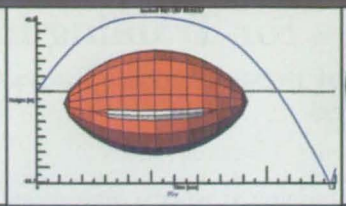


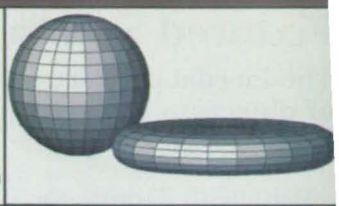
Out of plane bending - Use nonlinear analysis to determine whether this plate will foreshorten and fall out of its support. Linear cannot predict geometry changes perpendicular to a load.



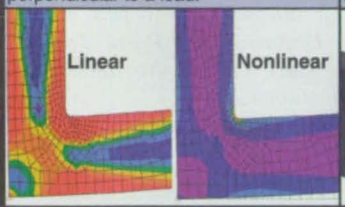
Permanent deformation - Algor's nonlinear analysis can predict the permanent deformation when the predicted stress exceeds the yield stress. Linear analysis can't do this.



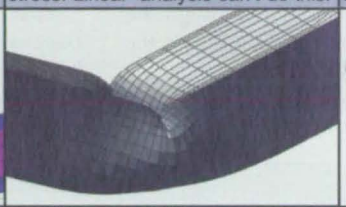
Trajectory - Basic motion, such as the trajectory of this rotating football is easily done using Algor's nonlinear analysis. Linear analysis cannot predict motion.



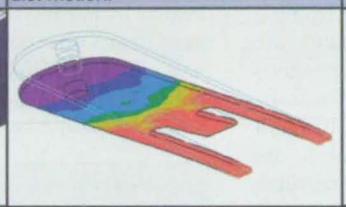
Squashing - Squashing this rubber ball in a vice using linear analysis cannot predict the final shape like this nonlinear analysis.



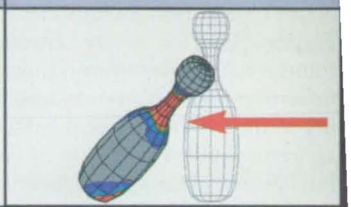
Stress concentration - Linear stress analysis will misrepresent both the stress and the deformation of this hanger due to minute changes in the fillet. Nonlinear analysis gets it right.



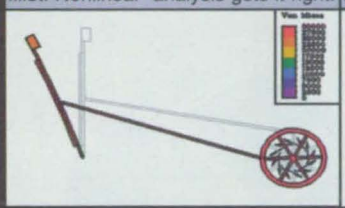
Local buckling - When failure is due to local buckling, the geometry fails at stresses much, much lower than the yield stress. Linear cannot detect local buckling.



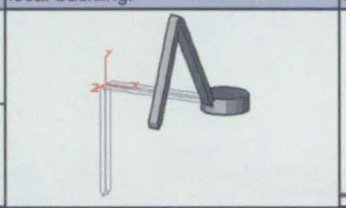
Snap-through - Any time you have a snap-through effect, your part is in motion until it stops on the other side. You need nonlinear analysis to predict this effect.



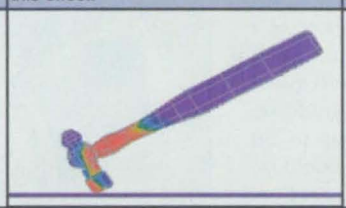
Impact - Nonlinear dynamic response predicts the stress in an object when it goes into motion as a result of impact by another object. Linear analysis cannot analyze for impact and motion.



4-bar link - Linear dynamic analysis cannot predict the forces and stresses due to periodic loading. Accupak/VE simulates the loading and stresses in one analysis.



3-D mechanism - When a moving object is a 3-D mechanism, high inertia forces can occur. You need Accupak/VE to predict the stresses caused by motion.



Contact impact - Kinematic motion and the stresses due to the shock of impact cannot be predicted by either linear stress analysis or kinematics analysis software. Accupak/VE does it in one shot..

Elastic large deformation - Nonlinear analysis predicts the stressed geometry when the deformation is significant, even if the material properties remain linear. Linear analysis fails at this.

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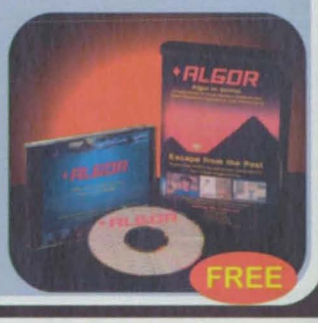

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For More Information Circle No. 510

Fixtured Spheres for Training in Simulated Weightlessness

The inertial properties of these neutrally buoyant spheres would approximate those of objects to be simulated.

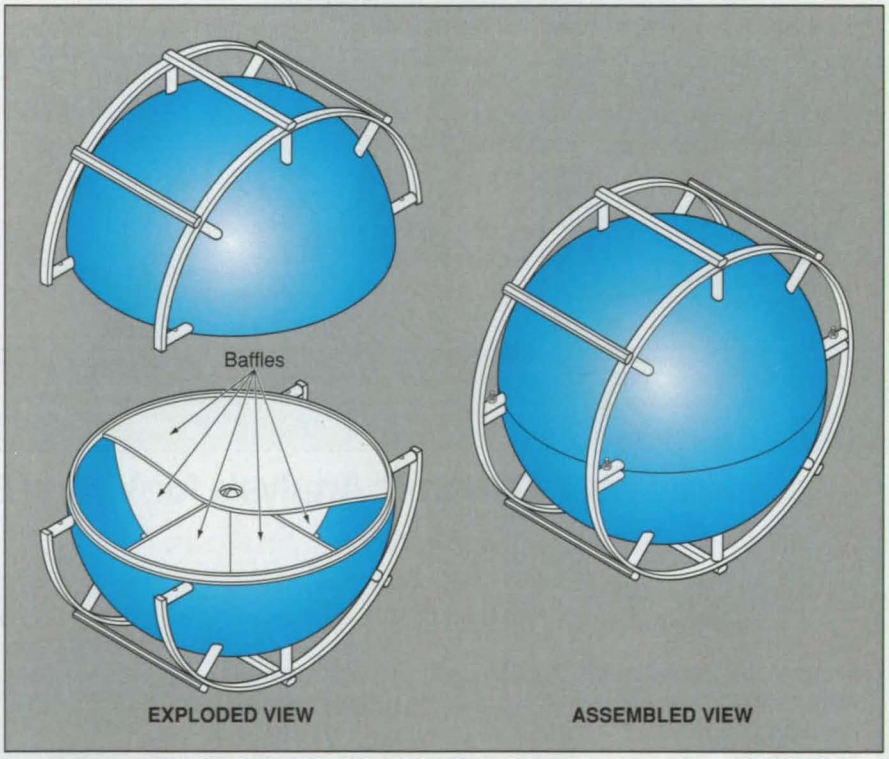
Lyndon B. Johnson Space Center, Houston, Texas

Weightless Environment Training Facility Inertial Training Spheres (WETFITSs) are proposed neutrally buoyant training tools that would be used in NASA's Weightless Environment Training Facility (WETF), where astronauts are trained underwater to manipulate objects in zero gravitation. Heretofore, the training in the WETF has provided astronauts accurate simulations of visual conditions but has not addressed the feel of manipulating objects. The WETFITSs are intended to address the issue of feel; more specifically, each WETFITS would be designed so that its inertial properties underwater would approximate those of a simulated object with a specified mass and six degrees of freedom in zero gravitation. A WETFITS (see figure) could be sized to simulate any large mass to be manipulated in zero gravitation, could be designed and manufactured cost-effectively, and would be reusable.

In WETF practice that continues to this day, the neutral buoyancy needed to simulate zero gravitation underwater is achieved by attaching polystyrene foam and lead weights to astronauts, equipment, and mock-ups of simulated objects. In so doing, no attempt is made to approximate the masses and other inertial properties of simulated weightless objects and, as a result, astronauts usually do not get an accurate feel for handling the objects in zero gravitation.

The WETFITS concept eliminates the need for lead weights and polystyrene foam. Instead, one would use a volume of water to approximate an object with a specified mass and make it close to neutrally buoyant. A sphere was chosen for the shape of the volume to minimize the drag force created by moving the object through the water in any direction. The sum of (a) the mass of the water in the sphere and (b) the extra apparent mass from boundary-layer generation would approximate the mass of the simulated object. A WETFITS would include internal baffles to enable some simulation of rotational inertia.

This work was done by Kathryn M. Miller, Michael J. Stagnaro, Christophis Lovchik, Dominic DelRosso, and Pierre Thuot of **Johnson Space Center**. *No further documentation is available.*
MSC-22501



A **Typical WETFITS** would include a sphere sized to contain a mass of water nearly equal to that of a simulated weightless object. Internal baffles would help to approximate the rotational inertia of the object.

Increased Life for Steel-Slitter Guide Rolls

Wear-resistant sleeves are press-fit onto shafts.

Lewis Research Center, Cleveland, Ohio

There has been some success in continuing efforts to increase the service lifetimes of the guide rolls in hot-roll-slitter machines in the steel industry. In these machines, hardened knives are used to slice sheets of steel from large steel coils. The sheets are up to 0.375 in. (9.525 mm) thick and have various lengths and widths. A steel coil to be cut is positioned in a hot-roll-slitter machine by use of four guide rolls (two on each side) that spin as the steel passes between them on the way to the knives. The guide rolls are thus subjected to harsh grating and scraping conditions as well as high-pressure rubbing and friction as the coil is unwound to be sliced. Consequently, deep grooves are quickly worn into the guide rolls, making it

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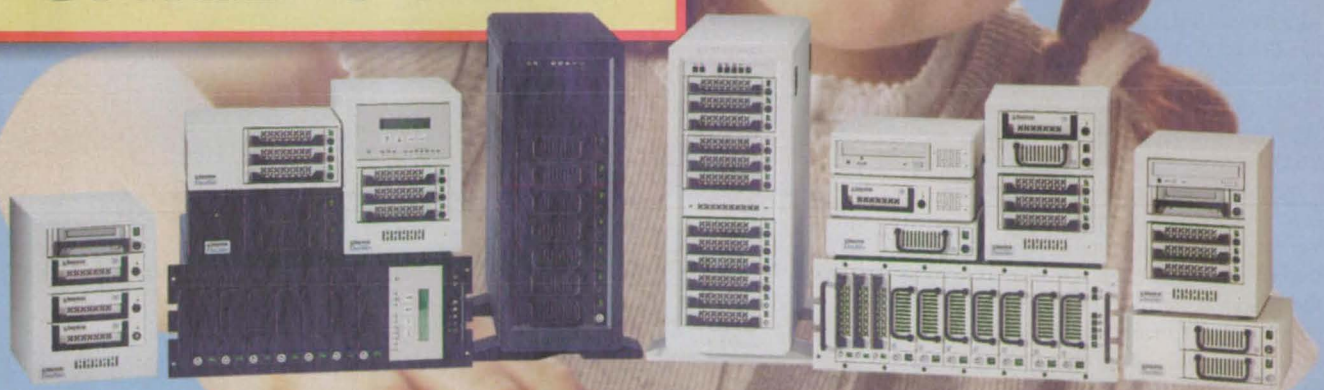

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For More Information Circle No. 525

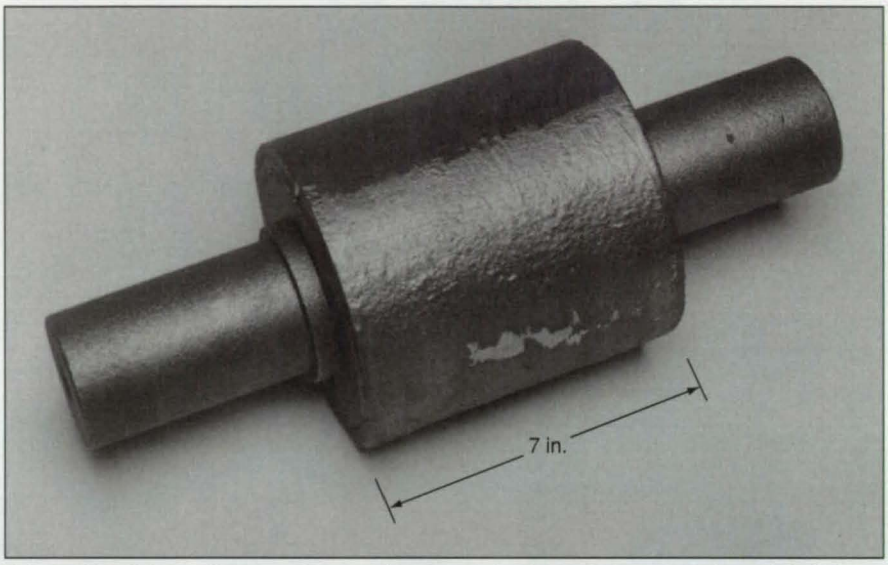
necessary to replace the guide rolls and thereby causing several hours of down time.

Guide rolls of modified design were constructed in an initial effort to increase the longevity and usefulness of the guide rolls and to reduce slitter-machine down time for changing of guide rolls. Each such guide roll included a shaft fabricated from 4140 steel, plus a sleeve that was machined, then pressed onto the shaft. A collar was added to key the sleeve in place. Then, to make the sleeve more resistant to wear, an abrasive-resistant material (PS-212) about 0.015 in. (0.38 mm) thick was plasma-sprayed onto the sleeve. In tests, the average life span of these rolls was found to be more than double that of rolls of the original, unmodified design. However, a new failure mode occurred; the coatings eventually became detached from the sleeves.

In a second modified design (see figure), each roll was equipped with a shell sleeve made from a more wear-resistant tool steel (D-2), which was machined and then heat-treated for longer wear life. In tests on slitter machines, the life spans of rolls of this second modified design were found to be increased by factors of at least four to five. In addition, the time needed to change the sleeves was reduced greatly, and the reduction in cost of changing sleeves (in comparison with changing entire rolls) was found to be substantial. Therefore, until a more-compatible coating can be found and proven advantageous in tests, rolls of the heat-treated shell-sleeve design are in use on the affected slitter machines, saving time and money.

This work was done by Richard Soltis and William Waters of Omni Corp. and Darryl Bruck of Diversity Manufacturing Co. for **Lewis Research Center**. *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16534.



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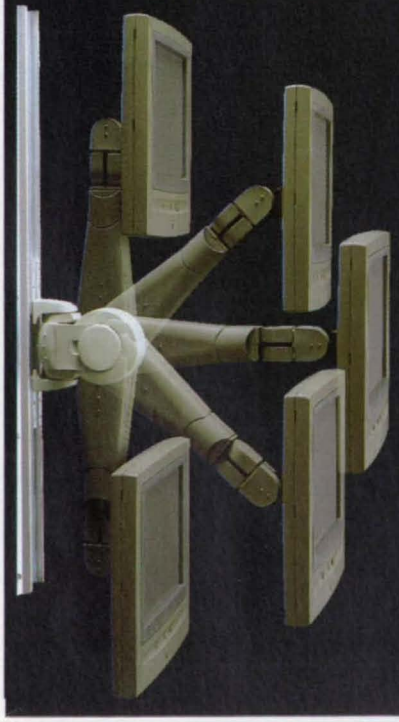

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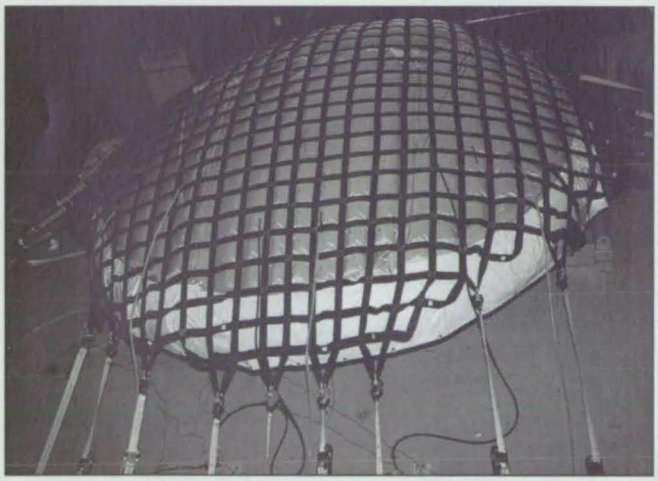
Applying Controlled Pressure Distributions to Complex Curved Surfaces

A straightforward technique involves airbags restrained by nets.

