December 1997

TECH BRIEFS

ENGINEERING SOLUTIONS FOR DESIGN & MANUFACTURING

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New Design & Analysis Software

The Products Behind Pathfinder

Laser Tech Briefs

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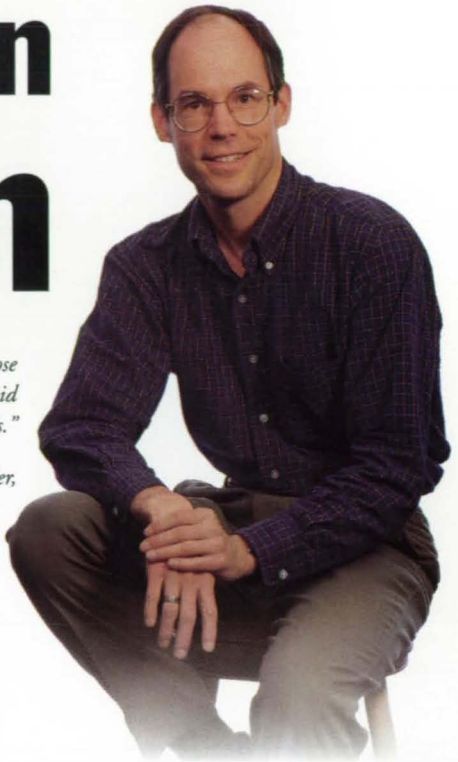
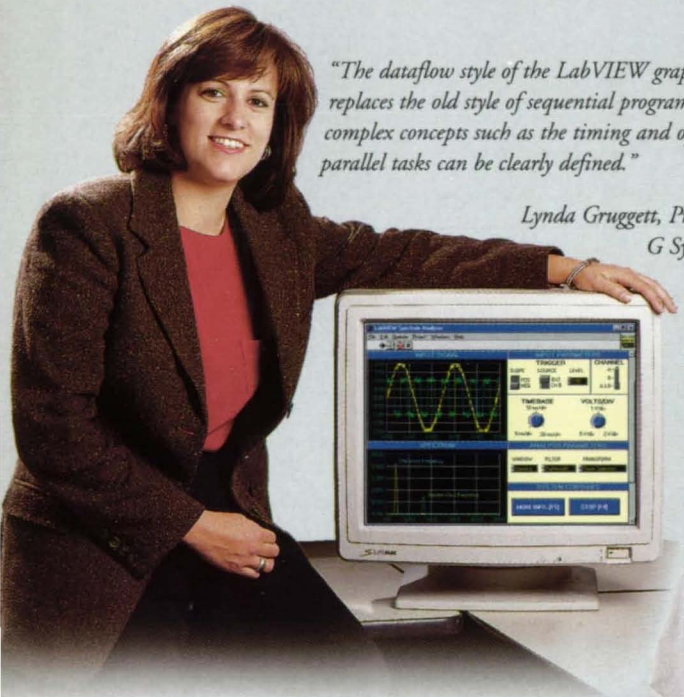


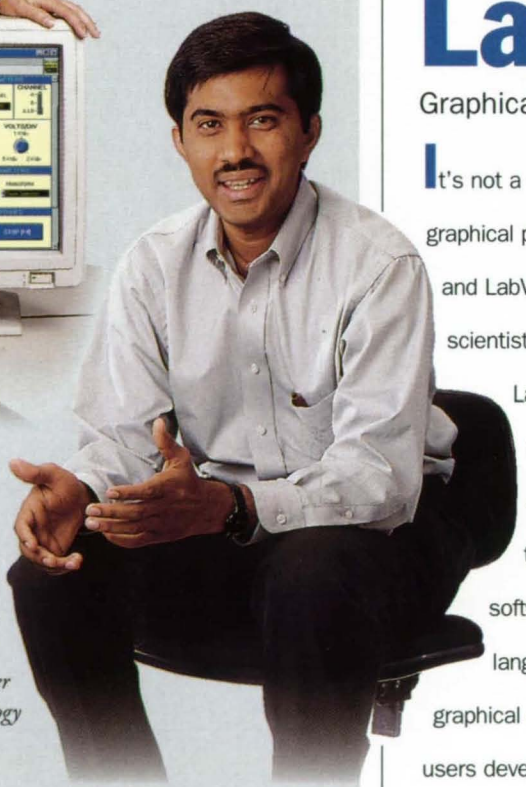
"As developers of high-performance DAQ applications, we chose LabVIEW because it provides the high-end tools needed for rapid development without restricting the use of 'C' for low-level needs."

Jim Campbell, Cofounder,
Viewpoint Software Solutions

"The dataflow style of the LabVIEW graphical language replaces the old style of sequential programming – now, complex concepts such as the timing and operation of parallel tasks can be clearly defined."

Lynda Gruggett, President,
G Systems





"LabVIEW software is easy to develop, debug, and maintain. It helps us concentrate on the application features without being caught up in fine details. This translates to on-time, on-budget projects and customer satisfaction."

Niranjan Ravulapalli, Project Manager
VI Technology

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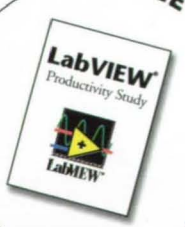

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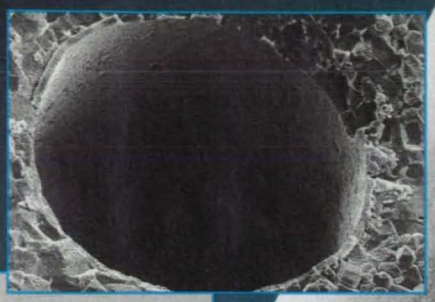
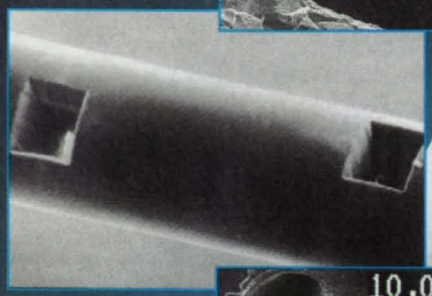
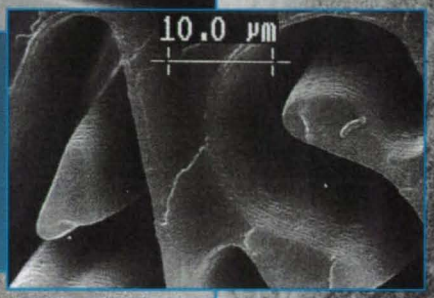


Drilling Al_2O_3 Ceramics: Thickness 600µm, hole diameter 40µm.

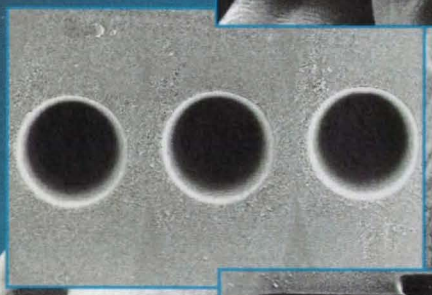


Drilling fiber biosensors

(Photograph courtesy of Exitech)



Excimer laser marking of human hair.



Laser drilled nozzles for ink jet printer

Micromachining of polyimide PYRALIN P12570 (DUPONT) with 1.7 µm resolution. LAMBDA 4248 excimer using 400 mJ/cm² at 248 nm.

(Photograph courtesy of MICROLAS)

Plastic insulation of processed copper wire, 50 µm diameter, ablated by excimer laser at 248 nm.

Q.

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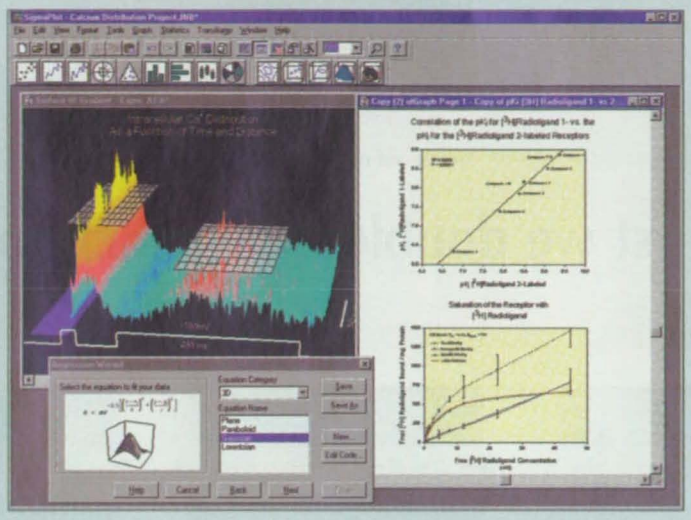
Dr. Barry Simon, Ph.D., *Desktop Engineering Magazine*, September 1996



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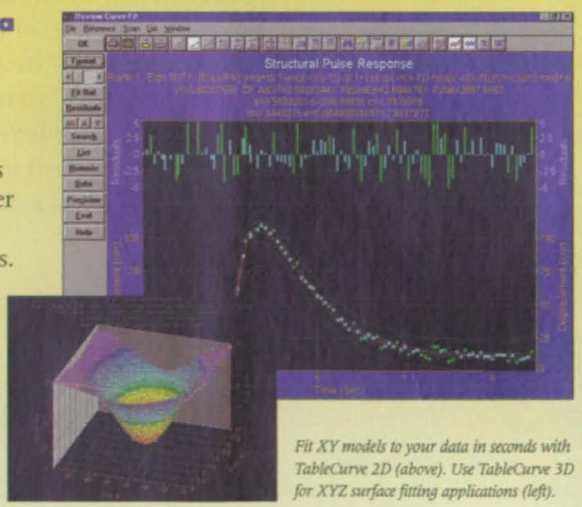

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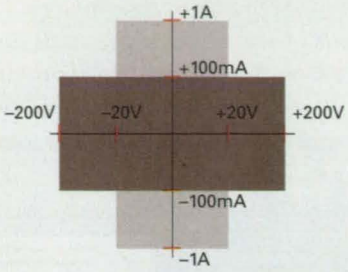

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	Dynamic Range 2400	2410	2420	Max system speeds:	External interface:	1 year basic accuracy: (5½-digit resolution)	
Voltage	±200V	±1100V	±60V	Pass/fail = 500µs	IEEE-488 (SCPI)	Volts	0.01%
Current	±1A/20V	±1A/20V	±3A/20V	To memory = 500µs	RS-232	Amps	0.02%
	±100mA/200V	±20mA/1100V	±1A/60V	To IEEE-488 = 1ms	Digital I/O	Ohms	0.04%
Power	22W	22W	66W	Range change = 13ms	Component handler		

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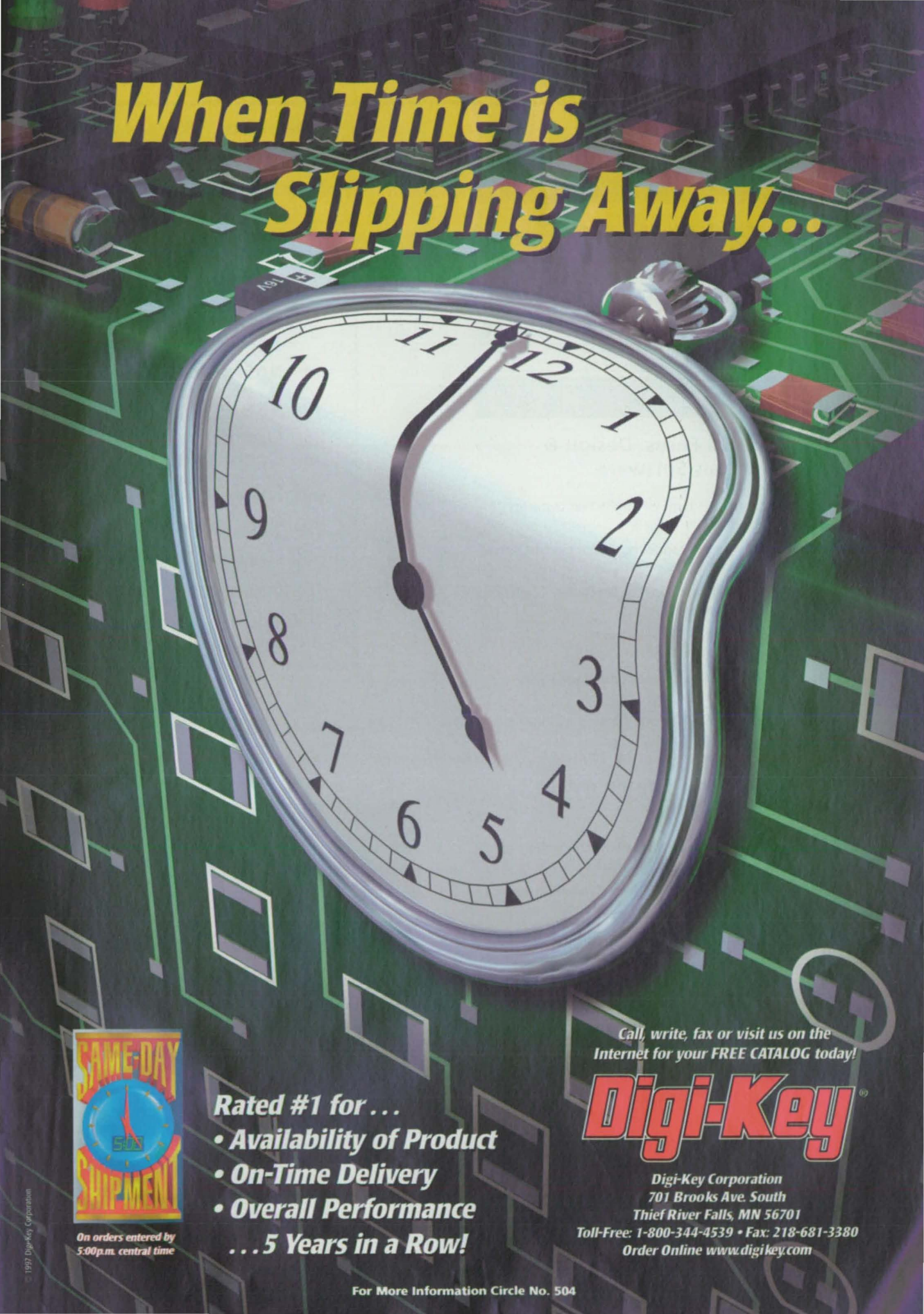
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NASA TECH BRIEFS

December 1997 • Vol. 21 No. 12

Features

Briefs

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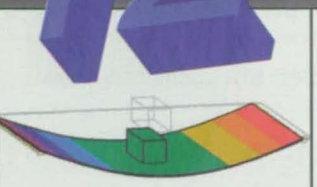
This panoramic view of the surface of Mars was taken by the Imager for Mars Pathfinder (IMP) from July 11 to 13. Different regions were imaged at different times over the three Martian days to acquire consistent lighting and shadow conditions for all areas of the panorama. This image is only a sample of the massive amount of data sent back from Pathfinder during one of the most successful missions in NASA history. Part of that success was due to the commercial products and technologies used to design, build, and operate the Pathfinder and its Sojourner rover. See Application Briefs beginning on page 20 to learn how NASA used some off-the-shelf products to get to Mars.

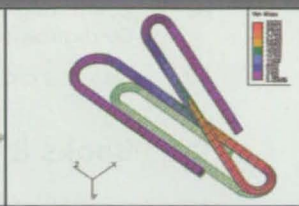
(Image courtesy of NASA's Jet Propulsion Laboratory)

Now: NONLINEAR that's EASY

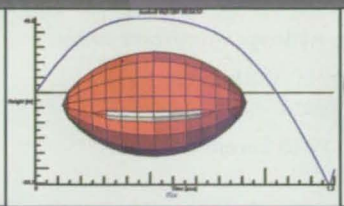
12 EASY things you can do with Nonlinear that you can't do with regular linear stress analysis



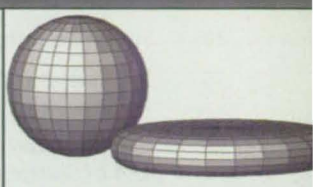
ut of plane bending - Use nonlinear alysis to determine whether this plate l foreshorten and fall out of its support. ear cannot predict geometry changes rpendicular to a load.



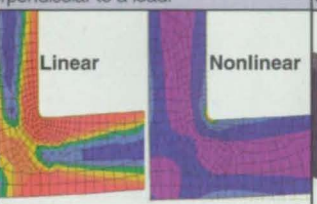
Permanent deformation - Algor's nonlinear analysis can predict the permanent deformation when the predicted stress exceeds the yield stress. Linear analysis can't do this.



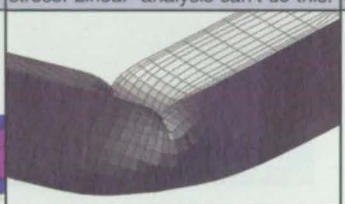
Trajectory - Basic motion, such as the trajectory of this rotating football is easily done using Algor's nonlinear analysis. Linear analysis cannot predict motion.



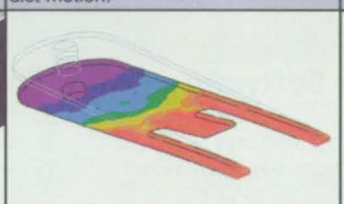
Squashing - Squashing this rubb ball in a vice using linear analy cannot predict the final shape like t nonlinear analysis.



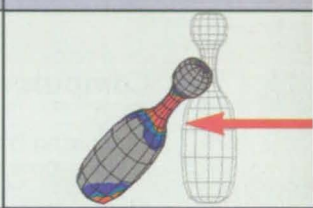
ress concentration - Linear stress alysis will misrepresent both the ress and the deformation of this nger due to minute changes in the et. Nonlinear analysis gets it right.



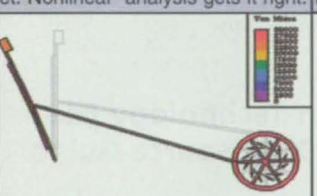
Local buckling - When failure is due to local buckling, the geometry fails at stresses much, much lower than the yield stress. Linear cannot detect local buckling.



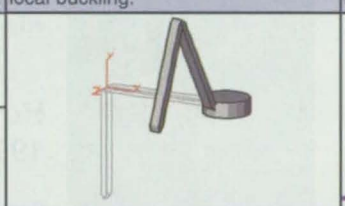
Snap-through - Any time you have a snap-through effect, your part is in motion until it stops on the other side. You need nonlinear analysis to predict this effect.



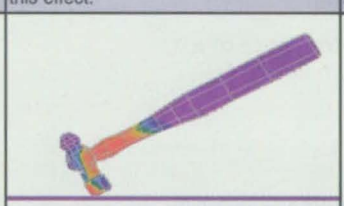
Impact - Nonlinear dynamic respon predicts the stress in an object wher goes into motion as a result of impact another object. Linear analysis cann analyze for impact and motion.



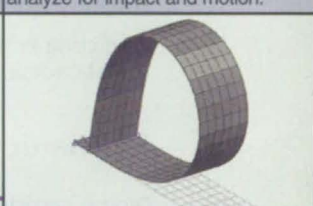
bar link - Linear dynamic analysis nnot predict the forces and stress- due to periodic loading. ccupak/VE simulates the loading d stresses in one analysis.



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 - Nonline analysis predicts the stressed geome when the deformation is significa even if the material properties rem linear. Linear analysis fails at this.

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Contents *continued*

Special Supplements

Laser Tech Briefs

Follows page 80 in selected editions only.

Hot Technology File 1998 Resource Guide

Pages 1H-32H

On the cover:

Shown is a portion of a Bombardier Skidoo turbine assembly created with Euclid Designer software from Matra Datavision, Andover, MA. The software allowed each individual part in the assembly to be made transparent, enabling the user to see objects that would otherwise be hidden. Automatic exploding and remounting features allowed the assembly to be "pulled apart" before being remounted. For more information on this program, as well as other design software, see the Special Focus on Design & Analysis Software beginning on page 38.

(Image courtesy of Matra Datavision)

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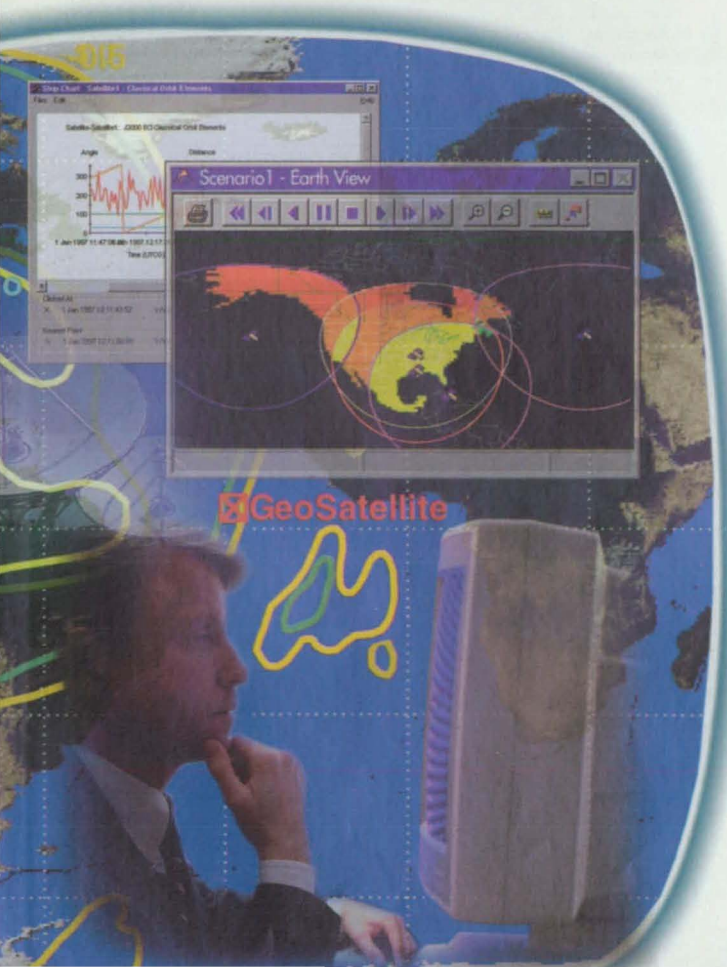

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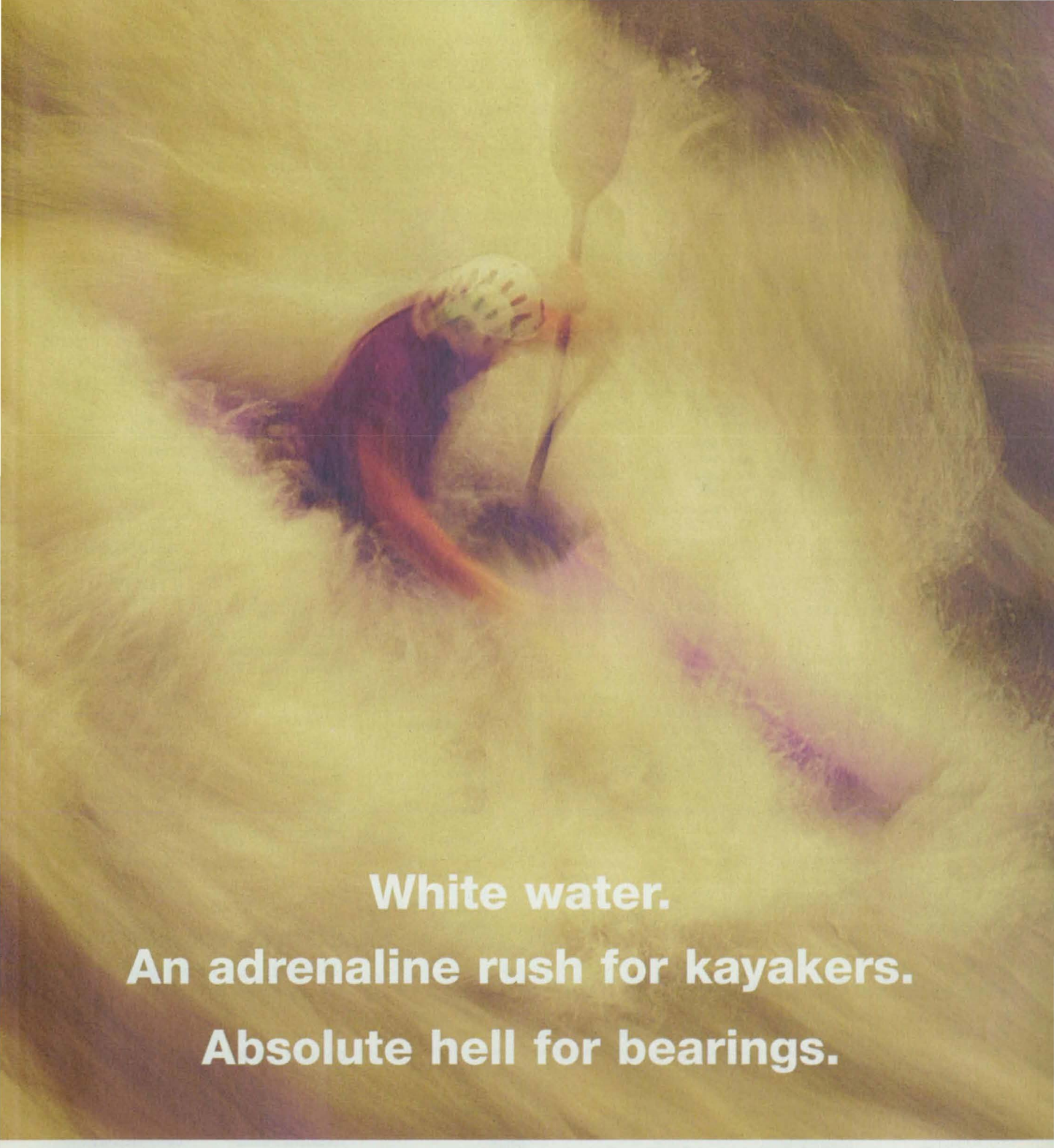

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NASA Commercial Technology Team

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
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Center for Technology Commercialization
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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.

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For More Information Circle No. 512

For More Information Circle No. 409

NASA PATENTS

Over the past three decades, NASA has granted more than 1000 patent licenses in virtually every area of technology. The agency has a portfolio of 3000 patents and pending applications available now for license by businesses and individuals, including these recently patented inventions:

Pulse-Echo Ultrasonic Imaging Method for Eliminating Sample Thickness Variation Effects

(U.S. Patent No. 5,629,865)

Inventor: Don J. Roth, Lewis Research Center

This method for nondestructive ultrasonic evaluation of materials measures velocity using a single transducer pulse-echo immersion system, automatic scanning, and digital imaging, providing a video image of the sample in color or gray scale that is a map of a material property such as porosity fraction. In the immersion method, the material to be evaluated is surrounded by a liquid and positioned over an acoustic reflector that is also immersed in the liquid. An ultrasonic wave of a known frequency is transmitted through the liquid and four separate echoes are recorded and evaluated at each scan point. Each echo is received as an analog waveform that is digitized and stored in a computer. Before the evaluation scans, nonlevelness and sample thickness variations are accounted for and eliminated by pre-scans to insure that the received reflections or echoes are within their set time windows to provide a complete waveform for evaluation and cross-correlation to accurately obtain the time-delay data used in calculating the velocity values.

For More Information Circle No. 765

Quick-Connect Bolt

(U.S. Patent No. 5,634,754)

Inventor: Bruce Weddendorf, Marshall Space Flight Center

The present invention can replace standard bolt-like fasteners in connections where it is difficult to initiate threaded contact without cross-threading — i.e., stripping — the threads or where conditions do not permit enough rotations for conventional tightening. The bolt is simply pushed into a female-threaded receptacle without rotation until a driving element prevents additional insertion. The element is attached to a shank tapered toward its head end, and terminating in a flange. As the bolt's threaded sleeve slides along the tapered shank to the head end, a coil spring around the tail end pushes against radial springs, which contract the threaded sleeve, forcing it to expand into the receptacle threads. The flange confines the threaded sleeve to the shank, and a key-in-groove system transfers torque from the shank to the threaded sleeve. Now the quick-connect bolt can be tightened in the usual manner with very little rotation.

For More Information Circle No. 766

Polarization Independent Electro-Optic Modulator

(U.S. Patent No. 5,654,818)

Inventor: Xiaotian Steve Yao, Jet Propulsion Laboratory

For advanced communications systems fiber optic cable systems promise to deliver adequate data bandwidth. But they require inexpensive and reliable optical transmitters (modulators) and receivers (demodulators). The most promising modulators are such electro-optic devices as Mach-Zehnder waveguide modulators, in which an input laser beam signal is separated into two. An electric field modifies the optical path length of one of them, thus phase-modulating that signal. At the output end the two signals are recombined and their interference converts the phase modulation into amplitude modulation. Unfortunately, current electro-optic modulating devices are extremely sensitive to the polarization plane of incoming light, necessitating ultraprecise alignment of the laser to the modulator and extreme stability. The invention modulates a light beam without sensitivity to the polarization plane of the input beam. A beamsplitter separates the incoming beam into two orthogonally plane-polarized beams. Each beam then passes through a separate electro-optic modulator and is modulated by the same data signal. After modulation they are recombined to yield a beam whose modulated components are orthogonally polarized. Not only is this device insensitive to changes in polarization of the input beam, but the final beam can be detected by demodulators without regard to polarization alignment of the modulated beam and the receiver.

For More Information Circle No. 768

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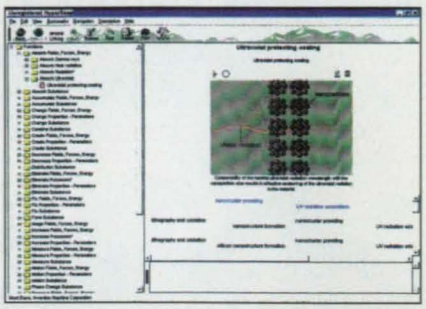
What's New On-Line

For those of you who have not yet visited the *NASA Tech Briefs* web site at **www.nasatech.com,** you're missing some exciting new features.

- Our enhanced web page now includes a revamped Technical Support Package (TSP) area, making it easier to download, free of charge, the additional information available from NASA for the tech briefs featured in each issue. Users have a choice of downloading the TSPs directly onto their computers or opening them immediately with Acrobat Reader. The TSPs are in PDF format and do require a PDF viewer.
- You may not know that you can renew or begin your subscription to *NASA Tech Briefs* on our web site. Go to the home page and provide the information requested for new or renewing subscribers.
- This month, we ask you to vote for the third annual Readers' Choice Awards for Product of the Year. In addition to the fax-back ballot on page 18, we also offer the opportunity to vote on our home page. Please make sure you cast your vote — by mail, fax, or on the web — by January 20. Check out our March issue for the announcement of your winners.
- Beginning in January, you'll be able to order information from advertisers on-line in our electronic Reader Service Center, and search advertised products by category.

Product of the Month



Invention Machine Corp., Boston, MA, has introduced IM-Phenomenon™ Professional Edition software that creates and analyzes new concepts. The software aids engineers at all levels and across all industries in developing new designs and solving complex technical problems. Compatible with Windows 95/NT, IM-Phenomenon uses artificial intelligence to suggest and link effects. The knowledge base of 1,000 scientific effects, more than 1,000 engineering examples, and 3,400 animation sequences provides descriptions and animated depictions of effects and their advantages. The software will suggest an effect or combination of effects that meet the user's needs, and will provide formulae, limitations, necessary materials, references, and real-world examples, as well as displaying two animated diagrams (micro and macro views) to show the effect in action.

For More Information Circle No. 795

NASA Turns 40

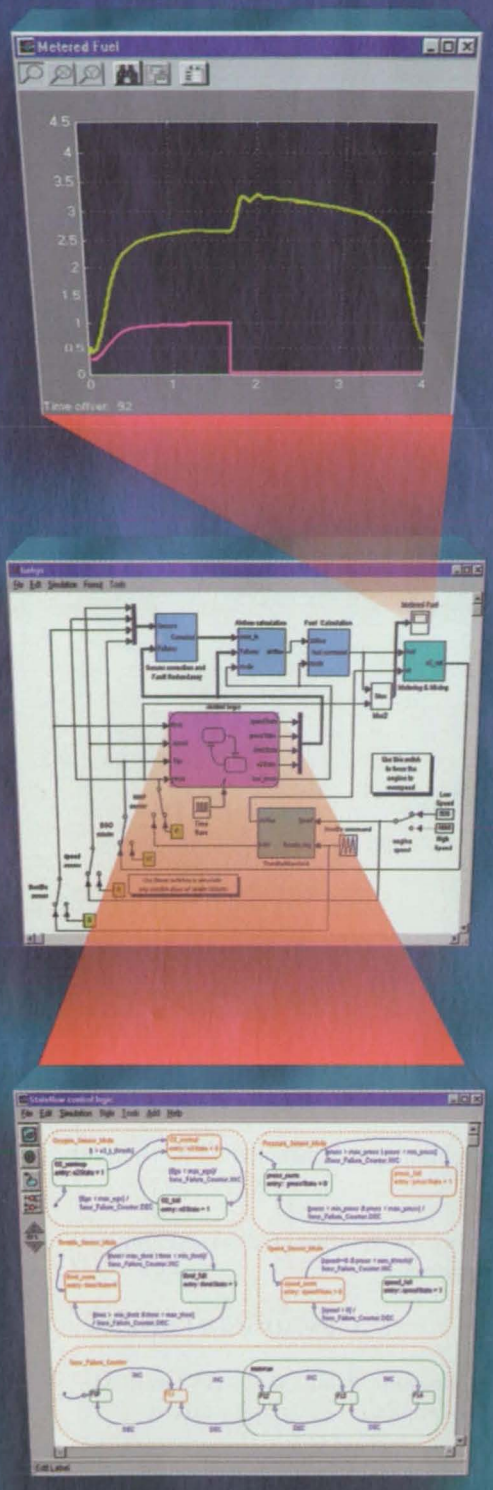
Join us in celebrating NASA's 40th Anniversary in 1998. The January issue of *NASA Tech Briefs* will begin a year of celebration as we look back each month at a different area in which NASA has had significant past accomplishments, current and emerging successes, and spinoff technologies that have impacted business and affected our everyday life. Read about NASA spinoffs in the area of Consumer Products in the January issue.

Reader Comments

"We are looking for information on Theory of Inventive Problem-Solving (TIPS/TRIZ) methodologies with the goal of applying this approach to our product development process. Our research group is particularly interested in reference literature describing the theory and application of the concepts and tools involved, such as function analysis and Altshuller's Matrix. Any suggestions on where to locate such information would be appreciated."

Mike Demchak
Preferred Technical Group
Rochester Hills, MI
mdemchak@ptgcorp.echlin.com

*(**Editor's Note:** Mike, you're in luck. Dr. Valery Tsourikov developed the concept of Computer-Aided Innovation in 1982 by integrating artificial intelligence with TIPS/TRIZ. The company he founded, Invention Machine Corp., Boston, MA, offers a number of technical problem-solving software packages incorporating this technology. The newest — IM-Phenomenon™ — happens to be our Product of the Month (see description above). You can contact Invention Machine at 200 Portland St., Boston, MA 02114; Tel: 617-305-9250; Fax: 617-305-9255; e-mail: info@invention-machine.com; www.invention-machine.com)*



Fault-tolerant fuel injection system

The Simulink diagram (center) models the controller with airflow and fuel mixing. The Stateflow diagram (bottom) shows logic for detecting and responding to sensor failures. The scope (top) shows both a continuous signal and a discrete-event signal, showing the response of the fuel rate to the sensor failure.

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Cast Your Vote for

NASA TECH BRIEFS

Third Annual Readers' Choice Awards

Each issue of *NASA Tech Briefs* highlights a Product of the Month — a new product with exceptional technical merit and practical value to our more than 200,000 engineering and management readers.

This month, *NASA Tech Briefs* readers are invited to vote for the one product among those highlighted throughout the year that you feel was the most significant new product introduced for the engineering community in 1997. The product with the most votes will be named *NASA Tech Briefs* 1997 Readers' Choice Gold Medal Winner for Product of the Year. The products with the second and third highest number of votes will be awarded, respectively, Silver and Bronze Awards.

Last year, *NASA Tech Briefs* readers awarded the Gold Medal honor to Knowledge Revolution for Working Model 3D™ virtual prototyping and design software.

Here is your chance to choose this year's winners. On the facing page are descriptions of each of the Products of the Month. Choose the **one** product you feel should receive Product of the Year honors.

All ballots received by the deadline date will be eligible for a random drawing to win valuable prizes, including SolidWorks 97Plus 3D mechanical design software from SolidWorks Corp., Concord, MA, a previous Gold Medal Winner. This fourth release of the Windows-native software features more than 160 enhancements and extended Internet support.

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 20, 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: _____

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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

Product of the Year Nominees

The Racal-Heim DATaRec A60 Recorder from Racal Recorders, Irvine, CA, is a six-channel DAT/DDS-2 instrumentation recorder for portable or standalone use. The analog input, digital recording/replay system features a maximum 125 kHz system bandwidth and provides two or more hours of continuous recording with greater than 90 dB signal-to-noise ratio. Each of the six channels is compatible with both conventional voltage and ICP sensor inputs, has user-selectable backwidth up to 25 kHz, and has ten input and three output ranges.

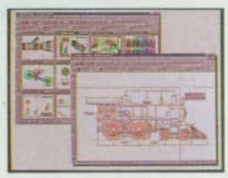
The MathWorks, Natick, MA, offers MATLAB 5 technical computing software, which provides a single environment for analysis, visualization, modeling, simulation, and large-scale application development and deployment. New features include support for multidimensional arrays and user-definable data structures; language enhancements; realistic 3D visualization graphics; and application development tools. It is available for Windows 95/NT, Macintosh, Power Macintosh, and UNIX platforms.

The CompuScope 8500/PCI, a PCI-based multi-megahertz data acquisition system from Gage Applied Sciences, South Burlington, VT, can transfer A/D data to PC memory at speeds of up to 100 MB/second. It features a sample rate of 500 million samples per second for on-shot signals, storing the digitized data in onboard memory. PCI bus interface, eight-bit vertical resolution, up to 2 megasamples of memory, and drives for DOS, QNX, and Windows 3.1/95/NT are featured.

National Instruments, Austin, TX, offers the DAQScope™, DAQMeter™, and DAQArb™ PCI, ISA, and PCMCIA instrumentation computer interfaces that are compatible with Windows 3.1/95/NT. The series includes the VirtualBench™ Scope, VirtualBench-DMM, and VirtualBench-Arb virtual instruments, which work with application software packages such as LabVIEW®. Users can build instruments with Internet connectivity that can send e-mail and interface to Microsoft Word and Excel. Drivers are available for C/C++ and Visual Basic.

CADKEY® 97 mechanical CAD software for Windows 4.0/95/NT from Baystate Technologies, Marlborough, MA, combines wireframe modeling with ACIS® solid modeling, allowing import or export of 2D/3D data to other CAD/CAM/CAE applications supporting the ACIS solid model kernel. The software converts wireframe to a solid model; constructs solids such as blocks, cones, and cylinders; and applies extruding, sweep, or revolving geometry into a solid.

Keyence Corp. of America, Woodcliff Lake, NJ, offers the CV Series Compact Vision System, a handheld machine vision system that provides a processing time of 1/60 sec., resolution of 240,000 pixels, 1/10,000 sec. synchronizing shutter, illumination adjustment, auto tracking, pattern matching, and gray search. Four image processing modes are available: area detection, pattern matching, absolute position detection, and relative position detection.



Vdraft™ AutoCAD-drawing-based CAD software from SoftSource, Bellingham, WA, is the first program produced outside of Autodesk that can create and edit AutoCAD drawings and DXF files in their native format with no translation. The Windows 95/NT program allows hundreds of drawings to be viewed and edited simultaneously, each in their own window. Commercial plug-in versions of the Vdraft Internet Tools are included for DXF, DWG, and SVF.

Polytel Computer Products Corp., Sunnyvale, CA, offers DraftPAD, a programmable touchpad for computer keyboards that customizes computer-aided design (CAD) applications. Available in 176-key and 300-key models, the touchpad incorporates multiple macros per key to eliminate repetitive keystrokes, and is supplied with pre-programmed macro files for popular design software. The unit works with the computer's operating system rather than the application program, and can be moved from one computer to another.

Hewlett-Packard, Palo Alto, CA, offers the Infinium family of oscilloscopes with bandwidths from 500 Mhz to 1.5 Ghz; maximum sample rates per channel of 1 Gsa/s, 2 Gsa/s, 4 Gsa/s, and 8 Gsa/s; and memory depth of 32K to 64K/channel. The instruments provide users with an analog-like front panel, a Windows 95-based graphical user interface, and a built-in information system. Features include separate scaling and positioning controls for each channel.

Anvil Express™ CADD/CAM software for Windows from Manufacturing and Consulting Services, Scottsdale, AZ, includes the SolidWorks™ solid modeler for parts and assembly modeling, multiple-surface milling, tool path simulation and verification, and Autosnap-3-D™ technology that automatically generates solid models from 2D geometry. Other features include multimedia tutorials; and parametric, surface, and wireframe modeling.

Cad.Lab, Santa Clara, CA, offers Eureka Gold 97 3D mechanical design software operating in a native Windows environment. Features include integrated conceptual design, engineering, and documentation that allow users to design within a single software environment. Surfacing capability for styling and concept design phases is integrated with 3D solids modeling. Product data management is enabled using the optional TeamManager™ through support of relational data management systems such as Oracle.

Invention Machine Corp., Boston, MA, offers IM-Phenomenon™ Professional Edition software that creates and analyzes new concepts. The Windows 95/NT software uses artificial intelligence to suggest and link effects. The knowledge base of 1,000 scientific effects, more than 1,000 engineering examples, and 3,400 animation sequences provides descriptions and animated depiction of effects and their advantages. The software will suggest an effect or combination of effects that meet the user's needs, and will provide formulae, limitations, and real-world examples.

Application Briefs

At 10:07:25 a.m. Pacific Daylight Time (PDT) on July 4, 1997, Mars Pathfinder successfully landed on the surface of Mars, marking NASA's return to the Red Planet more than 20 years after the Viking I and II missions. NASA received instantaneous confirmation that Pathfinder had landed right-side-up on its base petal. The craft and its Sojourner rover then waited for the Martian sunrise in order to power up and begin transmitting data and images back to Earth. And transmit they did. In fact, the Pathfinder lander operated nearly three times longer than its design lifetime of 30 days, and the rover operated 12 times longer than its design lifetime of seven days. Flight operators at NASA's Jet Propulsion Lab (JPL) received the last successful data transmission on September 27. The Pathfinder, in its 83 days of operation, returned 2.6 billion bits of information.

The most successful and highly publicized NASA mission since Apollo 11 landed on the Moon 28 years ago, Pathfinder represents the best of the "new" NASA - better, faster, and cheaper - thanks to the use of commercial off-the-shelf products used in its construction and operation. Thirteen of those products, the companies that supplied them, and their specific roles in the success of the Pathfinder mission are described here.

Eagle-Picher Industries, Technology Division

Joplin, MO

Products manufactured by three different divisions of Eagle-Picher were chosen for use on the Pathfinder mission — one to help it land on Mars, one to keep the craft powered, and one to help run the Sojourner rover. First, the Pathfinder was able to make a soft landing on the Red Planet with landing parachutes deployed with thermal batteries manufactured by the company's Federal Systems Department in Joplin.

After landing, Pathfinder required constant electrical power to conduct experiments and communicate with Earth. The electrical power is generated by gallium arsenide (GaAs) solar cells supplied by the U.S. Air Force. Eagle-Picher's Environmental Science and Technology Department in Miami, OK, provided the germanium substrates used in growing the crystalline GaAs structures.

Finally, the Sojourner Rover is powered by the same high-efficiency solar cells using Eagle-Picher substrates. Along with these substrates, the company's Commercial Products Department in Seneca, MO, supplied a lithium-thionyl chloride battery back-up for the on-board electronics.

For More Information Circle No. 771

Wind River Systems

Alameda, CA

The Pathfinder features a control system that must manage a complex series of functions, including controlling the craft's descent and trajectory, and maintaining ground operations. Since it had to operate in a harsh environment, the system had to be rugged, reliable, and have efficient software code. An IBM RAD-6000 radiation-hardened PowerPC was chosen for the Pathfinder lander, and included VxWorks, the Wind River Systems real-time operating system.

The VxWorks development tools already were running on the PowerPC, and the system provided portability. "It allowed us to utilize low-cost platforms with commercial components while the flight computers were being developed," said Lloyd Keith, a JPL engineer. More than 150,000 lines of code were developed on host systems ranging from SPARC workstations to a 68000-based VME board.

Engineers were able to make modifications on the fly. "When your target is millions of miles away, that's an extremely important capability," said David Larrimore, vice president of marketing for Wind River Systems.

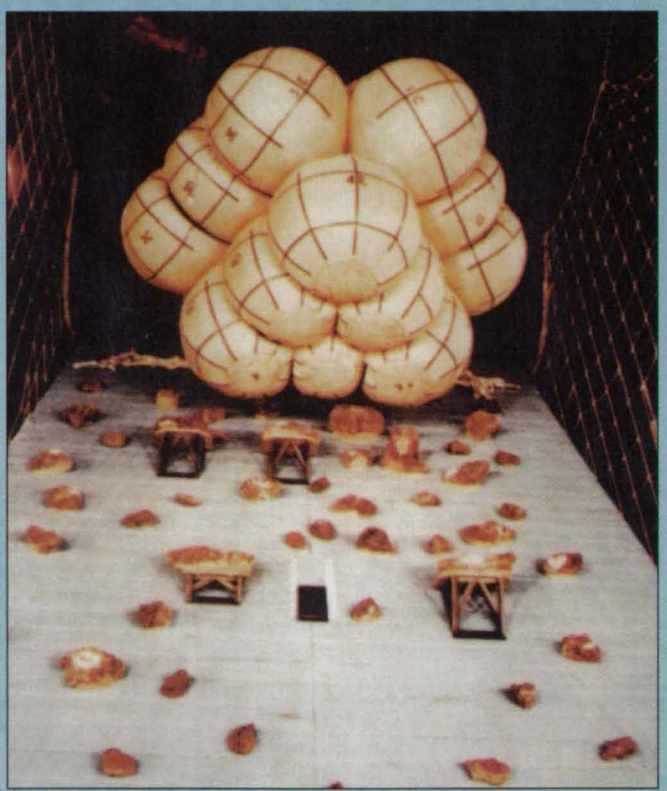
For More Information Circle No. 783

ILC Dover

Frederica, DE

A revolutionary, low-cost concept was initiated by JPL to enable Pathfinder to land safely on the rough Martian terrain. The method utilized a system of airbags that would provide a cushioned landing instead of using retrorockets, which could have contaminated the landing site.

ILC Dover, which designed and manufactured the Apollo, Skylab, and Space Shuttle space suits, worked with JPL to validate the airbag concept in three months. The airbag system program that culminated with Pathfinder's flight took less than 20 months, including mission-unique materials development, prototype fabrication and testing, full-scale development/test, qualification, and flight system phases.



ILC subcontracted Thiokol Corp. for the gas generators used to inflate the bags, and enlisted Rockwell International for validation of the predicted dynamic characteristics of the airbags. In conjunction with JPL, ILC also managed NASA's Lewis Research Center's Plumbrook Station facilities for drop-test verification and inflation tests of the airbags.