Lyndon B. Johnson Space Center, Houston, Texas

A technique for applying controlled test pressures to curved surfaces is based on a principle similar to that of a compartmented pilot's or astronaut's pressure suit. The technique involves the use of airbags that accommodate geometric complexity in both the surface under test and in the spatial variation of the pressure to be applied. This method also provides the enhanced capability to vary the pressure locally, refining the load distribution at the airbag interfaces.

Previous methods for applying pressure loads have involved the use of point-load actuators distributed over the test surface. In using this technique, especially with surfaces of complex curvature, the controllability of the actuators with respect to directions of the loads that they apply is limited and the concentrated load at the actuator locations is a poor approximation of the desired pressure distribution. In a technique similar to the present method, pressure is applied to the test surface via an airbag restrained by a negative mold of the surface. However, this technique requires the expense of constructing the mold and the mold leaves little flexibility to adapt to the variations in shape of the test surface.



An **Assembly of Airbags Restrained By a Net** applies pressure to an aerodynamic test surface — in this case, simulating aeropass loads on the surface of a spacecraft aerobrake.

In the present method, one or more airbags are restrained against the test surface by use of a custom-fitted net (see figure). The quantity, size, and inflation pressure of each of the airbags can be adjusted to obtain a sufficiently accurate approximation of the required pressure distribution. Airbag geometry is sized by the maximum deflection of the net and the deflections of the structure. The net system includes a means of adjustment to compensate for net stretching and control of net separation from the structure. Ratchet mechanisms secure the net to the ground or to a suitable framework and serve as means of adjusting preloads to control deflections of the airbags.

This work was done by Michael C. Eubanks, John J. Zipay, and Edgar O. Castro of **Johnson Space Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category,* ***or circle no. 156*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*
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For More Information Circle No. 415

Improved Lifetime for Stirling Cryogenic Coolers

Core-technology advances extend maintenance-free operating life of coolers to more than 50,000 hours.

Stirling Technology Company, Kennewick, Washington

A Stirling cooler is a mechanical system that approximates the ideal gas cycle. Often associated with airborne or portable cooling applications that require compact design and low input power, Stirling coolers are suitable for such applications because of their high efficiency. Compared to Gifford-McMahon and Joule-Thomson cycles, Stirling offers more than twice the cooling performance in the capacity range from 1-100 W. The coolers have a variety of military and commercial applications in infrared receivers and thermal imaging equipment.

Although Stirling coolers have been widely adopted for these applications, the cooler's life, typically less than 7500 hours, has prevented broad commercial use. Stirling Technology Company (STC) has developed a family of long-life coolers based on flexure bearings, clearance seals, and low-cost linear drive motors. Two NASA SBIR contracts, with Marshall Space Flight Center (solicitation year 1994) and Goddard Space Flight Center (solicitation year 1994) provided funding to advance the core technologies used in these coolers. A low-cost linear drive compressor and flexure bearings serve as the technology platform for STC's BeCOOL™ cryogenic coolers, capable of more than 50,000 hours of continuous operation with no maintenance.

Through the Goddard SBIR Phase II contract, STC was able to develop a low-cost, highly reliable linear-drive gas compressor. The compressor provides a 60-Hz pressure wave that drives the Stirling gas cycle. Dr. Syed Nasar, chairman of the electrical engineering department at the University of Kentucky, provided the theoretical design, while STC converted his design into hardware. The compressor is seen on the left side of Figure 1.

The special features that provide low-cost manufacturing and maintenance-free operation that were realized in this program are the following:

- Moving iron motor: The linear motor mover is iron and the magnets are

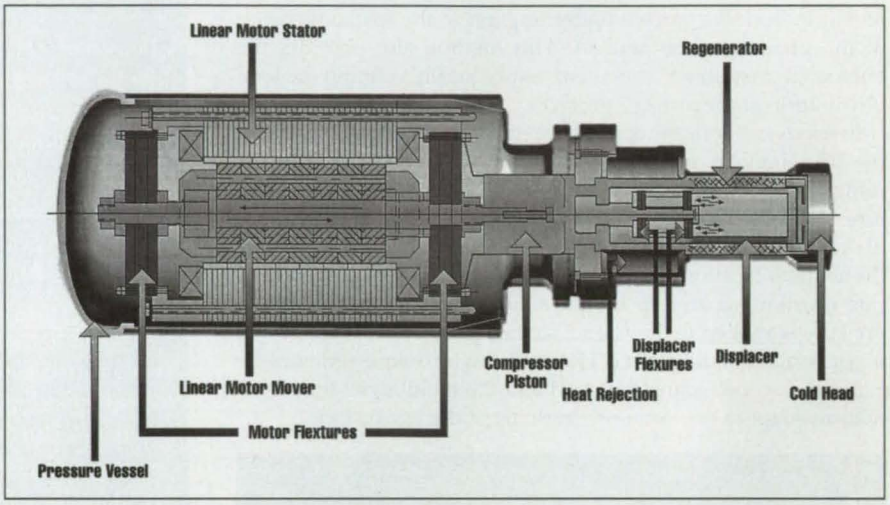

Figure 1. Components of Stirling's BeCOOL family of **Long-Life Cryogenic Coolers.**

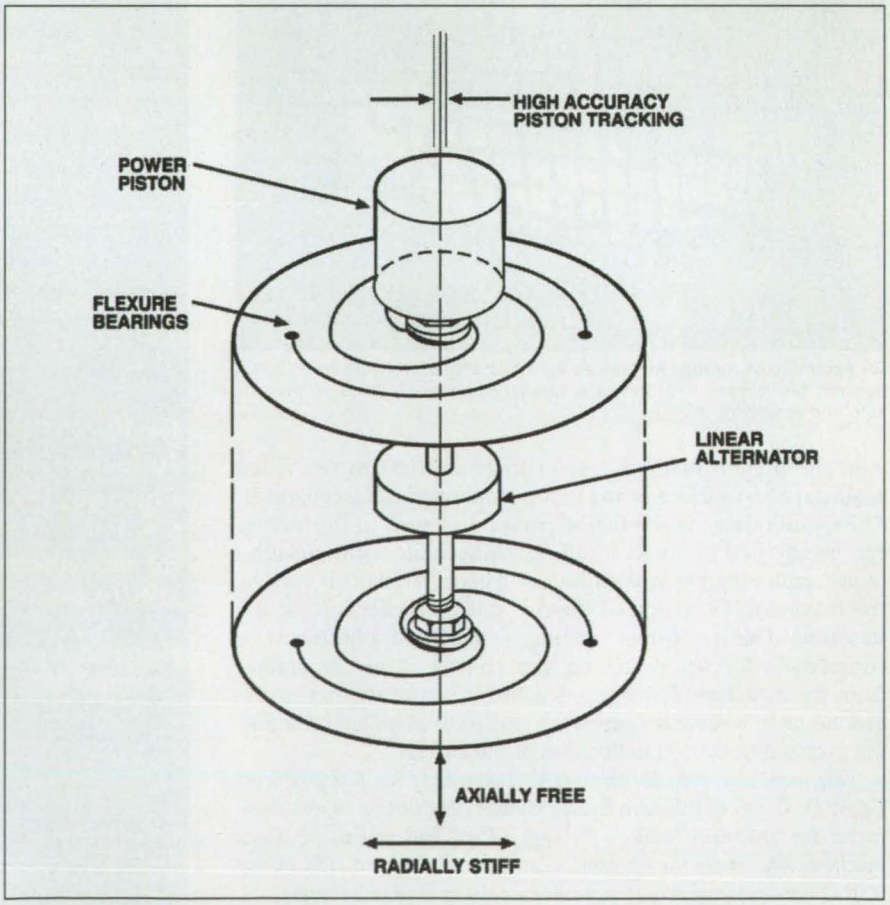

Figure 2. Design of the **Flexure Bearing.**

integrated into the stationary motor stator. In this configuration, the magnets are not exposed to cyclic motion that can induce cyclic stresses and cause demagnetization over time.

- Flexure bearings and clearance seals: The linear motor mover is supported by flexure bearings (see Figure 2). The flexures align the compressor piston along the longitudinal axis while preventing radial misalignment. This technique allows for the use of a clearance seal between the piston and the compressor housing. By using a very small clearance seal instead of a rubbing seal, there is no contact between the power piston and the compressor housing.
- Low-cost manufacturing: The linear drive compressor uses standard electric motor materials and fabrication methods. This technology is mature and very low in cost.

The use of flexure bearings in Stirling machines is a core technology that the company has been developing since its founding in 1984. Flexure bearings allow for axially free displacement while preventing radial movement (see Figure 2). This technique provides highly accurate piston tracking with no contacting parts. Since the flexures are essentially springs, they have simple mechanical configurations, and they can be accurately modelled. Flexure bearings are used in both the linear-drive compressor to support the motor mover and in the cold head to support the gas displacer. STC's bearing design is shown in Figure 2.

Overcoming price barriers and operating-life limitations allow BeCOOL to be used in a wide range of commercial applications. Since their introduction in 1996, the coolers have been sold for mainframe microprocessor cooling, ultralow-temperature biomedical freezers, and laser cooling. STC is actively pursuing new cooling applications in microwave communications and sensor devices. The combination of new cooling technologies and the emergence of new applications for ultralow-temperature cooling has enabled STC to establish a commercial production base for these coolers. Figure 3 shows the standalone laboratory model of the cooler. It provides 15 W of cooling at liquid nitrogen temperatures. The user can define a temperature setting or program a cooling cycle. All that is required to operate the machine is a 110-V electrical supply.

Figure 3. The **Standalone Laboratory Model of the Cooler.**

This work was done by **Stirling Technology Company**, *4208 W. Clearwater Ave., Kennewick, WA 99336, under NASA SBIR contracts monitored by* **Marshall Space Flight Center** *and* **Goddard Space Flight Center**. *For more information on the BeCOOL cooler design and product, contact Hank Crawford at hcrawford@stirlingtech.com.*

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For More Information Circle No. 416

Rapid Prototyping of Cast Metal/Fiber Composites

This process is a faster and more cost-effective method of prototype production.

Marshall Space Flight Center, Alabama

A rapid prototyping process enables the incorporation of continuous fiber reinforcement into a cast metal-matrix composite. In one older process, cast metal-matrix composites are made by introducing fibers or particles into molten or partially solidified metals, then casting the resulting slurries into molds. In an older process, masses of particles are preformed, then molten alloys are infiltrated into the masses. The alloys then freeze in the interstices, forming metal-matrix composites.

In the rapid prototyping process, fibers are inlaid into a wax model that is later shelled and cast. In a demonstration of the feasibility of the process, a fused-deposition apparatus was used to make a model tensile bar. For concept verification trials, the intervals between fibers were determined and grooves were carved into two tongue depressors at those predetermined intervals. Each tongue depressor was taped onto opposing ends of a sample wax model. A fiber was then placed into each groove of one tongue depressor and taped down. The fibers were then drawn across the build space and placed into the grooves of the tongue depressor on the other side and taped down. This resulted in a framelike structure made of the fibers strung between the two ends.

This framelike structure was removed from the wax model and another one constructed using the same method. The fused-deposition apparatus was preprogrammed to pause between successive layer-building processes to enable the innovators to construct another frame.

For these trials, emphasis was placed on the applicability of producing continuous-fiber-reinforced metal-matrix composites by rapid prototyping. Therefore, a simple alignment of fibers previously proven to strengthen the part being built was used. However, there is a need to incorporate metal-matrix composites into regular production parts, and not into tensile-test bars only.

Although these concept verification trials involved linearly aligned fibers, the innovators are currently working on conceptual designs for circularly aligned fibers.

This work was done by Floyd E. Roberts and Erica Dudley of the **Marshall Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing and Fabrication category,* ***or circle no. 192*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center; (205) 544-0021. Refer to MFS-31180.

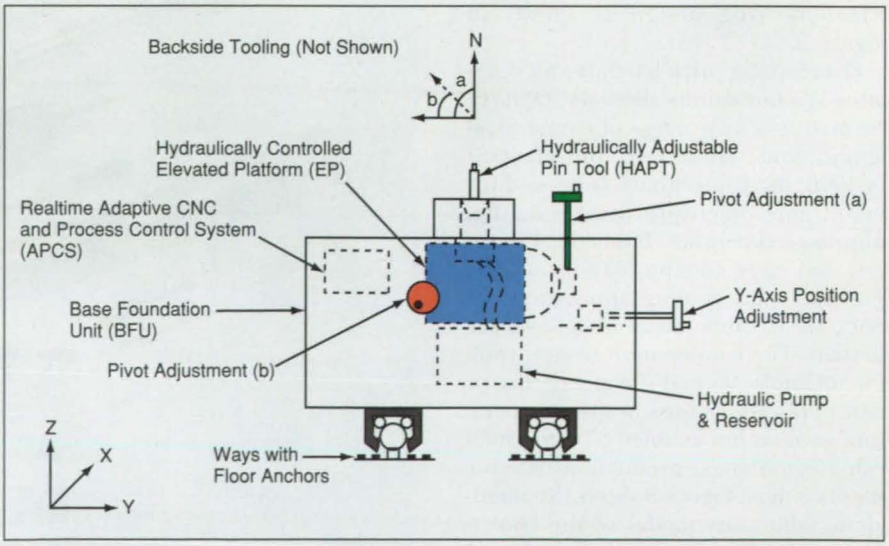
Friction Stir Weld System for Welding and Weld Repair

An improved apparatus takes the friction stir weld process to the manufacturing floor as a complete system.

Marshall Space Flight Center, Alabama

A friction stir weld (FSW) system for welding and weld repair can be used on the manufacturing floor, as well as in the laboratory environment. This FSW system can be used in a wide variety of welding and weld repair applications. It is capable of handling up to 6,000 pounds (26.7 kN) of axial load while operating within close tolerances.

This FSW system includes seven subcomponents: a base foundation unit (BFU), a hydraulically controlled elevation platform (EP), the hydraulically adjustable pin tool (HAPT), backplate tooling, fixturing, a roller mechanism, and the real-time adaptive computer numerical control (CNC) and process control system (APCS). Together, these subcomponents allow the FSW to be used on the manufacturing floor as a complete welding system.



The Subcomponents of the Friction Stir Weld System for welding and weld repair function as one integrated welding system.

The BFU is unique to accommodate the internal mechanical entities of the system. It is designed to operate under the radial and axial loads associated with the FSW process. The hydraulically controlled EP is the result of novel applications of existing technologies to create an elevation feature with three axes of movement, specially designed to function under operating pressures. This movement is necessary to attain the proper pin tool location with respect to the center of the weld joint. The HAPT is a standalone piece of hardware, which was integrated into the FSW system. (However, the positioning of the a & b axis around the N axis is unique.) The APCS component was specially designed to function as an integrated controller for a variety of functions and data gathering operations.

The novelty of the FSW System for welding and weld repair is the fact that the seven subcomponents act as one integrated welding system. This system has unlimited applications in manufacturing where welded structures are vital to the fabrication cycle. This apparatus provides the capability for initial welding and weld repairs of friction stir welds and fusion welds.

This equipment is extremely energy efficient. A single-pass, 12.5–mm deep weld can be made in 6xxx series alloy using a gross power of no more than 3 kW. Also, the maintenance of this equipment is minimal, requiring no special operation or operator maintenance training. In addition, this machine tool is ideally suited to automation and integration with other machine-tool operations.

Another advantage of this system and its mode of operation is that there is no need for such consumables as filler wire or the shielding gas that is needed for welding aluminum alloys.

With this system, it is possible to make butt- and lap-seam welds between wrought, cast, and extruded materials, leading to simplification of manufacture.

Finally, the FSW process is a clean process, producing none of the health hazards such as welding fumes or radiation.

This work was done by Jeff Ding of **Marshall Space Flight Center**, *Peter L. Romine of Florida International University, and Peter A. Oelgoetz of Boeing North American, Inc. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing and Fabrication category,* ***or circle no. 198*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*
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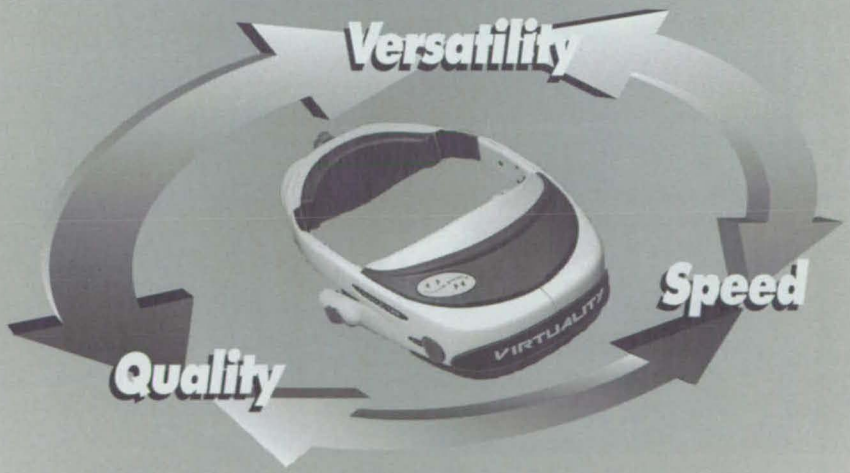

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Chemiluminescent Quantitation of Organic Compounds in Water

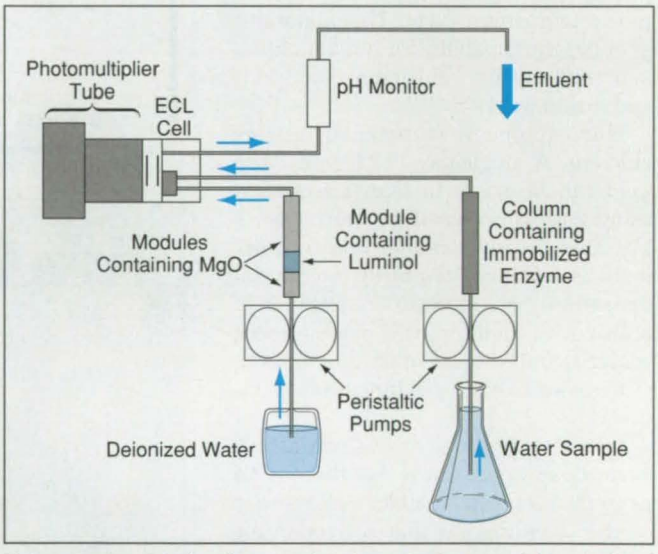
Electrocatalyzed reactions generate light indicative of concentrations of selected compounds.

Lyndon B. Johnson Space Center, Houston, Texas

A method of measuring the concentration of a selected organic compound (analyte) in a sample of water involves (1) producing hydrogen peroxide as a byproduct of enzyme-catalyzed oxidation of the analyte, (2) producing light in an electrocatalyzed reaction of the hydrogen peroxide with luminol, and (3) measuring the intensity of this light. The method could prove useful in a variety of applications, including water-purification systems, closed environmental life-support systems, bioreactors, and other biotechnological systems.

The luminescent reaction is effected by feeding two aqueous streams into an electrocatalyzed-luminescence (ECL) cell (see figure). One stream carries luminol dissolved from a bed of luminol crystals. The rate of dissolution of luminol from the bed and the concentration of luminol in the water is maintained at the desired level by maintaining the pH of the water at 10.3; for this purpose, the flow of water is directed through basification modules containing MgO, both upstream and downstream of the luminol bed. (Rebasification downstream of the luminol bed is necessary because the dissolution of luminol neutralizes the solution.)

The other aqueous stream that flows into the ECL cell contains the analyte. If the analyte is H_2O_2, then this stream is fed directly to the ECL cell without further treatment. If the analyte is an organic compound or compounds, then this stream is first passed through a column containing an immobilized enzyme that catalyzes the oxidation of the analyte. For example, if the analyte is ethanol, then the enzyme is alcohol oxidase. The effluent from the column thus contains the products of the enzyme-catalyzed oxidation, including H_2O_2.



Light Is Produced in the electrocatalyzed reaction between (a) luminol and (b) H_2O_2, which is introduced into the sample stream by the enzyme-catalyzed oxidation of the analyte. The amount of light emitted is approximately proportional to the concentration of the analyte in the sample stream.

The two streams are mixed in the ECL cell. A controlled voltage across the cell catalyzes the oxidation of the luminol by hydrogen peroxide from the sample stream. A photomultiplier measures light emitted by this reaction. The intensity of this light is approximately proportional to the concentration of the analyte in the sample.

This work was done by Charles E. Verostko of **Johnson Space Center** *and James E. Atwater, James R. Akse, Jeffrey DeHart, and Richard R. Wheeler, Jr., of Umpqua Research Co. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Life Sciences category,* ***or circle no. 111*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*

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, Johnson Space Center; (713) 483-4871. Refer to MSC-22605.

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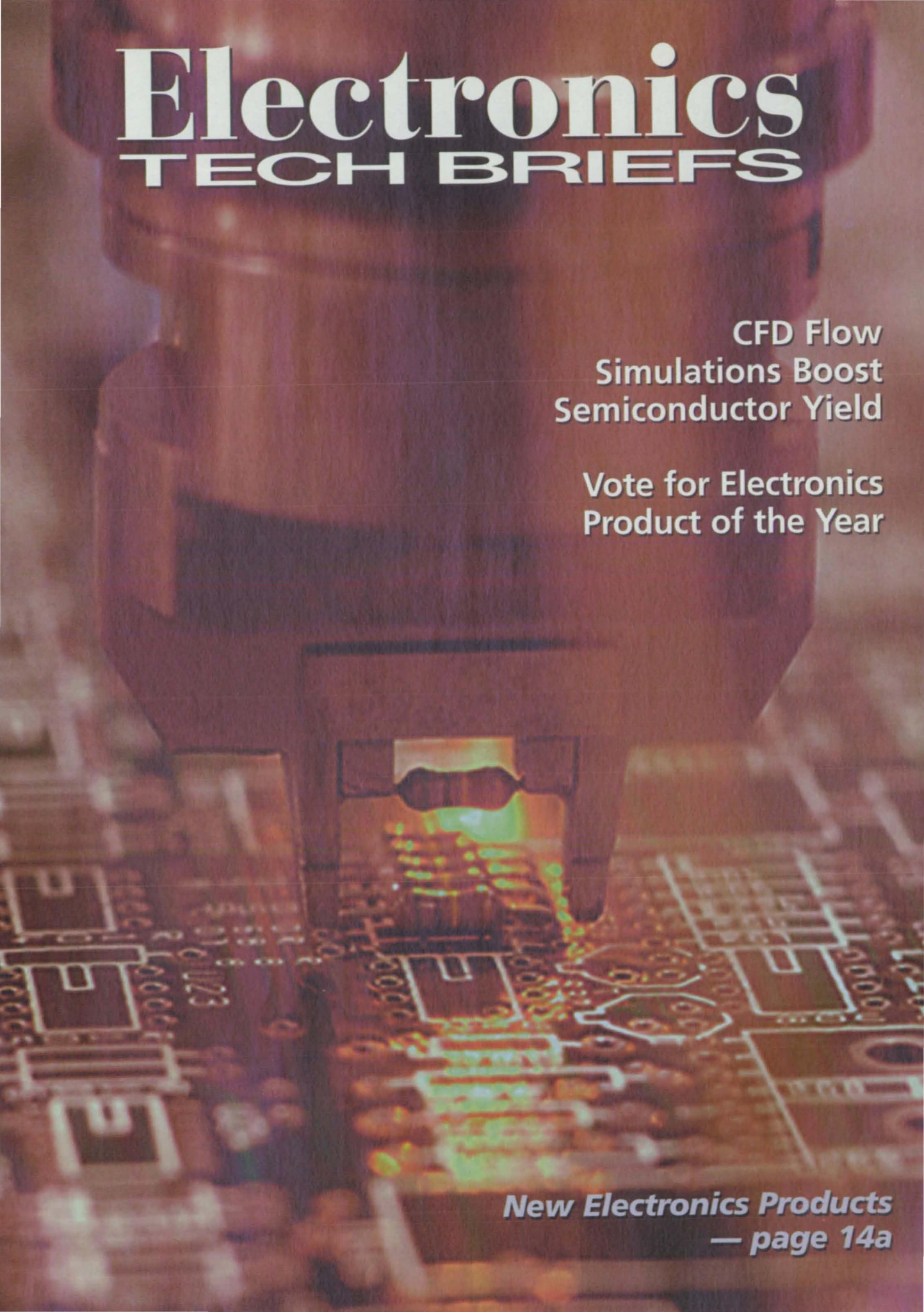

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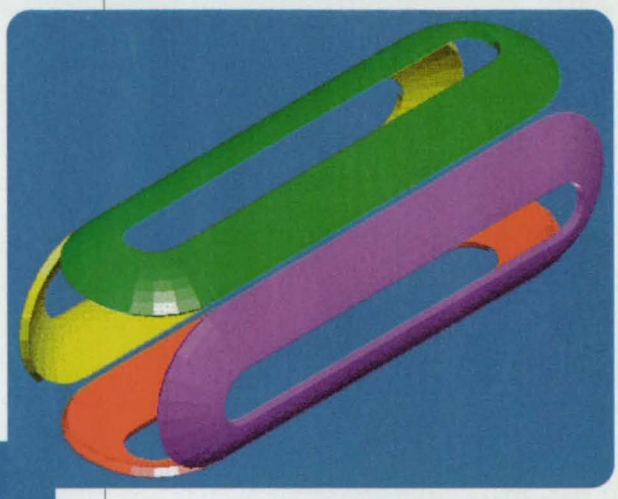

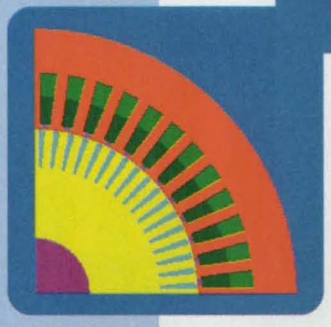

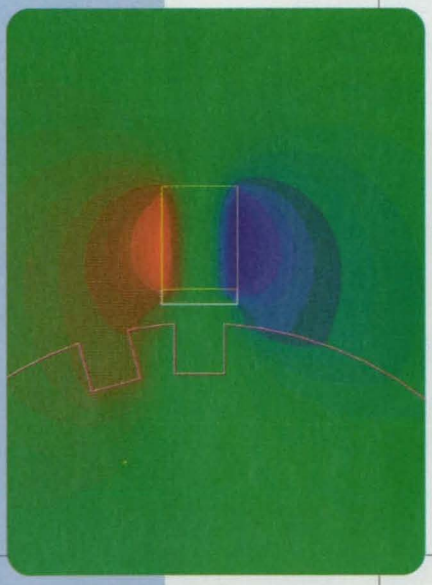

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CONTENTS

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National Instruments, Austin, TX, produces a full range of machine vision and motion control boards and software for a variety of applications, including automated microcircuit chip and part placement, component alignment, and inspection control, industrial motion control, and laboratory automation. This month the company expands its line with IMAQ Vision 4.1.1 machine vision and image processing software, suitable for industrial machine vision and scientific imaging applications, as well as factory and laboratory automation operations. See "Product of the Month" in "New Products," page 14a.

NEWS BRIEFS

Notes from Industry and the Federal Laboratories

FLIR Systems Inc., of Portland, OR, announced last month that its planned acquisition of **AGEMA Infrared Systems** of Stockholm, Sweden, had been approved by shareholders in a transaction valued at about $80 million. The merger creates the world's largest commercial infrared imaging company. FLIR Systems stockholders voted early in December to issue approximately 4.2 million shares of the company's common stock to AGEMA's parent company, **Spectra-Physics AB**, in exchange for which FLIR Systems received all outstanding shares of AGEMA stock. AGEMA specializes in advanced infrared thermal imaging and measurement products for industrial applications and selected applications for government. FLIR Systems designs, manufactures, and markets imaging systems worldwide for applications including public safety, defense, navigation and environmental protection.

OrCAD, of Beaverton, OR, a leading provider of electronic design and analysis (EDA) tools for the Intel®/Microsoft® platform, announced that it had signed a definitive merger agreement with **MicroSim® Corp.**, of Irvine, CA. MicroSim supplies PC-based analog and mixed-signal simulation software for designing printed circuit board (PCB) systems. After the merger, OrCAD plans to offer an expanded line of EDA products and services for system design. About 2.5 million shares of OrCad common stock will be issued in the merger. The transaction is subject to the approval of shareholders of both companies at meetings that were scheduled to take place last month. It is also subject to applicable government approvals, including that of the Securities and Exchange Commission.

OrCAD will retain MicroSim's existing Irvine facility and operate it primarily as a product development center.

Raytheon TI Systems Inc. (RTIS) of Plano, TX, formerly Texas Instruments Defense Systems and Electronics, recently received a $3 million three-year contract from the **U.S. Air Force Rome Laboratory**, Rome, NY. RTIS is teamed with Cae Soft Corporation in Rockwall, TX, and the Hughes Dayton Engineering Office, OH, to provide "advanced technology for space-time adaptive processing (STAP) modeling."

Rome Labs has been developing STAP simulation capabilities for the last five years in an airborne radar (pulse-Doppler) simulation called the Rome Labs Space-Time Adaptive Processing Algorithm Development Tool (RLSTAP/ADT). Last year RTIS was awarded, and is currently executing, a contract from Rome Labs to add Higher Order Effects (HOE) to RLSTAP/ADT. These effects include radome and airframe interaction. RTIS was positioned well for its newest contract through answering the lab's needs in connection with the HOE contract.

When finished, RLSTAP will be a complete radar system simulation in the areas of pulse-Doppler, synthetic aperture radar, slow ground-moving targets, and electronic countermeasures/electronic counter-countermeasures.

The **National Institute of Standards and Technology (NIST)** has developed a technique called near-field scanning optical microscopy (NSOM) that it calls an emerging method combining the nondestructive advantages of optical microscopy with nanometer-scale resolution near that of atomic force or electron microscopes. Working in collaboration with researchers at the University of Virginia and the Naval Research Laboratory, the NIST physicists devised an instrument that channels laser light through a fiber optic probe, scanning it about 10 nm above a sample surface, and then collects it on the other side. An opening at the tip of the probe is about 50 nm wide, smaller than a wavelength of visible light but large enough for a small portion of the radiation to escape.

NIST says the new technique should be useful for measuring nanometer-scale optical properties of waveguides and other fiber optic communications components, as well as for viewing delicate biological samples and for characterizing nanometer-scale structures and defects during semiconductor manufacture.