For More Information Circle No. 772

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September 1997, *BackOffice Magazine*

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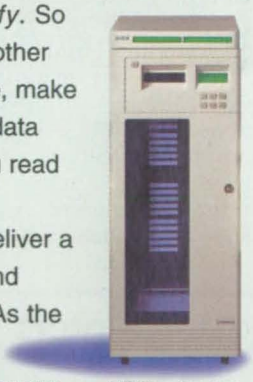

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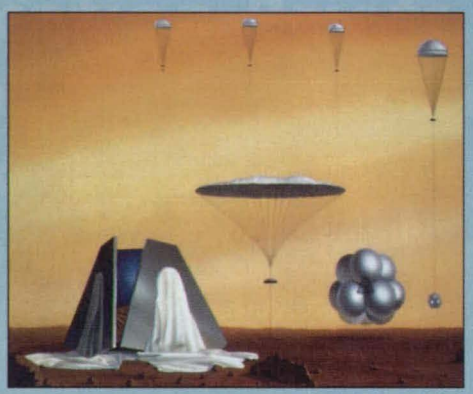
CYBERNETICS

Mechanical Dynamics

Ann Arbor, MI

Engineers at JPL conducted exhaustive tests to determine if the entry and landing systems for the Pathfinder craft would work as planned. JPL used ADAMS mechanical simulation software, which revealed that wind gusts and rocket braking forces could result in the entry pod swaying violently as it parachuted through the Martian atmosphere. "This was a major revelation," said Ken Smith, JPL's group leader for loads and dynamics on the project.

To demonstrate the swaying action and impact angles, engineers presented an ADAMS animated video of the descent at a project review meeting. "After seeing the realistic ADAMS video, everyone knew immediately we had a problem," Smith said. Based on the ADAMS simulations, JPL engineers redesigned the parachute bridle assembly to reduce sway, adding extra layers of abrasion material to the shock-absorbing airbags.



ADAMS also was used to analyze the separation of the entry pod from the cruise vehicle, the heatshield from the vehicle, and the lander from the backshell. JPL engineers ran 500 ADAMS simulations using the Monte Carlo method of generating random numbers. The method also generated a ground terrain model to represent the Martian surface. The simulations took about 750 CPU hours on Hewlett-Packard 700 Series workstations, and produced important data on the altitude, trajectory, velocity, and impact angle of the lander, as well as forces on the parachute risers and drag lines.

For More Information Circle No. 774

Maxon Precision Motors

Burlingame, CA

Eleven miniature DC motors were used to power the Sojourner rover across the Martian landscape: one in each of the six drive wheels; four to steer the rover; and one to deploy scientific instruments. Manufactured by Maxon, prototypes of the motors were supplied in 1993 to JPL, which modified the motors to function on the unique terrain of Mars.

Each motor weighs only 38 grams, measures 16 x 41 mm, and has an ironless rotor for smooth rotation, even at the slow, 3.3 ft./minute travel speed of the rover. Low inertia and linear speed-torque constants enabled Sojourner to maneuver grades of up to 26 degrees.

"Sojourner had to squeeze every bit of solar power to perform its varied tasks," said Sam Robinson, executive vice president of Maxon Precision Motors. Rated at 3.2 watts output power and 86 percent efficiency, the motors are designed to withstand temperatures down to -100°C, according to Robinson.

For More Information Circle No. 773

Spacetec IMC Corp.

Lowell, MA

From JPL, engineers were "virtually driving" the Sojourner rover over the surface of Mars more than 45 million miles away using the Spaceball 2003 3D input control device. The sphere, which sits on the desktop, enabled Brian Cooper of JPL to push forward, pull back, or twist side-to-side, manipulating the movements of the rover with six degrees of freedom. Cooper worked with virtual reality models of Sojourner and the surface of Mars, using images from a stereo imaging system mounted on the lander. Using special battery-powered goggles that allowed him to see the Martian surface in 3D with stereo images presented to each eye (see n-Vision brief following), he overlayed the images with a 3D rendered model of the rover and manipulated the model with the Spaceball 2003.

Cooper programmed the rover's movements in much the same way animators create key frames in animation programs. "As I move the Spaceball around on the Mars surface images, I can tell that the rover is in a certain place," said Cooper. "I click on one of the Spaceball programmable buttons and leave a 'lawn dart' marking where I want the rover to go. Once I accept these intermediate locations, they are organized in a sequence and the rover will go to these places," he explained.

Cooper was able to generate an artificial terrain model based on the stereo images and create a "virtual camera" to view the rover's journey from above, as well as examine obstacles from different angles. He used the Spaceball to position the aerial camera view, "then fly over the terrain from a position that doesn't really exist." This enabled him to zoom in on objects for a closer look and identify terrain hazards that the rover needed to avoid.

For More Information Circle No. 779

n-Vision

McLean, VA

A variety of devices were used to "drive" the Sojourner rover over the Martian terrain. At JPL, Brian Cooper used Virtual Binoculars from n-Vision. Similar in appearance to a high-tech pair of binoculars, the goggles allowed Cooper to sit at his console and scan the Martian landscape. The binoculars "give you a sense of spatial awareness that allows you to look around and feel like you are actually standing on Mars," according to Daryl Rasmussen of NASA's Intelligent Mechanisms Group.

The lightweight binoculars were integrated with advanced graphics computers and stereo cameras mounted on the rover. They provided realistic, high-resolution images of the Martian views captured by the cameras.

"The use of immersive visual technology has been a big hit for the Pathfinder mission," said Rasmussen. "The ability to visually experience Mars in the same manner that we experience our world opens up new ways for us to acquire knowledge. We are now able to archive the science through a user interface that is natural," he added.

For More Information Circle No. 775

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SoMat Corp.

Champaign, IL

The air bags that cushioned the Pathfinder's landing were tested with a rugged data acquisition system originally developed for automotive crash testing. The bags had to keep impact loading of the lander below 50 G during landing at a speed of up to 28 meters per second. The Denton-SoMat Intelligent Dummy Data Acquisition System (IDDAS) — developed, built, and marketed jointly by SoMat and Robert A. Denton Inc. of Rochester Hills, MI — was designed originally to collect transducer data from instrumented dummies in automotive crash testing. The system acquires 39 channels of data to evaluate the tests and is lightweight and self-contained.

Evaluating the bag performance required the acquisition of a large amount of data, including 12 accelerometer channels,

pressure and temperature channels for each of the four bags, and forces on the 16 tendon straps that held each of the bags to the lander. The IDDAS, with a capacity of up to 48 data channels per system, was selected because of its portability and its ability to withstand a 50-G impact.

The IDDAS was customized for the airbag tests, since it originally was designed to rely upon the dummy as a heat sink. Since testing in a nearly complete vacuum eliminated the chance for convective cooling of the IDDAS electronics, radiant cooling was the only method of dissipating heat within the device. The system was programmed with a notebook computer by JPL engineers, and individual test set-up files were called up by technicians.

For More Information Circle No. 778

Spar Aerospace Ltd.

Toronto, ON, Canada

When the Pathfinder craft landed on Mars, one of the first of NASA's concerns was whether its two ramps (one fore and one aft of the spacecraft) would deploy properly, allowing the Sojourner rover to descend onto the Martian surface. The ramps, designed and built by Spar Aerospace subsidiary Astro Aerospace, had to survive 62 Gs of impact as the spacecraft bounced on its airbags on the planet's surface; operate in temperatures down to -110°C; and carry the weight of the rover as it descended. The combined weight of the two ramps was less than 2 kg.

The 1-meter-long ramps were released from their stowed position by the firing of explosive cable cutters. The technology that allowed them to safely unfurl was first developed by Spar in the 1960s and has been applied to new space technologies over the past 40 years. Known as Storable Tubular Extendible Mechanism (STEM), the method compactly rolls up a steel tube, which then is deployed to its tubular form.

"These ramps were critical to the successful disembarkment of the rover," said David Masotti, president of Spar Space Systems. The contract for the design and construction of the ramps was about $400,000.

For More Information Circle No. 780

United States Air Force, Wright Laboratory

Wright-Patterson Air Force Base, OH

The Pathfinder spacecraft carried two payloads to Mars: the Sojourner rover and the lander. Both are powered by high-efficiency solar cells made of gallium arsenide (GaAs) on germanium and lithium thiorryl-chloride batteries.

Developed by Wright Laboratory's Aero Propulsion and Power Directorate, the solar cells provided the rover with power for its computers, lasers, motors, and radio modem. Sojourner generated most of its power from a lightweight solar array — a flat panel mounted on top of the rover. Approximately 200 of the solar cells made up the rover array and another 2,500 comprised the lander's three triangular arrays.

Each cell is very light, thin, and fragile — about the size and width of a razor blade. They are each connected electrically in combinations of series and parallel strings in numbers sufficient to provide the necessary current and voltage-level outputs. To perform its normal activities, the rover required a nominal power supply of 16 watts. When there was no solar light, Sojourner used nine of the Wright Laboratory-developed D-sized non-rechargeable batteries.

"The batteries can't be recharged so they were used sparingly, primarily during periods of low light or at night," according to Dr. James D. Scofield, research engineer with the Aero Propulsion and Power Directorate. The power generated by the solar array and the batteries was distributed to provide more than 10 different voltage levels for various rover functions.

Applied Solar Energy Corp. of Industry, CA, was the contractor to Wright Laboratory for development of the solar cells.

For More Information Circle No. 782

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For More Information Circle No. 548

PARAMETRIC
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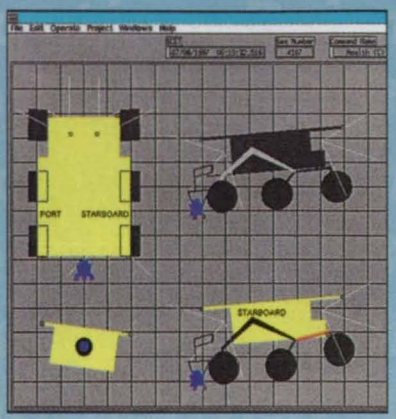
Application Briefs

National Instruments

Austin, TX

Engineers at JPL used LabVIEW™ graphical instrumentation software to analyze and visualize data from Sojourner. The system — developed on Macintosh computers and Windows PCs running on Sun SPARCstations — utilized six workstations running programs developed with LabVIEW, and enabled JPL scientists to analyze the position of the rover, its temperature, how much power remained in the rover's batteries, and monitored its overall health.



LabVIEW's "virtual instrumentation" feature plotted internal and external temperature of the rover during morning, afternoon, and evening hours, as well as at sunrise, when the rover began to power up for the day. The software also analyzed rover engineering data with several views of the rover, depicting the position of the arms, bogies, and mechanisms, and the state of the contact sensors.

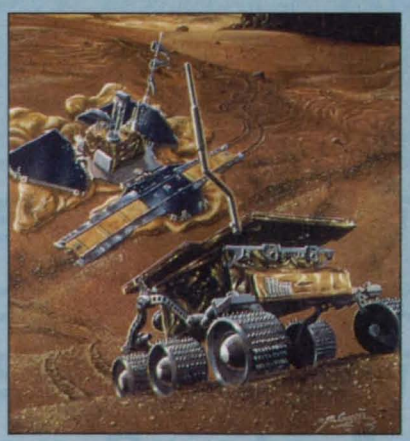
Finally, LabVIEW analyzed the Sojourner data, providing overhead views of the landing site, as well as those taken by the rover as it moved across the terrain. The information displayed by LabVIEW was based upon the actual telemetry data acquired by the rover.

For More Information Circle No. 776

Teledyne Relays

Hawthorne, CA

From the early deep-space probes such as Voyager I, Teledyne Relays has supplied Hi-Reliability relays to the space market. The same replays were used in the Pathfinder craft and the Sojourner rover.



Twelve magnetic latching high-shock relays, screened in accordance with a customer source control drawing, were used in the Pathfinder's power supply system. Six of the relays were used to operate the motor control system of the rover.

The latching relays also were used on the Mars Global Surveyor spacecraft, which entered orbit around Mars in September and will spend two years mapping the planet's surface and magnetic fields, relaying the data back to Earth.

For More Information Circle No. 781

Silicon Graphics

Mountain View, CA

The valuable data and images of Mars that the Pathfinder and Sojourner have sent back to Earth is processed by Onyx2™ visualization supercomputers, two 02™, and eight OCTANE™ desktop workstations. WebFORCE® Origin200™ servers host the interactive JPL web site and a Silicon Graphics mirror site that chronicled the landing.

"The Mars Pathfinder project represents a milestone in history that's comparable to landing on the moon three decades ago," said Robert Ewald, executive vice president of Computer Systems at Silicon Graphics. The systems have been used to analyze data, provide 3D interaction on the web, and navigate the microrover, according to Ewald.

The Sojourner and its surface instruments collected samples to investigate Mars' geology, geochemistry, soil, and

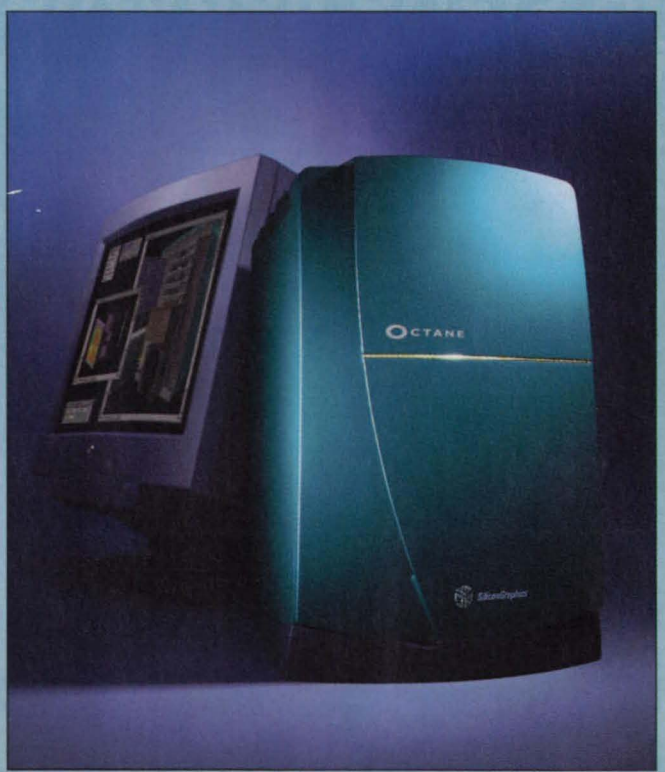


Photo courtesy of Silicon Graphics, Inc.

atmospheric properties. An Onyx2 managed the processing and control functions required to maneuver the rover. When image data from the rover's embedded cameras was returned to Earth, it was processed by the Onyx2 into a detailed 3D model of the Martian surface. The image data was overlaid onto the model to create a realistic representation of the planet's terrain.

The WebFORCE server, hosting millions of hits per day early in the mission, also manages the dissemination of web site content to approximately 20 mirror sites. It includes animated simulations of the landing and deployment of the rover, as well as an interactive VRML site where visitors can drive a virtual rover on a simulated surface of Mars.

For More Information Circle No. 777

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For More Information Circle No. 516

Technology 2007: The Future on Display

In last month's issue, we presented cutting-edge products and inventions that were on display at Technology 2007, held in September in Boston. Here, in the second part of our show wrap-up, we highlight more of the exceptional technologies, companies, and individuals that made Technology 2007 the "Engineering Innovation Show."

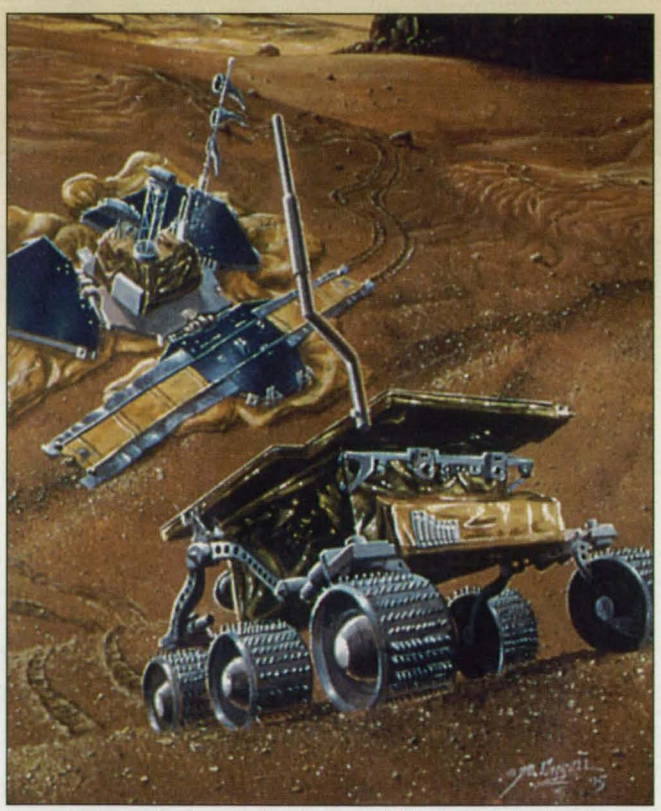
They Came From Mars

NASA's cutting-edge technologies on display at the show didn't end with the weather-forecasting innovations achieved through Mission to Planet Earth (see *NASA Tech Briefs,* November 1997, p. 24). The NASA pavilion also featured emerging technologies from the Mars Pathfinder. Developed at Jet Propulsion Laboratory, the home of the Pathfinder, the technologies are in various stages of development toward becoming licensable. Along with the following NASA-developed technologies, the Pathfinder mission made use of a variety of off-the-shelf commercial products, some of which are described in the Application Briefs beginning on page 20.

JPL is exploring ways to commercialize Silica Aerogel Insulation, which was used as electronics insulation material in the Sojourner rover's warm equipment box. Since surface temperatures on Mars plunge to -100°F at night, sensitive electronics needed to be kept at proper operating temperatures. Aerogel, one of the world's best insulation materials, features a frothy molecular structure that gives it a density only a few times greater than that of air. Properly supported, it can bear up to 1,000 times its weight, giving it great promise for use in refrigerators, ice chests and coolers, and Thermos bottles.

The unique rocker-bogie suspension of the rover provided exceptional stability and enabled it to negotiate rocks almost as high as the rover itself. The patented JPL suspension joins the three wheels on each side with only two swinging joints, and connects the bogie to the chassis at a single point. It combines independent drive and individual steering for each wheel. Applications for the technology include off-road all-terrain vehicles, handicapped assistance vehicles, search and rescue vehicles, and robots for fire-fighting and defusing bombs.

The 1997 NASA Software of the Year was awarded to a software package used on the Pathfinder. DARTS (Dynamics Algorithms for Real-Time Simulation), written by three JPL engineers (see *NASA Tech Briefs,* October 1997, p. 70), generates real-time simulations to test and verify flight software and hardware. In addition to Pathfinder, DARTS has been used on the Galileo, Cassini, Stardust, and New Millennium missions and has saved JPL an estimated $10 million.



An artist's rendering of the Mars Pathfinder lander (background) and the Sojourner rover (foreground).

For more information on Mars Pathfinder technologies, contact the JPL Public Affairs Office at 818-354-7006 or visit the Mars Pathfinder web site at http://mpfwww.jpl.nasa.gov

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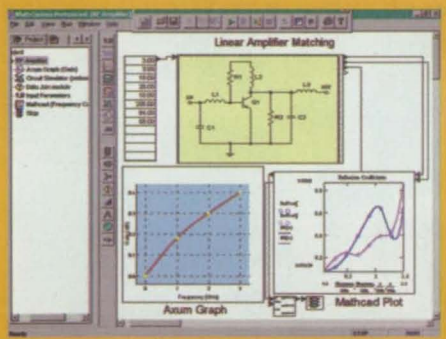

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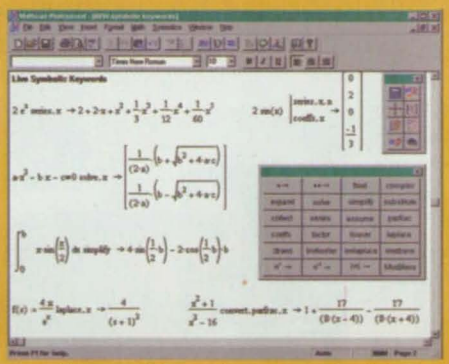

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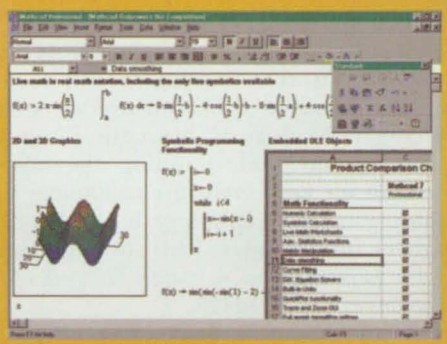

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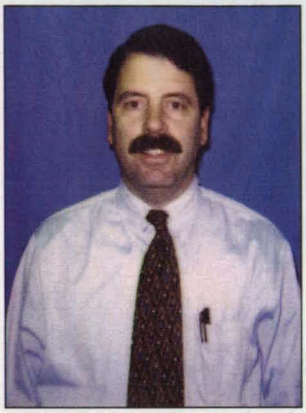
Making Tech Transfer Work

The Technology 2007 conference program began its Tuesday sessions with a Plenary Session that featured William Neill, Collaborative Product Development Program Manager for Hewlett-Packard (HP) on "Making Technology Transfer Work for the Bottom Line: Keys to Developing Effective, Sustainable Tech Transfer Processes." Neill's presentation focused on how to make the tech transfer process work across all technologies, markets, and customers, and Hewlett-Packard's broad view of technology transfer.

HP's approach to tech transfer is based on gaining a unique view of customer needs and positioning itself for a competitive advantage. Having grown from an engineering focus, said Neill, "our approach naturally is based on scientific method. One of the significant parts of our technology transfer process is something we call the 'Ten-Step Process.' It consists of data collection, analysis, planning, and measurement."



Bill Neill of Hewlett-Packard

The Ten-Step Process consists of setting objectives, identifying customers and how they buy, identifying competitors, and looking at the products, services, and financial resources that are required to be successful. Having learned what customers need, HP then looks at changing needs, growth trends, and opportunities for the future. "We have consistently focused on growing opportunities," Neill said, "and we consistently find ourselves one of the top respected companies for the quality of our products. This requires a significant change in how one views technology and their role in the technology transfer process."

HP has learned a great deal from the tech transfer process. According to Neill, the company has discovered that "communicating the value of the technology is the critical role of the process, and understanding the customer's needs is the key to effective technology transfer. Sharing useful technology is the key to profitability since it lowers R&D costs and risk."

For more information, contact Bill Neill of Hewlett-Packard at 617-270-2428.

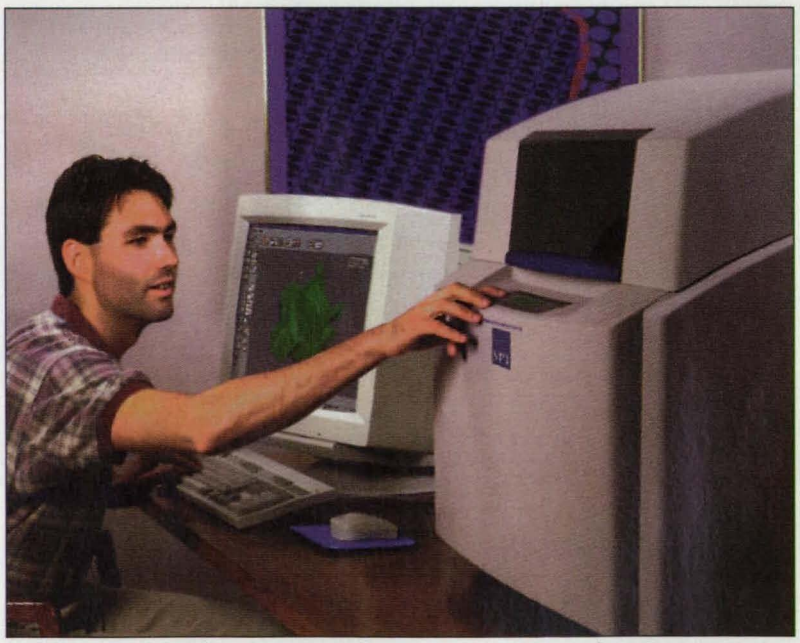
Small Business Stars

At a special Awards Reception at the Hynes Convention Center Grand Ballroom on Tuesday, Kathy E. Jordan, President of Kae Corp. — a media relations, marketing, and training firm in Huntsville, AL, and a longtime advocate for small business — presented five Small Business Innovation Research (SBIR) Technology of the Year Awards. These awards are given to U.S. companies that have developed and commercialized innovative products or processes through the federal government's Small Business Innovation Research program, which awards grants to firms with 500 or fewer employees to perform leading-edge R&D that addresses the nation's most critical technical needs.

The Grand Winner of the 1997 SBIR Technology of the Year Award was Sanders Design International, Wilton, NH, for its Ink-jet Rapid Prototyping Machine (IRPM), supported by an SBIR contract with the U.S. Air Force. The IRPM uses both additive and subtractive methods of building solid free-form models to achieve a tenfold improvement in prototype accuracy, surface quality, and finite feature detail over traditional methods. The IRPM provides an overall accuracy of 0.001 in. within a cubic-foot volume, building patterns at speeds comparable to less accurate systems and improving the accuracy of model-building by an order of magnitude at a fraction of the cost. The economic impact of the IRPM is foreseen in the capability of the investment casting and plastic molding industries to produce tooling-grade prototypes directly. Sanders Design International is developing markets for the IRPM in the manufacturing sector of the automotive, electronic and electrical, appliance and consumer products, industrial tools, aerospace, and medical markets.

Winner in the Computers/Electronics category was Displaytech Inc., Longmont, CO, for the ChronoColor™ ferroelectric liquid crystal miniature display, supported by a NASA Johnson SBIR contract. These miniature imaging devices (MIDs) are a complete display built on the surface of a very large-scale integrated (VLSI) chip. All of the circuitry required to drive the display, as well as the active matrix circuitry for switching each pixel in the display, is integrated, substantially simplifying the interface. Because ChronoColor uses only a single very-high-resolution MID, device costs and overall system costs can be dramatically reduced. They offer full-color images and significant advantages in throughput efficiency and fill factor over alternative systems.

In the Environment, Energy, and Resource Management category the winner was KSE Inc., Amherst, MA, for a photocatalytic Adsorption-Integrated-Reaction (AIR) air purification process. The work was the result of an SBIR contract with NASA. The process employs a proprietary catalytic adsorbent to trap and concentrate dilute contaminants from the air on its surface. This photocatalyst is continuously illuminated with ultraviolet light, which promotes dissolution of the contaminant into environmentally safe compounds such as water and carbon dioxide, and restores the photocatalyst



Sanders' ModelMaker II system, shown with a CAD workstation, turns CAD files into 3D thermoplastic models suitable for molding and casting.

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surface to capture more contaminants. KSE says the photocatalyst is orders of magnitude more active than any competing catalyst, resulting in very small, inexpensive units. Agreements are in the works with a large NASA contractor to conduct plant chamber flight tests next year, and a commercial customer has purchased a unit for control of emissions of airborne chlorinated hydrocarbons at a Superfund site.

In the Industrial/Manufacturing and Materials category, the prize went to Foster-Miller Inc., Waltham, MA, for Z-Fiber™, a process developed with the support of a U.S. Navy SBIR contract. The patented method consists of Z-direction reinforcement of composite laminates to reduce delamination and increase general damage tolerance. The process uses ultrasonics to insert small-diameter composite or metal rods through the thickness of the composite. The rods lock the layers of composite material together for three-dimensional strength. The process is accomplished under the normal heat and pressure of autoclave cure, so no new materials or extensive equipment upgrades are required to Z-reinforce a composite product. Aztex, Inc., a new company, was spun off in 1995 to manufacture Z-Fiber. The Navy MANTECH program is testing Z-Fiber as a replacement for fasteners on aircraft, which Foster-Miller estimates could save $300,000-$500,000 per aircraft in fastening costs.

Finally, in the Sensors/Instrumentation category, DeWitt Brothers Tool Company Inc., Ancramdale, NY, garnered top honors for a method of diffraction range-finding that uses a handheld 3-D scanner and holograms. With a National Science Foundation SBIR contract, the company developed a patented "chirp" grating designed with custom software and made by combining a spherical wave with a plane wave. These produce regular patterns for subsequent computer image processing, making possible generic holograms for three-dimensional imaging under field conditions. The company's prototype can digitize 15,000 x-y-z points a second within a meter cubed with a resolution of 0.01 mm and an accuracy of 0.1 mm. The company envisions applications in 3-D computer graphics, CAD/CAM, autonomous vehicle navigation, robotics, machine vision, and a host of other uses of such surface coordinate data.

For more information on the SBIR program, contact the SBIR Conference Center at 360-683-5742.

Inframetrics' ThermaCAM SC1000 can be controlled from either a window in ThermaGRAM PRO software, or by the camera controls directly.

The Best of New England

Technology 2007 provided a unique opportunity for attendees to view New England's most innovative new products and inventions in the New England Technology Showcase (NETS). A Best of Show, Spinoff Achievement Award, and Best of Show Honorable Mention were presented to three NETS companies during the awards reception.

The Best of Show Award for the most innovative and commercially significant technology or product exhibited at NETS was presented to Inframetrics of North Billerica, MA for the SC1000 ThermaCAM™ handheld infrared camera. The camera can operate as a standalone camera or as a dedicated real-time digital system when interfaced with the company's ThermaGRAM PRO 95 real-time digital image processing system for Windows 95.

The SC1000 was developed for users in the scientific market who require high sensitivity and advanced image processing capabilities to support their infrared imaging and temperature analysis applications. The unit can provide screen temperature measurement accuracy of better than ±2% or 2°C. It can operate continuously from a single standard camcorder battery for more than two hours, and an optional battery belt will run the camera for 12 hours.

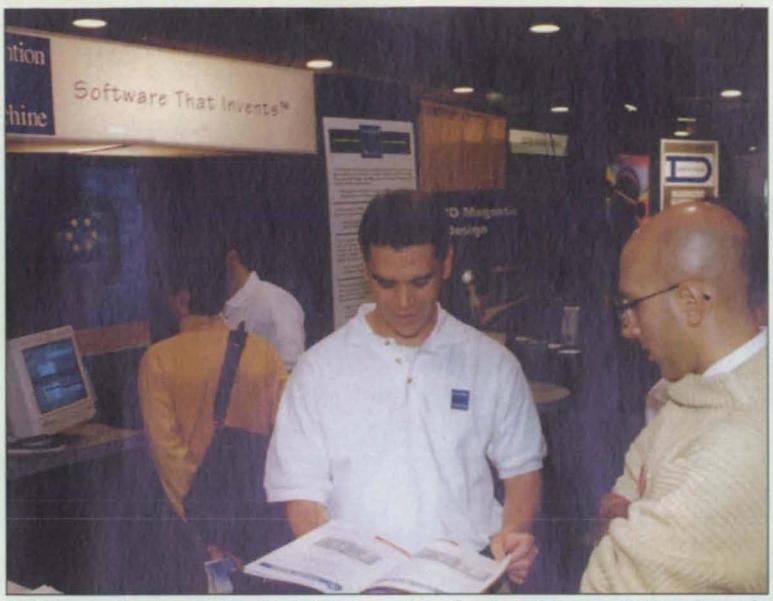
The focal plane array radiometer weighs six pounds with the power source and has FLASH PCMCIA compatibility for storage of up to 256 images on a single card. Remote control and focus from a PC or handheld controller is possible via a serial remote control port.

Inframetrics, established in 1975, supplies other thermal imaging and temperature measurement systems, components, and accessories to scientific, industrial, aerospace, law enforcement, and military markets.

For more information on Inframetrics, contact the company at 16 Esquire Rd., North Billerica, MA 01862-2598; Tel: 508-670-5555; Fax: 508-667-2702; or visit them on the Web at www.inframetrics.com.

For demonstration of the most innovative and commercially significant product applying technology developed by, for, or with the federal laboratory and university R&D communities, the Spinoff Achievement Award for NETS was presented to JENTEK Sensors of Watertown, MA. The JENTEK Sensor™ System concept originated with research into dielectrometry and magnetometry conducted at the Laboratory for Electromagnetic and Electronic Systems at the Massachusetts Institute of Technology (MIT). The company's resources include a team of engineers, scientists, and software development specialists from MIT.

JENTEK provides thin and conformable inductive and capacitive sensors for measuring physical property variations as a function of depth from a part surface, and for gauging geometric properties such as coating thickness and proximity. Patented JENTEK Magnetometer and Dielectrometer probes provide real-time measurements on flat, convex/concave, and conical surfaces; a patented multiple wavelength Interdigital Electrode Dielectrometer (IDED) provides characterization of multiple layered media.



Visitors to the Invention Machine Corp. booth at Technology 2007 viewed a demonstration of TechOptimizer™ Professional Edition problem-solving software.

Other products that are available commercially include GridStation™ software for data interpretation from single and multiple sensors and operating conditions; and the Meandering Winding Magnetometer (MWM™), which includes GridStation software, customized MWM probes, and either commercially available impedance and LCR meters, or customized JENTEK instrumentation.

For more information on JENTEK Sensors, contact the company at 200 Dexter Ave., Watertown, MA 02172; Tel: 617-926-8422; Fax: 617-926-8744; or e-mail at jentek@shore.net.

Invention Machine Corporation of Boston received a NETS Best of Show Honorable Mention Award for its TechOptimizer™ Professional Edition technical problem-solving software, which is designed to work with engineers and scientists in resolving engineering problems at a conceptual level. It uses a new category of engineering software called Computer-Aided Innovation (CAI) to help users correctly state and solve engineering problems.

TechOptimizer software incorporates five modules: the TechOptimizer module helps the user correctly state the engineering problem; the Effects, Principles, and Prediction modules are then used to find innovative solutions; and the Feature Transfer module offers another approach to effective problem-statement and solution.

Invention Machine, which markets Tech Optimizer to product and process engineers, design engineers, scientists, engineering managers, and individuals involved in R&D, announced last month their newest problem-solving software package called IM-Phenomenon™ Professional Edition. (See UpFront on page 16 for more information on the new software, which is this issue's Product of the Month.)

Contact Invention Machine Corp. at 200 Portland St., Boston, MA 02114-1722; Tel: 617-305-9250; Fax: 617-305-9255; or visit them on the Web at www.invention-machine.com.

A "Major" Achievement

A Life Achievement Award in Technology Transfer was presented to Major Audie Hittle, who retired October 1 from the U.S. Air Force as Chief of the Electronics Systems Center (ESC) Technology Transfer Branch at Hanscom Air Force Base, MA. In his position at the ESC, Hittle enhanced the transfer of technologies between federal laboratories and defense, commercial, and international industries in support of Air Force missions. By personally initiating, negotiating, or managing nearly 90 cooperative research and development agreements (CRADAs), he helped the Air Force leverage its technology investment and integrate technology transfer into its strategic goals. These CRADAs leveraged more than $35 million worth of industry contributions, cash, and technical resources.

Air Force Major Audie Hittle (Ret.) accepts his Life Achievement Award in Technology Transfer from the Technology Utilization Foundation.

Major Hittle also successfully implemented a CRADA approval process that completes negotiation, coordination, and approval in less than 30 days. The first Air Force officer specifically educated in technology transfer, Major Hittle earned a master's degree in Management of Technology from MIT's Sloan School of Management. He served two terms on the FLC's executive board, the first military officer to be elected to this body. In addition, Hittle was a founding member of the New England Chapter of the Technology Transfer Society.

Mark Your Calendar ...

... for **Technology 2008,** to be held from November 3-5, 1998 at the Hynes Convention Center in Boston.

Technology 2008 will be co-located with the Photonics East and Electronic Imaging International conferences for the second year.

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Commercialization Opportunities

Circular Array Antenna With Microstrip-to-Slot Transitions

This relatively simple, low-profile antenna forms a toroidal radiation pattern. The antenna can be mounted on the roof of a vehicle for use in mobile/satellite communication.
(See page 54.)

Neuroprocessor for Detecting Misfire in an Automotive Engine

A neuroprocessor performs a complex diagnostic test to detect engine misfire, which the presently used engine-control microprocessors cannot do very efficiently. Such neuroprocessors are intended to satisfy the progressively stricter emission requirements of the Clean Air Act.
(See page 60.)

Capillary-Pumped Loops for Equalizing Body Temperatures

These thermal-control devices designed for protective suits would distribute heat more uniformly and thus make the wearer more comfortable. Heat from the usually overheated parts of the human body, e.g., armpits, would be transferred over to the usually colder extremities, e.g., hands and feet.
(See page 64.)

Improved Oxidation-Resistant SiC(Si/SiC) Composites

These composites are designed to resist oxidation at high temperatures in the presence of air and steam. Most likely applications are in advanced aircraft engines and gas turbines.
(See page 68.)

Lightweight Panels With Embedded Perpendicular Metal Pins

Among the advantages of these types of composite structures, developed originally to shield spacecraft against high-speed impacts, are a twenty-fold increase in delamination resistance, which is important for aircraft structures; better joining to supporting ribs; and improved thermal conductivity, which makes them appealing to electronic packaging.
(See page 70.)

Coating Fibers With Ceramics by Use of Slurries

Fibers for use in metal-matrix/fiber composite materials are coated with a ceramic-matrix/fiber interfacial layer by use of slurries instead of chemical vapor deposition. Advantages are lower cost, fewer processing steps, and better quality control.
(See page 72.)

Carbon Papers for Negative Electrodes in Lithium Cells

Experiments point to commercial carbon papers as candidate negative electrodes for lithium-based electrochemical cells. These papers have been shown to offer high reversible charge/discharge capacities.
(See page 74.)

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Revolutionizing workstation performance, Micron introduces our exclusive Samurai chip set on the Powerdigm XSU workstation. A powerful, Intel processor-based workstation, the Powerdigm XSU will execute your most demanding business and technical tasks – and it's flexible enough to run the most popular PC programs.

Engineered and developed by Micron, the Samurai chip set is the first to offer a 64-bit/66MHz PCI bus, based on Intel architecture. The Samurai chip set enables greater bandwidth for people who demand maximum throughput from their workstations and integrated peripherals.

The Powerdigm also supports dual monitors, dual Pentium II processors, multiple ultra-wide SCSI-3 hard drives and 10/100 network adapters. The Fire GL video cards offer no-compromise 3D performance and Jaz drives are standard.

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Iomega Jaz SCSI drive with 1GB removable cartridge
Wavetable stereo sound with speakers
3Com Fast EtherNet 10/100 PCI network adapter
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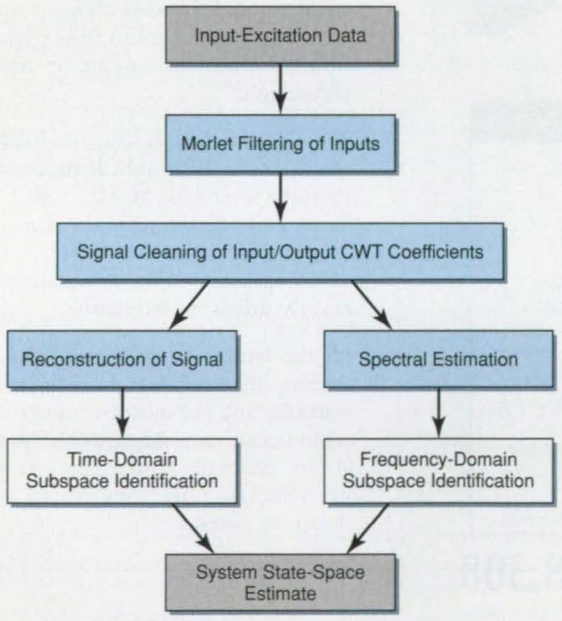
Wavelet Analysis of Flight-Test Data on Aeroelasticity

Wavelet analysis offers advantages over Fourier analysis.

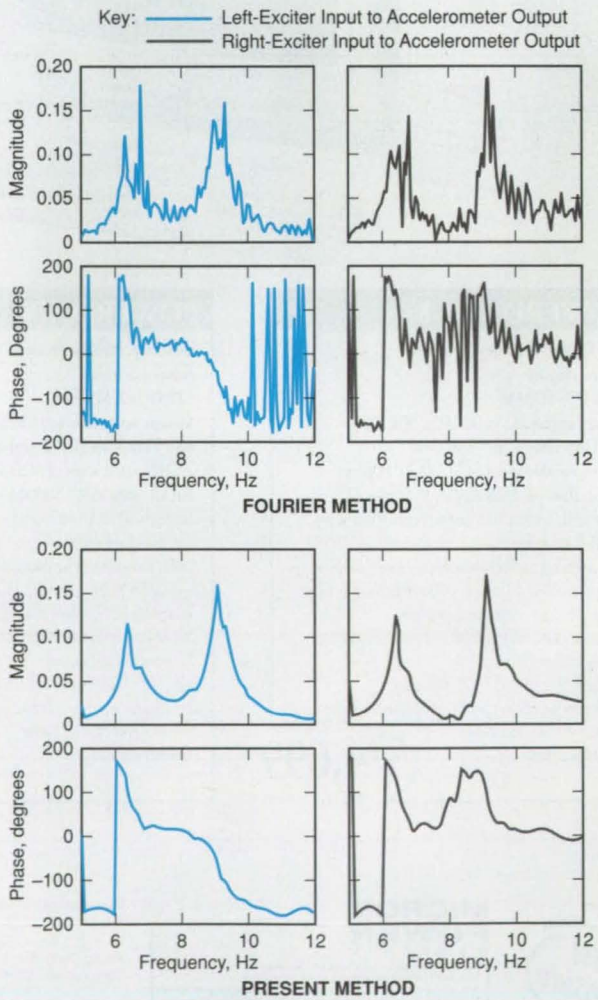
Dryden Flight Research Center, Edwards, California

A method of computational filtering enables the removal of distortions from flight-test data. The method is built upon and adapts the methods of wavelet-transform analysis to the particular test data. Although this method does not depend on the type of test data or other data to be analyzed, the initial application was to aeroelastic-flight-test data (e.g., accelerometer readings) generated with the help of structural-vibration-excitation systems on the F/A-18 Systems Research Aircraft (SRA) and the High Alpha Research Vehicle (HARV). Such excitation systems are often essential for enabling system-identification algorithms to resolve stability trends from noisy measurements, inasmuch as atmospheric turbulence generally does not provide excitation of the type needed for determining vibration-mode characteristics.

In processing flight flutter data, one attempts to analyze the characteristics of the data in terms of times, shapes, amplitudes, frequencies, and durations of events in the data. Such analyses have traditionally been performed by use of classical Fourier techniques. However, Fourier techniques are suspect in the presence of the inherently transient nature of in-flight aeroelastic dynamics; this is because the basic Fourier-analysis



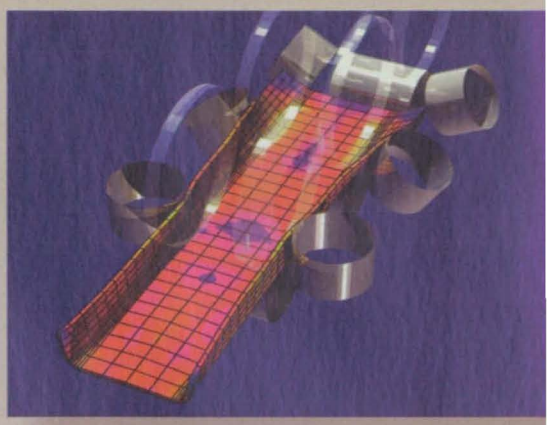
SYSTEM-IDENTIFICATION PROCEDURE



TRANSFER FUNCTIONS OBTAINED BY THE FOURIER METHOD AND THE PRESENT METHOD

Figure 1. **Transfer Functions** constructed by use of the present method (using part of the procedure illustrated at the left) are cleaner than are those obtained by Fourier techniques.

There's a world of difference waiting. The competition isn't.



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assumptions of infinite duration and at least local periodicity make it impossible to represent adequately the intermittency, modulation (amplitude, phase, or frequency), nonperiodicity, non-stationarity, time-variance, and/or nonlinearity in the data.

Wavelets are versatile harmonic-analysis tools that combine both time and frequency representations into localized waveforms. Given a segment of experimental data, the wavelet transform is constructed by convolving a selected series of local waveforms with the data to identify correlated features or patterns in the signal represented by the data. The result is a set of wavelet coefficients that can be interpreted as multidimensional correlation coefficients. Features of shape, size, and location are naturally characterized by these waveforms and related coefficients.

The salient features of the original signal are reconstructed by exploiting the redundancy of the wavelets in the continuous wavelet transform (CWT). Unwanted time-frequency components are removed from the data by masking; that is, by setting the corresponding wavelet coefficients to zero. This procedure is followed to filter unwanted distortions and extract desired features from input (e.g., vibrational-excitation) and output (e.g., structural-vibrational-response) data. Extraction of features by this procedure offers advantages over traditional band-pass-filtering and thresholding techniques in that it results in the removal of unwanted features while leaving desired signal components intact.

Inasmuch as the F/A-18 structural excitations are essentially short-time sinusoids, a wavelet basis function could be expected to represent the characteristics of the excitation data. The Morlet wavelet was chosen as the basis function

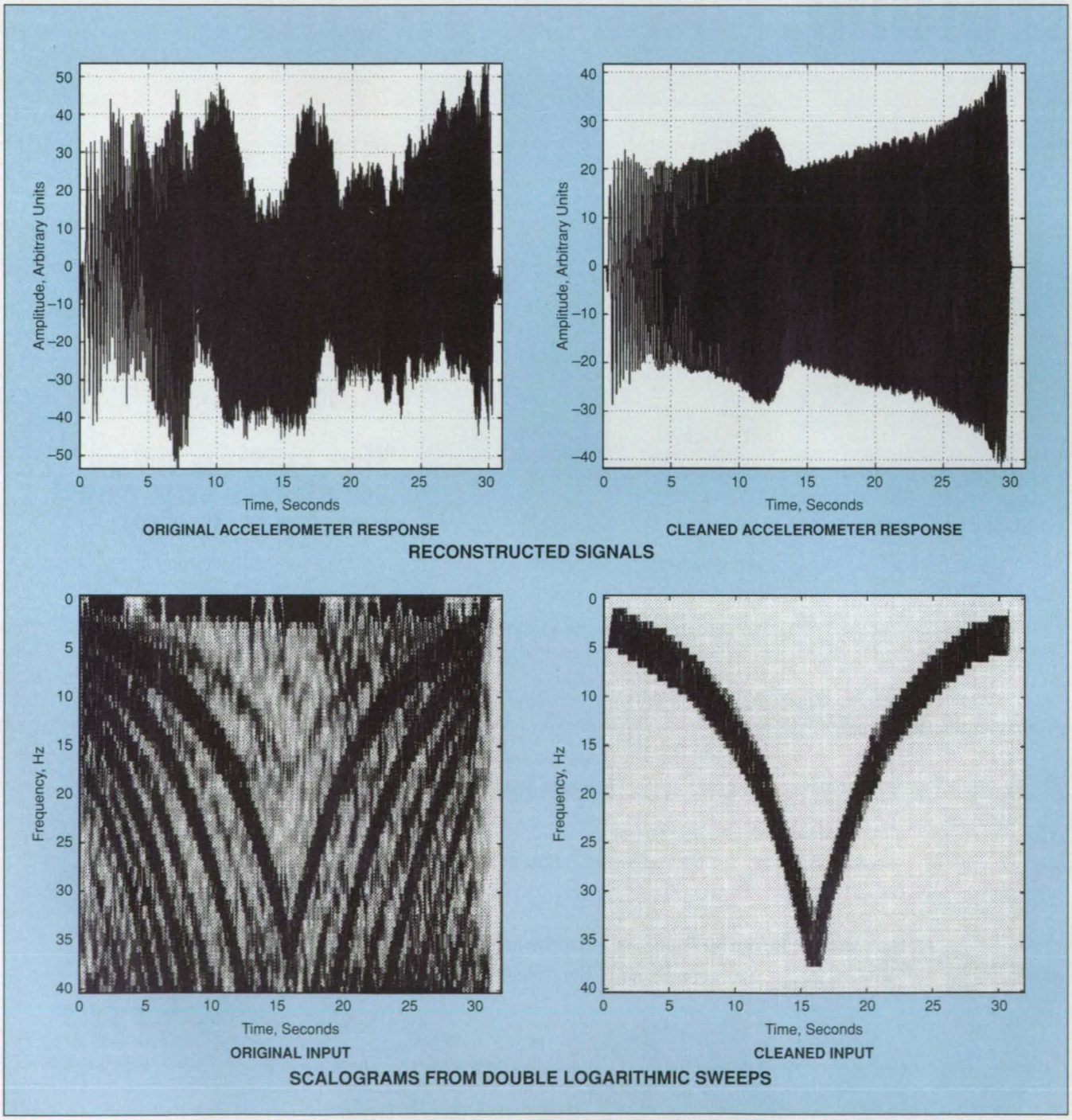

Figure 2. These **Examples of Reconstructed Signals and Scalograms** illustrate the utility of the present method for cleaning signals.