Advanced Refractory Technologies Inc. (ART), of Buffalo, NY, has been awarded a Phase I Small Business Technology Transfer (STTR) contract by the **National Science Foundation (NSF)** to work on a proposal entitled "Field Emission Displays Based upon Diamond-Like Nanocomposite Films." ART and the Center for Advanced Thin Film Technology at the State University of New York, Albany, will join forces to optimize the electronic properties of ART's proprietary Dylyn® for use as a cathode material in field emission displays (FEDs). ART expects that distinct technological advantages of diamond-like composites over existing low-field thin-film cathode technologies will be demonstrated during the Phase I effort.

CFD Flow Simulations Improve Semiconductor Yield

Intra-industry cooperation follows a SEMATECH research report

SEMATECH researchers recently demonstrated how semiconductor manufacturers could increase yield in a popular industry reactor. Originally, semiconductor manufacturers asked SEMATECH to investigate why wafers were contaminated during a cleaning operation. Computational fluid dynamics (CFD) was used to analyze flow patterns to determine operating conditions that eliminate flow recirculation zones believed to be causing contaminants to be deposited on the wafer. With a better understanding of the flow, researchers were able to reduce the recirculation zones and remove them as a potential source of contamination.

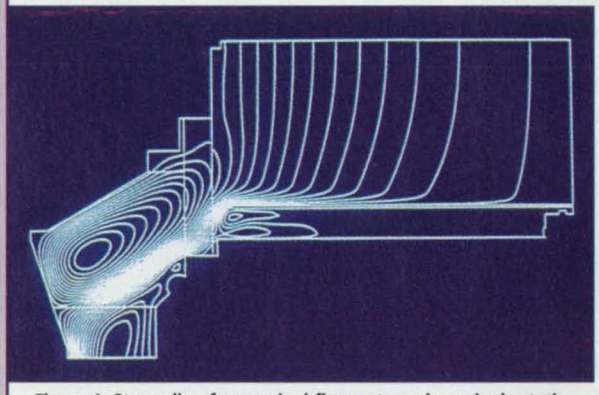

Figure 1. Streamline for nominal flow rate and nominal rotation.

SEMATECH (SEmiconductor MAnufacturing TECHnology) was founded in 1987 as a consortium of American semiconductor manufacturers working with government and academia to sponsor and conduct research aimed at assuring leadership in semiconductor manufacturing technology for U.S. industry. SEMATECH is a nonprofit organization that develops advanced semiconductor manufacturing processes, materials, and equipment and validates its research in a "proofing" facility that simulates its members' production lines. Results of this research are transferred to consortium members who use it for commercial and military applications. SEMATECH's mission is to solve the technical challenges required to keep the U.S. number one in the global semiconductor equipment industry.

SEMATECH has strong ties to U.S. suppliers belonging to SEMI/SEMATECH and closely cooperates with the Semiconductor Research Corporation. Its members include: Advanced Micro Devices Inc., Lucent Technologies Inc., Digital Equipment Corp., Hewlett-Packard Co., Intel Corp., IBM Corp., Motorola Inc., National Semiconductor Corp., Rockwell International Corp., and Texas Instruments Inc.

The reactor in question uses etchants to remove residual process materials from silicon wafers. The wafer is placed in the reactor close to a diffusive screen by which the etchant gases are introduced. The reactor is also designed to introduce distilled water and nitrogen for wafer rinsing and drying, respectively.

The problem encountered by the SEMATECH member companies that use this type of equipment involved contaminants found on the wafers. SEMATECH researchers surmised that recirculation patterns within the reactor were causing this phenomenon, and ran a number of computer simulations with the CFD code in an attempt to validate the hypothesis. These flow simulations varied the amount of chemical reactants used, wafer handling methods, nitrogen flow rate, amount of water used for rinsing, and other possible factors in order to identify the source of the problem. The results showed no clear pattern.

SEMATECH asked CFD Research Corporation of Huntsville, AL, to simulate the operation of the reactor using their CFD-ACE CFD software. The CFD analysis process began with obtaining shop drawings of the reactor. CFD Research analysts digitized these drawings and ran meshing routines that automatically generated the analysis grid. The model was constructed in three different versions with varying levels of complexity, resulting in 30,000, 60,000, and 90,000 cells. After some experimentation, it was decided to use the 30,000-cell model for most subsequent runs because it offered the best blend of accuracy and fast solution times on an IBM RS/6000 workstation. A key advantage of CFD-ACE in this application is that it offers a complete three-dimensional body-fitted coordinate model of the system. For a geometry as complex as this one, most other CFD codes would have either used a 2D model or approximated the geometry with orthogonal grids.

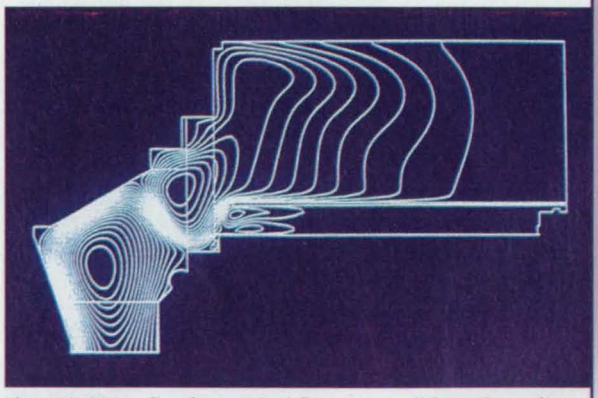

Figure 2. Streamline for nominal flow rate and three times the nominal rotation.

The CFD-ACE analysis showed recirculation patterns that might be responsible for depositing particles back onto the wafer. At the flow rates typically used for production runs, the model showed that gases could back up rather than exit smoothly through

the exhaust port as was intended. SEMATECH and CFD Research engineers collaborated on a sequence of analysis runs designed to determine the sensitivity of the results to the different variables mentioned above. These parametric studies showed the key variables affecting the flow fields and provided data on key relationships between variables. Figures 1 through 3 show typical plots of variables. The analysts developed a chart that showed optimal settings for key variables within the reactor.

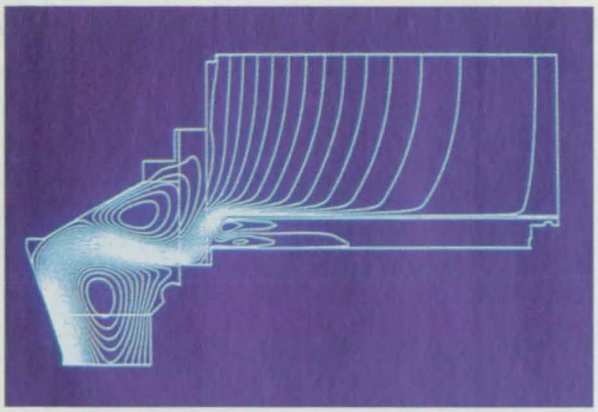

Figure 3. Streamline for five times the nominal flow rate and three times the nominal rotation.

For SEMATECH member companies, the new recommendations and operating protocols resulting from the CFD-ACE model made it possible to quickly and inexpensively eliminate a potential source of contamination within the reactor. For the reactor's manufacturer, the model also enabled CFD Research analysts to suggest areas of potential improvement, including design changes, procedural variations, etc. For example, CFD researchers were able to model and recommend optimized wafer handling, gas diffusion, and etching processes that all promised improved yields. The manufacturer of the reactor was so impressed with the results of the simulation that they are integrating them into their own ongoing research and development efforts. This type of cooperation and follow-on is exactly what is desired at the conclusion of a SEMATECH research project. Overall, this investigation demonstrates the potential of CFD technology to improve yields and reduce cycle time in a wide range of semiconductor applications.

Several years ago, SEMATECH instituted a benchmarking program intended to evaluate the performance of leading CFD software packages for semiconductor manufacturing applications. The key applications that were used were rapid thermal processing and chemical vapor deposition. The purpose of this study was to evaluate the accuracy and ease of use of the programs. SEMATECH wrote reports on each of the leading packages used in the semiconductor manufacturing industry. The benchmarking studies concluded that all such programs have individual strengths and weaknesses and that none could be recommended as an across-the-board solution.

A key advantage of CFD-ACE that was highlighted in these tests was its ability to model stiff chemical reactions in complex processes, such as chemical vapor deposition. This refers to its ability to simulate a scenario in which there are a number of different chemical species undergoing gas-phase surface reactions. In this situation, the differences in the rates of the different reactions can be critical to an accurate solution.

This work was reported by Franz Geyling, fellow of the technical staff, and Roger Hill, modeling engineer, of **SEMATECH Corp.,** *Austin, TX, and Anantha Krishnan, group leader,* **CFD Research Corp.,** *Huntsville, AL. For more information, contact CFD Research Corp., 3325 Triana Blvd., Huntsville, AL 35805; (205) 536-6576; fax: 205-536-6590; web site: http://www.cfdrc.com.*

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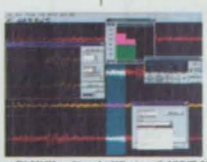

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Photoelectrochromic "Smart" Windows and Displays

A self-powered, self-controlled device is ideal for architectural glass and other uses.

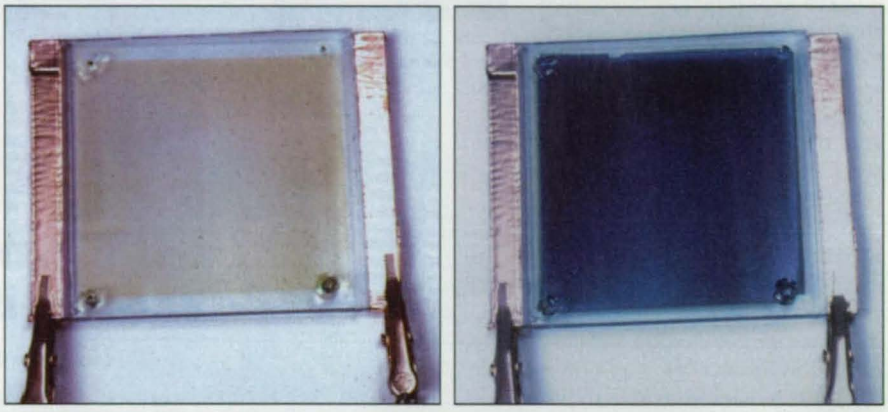
National Renewable Energy Laboratory (NREL), Golden, Colorado

Electrochromic devices change color and light transmissivity upon application of an electric charge. As such they should prove valuable as "smart" windows that can reduce air-conditioning costs by being darkened to absorb sunlight and reject unwanted solar heat. The biggest drawback is the cost of providing a power source and controls for the windows. NREL researchers have worked on various ways of self-powering electrochromic windows with solar cells or photovoltaic (PV) films (also available for licensing). A recent development is a new form of self-controlled and self-powered photoelectrochromic system that integrates the photovoltaic and electrochromic elements into a single device.

Recent advances in the field of photoelectrochemistry have produced technology for liquid-junction solar cells that could potentially compete with solid-state semiconductor PV technologies. Nanocrystalline titanium dioxide film, normally only responsive to ultraviolet light, is coated with a dye that both reduces corrosion of the TiO_2 electrode and sensitizes it to a broad spectrum of visible light. In response to light, this dye injects electrons into the TiO_2, replacing them with electrons from an iodine solution electrolyte. The iodine absorbs electrons at the counter-electrode, completing the electrical circuit and maintaining a stable chemical balance.

Seeing that this technology could be complementary to electrochromics, NREL researchers coated the counter-electrode with tungsten trioxide electrochromic film and added lithium (electrochromic darkening occurs when an electrical charge drives the small lithium cations into the lattice of the WO_3) to the electrolyte solution. The result is a single-element device—requiring no external power source or sensors—that darkens when exposed to sunlight and clears when no longer sunlit. Unlike simple photochromic reactions, such as photogrey glasses, however, there are two separate processes involved, and both the photovoltaic and electrochromic processes can be optimized and adjusted. Also, because both darkening and clearing occur as a result of a complete electrical circuit, either state can be preserved by breaking the circuit with an external switch.

The TiO_2 electrode and WO_3 electrochromic film can be easily applied to commercially available tin-oxide-coated (electrically conductive) glass, so that NREL's photoelectrochromic technology should lend itself to inexpensive mass-production processes. With an electrolyte layer that is thin relative to the cell area, the electrochromic reaction is confined to areas that are directly illuminated. This makes it possible to use the technology for optical displays or optical switches as well as for smart windows. NREL is seeking industrial partners—most likely glass or thin-film manufacturers—to help perfect and commercialize this highly promising technology.



The **Photoelectrochromic Cell** turns from its bleached, largely transparent state (left) to its dark blue sunlight-blocking state within about a minute of exposure to bright light, and reverts to its bleached state within a few minutes after the light stops. Disconnection of the circuit with an external switch would allow, for example, the opaque state to be maintained for a day or the bleached state for the winter season.

The lead researcher for development of photoelectrochromic technology is Brian Gregg of the **National Renewable Energy Laboratory.** *Inquiries concerning rights for commercial use of this invention should be directed to NREL's Business Venture Center; (303) 275-3038; E-mail: technology_transfer@nrel.gov.*

Reducing Surface Leakage Currents in FPAs of QWIPs

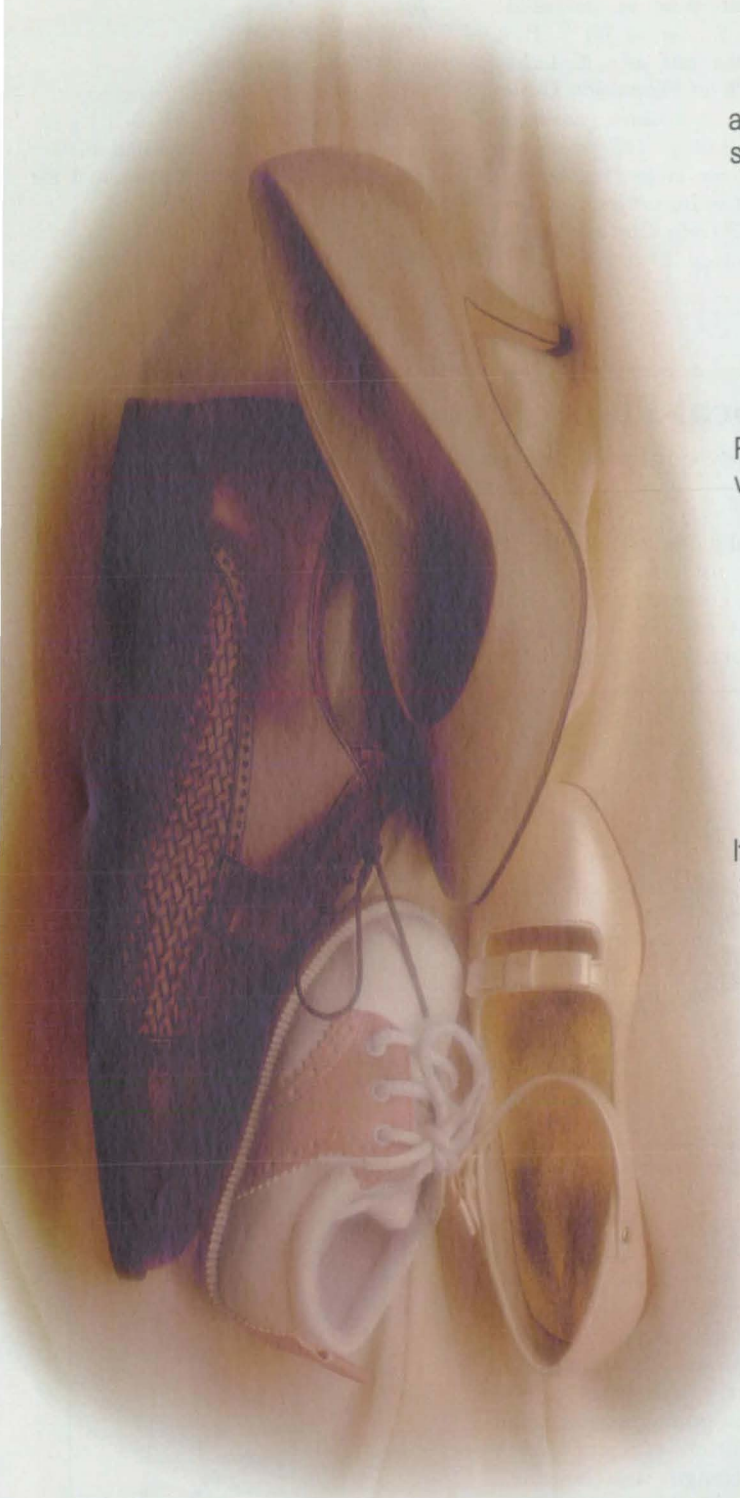
Total dark currents could be reduced substantially.

NASA's Jet Propulsion Laboratory, Pasadena, California

Chemical surface treatments during fabrication have been proposed to reduce surface leakage currents in focal-plane arrays (FPAs) of quantum-well infrared photodetectors (QWIPs). For reasons explained below, if most or all of the surface leakage currents could be eliminated by such treatments, then total dark currents could be reduced to about 1/4 or 1/5 of their original values.

The surface leakage current of a QWIP is a component of its dark current and is proportional to its circumference. The other components of the dark current of a QWIP originate within the bulk of its material and are proportional to its area. By fundamental geometry, the ratio between circumference and area is inversely proportional to width. Thus, as a QWIP is made narrower to incorporate it into a FPA, the ratio between its surface leakage current and the other components of its dark current increases. At the typical lateral dimensions (40 by 40 μm) of a QWIP in an FPA, the surface leakage current is about 4 times the total of all the other components of dark current; that is, the surface leakage current constitutes about 4/5 of the dark current.

Since the earliest days of solid-state electronics, it has been recognized that



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surfaces and interfaces play a decisive role. Solid-state electronic devices are uniquely sensitive to electrically active surface sites, even at concentrations as small as one part per million. Electrically active surface sites originate in unsatisfied covalent bonds. By satisfying all covalent surface bonds, one could shift surface electron-energy states out of the band gap and into the valence and conduction bands, thereby reducing the surface leakage current. The proposed surface chemical treatments are intended to satisfy the covalent bonds. They include treatment of open surfaces with inorganic sulfides (e.g., LiS_2, NH_4S, or $Na_2S{\cdot}9H_2O$) or using NH_4OH wet chemical etch to define mesas and passivating open areas with SiN.

This work was done by Sarath D. Gunapala, Mani Sundaram, Jin S. Park, Sumith V. Bandara, and John K. Liu 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 Circuits category,* ***or circle no. 136*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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Refer to NPO-19669, volume and number of this NASA Tech Briefs *issue, and the page number.*

Cross-Grating Coupling for Focal-Plane Arrays of QWIPs

Narrow-band coupling with increased efficiency could be achieved.

NASA's Jet Propulsion Laboratory, Pasadena, California

Cross-diffraction gratings have been proposed to provide optical coupling to quantum-well infrared photodetectors (QWIPs) in focal-plane arrays (FPAs). The cross-grating coupling scheme is intended to enhance optical coupling (and thus increase quantum efficiency) within narrow spectral bands; this would make it possible to construct improved wavelength-selective infrared-imaging instruments for a variety of scientific, industrial, and military applications.

The structure of a QWIP FPA poses an optical-coupling problem because of a confluence of three considerations:

1. The direction through the thicknesses of the quantum wells is perpendicular to the focal plane;
2. Quantum selection rules allow the detection of only that part of the incident light that is electrically polarized along the direction through the thicknesses of the quantum wells and thus perpendicular to the focal plane; and
3. The light to be detected is incident along directions approximately perpendicular to the focal plane, and thus only a small fraction of it is electrically polarized along the thicknesses of the quantum wells.

Heretofore, the coupling problem has been solved by use of random reflectors, which provide reasonable coupling efficiency over a broad spectral band. Like random reflectors, crossed diffraction gratings would effect the desired conversion of polarization via scattering; however, the inherent periodicity of a diffraction grating could be exploited to enhance conversion at a desired wavelength. The design of a cross grating for this purpose involves the following mathematical model (see Figure 1): The grating is considered to be a perfectly electrically conductive slab with a rectangular array of holes through its thickness, and each hole is regarded as a waveguidelike cavity. The task is to choose the dimensions of the grating to maximize the power diffracted, at the desired wavelength, from a normally incident beam into waveguide modes with through-the-thickness polarization.

In a preliminary assessment of the utility of the cross-grating concept, the absorption quantum efficiency as a function of wavelength was computed for a QWIP FPA of 30-by-30-μm pixels with a cross grating optimized for a wavelength of 8.4 μm and light incident through f/2.3 optics. The result of this computation was compared with the measured quantum efficiency vs. wavelength of the same QWIP with a 45°-polished-edge reflector instead of a cross grating. As illustrated in Figure 2, the computation predicted that the use of the cross grating would increase the quantum efficiency at the wavelength of 8.4 μm wavelength and would reduce the width of the spectral pass band.

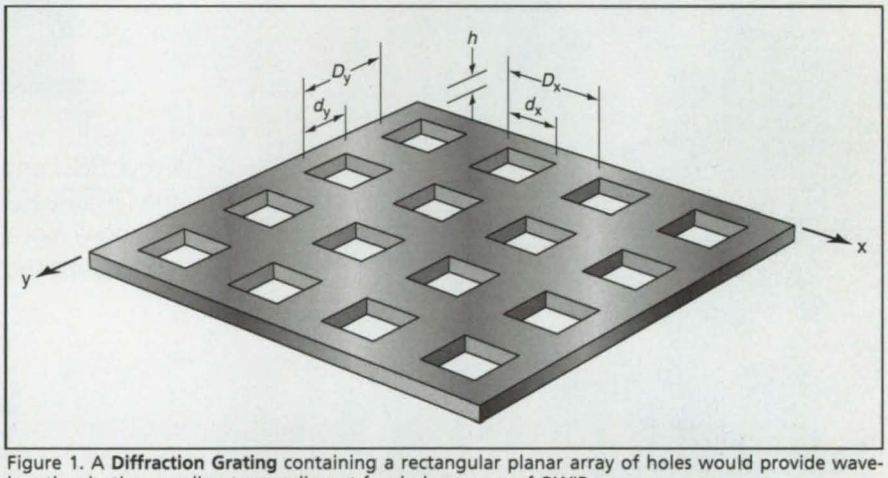

Figure 1. A **Diffraction Grating** containing a rectangular planar array of holes would provide wavelength-selective coupling to an adjacent focal-plane array of QWIPs.

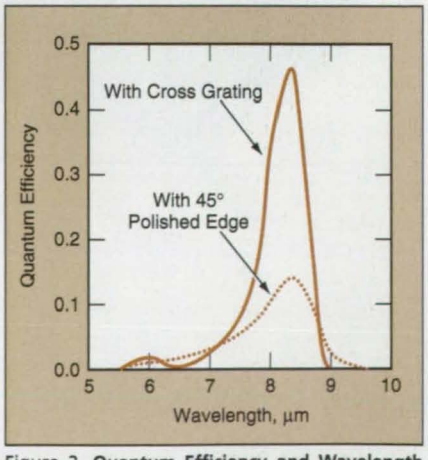

Figure 2. **Quantum Efficiency and Wavelength Selectivity** would be increased by use of an optimized cross grating instead of a 45°-polished-edge reflector.

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Leaping Ahead...RIB-IT II, the FLC's second Re-invention Initiative Between Industry and Technology national technology search program, has identified 36 potentially commercial technologies. Chosen from 433 SBIR Phase II nominations from federal labs and contractors all over the US, these innovations — representing all subjects — will be evaluated at the first level (RIB-IT View report).

All Winners... Twelve finalists will be selected from the 36 for the in-depth reports, including business plans and partnership assistance. All strong candidates with market potential — *partnership opportunities* — will be compiled into a book, available in spring 1998. The most commercially promising technologies from RIB-IT I are described in *The RIB-IT Views, 38 Model Technology Assessments and Partnership Opportunities.* For a *free* copy, E-mail flc@zyn.com.

This work was done by Sarath D. Gunapala and Sumith V. Bandara of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Electronic Components and Circuits category,* ***or circle no. 137*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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Refer to NPO-19657, volume and number of this NASA Tech Briefs *issue, and the page number.*

Two-Wavelength Focal-Plane Array of QWIPs

One device could image the same scene at two wavelengths simultaneously.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed focal-plane array (FPA) of quantum-well infrared photodetectors (QWIPs) would exhibit peak response at two wavelengths. Heretofore, single-focal-plane arrays of photodetectors optimized for two or more wavelengths have not been available. This FPA is intended to be a prototype of multispectral imaging devices for a variety of scientific, industrial, and military infrared instruments.

In the proposed device, the two-wavelength-peak response would be achieved by use of a multiple-alternating-quantum-well structure in $Al_xGa_{1-x}As$ photodetectors (see Figure 1). This structure would comprise 50 periods of alternating quantum wells. The energy depth and geometric thickness of the first well in each period would be optimized to obtain peak response at a wavelength of 8.5 μm; the corresponding parameters of the second well in each period would be optimized for peak response at a wavelength of 10.5 μm. The quantum wells would be separated by $Al_xGa_{1-x}As$ barriers 500 Å thick.

To prevent additional quantum reflections in the continuum transport band at the locations of the barriers, all the barriers would have to be of the same energy height and thus fabricated with the same proportion (x) of aluminum. The wells for 8.5-μm peak response would be made of GaAs. The wells for 10.5-μm response, being of a different energy depth, would have to be made with a different proportion (y) of aluminum.

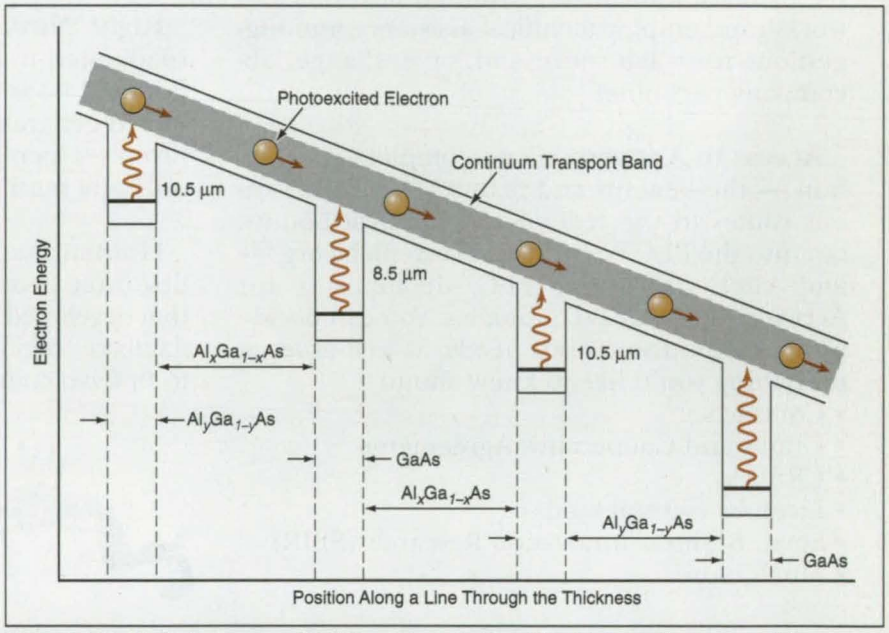


Figure 1. This **Multiple-Quantum-Well Structure** is designed to obtain peak response at two wavelengths and to provide a smooth continuum transport band (to prevent quantum reflections at the barriers).

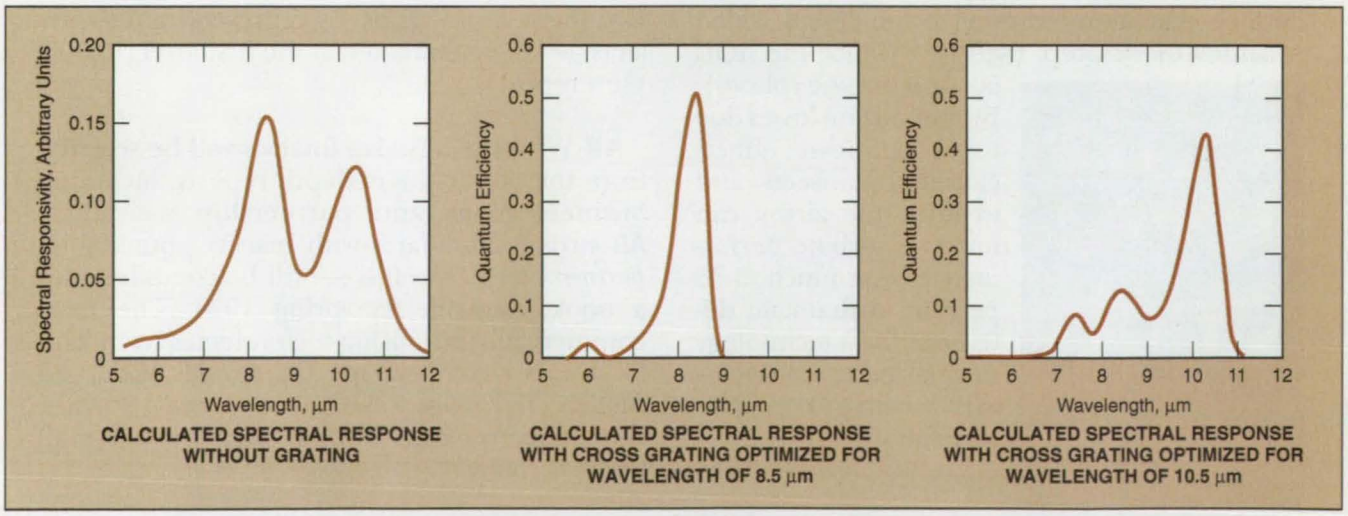
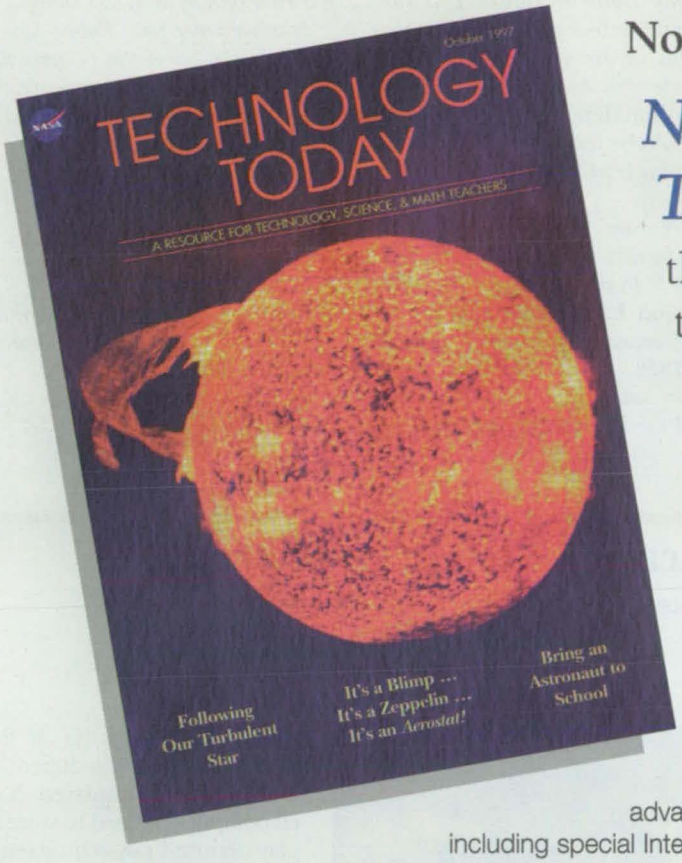


Figure 2. The **Two-Peak Spectral Response** of the proposed QWIP could be changed to single-peak responses by cross diffraction gratings.