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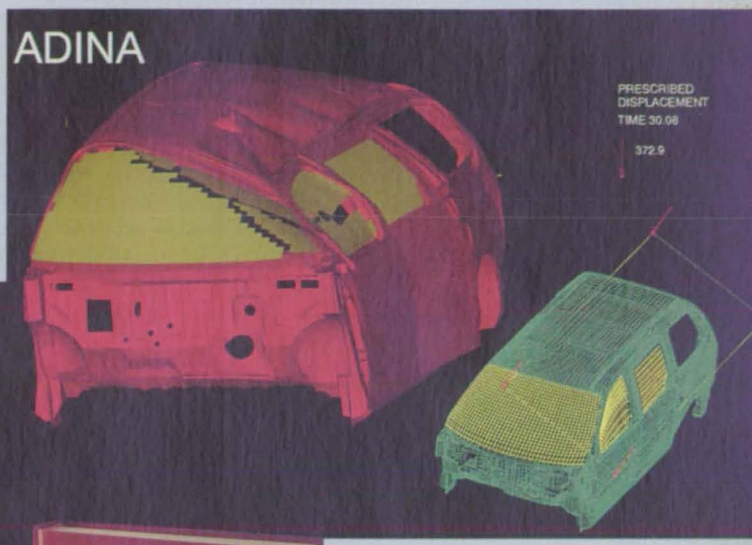
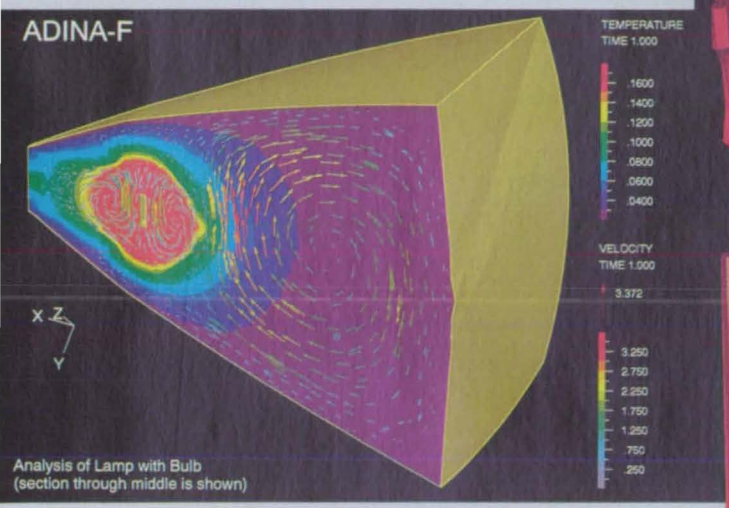
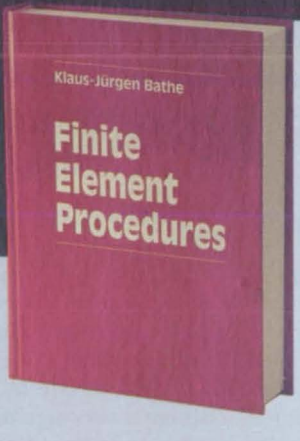
Structures & CFD



Crush analysis, static solution



Fluid flow with specular radiation



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because of its clear interpretation in the frequency domain (Gaussian window) and time domain (locally periodic waveform) for the analysis of vibration data.

Transfer functions are used in structural dynamics to acquire state-space representations of the system modal dynamics, to determine stability estimates with standard methods, and to predict flutter boundaries with more advanced techniques. Traditional Fourier-transform methods involve averaging, windowing, and other procedures that often disguise important features in data. The present method includes a recipe to circumvent this deficiency by utilizing a wavelet-based feature-extraction filter to estimate cleaner transfer functions based on localization in frequency and time. The left part of Figure 1 schematically depicts a system-identification procedure (including a procedure for constructing transfer functions) according to the present method.

The right part of Figure 1 presents an example of how the results achievable by use of the Morlet filter surpass those achievable by standard Fourier techniques. The Morlet processing affords an obvious improvement for identifying modal peaks in the presence of noise and in establishing well-defined phase response. Identification schemes used to extract modal data, state-space representations, and stability boundaries will perform better when the Morlet-filtering procedure is incorporated into them.

In reconstructing a signal, one uses the redundancy of the wavelets to estimate a time signal best approximated by the CWT. The real Morlet transform assures a reconstruction in phase with the original signal. The top part of Figure 2 presents an example of a reconstructed original signal and a reconstructed, cleaned version of the signal.

An example of filtering the undesired features of more-complicated input/output signal pairs in the time-frequency representation involves the use of a double logarithmic sweep from an excitation system. The bottom part of Figure 2 contains planar scalograms (maps of CWT coefficients) that pertain to this example. Harmonics from strain-gauge input measurements can be detected readily in the left scalogram. The presence of these harmonics indicates nonlinear exciter-vane response from rotating slotted cylinders at the wing tips. Such nonlinearity is deemed undesirable for subsequent analysis by linear state-space identification methods. Therefore, the input signal is processed by (a) extracting the desired time-frequency map from the left scalogram, yielding the right scalogram, then (b) reconstructing the time-domain input signal from the data represented by the right scalogram.

This work was done by Martin Brenner of **Dryden Flight Research Center** *and Eric Feron of Massachusetts Institute of Technology. For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Mathematics and Information Sciences category,* ***or circle no. 154*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge). DRC-96-76*

Software for Modeling Dynamics of Optical Interferometers

NASA's Jet Propulsion Laboratory, Pasadena, California

The Single Mode Acquisition Code (SMAC) computer program mathematically models the optical, mechanical, and electronic dynamics of high-finesse, long-baseline, multiple-cavity optical interferometers like those used in gravity-wave detectors. Dynamical situations that can be simulated include those that involve noise and/or multiple modulation frequencies and sidebands. SMAC includes components for modeling the dynamics of cavity-control servomechanisms, electronic closed-loop servo control subsystems, and synchronous-detection electronic circuitry. Nonlinear time-domain models are incorporated for use in designing and testing lock-acquisition controllers. Once lock has been achieved, small-amplitude transfer functions represent cavity signals adequately. SMAC provides a graphical user interface for defining problems and controlling execution with respect to the problems. SMAC also provides extensive pre- and post-processing support.

This program was written by Laura Needels, David Redding, and Lisa Sievers 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 Computer Software category,* ***or circle no. 115*** *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-20122.

Improved Software for Modeling Controlled Optical Systems

NASA's Jet Propulsion Laboratory, Pasadena, California

Modeling and Analysis for Controlled Optical Systems (MACOS) is an easy-to-use computer program for simulating and analyzing the behaviors of a variety of optical systems. MACOS includes S-MACOS, a subroutine software package that provides MACOS commands to any program written by the user, enabling the incorporation of full optics-modeling functionality into other computer codes. MACOS and S-MACOS are improved versions of COMP and SCOMP, which have been applied to more than 30 space- and ground-based instrument systems, including telescopes, cameras, radio antennas, optical interferometers, imaging spectrographs, integrated optical devices, and adaptive-optics systems. MACOS features include a command-line user interface, graphical display of results, interactive dialogues that guide the user through all functions, and ten levels of macros. System models are built up from component models of optical elements (e.g., mirrors, lenses, and diffraction gratings) and surface types (e.g., flats and conics of revolution). Instrument-simulation capabilities are achieved through hybrid ray-trace and physical-optics diffracted-beam propagation combined with sophisticated imaging simu-

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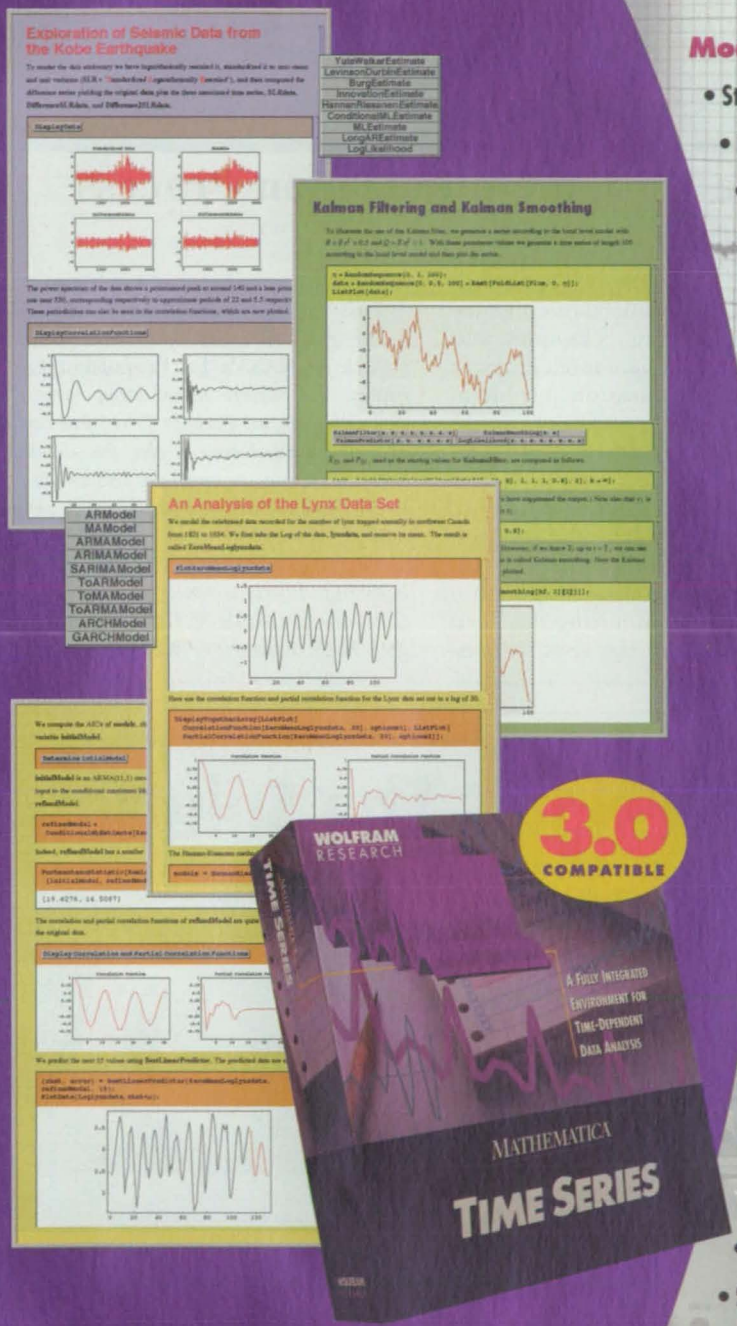

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- Nonstationary time series models: ARIMA, SARIMA
- Univariate and multivariate time series models
- Structural models: State-space form and the Kalman filter
- ARCH and GARCH models
- Covariance, correlation, and partial correlation functions

Model Identification

- Estimation of sample covariance, correlation, and partial correlation functions
- Akaike's Information Criterion (AIC)
- Bayesian Information Criterion (BIC)

Parameter Estimation

- Yule-Walker, Levinson-Durbin, Burg's, innovations, and long autoregression algorithms
- Hannan-Rissanen procedure
- Maximum likelihood method

Diagnostic Checking

- Residuals
- Portmanteau test
- Information matrix

Forecasting

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- Updating the prediction

Spectral Analysis

- Spectra of ARMA models
- Spectrum estimation
- Smoothing spectrum using lag and spectral windows

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For More Information Circle No. 561

lation features. MACOS includes such unique integrated modeling features as linear matrix models of optical instruments and the ability to export linear models directly into Matlab or other numerical-analysis software environments for integration into system-level analyses.

This program was written by David C. Redding and Laura Needels 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. 189*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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

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Refer to NPO-19841, volume and number of this NASA Tech Briefs *issue, and the page number.*

Software for Automating the Design-Optimization Process

NASA's Jet Propulsion Laboratory, Pasadena, California

The Optimization Assistant (OASIS) computer program is a research prototype of a design-optimization software tool. It is being developed to automate much of the process of solving a complex constrained optimization problem of the type encountered in designing a spacecraft, and to facilitate rapid "what-if" analysis of design. As currently envisioned, OASIS would comprise three major components; (1) a set of generic, configurable, metaheuristic optimization algorithms (including genetic and simulated-annealing algorithms); (2) an adaptive problem solver based on artificial-intelligence and machine learning techniques; and (3) a spacecraft-design model. For a given design-optimization problem, the spacecraft-design model would accept, as input, the decision variables to be optimized and would output the value of an objective function. For the specific problem, the adaptive problem solver would select an appropriate optimization algorithm and configure it, minimizing the need for intervention by the user to customize software for that problem.

This program was written by Alex Fukunaga, Steve Chien, and Andre Stechert 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. 188*** *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-20073.

Software Helps Determine Viability of New Products

John F. Kennedy Space Center, Florida

The Product Survey Tool computer program facilitates the collection and analysis of data for predicting the viability of a new system, product, or project (hereafter, "product" for short), while the product has not yet advanced beyond the concept stage. The program asks questions about the product and, through a graphical user interface, collects the answers. The program stores the answers in a database, from which the answers can be extracted and summarized or plotted to assist managers in making decisions about viability. The program has been partially developed, and some of the questions are specific to the original application at Kennedy Space Center. Further developments in the areas of report generation, graphical display of results, maintenance optimization, and data security are needed to fully realize the commercial potential.

This work was done by Charles L. Wood and Curtis C. Dugger of **Kennedy Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Computer Software 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, Kennedy Space Center; (407) 867-2544. Refer to KSC-11925.

Program for Remote Viewing of Reports Containing Graphics

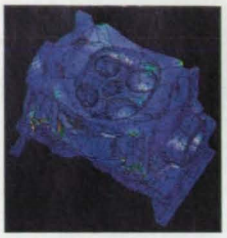
John F. Kennedy Space Center, Florida

The On-line Report Viewing Application computer program provides a graphical user interface for displaying the contents of management-presentation-style reports that contain mostly charts and graphs. The program makes it unnecessary to print and mail multiple copies of the reports. Residing on a mainframe computer where the original electronic copies of the reports are maintained, the program enables readers to gain access to the reports through their individual computer workstations in a network connected to the mainframe computer. Maintaining the original electronic copies of the reports on the mainframe computer offers an additional advantage of rapid, semiautomatic updating of the reports. Access to reports is limited to authorized readers by use of identification codes. The application also tracks user access down to user ID for management visibility of the usefulness of the report. An authorized reader can use a mouse to move through a report and/or select a specific page, chart, or graph by name. The reader can also print any page of the report.

This work was done by Thomas C. Woodbridge of United Space Alliance (formerly Lockheed Martin) for **Kennedy Space Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Computer Software category,* ***or circle no. 172*** *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, Kennedy Space Center; (407) 867-2544. Refer to KSC-11896.

Design & Analysis Software



Pro/MECHANICA STRUCTURE **structural simulation and optimization software** from Parametric Technology Corp., Waltham, MA, allows simulation and optimization of the structural performance of a design. Users can select material definitions from a provided library or define a new material, create structural loads, and define displacements for model entities. The software utilizes a finite element solution approach. Static, modal, pre-stress static, pre-stress modal, linear buckling, and nonlinear contact analyses are available.

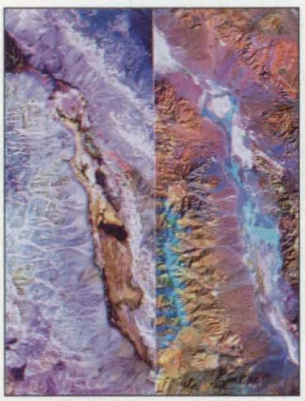
A design can be optimized based upon multiple analyses. Results window definitions specify the analysis and load sets to use, the quantity to display, the desired location on the model, and the display options. An optional Pro/MECHANICA VIBRATION module adds four types of dynamic structural analyses: dynamic time response, dynamic frequency response, dynamic random response, and dynamic shock response. The program extends simulation and optimization capabilities to users of CATIA, Unigraphics, and other CAD packages.

For More Information Circle No. 739

Microcadam, Los Angeles, CA, has introduced Helix Design System Version 4, Release 1 **solid modeling software** with integrated parametric drafting for Windows 95/NT. The system features Helix Modeling™ V4 that enables creation of a 3D solid model from 2D data imported from any CAD system. It includes sheet metal design tools, kinematic tools, assembly modeling, surface modeling, and visualization capabilities via wireframe, hidden line, and shaded image rendering.

Also featured is Helix Drafting™ V4 that includes D-cubed parametric design technology and raster capabilities. The Helix Design System package provides the ability to create 2D layouts of solid models inside the modeler with bi-directional associativity.

For More Information Circle No. 741



ENVI Version 3.0 **data analysis software** from Research Systems, Boulder, CO, features a new suite of geographic information systems (GIS) tools and new routines for orthorectification of air photos and satellite images. It can be used to visualize and analyze any type of satellite or aircraft digital imagery, including Landsat, SPOT, AVIRIS, and Radarsat.

A heads-up vector digitizing capability enables users to interactively catalog vector and feature properties on the computer, rather than by hand from the hard copy image plot. Other new features include support for the Spatial Data Transfer Standard (SDTS), support for U.S. and world location maps, and spectrum identification tools. It is available for Windows 3.1/95/NT, Macintosh, native Power Macintosh, UNIX, and Linux.

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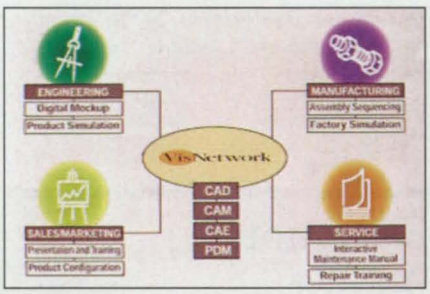


Engineering Animation, Ames, IA, has introduced VisNetwork **data analysis/visualization software,** which allows users to manage distributed product data from various platforms, CAD systems, and PDM systems. Complex parts with up to a million parts can be viewed and analyzed in an interactive visual environment. The program uses optimized data from VisFly, the company's 3D product visualizer, and VisMockUp, a digital prototyping software, and caches and filters the required information.

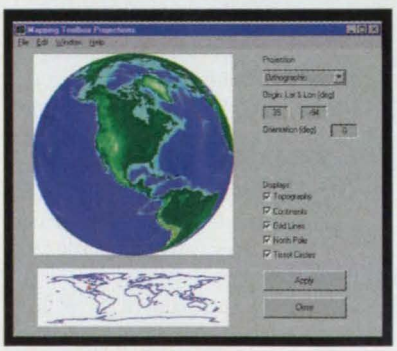
Engineers designing assemblies in different locations can immediately access any part or the entire product regardless of where the data resides. Users from various departments can view the data by selecting particular attributes, regions of interest, or the entire product.

For More Information Circle No. 748

Structural Research & Analysis Corp., Los Angeles, CA, offers COSMOS/Works 3.0 **design analysis software** for SolidWorks, which meshes and analyzes large models. It allows users to apply localized boundary conditions such as cylindrical and spherical constraints using existing reference planes and axes within SolidWorks. Shell elements enable analysis of thin-walled structures.

Basic (interface, stress, displacement, frequency, buckling, and heat analyses with direct and FEE solvers), Intermediate (Basic plus nonlinear and dynamic response analyses and alternate analysis modeler), and Advanced (Intermediate plus fatigue, laminar fluid flow, optimization, and electromagnetics modules) configurations are available.

For More Information Circle No. 746



The MathWorks, Natick, MA, offers Mapping Toolbox 1.0 **geographic data analysis and visualization software** for analysis and display of geographically based information. Based on the MATLAB 5 computing language, the software allows users to apply MATLAB numerics and visualization capabilities to analyze datasets and plot geographic information.

The software contains over 60 map projections, atlas data, astronomical data, and external interface functions for reading common government map data from CD-ROMs or the Internet. It performs geographic computations, data fusion, map projection display, and generation of presentation graphics. Platforms include Windows 95/NT, UNIX, Macintosh 68K, and Power Macintosh.

For More Information Circle No. 742

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TAS-Thermal Analysis System **thermal modeling software** from Harvard Thermal, Harvard, MA, provides interfaces to the standards in thermal analysis tools such as SINDA/G, SINDA/FLUINT, and TRASYS. The Windows version features model generation, execution, and post-processing in a single environment, as well as built-in steady state and transient fast finite different solvers.

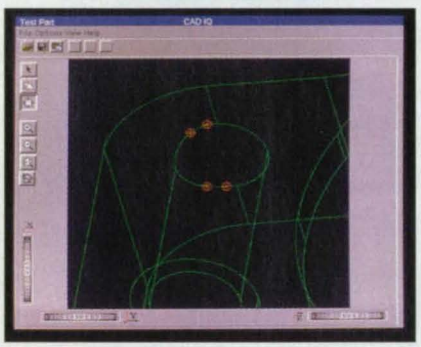
Other features include concurrently open multiple models, and colors that provide feedback of element type, properties, and temperature results. The program features a FEMAP interface and includes a translator to and from MSC/NASTRAN and ANSYS. It operates in Windows 95/NT.

For More Information Circle No. 740

EdgeCam for Mechanical Desktop **CAM software** from Pathtrace, Ontario, CA, is a 32-bit Windows 95/NT system integrated with Autodesk's Mechanical Desktop solid and surface modeling program. EdgeCam directly machines solid models and automates the NC programming process. It supports mills, lathes, and wire EDM.

Manufacturing information such as features, material, and volume are extracted automatically from solid models to automate programming. Manufacturing operations can be applied automatically to features. Geometry is not filtered through a translator, and tool paths are saved with the model.

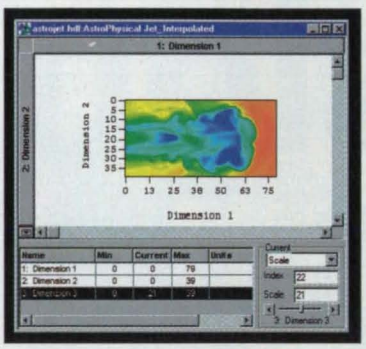
For More Information Circle No. 745



CAD/IQ **model analysis software** from International TechneGroup, Milford, OH, analyzes models generated by CAD software systems and identifies geometric and topological errors and anomalies. Supported model formats include CATIA, Pro/ENGINEER, and Unigraphics. Support for CADDS5, I-DEAS, IGES, STEP, and ACIS-based systems will be available.

The software enables users to predict model interoperability with downstream applications, allowing CAD models to be processed by downstream product development applications such as finite element modeling, numerical control, rapid prototyping, and data exchange without reworking the model.

For More Information Circle No. 738



Fortner Software, Sterling, VA, has announced version 1.1 of Noesys **science data analysis and visualization software,** which features enhanced support for the Hierarchical Data Format (HDF) data standard and a new import facility for netCDF files used to store meteorological data. The Windows program works with datasets of virtually any size or dimension, and enables access, organization, analysis, and visualization of large data sets.

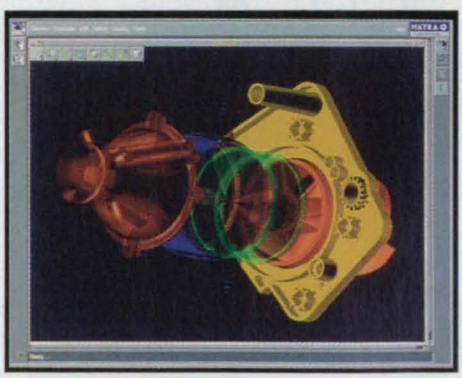
Users can create, view, and edit datasets that contain up to seven dimensions, allowing exploration of volumetric, multi-parameter data produced by Earth-observing satellites. New macro interpreter functions allow users to subset files normally too large to be opened on desktop computers with limited memory.

For More Information Circle No. 735

Numan Intelligence, Troy, MI, offers NuEngineer and NuSearch **design analysis software.** NuEngineer enables users to create and analyze hundreds of engineering/CAD designs. Users work with a visual interface to intelligently choose the designs to search through from an infinite number of possible new designs.

NuSearch can be integrated directly with most existing CAD packages and legacy CAD data. It can be integrated with other engineering applications such as simulations, spreadsheet tools, electronic circuit design, control algorithm design, finite element analysis, and computational fluid dynamics.

For More Information Circle No. 736



Matra Datavision, Andover, MA, has introduced Version 1.2 of **Euclid Quantum CAD/CAE/CAM/PDM software,** which contains two new products for styling and drafting: Euclid Styler and Euclid Drafter. Both can be used as standalone solutions or linked to other Quantum applications.

Euclid Styler provides users with features for creating complex shapes, and contains more than 300 specialized functions. Euclid Drafter offers automatic recording functions that memorize object characteristics and apply the properties to drawings under construction. Styles and drafting parameters are automatically standardized.

For More Information Circle No. 737

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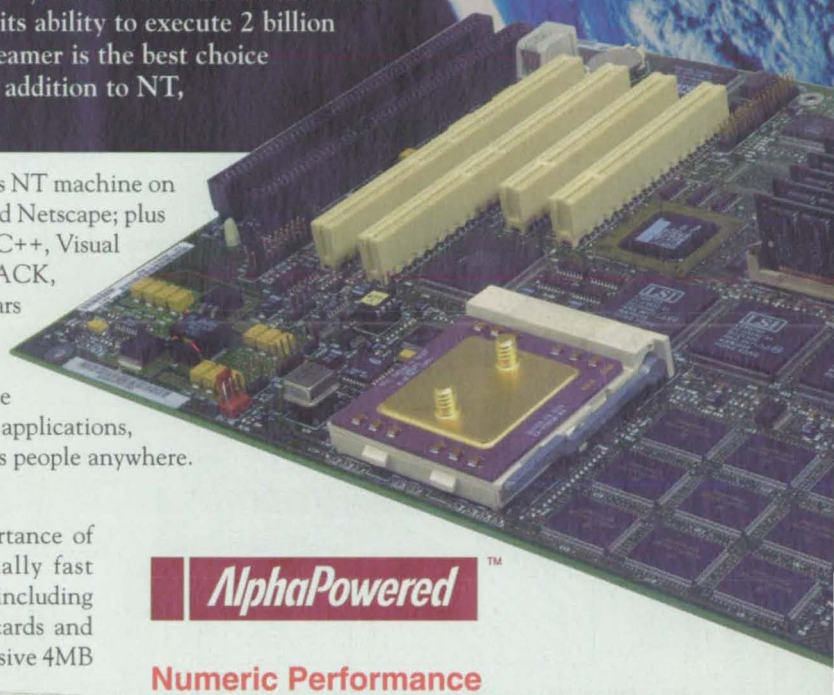

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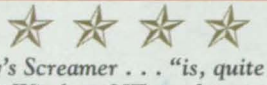

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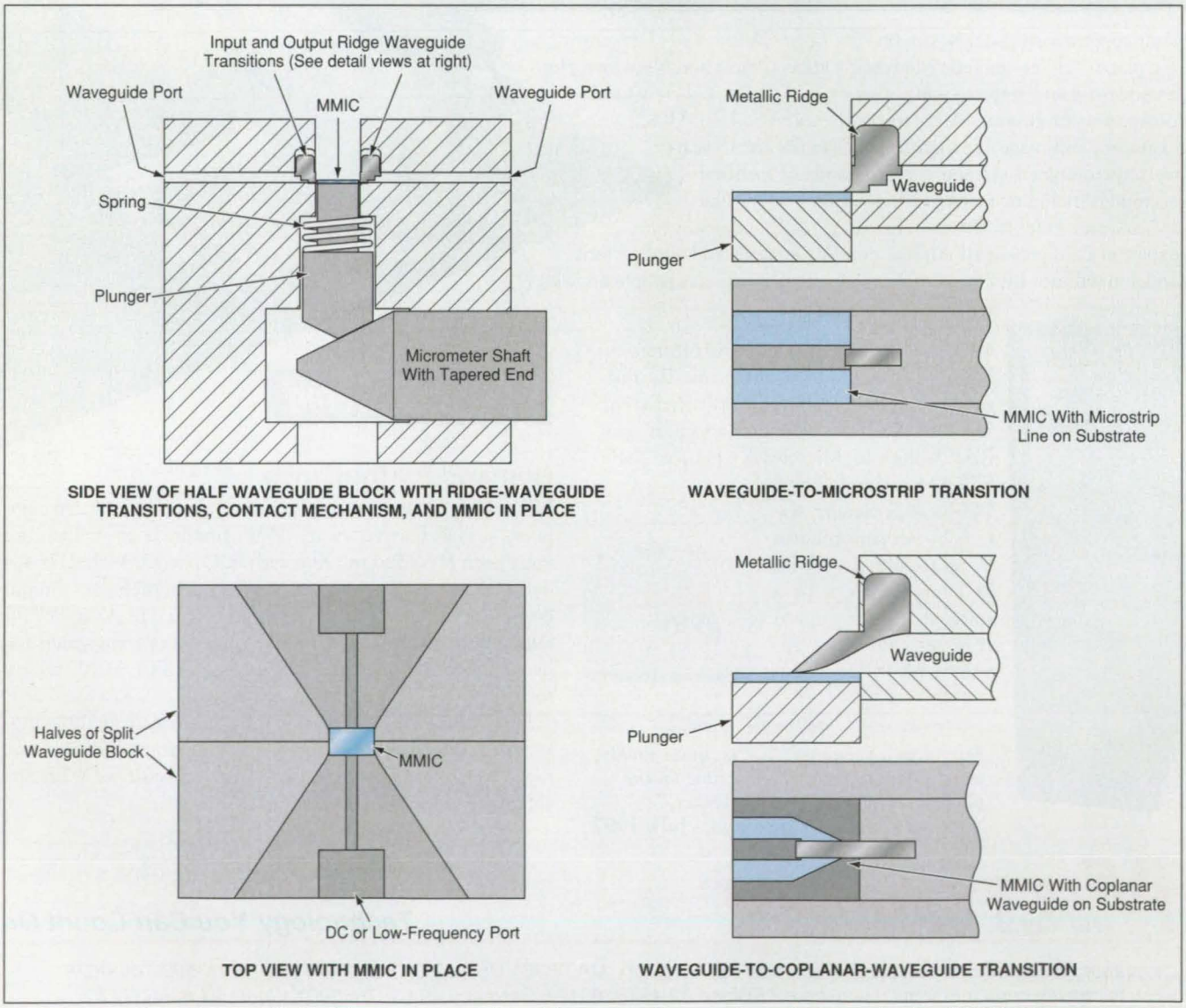
Fixtures for Vectorial Characterization of Submillimeter-Wave Circuits

It should soon become possible to make vectorial measurements at frequencies up to 1 THz.

NASA's Jet Propulsion Laboratory, Pasadena, California

Convenient probe fixtures for measuring the input and output electrical characteristics of monolithic microwave integrated circuits (MMICs) at frequencies of hundreds of gigahertz are undergoing development. These fixtures contain flexible mechanisms for rapid mechanical and electrical attachment to MMICs, and provide for bias input and/or low-frequency output. Both coplanar-waveguide and microstrip versions are available. One prototype fixture is designed for frequencies up to 640 GHz, and parts of it have been tested at 160 GHz. The probe-fixture designs are frequency scalable, so that it should soon become possible to realize the potential of modern network analyzers for testing MMICs at frequencies up to 1 THz.

A probe fixture of this type (see figure) includes a housing in the form of a split waveguide block. The split waveguide configuration makes it fairly easy to machine waveguides. Fabrication and setup are simplified further by making the input and output ports collinear.



This **Probe Fixture** in a split waveguide block incorporates several novel features to achieve an advance in characterization of MMICs at frequencies of hundreds of gigahertz.

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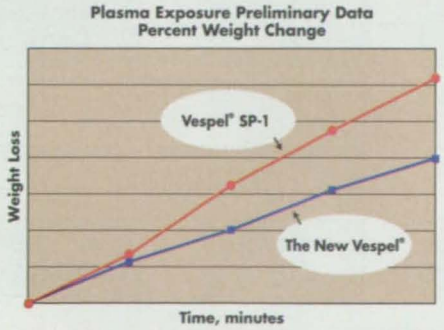

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Unlike in a typical probe fixture designed for lower frequencies, radio-frequency contact with an MMIC to be characterized is not effected with a coaxial microstrip or coplanar-waveguide probe. Instead, radio-frequency contact with the MMIC device is made via two ridge waveguide transitions, which are of either (a) a waveguide-to-coplanar-waveguide design or else (b) a waveguide-to-microstrip design, depending on the nature of the MMIC device to be characterized. The ridge waveguide transitions are fabricated on thin metallic sheets by a photolithographic etching process, and are then mounted permanently in the waveguide block.

The MMIC to be characterized is placed on a spring-loaded plunger, which is used to contact nondestructively the ridge transitions with pads on the surface of the MMIC chip. A micrometer is used to pressurize the spring contact accurately. Access to the MMIC for bias or low-frequency input/output is provided by radio-frequency-isolated, microstrip-style conductors within the waveguide block in the plane of the MMIC chip. These conductors are terminated in wire bonds to the MMIC chip and in SMA connectors mounted to the outside of the waveguide block.

This work was done by Jean Bruston, Peter H. Siegel, and Pete Bruneau 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. 103*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*
NPO-19949

Power-Delay Circuit for AC-Turn-On and AC-Turn-Off Tests

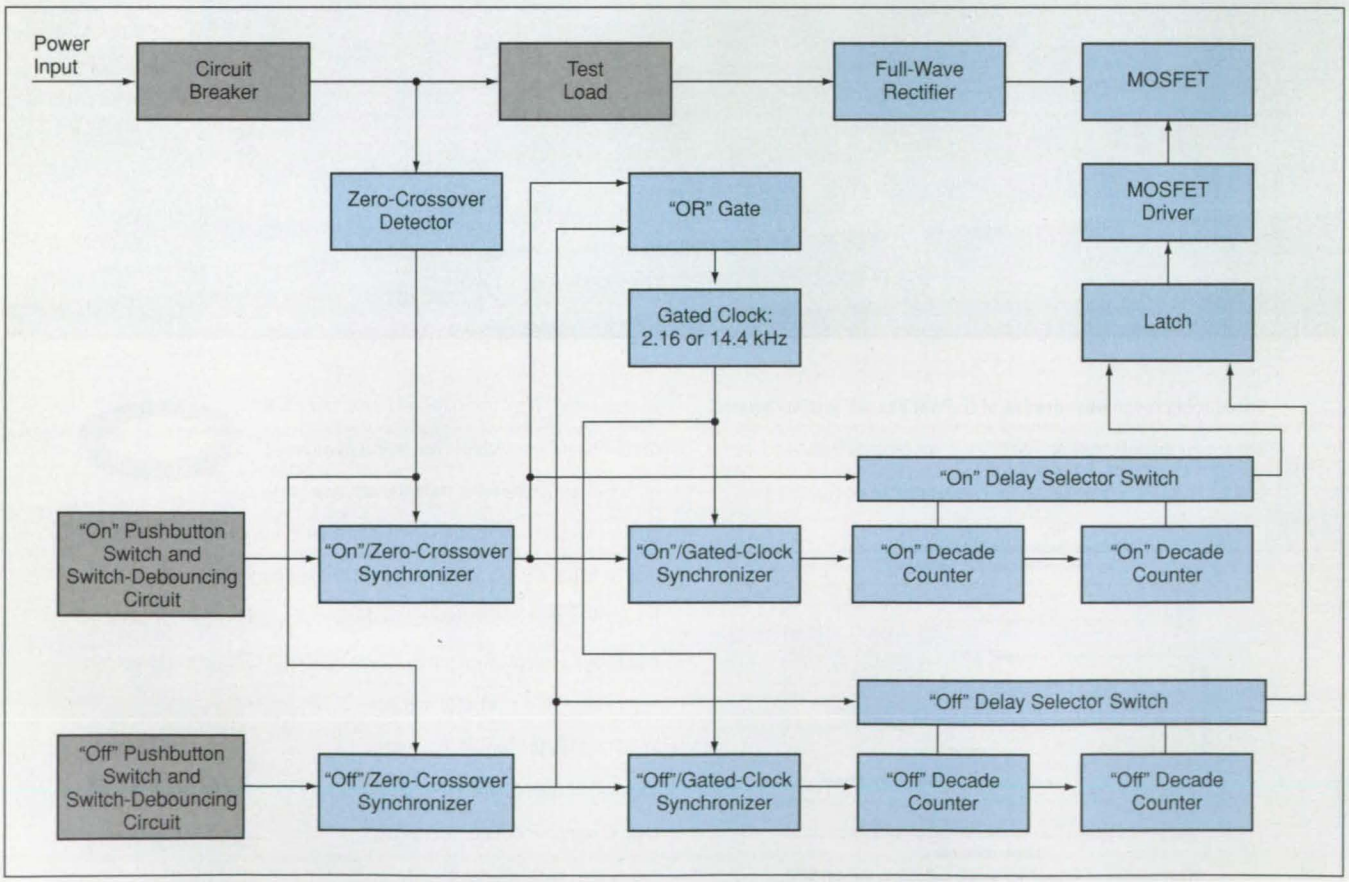
Turn-on and turn-off delays are selectable at phase resolution of 10°.

Lewis Research Center, Cleveland, Ohio

A power-delay circuit has been designed for use in ac-turn-on (inrush) and ac-turnoff tests of other electronic equipment. Standard testing for electromagnetic interference includes such tests. Inrush tests pertain to (a) the transient current drawn when a piece of equipment is initially turned on and (b) the effect of this transient current on the power-line voltage. In another transient associated with turn-off, power is reflected back to the source. In the case of dc equipment, the constancy of the supply voltage makes turn-on and turn-off testing a fairly straightforward problem. In the case of ac equipment, the periodicity of the supply voltage complicates the testing problem.

The power-delay circuit itself operates from 120 Vac. The input to the load under test may be any ac line voltage up to 120 V at a maximum peak load of 20 A at either 60 or 400 Hz. The rise and fall times of the switched load current are less than 5 μs. The circuit enables the tester to choose any turn-on delay in the phase range of 0 to 360°, with a resolution of 10°, at either power-line frequency.

The circuit (see figure) was designed



The **Power-Delay Circuit** sets the time of turning on or turning off power to the test load; the time turn-on or turn-off time can be set to within 1/36 of a cycle at a power-line frequency of either 60 or 400 Hz.

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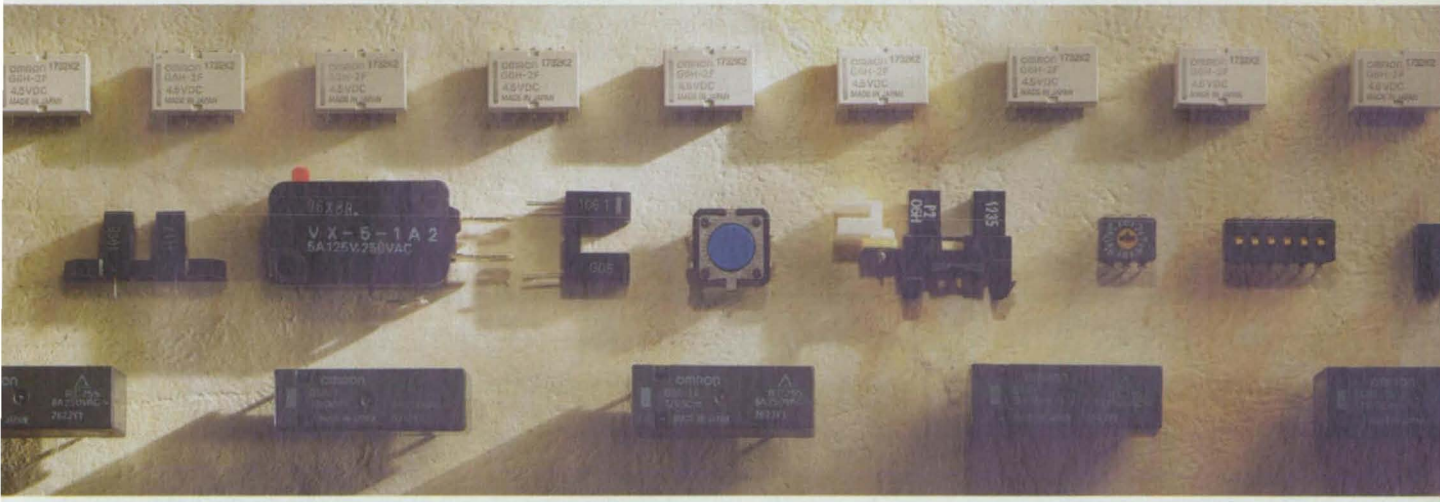

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around readily available components for convenience. A zero-crossover detector generates a pulse each time the instantaneous power-line potential crosses from a negative to a positive value. The zero-crossover pulse is optically coupled to a pair of synchronizers, along with the outputs of either an "on" or an "off" pushbutton-switch/debouncing-circuit unit. The outputs of the affected synchronizer is a pulse synchronized with a zero crossover.

A clock gated by the "on" or "off" zero-crossover synchronizer pulse generates a square wave at a frequency of 2.16 kHz for a 60-Hz power line, or else 1.4 kHz for a 400-Hz power line. This gated clock is what provides the 10° phase resolution. One in another pair of synchronizers generates an "on" or "off" signal synchronized to the gated clock signal. The "on" or "off" signal is counted to the selected delay by a pair of cascaded decade counters synchronized to the gated clock.

The "on" or "off" signal is routed to a latch that holds off the power to the test load until the desired turn-on time, then keeps the power to the load turned on until the latch is reset by the "off" delay circuit. The output of the latch drives "on" and "off" indicator light-emitting diodes and is optically coupled to a driver for a metal oxide semiconductor field-effect transistor (MOSFET). Inasmuch as a MOSFET is a dc device, a bridge rectifier comprising ultra-fast-recovery diodes is used to enable switching of the input ac power with the MOSFET. An ultra-fast-recovery diode is used as a flyback device to improve the fall time of the circuit.

This work was done by Dennis Eichenberg and Noel B. Sargent of **Lewis Research Center** *and Michael Herlacher of Cortez III. 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-16462.

Circular Array Antenna With Microstrip-to-Slot Transitions

This relatively simple, low-profile antenna provides a toroidal radiation pattern.

Lewis Research Center, Cleveland, Ohio

Figure 1 illustrates various aspects of a low-profile microwave antenna that could be mounted on the roof of a vehicle for use in mobile/satellite communication. This antenna includes a circular array of end-fire, linearly tapered slot antenna elements. It radiates in the radial direction in the azimuth (nominally horizontal) plane, providing an overall toroidal radiation pattern with a tilt above the horizon. Unlike other low-profile antennas, this one produces the desired omnidirectional radiation pattern, without need for phase shifters or scanning mechanisms. Other advantages of this antenna include high element gain, operation over a wide frequency band, equal beam width in two orthogonal planes by proper choice of flare angle, and simple construction.

The tilt above the horizon is achieved by placing the array above a ground plane, which also simulates the metal roof of a vehicle. The antenna is connected to a coaxial cable at its center via a modified OS-50 coaxial connector that surface-launches the microwave power. A microstrip feed network of T-junctions and right-angle bends constitutes a 16-way power splitter between the coaxial cable and the 16 radial strip lines. The characteristic impedance of the microstrip lines is 50 Ω and is maintained throughout the splitter. Each of the 16 microstrip lines in the outermost part of the power splitter is electromagnetically coupled to one of the slots in the array. Electromagnetic coupling eliminates pin and solder connections and thereby increases reliability and lowers the cost. It also widens the operational frequency band, which is centered at a nominal frequency of 18 GHz.

The top part of Figure 2 shows H-plane radiation patterns measured with and without a metal ground plane under the antenna. In the presence of the ground plane, the pattern is displaced upward about 28° in elevation and the 3-dB angular width of the beam in elevation is about 22°. Tilting the array in elevation enables one to measure the E-plane radiation pattern; the bottom part of Figure 2 shows a typical peak pattern, in which the ripple is ±2 dB. Rotating the antenna in increments of 90° enables one to measure the E-plane pat-

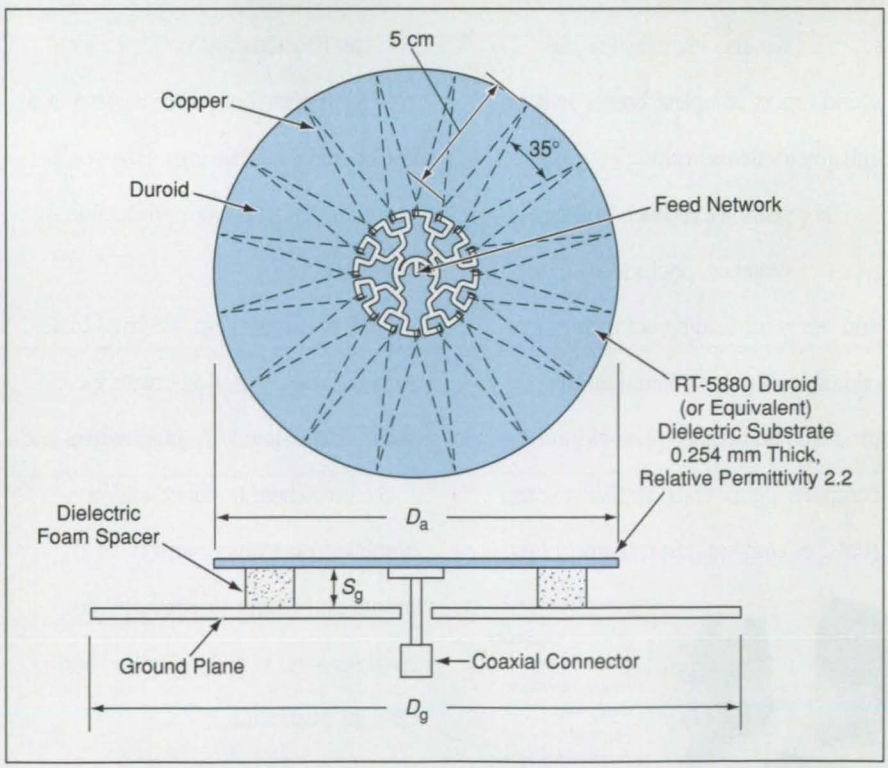

Figure 1. This **Low-Profile Antenna** includes a power-dividing microstrip feed network electromagnetically coupled to a circular array of 16 linearly tapered slot antenna elements. D_a = 16 cm, D_g = 30 cm, and S_g = 5 mm, which is 0.286 × the free-space wavelength at the nominal frequency of 18 GHz.

tern for each of four quadrants. The four radiation patterns are found to be very similar, demonstrating that the antenna has an omnidirectional characteristic in the azimuth plane.

The measured return loss of the antenna at the coaxial port is less than –10 dB (at 2:1 voltage standing-wave ratio) over the frequency range from 18 to 20 GHz. The antenna exhibits a gain of about 10 dB. The height of the antenna is less than 10 mm. By adding a four-way switch to the feed network, one could convert the antenna to multibeam operation for cellular communication.

This work was done by Richard Q. Lee and Susan Reinecke of **Lewis Research Center,** *Eron S. Kelly of Princeton University, and Rainee N. Simons of NYMA, Inc. 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. 113*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*

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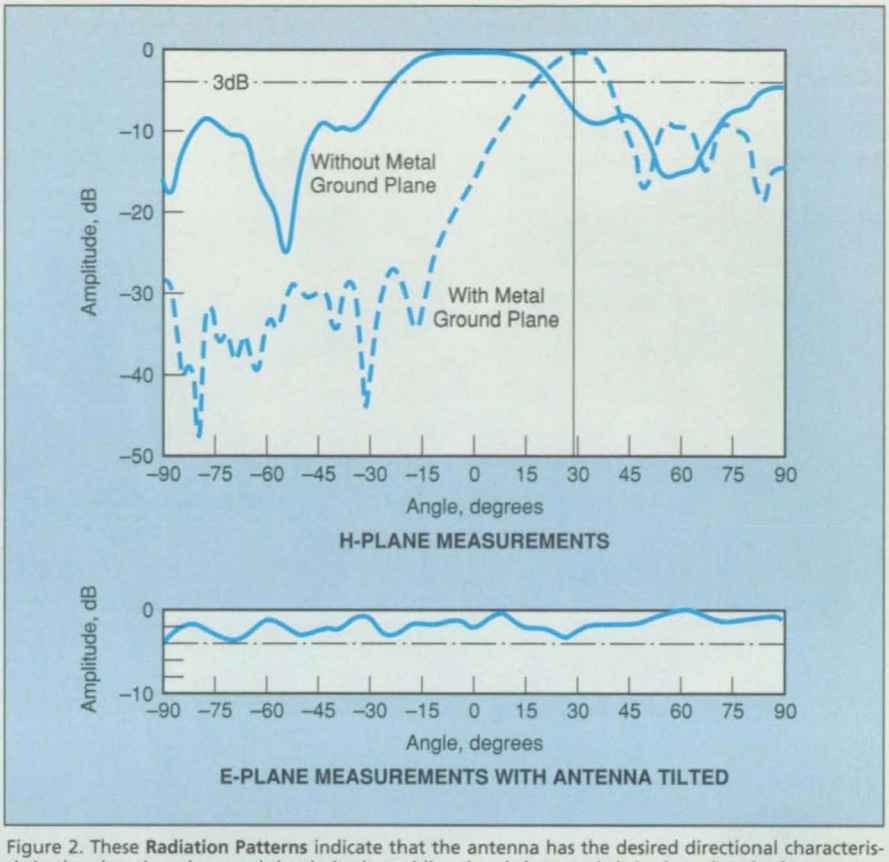
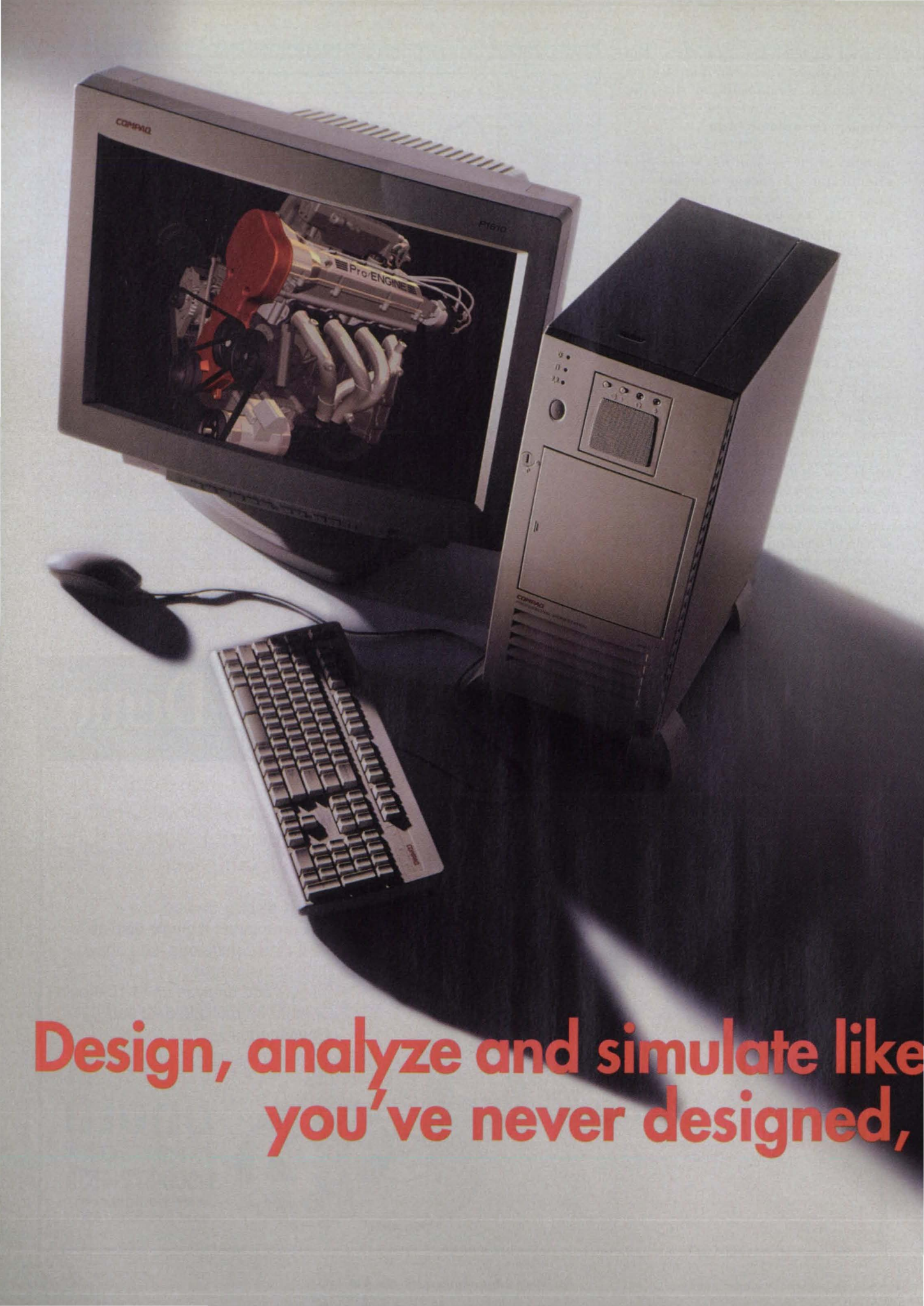


Figure 2. These **Radiation Patterns** indicate that the antenna has the desired directional characteristic in the elevation plane and the desired omnidirectional characteristic in the azimuth plane.



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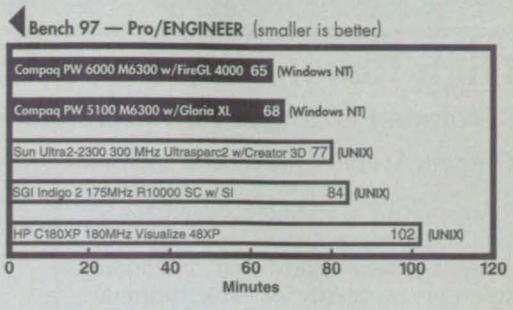

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analyzed and simulated before.

High-Resolution Decoder for Multianode Detectors

Resolution is doubled by discriminating between even- and odd-fold anode pulses.

Goddard Space Flight Center, Greenbelt, Maryland

An improved decoding circuit for a multianode microchannel-array (MAMA) detector doubles the spatial resolution over that previously available, without loss of temporal resolution. As explained below, it does this by a scheme that includes parallel processing of a least-significant bit, indicative of the pixel location, during the normal signal-processing period.

The MAMA is a photon-counting detector that employs a photocathode for photon/electron conversion and a microchannel plate for electron multiplication. The output of the microchannel plate is taken in the form of pulses of electrons that impinge on an array of crossed sets of interdigitating anodes (see Figure 1). The anodes shown determine the horizontal position of a photon event. The vertical position is determined by another pair of interdigitating anode sets (not shown), which run underneath and perpendicular to the first pair of anode sets. Charge amplifier circuits amplify the signals detected by the anodes. A digital decoder circuit interprets the outputs to determine the position of an event. The decoder does this through coincidence discrimination, which is the process of identifying two or more contiguous anodes that experience electron pulses that are coincident in time and inferring the pixel location of an event.

As shown at the bottom of Figure 1, a photon can give rise to simultaneous pulses in two or more adjacent anodes in one of the crossed sets; such a pulse is known in the industry as an "n-fold," where n denotes the number of anodes involved. Also, note that a pixel is bounded along one axis by the centerlines of two adjacent anodes. For purposes of determining position, any n-fold with n even and $n > 2$ can be reduced by the decoding circuitry to an equivalent 2-fold that occupies the same central pixel as does the n-fold. However, an n-fold with n odd could be converted to an equivalent 2-fold that could be assigned to either one of two adjacent pixels. This affords an opportunity to halve the effective pixel size (double the resolution by assigning the equivalent 2-fold to the position midway between the pixels).

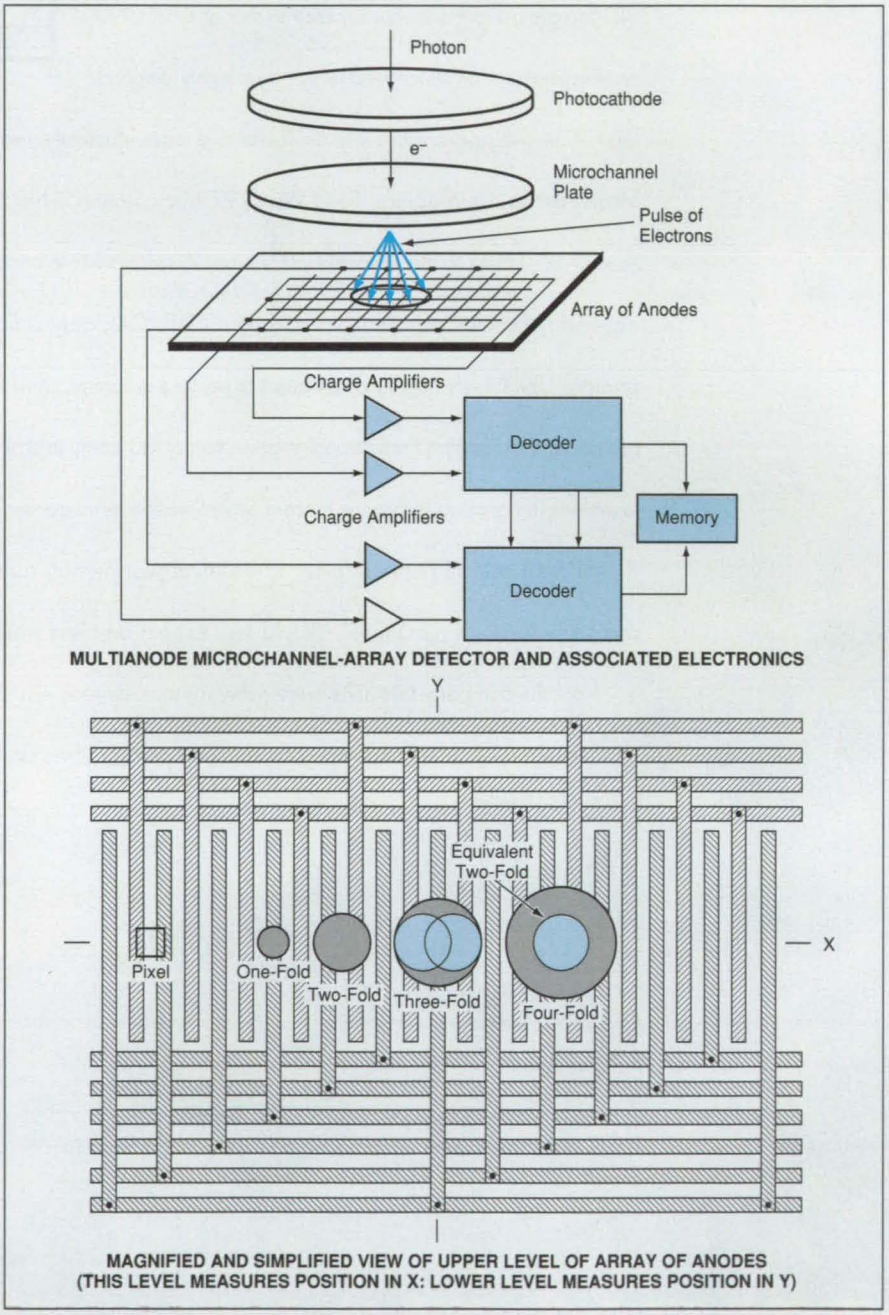
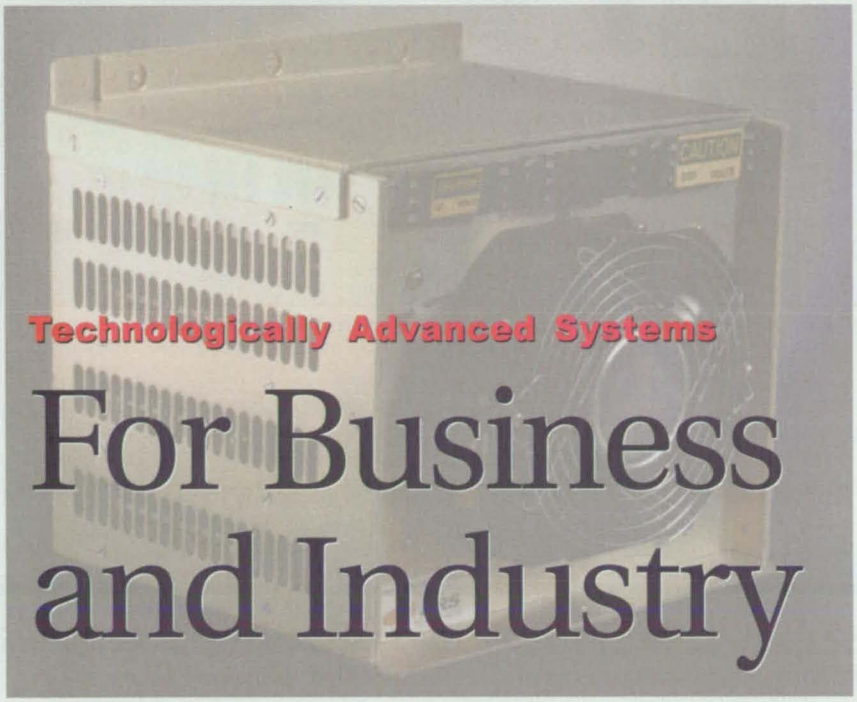


Figure 1. **Decoders Determine the Position** of a photon by coincidence discrimination among pulses of electrons collected by an array of anodes.

The improved decoder is fabricated as an application-specific integrated circuit (ASIC). This ASIC discriminates between even-folds and odd-folds to generate a single least-significant bit indicative of half the pixel interval that was available previously.

PCS Plus



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Reliability and Quality

Assembled at our ISO 9002 certified facility, the *PCS Plus* offers superior reliability and quality by virtue of our consistent, well documented manufacturing processes.

Efficiency

The *PCS Plus* alleviates the need for costly external solutions to power line emissions by eliminating EMI/RFI problems at the source. The output voltage of the power conditioning portion of the *PCS Plus* is regulated to ± 2% and, as such, maximizes the efficiency of any additional downstream converters.

Performance

All of our power conditioners accept unfiltered AC line voltage, condition it and convert it to DC capacity. The *PCS Plus* filters and regulates power as it provides multi-output DC supply to electronic equipment, providing protection against surges and harmonic currents. The *PCS Plus* also provides a charging and control system so that it can serve as an uninterruptible power supply with the addition of a battery module.

Requirements

All of our solid state power conditioning systems meet requirements and standards for both industrial and military applications.

Weight/Space/Cost Savings

The *PCS Plus* is a compact unit and offers a weight savings of approximately 80 lbs. compared to similar ferroresonant transformers coupled to solid state switching supplies.

Input Characteristics:

Voltage: 85 to 264 Vrms
Three phase, either delta or wye
47 to 440 Hz line frequency
(Mil-Std-1399/300A) Compliance for Types I, II and III

Current:
Inrush limited to <15 Amps peak
Maximum 11.3 A_{rms} (three phase line),
<3mA_{rms} on wye neutral
Power Factor Correction >98%

Electromagnetic Compatibility:
FFC docket 20780 and VDE 0871 Compliant
Mil-Std-461D Conducted Emissions CE101
IEC 1000-3-2 (EN 61000-3-2) Compliant

Protection:
Internally fused
3750 VDC High Potential Insulation Breakdown
Safety ground leakage <3.6 mA_{rms}
(Mil-Std-2036)

Output Characteristics

Power: 2.5 kW
Current: 8.3 Amps
Voltage: 5 VDC 160 Amps (200A)
12 VDC 10 Amps 3 Outputs
28 VDC 7.1 A
15 VDC 13 A
54.4 VDC For charging four 12 V battery cells
Conducted Output Ripple <0.3%

Efficiency: 80% (at full load, 72%, minimum)

Protection: Overvoltage 125%
Overcurrent 125-140%

TTL Status Interface:
AC Fail, Battery Low, Charge On, Charge Complete, ON Battery, and Fan Failure

Control Inputs:
Inhibit Output, Inhibit Charge, Inhibit UPS, and Reset

Mechanical Characteristics

Operating Temperature:
-20 to +55°C (-4 to +131°F)
Weight: 33 lbs.
Size (in inches): 10h x 15.25w x 11d

Reliability and Quality

MTBF: 75,000 hours at 45°C
ISO 9002 Certified World Class Manufacturing Facility
Approved Mil-Q-9858A and Mil-I-45208A Quality programs
Workmanship: IPC-A-610B Class 3,
Soldering: ANSI/J-STD-001B
Warranty: Unlimited guarantee against defects in material and workmanship

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This operation is performed in parallel with the standard decoding, with no loss of decoder speed, and necessitates the addition of minimal hardware to the standard decoding circuitry. (However, the size of the memory must be quadrupled.)

High-resolution decoding dramatically improves image quality, as illustrated in Figure 2, which shows a normal low-resolution image of a portion of a USAF test target and a high-resolution image of the same target. The high-resolution image resolves much smaller features and displays greater detail. The images were recorded with a 16-bit depth, but they are displayed in an 8-bit mode. Therefore, the brightest areas of the images, such as the inner portions of the largest rectangles, experience "roll-over" in the displayed image.

This work was done by David B. Kasle of **Goddard Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Systems category, or* ***circle no. 131*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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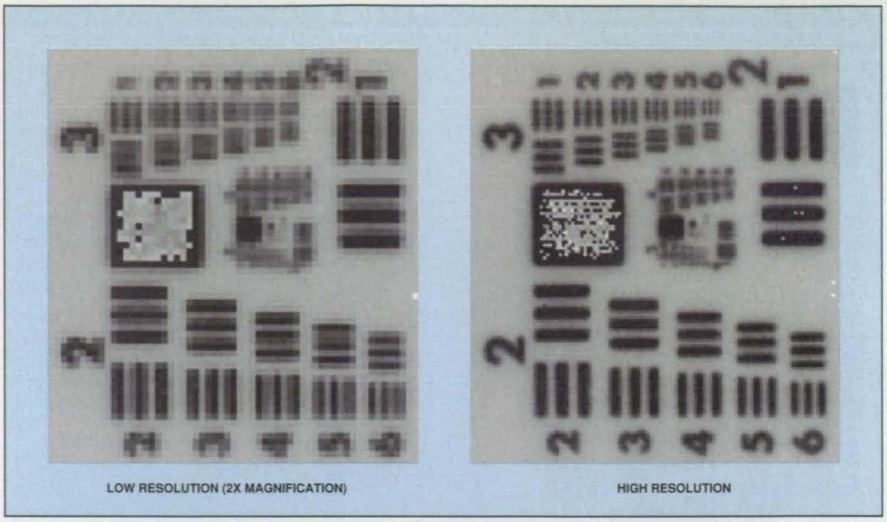

Figure 2. **High-Resolution Decoding** produces superior image shown on the right. For comparison, the left side shows normal-resolution image (2x magnification) of a portion of a USAF test target.

Neuroprocessor for Detecting Misfire in an Automotive Engine

Indications of misfire are derived from crankshaft-acceleration and other sensory inputs.

NASA's Jet Propulsion Laboratory, Pasadena, California

An application-specific integrated circuit (ASIC) has been developed as a prototype of neuroprocessors for detecting misfire in internal-combustion piston engines. Such neuroprocessors are intended to satisfy a requirement, imposed by the Federal government pursuant to the Clean Air Act, to equip automobiles with onboard diagnostic capabilities that include a misfire-detection capability.

Engine misfire is defined as incompleteness or absence of combustion in a given cylinder at its intended time of firing. Misfire causes a diminution or loss of the torque pulse that the firing is intended to produce, giving rise to a deficit in crankshaft torque or acceleration. The detection of an acceleration deficit is the basis for detecting a misfire, but the detection problem is complicated in that the acceleration-deficit signal is obscured by crankshaft torsional oscillations, which are dominated by the more-frequently-occurring normal combustion events. A neuroprocessor was chosen for this diagnostic task because engine-control microprocessors now in common use cannot efficiently perform the complex mathematical operations necessary to extract misfire signals from the outputs of engine sensors.

The neuroprocessor receives four sensory inputs (see Figure 1), of which two are crankshaft speed and acceleration signals, computed as time derivatives of the output of a crankshaft-angular-position sensor; these derivatives are computed at small crankshaft-angle intervals between nominal firings. The third sensory input is an indication of which cylinder firing is the one currently under observation; this input may not be strictly necessary, but is desirable in that it provides relatively clean phase information and enables the neuroprocessor to synchronize itself more rapidly with engine cycles as operating conditions change. The fourth sensory input is an engine-load signal.

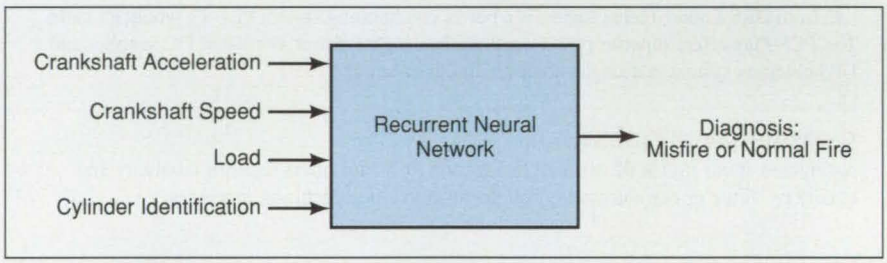

Figure 1. A **Neural Network** with time-lagged feedback in two hidden layers processes four sensory inputs to obtain indications of misfire.

The neuroprocessor is characterized as a recurrent neural network with four inputs (not counting a bias input), 20 time-lagged recurrent nodes (neurons) in a first hidden layer, 10 time-lagged recurrent nodes in a second hidden layer, and a single output node. The neuroprocessor ASIC is implemented in high-speed complementary metal oxide/semiconductor (CMOS) very-large-scale integrated (VLSI) circuitry with a bit-serial architecture, which makes for compactness and cost-effectiveness because (1) it entails fewer interconnections and less hardware than does bit-parallel architecture and (2) it involves the periodic, repetitive use of the same circuitry in a time multiplexing scheme to implement successive layers in the neural network (see Figure 2). Such an architecture is feasible in the automotive diagnostic application because the engine speeds are low enough and the electronic circuitry operates rapidly enough that all electronic neural-network processes for a given input/output

sampling period can be completed before the beginning of the next period.

The neural network is trained by the dynamic back-propagation method, using data from known normal-fire and misfire events under a large variety of operating conditions. The target output for the neuroprocessor is a +1 or a –1, according to whether or not the processing of inputs reveals a misfire 8 time steps earlier. The 8-time-step offset was found, in preliminary training trials, to enable the neural network to utilize sensory information from short-lived disturbances that persist for an engine cycle after a normal-fire or misfire events that the network is required to classify.

The foregoing combination of features affords flexibility to realize different neural-network configurations for different diagnostic functions. A neural network of this type is believed to be capable of functioning as a universal dynamic approximator in that it can be made to approximate any dynamic transfer function to arbitrary accuracy, provided that it is configured with a suitable number of nodes in hidden layers. Inasmuch as any neural network could, in principle, be composed of neural-network building-block integrated-circuit chips, this approach offers the opportunity to trade off computation speed versus cost (more chips with less time multiplexing versus fewer chips with more time multiplexing). This approach also enables the use of the same chips for multiple tasks. In effect, the number of chips needed is determined by the time constraints on the computation, and multiple tasks can be performed by storing and loading the weights for the transfer function of each task at the time of that task.

This work was done by Raoul Tawel and Nazeeh Aranki of Caltech and Lee A. Feldcamp, Kenneth Marko, Gintaras Puskorius, and John James of Ford Motor Co. 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. 152*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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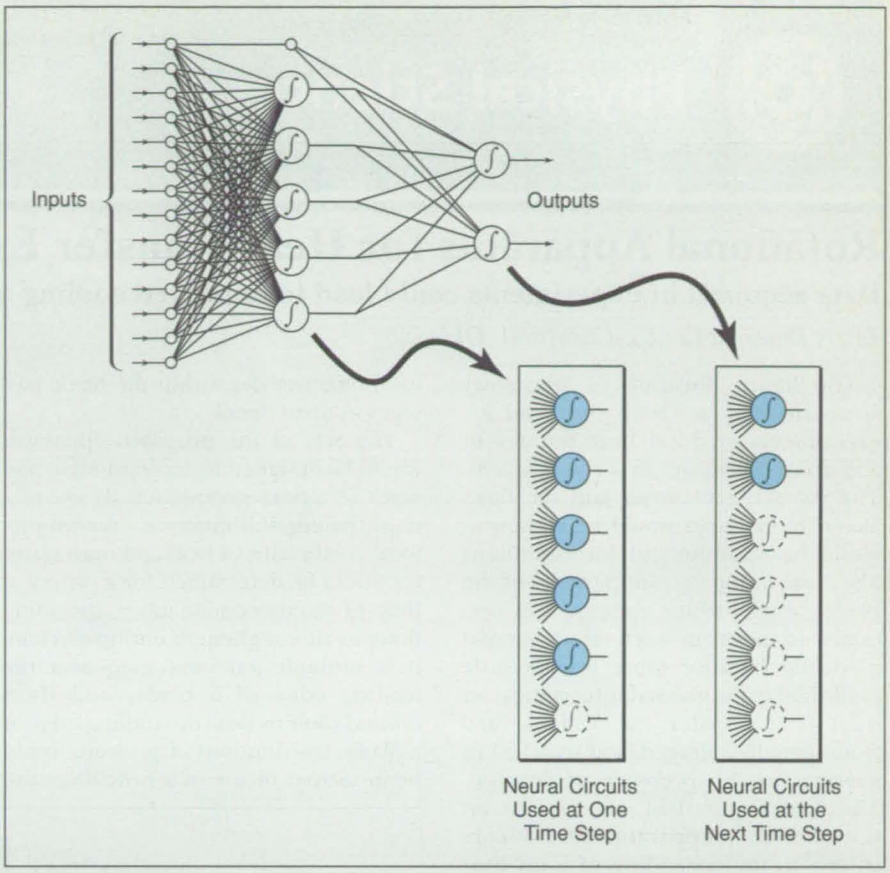


Figure 2. A **Time Multiplexing Scheme** enables the reuse of the same neural circuits to implement successive layers of the neural network. The neural network shown here is not the one described in the text, but, rather, a simplified feedforward neural network for the purpose of illustrating the time-multiplexing scheme.

Rotational Apparatus for Heat-Transfer Experiments

Data acquired in experiments could lead to improved cooling of turbine blades.

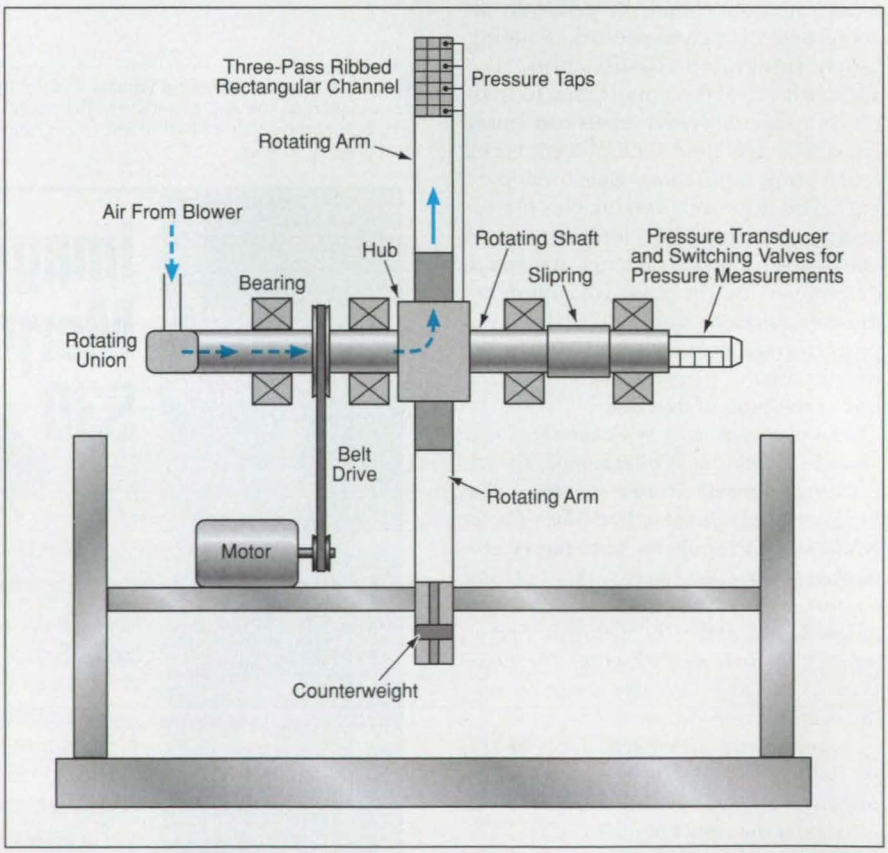
Lewis Research Center, Cleveland, Ohio

The figure illustrates a laboratory apparatus that has been proposed for experiments on local heat transfer in and around passages in a rotating arm. The passage geometries and the flows along the passages would be chosen to model heat-transfer and flow conditions like those in the coolant passages of the blades of gas-turbine engines. It is necessary to perform such experimental modeling because there is very little published experimental information on local heat transfer (as distinguished from spatially averaged heat transfer) in passages in the presence of rotation. The data acquired in experiments on the proposed apparatus would contribute to understanding of local heat transfer in gas-turbine blades, thereby helping engineers to design blades for efficient cooling.

In a gas-turbine engine, cooling air is bled from a compressor (which is part of the engine) and directed to flow along the internal passages of the turbine blades; of course, this cooling bleed flow is obtained at the expense of total engine output. To maximize turbulence in order to maximize the transfer of heat from the blade to the cooling air, ribs are cast onto two opposite walls of each passage. Rib-induced separation and attachment of flow along the passages create zones of high and low heat transfer. Rotation aggravates the nonuniformity of heat transfer by pushing the flow onto the pressure side (where heat transfer is thus increased) and away from the suction side (where heat transfer is thus reduced). Therefore, it is necessary to determine coefficients of local heat transfer in order to identify hot spots and quantify enhancements of heat transfer on leading and trailing passage walls in the presence of rotation. Moreover, coefficients of local convective transfer of heat between hot gases and blades are greater than the thermal conductivities of the blades; thus, a blade designer cannot rely on the thermal conductivity of the blade to smooth out local errors in computed heat fluxes, and this makes it imperative to know the coefficients of local heat transfer within the blade passages in great detail.

The arm of the proposed apparatus would be designed to accommodate passages of various geometries. By use of a naphthalene-sublimation technique, local coefficients of heat and mass transfer would be determined for a variety of flow/geometry combinations, including flows in rib-roughened, multipass channels, multiple jets impinging near the leading edge of a blade, and flows around pin-fins near the trailing edge of a blade. Distributions of pressure would be measured by use of a switching-valve unit that would sequentially connect the transducer to pressure taps at various locations in the passages. A slipring assembly would be included to provide an option for conducting heat-transfer experiments.

Experiments have been conducted in a two-pass, square-cross-section channel on a small-scale prototype of the proposed apparatus, using the naphthalene-sublimation technique. Local distributions of heat and mass transfer were obtained in cases in which ribs were aligned at various angles. The most significant finding from these experiments was that high rates of heat and mass transfer on the trailing wall can be achieved with ribs smaller than those used conventionally (hydraulic-diameter-to-rib-height ratios of 16 or 32 instead of the conventional values of 8 to 10).



Experiments on Heat Transfer in a channel on a rotating arm would be performed to gain understanding of thermal and flow phenomena in coolant passages of gas-turbine blades.

This work was done by Rajesh Kukreja of Lynntech, Inc., for **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. 127*** *on the*

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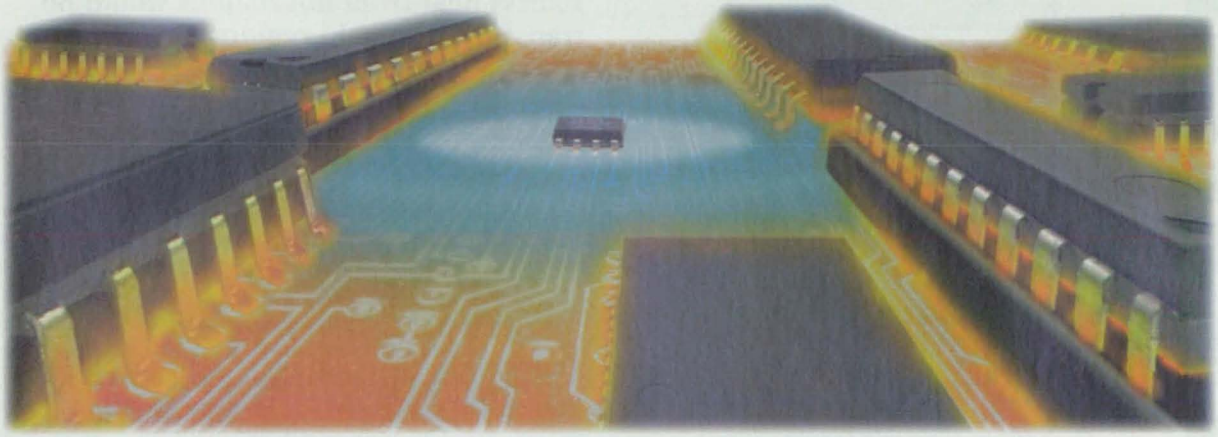

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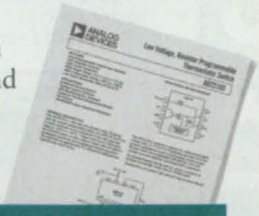

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Capillary-Pumped Loops for Equalizing Body Temperatures

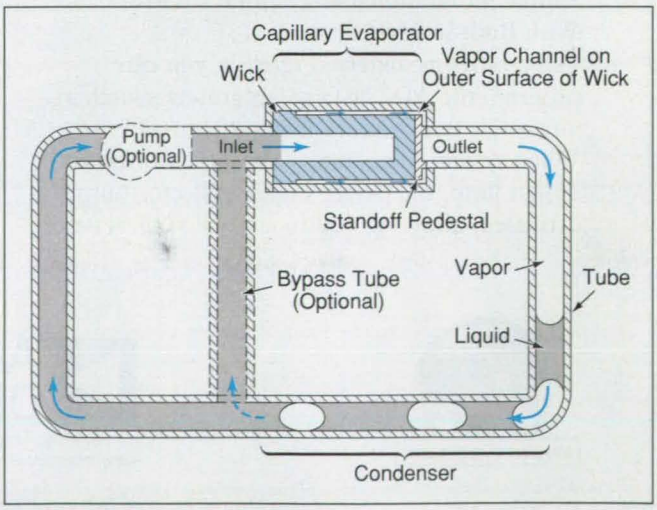
Excess heat from hot regions would be transferred to cold regions.

Goddard Space Flight Center, Greenbelt, Maryland

Capillary-pumped-loop devices are intended for incorporation into protective suits. These thermal-control devices would be used to equalize temperatures for the wearers. For example, a device of this type could be used to transfer excess heat from parts of the human body that tend to become overheated (e.g., armpits) to other parts that tend to become cold (e.g., hands).

A typical device of this type (see figure) would include a capillary evaporator with a wick inside, a condenser, and connecting tubes, all containing a working fluid. The working fluid could be, for example, water, an alcohol, or a non-CFC refrigerant. The wick would be made of a suitable porous material. The wick, the tubes, and the evaporator and condenser housing would have to be made of materials compatible with the working fluid and with each other. Unlike heat pipes, there would be no wicks in the tubes between the evaporator and condenser.

The fluid in liquid form would be held in the wick in the evaporator by capillary action. Absorbing heat from the evaporator surroundings, the fluid would evaporate into channels in the outer surface of the wick. The resulting vapor would flow along these channels to the evaporator outlet, then along a tube to the condenser, the surroundings of which would be cooler than those of the evaporator. The fluid would return to liquid form in the condenser, giving up latent heat of vaporization to the surroundings. The liquid would flow from the condenser, along a return tube to the evaporator inlet. Finally, the liquid would enter the evaporator wick, completing the cycle.



Capillary Action in the Evaporator would provide some or all of the pump pressure needed to circulate the fluid. One of the advantages of capillary pumping is a potential for a low mass-to-heat-transfer ratio.

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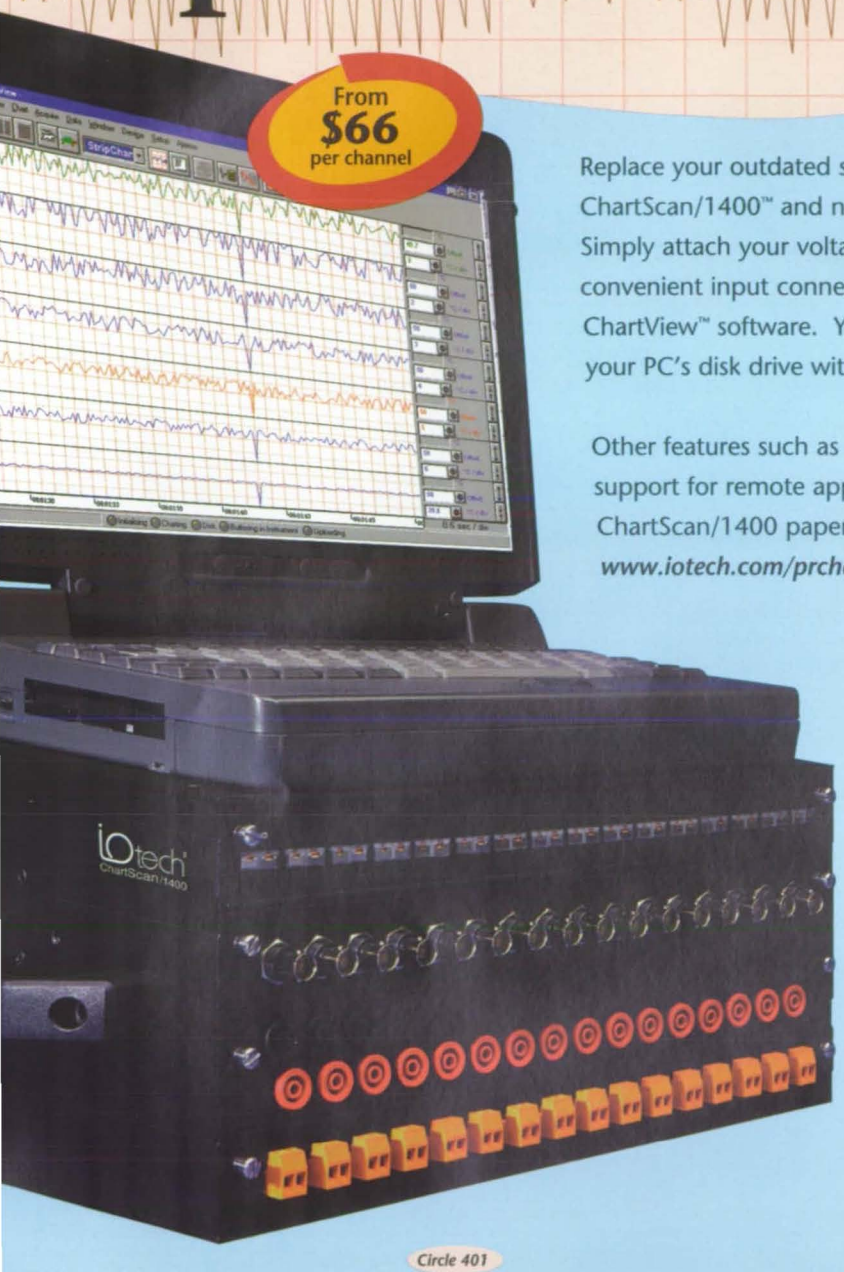

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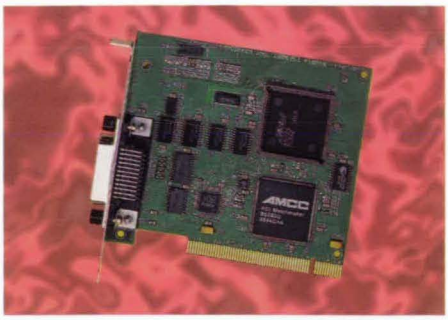

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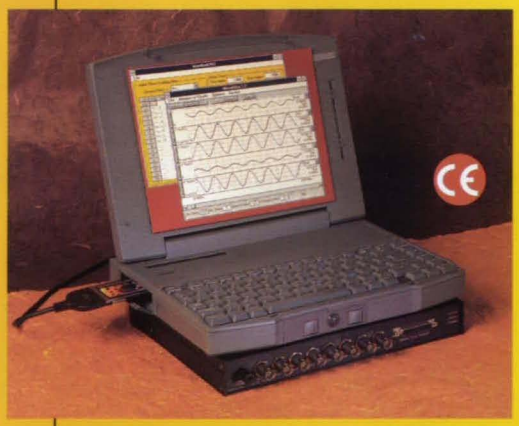

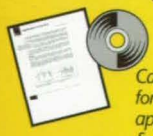

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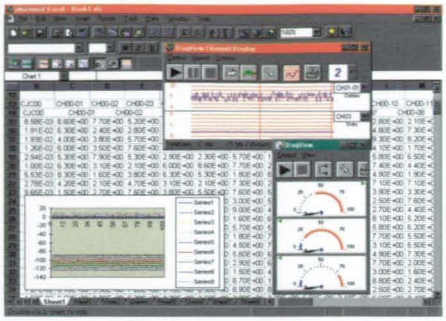

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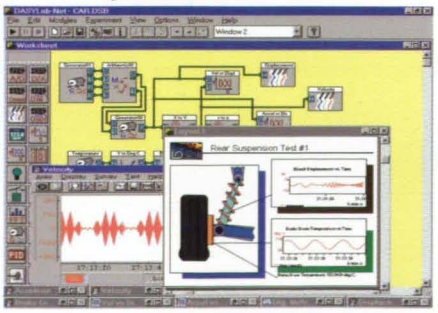

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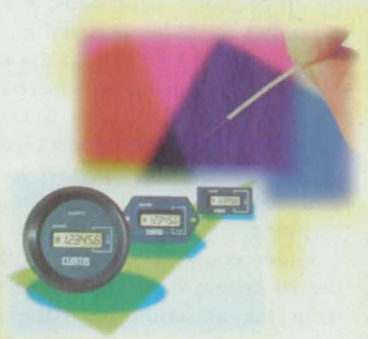

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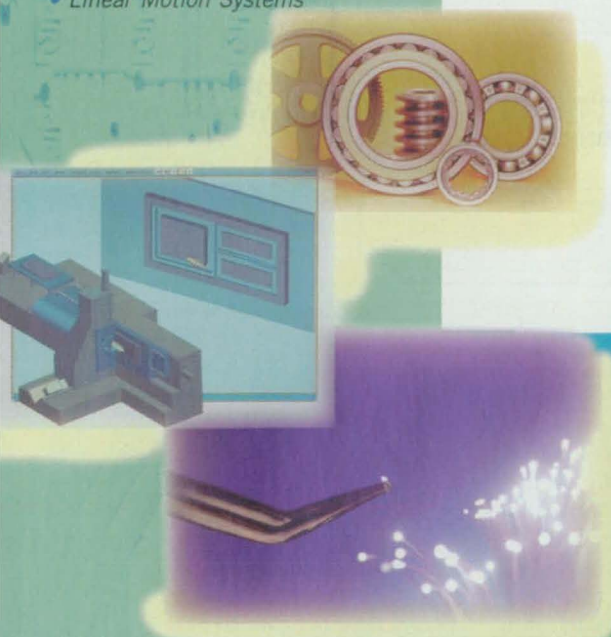

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Capillary action in the evaporator should ordinarily provide adequate pump pressure. Optionally, a mechanical pump could be included in case the capillary head provided by the evaporator were insufficient to overcome any frictional head or any static head induced by differences between heights in different parts of the loop. An optional bypass tube could also be included.

There could be many variations on the foregoing basic theme, even apart from the selection of materials. For example:

- Multiple evaporators and/or multiple condensers could be ganged in parallel by use of suitable inlet and outlet manifolds.
- The tubes between the evaporator and condenser could be straight or bent, rigid or flexible, and could have any of a variety of cross-sectional shapes.
- A wick could be installed in the evaporator as well as in the condenser.
- The wick(s) could be fabricated with various combinations of parallel, radial, circular, and/or otherwise patterned interior and/or surface channels to enhance the flows of liquid and vapor.
- The surfaces of the evaporator and condenser could be designed to enhance the transfer of heat.

This work was done by Theodore D. Swanson and Paul Wren (deceased) of **Goddard Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 165*** *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, Goddard Space Flight Center; (301) 286-7351. Refer to GSC-13329.

Steady Capillary-Driven Flow

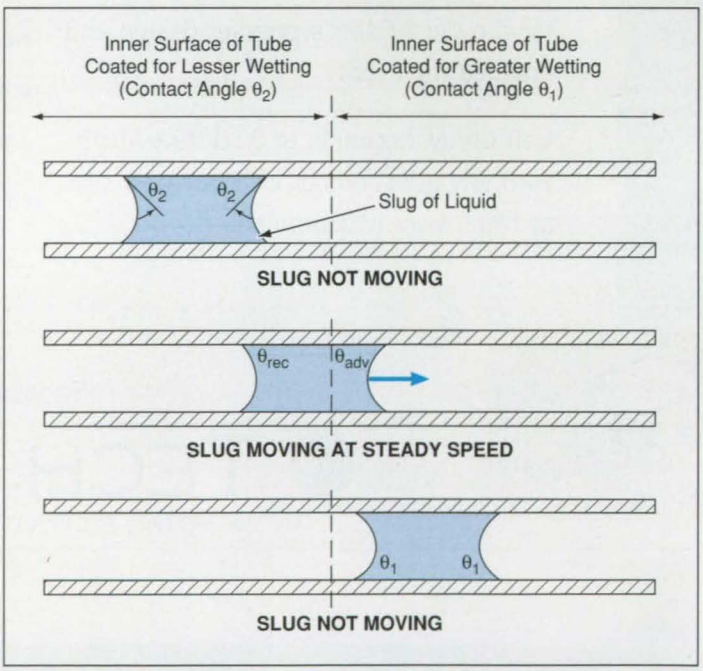
This phenomenon can be exploited to study basic physical mechanisms of dynamic wetting.

Lewis Research Center, Cleveland, Ohio

A technique for generating steady capillary-driven flow has been devised to add to the available means for studying physical mechanisms of wetting and capillary flows. Related capillary-flow techniques have been used for decades, but they have involved, variously, unsteady flows or the use of pumps, gravity heads, or other noncapillary means to generate flows. The present technique differs from the older techniques in that the flow is generated solely by capillary means; it is a truly steady flow governed by the physics of dynamic wetting.

This technique involves the movement of a slug of liquid along a round capillary tube, the inner surface of which is treated to obtain a certain degree of wetting along part of its length and greater or lesser wetting along the remainder of its length (see figure). The slug is injected into the tube at the less-wetting end, becomes accelerated in a brief transient upon reaching the less-wetting/more-wetting discontinuity, and thereafter travels from the less-wetting toward the more-wetting end with a steady speed as long as it bridges the discontinuity.