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The left-hand part of Figure 2 shows the calculated spectral responsivity of the proposed QWIP. To increase quantum efficiency and wavelength selectivity, the FPA would also include cross diffraction gratings like those described in the companion article, "Cross-Grating Coupling for Focal-Plane Arrays of QWIPs" (NPO-19657). These gratings would be optimized for the wavelengths of 8.5 and 10.5 μm and would be positioned in alternation over successive columns. As a result, all the photodetectors in one column would exhibit peak response at one of these wavelengths and all the photodetectors in the next column would exhibit peak response at the other wavelength, as shown to the right in Figure 2. Thus, the FPA would detect two column-interlaced images of the same scene in different wavelength bands. The outputs from the photodetectors in alternate columns could be fed to two video monitors to display both wavelength images simultaneously.

This work was done by Sarath D. Gunapala, Sumith V. Bandara, True L. Lin, and Jin S. Park 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 Circuits category,* ***or circle no. 138*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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Refer to NPO-19658, volume and number of this NASA Tech Briefs *issue, and the page number.*

Automated Seafloor Classification System (ASCS)

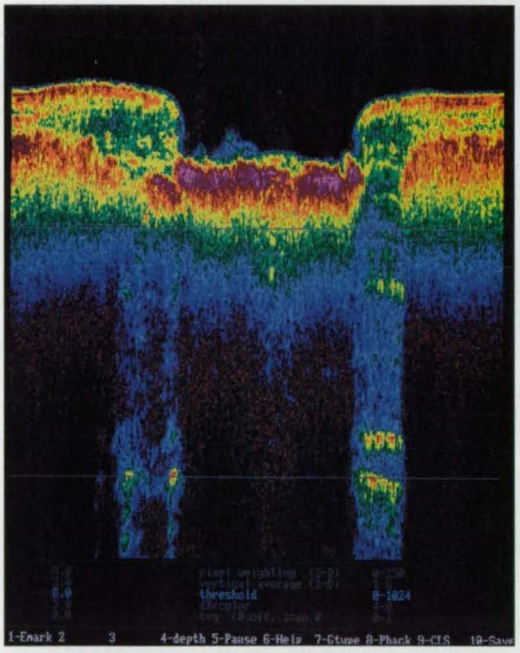
A high-resolution seismic system can remotely and accurately estimate and map seafloor sediment properties.

Naval Research Laboratory, Washington, DC

As the highest resolution seismic system available, the automated seafloor classification system (ASCS) can remotely and accurately map sediment properties for many seafloor applications. The ASCS can accurately predict, in near-real time, sediment type and a number of selected geotechnical properties of the upper several meters of the sea floor while in an underway survey mode.

This system functions as a flexible research data acquisition platform for collecting data. The record produced can be used to predict sediment structure and type, as well as such properties as attenuation, density, porosity, shear strength, compressional and shear velocity, and mean grain size.

The ASCS software displays each of these sediment properties in near-real time in the format shown in the figure, or as a scrolling tabular display of numerical values. The system also allows simultaneous collection of coregistered sidescan sonar data. This feature gives a three-dimensional look at the upper meters of the sea floor. It can display the digitized acoustic return as a function of amplitude vs. time. The device has extremely robust system-controlled data acquisition, storage, and processing hardware and software. The system transmits an acoustic pulse, digitizes the acoustic return to 16 bits, records the raw data on a removable-media hard drive, and shows three different displays in near-real time.



An **ASCS Display** depicting seafloor sediment properties such as structure and type, as well as geotechnical properties such as density, porosity, and shear strength.

The ASCS system normally operates at 15 kHz. It measures, both quantitatively and qualitatively, the amplitude (echo strength) and pulse characteristics of the return acoustic signal in 10 adjustable-width time windows that correspond to depth increments in the sediment. The ASCS produces a high-resolution analog seismic record of the upper few meters of the seafloor on which the amplitudes of the echo returns from the sediment's depth increments are displayed. A dedicated computer is used to store and display digitized raw echo strength and Global Positioning System (GPS) navigation data in near-real time. There is also the capability to apply algorithms based on the multilayer acoustic theory to compute acoustic impedance for each of the depth increments in the sediment. This continuous profile of acoustic impedance is then used, in combination with a series for empirical relationships, to predict sediment structure and type, as well as to predict attenuation, density, porosity, shear strength, compressional and shear velocity, and mean grain size.

Potential applications of the ASCS include:

- Locating pipelines and other buried objects;
- Data recording;
- Industrial process monitoring;
- Medical applications for anything that uses acoustic wavefronts;
- Recording any voltage regardless of the source.

This work was done by Douglas Lambert, **Naval Research Laboratory,** *Stennis Space Center, Mississippi. Inquiries concerning rights for the commercial use of this invention should be directed to the Office of Technology Transfer, Code 1004, 4555 Overlook Ave. SW, Washington, DC 20375-5320; (202) 767-7229; fax (202) 404-7920.*

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First Annual Product of the Year Award

Beginning in May, each issue of the *Electronics Tech Briefs* supplement to *NASA Tech Briefs* carried a Product of the Month—an electronics product the editors felt was of special interest and value to readers who work with electronics. This month *Electronics Tech Briefs* readers are invited to vote for the one product you deem the standout among the four described below.

Please read the descriptions below of the Products of the Month, and choose the ONE you feel should receive the Product of the Year award. On the ballot below please clearly indicate your choice in the appropriate box, and fax or mail the completed ballot to reach the editors by January 30, 1998. The *Electronics Tech Briefs* Product of the Year will be announced in the March 1998 issue.

MAY: *Visual PCB Assembly Inspection System*
GenRad Inc., Concord, MA, offers the Viper Visual Inspection System, designed to provide a cost-effective solution for detecting and preventing defects in the component-placement process for printed circuit board (PCB) assembly. It provides a full suite of techniques for detection of device presence or absence on components as small as 0.04 by 0.02 in., device orientation, and x/y and rotational position of every board component.

JULY: *Desktop Electronic Design & Analysis*
MicroSim Corp., Irvine, CA, introduces Release 8, which it calls a tightly integrated start-to-finish desktop electronic design automation (EDA) system for mixed analog/digital designs. Design Journal™ enables engineers to mark checkpoints at key crossroads, try alternative design directions, compare the results of all the alternative choices on a single graph, then proceed with the best option. Design Manager functions as an automatic organizer, linking together all files associated with the design into a single, self-contained entity.

SEPTEMBER: *Software/Platform for Semiconductor Inspection*
Cognex, Natick, MA, introduces the 8000 Series™, a new machine vision platform that incorporates its new PatMax™ software and plugs directly into the PCI bus of standard Pentium MMX™ computers. The series includes a range of products from the low-cost 8100 to the 8400, which incorporates a digital signal processor that enables operation up to 10 times faster than current Cognex products. The company also says that PatMax-equipped systems will locate and precisely align the new 300-mm generation of wafers.

NOVEMBER: *"Smart Power" Pulse Width Modulation Device*
SGS-Thomson Microelectronics, Lincoln, MA, calls its new VIPer100 a unique monolithic combination of a state-of-the-art current-mode pulse width modulation (PWM) circuit and an optimized avalanche energy-rated high-voltage vertical power MOSFET. Key features include automatic burst-mode operation in standby condition, and programmable switching frequency up to 200 kHz. The company says the device can deliver up to 100 W of output power while using more than 50 percent fewer components than a discrete solution.

1997 *Electronics Tech Briefs* PRODUCT OF THE YEAR BALLOT

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- ❑ **May:** GenRad Inc. Viper Visual PCB Inspection System
- ❑ **July:** MicroSim Corp. Release 8 Desktop Electronic Design Automation System
- ❑ **September:** Cognex 8000 Series Software/Platform for Semiconductor Inspection
- ❑ **November:** SGS-Thomson VIPer100 Pulse Width Modulation Device

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A Laser Doppler Velocimetry (LDV) System for Fish Bypass Evaluation

A three-beam, two-component LDV device is used to measure velocities precisely along a surface.

U.S. Army Engineers Waterways Experiment Station (WES), Vicksburg, Mississippi

Laser Doppler velocimetry (LDV) systems have been used for a number of years in field and laboratory applications. The normal LDV system consists of a two-color, four-beam system for obtaining two-component velocity measurements. These systems perform well in open flow but are not capable of obtaining velocity measurements along surfaces unless an angle is added to the LDV system probe. But adding an angle to the probe alignment introduces a small error into the measured velocities. The error can be as high as 1.38 percent of the vertical component for a system with a 50-mm beam spacing and a 600-mm focal length.

Through the use of physical models, the Army Corps of Engineers WES has been involved in designing fish bypass screening systems for Corps projects on the Snake and Columbia Rivers in the northwest United States for 13 years (Figure 1).

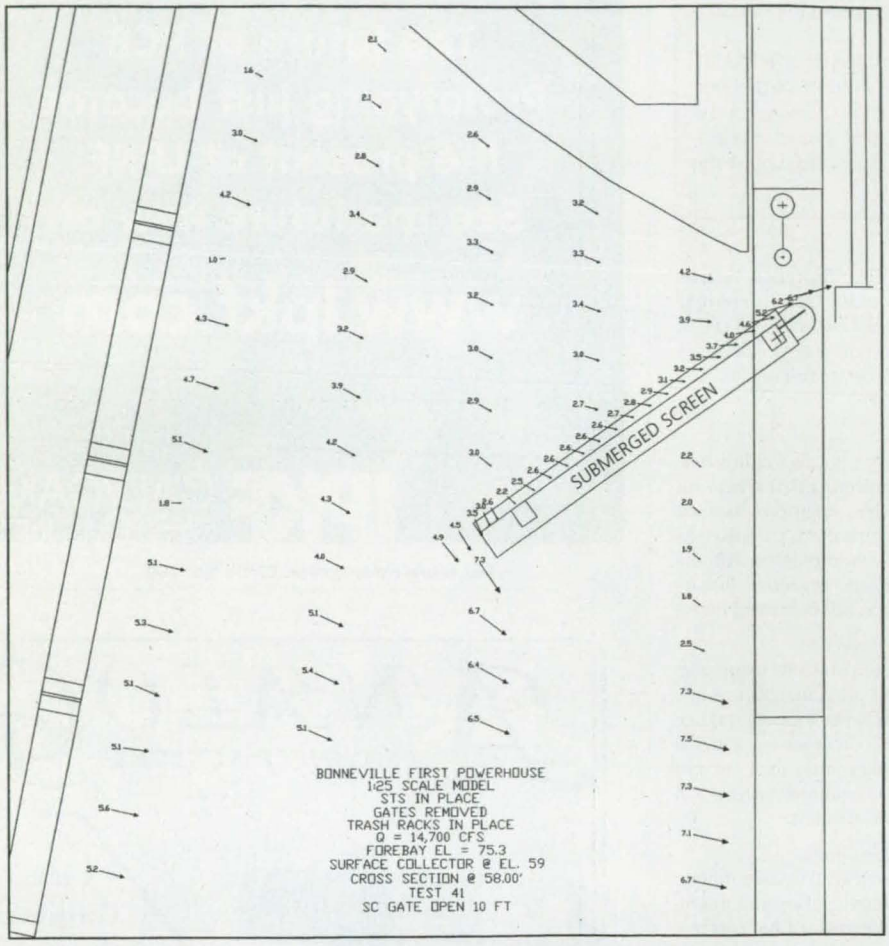

Figure 1. **Velocity Vectors** in the Powerhouse Intake at Bonneville Dam.

Velocities along the screen surface dictate whether a juvenile salmon will be guided around the turbines without being injured. These velocities must be accurate and repeatable.

To insure a precise measurement, WES uses a two-color, three-beam arrangement to perform measurements along a screen surface (Figure 2). With this system, both colors are present in one shared beam as well as each individually colored beam. The mutual beam is at a 90-degree angle to the other two, which changes the beam spacing from 50 mm to 35.35 mm. In a three-beam system, the beam arrangement can be rotated to align the hypotenuse of the arrangement along the screen surface, and the velocity magnitude can be resolved by determining how the arrangement has been rotated from the reference plane. The system can also easily obtain velocities with the colors at right angles to the mutual beam oriented to an x-y plane in the physical model.

The disadvantage of using a three-beam LDV system is that less power is delivered to the measuring volume, resulting in a noisier signal. In most cases, this can be resolved by using a higher-power laser or by adding more seeding material to the water flow. WES uses a 4-W argon laser attached through fiber optics to a fiber probe that collects light in the backscatter mode. For difficult measurements, seeding material is added to a column of water located at a safe distance upstream of the point at which measurements are recorded. Successful measurements have been recorded along screen surfaces through 550 mm of water and three sheets of 0.013-m-thick plexiglass.

Along with precise measurements, precisely controlled measuring positions are also important. To complement the three-beam LDV system, WES uses computer-controlled traversing systems to control the position of the laser probe to within 0.1 mm, thus assuring any difference in the flow field is due to a physical change in the model.

This work was done at the **U.S. Army Engineers Waterways Experiment Station,** *Vicksburg, MS.*

For more information about the application of two-color, three-beam LDV systems, contact Bob Davidson, Research Hydraulic Engineer, at (601) 634-3052; fax (601) 634-4158.

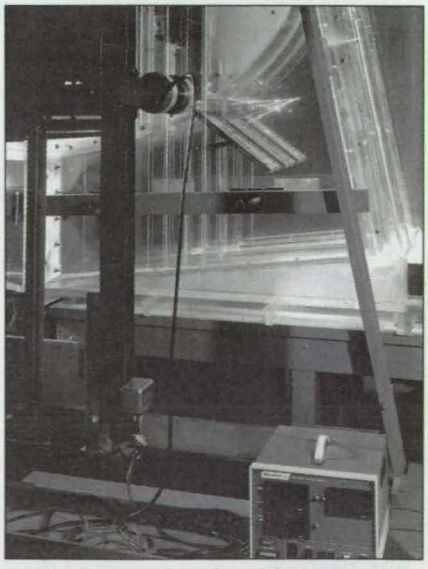

Figure 2. **Laser Doppler Velocimetry Probe** mounted on a transverse system at the U.S. Army Engineers Waterways Experiment Station

Image-Matching System Highlights Changes in Skin Lesions

Growth of moles is highlighted to prompt closer examination.

NASA's Jet Propulsion Laboratory, Pasadena, California

A video imaging and image-data-processing system for use in dermatological examinations acquires and processes images of patients' skins. The system processes a current image of a selected area of a patient's skin along with an image of the same area acquired previously, generating a comparison image that highlights any nevi (moles) that have appeared, disappeared, grown, and/or shrunk in the interim.

Most nevi are harmless, but changes into malignant melanoma can occur. Early detection is essential for effective treatment of malignant melanoma. Some patients have hundreds of nevi, so that it is difficult to track changes in the nevi that could signify the development of melanoma. The present image system assists the physician in identifying changes in nevi; the physician can then concentrate on examining any changed nevi.

The system includes a video camera, which is used to acquire the images. Typically, an image covers the patient's back from neck to waist. The first image of this area is digitized and stored on a computer disk. In a subsequent examination, a second image of the same area is digitized, stored, and processed along with the first image to generate the comparison image.