The basic observable phenomena pertaining to the movement of the slug in the capillary tube have been analyzed, yielding equations for the acceleration and the steady-state speed of the slug as functions of the mass density, surface tension, and viscosity of the liquid; the inner radius and length of the tube; the length of the slug; the orientation of the tube in the gravitational field; and the liquid/tube contact angles in the two differently wetted regions. Experiments have been conducted under conditions intended to minimize the effect of gravitation, using narrow tubes (inner radii of the order of 0.5 mm) oriented horizontally on a table and using wider tubes (inner radii of the order of 5.0 mm) in a drop tower. The results of the experiments agree well with the predictions over a large parametric range. The results also show that the speed is strongly affected by the level of cleanliness of the tube surface.



The **Slug of Liquid Is Driven** from the less-wetting end toward the more-wetting end by capillary action as long as the slug straddles the q_2/q_1 discontinuity.

The technique is expected to prove useful in experiments on the physics of dynamic wetting. Effects of microscopic surface roughness, cleanliness, and patchy wettability could be investigated and quantified in detail. The low-gravity environment of the drop tower affords additional possibilities that could be exploited to enhance understanding of capillary-driven flows on nonideal surfaces.

This work was done by Mark M. Weislogel 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. 157*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*

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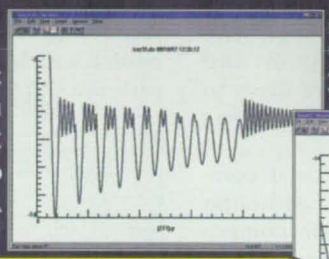

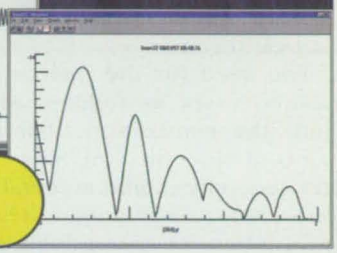

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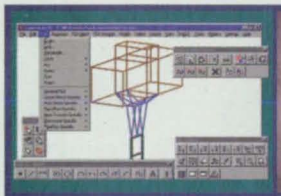

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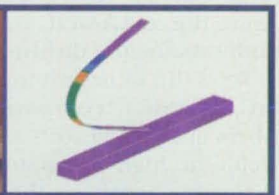

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Matrix additives and fiber coatings help to seal cracks to retard infiltration of oxygen.

Lewis Research Center, Cleveland, Ohio

Improved composites of SiC fibers in Si/SiC matrices have been invented for use in applications in which there are requirements for materials that can resist oxidation at high temperatures in the presence of air and steam. Such applications are likely to include advanced aircraft engines and gas turbines.

The need for the improved composites arises as follows: Although both the matrix and fiber components of older SiC/(Si/SiC) composites generally exhibit acceptably high resistance to oxidation, these composites become increasingly vulnerable to oxidation and consequent embrittlement whenever mechanical or thermomechanical loads become large enough to crack the matrices. Even the narrowest cracks become pathways for the diffusion of oxygen.

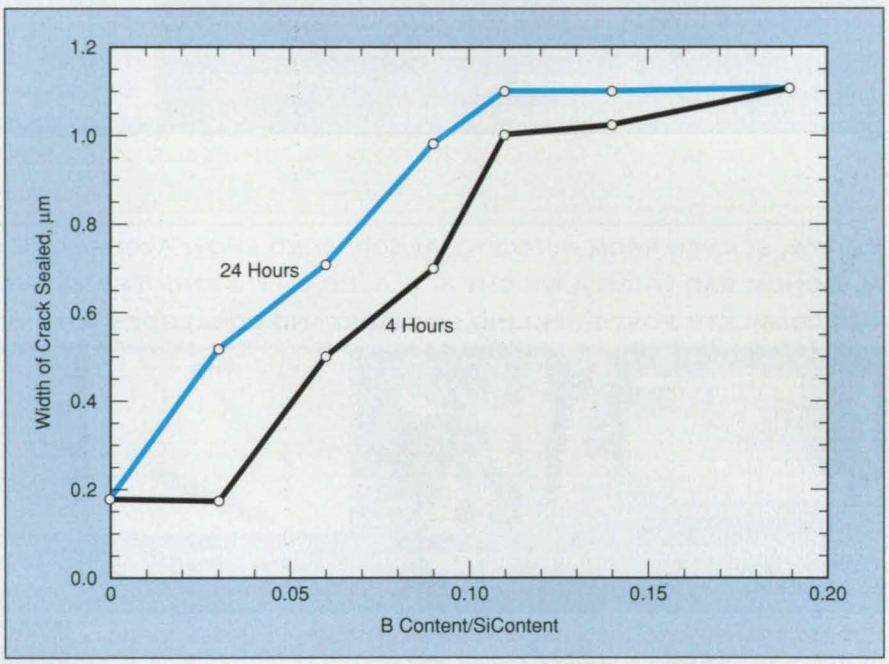
Typically, to impart toughness to an SiC/(Si/SiC) composite, the SiC fibers are coated with a material that yields at high stress to allow some slippage between the fibers and matrix. If oxygen infiltrates through the cracks to the fiber coatings, then, at high temperature, the oxygen reacts with the coatings (and eventually with the fibers), causing undesired local bonding between fibers and the matrix and consequent loss of toughness. In addition, the resultant concentration of stress and deterioration of the fibers at the bonding locations give rise to failure of fibers. If the process of infiltration and oxidation continues, then eventually the remaining fibers become unable to bear the load, causing the composite to fail at a stress appreciably below its initial (as-fabricated) ultimate strength.

The improved composites incorporate matrix additives and fiber coatings that retard the infiltration of oxygen by reacting with oxygen in such a way as to seal cracks and fiber/matrix interfaces at high temperatures. These matrix additives and coating materials contain glass-forming elements — for example, boron (see figure) and germanium.

Boron is particularly suitable for use in fiber coatings because it can react with oxygen to form boron oxide, which can, in turn, interact with the silica formed by oxidation of the matrix and fiber materials to produce borosilicate glasses. Boron and SiB6 may prove to be the coating materials of choice because they do not introduce any elements beyond those needed to form borosilicate glasses.

One way to fabricate an SiC/(Si/SiC) composite object is to first make a preform of silicon carbide fibers interspersed with a mixture of silicon carbide and carbon particles, then infiltrate the preform with molten silicon. Boron can be incorporated by chemical vapor deposition onto the fibers prior to making the preform.

Boron and germanium can be incorporated into the matrix by adding these elements to either the matrix or the molten silicon infiltrant. Inasmuch as the solubility of boron in silicon is limited, it may be necessary to add the boron via the preform in a typical case.



The **Widths of Cracks That Were Sealed** were measured in SiC/(Si/SiC) specimens that contained various proportions of boron. The specimens were exposed, variously, for 4 or 24 hours, to an atmosphere of 90 percent water and 10 percent oxygen at a temperature of 900 °C.

This work was done by F. N. Mazandarany of General Electric Co. for **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. 106*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*

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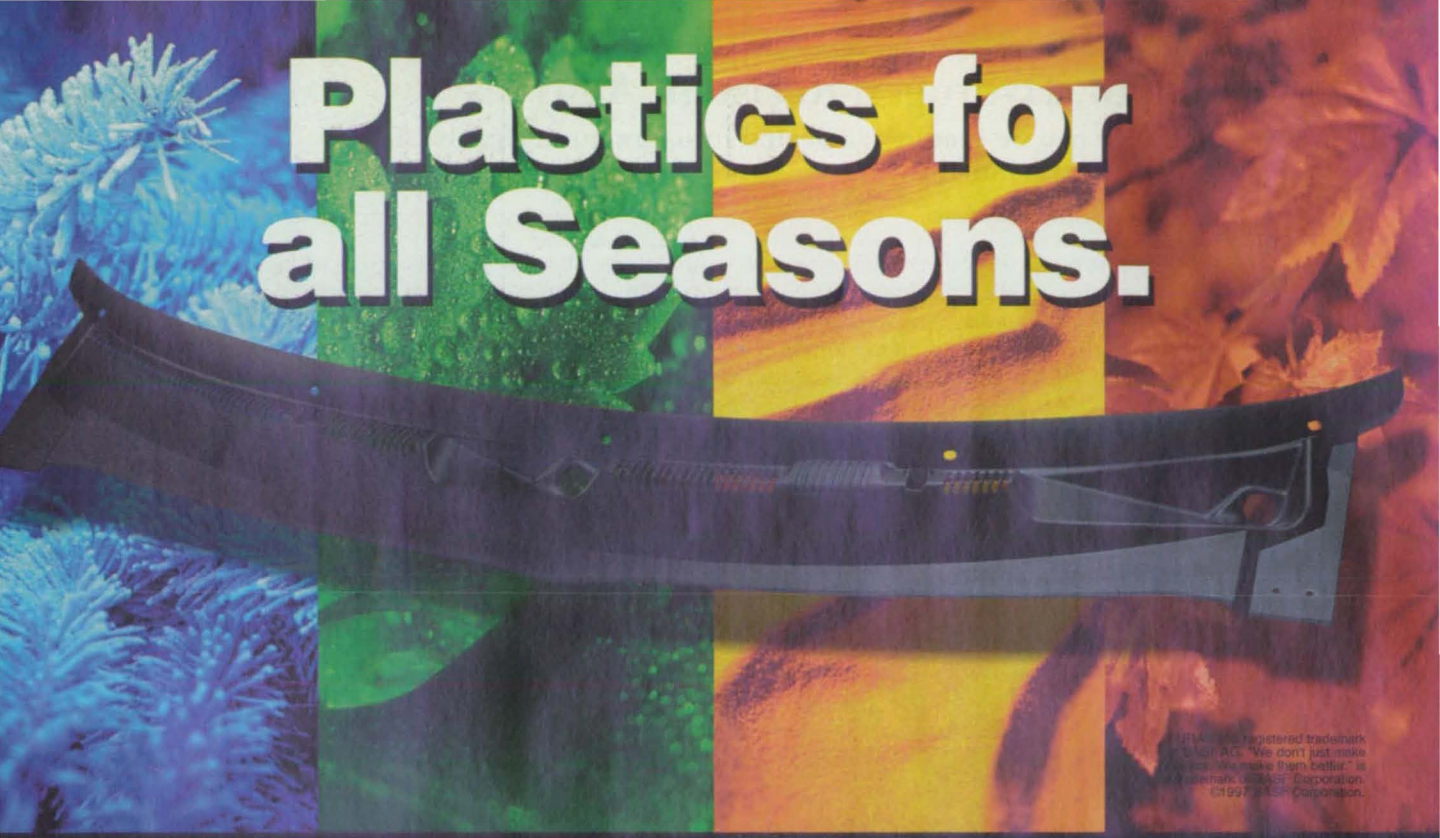

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High-Strength, Hydrogen-Resistant Alloy

Innovative new alloy can be readily fabricated into components suitable for use in hydrogen environments.

Marshall Space Flight Center, Alabama

NASA-23 is a hydrogen-resistant alloy that has been developed for applications in which there are requirements for high strength and high resistance to corrosion. The technology for this alloy was spurred by the fact that the industry did not have high-strength, hydrogen-resistant alloys available.

Adequate resistance to corrosion is necessary for the survival of alloys in hydrogen environments. Alloys for use in such environments typically contain a minimum of 10 weight percent chromium. The unique feature of NASA-23 is that it combines high strength with resistance to corrosion, and can readily be made into parts that are suitable for use in hydrogen environments.

The use of high-strength alloys that have low resistance to hydrogen results in frequent replacement of components because hydrogen severely degrades mechanical properties of these alloys. At present, coatings that serve as barriers to hydrogen/metal interactions are often applied to such alloys used in hydrogen. However, the use of coatings does result in higher production costs. Additionally, alloys that have lower resistance to hydrogen can be used by increasing section sizes; however, this method results in an increase in component weight.

NASA-23 can be used for components that encounter temperatures up to 1,200 °F (649 °C) in hydrogen environments.

Innovators of NASA-23 carefully chose alloying elements of iron, nickel, cobalt, chromium, niobium, titanium, and aluminum to ensure adequate precipitation hardening for strength and minimum precipitation of detrimental grain boundary precipitates.

This work was done by B.N. Bhat and W. B. McPherson of the **Marshall Space Flight Center** *and A.K. Kuruvilla of IITRI. For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Materials category,* ***or circle no. 177*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*

MFS-26493

Lightweight Panels With Embedded Perpendicular Metal Pins

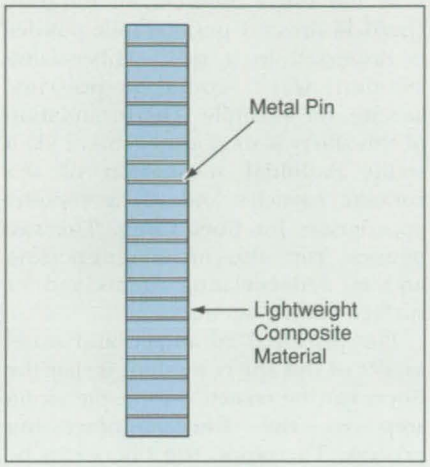
These panels have potential for both terrestrial and outer-space applications.

Marshall Space Flight Center, Alabama

Lightweight panels made of organic composite materials with embedded metal pins oriented through the thickness (see figure) have been investigated for their potential utility as the outer layers of multilayer shields ("bumpers") to protect spacecraft against high-speed impacts of natural and artificial debris. Composite-material panels containing

through-thickness pins are also of great potential use on Earth; for example, composite panels with pins embedded using this manufacturing technique have been shown to yield a twenty-fold increase in delamination resistance, when compared with the same composite without pins, resulting in significantly improved composite aircraft structures. Similarly, this approach has great potential appeal for the joining of composite components, such as skin panels to supporting ribs. In addition, the use of embedded pins can increase the through-thickness thermal conductivity of panels, making them potential candidates for electronic-packaging support structures.

In the spacecraft application, an outer bumper panel would be used to fragment debris particles incident at speeds of the order of 3 km/s. The fragmented debris would be further fragmented and spread out by an inner bumper panel (typically made of aluminum) before reaching the pressure wall of the spacecraft. Thus, the impact of each debris particle would be spread over a large area of the spacecraft structure to minimize damage to the pressure wall. The protective function of the pins is to provide high shock impedance to promote fragmentation of incident debris. The function is essentially the same (albeit in a reversed role) as that of long-rod penetrators that have been used on Earth to defeat tank armor. In experiments in which high-speed projectiles with masses of the order of 1 g were used to simulate incident space debris, pins with diameters of 7.5 mils (0.19 mm) embedded in graphite-fiber/epoxy-matrix composite at a volume fraction of 4 percent provided better protection than did pins of greater diameter or pins embedded at smaller volume fractions. More importantly, in a hypervelocity test at normal incidence, a double bumper having a composite front layer containing embedded pins and a spaced rear layer of aluminum significantly outperformed a similar bumper in which both layers were made of aluminum.



Metal Pins Oriented Through the Thickness of a lightweight composite-material panel impart special mechanical and thermal characteristics, depending on the pin material, diameter, and volume fraction.

Of course, for terrestrial applications, it is often preferable to use pins of different materials, diameters, and volume fractions. The process has considerable flexibility, and composite panels have been made successfully using pins of various types of metals as well as nonmetals.

This work was done by John Gassner, Patricia Schwartz, and Charles Carey of Foster-Miller, Inc., for **Marshall Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 124*** *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-26368.

Coating Fibers With Ceramics by Use of Slurries

This method is an attractive alternative to chemical vapor deposition.

Lewis Research Center, Cleveland, Ohio

Fibers for use in metal-matrix/fiber composite materials can be coated with ceramic-matrix/fiber interfacial layers by use of slurries. Heretofore, it has been common practice to form these interfacial layers by chemical vapor deposition (CVD). The slurry coating method offers several advantages over CVD — including lower cost.

CVD entails a number of disadvantages:

- Coating the fibers by CVD is very costly because of the capital equipment involved and because special tooling is usually needed.
- CVD adds a separate step to the overall process of fabrication of a metal-matrix/fiber composite.
- Coatings formed by CVD are susceptible to damage from handling.
- In an application in which fibers are required to be woven, coating must be done after weaving, and this generally necessitates an additional desizing operation.

In the slurry method, an ultrafine (particle sizes < 1 μm) ceramic powder is dispersed in a typical fiber-sizing solution, which could be polyvinyl acetate, for example. The formulation of this slurry is such as to achieve (1) a stable colloidal suspension of the ceramic particles and (2) a viscosity appropriate for fiber sizing. The suspension can also include dispersing and/or deflocculating agents and/or surface-wetting agents.

The principal advantage and novel aspect of this slurry method is that the fibers can be coated during the sizing step of the fiber-manufacturing process. Therefore, the fibers can be coated in a more nearly pristine state, and the combination of the coating and sizing affords some protection for both the fibers and the coating against damage from handling in subsequent operations. Thus, fibers could be woven in the coated state if necessary, and the sizing compound could be burned off prior to infiltration of the woven fabric with matrix material.

The low cost (relative to CVD) of this slurry coating method is realized directly through reduction in the number of processing steps, lower prices of raw materials, and less use of expensive capital equipment. Part of the reduction in cost is realized indirectly through the processing flexibility that results from increased ease of handling of the coated fibers and the possibility of weaving fibers in the coated state.

This work was done by Stuart A. Sanders and Imelda P. Smyth of United Technologies 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-16060.

Sputtered Au/Cr Bilayers as Solid Lubricants on Alumina

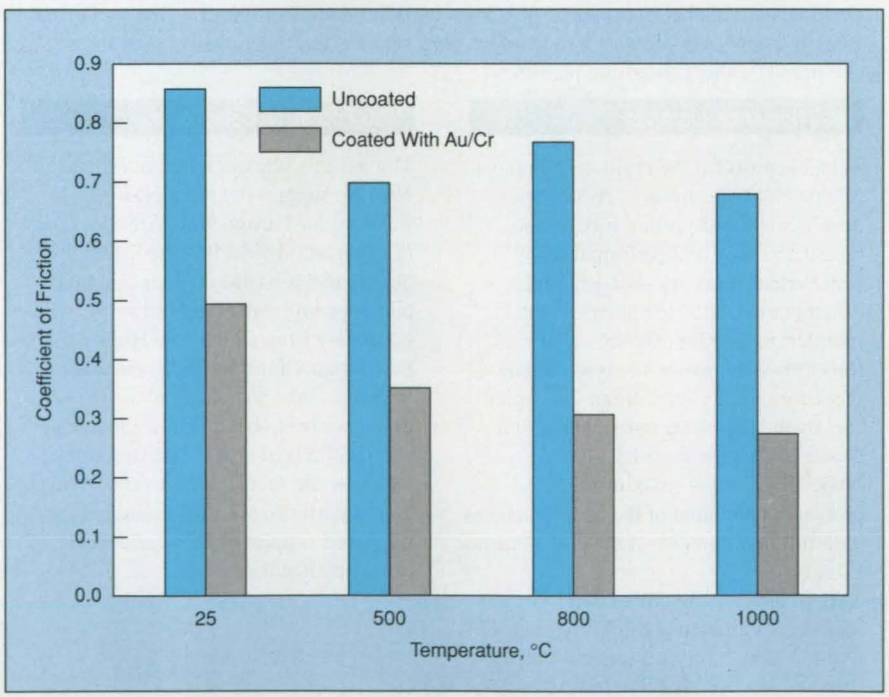
Friction and wear in slow sliding at high temperatures are reduced.

Lewis Research Center, Cleveland, Ohio

Sputter-deposited surface bilayers of gold on chromium have been found to be effective as solid lubricants to protect alumina substrates in applications that involve sliding at high temperatures. The use of thin surface layers of gold, lead, copper, or other soft metals to protect hard metallic substrates is well known. Whether the substrate is metal or, as in this case, ceramic, the basic principle of solid lubrication remains the same: under a sliding load, the soft overlayer (in this case, gold) shears rather than abrades, and thereby protects the hard substrate, which carries the mechanical load.

The novel aspect of the present development lies in the particular choice of materials, which was guided by the following considerations:

- The low thermal conductivity and high thermal stability of alumina make it an attractive candidate substrate material for high-temperature applications.
- Gold offers the advantages of chemical stability and a relatively high melting temperature of 1,073 °C.



These **Coefficients of Friction** were determined from experiments with uncoated and Au/Cr-coated alumina disks at a sliding speed of 1 m/s and a pin/disk load force of 4.9 N.

- Unfortunately, because of its chemical stability (nonreactivity), gold adheres poorly to alumina substrates; gold does not even wet alumina. This makes it necessary to deposit an interlayer of a more reactive metal between the alumina substrate and the gold overlayer so that the gold overlayer can adhere.
- Chromium has been used in the electronics industry to form bonding interlayers between silicon substrates and gold surface electrical contacts.

The concept of sputter-deposited Au/Cr coatings as solid lubricants was tested in experiments in a high-temperature pin-on-disk tribometer. Alumina disks — some uncoated and others sputter-coated Au/Cr bilayers — were slid against uncoated alumina pins in air at temperatures from 25 to 1,000 °C, at sliding speeds from 1 to 15 m/s, and with pins pressed against disks at various loads from 4.9 to 49 N. Friction forces were measured during the tests, and post-test analyses were performed to determine the nature and extent of wear.

The results of the experiments (for example, see figure) indicate that in the presence of Au/Cr surface layers, friction was reduced by about half. In most cases, the coefficients of friction of Au/Cr-coated specimens decreased with temperature from 25 to 1,000 °C. At the lowest sliding speed of 1 m/s, pin-wear factors [wear volume ÷ (load force × sliding distance)] for Au/Cr-coated disks were found to be 10 to 100 times lower than for uncoated disks. Pin-wear factors were largely unaffected by increasing loads up to 29.4 N. Sliding speed had little effect on friction. However, wear factors for Au/Cr-coated specimens increased strongly with sliding speed, even exceeding those for uncoated specimens in some cases. On the basis of these results, it appears that Au/Cr coatings provide adequate lubrication for moderately loaded sliding alumina substrates at speeds up to about 1 m/s and temperatures up to 1,000 °C.

This work was done by Christopher DellaCorte of **Lewis Research Center** *and Patricia A. Benoy of Saint Louis University. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category,* ***or circle no. 176*** *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-16467.

Carbon Papers for Negative Electrodes in Lithium Cells

These papers feature high reversible charge/discharge capacities.

NASA's Jet Propulsion Laboratory, Pasadena, California

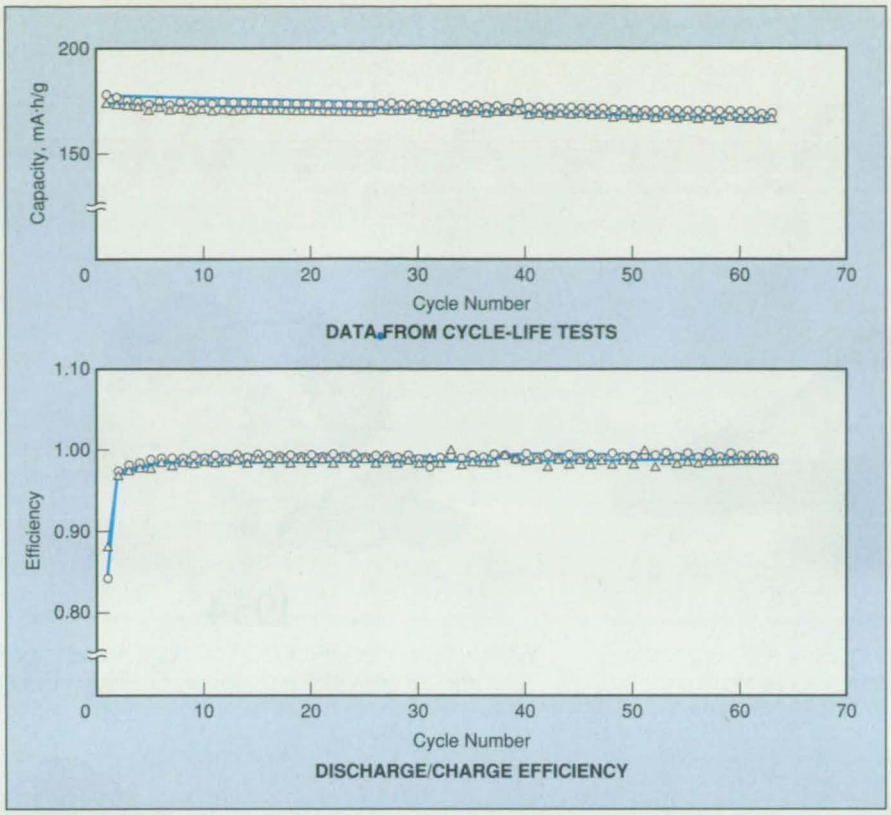
Experiments have demonstrated the feasibility of using selected commercial carbon papers as negative electrodes (anodes) of lithium-based electrochemical cells. Various lithium-intercalating materials, including different forms of carbon, are being investigated as candidate anode materials. Li-intercalating materials are attractive as alternative anode materials because, in comparison with lithium itself as the anode material, they offer significant improvements in safety and cycle life.

Some other forms of carbon (including graphite and coke) evaluated for this purpose at NASA's Jet Propulsion Laboratory have thus far proved unsuitable because they have exhibited loss of charge/discharge capacity during the first few charge/discharge cycles. In general, the selection of a carbon Li-anode material is complicated by the strong dependence of charge/discharge characteristics on the specific form of carbon. These characteristics include the intercalation characteristics (amount, kinetics, and potential of Li intercalation), and the loss of capacity (equivalently, the irreversible component of the charge/discharge capacity or "irreversible capacity," for short). The irreversible capacity is consumed during the first few charge/discharge cycles as some of the lithium becomes irreversibly intercalated and surface films form.

Thus, desirable characteristics for a carbon Li-anode material include high reversible capacity at potential close to that of Li at moderate to high rates of intercalation, plus low irreversible capacity. The carbon papers tested in the experiments were found to exhibit such characteristics. These carbon papers are made from carbon fibers of defined history and sources, using binder resins that are eventually carbonized and graphitized. These papers are 60 to 80 percent porous, and, in comparison with some other forms of carbon, are flexurally strong and highly electrically conductive. The carbon papers are available with various fiber lengths and in various thicknesses. They are used commercially in several applications, including fuel cells and supercapacitors.

In the experiments, sheets of the carbon papers were electrochemically tested against $LiCoO_2$ cathode in an electrolyte solution that comprised $LiPF_6$ dissolved in a mixture of ethylene carbonate and diethyl carbonate. A lithium reference electrode was included in each electrochemical cell. Microporous polypropylene sheets were used as electrode separators, and polytetrafluoroethylene shims were used to provide compaction for the electrode stack. The cell was subjected to charge/discharge cycles by use of an automatic battery cycler at a constant current density of 0.2 mA/cm^2, between cutoff potentials of 4.1 V on charge and 2.5 V on discharge.

As shown in the upper part of the figure, the measured charge/discharge capacities started high and remained high after 65 cycles (tests were continuing when the information was submit-



Data From Charge/Discharge Cycling Tests of Li cells containing anodes made from two commercial carbon papers illustrate the high performances achievable when these papers are used as alternatives to lithium itself as the anode material.

ted for this article). The lower part of the figure presents the measured values of discharge/charge efficiency, which is defined as the ratio between the capacity during a given discharge and the capacity during the immediately preceding charge; this plot shows that within the first few cycles, each cell achieved a discharge/charge efficiency close to 100 percent. Both carbon papers were found to exhibit relatively high (≈ 175 mAh/g) reversible Li-intercalation capacities, with a relatively low (≈ 40 mAh/g) irreversible capacity. These performance characteristics are comparable or superior to the majority of other carbon/graphite materials, and the carbon papers can be easily tailored to satisfy specific needs.

This work was done by Ratnakumar V. Bugga, Chen-Kuo Huang, Subbarao Surampudi, and Gerald Halpert 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 Materials category,* ***or circle no. 164*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*
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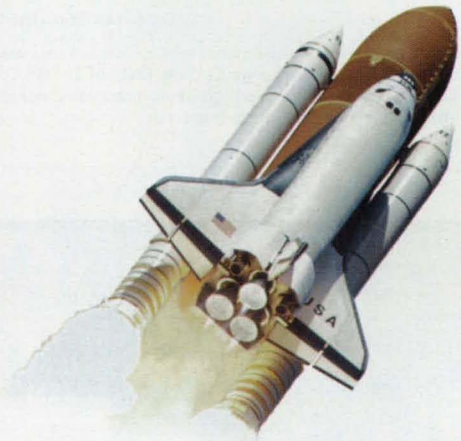

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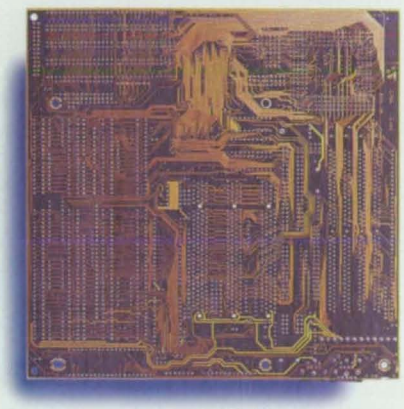

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Optimizing Program Does Feasible-Directions Gradient Search

SEEK is a general-purpose optimizing software tool that performs a gradient search optimization of the user's problem to find a best set of design parameters. SEEK was written to assist a mechanical designer in developing a balanced optimal design, keeping the designer in the process while searching systematically among potential designs.

SEEK was also written to be interactive and to communicate clearly to the user. It requires the user to write two analysis subroutines and an input data file for his/her application. By requiring text labels for all variables, the program is able to label its restatement of the problem and all results in the user's words. Optimization is performed by use of a modified feasible-directions gradient technique. The SEEK output file includes an echo of the input data and an analysis of the optimized design. In addition to finding its own optimum, the program allows the user to enter alternative designs for comparative analysis. Analyses of all user designs are also included in the output file.

The SEEK user's manual illustrates the model preparation and programming required to use SEEK for four examples: a bushing design, a spring design, a gear design, and a curve fit. Each of these examples represents a different design problem. The use of SEEK is limited to solving problems that can be modeled continuously with finite constraint and objective-function values over the search area.

SEEK is written in FORTRAN 77 for use on IBM PC-series and compatible computers running MS-DOS. A FORTRAN 77 compiler is required. SEEK has been successfully implemented on an IBM PC 486DX/33 computer running MS-DOS 5.0 with the Lahey F77L 5.1 compiler. The standard distribution medium for SEEK is one 3.5-in. (8.89-cm), 1.44MB, MS-DOS-format diskette. SEEK was released to COSMIC in 1997 and is a copyrighted work with all copyright vested in NASA.

This program was written by Harold H. Coe of **Lewis Research Center** *and M. Savage of the University of Akron. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Computer Software category,* ***or circle no. 147*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
LEW-16446

Algorithm for Lossy/Progressive/Lossless Image Compression

The Efficient Reversible Image Compression (ERIC) algorithm compresses and decompresses image data at selectable performance levels. By use of a fast integer wavelet transform, the algorithm losslessly compresses the data on an image into several subimages that represent the image at various levels of spatial resolution and amplitude accuracy. Each subimage is then entropy (Huffman) coded. Decompression of the first subimage reconstructs the image data at the lowest level of accuracy. Decompression of subsequent subimages reconstructs the image data at progressively greater accuracy. Decompression of all subimages reconstructs the original image data exactly. Inasmuch as less-accurate approximations require less data-transmission bandwidth, the algorithm is particularly useful where the user finds it necessary to choose the closest approximation achievable under a given bandwidth constraint. The lossless-compression ratios achieved by this algorithm exceed those of the best previously available standard lossless compression algorithms, which do not give progressively accurate approximations.

This program was written by Eric Majani 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. 146*** *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-20141.

Prototype Distributed-Visualization Software System

An image-distribution system was developed to facilitate interactive manipulation of high-data-volume images by remote users over a slow network. The system is based on a client/server model integrating a high-performance server running parallel visualization applications and a remote client workstation providing control and display. In order to deliver the image frames generated by the visualization server to the client system quickly, the image distribution system employs a data-compression algorithm developed at JPL, ERIC (Efficient Reversible Image Compression), to reduce the data volume.

The software system employs various optimization steps to provide greater than 5 video frames per second at the client system. The optimization steps include pipelining of the compression, transmission, and decompression and the use of shared-memory X calls. The pipelining minimizes the compression process overhead by balancing the execution times involved in compression, transmission, and decompression and by overlapping these steps.

In this system, compression can be performed in either lossy mode or lossless mode. The lossy mode, is used for quick browse where the data quality is not as important or for applications with a preset data quality. The lossless mode is used where data quality may be important but cannot be set a priority. In this mode, the data can be sent progressively until the quality has been satisfied up to the original quality.

The server system with an API is available on a Cray T3D and it can be integrated with parallel visualization applications producing monochrome image as well as multispectral images. A demonstration system was developed integrating an interactive parallel volume renderer at Cray Research Center in Minnesota and an SGI Indigo 2 workstation at JPL in California. It was successfully demonstrated, displaying 5 monochrome image frames per second on the SGI.

This program was written by Roberto Mendoza, Eric Majani, and Meemong Lee 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. 139*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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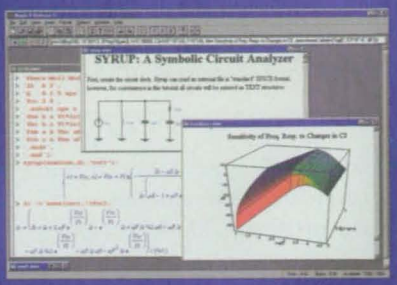

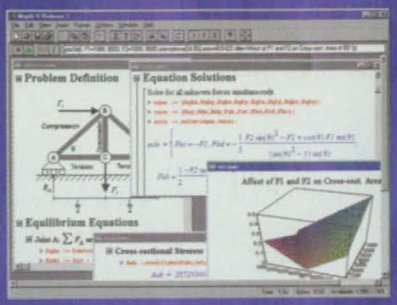

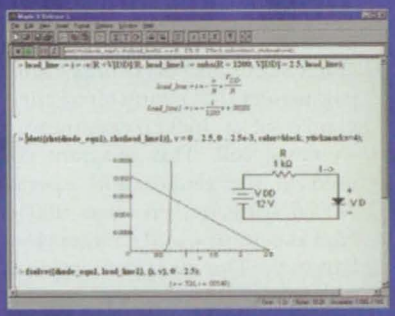

If you are solving problems with conventional methods of pencil and paper, spreadsheets or numeric based programs then take a look at the New Maple V Release 5. In today's global market, the need to increase the speed of product development and minimize cost is vital. Maple V's powerful symbolic mathematical processing system reduces or eliminates expensive prototyping and is the perfect solution for cost-effective modeling and simulation design.

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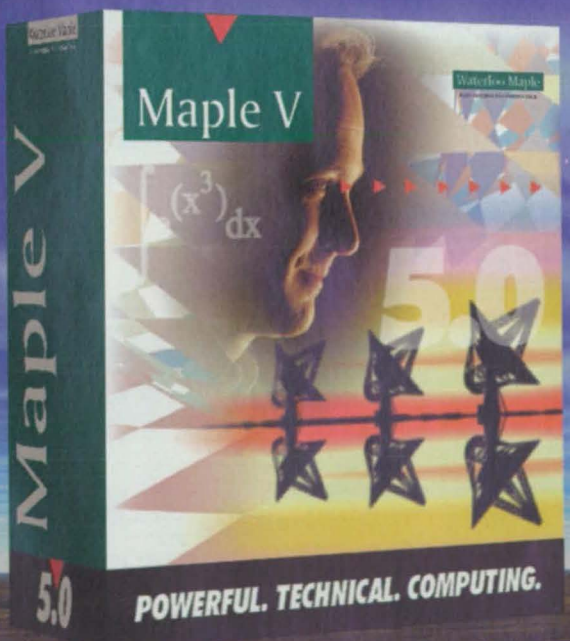

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The Nickel Cadmium Performance Prediction Model computer program predicts the current, voltage, heating, efficiency, state of charge, and other parameters that characterize the performance of a nickel/cadmium electrochemical cell. This program could be used in the design and operation of Ni/Cd batteries, products that contain Ni/Cd batteries, and chargers for Ni/Cd batteries. The program implements a mathematical model based on first principles; it includes submodels of thermodynamics, mass transport, chemical kinetics, mass balance, and energy balance. Kinetic equations for eleven different reactions (including solid/liquid and gas-phase reactions) are included. Unlike other Ni/Cd-performance-predicting programs driven by static data bases or analog circuit models, this program is capable of predicting time-dependent and hysteretic behavior. This program is easy to use, and can be executed on any Apple Macintosh or compatible computer. To be able to run a graphical user interface in the program, one must use the AppleScript and MacOS 7.5 software. The program requires less than 4 MB of disk storage (including user files) and only 4 MB of random-access memory.

This program was written by Paul J. Timmerman and Carlos E. Sanchez 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. 161*** *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-19991.*

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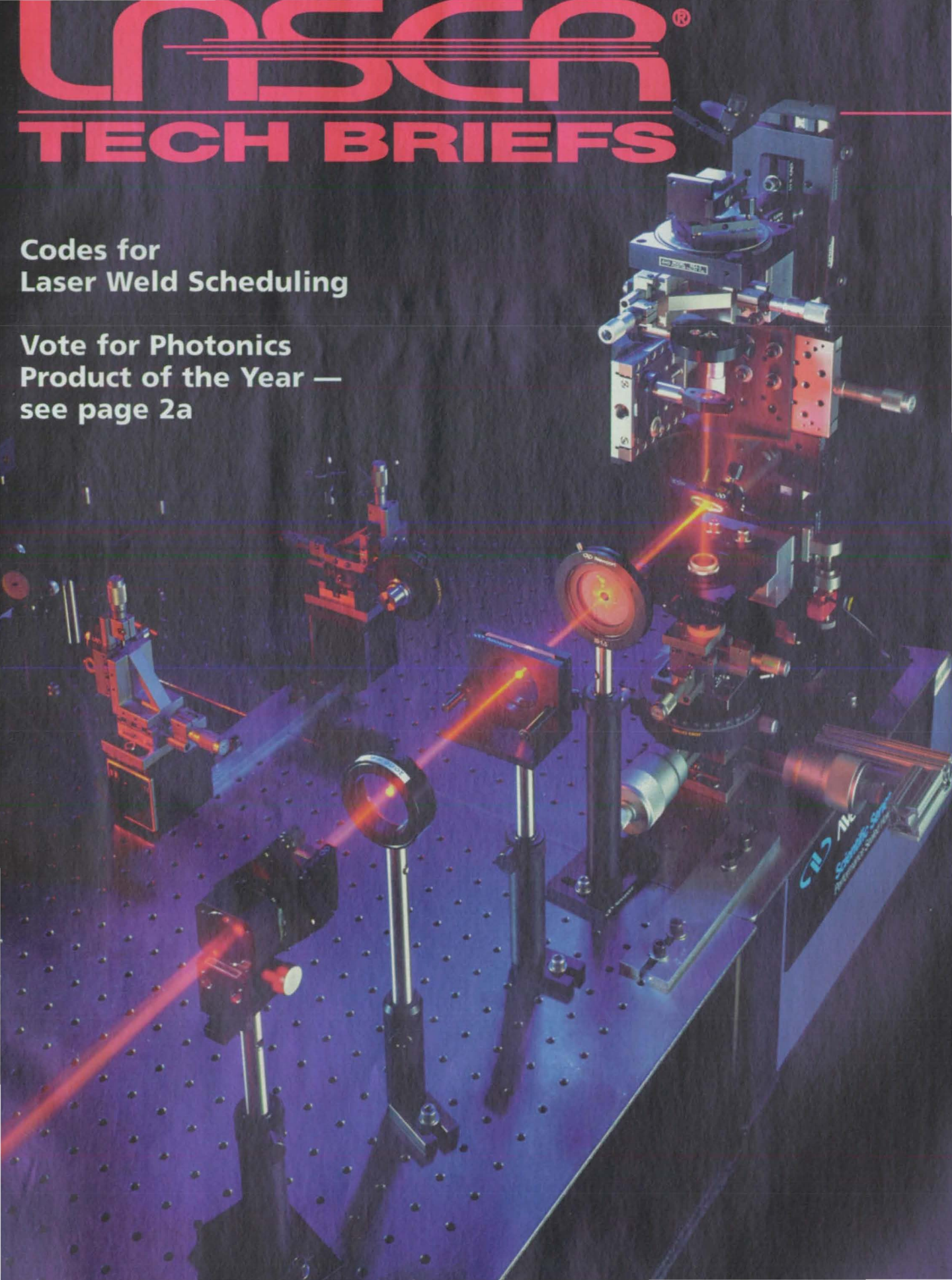
LASER TECH BRIEFS

Codes for Laser Weld Scheduling

Vote for Photonics Product of the Year — see page 2a



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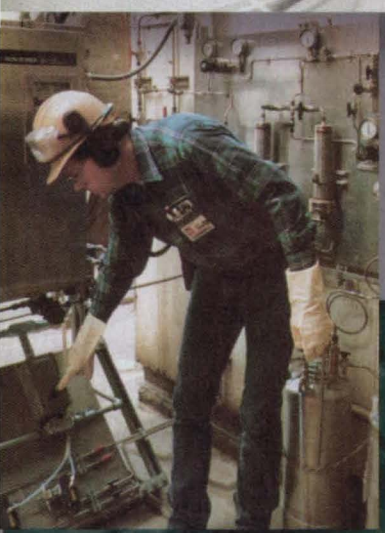

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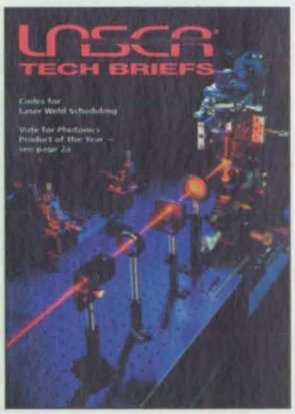
LASER TECH BRIEFS

Laser Tech Briefs Supplement to *NASA Tech Briefs* December 1997 Issue Published by Associated Business Publications

LASER TECH BRIEFS

FEATURE

DEPARTMENTS



On the cover:
An ultrafast laser measures the azimuthal dependence of second-harmonic generation in a spontaneously ordered GaInP thin film. Atomic ordering, a form of bandgap engineering used at the National Renewable Energy Laboratory's Basic Sciences Center, results in a change to the crystal symmetry of the material. This is revealed in the second-order nonlinear susceptibility, which can identify crystal directions that are isotropic to linear measurements. *Photograph courtesy Coherent Inc. Laser Group.*

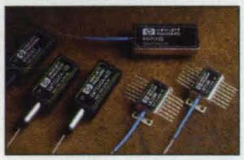
Cast Your Vote for

LASER TECH BRIEFS

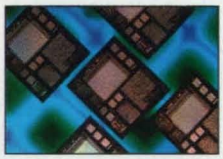
First Annual Product of the Year Award

Beginning in April, each issue of the *Laser Tech Briefs* supplement to *NASA Tech Briefs* carried a Product of the Month—a photonics product the editors felt was of special interest and value to readers who work with lasers, optics, fiber optics, video and imaging equipment. This month *Laser Tech Briefs* readers are invited to vote for the one product you deem the standout among those described below. The product garnering the most votes will be named *Laser Tech Briefs* Product of the Year.

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 15, 1998. The *Laser Tech Briefs* Product of the Year will be announced in the March 1998 issue.



April: *1500-nm Distributed Feedback Laser*
Hewlett-Packard Co., Dallas, TX, specifies its new LSC2500 laser source for operation under ATM standards at SONET OC-48 and STM-16 speeds of 2.488 Gb/s. The directly modulated distributed feedback laser, intended for long-haul telecommunications, fiber optic sensors, cable television, and instrumentation, is capable of distances greater than 200 km over single-mode fiber. With a -20 to +65 °C operating temperature range, it delivers more than +3.8 dBm output with slope efficiency adjustable to more than 0.06 mW/mA. The package includes a photodiode for output monitoring, and a Peltier-effect thermoelectric cooler.



June: *Single-Chip NTSC Color Camera*
VLSI Vision Ltd., Saratoga, CA, introduces the VV6405, which it calls the world's first single-chip NTSC color camera. Using VLSI's complementary metal-oxide semiconductor (CMOS) technology, the device delivers color video with just a single external crystal and single-rail 5-V power supply. It combines on a single standard CMOS chip a 1/4-in. Color MOS™ photoplane, video timing controller, 8-bit A/D video converter, 300-MIPS color DSP engine, 5 video line memories, auto exposure control and control balance, and NTSC composite video encoder. The chip draws about 100 mA at 5 V, which VLSI says puts its power consumption at about 20-30 percent of CCDs.

August: *PC Laser Beam Analyzer*
Spiricon, Logan, UT, says the LBA-300PC laser beam analyzer Version 1.2 incorporates a number of features for higher performance. Chief among these, according to the company, is the patented Ultracal automatic calibration technique, which sets the baseline of the camera precisely at zero, and saves negative numbers for use in precise beam calculations. Spiricon says this makes the LBA-300PC the only commercial-grade camera system able to make second moment beamwidth measurements, the new ISO standard. This version runs under the 32-bit mode of Windows 95B, which speeds up beam profile access and processing.

October: *Laser Cutting System for Micromachining*
New Wave Research, Sunnyvale, CA, describes the EzLaze™ as a small solid-state laser cutting system designed for semiconductor failure analysis, design verification, LCD repair and other micromachining applications. Available in single- and multiwavelength models that include New Wave's patented Advanced Beam Delivery System (ABDS), EzLaze features single-shot, 1-Hz- or 5-Hz-burst pulse repetition rates. Mounted on the Mitutoyo FS60 or A-Zoom microscopes, it can produce uniform, repeatable cuts ranging from 1 × 1 μm to 50 × 50 μm. Three wavelengths—1064 nm, 532 nm, and 355 nm—are available at the flip of a switch. Energy output is 0.6 mJ; pulse widths vary from 5 to 7 ns depending on wavelength. EzLaze comes with PCLaze™, a Windows interface that allows users to select cut size, triggering, and wavelength through a computer running Windows 95 or Windows NT.

December: *High-Power Excimer Lasers*
Lambda Physik, Ft. Lauderdale, FL, introduces the NovaLine 100, the first in a new series of high-power excimer lasers. With 100 W of stabilized output power, the KrF laser is ideal for such industrial microstructuring tasks as high-speed circuit-board via drilling, ink-jet printer nozzle drilling, and wire stripping, the company says. NovaTube™ metal-ceramic laser tube construction extends tube and gas lifetimes without the need for a cryogenic purifier, according to Lambda Physik. Other features are Slide Valve™ tube window mounting for fast cleaning or replacement, and an internal HaloSafe™ solid-state halogen generator. Pulse energy is 400 mJ and repetition rate is 250 Hz at 248 nm.

1997 *Laser Tech Briefs* PRODUCT OF THE YEAR BALLOT

Indicate your choice by clearly marking the appropriate box. Fax or mail your completed ballot to Robert Clark, Senior Editor, *Laser Tech Briefs,* 317 Madison Avenue, Suite 1900, New York, NY 10017; Fax: 212-986-7864.

- ❑ **April:** Hewlett-Packard LSC2500 DFB laser diode
- ❑ **June:** VLSI Vision Ltd. VV6405 single-chip NTSC color camera
- ❑ **August:** Spiricon LBA-300PC laser beam analyzer
- ❑ **October:** New Wave Research EzLaze laser micromachining system
- ❑ **December:** Lambda Physik NovaLine 100 excimer laser

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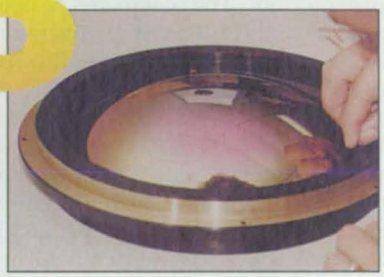
3



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The assembly of optical and electro-optical components and devices requires extreme care plus special tools and training. II-VI understands these critical factors and brings them together to assemble components ranging from simple mounted lenses to complex electro-optical modulators and military subassemblies.

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NEWS BRIEFS

Notes from Industry and the Federal Laboratories

SpecTran Specialty Optics Co. used a symbolic fusion splicing of a fiber optic cable to mark the official opening of its new offices and manufacturing complex in Avon, CT, last fall. The expansion is part of a $9-million project that will significantly increase the company's manufacturing capacity. The new facility is more than 50 percent larger than Specialty Optics' previous location close by, and features new equipment, including state-of-the-art fiber draw towers that will greatly increase capabilities for manufacturing a variety of advanced new products for communications, industrial, transportation, and medical markets worldwide. The firm is a wholly owned subsidiary of SpecTran Corp. of Sturbridge, MA, which supplies optical fiber, cable, and custom fiber optic products for communications and specialty markets. SpecTran Specialty Optics is located at 55 Darling Dr., Avon, CT 06001-1260; (860) 678-0371.

Donnelly Optics Corp. of Tucson, AZ, brought its $2.8-million state-of-the-art facility on line in October for the design, development, and manufacture of precision plastic optical systems. The 40,000-square-foot facility includes an injection molding room designed to accommodate 20 precision molding machines ranging from 55 to 250 tons; a polymer characterization laboratory; a precision optical tooling and fabrication facility; and a metrology laboratory. The molding assembly and packaging production areas and QA, metrology and characterization laboratory facilities are all Class 100,000 cleanroom-protected. The company designs and manufactures injection-molded diffractive, refractive, and hybrid lens systems. It is located at 4400 S. Santa Rita Ave., Tucson, AZ 85714; (520) 806-3838; fax: (520) 806-3899.

Veeco Instruments of Plainview, NY, announced that it had completed a merger with **WYKO Corp.** of Tucson, AZ, a well-known supplier of optical interferometric measurement systems for the optical, data storage, and semiconductor industries. WYKO, which was privately held, had sales of $8.2 million and operating income of $2.4 million for the three months ended March 31, 1997.

Semiconductor manufacturers use WYKO equipment for measuring flip chips and wafer roughness. A new in-line laser inspection system precisely adjusts the static attitude of disk-drive suspension arms, making it useful for next-generation miniaturized automated thin-film head fabrication. WYKO is located at 2650 East Elvira Rd., Tucson, AZ 85706-7123; (520) 741-1044; fax: (520) 294-1799.

Veeco Instruments is a worldwide manufacturer of precision ion-beam systems, vapor deposition systems, and surface metrology equipment for microelectronic markets.

The Air Force's Phillips Laboratory, at Kirtland AFB, NM, awarded **Black & Veatch Special Projects Corp.** of Overland Park, KS, a contract to build an advanced laser research facility. The 29,600-square-foot facility will be used for research and development of chemical, electrical, and hybrid lasers for use in air-, ground-, and space-based systems. A two-story structure with offices for more than 50, the facility is to include six laboratories, four of them Class 10,000 clean rooms and two Class 100,000. There will also be a chemistry lab, machine shop, electronics lab, and conference room. Two labs will be dedicated to chemical laser work, such as the chemical oxygen-iodine laser developed by Phillips and used in the Airborne Laser program that envisions laser-carrying aircraft for destroying theater ballistic missiles.

A Suite of Codes for Laser Weld Scheduling

A model-based approach to devising optimal laser weld schedules has been developed.

Sandia National Laboratories, Albuquerque, New Mexico

A suite of MATLAB-based optimization applications has been developed at Sandia as aids for determining CO_2 laser, pulsed Nd:YAG laser, and plasma-arc weld schedules. This brief will concentrate on the CO_2 laser, but all have a common user interface and code organization. The raison d'etre for these applications has been to bring a model-based approach to some of the welding methods that are applied to high-reliability weld configurations. Advantages of laser welding are that it is able to achieve deep penetration and minimizes heat input, both key features when used in conjunction with optimization.

A semi-empirical model blends the results of data fits with thermodynamic relations. The final model consists of a set of nonlinear algebraic relations. For CO_2 welding, the model inputs, or "weld schedule," consist of the constant power delivered from the laser (q_o), the constant part travel speed (υ), and a fixed lens, focused or defocused, as characterized by the beam spot diameter (D). The model responses to these inputs characterize the "weld pool" and consist of 1) Energy Transfer Efficiency (η_t), which is the ratio of heat absorbed by the workpiece to the incident laser energy, 2) Melting Efficiency (η_m), the ratio of heat to melt the fusion zone to that absorbed by the workpiece, 3) Penetration Depth (P), the deepest extent of the weld below the metal surface, and 4) Weld Width (W), which is the width at the surface based on a parabolic cross-sectional shape approximation. In summary, $(\eta_t, \eta_m, P, W) = f_-(q_o, \upsilon, D)$. The quantities q_o, υ vary continuously between bounds, while D is confined to four discrete lens sizes for the focused lens case. This will result in a discrete variable optimization problem. For a defocused lens, a continuous variable formulation is used.

The model equation for P was empirical using the ratio of $q_o/\upsilon D$ as a kernel. η_t was derived from a Fresnel energy absorption model as a function of P. Both P and η_t were augmented with additional parameters which were computed via nonlinear least-squares fitting of experimental data from over 100 welds on 304 stainless, 1018 steel, and tin. Scaling of the P, η_t equations was necessary due to the span in variable orders of magnitude. η_m and W were based on thermodynamic relations employing dimensionless parameters (Ry, Ch) [see Fuerschbach, P.W., "Measurement and Prediction of Energy Transfer Efficiency in Laser Beam Welding," *Welding Journal*, 75(1): 24(s)-34(s), 1996]. Ry and Ch have embedded material constants for thermal diffusivity and enthalpy of melting which permitted applicability of the model materials not used in experimentation.

From the derived model, $(\eta_t, \eta_m, P, W) = f_-(q_o, \upsilon, D)$, the following optimization problem combinations could be stated: Find a q_o, υ, D triplet to: maximize a figure of merit: η_t or η_m or $\eta_t{}^*\eta_m$, and constrain dimensions: P *and* W or P to desired values for a given material.

A two-part optimization procedure was developed. A steady-state genetic algorithm (ideal for discrete variable problems, but slow to converge) was used to "scan" the available q_o, υ, D "space" and arrive at a triplet that would be "close" to solving the problem of choice as stated above. This solution was then used in the focus problem as an initial guess to solve two types of faster, gradient-based subproblems corresponding to the aforementioned constraint combinations . In the first subproblem type, the user seeks a q_o, υ combination at each of the n values of D that generates the desired constraint values on both P and W. Each of these subproblem solutions requires a nonlinear algebraic solver. The algorithm then sorts on the n or less acceptable constraint solutions according to the figure of merit chosen. For the second subproblem, the user seeks a q_o, υ combination for a desired P value only. Each of the n subproblems uses a nonlinear optimization algorithm. Again, a sorting is done on each of the subproblem solutions. In the defocus problem, D is bounded, but continuous, and once found is matched via an optics relation to the appropriate lens(es).

The MATLAB-based code is packaged with a graphical user interface (GUI), analysis graphics, and weld cross-section display updates. The GUI is divided into a "best" weld schedule listing, plot selection, and weld specifications. The best output list contains the computed weld schedule and associated responses (or process vari-

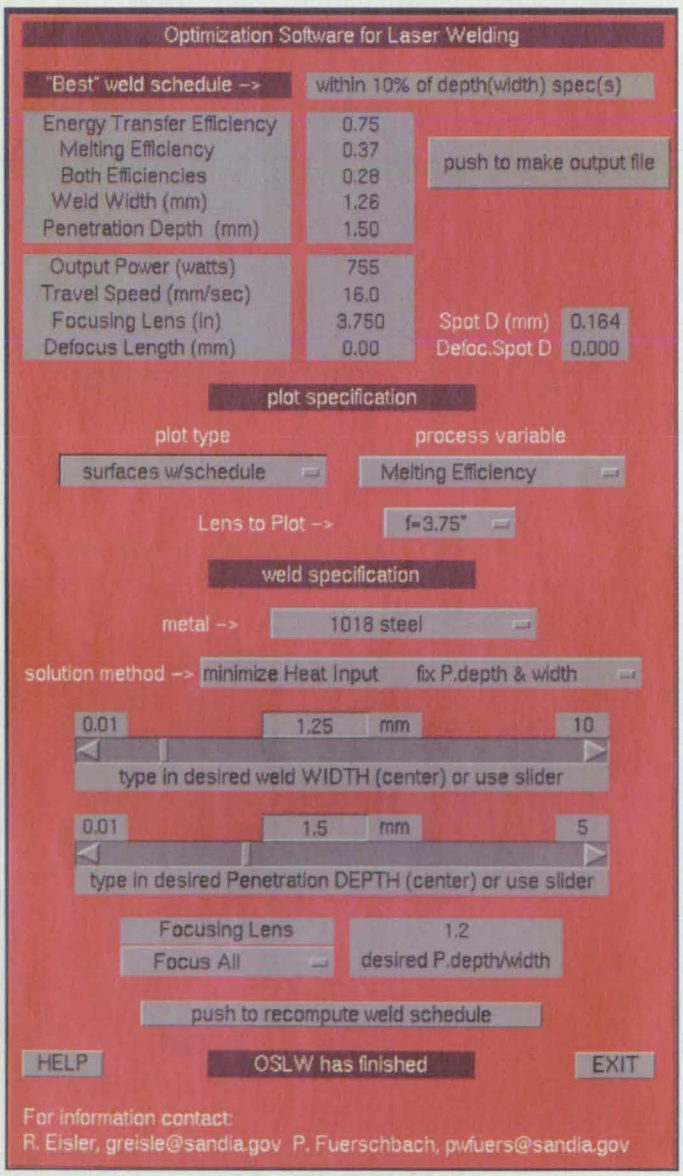


Figure 1. **Optimization Software Graphical Display.**

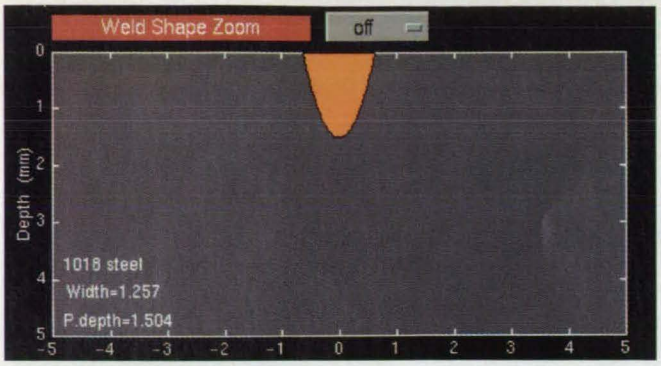


Figure 2. **Weld Shape Zoom Display.**

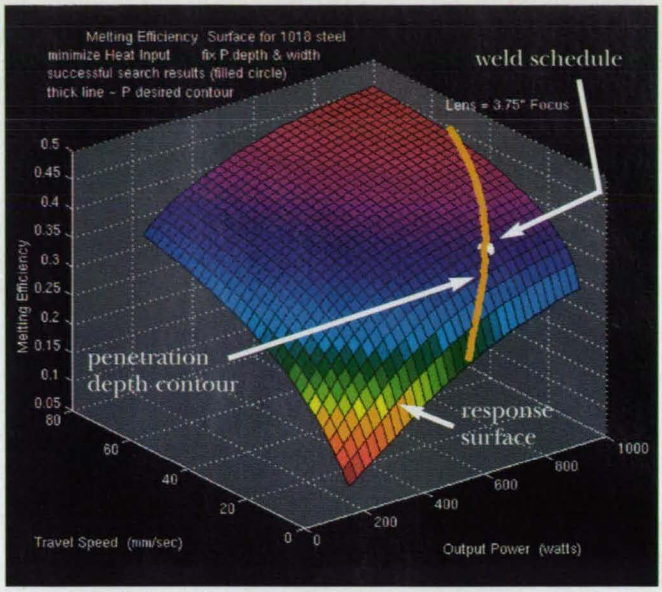


Figure 3. **Analysis Display of Penetration Depth Contour.**

ables) from the previous optimization. The plot selection provides four types of analysis plots (both 2-D and 3-D) for each process variable. In addition, a fifth type of plot guides the user in selecting feasible *P, W* combinations. The weld specification accepts inputs for material, optimization combination, desired depth, and width. Computation is launched via push-button. A HELP window is provided to explain code contents and feature layout.

A "status" bar informs the user of code activity.

Completion of the weld schedule computation results in updated weld shape and analysis graphics displays. The shape display shows fits of a parabola to the computed depth and width, which for the experimental data is a good approximation.

2-D and 3-D analysis plots display the entire penetration depth contour of which the compute weld schedule is but one point. This allows the weld engineer to do tradeoffs if a neighboring suboptimal solution is sufficient. The engineer can "flip" between the available plot types without recomputing.

When η_t is not maximized, more expensive and powerful lasers are needed to compensate for lost energy and higher production rates cannot be achieved. When η_m is maximized, it assures that heat input to the part is as low as possible. The use of this software could lead to substantial time and cost savings to laser weld producers.

This work was done by G. Richard Eisler and Phillip Fuerschbach of **Sandia National Laboratories**. *For further information, contact Rick Eisler at Dept. 9234, Albuquerque, NM 87185-0439, (505) 844-4838; E-mail: greisle@sandia.gov.*

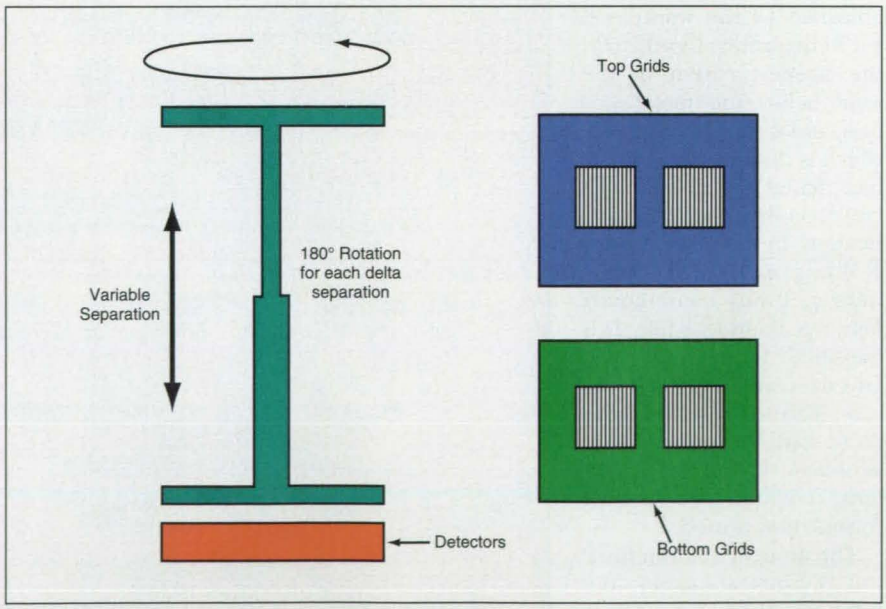
One-Grid-Pair Fourier Telescope for Imaging X and Gamma Rays

This telescope design provides better imaging at a significantly lower cost.

Marshall Space Flight Center, Alabama

A telescope design, using only one real and imaginary set of grid pairs, provides superior performance at a greatly reduced cost. Previous Fourier telescope designs required many fine grid pairs constructed from material such as tungsten. These multiple-grid telescopes were extremely large in order to provide a reasonable collecting area and required unreasonably long focal lengths.

The Fourier-transform design eliminates all but one set of grid pairs by incorporating rotation of the grid pairs and movement of the mass separating the two grids. This telescope has a set of subcollimators that feed discrete detectors. A measurement of the amplitude and the phase at selected points in the visual plane provides the real and imaginary parts of the Fourier component measured by a given subcollimator. A spatial modulation collimator (SMC) uses slight differences in the geometry of



A **One-Grid-Pair Fourier Telescope** provides better imaging through rotation of the instrument and separation of the grid pair during operation.

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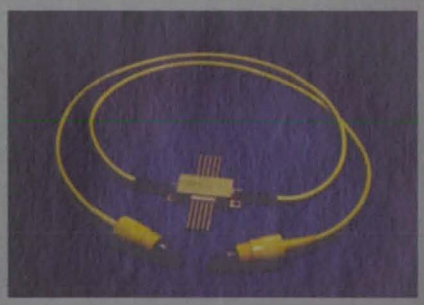

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the grids of an aligned pair to modulate the incoming hard x-ray wave front, enabling the Fourier component to be measured. A rotating modulation collimator (RMC) uses the rotation of the instrument itself about its line of sight to provide modulation. The RMC integration time for a single frame is now linked to the rotation time of the satellite upon which the telescope is mounted. Therefore, integration time for the RMC can be significantly longer than the detection time that constrains the SMC.

Since the visibility function in the observational plane is directly related to the brightness distribution in the object plane via a Fourier transform, an image is obtained from the inverse Fourier transformation of the visibility function. A complete, well-defined image requires the measurement of the visibility function at a sufficiently dense set of points in the plane. Simulation is the best way to determine whether enough points are to be measured for a given source to provide an acceptable image.

Essentially, the Fourier concept involves sampling selected Fourier components from a wave front emitted by the source. Each component may be visualized by a single point on a common complex surface. By measuring a number of components over a significantly large spatial frequency spectrum, the Fourier surface may be approximated. An inverse Fourier transform of the surface function yields an approximate or "dirty" image. When viewing a typical dirty image, the processing artifacts can make the picture very difficult for the eye to see.

The Astronomical Image Processing System (AIPS), a software operating system widely used by radio astronomers, was incorporated into the simulations for the Fourier-transform telescope to clean the dirty images. This software package, which uses optional algorithms, also displayed the simulation images in a number of different ways.

Substantial progress has been made in studying x-ray and gamma-ray imaging instruments and associated support spacecraft platforms, such as the space station, the space shuttle, and Earth-orbit satellites. Through design simulations, a less-costly telescope, requiring only one set of real and imaginary grid pairs to provide better images of hard x-ray and gamma ray sources, has been developed.

This work was done by Jonathan Wesley Campbell of **Marshall Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 194*** *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-31176.

Diode-Laser Devices for Aiming and Ranging an X-Ray Source

Other sources of invisible radiation (microwaves, infrared, ultrasound) could also be aimed.

Marshall Space Flight Center, Alabama

Two diode-laser devices have been developed to facilitate the correct positioning and orienting of an x-ray source with respect to an object to be inspected. The first of these devices is used to aim the x-ray beam toward a designated point on the object. This device is also used to measure, to within a fraction of a degree, the angle between the x-ray beam and the object surface on which the designated point lies. It is necessary to measure this angle because angular errors as small as 1° have been known to lead to incorrect interpretation of x-radiographs. The second diode-laser device is used in conjunction with the first device to measure the distance between the x-ray source and the designated point on the object. Knowledge of this distance is necessary for extracting three-dimensional position information from x-radiographs.

Laser devices have been used previously for aiming x-ray sources. The advantage of the present laser devices is relative simplicity; they contain fewer parts and are easier to use. The present aiming device (see Figure 1) comprises a diode-laser gunsight mounted on a plastic or aluminum base that has been machined to mate with the port flange of an x-ray tube. An essential part of the fabrication of this device is a prealign-

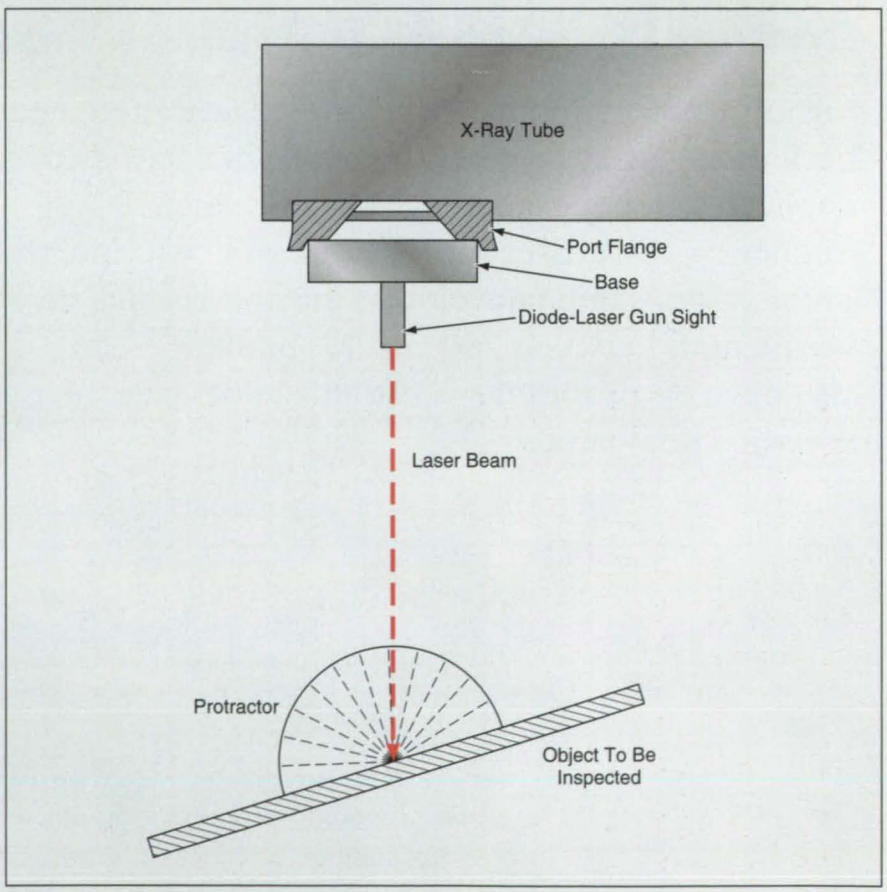

Figure 1. The **Diode-Laser Aiming Device** is attached temporarily to an x-ray tube and used to visibly mark the path that will later be followed by x-rays.

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ment procedure in which a special optomechanical alignment jig that holds a piece of x-ray film is used to position and orient the diode-laser gunsight to make the laser beam coincide with the x-ray beam. The aiming device is held on the x-ray tube by an elastic strap and can thus be installed and removed quickly and easily.

During aiming, the x-ray tube is turned off. The beam of visible light emitted by the diode laser marks the path of the x-ray beam. The position and orientation of the x-ray tube and/or the object to be inspected are adjusted until the laser-illuminated spot is centered at the designated point on the object. The angle between the beam and the surface of the object is measured by use of a protractor positioned to be grazed by the edge of the beam.

The second (distance-measuring) diode-laser device comprises another diode-laser gunsight mounted on a vernier-caliper positioning mechanism. The positioning mechanism is attached to the aiming device and used to position the second laser-beam source at a known lateral distance from the first laser-beam source. In another prealignment procedure, the second laser beam is aimed to intersect the first laser beam at a known fixed angle, regardless of the lateral-distance setting. In use, the lateral distance is adjusted until the two beams intersect at the designated point on the object to be inspected. Then the distance between the x-ray tube and the object to be inspected can be calculated from the known lateral distance and the known angle of intersection by simple trigonometry. This device could be assembled to allow 1-in. (2.54-cm) of caliper movement to equal a 10-in. (25.4-cm) change in x-ray path length.

Modified versions of these diode-laser devices could be used to aim sources of other types of invisible radiation (microwaves, infrared, and ultrasound). Of course, the prealignment procedure for the aiming device would be different for different types of radiation.

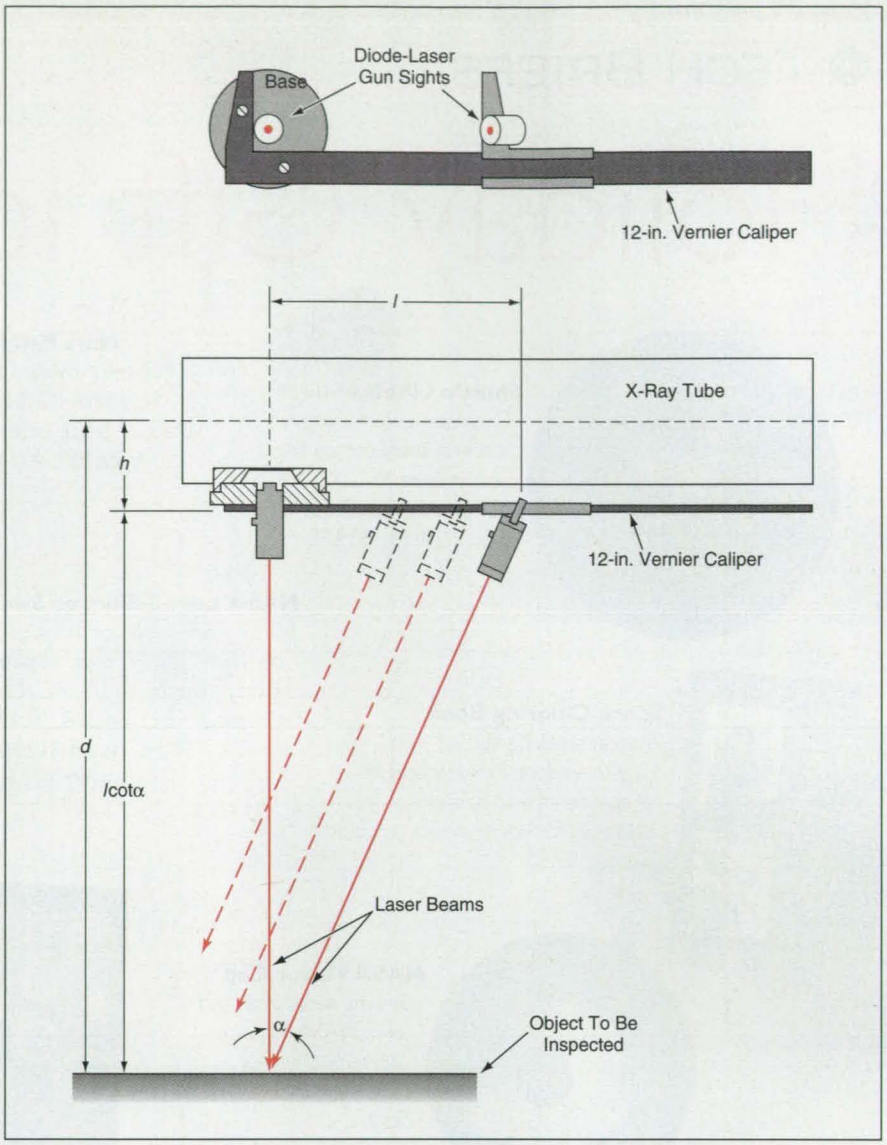


Figure 2. **Two Laser Beams** that originate from known locations intersect at known angle α. The distance from the axis of the x-ray tube to the object to be inspected is given by $d = h + l \cot \alpha$.

This work was done by Glenn Cotty, Craig Clauss, and David Olson of Lockheed Martin for **Marshall Space Flight Center.**

For further information, access the Technical Support Package (TSP) ***free online at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 195*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*
MFS-31170

Image-Warping Coherent Fiber-Optic Bundles

Images could be warped away from nonfunctional areas of retinas to restore some vision.

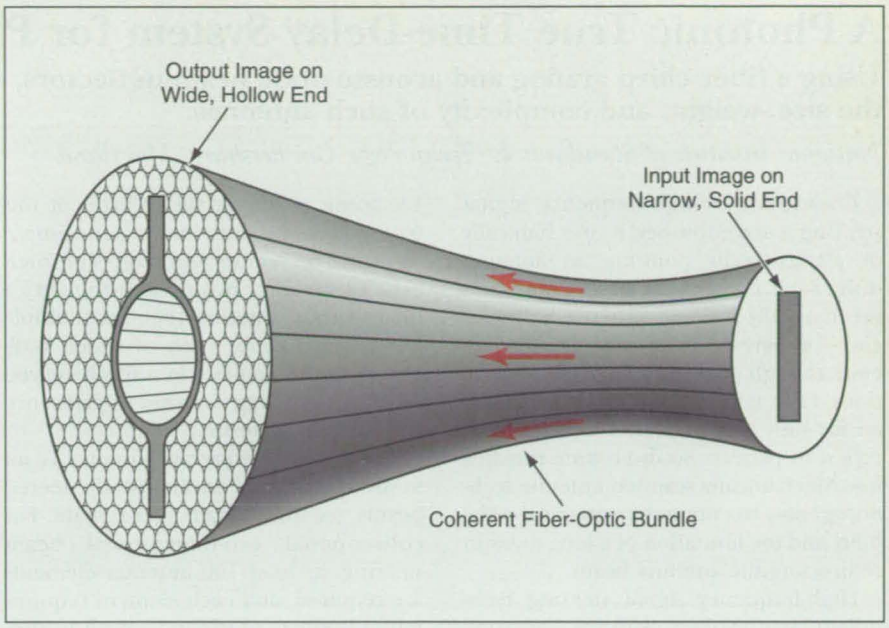
Lyndon B. Johnson Space Center, Houston, Texas

Tapered coherent fiber-optic bundles of a proposed type would be designed to warp images according to predetermined mappings. In one important potential application, an optical device of this type would be used to compensate partly for the loss of vision in the central part of a retina. The device would warp the image onto the remaining sensitive outer part of the retina, in such a way that a distorted but partly usable version of the central part of the image could be seen.

The distortion of an image onto the remaining functional part of a retina was mentioned as one of the potential applications of a developmental digital/analog image-processing system described in "Programmable Remapper" (MSC-21350), *NASA Tech Briefs*, Vol. 14, No. 6 (June, 1990), page 46. Of course, an image-warping coherent fiber-optic device would lack the programmability of an electronic image-

processing system, but in return it would offer ruggedness and essentially unlimited processing speed.

Tapered coherent fiber-optic bundles that magnify or minify have been produced by heating and stretching solid, originally cylindrical coherent fiber-optic bundles. A device of the proposed type would also be made by heating and stretching a cylindrical coherent fiber-optic bundle, but in this case, the bundle would start out as a hollow cylinder; that is, it would have a central hole running along its length. The bundle would be stretched and heated while a vacuum was applied to the central hole (see figure). The atmospheric pressure on the side of the bundle would thus force the sides inward, causing the hole to taper down to a smaller diameter and eventually to close as stretching proceeded. Once the stretched bundle had cooled, a transverse cut would be made at or near the midlength to expose a cross section in which the central hole was closed.



A **Coherent Fiber-Optic Bundle** would be made to taper from a hollow wide end to a solid narrow end. An image focused on the solid narrow end would emerge from the wider end magnified and warped away from the central region.

An image focused on the circular surface at the narrow end of the bundle would travel along the optical fibers and would become warped as desired because it would emerge from the corresponding fibers redistributed on the ring surface at the wide end (see figure). No image would be formed in the hollow interior region at the wide end.

This work was done by Richard D. Juday of **Johnson 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. 196*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

MSC-22435

A Photonic True Time-Delay System for Phased-Array Antennas

Using a fiber chirp grating and acousto-optic beam deflectors, the system promises to reduce the size, weight, and complexity of such antennas.

National Institute of Standards & Technology, Gaithersburg, Maryland

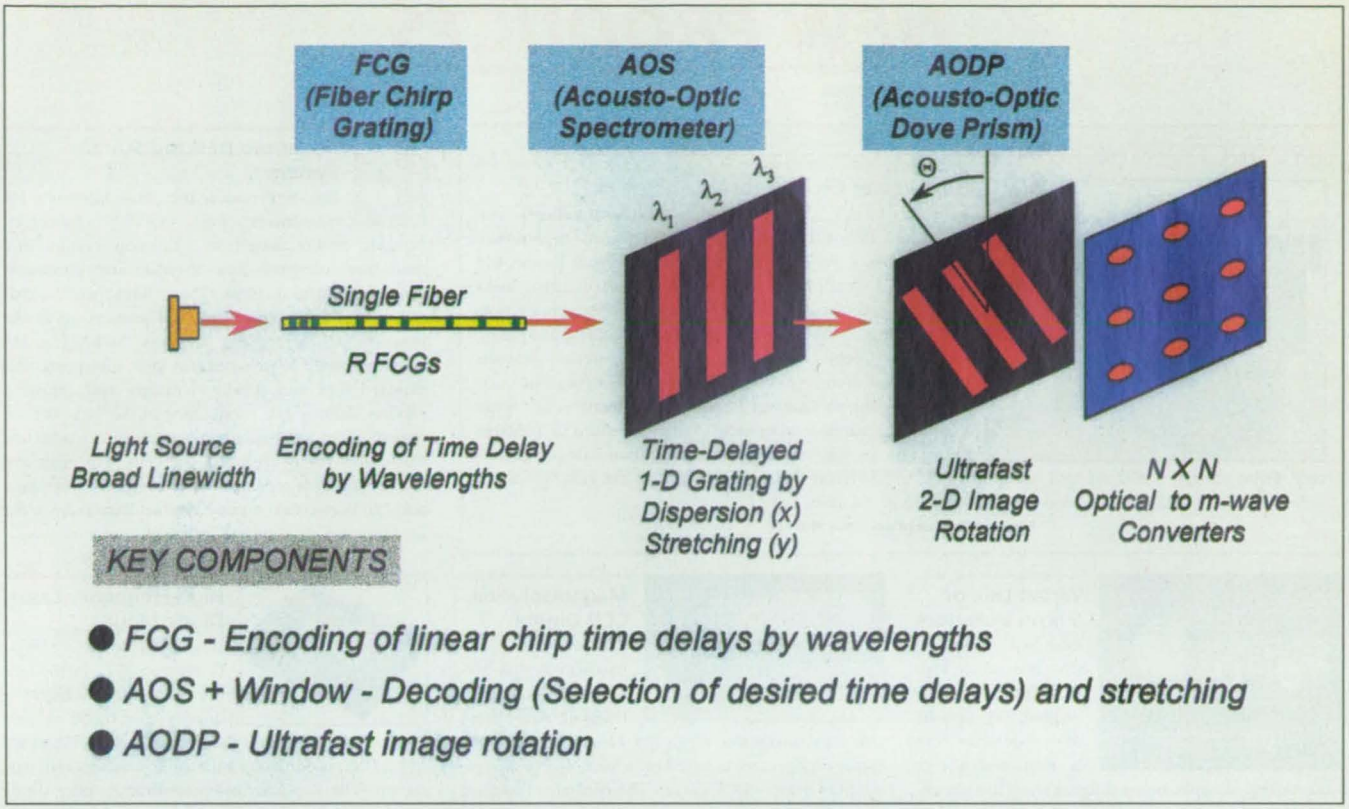
Conventional high-frequency signal steering is accomplished by mechanically or electronically pointing an antenna dish. Such conventional rotodome and mechanically scanned antenna technologies for early-warning surveillance aircraft, though proven, have several limitations. Each target of interest is illuminated for only a brief period of the antenna's scan pattern, so dwell time remains low. Mechanically scanned antenna technology also has limited mechanical reliability and the limitation of a long delay in redirecting the antenna beam.

High-frequency signal steering technology has evolved with phased-array antennas, which eliminate the mechanical steering with fast electronic beam steering. Phased-array antennas can be used for radar imaging, target illumination, and communication devices. Electronic scanning via an array of this type allows the antenna to concentrate its power on sectors and targets of interest. Electronic beam steering in a phased-array antenna requires multiple antenna elements, each of which radiates radio frequencies in a synchronized pattern, resulting in the interference that directs the beam.

While a phased-array antenna is an improvement over mechanically steered beams, technical challenges remain. For conventional two-dimensional beam steering, at least 100 antenna elements are required, and each element requires multiple fibers of varying length to produce various time delays for it.

As a result, various conventional fiber optic approaches to 2-D beam steering have the limitations of high complexity, requiring between 10,000 and 10 million optical fibers. Because phased-array antenna beam steering is based on time delay, multiple-direction steering requires multiple time delays, ranging from 0.05 picosecond to 100 nanoseconds.

In conventional phased-array antennas, such time delay is accomplished by sending light signals through long bundles of fiber optic cable. The time required for light to travel the length of the fiber results in the required delay: a 100-ns delay requires approximately a 20-km fiber, using conventional technologies. Also conventional time-delay systems must utilize either multiple laser diodes (Hughes) or a fast laser frequency-tunable over a broad range (Naval Research Laboratory). Finally, conventional phased-array technologies use photon-to-electron converters. This con-



Schematic showing the NIST design approach to the **Photonic True Time-Delay System** for phased-array radars.

version step results in a speed bottleneck and additional component cost. Also, use of the converter means that the array cannot receive a signal at the same time it is transmitting a signal.

In contrast, the NIST true time-delay device reduces the multiple optical fiber complexity to one fiber. The system uses an inexpensive broad-linewidth LED light source, a single fiber chirp gradient for encoding of linear chirp time delays by wavelengths, an acousto-optic spectrometer, and an acousto-optic Dove prism for ultrafast (<10 μs) image rotation. This system eliminates the need for long, bulky bundles of fiber optic cable.

The invention also uses an inexpensive light-emitting diode as its light source, eliminating the need for splitters, combiners, and switches required in conventional phased-array technologies. Finally, the system is "optically transparent," in that it permits the simultaneous bidirectional travel of transmitted and received signals–there is no photon-to-electron conversion.

Applications of the improved antenna system include military terminal guidance munitions, self-protection sensors, ballistic missile interceptors, landing guidance radar, and collision or obstacle-avoidance sensors, all of which need good acquisition range and high angular accuracy. In commercial markets, the system may enable communications users to receive broadband, high-data-rate, duplex voice information from moving platforms.

Further development of this inventions should reduce the cost of phased arrays so that they can be used on commercial systems such as personal navigation devices, paging, and airborne phones, faxes, and other services. This invention could reduce the cost of cellular base-station antenna systems: they could generate multiple spot beams, each of which could track cellular users moving through their area of coverage at lower transmission power than current cellular broadcast technologies. Also, the simultaneous bidirectional feature of the invention would be particularly suitable for communications services. Another potential commercial application is between a moving communications device and a low-orbit satellite. Today, several manufacturers offer a satellite phone for $3000-5000. The ability to generate a small beam that can be scanned makes it possible to radiate less power for the same received signal levels, and since the amount of radiated power dictates the size of the solar-cell array on satellites and the size of the batteries that are required in handheld transceivers, reductions in the requirements for radiated power can lead to reductions in cost and weight.

This work was done by Dr. Eung-Gi Paek at the Information Technology Laboratory of the **National Institute of Standards & Technology**. *For more information on the commercial use of this and other NIST technologies, contact Randy Smith, Technology Licensing Officer, at (301) 975-4651; fax (301) 869-2751; E-mail: wrsmith@nist.gov.*

NEW PRODUCTS

PRODUCT OF THE MONTH

High-Power Excimer Lasers

Lambda Physik, Ft. Lauderdale, FL, introduces the NovaLine 100, the first in a new series of high-power excimer lasers. With 100 W of stabilized output power, the KrF laser is ideal for such industrial microstructuring tasks as high-speed circuit-board via drilling, ink-jet printer nozzle drilling, and wire stripping, the company says. NovaTube™ metal-ceramic laser tube construction extends tube and gas lifetimes without the need for a cryogenic purifier, according to Lambda Physik. Other features are Slide Valve™ tube window mounting for fast cleaning or replacement, and an internal HaloSafe™ solid-state halogen generator. Pulse energy is 400 mJ and repetition rate is 250 Hz at 248 nm. All utilities are supplied from below, and all maintenance access is from one side of the laser only.

For More Information Circle No. 796

Varied Line of Silicon Detectors

Edmund Scientific Co. Industrial Optics Division, Barrington, NJ, says its silicon detector line is designed for a wide variety of applications ranging from the ultraviolet to the near infrared. Edmund Scientific offers detectors of varying characteristics such as breakdown voltage, dark current, noise equivalent power, quantum efficiency, responsivity, and rise time. Edmund's application engineers are available to assist the customer in selecting the proper detector for an application.

For More Information Circle No. 798

Connectorized Laser Diodes

Polaroid Laser Diode, Norwood, MA, offers its connectorized laser diodes in three standard connector terminations: ST, FC, and SMA. Coupling efficiency of better than 65 percent is guaranteed using 200-micron-core step index fiber. The company says that, taking advantage of its custom low-thermal-impedance 9-mm package, advanced microlensing capability, and precision manufacturing technology, it can economically deliver hundreds of milliwatts of power into multimode fibers of 100-micron and larger core diameters at wavelengths from 660 nm to 980 nm. Diodes from 200 mW to 2 W of output power can be incorporated in this package.

For More Information Circle No. 801

Advanced Beam Pointing and Control

The BeamLok accessory from Spectra Physics Lasers, Mountain View, CA, designed for use with its Quanta-Ray Pro Series Nd:YAG lasers, offers advanced beam pointing with active control and divergence reduction. Consisting of a far-field detector, corrective mirror, and D-Lok sensors, the device integrates them into a dedicated microprocessor-based controller to provide complete feedback control. The company says the resulting system has faster warm-up times, typically under 15 minutes, and longer flashlamp lifetimes. RS-232/IEEE compatibility enables BeamLok to be incorporated into existing automated systems.

For More Information Circle No. 804

Megaresolution CCD Digital Camera

Eastman Kodak Motion Analysis Systems Division, San Diego, CA, announces the Megaplus Model 16.8i, a full-frame digital camera based on a 4096-×-4096 charge-coupled device (CCD) array. The company designed the 16.8-million-pixel camera for demanding applications such as megaresolution document imaging, aerial film digitization, and high-end photogrammetry. Each pixel is 9 microns square, providing a 100-percent fill factor. Compatible with commercially available framegrabbers, the camera can be operated remotely via a bidirectional serial communications port. Dynamic range is better than 48 dB.

For More Information Circle No. 799

UV-VIS Spectrophotometer with Single Source

Varian Associates, Palo Alto, CA, says that the key to the performance of its new Cary 50 UV-visible spectrophotometer is the use of a single xenon pulsed lamp source. Unlike other UV-VIS instruments that use two light sources that are always on, the Cary 50's single source is only on when the instrument is taking a reading. Varian calls the Cary 50 the fastest scanning instrument on the market for the 200-400-nanometer range, the most commonly made UV-VIS measurements: the xenon flashlamp allows scan speeds of up to 24,000 nm/min.

For More Information Circle No. 802

Digital Laser-Beam Analyzer

Merchantek Electro-Optics, Carlsbad, CA, announces Vision 1024, a new laser-beam analyzer that incorporates digital camera technology. The 10-bit digital CCD has four times the dynamic range of the standard analyzer, the company says, for greater measurement accuracy. The high signal-to-noise ratio enables the device to detect Airy's disks, fringes, and details that escape 8-bit systems. Fuzzy-logic triggering measures continuous-wave and pulsed beams from 1 Hz to 1 kHz. The palm-sized controller is microprocessor-based, works with or without a computer, and plugs directly into a monitor, printer, or other peripheral.

For More Information Circle No. 805

Advanced Desktop Scanner System

Sensor Products Inc., East Hanover, NJ, introduces the TOPAQ® Advanced Imaging System, based on a desktop scanner that reads and interprets Fuji® Prescale and Pressurex® pressure-indicating films. These films permanently and irreversibly change color in proportion to the pressure that is applied to them. TOPAQ, a PC-Windows-based system, scans and interprets this exposed film and produces images and statistical reports. Among the capabilities of the large-format densitometer are histograms of pressure levels, line scans, and zoom up to 800 percent. The user can analyze multiple regions or single regions of interest, and can convert on a pixel-by-pixel basis from color intensity to a corresponding level of pressure (psi).

For More Information Circle No. 797

High-Frequency Laser Diode Mount

ILX Lightwave Corp., Bozeman, MT, introduces the LDM-4984RF high-frequency laser diode mount, which it says combines the demanding performance of 2.5 Gb/s modulation with the convenient butterfly mount. The company suggests using its laser diode connectors for current and temperature control, impedance-matched 50-ohm SMA modulation input, and clamping mechanism with the mount, providing everything needed to quickly mount, control, and modulate the most popular RF telecom laser diodes in the butterfly mount. Like other mounts in the LDM-4980 series, the device has standard connector formats and case temperature control options.

For More Information Circle No. 800

Optical Reimaging Unit for Industrial Use

Opto Power Corp. (OPC), Tucson, AZ, introduces the OPC-ORU-C2M, a CCD-based optical reimaging unit (ORU) that focuses light from laser modules into smaller or larger spot sizes. Equipped with a small color CCD camera, which provides on-axis real-time views of laser spots focused on target areas, the unit can be used with OPC's high-power fiber-coupled diode lasers. Capable of enlarging spot sizes by twofold, the device is available with working distances up to 42 mm. OPC says the unit promises to expand the use of high-power diode lasers in applications including soldering, marking, heat treating, sintering, and welding.

For More Information Circle No. 803

Dense Wavelength Division Multiplexer

The new dense wavelength division multiplexer (DWDM) from E-TEK Dynamics Inc., San Jose, CA, is described as an 8- or 16-channel module for increasing fiber capacity in a wavelength division multiplexing network. The ITU channels of the DWDM (patent pending) are narrowly spaced at 200 GHz apart with a typical insertion loss ≤4.5 dB and typical adjacent channel isolation ≥30 dB. The company guarantees polarization dependent loss at less than 0.1 dB. Optical power is 250 mW maximum. In addition to multiplexing, E-TEK Dynamics recommends the device for optical fiber amplifiers and CATV applications.

For More Information Circle No. 806

TECH BRIEFS

Hot Technology File

1998 Resource Guide for Design Engineers & Managers

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Supplement to NASA Tech Briefs *December 1997 Issue*

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Dolch: The Rugged Edge

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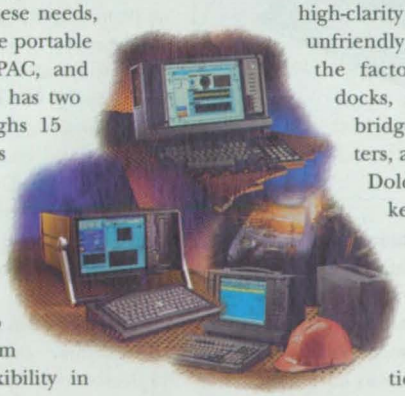
Configurable Portable Computers

Long ago, Dolch learned that its customers wanted to take applications that ran on the desktop and port them to field-portable platforms. This meant that we had to retain the flexibility and expandability of the desktop system while dramatically shrinking the package. Each application required the platform to host some number of add-in ISA or PCI function cards and have great flexibility in the choice of peripherals, and to be rugged enough to survive field handling. To serve these needs, Dolch developed three portable systems: the LPAC, PAC, and MegaPAC. The LPAC has two add-in slots and weighs 15 pounds, the PAC has five slots and weighs 20 pounds, and the MegaPAC has nine slots and weighs 25 pounds. Each has been optimized to provide the maximum of configuration flexibility in the minimum package space.



To keep costs down, we chose to base our systems on commercially available components tailored for our use. For example, computer motherboards for Dolch are produced with controlled configurations for fabrication revision levels, assembly revision levels and BIOS revision level. Unlike common components purchased at the local computer mart, Dolch's component engineering group does not allow our vendors to change anything without a thorough evaluation of the new configuration. This process allows us to provide cost-effective solutions to our customers while providing a high-quality, configuration-controlled product that is consistent over the life span of our customers' projects.

Rugged Flat-Panel Display Systems

In 1990, Dolch was the first company to put a full-color TFT screen in a portable computer. Since then, we have been the leaders in providing new technology displays to our customers in rugged packages that survive in harsh environments. Based on this experience, Dolch has pioneered implementation of high-clarity TFT displays into unfriendly environments like the factory floor, loading docks, spindrift whipped bridges of coastal cutters, and the like.

Dolch has tackled the key problems facing information display in hostile environments, protection from shock and vibration, sealing from the intrusion of dust and liquids, viewing clarity in high ambient light, and display information transmission over long distances.

First, all Dolch monitors are constructed of aircraft aluminum or stainless steel. Critical components are shock-mounted using IsoGuard isolators or are hard-mounted to substantial structures. This provides resistance to the shock and vibration of factory machinery or moving vehicles.