Because of differences between the relative alignments of the camera and patient in acquiring the two images, these images are not exactly registered with each other. Therefore, processing begins with the manual selection of a number (typically between 2 and 20) of nevi for use as landmarks in computing a nonlinear geometric transformation between corresponding points in the two images; the transformation is exact at the landmarks and a close approximation between them.

The average of the intensities of the central pixels of the landmarks in each image is computed, and is designated intensity A. The average of the intensities of all other pixels in each image is computed and designated intensity B. A linear transformation between the A and B intensities of both images is computed and used to correct the contrast between the images after they have been geometrically transformed into registration. A local shading correction is also applied; from the intensity of each pixel in each image, the median pixel intensity of all pixels in a small rectangular area around the pixel is subtracted.

From the shading-corrected, contrast-corrected intensity of each geometrically transformed pixel in the second image, the shading-corrected intensity of the corresponding pixel in the first image is subtracted. To bring negative values into the range of visibility, a middle gray-level intensity is then added to all pixels. The result is the comparison image. Wherever a nevus has grown or appeared between the time of acquisition of the first and second images, a dark spot is generated in the comparison image. Similarly, wherever a nevus has shrunk or disappeared, a bright spot can be seen in the comparison image.

Optionally, the comparison image can be rendered in false color to facilitate examination. Instead of adding a gray level, the negative changes in intensity (darkening changes, which could signify melanoma) are displayed in red, while positive changes in intensity (brightening, signifying disappearance or shrinkage of nevi) are displayed in green. The image can be enhanced even further by restricting red and green coloring to those pixels for which the differences between the first and second images exceed a specified threshold value.

This work was done by Robert H. Selzer 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 Life Sciences category,* ***or circle no. 139*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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New Products

PRODUCT OF THE MONTH

Machine Vision/Image Processing Software

National Instruments, Austin, TX, announces IMAQ Vision 4.1.1, the new version of its machine vision and image processing software. It takes advantage of MMX technology to accelerate fixed-point imaging functions up to 400 percent in some applications, the company says. IMAQ Vision 4.1.1, a library of machine vision and image processing functions for LabVIEW™ and BridgeVIEW™, incorporates MMX performance when this processor technology is present, but otherwise functions on a standard Pentium processor or even a 486 with a coprocessor. It includes an extensive set of functions for gray scale, color, and binary image display; image processing (statistics, filtering, and geometrical transforms); shape matching and blob analysis; and gauging and measurement. National Instruments says the program is suitable for industrial machine vision and scientific imaging applications, and factory and laboratory automation operations that require reliable, high-speed vision systems.

For More Information Circle No. 793

Imaging Board for Digital Camera

EPIX Inc., Buffalo Grove, IL, makes available the PIXCI-D imaging board for the Hitachi KP-F100 and KP-F110 10-bit high-resolution digital cameras. It captures the 1300-pixel by 1024-line image from the KP-F100 at 12 images per second, or the 1024-pixel by 1024-line image from the KP-F110 at 30 images per second, and stores the image sequence in PCI motherboard memory. EPIX provides camera control hardware and software for asynchronous triggered capture and integration. Software tools are available for design, debug, development, and production of machine vision products.

For More Information Circle No. 795

CMOS Imaging Chips

VLSI Vision, San Jose, CA, introduces the VV6300 and VV5300, new low-resolution digital-output CMOS imaging devices. Both color (VV6300) and monochrome (VV5300) versions have 160 × 120 pixels, and offer 8-bit digital output, auto exposure, serial control, and single 5-V power supply. Both feature electronic exposure and gain control over a wide range, the company says, enabling the use of a single fixed-aperture lens, and a bidirectional two-wire serial communication interface allows the devices to be configured and their operating status monitored.

For More Information Circle No. 798

Intensified Ultraviolet Cameras

CIDTEC, Syracuse, NY, makes available its new ultraviolet-sensitive intensified solid-state video camera, fiber-optically coupled with image intensifiers from Delft Instruments. The company says the line of intensified monochrome video cameras, specifically designed to address the needs of expanding scientific and image processing markets, is tailored for applications where response below 400 nm is critical. They are available in RS-170, CCIR, or progressive scan formats. Additional configurations are available according to desired wavelength response from UV to IR, including solar blind.

For More Information Circle No. 801

Color Plasma Display Module

Fujitsu Microelectronics, Inc., San Jose, CA, is offering the Plasmavision™ 42, a standalone version of its ImageSite™ 42-in. flat-panel color plasma display monitor. The display is capable of producing 16.7 million colors at 852 × 480-dot resolution. It has a 16:9 aspect ratio and a 160-degree horizontal and vertical viewing angle. The company says the operating time of approximately 30,000 hours is nearly three times that of a cathode ray tube display. Plasmavision 42 accepts NTSC, PAL, and SECAM television signals as well as VGA, Super VGA, and Macintosh graphics inputs.

For More Information Circle No. 796

Digital Signal Processing Board

Loughborough Sound Images Inc., Lexington, MA, created the dual-processor PCI/C6600 digital signal processing board to support Texas Instruments' C6x chip. It provides 3200 MIPS of peak processing power for high-performance systems. Equipped with two 200-MHz processors, the dual architecture allows the first processor to act as both a data processor and an off-board data router with access to a PCI interface, a DSPLINK2 interface, and TMS3204C4x communication ports. This architecture also provides the ability to use the primary processor as an intelligent I/O preprocessor.

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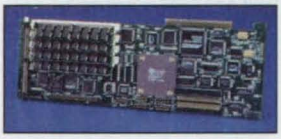

Frame Grabber/ Image Processor

DIPIX Technologies Inc., Ottawa, Ont., Canada, says its XPG-1000 Power Grabber family of imaging boards offers flexible frame grabbing and high-speed image processing for PCI and ISA bus PCs. The XPG-1000 will interface with any sensor or camera at data rates up to 48 Mbytes/s. It has an on-board TMS320C40 digital signal processor and a combination of DRAM and SRAM memory. The XPG-1000 supports up to 256 Mbytes of image memory and an optional real-time display board with on-board SVGA for display resolutions up to 1280 × 1024 noninterlaced.

For More Information Circle No 802

VXIbus-Based Data Acquisition and Control

Hewlett-Packard, Loveland, CO, calls its DAC1000 data acquisition and control system the first of a new generation of VXIbus-based systems that has evolved to meet a growing need for lower cost and more flexible measurement and control. At the heart of the DAC1000, the company says, is the HP E1419A, a single-slot C-size, 64-channel module that handles all of the I/O functions. It comprises a 40-MHz digital signal processor, a high-speed 16-bit 64-channel (max) scanning A/D converter, and slots for 8 signal conditioning plug-ons (SCPs). It provides engineering units conversion "on the fly" at full speed.

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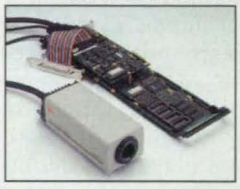

Digital Image Capture System

Edmund Scientific, Barrington, NJ, offers a digital image capture system built around its Oculus-PCI Ultra image capture board and Kodak's Megaplus Model ES 1.0 CCD camera. With its 1000-×-1000-pixel capacity, the system offers digital images that can be captured and viewed in real time. Edmund says that when combined with a compatible computer (not included) and a high-performance Edmund optical system, the unit can provide resolutions double those of video-based systems. Because the Megaplus is a progressive scan digital output camera, the resolution is not limited by the standard video bandwidth.

For More Information Circle No. 797

Digital Video Processing Module

DigiVision, Inc., San Diego, CA, announces the ZIPR™ 4500, the first in its Digital Synthe-Tec™ series of digital video processing modules. Among the features the company calls unique are a continuous electronic zoom that mimics a true optical zoom function without the problems of light loss or edge distortion; interpolated line doubling and quadrupling that can provide high resolution for large digital monitors; and a roam feature that allows the user to roam anywhere within the boundaries of the unzoomed field of view. Because ZIPR provides noninterlaced video output, DigiVision says, the signal can be displayed on high-resolution monitors.

For More Information Circle No. 800

3D X-Ray Inspection System

CR Technology, Laguna Niguel, CA, is supplying its new 3D microtomography x-ray inspection system. According to the company, the CRX-3D quickly and accurately generates high-quality slice-by-slice images of integrated circuits, components, hybrids, and other devices, detecting miswires, opens, shorts, and voids in flip chip, fine pitch, and ball grid array packages. The system's holding fixture rotates the component through 360° while the image camera takes individual video frames. The software then uses the digitized images to reconstruct the component's interior.

For More Information Circle No. 803

Vol. 22, No. 1 January, 1998 This card expires: June 30, 1998

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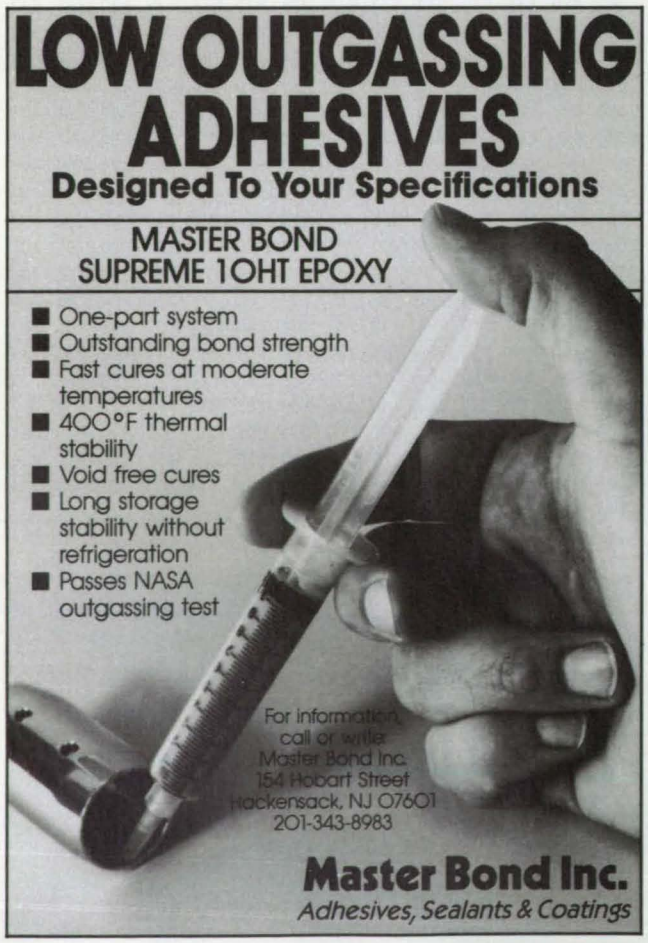
Books & Reports

Potential Commercial Applications From Microgravity Combustion Research

The paper entitled "Potential Commercial Applications From Combustion and Fire Research in Space" reviews the status of potential commercial applications derived from research on combustion in microgravity environments encountered in orbiting spacecraft. Such research contributes to the understanding of basic combustion processes, including those that occur in normal Earth gravity. Research topics discussed include solid-surface combustion, droplet combustion, and formation of soot. Potential applications include fire safety in spacecraft and terrestrial systems, innovative combustor designs for aerospace and ground propulsion systems, sensors and controls for combustion processes, and formation of advanced materials by use of combustion-synthesis processes.

This work was done by Robert Friedman and Valerie J. Lyons of **Lewis Research Center.** *To obtain a copy of the paper, "Potential Commercial Applications From Combustion and Fire Research in Space," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 131*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16538.



Characterization of Woven-Carbon/Copper-Matrix Composites

Designing metal-matrix composites into actual components requires both experimental and analytical characterization of the behavior of these composites. This report describes mathematical modeling and experimental characterization of the elastoplastic behaviors of composite materials made of copper and copper-alloy matrices reinforced with carbon fibers in a biaxial weave known in the industry as "8-harness satin." The experiments included monotonic- and cyclic-tension and -compression tests, combined tension/compression tests, and monotonic- and cyclic-shear tests, with strain gauges attached to specimens oriented, variously, with the fill or warp directions of the weaves along the directions of applied stresses.

This work was done by Brett A. Bednarcyk, Christopher C. Pauly, and Marek-Jerzy Pindera of the University of Virginia for **Lewis Research Center.** *To obtain a copy of the report, "Experimental Characterization and Micromechanical Modeling of Woven Carbon/Copper Composites," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 132*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16540.

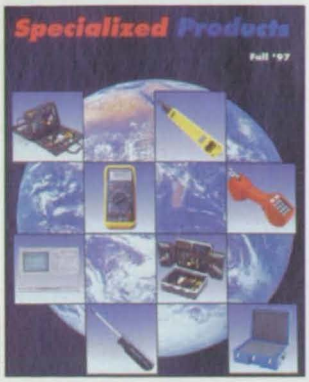
Equations for Failure Modes of Mechanical Systems

A report presents information compiled from a search of the literature on failure modes of mechanical systems. The report was written to provide a reference base for the application of first-order reliability methods to mechanical systems in the development of a system-level design methodology. In the report, each of 20 failure modes is assigned to one of four classes: wear, corrosion, fatigue, or material degradation. A brief description of each class and mode is presented. For each mode, there is a definition, plus a description of one or more failure mechanism(s) and/or one or more mathematical model(s). The mathematical models include equations, denoted "limit-state relationships," that describe such quantities as rates of wear or corrosion as functions of physical and chemical conditions and of relevant process variables.

This work was done by Michael Kowal and Thomas Cruse of Vanderbilt University for **Lewis Research Center.** *To obtain a copy of the report, "Compendium of Mechanical Limit-States," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category,* ***or circle no. 133*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16497.

New Literature

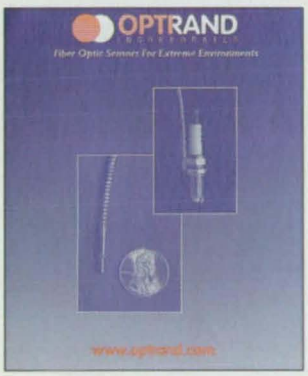


Specialized Products, Southlake, TX, has released a 378-page catalog of **tools, tool kits, cases, and test equipment**. Included are more than 100 standard tool kits, and cases for storing, protecting, and carrying tools, computers, instruments, and circuit boards.

For More Information Circle No. 729

An 80-page reference manual from Anorad Corp., Hauppauge, NY, describes more than 50 types of **linear servomotors**, including iron and ironless core, air and liquid cooling, and brushless and brush DC types. Electronic requirements such as controllers, amplifiers, and encoders are included.

For More Information Circle No. 731



Optrand, Plymouth, MI, offers an eight-page brochure describing **fiber-optic sensors** for extreme environments. Included are pressure sensors, pressure-measuring spark plugs and assemblies, interface units, installation tools, and accessories.

For More Information Circle No. 728

Galil Motion Control, Mountain View, CA, has published a 1998 catalog of **motion control** products, including over 200,000 motion controllers, software tools, amplifiers, and motors.

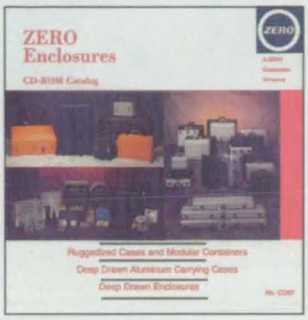
For More Information Circle No. 725

A 24-page catalog of **test and measurement instruments and process control products** is available from GMC Instruments, Lake Zurich, IL. Products include handheld multimeters/powermeters, testers, panel recorders, and AC transducers.

For More Information Circle No. 733

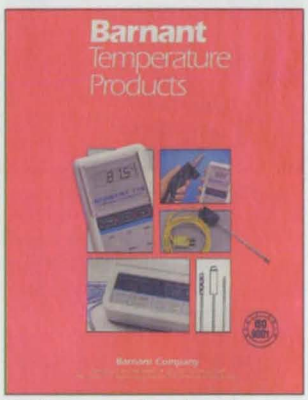
DATEL, Mansfield, MA, has introduced a 16-page brochure describing two-wire digital **panel meters**, as well as miniaturized, general-purpose DPMs. The two-wire meters require two connections to screw terminals on the back of the meter.

For More Information Circle No. 732



ZERO Enclosures, North Salt Lake City, UT, has introduced a CD-ROM catalog featuring over 120,000 aluminum **enclosures and cases**. Applications include safeguarding electronics and air-transport cargo.

For More Information Circle No. 726



A 20-page catalog from Barnant, Barrington, IL, offers **temperature products** including handheld thermocouple thermometers, infrared probes, temperature controllers, accessories, and field kits. Also described are RTD, thermistor, and intrinsically safe products.

For More Information Circle No. 730

An electronic catalog of **retaining rings and wave springs** from Smalley Steel Ring, Wheeling, IL, also allows users to input parameters from their assemblies and calculate limiting factors. The catalog requires a PC and Windows 3.1, 95, or NT.

For More Information Circle No. 727

Patriot Sensors and Controls introduces a new line of pressure transducers for aircraft applications, featuring sensor technology that's a step ahead of other pressure transducer designs.

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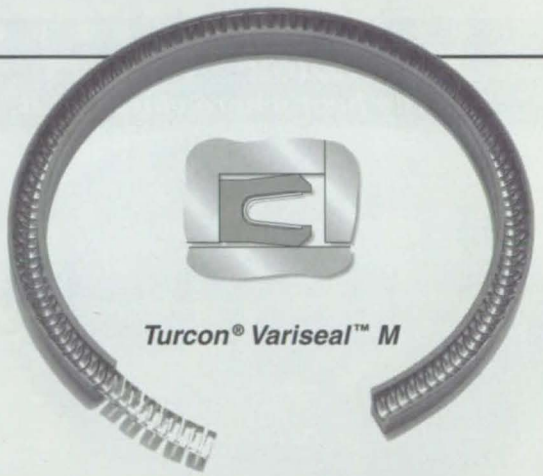

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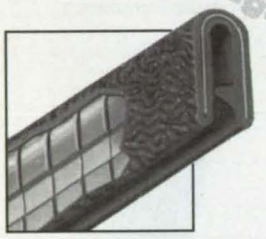
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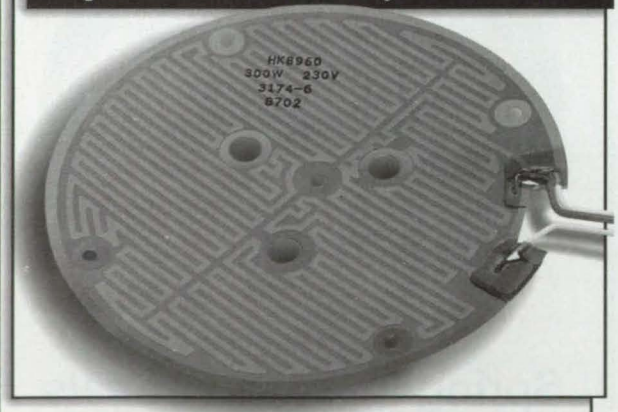

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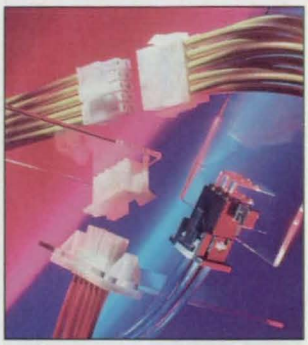
For More Information Circle No. 423

New on the Market

Dexter Magnetic Materials Division, Fremont, CA, has introduced a hysteresis torque **coupling** that maintains constant torque independent of rotation speed. Made from Hysterloy, a heat-treated magnetic material, the coupling is adjustable over a range of torque values and requires no maintenance. The coupling can be used as a clutch that will start slipping at a preset value or as a constant torque brake which will not vary with speed.

For More Information Circle No. 717



Molex, Lisle, IL, has announced the Mini-Fit HCS high current **connector system** that can carry up to 12 amperes per circuit, depending on housing configuration. The 4.2-mm centerline power connector can be designed into wire-to-wire, wire-to-board, and board-to-board applications in computers, computer peripherals, modems, power supplies, and business equipment.

For More Information Circle No. 713

The MS2650B and MS2660B series of portable **spectrum analyzers** from Anritsu Wiltron Co., Morgan Hill, CA, feature a built-in frequency counter, FM demodulation waveform display, GPIB or parallel interface, and memory card interface. The MS2650B has a 9-KHz to 3-GHz frequency range; the MS2660B covers the 9-KHz to 8.1-GHz range.

For More Information Circle No. 723

Danfoss Electronic Drives, Rockford, IL, has introduced the VLT 5000 Series adjustable frequency **drives** that incorporate a sensorless vector drive system for infinite variable speed and torque control of AC induction motors from 1 to 600 hp. The drives feature a microprocessor-based digital design, a removable display/keypad system, and are available for 200V-240V and 380V-500V line voltage, three-phase, 50/60 Hz.

For More Information Circle No. 719

Tru-Connector Corp., Peabody, MA, offers the HN series of **plugs, jacks, receptacles, and adapters** for use with RG400, RG393, RG217, and RG218 cables. Capable of handling up to 5,000 V, the connectors have an impedance of 50 ohms and a dc to 4-GHz frequency range. Bodies are made of brass with a silver or nickel silver finish, with silver or gold-plated brass, phosphor-bronze, or beryllium-copper center conductors.

For More Information Circle No. 711

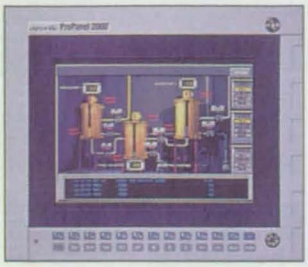
Imagenation Corp., Beaverton, OR, offers the PC/104-Plus and CompactPCI color **frame grabbers** for embedded machine vision (EMV) applications. They are compatible with standard PC components and support current EMV software. The PXC200 features a PCI bus interface; the PX610 and PX510 offer real-time video capture for scientific applications.

For More Information Circle No. 715

The CL100 and CL110 symmetrical and flanged **compression limiters** from Spirol International Corp., Danielson, CT, strengthen plastic components subject to high-torque loads while minimizing stress in bolt holes. Internal hole diameters accept bolt sizes of 1/4", 5/16", and 3/8"; 17 standard inch and metric lengths are available.

For More Information Circle No. 712

New on the Market



Azonix Corp., Billerica, MA, has introduced an enhanced ProPanel series of PC-based human-machine interface **industrial workstations** with sealed cast-aluminum casing; flat-panel, TFT active-matrix display; and low internal temperature rise. The 4" deep workstations also feature Intel Pentium processors with speeds of up to 166 MHz and main memory up to 128 MB, and operate under Windows NT/95 and DOS.

For More Information Circle No. 722

Modgraph, Woburn, MA, has introduced Guardian Plus™ ruggedized industrial **laptop PCs** that feature shock-mounted electronics, display, and drives, and a sealed keyboard. The 11.3" color active-matrix TFT-LCDs support 800 x 600 resolution. Pentium processors up to 200 MHz are available.

For More Information Circle No. 714

Westamp, Chatsworth, CA, has introduced the SP2k Series digital positioning **brushless servodrives** for multi-axis motion control. The drives feature a 32/64-bit floating-point digital signal processor and electronic gearing capabilities. Its power electronics drive one servomotor and control electronics for two or four axes of motion.

For More Information Circle No. 710

The Model 7600A high-speed **strain gage readout conditioner** from DCI, Olathe, KS, allows users to detect, store, and recall a peak input signal or runout that is the difference between the peak and minimum signal. Parameters can be detected 1,000 times per second with up to 65,000 counts of resolution.

For More Information Circle No. 718

The SBC-MaX™ **single-board computer** from Computer Dynamics, Greenville, SC, features an MMX Pentium™ CPU to 200 MHz, C&T's 65555 video controller, 100BaseT Ethernet, 16-bit Sound Blaster™ audio, and two Universal Serial Bus (USB) ports. A hard disk drive can be mounted directly onto the board, and the two-channel IDE hard disk interface supports up to four IDE drives.

For More Information Circle No. 720

Bimba Manufacturing Co., Monee, IL, offers repairable metric **position feedback cylinders** that provide continual position sensing via an internal linear resistive transducer (LRT) assembly. A quick-connect cable connector and adjustable integral flow controls are standard. The cylinders meet ISO 6431/VDMA 24562 standards. They are available in six bore sizes from 32mm to 100mm, and in stroke lengths up to 600mm.

For More Information Circle No. 721

The LA Series of sealed **pushbutton switches** from E-Switch, Brooklyn Park, MN, comes with Ø29mm or Ø25mm pushbutton heads and are oil- and water-tight to IP65 specifications. Available in a variety of lamp types ranging from 6V DC to 220V AC, the illuminated switches come in both momentary and latching configurations.

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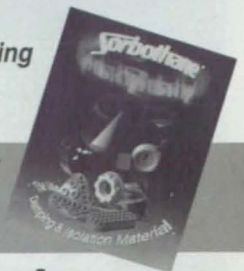

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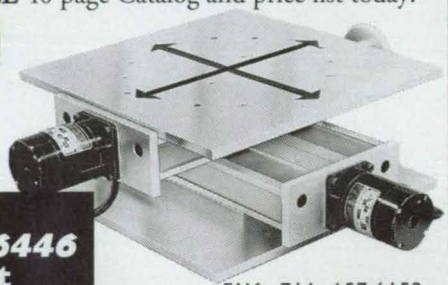

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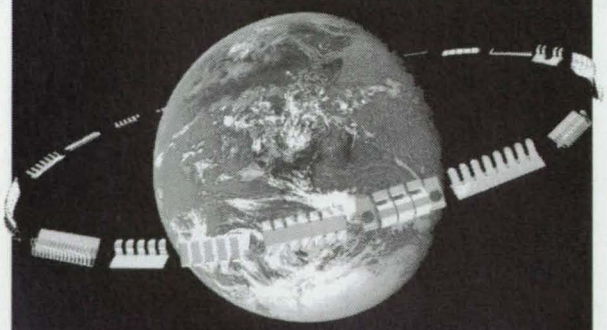

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For More Information Circle No. 427

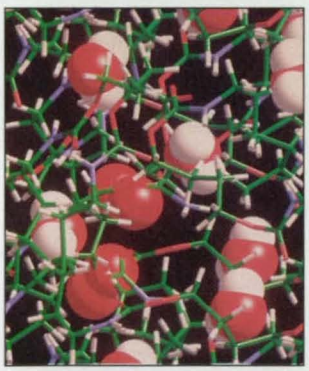
New on Disk

OptiStruct® 3.1 finite element-based **optimization simulation software** from Altair Computing, Troy, MI, facilitates optimal structural designs by computing the optimum material topology for a model within a given design space. The program features a sparse matrix solver for both linear static and Lanczos eigenvalue analyses. It offers a NASTRAN® input format and includes a finite-element library for modeling.

For More Information Circle No. 700

Imageware Corp., Ann Arbor, MI, has announced Version 8.0 of Surfacer **surface modeling and reverse engineering software**. Point-cloud segmentation tools allow rapid creation of curve networks from arbitrary point clouds. NURBS surface models can be transferred to downstream applications such as CAD, CAM, solid modelers, rapid prototyping systems, or animation software.

For More Information Circle No. 705



Cerius² 3.0 **polymer modeling software** from Molecular Simulations, San Diego, CA, offers new features such as C² •Synthia, which applies statistical correlation methods to predict properties of amorphous linear polymers; and C² •Polymer Builder, which speeds construction of homopolymers and copolymers.

For More Information Circle No. 707

DARcorporation, Lawrence, KS, has announced the release of 11 **airplane design and analysis software** programs for Windows™ designed to run on IBM-compatible computers. Each program is based on Advanced Aircraft Analysis. Programs cover stability and control; drag and lift analyses; flight dynamics; preliminary weight sizing and performance sizing of airplanes; cost estimation; and atmospheric properties.

For More Information Circle No. 703

DRAFT-PAK **mechanical CAD accelerator software** for Windows from Baystate Technologies, Marlborough, MA, automates the creation of mechanical components, allowing users to automatically build assembly parts, such as fasteners, as a 3D solid model in one step. Gears, racks, bearings, shafts, and structural members such as I-beams also can be constructed as a solid model in a single operation. An edit fields function allows variables and mathematical equations to be used during the design process.

For More Information Circle No. 702

Version 2.3 of ICEM Surf **CAD software** from ICEM Technologies, Arden Hills, MN, includes a tool that converts NURBS surfaces from other CAD systems into Bezier representations. The program can read trimmed surfaces via IGES, ASCII-Part, or directly from CADDS or CATIA, and store the original edges in a database. Raw data can be imported in X, Y, Z formats. The software is available on UNIX workstations.

For More Information Circle No. 704

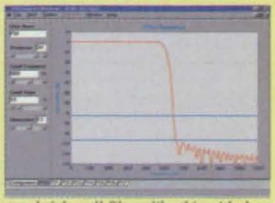
AESOP Corp., Chicago, IL, has released SiMPLE++ 4.0 **simulation and visualization software**, which allows object-oriented, graphical, and integrated modeling, simulation, and visualization of systems and business processes. It includes more basic objects to simplify modeling, new statistical analysis tools, and communication interfaces.

For More Information Circle No. 701

Jovian Systems, Woburn, MA, offers Version 2 of Pegasus **parallel processing design software** for Windows 95/NT which automates writing of real-time code to run in parallel on multiple programmable DSP chips. The system allows mapping of code onto hardware containing any number of DSP chips. Analog or digital I/O is connected by placing blocks in the diagram.

For More Information Circle No. 706

DIGITAL SIGNAL CONDITIONING



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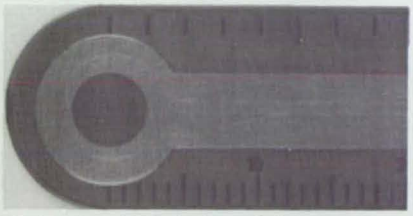

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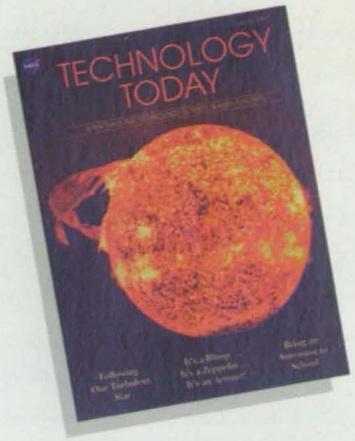

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Amtec Engineering	www.amtec.com	408	44
Analog Devices, Inc.	www.analog.com/SHARC.MCM		51
Ansoft Corporation	www.ansoft.com	470	COV IIa
Astro-Med, Inc.	www.astro-med.com	558	19
ATI Industrial Automation	www.ati-ia.com	407	42
Autodesk, Inc. AutoCAD	www.autodesk.com/a574		15
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Bentley Systems, Incorporated	www.bentley.com/modelserver		9
Capacitec		582	87
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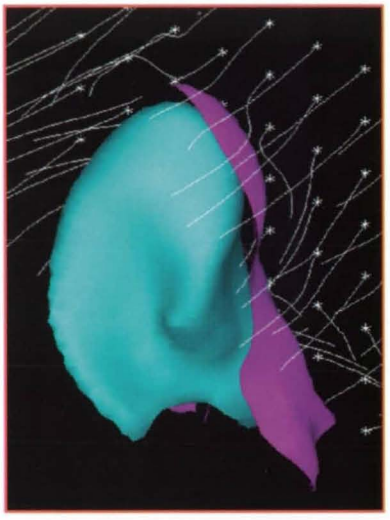

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