Second, multiple o-ring seals are used to provide sealing from spray, hose-down or, in some cases, immersion. Our products carry U.S. ratings of NEMA 4, 4X, and 12, and international ratings of IP54, 66, and 67. This sealing provides protection from dust as fine as that found in paper mills and from full water hosedown.

Third, Dolch has developed a series of high-bright and super high-bright backlighting systems that improve our monitors' luminance and contrast ratios to the point that these displays are visible with great clarity in direct sunlight.

Lastly, our DynaLink extension series provides long-distance remote transmission of the display data from a simple 25' to 500' analog extension to a 100-mile digital fiber optic transmission system that provides complete display clarity at the remote site while providing remote operation of a keyboard, mouse or printer.

All of these design features are directed to supplying a complete information display solution for applications in out-of-the-ordinary environments.

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Dolch is established in over 30 countries throughout the world with direct company-owned locations in California, Maryland, Germany, and the United Kingdom. Each primary location can assist in specifying the exact configuration required to satisfy a customer's application, whether a standard product or a custom configuration. Twenty-four-hour support is provided through a technical support page at www.dolch.com, along with an FTP site and a problem-reporting feedback system.

Dolch believes in focusing on its niche, providing the most refined solutions for tough application in portable computing and information display. This is all we do and we strive to be the best at what we do.

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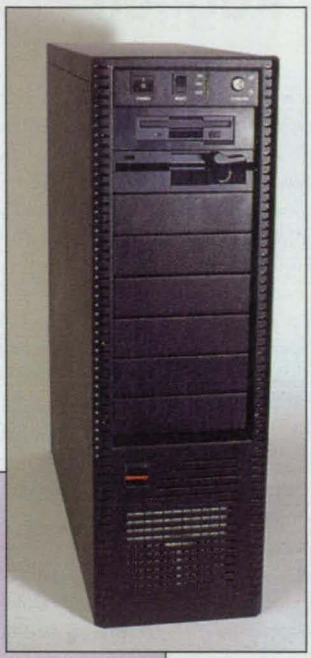

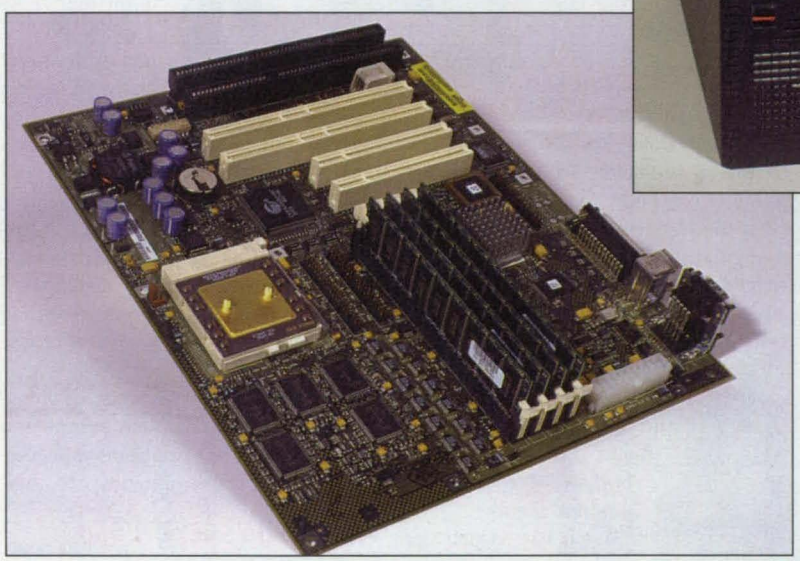

One of the problems with getting more done for less is tech support. Our service starts with the use of the telephone: when you call us you talk to a competent person. Because we appreciate the critical nature of your work, every one of our products comes with free tech support for two years. This means we charge a little more for our production-grade compilers, but they still cost much less than the mini or mainframe tools of the past. Our excellent tech support makes it possible for us to quote your favorite DEC UNIX and OpenVMS systems, yet also deliver NT and Linux. And we know how to take care of special situations, including rack-mounted industrial-grade systems and RAID-controlled hard disk farms.

Microway's current software product line is anchored by NDP Fortran, which is available for Pentiums and generates Alpha code for DEC UNIX, NT, and Linux. Digital and Intel's ten-year agreement insures that the Alpha 21164 processor and its successors (21264 and 21364) will continue to be performance leaders in the high-speed numerics market for years to come. Intel will manufacture the Alpha, which Digital engineers will design and market. This means that you can count on Microway to continue our tradition of designing state-of-the-art motherboards, workstations, and add-in cards based on the Alpha and other RISC processors.

Our customers for Alpha systems include most of the major universities and government labs. Typical applications run as fast on a 300 MHz 21164 as they do on a Cray Y/MP. Our current 600 MHz product employs faster caches, which help its speed scale with frequency. It delivers 343 Linpack megaflops and dot products that hit 1.2 gigaflops.

To take advantage of the Alpha's enormous power, we have developed a scheduler that not only makes it possible to issue four instructions per clock, but to lead loads ahead of their uses. This helps to reduce the latency of caches and memory.

Microway hardware products have always been popular with government, industry, and university researchers. Our i860 powered cards were used to search for oil, improve MRI resolution, do air flow studies on jet engines, and help the NASA SETI project search for extraterrestrial life. An NT-powered Alpha Screamer currently is being evaluated by NASA to control shuttle missions, while a government agency is now using Screamers to run, in minutes, neutron scattering simulations that used to take days.

Company History

Microway was founded in 1982 to help scientists and engineers take advantage of the IBM-PC. Our first product was a library, which made it possible to use an 8087 in a PC. We bundled our libraries with 8087s and became one of Intel's largest customers.

Our hardware products included PC accelerators, coprocessor cards, and motherboards. In 1986, we introduced the first 32-bit Fortran to run on an Intel PC. The first PC to hit a megaflop used a Microway/Weitek coprocessor driven by NDP Fortran. Over the years, NDP Fortran has been used to port hundreds of popular mainframe applications, including MATLAB and ASPEN, to Intel-based PCs.

Microway's workstations have been purchased by university and NASA laboratories since 1989. *PC Computing Magazine*, in July 1997, named our Alpha "the fastest Windows NT workstation on the planet...the performance leader."

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Circle No. 651

ADINA

Finite element analysis in engineering product design is now well established. Commonly, organizations use various computer programs for specific tasks of finite element analysis, and these individual programs are to various degrees integrated in the computer-aided design process. For example, one finite element program is used for linear static and dynamic structural analysis, another program is used for acoustic analysis, and yet another program is used for nonlinear structural analysis. For nonlinear dynamic analysis, frequently also different explicit and implicit codes are employed. In addition, finite volume-based programs may be used for fluid flow analyses, and virtually no capability is available to analyze complex fluid flows with structural interactions.

The mission of ADINA R&D is to provide one effective finite element program system—the ADINA System—that can be used to perform comprehensive finite element analyses of structures, fluids, and fluid-structure interactions.

The use of one program system that is fully integrated for structural and fluid flow analyses, and that therefore can be used instead of a series of other analysis codes, provides for a tighter integration of the complete analysis process in the CAE environment, less cost, and higher reliability and effectiveness.

The ADINA System is unique because of its wide range of analysis capabilities. Structures can be modeled as linear or highly nonlinear, including material nonlinearities, large deformations and contact. Static analysis, frequency solutions, or transient analysis using mode superposition, explicit or implicit time integration can be performed. Restart from one type of analysis to another is directly possible. Fluids can be modeled as acoustic fluids, or incompressible or compressible fluids governed by the full Navier-Stokes equations. In fluid flows with structural interactions, completely different mesh discretizations can be employed for the structure and the fluid. The solvers of the program system are fully supported by in-house developed pre- and post-processing, including automatic meshing, and the system also can be employed directly with CAD programs such as Pro/ENGINEER by accessing the geometry and I-DEAS or PATRAN by using their databases.

The generality, effectiveness and reliability of the ADINA System are due to the specific finite element procedures, the sparse matrix solution techniques, and parallel processing used. Many of the techniques are described in the textbook, *Finite Element Procedures*, by K.J. Bathe (Prentice-Hall, 1996).

Rollover analysis of a minivan produced by the ADINA System. The simulation shows the result of a rigid surface (representing a road) being pushed against the van at a very slow speed.

Company History

ADINA R&D, Inc. was founded in 1986. However, a graphical user interface for pre- and post-processing and effective CAE connection was lacking until 1996.

The new emphasis on ease of use of the ADINA System has rendered the System a very attractive analysis tool in many industries.

More information on ADINA R&D is given on the Web at www.adina.com

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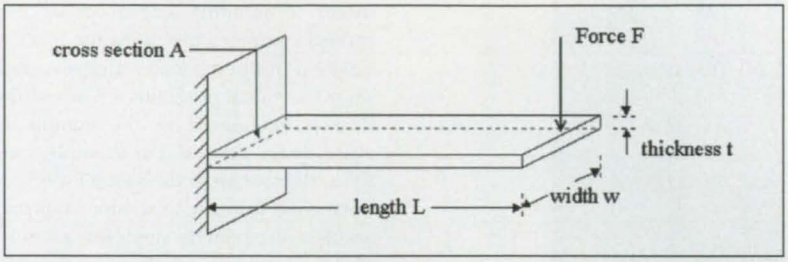
Circle No. 652

ALGOR®

Algor, Inc. produces finite element analysis and event simulation software for Windows NT/95, UNIX, and DEC Alpha running Windows NT operating systems. More than 16,000 engineers in more than 60 countries use Algor software. As a service to the mechanical engineering community, Algor presents this paper on event simulation.



A cantilever beam subjected to a force at the unconstrained end.

Introduction

Event simulation is vastly different from what we learned in college about linear stress analysis. We were taught that stress, deformation, and displacement are functions of force. In event simulation, we assume that forces result from some type of action or motion, which produces deformation, displacement, and force.

Contrasting Event Simulation with Classical Methods

Classical Methods

As an example, let's use a cantilever beam subjected to a force at the free end, shown in the accompanying diagram. The maximum stress (at A) is given by:

$$\sigma = \frac{Mc}{I} \qquad [1]$$

M is the moment generated by the force F (M=FL), c is the distance from the neutral axis to the edge of the beam (c=t/2), and I is the area moment of inertia ($I=wt^3/12$). This result is based on Hooke's law (|F|=k|d|): force is a linear function of displacement.

In finite element analysis, the matrix equation {F} = [K] {d} is solved for the displacement vector, {d}, from the force vector {F}, and the stiffness matrix, [K]. Subsequently, the stresses are calculated from the equation $\{\sigma\} = E\{\varepsilon\}$, where $\{\varepsilon\}$ is the strain vector. E is Young's modulus, which corresponds to Hooke's constant, k.

All would be well if the beam were always at rest, which is the only time when equation [1] is valid. However, the engineer must consider the "worst case scenario," which occurs when the beam is in motion.

Event Simulation

According to Newton's second law,

$$F = ma \qquad [2]$$

or force equals mass multiplied by acceleration. This law quantifies that mass causes resistance to changes in motion. Note that under the influence of gravity, a body at rest generates a force (mg), where g is the acceleration due to gravity.

In special cases of constant acceleration (i.e., gravity field near earth's surface) and short-lived events (say of length Δt), Equation [2] can be rewritten as

$$F = m\frac{\Delta v}{\Delta t} \text{ or } F\Delta t = m\Delta v \qquad [3]$$

where Δv is the amount by which the velocity changes during Δt time. Thus a force of 1,000,000 lbs. acting over 0.000001 seconds produces the same impulse (or change in momentum) as a force of 1 lb. over 1 second.

Event simulation relies on the combination of Newton's second law and Hooke's law as follows:

$$F = ma = -kd \text{ or } ma + kd = 0 \qquad [4]$$

The force is in the opposite direction of the displacement, requiring a negative sign in front of k. Also, note that the nebulous quantity force can be eliminated, and that the concept of time has been introduced through the acceleration. To simulate real world problems, we can also take damping or friction into account by:

$$F = -cv \qquad [5]$$

where v is the velocity and c is a constant. Combining equations [4] and [5] and eliminating force (F), we obtain:

$$ma + cv + kd = 0 \qquad [6]$$

or in matrix form:

$$[M]\{a\} + [C]\{v\} + [K]\{d\} = 0 \qquad [7]$$

This is the basic equation of event simulation; note how it models the combination of motion, damping, and

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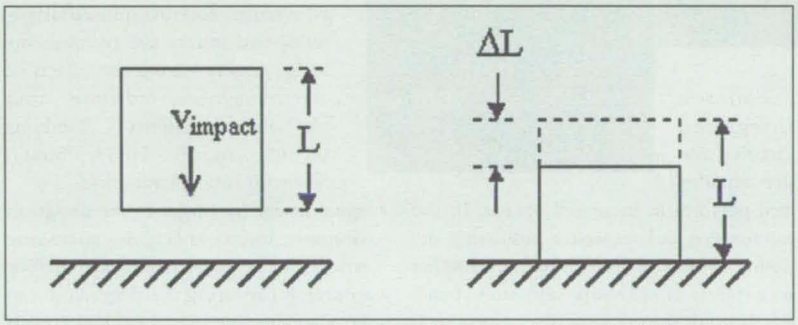
mechanical deformation. If stresses are of interest, they can be calculated during the analysis by applying the formula $\{\sigma\} = E\{\varepsilon\}$, where $\{\varepsilon\}$ (the strain vector) is easily obtained from the displacement vector $\{d\}$. In event simulation, the concept of force is superfluous.

Numerical Example

Imagine a cube of mass m impacting a rigid surface along a face. We are interested in the maximum deformation experienced by the cube. We first perform a hand calculation for the maximum compression length. Then we use event simulation to solve the same problem more quickly and compare results.



Cube just prior to contact (left side). Cube at time of maximum deformation (right side).

By Newton's second law, the impact force is given by equation [3]. We assume that the cube's entire mass is located at its centroid and that for any particular location on the cube, the acceleration is constant throughout the impact. Equation [3] takes the form:

$$F = \frac{1}{2} m \frac{\Delta v}{\Delta t} \qquad [8]$$

where Δv is the change in velocity of the top of the cube during the impact interval, Δt. the factor of 1/2 in equation [8] is needed because we are applying equation [3] at the centroid. We expect the top of the cube to move twice as fast as its centroid once contact is made. The constant acceleration assumption combined with basic kinematics allows us to obtain an expression for the amount by which the cube deforms during impact:

$$\Delta L = \frac{at^2}{2} \quad \text{or} \quad \Delta L = -\frac{\Delta v \Delta t}{2} \quad \text{or} \qquad [9]$$

$$\Delta L = -\frac{v_{impact} \Delta t}{2},$$

where v_{impact} is the velocity of the top face of the cube, at the moment that contact is made. We need the negative sign in equation [9] because Δv is negative and we seek a positive value for ΔL. Note how Δv is replaced by just v_{impact} because at the time of greatest deformation, the top of the cube is not moving.

By Hooke's law, the force on the cube is given by

$$F = -k\Delta L \qquad [10]$$

Combining equations [8] through [10], yields:

$$\Delta L = \frac{v_{impact}}{2} \sqrt{\frac{m}{k}}. \qquad [11]$$

Putting k in terms of E (k=EL for a cube length L deforming along an axis perpendicular to a face), one obtains:

$$\Delta L = \frac{v_{impact}}{2} \sqrt{\frac{m}{EL}}. \qquad [12]$$

Using Algor software, we simulate the same impact problem using these values: cube length (L) = 1.0 in., mass (m) = 0.000253 lb_m, material Young's modulus (E) = 10^7 lb/in.^{2}, starting elevation = 100 in., and gravity field = 386.4 in/sec^2. The software predicts a maximum deformation (ΔL) of 0.000694 in. which compares closely with the value of 0.000699 in. given by equation [12]. Note that we did not need the impact force or velocity.

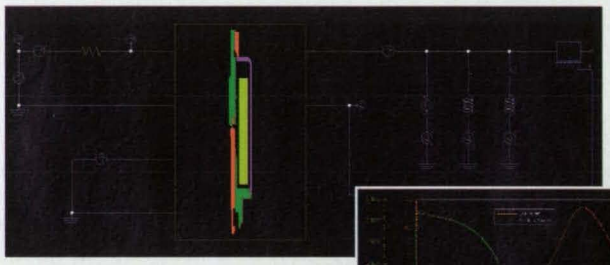
Conclusions

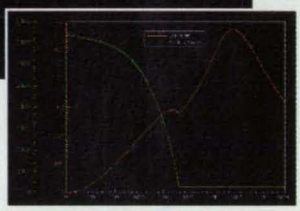
This example demonstrates the difficulty of analyzing a simple impact problem without using Algor's event simulation software. Imagine how involved, or even impossible, the hand calculation for force would be for a typical part - not a cube. And, without the force, a static finite element analysis would have little meaning. On the other hand, event simulation software can handle a model of any complexity. Furthermore, event simulation has the useful by-product of generating a "frame-by-frame" record of the event.

Circle No. 653

ANSOFT

The rules have changed. Since the early 1970s, design engineers have used EDA software to assist in electronic design and development. EDA software automates the previously manual, time-consuming, error-prone design process, resulting in dramatic increases in productivity and efficiency. To date, the best EDA technology has relied upon circuit theory and automating traditional design rules to reduce the design cycle. However, as design and manufacturing technology has focused on increased performance, miniaturization, and yield, the applications for EDA software have expanded from computers to communication, semiconductor, automotive, aerospace, and consumer electronic products.





The need to model accurately the electromagnetic interaction inherent in these electronic components and systems has increased. Ansoft Corporation offers leading-edge technology based on electromagnetic principles to meet these high-performance needs. Traditional EDA tools that are not based on electromagnetic principles and therefore only approximate electromagnetic interaction, cannot model such systems with requisite degree of accuracy for the design of today's products.

Performance, measured principally by the clock speeds of high-speed circuits, has increased dramatically in the past decade. Frequencies today are in the 100-500 MHz range, and leading-edge rise times are typically several hundred picoseconds. High-performance systems with frequencies of approximately 100 MHz and beyond exhibit a high level of electromagnetic interaction causing the degradation of the quality of electrical signals. In addition, the electromagnetic radiation emitted by electronic products is regulated by the Federal Communications Commission as well as equivalent bodies in Europe and Japan. Commercialization of these products is contingent upon meeting government-specified electromagnetic compatibility requirements.

The commercialization of electronic products from portable computers to handheld digital phones depends upon reduced size. In the semiconductor industry, the demands for miniaturization have led to the creation of deep-submicron integrated circuits that are smaller and perform at increased speeds. In the automotive and aerospace industries, the ability to miniaturize components has led to a variety of economic and safety benefits through the creation of products such as electronic fuel injectors, micro-motors, and variably deployed airbags.

Yield is the measure of the manufacturability, reliability, and cost-effectiveness of a design. A high yield implies that the component or system can be produced in large volumes and that a high percentage of manufactured units will perform within the design specifications. As levels of electromagnetic interaction increase, the need to accurately estimate the variation on electrical performance correlated to manufacturing tolerances is crucial.

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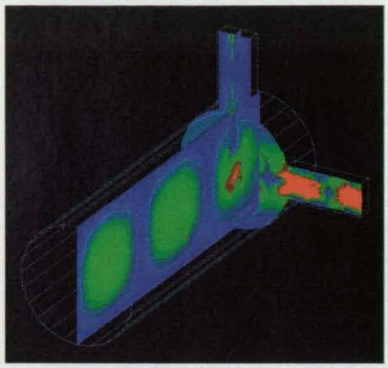
Ansoft Products

Ansoft's software tools, available worldwide, address the limitations of traditional EDA software by providing design engineers with easy-to-use tools to model accurately electromagnetic interaction. Ansoft's solutions decrease the time required to complete the design process by providing accurate estimates of the critical design characteristics as performance, miniaturization, and yield during the design process.



Ansoft's solutions are offered for the three dominant segments of the EDA market: High Frequency, Signal Integrity, and Electromechanical.

- **High Frequency:** Enables the design of radio frequency integrated circuits, antenna and radar systems, and microwave components by accurately solving the effects of electromagnetic radiation from electronic systems. Products include Ansoft HFSS, Strata, Serenade, and Clementine.
- **Signal Integrity:** Target to the design of computer interconnects, IC packaging structures, and electronic systems by accurately capturing the degradation in signal quality due to higher clock speeds and smaller physical dimensions. Products include Eminence, Spicelink, and Extractor.
- **Electromechanical:** Analyzes the electrical performance of product designs to increase yields and applied in the design of sensors, solenoids, motors, and transformers. Analysis capabilities include electromagnetic, system and coupled electromagnetic thermal/structural. Products include EMSS, Maxwell 3D, Maxwell 2D, and EMAS.

Are traditional EDA tools obsolete? Not a chance! They provide the big picture of the component within its intended system. However, the need to incorporate electromagnetic interaction within this big picture analysis is apparent. Ansoft's products seemlessly integrate to system simulation tools such as SPICE, allowing the system design to incorporate the electromagnetic effects.

Circle No. 654

DesignWorks

Motion, Structure & Thermal Analysis Embedded in SolidWorks

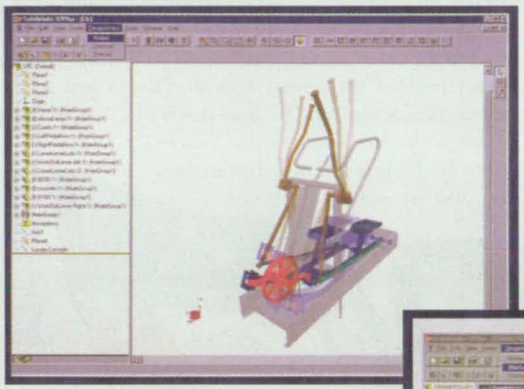
CADSI is a recognized leader in developing software for the simulation and analysis of mechanical assemblies and components. Our suite of Simulation Driven Design™ software is used to realistically simulate the dynamic motion of 3D mechanical systems, improve the structural and thermal integrity of parts, and reduce the time and cost associated with physical prototyping. To successfully implement Simulation Driven Design™, our simulation software must be embedded in the CAD environment, it needs to be easy to use, and the results must be accurate and fast.

Our strategy for Simulation Driven Design is to deliver highly-capable simulation technology to the design engineer. To achieve this, we are embedding our proven mechanical simulation technology in CAD programs such as SolidWorks (Concord, MA). Our newest, most-affordable, and easiest-to-use suite of simulation software, DesignWorks, is fully embedded in SolidWorks. Robert McGill, SolidWorks Solution Partner Manager, states, "CADSI's 'single window' application in SolidWorks benefits design engineers by enabling them to perform motion, structure, and thermal analysis directly on their SolidWorks model. There is no need for the designer to transfer the data to another program or to learn another user interface." By completely embedding DesignWorks simulation in SolidWorks, it eliminates errors in data translation and repetitive modeling, thereby speeding the design and analysis process.

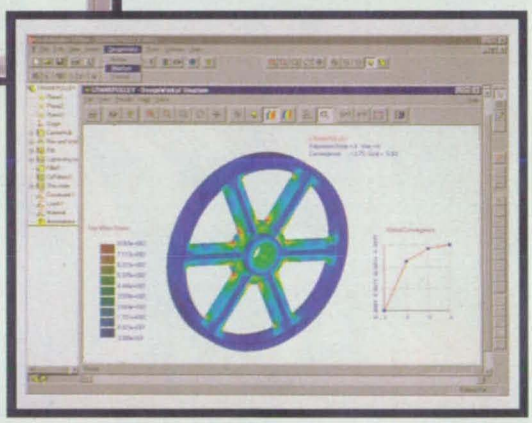
An additional benefit of design simulation in SolidWorks is the identification of critical design parameters early in the development process. Visual review of design performance through graphs, animation, and color contours in SolidWorks, assures design engineers that the product will meet the physical demands of the real world. During the design and optimization of a tractor chassis, Brent Backhaus, a design engineer, commented, "DesignWorks is one of the fastest, most robust, and most efficient design simulation packages I have ever used." Reliable simulation results inside of SolidWorks allow the designer to intelligently make changes, then quickly rerun the analysis to validate the design improvement.

CADSI's customers have documented that accurate design analysis reduces the number of physical prototypes that must be built and tested. NASA's Johnson Space Center reported eliminating at least 10 physical test cycles in the weight reduction of seats for the Space Shuttle. Ebonite International saved a full year of physical tests on the production of a new bowling ball by using dynamic motion simulation embedded with the CAD system. In a world where time is money, manufacturers are beginning to reap the financial benefits of computer-based design simulation.

CADSI is the only SolidWorks Gold Partner that develops and markets motion, structure, and thermal analysis embedded in SolidWorks. The benefits of DesignWorks can be implemented today, quickly and cost-effectively. Simulation Driven Design delivers improved product quality, reduced engineering costs, and faster time to market. Discover DesignWorks and the reality of Simulation Driven Design—contact CADSI today.



DesignWorks/Motion embedded in SolidWorks automatically calculates reaction loads, positions, velocities, and accelerations.



DesignWorks/Structure automatically uses the loads predicted in DesignWorks/Motion to perform stress, displacement, and natural frequency studies directly on the SolidWorks part.

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DISCOVER THE REALITY OF SIMULATION DRIVEN DESIGN™

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Circle No. 655

MARC
Analysis
Research
Corporation

Finite Element Analysis Using Scalable Parallel Processing on UNIX and NT

MARC Analysis Research Corporation has released its advanced nonlinear analysis system, MARC K6.3, on a variety of UNIX and NT parallel processing platforms. This includes MPP platforms from companies such as Digital, SGI, Sun, IBM, HP, and Compaq.

The need for accurate simulations of products and manufacturing processes has increased both the size and the complexity of nonlinear finite element simulations necessary for companies to remain competitive in the global marketplace. New algorithms utilizing parallel processing have been developed which make possible linear scalability of such simulations across multiple CPUs. For example, on the Sun platform, this algorithm has shown scalability of 9.4 using 8 CPUs.

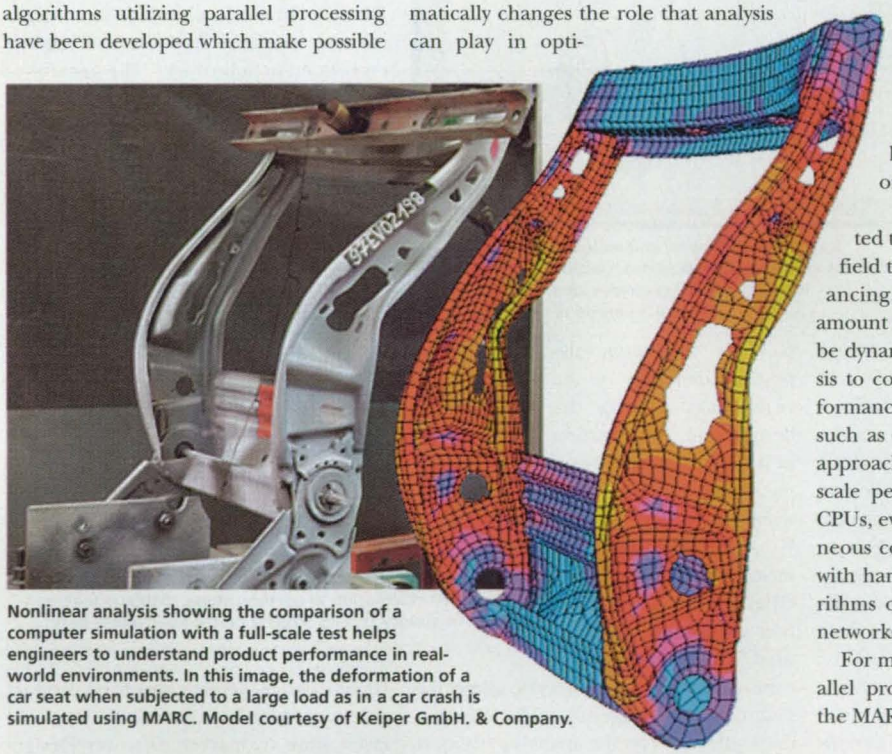
The implications for designers and structural engineers are dramatic. In one typical benchmark, a customer performed an analysis of a manufacturing simulation on an HP-735 and then performed the same analysis on an 8-CPU Digital parallel processing system. The analysis time went from 16 *hours* down to 16 *minutes* for the same results. This dramatically changes the role that analysis can play in optimization and verification of a design.

MARC leads the way in this field and is the only major finite element system which shows this kind of scalability. According to Louis M. Crain, President and CEO of MARC, "This kind of dramatic scalability is no accident. It is the result of a four-year project to reinvent our methods and algorithms for the parallel processing revolution that is now upon us."

The latest parallel platform to be supported by MARC K6.3 is the four-CPU Compaq computer using Intel Pentium Pro 200 MHz processors running under Windows NT 4.0. Although the results are preliminary, scalability is typically near and sometimes above 4.0 on four CPUs.

In the future, MARC is committed to continuing its leadership in this field through a project called "load balancing." Using this approach, the amount of work assigned to each CPU will be dynamically adjusted during the analysis to compensate for differences in performance, load, and analysis conditions, such as contact and adaptivity. With this approach, MARC expects to be able to scale performance to large numbers of CPUs, even on a network of non-homogeneous computers. MARC is working now with hardware vendors to test these algorithms on up to 128 CPU MPP systems, networks of workstations, and NT clusters.

For more information on the latest parallel processing benchmark results, visit the MARC web site at www.marc.com.



Nonlinear analysis showing the comparison of a computer simulation with a full-scale test helps engineers to understand product performance in real-world environments. In this image, the deformation of a car seat when subjected to a large load as in a car crash is simulated using MARC. Model courtesy of Keiper GmbH. & Company.

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Circle No. 656

Charles J. Digate, Chairman, President & CEO

MathSoft

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MathSoft is the leading provider of the broadest line of quantitative and analytical software for business and academia. Founded in 1984, it has more than one million users of its Mathcad®, StudyWorks!, S-PLUS®, StatServer® and Axum® software worldwide. Users include technical professionals worldwide at more than 90% of the Fortune 1000 companies and over 500 government installations, and student and faculty at over 2,000 colleges and universities.

MathSoft distributes its products through third-party resellers, including retail and software stores, catalogs, college bookstores, value-added resellers, and publishers. All MathSoft products are available by contacting MathSoft directly.

Additionally, MathSoft has an on-line math, science and engineering web store, The MathSoft WebStore (http://www.mathsoft.com/webstore/). Here you can find detailed information on MathSoft's products using an on-line catalog. Consumers are able to download the software directly or test the products before purchasing.

MathSoft is publicly traded on the NASDAQ Small Cap System under the symbol MATH.

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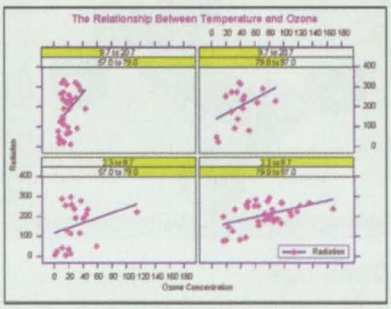
Products and Applications

• Technical Professional Suite 7

The Technical Professional Suite is a compilation of integrated, intelligent, market-leading tools to service all of the needs of today's technical professional at two-thirds the price if sold separately. The Suite consists of Mathcad 7 Professional, Axum 5, Mathcad 7 Treasury, Net-It Now! Starter Edition, and Microsoft Internet Explorer. It is designed to assist engineers, scientists, statisticians and other technical professionals to create and manage technical documents from start to finish.

The Technical Professional Suite is available for single users and workgroups (5-seat, 10-seat) as well as through MathSoft's Open Licensing plan, which allows for variable quantity licensing of any combination of MathSoft products at and above 25 seats. Single-user licenses are available for $599.95.



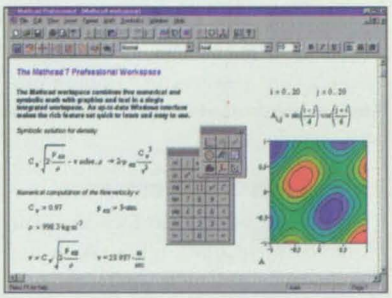
System requirements include Windows 95, Windows NT 3.51 or higher, recommended hardware of 486/66 (co-processor strongly recommended) with 24 MB RAM for concurrent use of bundled applications, or 16 MB RAM for individual use; a CD-ROM drive; super VGA or higher graphics card and monitor; and mouse or other compatible pointing device. Users may install subsets of the suite on their hard drive; full installation requires at least 35 MB hard disk space (a maximum of 132 MB hard disk space for installation of all content).

• Mathcad 7

MathSoft's flagship product, Mathcad, is the most widely used technical calculation software worldwide with more than one million users.

Mathcad 7 Professional is an integrated environment for performing, documenting, and communicating technical calculations. It enables users to enter, edit and solve equations, to visualize the results with sophisticated graphs, and to document and communicate their analysis.

Mathcad 7 Professional takes full advantage of OLE 2 to work with other applications, supporting drag and drop and in-place activation as both client and server. A built-in version of Microsoft Internet Explorer powers a unique content window that provides access to Mathcad and HTML-based resources anywhere on the Internet. A new visual language called MathConnex manages data flow between Mathcad and other numerical applications. Mathcad 7 is available in Professional, Standard and Student editions for Windows 95 and NT 3.51 or higher.



• Axum 5

Award-winning Axum is a powerful and flexible technical charting and data visualization package. There are over 10,000 registered users of Axum worldwide. Axum 5 is available for Windows 95, NT, and Windows 3.1x. Axum combines the ease of use of the best-selling PC business graphics package with powerful features such as 31 2D and 3D technical plot types, 3D contour plotting, linear and nonlinear curve-fitting, and new multi-panel plots to help reveal data patterns you can't see using traditional techniques. Fully interactive, elements from Axum 5 can be embedded in Mathcad worksheets, providing users with an integrated backdrop for the creation of publication-quality projects.

• Mathcad 7 Treasury

The Mathcad 7 Treasury's interactive, intuitive explanations and background information on the algorithms used in Mathcad make it the perfect add-on vehicle for for users of all levels to learn about MathCad.

Circle No. 657

SolidWorks

SolidWorks Corporation offers SolidWorks 97Plus, the fourth release of the company's award-winning Windows-native 3D mechanical design software. SolidWorks 97Plus solid modeling software features over 160 customer-driven enhancements including performance optimization for large assemblies, enhanced sweeping and lofting, interactive customizable exploded views, improvements in detailing, and expanded Internet capabilities.

SolidWorks is the first Windows-native 3D mechanical design software developed for mainstream engineers. Today, SolidWorks is the fastest-growing company in the history of the CAD/CAM industry and the software has received 13 industry awards. With this latest release of its software, SolidWorks continues its commitment to customers, partners, and resellers in bringing production solid modeling to the mainstream engineer.

Assemblies & Performance

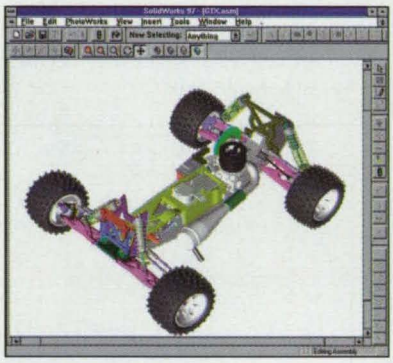
SolidWorks 97Plus performance improvements include optimization for large assemblies. Configuration support has been extended to include enhanced sub-assembly interaction. With SolidWorks 97Plus software, multiple configurations can be defined beyond the assembly level down to multiple configurations for sub-assemblies. SolidWorks 97Plus also incorporates:

- Customized exploded views, allowing users to better communicate the assembly nature of a design
- A Weld Wizard - easy-to-use, step-by-step guide to mating multiple parts
- Support for multi-user environments including part locking

Part Modeling

SolidWorks continues to add even more powerful part modeling improvements including enhanced sweeping and lofting using guide curves, enabling users to create free-form highly stylized parts. Additional part modeling enhancements include:

- The ability to add 3D annotations to parts and assemblies for improved communication
- The selection of silhouette edges to reference geometry
- Automatic creation of bend reliefs for sheet metal design
- The ability to create a rounded face using the "dome" function
- A Feature Toolbar to facilitate user interaction in creating features quickly and easily
- Shrinkage control for mold makers
- Face filleting
- Patterning of patterns and mirror of patterns



Drawings

With more than 65 enhancements in detailing capabilities, users now have additional control over drawings. Key features include:

- The FeatureManager design tree now available in drawings
- A new detailing toolbar for easy access to commonly used features
- Import of 3D annotations from the model or assembly
- The ability to create hyperlinks to notes, other files, or Internet-related materials
- Selection of multiple shapes for balloons
- Creation of rotated text
- Multi-sheet support; cut and paste views between sheets

Ease-of-Use Enhancements

With each release of its mechanical design system, SolidWorks continues to improve its ease of use. In SolidWorks 97Plus, the user interface has been further simplified to include enhancements to the FeatureManager design tree; a modeling and detailing toolbar; and a rollback bar that allows users to investigate the design sequence by dragging the bar step by step. Enhanced viewer diagnostics, such as the "what's wrong" option in the FeatureManager, allow users to better understand and evaluate design intent. SolidWorks 97Plus also features a concurrent usage option that allows multiple users to work on an assembly at the same time.

Internet Support

Designed with the Internet in mind, SolidWorks 97Plus software makes it easy for users to share designs, in native SolidWorks format, within and across engineering organizations. With Solid Works 97Plus, users can add hyperlinks directly to parts, drawings or assemblies, allowing users to link automatically to the Internet or externally referenced files to view design-related information. Solid Works has also introduced a free Internet plug-in product, the SolidWorks 97Plus Viewer, concurrent with the release of SolidWorks 97Plus, to allow non-SolidWorks users to review native design data. By using native data, users can be sure they are reviewing the most current version of the design without having to worry about intermediate file transfer formats.

About SolidWorks

SolidWorks Corporation, a corporation of Dassault Systemes S.A. (Nasdaq: DASTY), develops and markets mechanical design software products for Windows. SolidWorks was founded in 1993 with the mission to bring production solid modeling to the desktop of every engineer. SolidWorks has offices worldwide and distributes its products through a network of 160 resellers in 43 countries. For more information and a product demonstration, contact your local SolidWorks distributor or reseller today. Look for new information available on the SolidWorks Web site (http://www.solidworks.com).

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Circle No. 658

WOLFRAM RESEARCH

An Extraordinarily Powerful, Unified Environment for Technical Computing

What is Mathematica?

Mathematica is the world's only fully integrated technical computing system, combining interactive calculation (both numeric and symbolic), visualization tools, and a complete programming environment.

Mathematica contains the world's largest collection of built-in special functions, designed to work both symbolically and numerically. Its unique automatic arbitrary-precision control tracks numerical uncertainty within calculations and adjusts numeric precision as needed. Standard abilities include Fourier and Laplace transforms, a powerful collection of matrix and tensor operations, optimization, root finding, and advanced curve fitting. Symbolic algebra capabilities allow you to perform integration, differentiation, and power series expansion, polynomial factorization and manipulation, equation solving, and closed-form solution of ODEs and many PDEs.

With Mathematica you can produce 2D, contour, density, and 3D graphics, animations, and even sounds.

Mathematica notebooks are platform independent, combining into a single electronic document format typeset mathematical expressions, formatted text, hypertext, and graphics, and customizable buttons and palettes. Typeset expressions in Mathematica notebooks are not frozen; they remain "live" and can be evaluated or used as input to a function.

An extensive help browser lets users find what they need quickly. The Help Browser includes the complete text of the latest edition of *The Mathematica Book*, Stephen Wolfram's definitive reference to the Mathematica system.

Mathematica is available for Windows NT, Windows 95, MacOS, UNIX, NeXTSTEP, and Linux.

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Champaign, IL 61820-7237
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http://www.wolfram.com/look/nta

When on the hunt for a solution, which is the better approach to technical computing: numeric or symbolic? The answer, of course, depends entirely on the purpose of the calculation. A numeric calculation can provide valuable quantitative information, while a symbolic calculation can offer deeper insight into the meaning of the solution. The ideal technical computing environment, then, would allow the user to move quickly from one kind of calculation to the other, or even combine the two when necessary.

Track of Asteroid 3753 as it moves through the sky of the southern hemisphere.

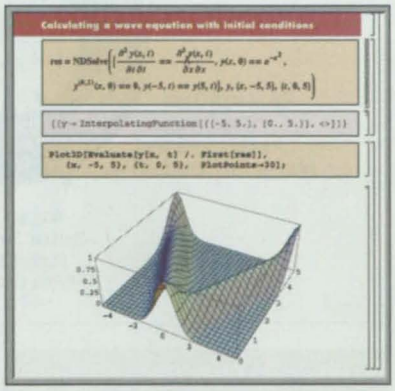
Mathematica® provides just such an integrated environment, but offers even more: powerful visualization tools; a flexible, intuitive programming language; and a complete technical publishing environment. The Mathematica user can create and optimize a model in symbolic form, and then use it to calculate numeric results of arbitrary precision. The Cassini mission, for example, has benefited from Mathematica, which was used for both simulation programs and probabilities calculations necessary for risk assessment.

Mathematica can manipulate expressions, scalars, vectors, matrices, and tensors of arbitrary dimension; and it operates in a consistent way, whether you are working with numeric data, symbolic expressions, or even a mixture of the two. The extraordinary set of built-in mathematical functions ranges from the elementary transcendentals to such specialized functions as those related to the Mathieu equation, the Legendre equations, and the hypergeometrics.

Mathematica's power to integrate both symbolically and numerically is simply unbeatable. Mathematica takes calculations that previously were prohibitively difficult, and makes them not only feasible but easy. DSolve and NDSolve can quickly solve a huge variety of differential equations, either symbolically or numerically to arbitrary precision. DSolve can solve all linear ODEs of any order with constant coefficients, and many linear equations with nonconstant coefficients, as well as a large fraction of the nonlinear ODEs.

NDSolve can solve any ODE, stiff or nonstiff; specifying initial and boundary conditions is easy. DSolve can provide general solutions for linear and weakly nonlinear PDEs; NDSolve can do the same for linear and weakly nonlinear PDEs of the form 1+1 dimension.

Mathematica's programming language gives users the best of all paradigms, whether they are accustomed to procedural programming, functional programming, or list-based programming. Users can define functions to perform symbolic operations, numerical computation, 2D or 3D graphing, or to communicate with other processes or computers via the MathLink® protocol.



Wolfram Research's Mathematica Applications Library offers add-on packages extending Mathematica's capabilities. Each contains a coordinated suite of functions and data types designed to provide tools valuable to a particular field.

Circle No. 659

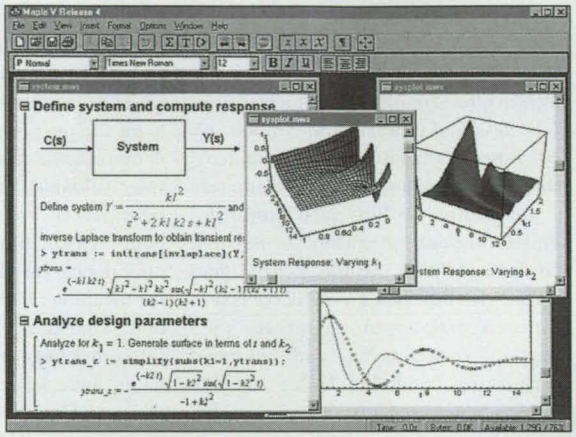
Waterloo Maple Inc.

Beyond Numerical Solvers: Application of Symbolic Mathematical Software in Modeling and Simulation

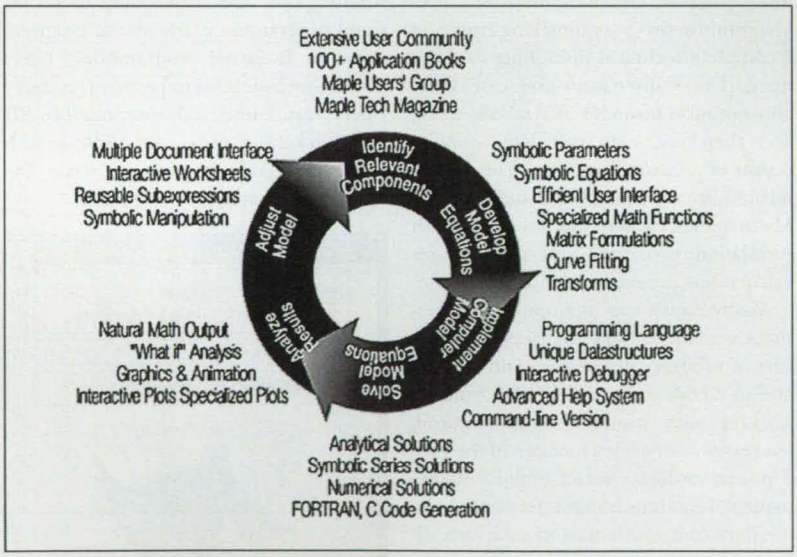
Traditionally, the role of computers in modeling and simulation has been that of solvers. Sophisticated numerical algorithms have been developed to solve models consisting of a wide range of mathematical constructs. Any numerical approach, however, has three fundamental disadvantages:

- All parameters must be known for solution, resulting in guess-work and excessive simulation runs to identify optimal parameter values.
- They have inherent errors due to the substitution of exact model information with approximations.
- They address only the solution phase. Modeling is a more complex task and often the most time is spent on the formulation of models and interrogation of results.

Maple V, an integrated symbolic mathematical processing system, addresses the shortcomings of conventional software by providing computing support for all phases of modeling and simulation.



Model Formulation: Maple V's symbolic manipulation replaces the error-prone manual development of models. Its functions in calculus, algebra, tensors, statistics, and others allow users to automate many formulation methods. Derivation of equations of motion through Lagrangian formulation, or control system transfer functions, are examples where Maple can save days over conventional work. In addition, optimized FORTRAN and C code generation offers the easiest way to link modern symbolic modeling techniques to legacy code and solvers.



Model Solution: Maple V can compute exact, closed-form solutions that maintain symbolic forms of parameters. You also can apply semi-numerical algorithms that are approximations of solutions but maintain the parameters in variable form. Examples include perturbation techniques and Galerkin methods for partial differential equations.

Model Optimization: The mathematical facilities offers facilities to compute necessary components of formal optimization (e.g., computation of symbolic Jacobians). Maple V's unique interface for interactive problem-solving and mathematical visualization provides a convenient environment to fully analyze model solutions.

Application Development: A true programming language streamlined for mathematical applications supports the above facilities. Advanced mathematical applications can be programmed in a fraction of the time that it would take with other languages. You can quickly develop an array of customized tools that can effectively deal with difficult model constructs such as non-linearities or stochastic elements. Consequently, Maple V provides an extremely cost-effective alternative to expensive simulation and design software.

For more complete discussion on the application of Maple V in advanced technical modeling, contact Waterloo Maple Inc. and request a copy of "Surpassing the Limits of Technical Computation."

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www.maplesoft.com

Circle No. 660

SPSS science™

Automated Curve Fitting Solves Design Issues

Every researcher looks for the clearest pathway to more compelling and accurate results. When facing challenges such as calibrating sensors, estimating thermal or stress responses, optimizing design parameters and refining system performance, engineers often employ curve fitting to find the best mathematical model for their data.

Finding the right model for two-dimensional and three-dimensional empirical data is among the more difficult tasks faced by scientists and engineers in their work due to the element of the unknown. While the output or dependent variable is clearly related to one or two independent variables, the relationship is not known in advance of the analysis. This often entails a time-consuming trial and error process and a strong statistical background.

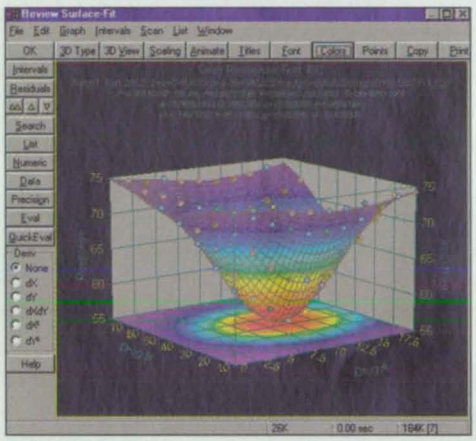
Automation Takes the Trial & Error Out of Curve Fitting

Now, engineers have access to software that completely automates the curve fitting process. The design philosophy of TableCurve 2D curve fitting software, and TableCurve 3D surface fitting software, both from SPSS Inc., suggests that curve and surface fitting are no longer complicated and tedious processes. The software automatically fits thousands of equations in a single step, ranking them in the order of best fit. The visual selection paradigms allow users to view each choice and avoid the traditional one-model-at-a-time approach. Using this method, the focus of the analysis is on which model is most appropriate to the task. Users save time by avoiding an extensive search for a solution.

TableCurve 2D fits more than 3,600 built-in linear and non-linear equations in a single automated step that requires no user input. Using TableCurve's extensive library of linear equations, engineers can find an approximating function for virtually any empirical data set. For parametric modeling, the collection of non-linear equations includes 74 different peak equations, 29 transition functions and 58 kinetic models. The product also includes the key waveform models and Fourier procedures that can be used to isolate overlapping waveforms.

As challenging as the task of automated curve fitting is, the degree of difficulty increases dramatically when fitting 3D surfaces. TableCurve 3D 3.0 employs analogous methods to TableCurve 2D for discovering viable 3D models for empirical data. Including a built-in function set of more than 450 million equations, TableCurve 3D uses an innovative selective subset procedure to fit more than 37,000 of the most likely equations from this greater set.

Both products offer state of the art smoothing and non-parametric estimation procedures. When a model is not included in the built-in set, the TableCurve products each offer versatile user functions that are simple to set up and which are automatically compiled for exceptionally fast fitting.

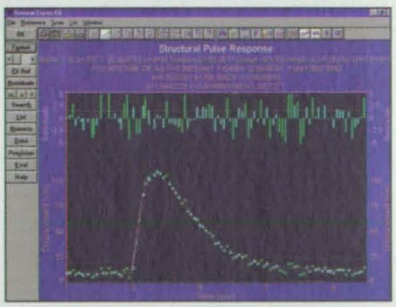


This drug reaction data was surface-fit with the optimal equation in less than two minutes by a novice TableCurve 3D user.

Applications of Technology

PACT95, the coalition that designed the fastest American yacht in the 1995 America's Cup race, Young America, chose TableCurve 2D to help optimize their design because it is the only program that searches through thousands of equations to describe difficult-to-model empirical data in seconds. Taking data samples from numerous sources, including wind tunnel tests, tank testing, and data from many other types of experiments, the software was able to convert vast amounts of empirical data into simplified curve fits. These algorithms were then input into a velocity prediction program that balances the equations of motion while looking for the fastest boat.

In electrical engineering, calibration curves and surfaces are obvious examples of curve fitting and surface fitting. If a linear response was present, the curve would be a straight line or the surface would be a simple plane. Non-idealities in sensing apparatus and electronics often assure some deviation from these simple models. Clearly, the models need to be more complex to deal with the nonlinearity of the device. SPSS Science offers a comprehensive array of award-winning software specifically designed for scientific and engineering research. Users can develop more meaningful conclusions and present clear, compelling results with SPSS' statistical, graphing and curve fitting packages. SPSS Science products include SigmaPlot, a program that creates technical graphs for research results, and SYSTAT, integrated desktop statistics and graphics software.



Residual graphs can be shown as either a separate window or included, as in this case, on the same Y axis as the main graph.

SPSS Inc.
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http://www.spss.com

Circle No. 661

Analytical Graphics, Inc. (AGI) is the producer of Satellite Tool Kit (STK), the leading commercial-off-the-shelf (COTS) analysis software tools for the aerospace industry. The STK software suite is a complete line of productivity tools that support end-to-end satellite mission processes. Spanning government agencies, academic institutions and commercial industries, STK users span all major organizations involved in aerospace.

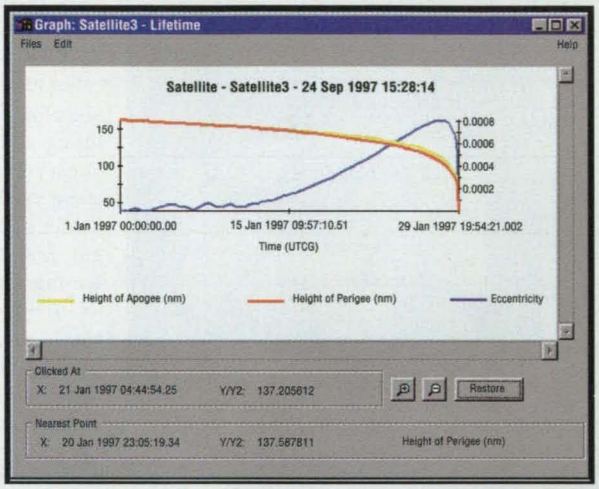
AGI was founded in 1989 by three aerospace engineers who set out to create a comprehensive suite of software that would revolutionize satellite systems analysis by increasing productivity and cost-effectiveness while reducing risk and redundancy. Eight years later, AGI remains dedicated to serving the global aerospace industry.

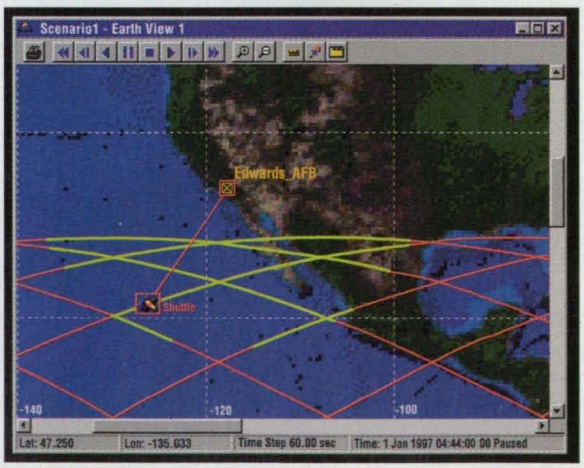
Today, AGI has over 115 employees throughout seven offices in the U.S. and abroad, supplemented by a network of business partners and international resellers. AGI's ingenuity has received attention from publications such as Inc. magazine, which recently included AGI in its annual Inc. 500 listing.

Satellite Tool Kit (STK) is the core module in a suite of interactive software products designed for complete satellite mission planning and analysis. STK 4.0, the latest full-powered release, can be downloaded free of charge via the AGI web site.

STK provides a flexible tool for all mission phases, from policy development and design, to launch and operations. STK 4.0's basic functions—propagation of vehicles, determination of access areas and times, and computation of sensor pointing angles—are critical to all mission types. In addition to the convenience of cross-platform compatibility, STK offers a cost-effective solution. Because it can be re-used for multiple missions, STK breaks the costly cycle of software redevelopment.

STK's screens quickly transform raw data into intuitive results. Vivid graphics and numerical tables allow users to quickly understand the complex relationships involving space- and ground-based objects.





STK Professional

For industry experts with the most complex needs, AGI offers STK Professional (STK Pro). The most advanced tool set of its kind, STK Pro comprises the sophisticated features most desired by those who use STK every day. These features, ranging from expanded coordinate system inputs and spacecraft attitudes to three-dimensional terrain elevation data and long-term propagators, allow the most demanding users to address a wide range of specialized problems.

STK Pro consists of six seamlessly integrated modules, including five completely new offerings. These modules include:

- Advanced Analysis Module™
- High Precision Orbit Propagator (HPOP)™
- Long-term Orbit Predictor™
- Lifetime™
- Terrain™
- High Resolution Maps™

The STK Software Suite

The STK name encompasses a suite of products that supports the specialized needs of a diverse customer base. AGI offers add-on modules and third-party products that extend STK's core functionality to address in-depth questions ranging from communication systems and network relationships to proximity concerns and coverage questions. Current offerings include:

- Programmer's Library (STK/PL)™
- Visualization Option (STK/VO)™
- Chains™
- Connect™
- Coverage Module™
- Comm™
- Close Approach Tool (CAT)™
- Distributed Interactive Simulation (DIS)
- STK/VO Earth Imagery
- STK Geographic Information System (STK/GIS)
- PODS (Precision Orbit Determination System)™
- Missile Flight Tool (MFT)™ from SAIC
- Generic Resource Event Activity Scheduler (GREAS) from Pacific-Sierra Research
- Navigator™ from CSC

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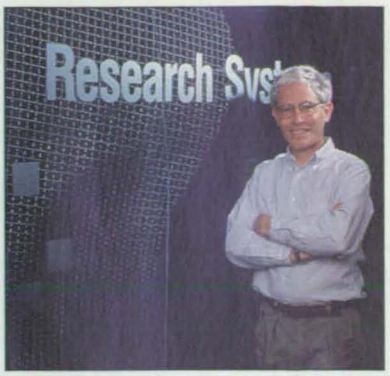
Circle No. 692

Research Systems



David Stern, President

Research Systems is dedicated to creating the best analysis, visualization and application development tools to help scientists and engineers minimize programming and gain deeper insight into their data. The company has grown steadily to more than 90 employees, with an emphasis on building a team whose expertise complements the work of its users. The original development group is intact and President David Stern maintains a significant role in producing and refining product code and direction. By hiring seasoned professionals for key management positions, Stern has enabled Research Systems to sustain strong revenue growth, maintain profitability and expand worldwide operations.

Research Systems' product line includes: IDL®, a complete, integrated software environment for data analysis, visualization and application development; ENVI®, an image processing application written in IDL, allowing access and analysis of remotely sensed data; and Research Systems' Visible Human CD™ Collection, the first complete, digital photographic reference set for exploring male and female human anatomy, containing more than 20,000 images of the human body.

Long-term success requires superior support after the sale. Research Systems' Professional Services Group and Technical Support staff offer everything from "hands-on" training courses and on-site consulting to prompt, helpful answers via telephone and email. To further personalize its service, Research Systems has partners throughout the world. Distributors in South America, Asia, Europe and the Pacific Rim provide an active link between Research Systems and customers outside the United States.

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e-mail: info@rsinc.com
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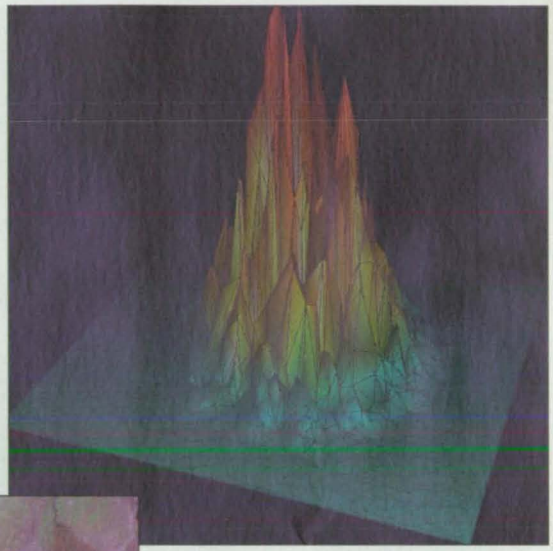
Products and Applications

IDL, the Interactive Data Language, is the ideal software for data analysis, visualization, and application development. IDL's features include: advanced image processing, interactive 2D and 3D graphics, insightful volume visualization, a high-level programming language, integrated mathematics and statistics, flexible data I/O, a cross-platform GUI toolkit, and versatile program linking tools. IDL is a powerful, cost-effective software package that has all the tools you need for any type of project — from "quick-look" interactive analysis and display, to large-scale commercial programming projects. The latest version of IDL, IDL 5.0, includes object-oriented programming, OpenGL accelerated graphics, an easy to use GUI visualization environment, linking to ODBC-compliant databases and the IDL Development Environment, the ideal place to write, run and modify IDL programs.

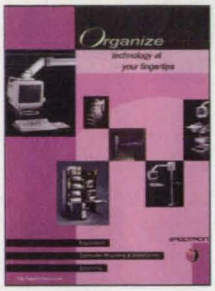


Available early in 1998, ION, IDL On the Net, will allow users to take advantage of the latest Internet and Java capabilities to integrate efficient data analysis and visualization into web-client applications. ION software is ideal for sharing data, analyses and graphics that need to be accessed by a wide variety of users, whether they are next door or on the other side of the world. And, all you need to connect with ION is a web browser.

ENVI, the Environment for Visualizing Images, the most interactive, powerful and easy-to-use remote sensing image processing package available. With ENVI, you can examine even the most complex images. You can import spectral libraries and perform sub-pixel analysis to discover more information with ENVI's advanced set of hyperspectral tools. Improve identification with ENVI's integrated radar tools by selecting polarizations, analyzing scattering patterns and extracting textural information. Due to ENVI's powerful underlying language, IDL, you can also customize all or part of ENVI to suit your individual needs. The latest version of ENVI includes an enhanced suite of GIS tools including "heads-up" vector digitizing, vector attribute editing and querying, orthorectification of airphotos and some satellite data and the ability to build new data layers or edit vector layers imported from other sources.

Research Systems' Visible Human CD Collection is the first complete, digital photographic reference for exploring human anatomy, equipping medical researchers, practitioners and educators with a simple, yet powerful tool for education and exploration. More than 20,000 image slices from a human male and female are compressed for convenient access onto two CD-ROMs. Version 2.0 of the Visible Human Male CD includes more than 70,000 labels describing three major systems of the body.

Circle No. 693



Flat Panel Display/ Computer Mounting Solutions

Ergotron's family of Computer WorkCenters and Flat Panel Mounting Solutions bring computer access to the "point of need." Utilizing a patented Suspension Technology, Ergotron products offer a unique combination of ergonomic adjustability; rugged construction; modular, space-saving design; and computer accessibility. Carts, wall-mounts, pole-mounts, and free-standing WorkCenters are available in multiple designs.

Contact Information:

Ergotron, Inc., 1181 Trapp Road, St. Paul, MN 55121; Tel: 612-681-7600; Fax: 612-681-7715; http://www.ergotron.com

Circle No. 662

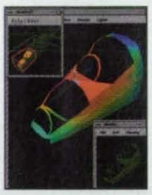
Airplane Design & Analysis Software

AAA and G.A.-CAD are integrated airplane design and analysis systems, taking users from weights to stability and control within the same environment. AAA includes military and commercial airplane design. G.A.-CAD is for general aviation airplanes and includes Aero-CAD, a 3D drafting tool with aeronautical design tools built in. Also Consulting Services and Roskam textbooks.

Contact Information:

DARcorporation, 120 E. 9th, Ste. 2, Lawrence, KS 66044; Tel: 800-327-7144 or 785-832-0434; Fax: 785-832-0524; e-mail: info@darcorp.com; http://www.darcorp.com

Circle No. 663



Numerical Algorithms Group Inc. (NAG)

25 years of experience providing state-of-the-art products:

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- Numerical Libraries:
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  FORTRAN
  FORTRAN 90
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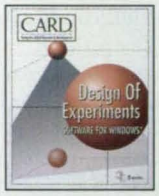
Contact Information:

Numerical Algorithms Group Inc. (NAG); Tel: 630-971-2337; e-mail: info-ntb@nag.com; www.nag.com

Circle No. 664



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Circle No. 665

Electromagnetic Design & Analysis Software

Vector Fields is a leading independent specialist company dedicated to the development and application of computer software for the design of electromagnetic devices and systems. Leading corporations in the USA are using Vector Fields software for the design of products as diverse as magnetic recording heads, electrical machines, loudspeakers, MRI body scanners, X-ray tubes, and CRTs. The software is available on most computer systems, including PCs and workstations, and is accompanied by extensive technical support.

Contact Information:

Vector Fields Inc., 1700 N. Farnsworth Ave., Aurora, IL 60505; Tel: 630-851-1734; Fax: 630-851-2106; e-mail: info@vectorfields.com; www.vectorfields.com

Circle No. 666

Hollow Shaft Units SHF-2UH

HD Systems has introduced a new zero-backlash, high-accuracy harmonic drive speed reducer, which features a large hollow shaft. The new SHF-2UH offers a compact design with an integral cross roller output bearing and hollow shaft through the gear. The design is both axially shorter and lower in weight, yet provides significantly increased torque capacity when compared to conventional harmonic drive gearing. This is accomplished by using their patented "S" tooth profile.

Contact Information:

HD Systems, Inc., 89 Cabot Court, Hauppauge, NY 11788; Tel: 800-231-HDSI or 516-231-6630; Fax: 516-231-6803; http://www.hdsystemsinc.com

Circle No. 667

MITSUBISHI

MR-J2

Mitsubishi's MR-J2 is a high-performance digital servo that features an absolute encoder; worldwide certification (UL, cUL, CE); position, speed and torque modes; zero speed oscillation function; industry-standard digital command pulse input; and an ultra-compact physical footprint design. Its automatic motor identification reduces set-up time and the high-frequency response (250+ Hz bandwidth) reduces machine cycle times.

The MR-J2 includes the world's first Real-Time Adaptive Tuning, offering hands-free gain adjustments, and has an RS232C serial communication interface. Installation is simplified with optional Windows-based set-up software.

D75

The single-slot D75 coprocessor motion control module by Mitsubishi saves a slot in the A/AnS backplane, allowing users to put more functionality into the modular A/AnS Series PLCs. Using a 32-bit Intel-based Reduced Instruction Set Computing (RISC) processor, the D75 controls up to 192 axes of motion. Storing up to 600 motion profiles for each axis, the D75 provides 15 different motion control methods.

An open collector command pulse output and differential command pulse output with a 400 kHz maximum output frequency, enables the D75 to work with any servo or stepper applications. The D75 also works with the SWOIVD-AD75P software programming package.

MR-C

Users looking for a competitively priced and real-time tuned servo will need to look no further. Mitsubishi has recently released the MR-C brushless servo system. It is an easy-to-use package that has a remarkably low price tag and is extremely compact, yet offers advanced servo functions that traditional stepper drives will never be able to offer. The hardware platform of the MR-C servo system is the same powerful 32-bit reduced instruction set microprocessor (RISC).

By incorporating a new miniaturized intelligent power module with a single micro-chip processing unit (CPU), Mitsubishi has produced its smallest size servo amplifier yet. The two amplifiers — 100 and 200 Watts — are available in single-phase, 110, and 230 VAC versions and have 100% torque from 0 to almost 4,500 RPM. Measuring only 1.57-in. wide, 5.12-in. high, and 3.94-in. deep, users can mount these units in the smallest of spaces.

Mitsubishi Electric Automation, Inc.
500 Corporate Woods Parkway
Vernon Hills, IL 60061
Tel: 800-445-4496 or 847-478-2100
Fax: 847-478-2253

Circle No. 668

CYBERNETICS

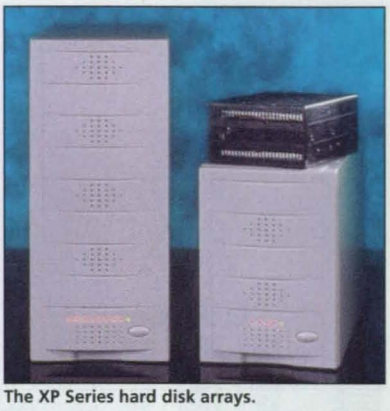
Cybernetics Speeds Data Acquisition and Processing

The Digital Data Recorder interface from Cybernetics provides a fast transfer of data to tape at a lower cost than other technologies. The CY-DDR enables researchers to write digitized data streams from analog-to-digital converters or other instrument recorders to Cybernetics' CY-9000LP DTF tape drive at speeds of up to 36 MB per second.

"The combination of our CY-DDR interface and CY-9000LP digital tape drive creates a custom high-speed recording solution at an unbeatable price," said Nick Harper, Vice President of Marketing. "It loosens the budgetary restraints on designing experiments that require high-speed, frequent sampling of data. Now, for under $40,000, you can reach performance that can cost over $150,000 with other solutions."

The CY-9000LP digital tape drive.

The CY-DDR interface features up to 128 MB of variable rate buffer to ensure a smooth transfer regardless of fluctuations in the data source, supports true bi-directional data flow for record and playback, and provides fast access to collected samples for post-processing. The CY-9000LP DTF tape drive can record 42 GB of data to each tape, greatly reducing the number of tapes required, as well as the costs and labor associated with purchasing, swapping, shipping, and storing them. Data can be striped to multiple drives for extremely high-speed samples, or cascaded back and forth for long duration data collection.



The XP Series hard disk arrays.

Once data has been stored to tape, XP Series disk arrays and RAID subsystems can boost the execution speed of host computers in data processing centers, improving productivity in disk-intensive applications. The high-performance disk arrays allow data to be transferred to and from tape more efficiently. Extremely high capacity — 51.2 GB, 25.6 GB, or 10.2 GB — provides sufficient online storage for complex algorithmic processing while a large buffer ensures a smooth flow of data between host and disk. By striping data to several drives in the array, these solutions increase speed and prevent the CPU bottleneck so frequently associated with data-intensive procedures.

Cybernetics has been providing businesses worldwide with advanced tape and disk storage solutions since 1978. The complete family of products includes a variety of high-performance DTF, 8mm, 4mm, and DLT tape solutions; magneto-optical disk drives; hard disk arrays; and RAID subsystems that are compatible with virtually all computer systems. With exclusive options like Data Compression, Data Encryption, and Multi-Host capability, Cybernetics provides total data management solutions. A commitment to field-tested technologies and engineering expertise have made Cybernetics an industry leader, and the same focus on engineering enables the company to provide unrivaled technical support and service.

Tape and disk storage solutions.

Cybernetics
111 Cybernetics Way
Yorktown, PA 23693
Tel: 757-833-9100
Fax: 757-833-9300

Circle No. 669

GOULD
Instrument Systems

Gould Introduces Two Load & Go Data Acquisition Systems with Seamless, Integrated Analysis Software

Gould Instrument Systems' new ACQuire Data Acquisition System features both portable and lab configurations, each with built-in, ready-to-use acquisition and analysis software. ACQuire allows for 16 channel inputs, dual sample rates, external sample rate, real-time continuous hard copy, and the ability to mark multiple events.

The ACQuire system includes integrated data acquisition, analysis, and data manipulation software. It runs at 50,000 samples per second aggregate (continuous to disk), with real-time hard copy running at 100mm per second, and offers completely integrated playback for review and measurement.

The ACQuire AP portable data acquisition system.

ACQuire LAB data acquisition system for critical component-level testing.

"What really distinguishes ACQuire is the powerful data display," states Stan Tofil, Data Acquisition Product Manager for Gould. "Because you can configure the system to show four different displays of data in real time on one screen, a plant engineer can see more of what's going on and make adjustments quicker. In test environments, researchers can see immediate effects and adjust their tests 'on the spot' without having to run the whole test and then wade through data."

Gould Instrument Systems
8333 Rockside Road
Valley View, OH 44125
Tel: 216-328-7000
Fax: 216-328-7400
www.gouldis.com

Two different configurations are available. ACQuire AP is a portable unit weighing under 20 lbs. with carrying case and laptop. Priced at $2,495, it features 5B isolated signal conditioning on a channel-to-channel basis and is ideal for collecting field data in various locations. The lab configuration features high performance, specialty signal conditioning for measuring temperature, strain, pressure, voltage, current, and other units. ACQuire LAB is priced at $3,995 and is an excellent solution for critical component-level testing.

"ACQuire was developed to be a totally self-contained system, requiring no integration with complicated external analysis packages," continued Tofil. "There is no need for lengthy training. Everything you need to begin acquiring and analyzing data is built into the system. Just load and go."

To assure the system will meet customer needs, Gould offers a free demo CD and an evaluation purchase program that will allow users to run the system in the actual application sight. "We've heard so many data acquisition stories about systems that don't fit the application or are simply too hard to get up and running, we thought we would take the risk out of ACQuire by letting the customer evaluate it for 30 days before finalizing the purchase," said Tofil.

Gould Instrument Systems is a leading supplier of data recorders, signal conditioning, and digital storage oscilloscopes. "Our core technologies offer a real advantage to users looking for reliable, functional data acquisition. While other companies emphasize the hardware or the software, we take an integrated approach of combining a truly representative measurement signal, acquisition capability, screen display, analysis software, and if desired, output to paper," stated Tofil. "ACQuire is the first of a number of integrated solutions from Gould designed to be 'good application fits' for the market."

Circle No. 670

Real-Time Multichannel Analog Signal Processor

The SPS6000 Signal Processing System can handle up to 32 analog inputs, including strain gages, LVDTs, and pulse/frequency. Output from each channel is a scaleable ±10V dc signal, accurate to ±0.02% of full scale. Signal processing functions include sum/difference, peak capture, auto zero, and sample/hold. Programmable filters also are provided.

Contact Information:

Daytronic Corporation, 2589 Corporate Place, Miamisburg, OH 45342-3694; Tel: 800-668-4745; Fax: 937-866-3327; www.daytronic.com

Circle No. 671

GaGe

Gage Applied Sciences, leaders in ultra-fast data acquisition products for PCI and ISA bus, offers the world's fastest 16-bit A/D cards sampling up to 10 MSPS, 12-bit A/D cards up to 100 MSPS, and 8-bit A/D cards up to 500 MSPS. Gage also offers the world's first Instrumentation Grade PC designed for PC-based instrumentation with front access to all connectors and a built-in color monitor, providing a complete turnkey solution. Extensive software driver pacakges also are available.

Contact Information:

Gage Applied Sciences, Inc., 1233 Shelburne Rd., Ste. 400, South Burlington, VT 05403; Tel: 800-567-GAGE; Fax: 800-780-8411; e-mail: prodinfo@gage-applied.com; www.gage-applied.com

Circle No. 672

FREE 1998 IOtech Catalog

Put the latest data acquisition solutions at your fingertips! IOtech's 1998 catalog is now available, offering you a wide selection of PC-based data acquisition systems and IEEE 488 communications products. This 280-page, easily-navigated catalog makes a valuable addition to your personal reference library. This year's catalog features more than 25 new products, including first-to-market and new-technology data acquisition systems that are not available from any other company. Request your free copy today!

Contact Information:

IOtech, Inc., 25971 Cannon Road, Cleveland, OH 44146-1833; Tel: 440-439-4091; e-mail: sales@iotech.com; http://www.iotech.com

Circle No. 673

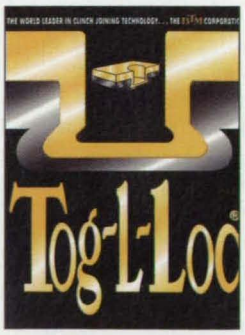
CELL STACK

Cell-Stack is a rugged, self-contained controller that can remotely operate the SoMat 2100 Field Computer System. Fully compatible with Windows, Cell-Stack can manage communication with the host PC and the data acquisition systems, control data acquisition systems, perform analysis, and archive and transfer data. Calibrate transducers, reconfigure test parameters, view data in real time, transfer data from Cell-Stack to you, and analyze and view results.

Company Information:

SoMat Corporation, PO Box 2998, Champaign, IL 61825-2998; Tel: 217-328-5359; Fax: 217-328-6576; e-mail: info@somat.com; http://www.somat.com/

Circle No. 674



Full-color brochure describes BTM's patented Tog-L-Loc sheet metal joining system. Tog-L-Loc easily joins plain, coated, or dissimilar metals without fasteners. No sparks, fumes, or soot are produced, and protective coatings are not burned or pierced. Tog-L-Loc joints have been demonstrated to retain 90% of their ultimate monotonic strength beyond 1,000,000 cycles in fatigue testing. Strong, consistent, and leakproof Tog-L-Loc joints can be nondestructively checked with a simple gage.

Contact Information:

BTM Corp., 300 Davis Rd., Marysville, MI 48040; Tel: 810-364-4567; Fax: 810-364-6178.

Circle No. 675

New Metallic Seal Profile Provides Exceptional "Spring Back"

The Wills Rings® C is a new seal that features a C profile and exhibits performance characteristics for operation in the most demanding static sealing applications. It also provides a spring-back ability to absorb and counter deformations in hardware up to three times greater than conventional metallic o-rings. Wills Rings C has a low seating load, is available in a range of coatings, and includes system pressure-actuated, hollow rings, solid rings, and gas pressure-filled rings. Temperature tolerances range from cryogenic to 850°C, and pressure tolerances from ultra-high vacuum to 145 psi.

Contact Information:

Busak+Shamban, 2531 Bremer Dr., Ft. Wayne, IN 46801; Tel: 800-767-3257.

Circle No. 676

Kingston® TECHNOLOGY

Kingston Flexible Storage

Kingston Technology is a nationally recognized leading manufacturer of storage enclosures. The Storage Products Division of Kingston was established in 1989, offering storage upgrades to its customers emphasizing the same philosophy that made Kingston's memory division so successful. Kingston Storage installations include Fortune 1000 companies, educational institutions, and countless government agencies worldwide.

Developing quality products is a Kingston trademark. Kingston storage products are sold worldwide through a select group of strategic partners including national and regional distributors.

The Data Silo family

The Data Express Group (Seamless)

Kingston flexible storage products.

Mix & Match For Flexible Storage Solutions

Kingston's storage products provide solutions specifically designed to reliably support increased storage capacity and system flexibility. Use the Kingston rugged Data Silo expansion chassis, available with up to 9 bays, to accommodate fixed storage needs. Utilize the reliable Data Express removable drive trays for system internal removable storage. Combine Kingston's Data Silo and Data Express units for a variety of custom external removable solutions.

More About Our Products

• **Data Silo DS500 Chassis (9-bay Rackmount or Tower)** Our Data Silo DS500 is a steel rackmount or tower, RAID or JBOD (Just a Bunch of Disks) external expansion chassis designed to reliably house any combination of up to 9 half-height (or 4 full-height and 1 half-height) devices. Used in conjunction with our Data Express removable device enclosures, the DS500 can house up to 12 removable devices.

The Kingston DS500 can support up to 4 host systems. This enclosure comes standard with a power-on LED indicator, 1 or more 300-watt, highly-rated, load-sharing, hot-swappable power supply(ies), and 2 quick-release, hot-swappable cooling fans. The DS500's front operator display panel provides a visual and audible warning alarm system that reports dangerous operating conditions.

Each DS500 unit is designed to support a variety of storage applications, from daisy chain configurations to high-performance RAID solutions. Prewired and custom wired configurations are available. The DS500 is compatible with all popular platforms.

• **Data Silo DS100 Chassis (1, 2 & 4-bay)** The Kingston DS100 family of expansion chassis can house up to (4) 3.5" or 5.25" half-height, or (2) 5.25" full-height SCSI peripherals. Each DS100 is constructed of rugged steel and is designed to easily withstand the high temperatures generated by today's high-performance devices. These chassis are equipped with internal wiring, blank filler panel(s), and highly-rated, auto-ranging, enhanced power supply(ies) and fan(s).

Various available versions of the Data Silo provide flexible options for storage expansion, making our Data Silo enclosures ideal for desktop, JBOD and RAID, single and dual port disk arrays. Combine our Data Silo DS100 chassis with our Data Express removable subsystem units and enjoy the convenience of up to 6 removable devices in a small footprint, desktop storage enclosure.

• **Data Express (Removable Device Enclosure)** The Kingston Data Express line of removable device enclosures can house any 3.5" drives or 3.5" front-load type devices. Data Express subsystems are mountable into any internal or external 5.25" half- or full-height peripheral expansion bay (model dependent).

Kingston Data Express units are solidly constructed and employ highly reliable mating connectors that are rated as high as 25,000 insertion cycles for most models. An ID select indicator, device carrier key lock, device activity indicator light, and antistatic insertion guide rails are standard features on most models. Hot-swap capability and solenoid device locks are available options on some models.

Our Data Express modular subsystems are ideal for applications that require cold, warm, or hot swapping of devices. In addition, the Data Express is perfect for data transfer or transportation, data security, archiving large files, JBOD, and RAID applications. "Mix and match" our Data Silo standalone expansion chassis with the Data Express for a custom, external removable solution.

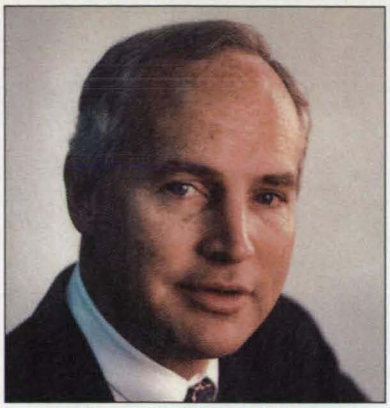
Warranty & Testing Information

All Kingston Storage Products carry a 7-year warranty, the longest in our industry, and a 30-day, no-questions-asked, money-back guarantee.

Every Kingston storage product is 100% tested and burned-in for 24 hours prior to shipment. All of our products are UL, CSA, and TuV approved and are designed to meet FCC class B and CE specifications.

Kingston Technology
17600 Newhope St.
Fountain Valley, CA 92708
Tel: 800-435-0642
Fax: 800-435-0056
e-mail: storage@kingston.com
http://www.kingston.com/storage

Circle No. 677



Francis J. Kramer, President & Chief Operating Officer

II-VI INCORPORATED

For the past two years, our advertisements, literature, and annual reports have included the phrase "Combining Excellence Across the Spectrum." At II-VI Incorporated, we feel that these words help convey the attitude and business philosophy of our growing organization. The word "Excellence" is basic to our goals, and expresses our dedication to quality in design, in manufacturing, and in service to our ever-growing customer base. "Across the Spectrum" helps describe the expansion of our product lines.

From our inaugural year of 1971 through 1994, II-VI Incorporated was dedicated primarily to infrared technology with products and services for industrial, commercial, military, and medical lasers covering the 2.0 to 20 micron wavelength range. Today, through internal product development, mergers and acquisitions, the breadth of the II-VI Incorporated product offerings now includes products to serve the rapidly expanding solid-state laser markets through our VLOC subsidiary. Using our knowledge of CdTe-based compounds, we have seen our eV PRODUCTS Division expand rapidly as it brings new technology to market in the field of gamma ray detector devices.

At II-VI Incorporated, special emphasis is being placed on research and new product development in the areas of electro-optical devices for use across a broad spectrum. We are providing high-end, high-specification components that meet our customers' requirements for optics and electro-optical devices from gamma ray to far infrared wavelengths.

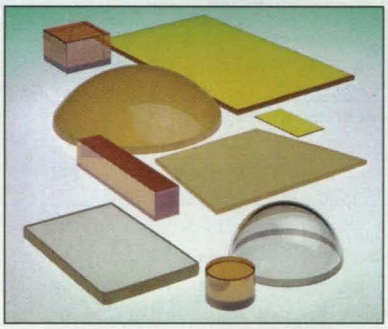
II-VI Incorporated
375 Saxonburg Boulevard
Saxonburg, PA 16056
Tel: 412-352-1504
Fax: 412-352-4980
http://www.optics.org/ii-vi/

Material Growth Capabilities

Optics and optical components which meet or exceed specifications begin with the highest quality substrate materials. Complete understanding of the unique properties, preparation, and process control of these materials is critical. II-VI Incorporated is recognized worldwide as the leader in infrared crystal growth technology and the design and development of thin film optical coatings.

Infrared Materials

• Zinc Selenide (ZnSe) - A fine-grained polycrystalline material, produced by chemical vapor deposition, superior for transmission for wavelengths of 0.5 to 14 microns. ZnSe offers excellent qualities for imaging due to its homogeneous and uniform crystalline structure.



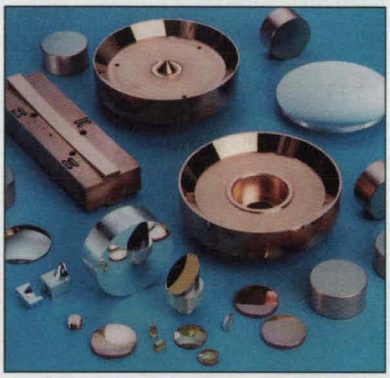
Zinc Sellenide and Zinc Sulfide materials.

• Zinc Sulfide (ZnS) - Regular Grade - A mechanically strong, small-grained material has useful transmission in the wavelength range of 4 to 12 microns and offers exceptional hardness and flexural strength. This material is used exclusively in IR missile dome and FLIR applications.

• Zinc Sulfide (ZnS) - MultiSpectral Grade - Exhibits a high and uniform level of transmission from the visible through the infrared, making it particularly useful in FLIR systems requiring transmission at shorter wavelengths.

• Cadmium Telluride (CdTe) - An ideal substrate in the 2 to 25 micron region where many materials have reduced or variable transmission due to the presence of absorption bands. Oriented single crystals of this compound also possess electro-optical properties, which in turn make them useful in application of electro-optical modulation of IR light.

• Cadmium Zinc Telluride (CdZnTe) - Used as a substrate for Epitaxial MCT (Mercury Cadmium Telluride) in the manufacture of IR focal-plane arrays. Using Horizontal and Vertical Bridgman techniques, ingots of up to 8Kg are produced, yielding high-purity, single-crystal substrates up to 6 cm x 8 cm. In addition, our eV Products Division utilizes high-pressure Bridgman growth for production of CdTe/CdZnTe solid-state room-temperature radiation detectors.



Diamond machined optics.

Gain Materials

II-VI Incorporated, through our VLOC subsidiary, offers a broad range of standard and custom laser gain and nonlinear materials including ruby, Nd:YAG and Nd:YLF, and optical components for industrial, scientific, and research lasers. Produced to stringent specifications, these materials are precisely fabricated and coated per customer requirements. In addition, VLOC is a producer of Cr:LISAF and Cr:LICAF crystals for tunable solid-state lasers.

The VLOC subsidiary develops and produces nonlinear materials such as potassium niobate (Knb03) and potassium titanyl phosphate (KTP) used for the generation of laser light throughout the visible and near-infrared spectrum. Potassium niobate is particularly well-suited for efficient conversion of infrared laser light into the blue-green spectral region via second harmonic generation (SHG).

For information on visible and near-IR products or materials, contact VLOC at 813-375-8562 or fax 813-375-5300. For information on middle IR products or materials, contact the II-VI Sales Department at the numbers listed at left.

Circle No. 678

DUPONT

Vespel®

Vespel® from DuPont Meets Needs of the Semiconductor Industry

Vespel parts and shapes are made from a unique polymeric material that has become the "gold standard" for a multitude of semiconductor applications. The largest current consumer of Vespel in the semiconductor industry is the etch segment, where Vespel is used in the process chamber for applications such as wafer clamping rings, insulator rings, edge rings, confinement rings, and lift pin components. Vespel is also used in PVD, CVD, ion implant, and other processes.

Among the benefits of Vespel for semiconductor applications are: improved die yield through reduced edge effect in many processes, reduced contamination and superior machinability compared to quartz and ceramic, excellent insulative and dielectric properties, and material purity in chamber use.

Because of its unique combination of properties, Vespel has been the polymer of choice for in-chamber applications. Engineers will often consider quartz, ceramic, and Vespel first for evaluation when chambers are being designed and tested.

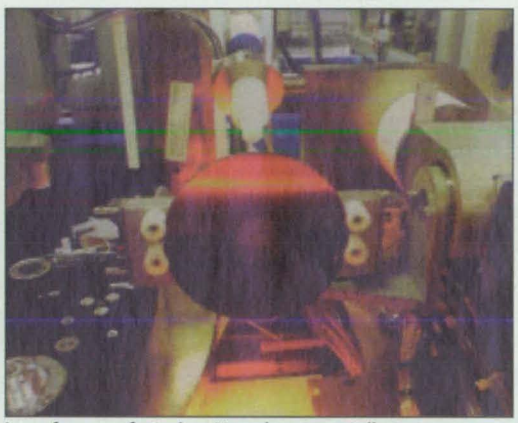
With the advent of high-density plasma, and with larger wafer sizes on the horizon, the semiconductor industry needs performance beyond even what previous generations of Vespel could deliver. Now, DuPont is using its capabilities in basic science and polymer research to provide advanced polymeric solutions for semiconductor use.

New Grades of Vespel for Semiconductor Manufacturing

DuPont introduces Vespel SCP-5000, a new generation of Vespel for polyimide parts and shapes for semiconductor manufacturing, with improved performance and added value in etching chambers and other demanding wafer processing environments. SCP-5000 provides improved part life and reduced cost of ownership in current etch systems and next-generation, high-density plasma systems.

Compared with the current industry standard, Vespel SP-1, Vespel SCP-5000 offers better retention of strength and toughness in prolonged service at elevated temperatures (up to 550°F or more). In addition, SCP-5000 delivers more chemical resistance, and longer life in oxygen-rich and plasma environments. With lower moisture absorption and a lower coefficient of thermal expansion, SCP-5000 can improve the fit to aluminum parts, reduce the risk of wafer damage, create fewer particulates, and reduce outgassing.

Vespel SCP-5000 will offer a polymeric alternative for engineers developing chambers using high-density plasma, with advantages including more uptime, reduced maintenance, and increased yields. SCP-5000 will be available by year-end 1997.



In wafer manufacturing, Vespel parts contribute to increased yields by reducing contamination and edge effect.

Vespel Keeps Pace with Shift to Larger Wafers

With the advent of 300-mm wafers, semiconductor equipment manufacturers are in need of larger-size parts. To meet the need for these larger parts that can stand up to aggressive chamber conditions and protect process purity, DuPont is now offering Vespel in diameters up to 16 inches. These larger parts are ideal for larger confinement rings, shield rings, focus rings, and various other uses. By year-end, DuPont will also begin offering 18-inch-diameter Vespel rings. Even larger diameters can be made available.

Capacity to Meet Growth Needs & Introduce Additional Offerings

In 1997, DuPont Vespel has doubled both its resin capacity and shapes-manufacturing capacity to meet the growing need for polyimide parts and shapes in the semiconductor industry. As the leading supplier of high-performance polymers to the industry, Vespel will also offer an increased range of semiconductor equipment and material solutions. For example, Zymaxx®, primarily targeted at the CMP segment, has recently been introduced. Zymaxx offers the chemical resistance of Teflon® in a structural material. Zymaxx improves the performance of CMP machines being used for parts such as wafer retaining rings (where it allows the use of one ring for all polishing needs, and can improve ring life dramatically), and bell housings (where it increases durability over aluminum, which pits in the presence of aggressive slurries).

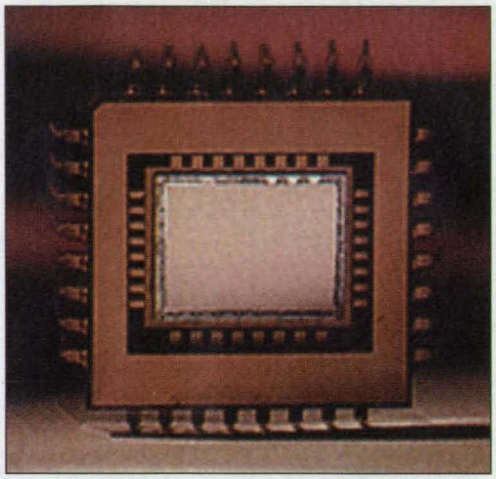
DuPont Vespel®
Tel: 800-972-7252
www.dupont.com/enggpolymers/americas/products/vespel.html

Circle No. 679

SARNOFF Corporation

The Sarnoff Corporation is a leader in developing sensing technologies for a wide range of applications, including measurement, identification, data collection, and communications. We have made major advances in imaging, communications, RF identification, optical detection, and short-range data transfer.

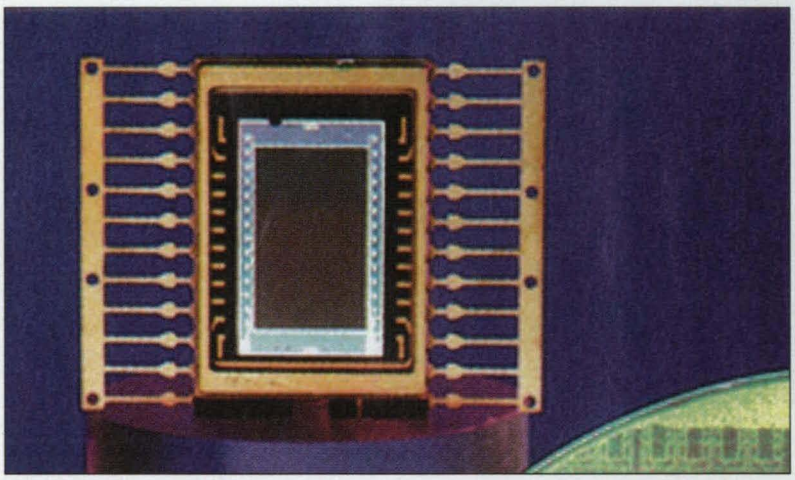
In microwave sensors, Sarnoff applies its long experience to such things as true-ground-speed sensors for locomotives, which increase load-pulling ability while saving fuel. Optical sources under development include ones with the ability to detect gas levels in the parts-per-billion range without interference. With more than 15 years of experience in RF identification and data-transfer systems, Sarnoff has developed products ranging from simple, inexpensive passive identifiers to sophisticated active remote transponders. An example is a credit-card-sized tag with more than 56 billion reprogrammable codes that can be remotely read or written to at ranges up to six meters. With three decades of experience in focal-plane-array development, Sarnoff has applied CCD technology to everything from security systems to high-speed (1,000 frames/second) missile-tracking systems and a variety of visible and infrared cameras.



320 x 244 PtSi IRCCD

In IR and visible imaging systems, Sarnoff's expertise includes thinned-back, illuminated CCDs in a variety of output amplifier designs, vacuum-UV imagers, a monolithic platinum/silicon process, and a CMOS cryogenic multiplexer process. Sarnoff also manufactures its own high-frame-rate visible and IR CCD camera systems.

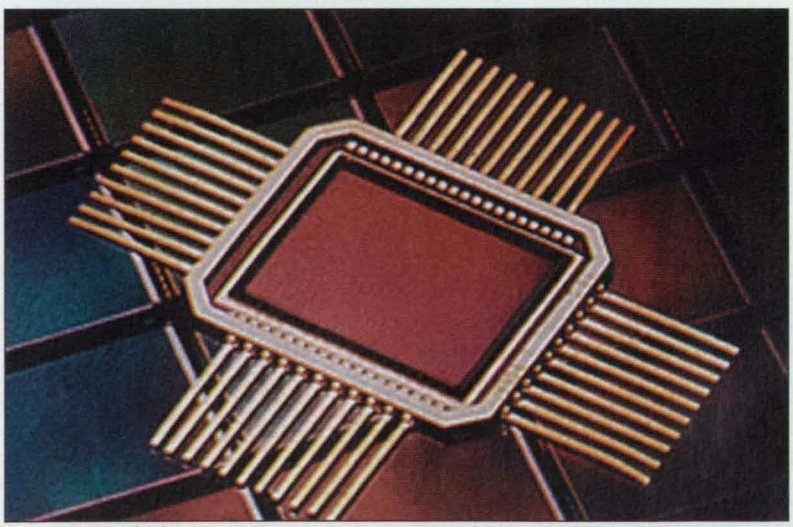
Sarnoff has two decades of experience in advanced silicon imager design, process technology development, imager design optimization, and product fabrication. We offer an extraordinary combination of foundry service flexibility and technology performance that includes full-service design and fabrication of final products.



Visible Back-Illuminated CCD

History

Established in 1942 as the RCA Laboratories and a wholly-owned subsidiary of SRI International since 1987, Sarnoff is one of the world's leading research and development organizations in solid-state electronics. President and CEO James E. Carnes heads a growing staff of 830.



640 x 480 IR Multiplexer

Sarnoff Corporation
Business Development
CN 5300
Princeton, NJ 08543
Tel: 609-734-2553
Fax: 609-734-2443

Circle No. 680

WATLOW

Watlow Electric Manufacturing Co.

The Total Thermal System Approach

At Watlow, we supply thermal system solutions better than anyone else. Because, unlike companies that just make heaters, or sensors, or controls, we design and manufacture all of these thermal system components to work together. As your single source supplier, we have to understand every aspect of the thermal system, and that yields advantages for you:

- Longer heater life
- More precise control
- Faster response time
- Higher productivity
- Optimal energy management

The people of Watlow have been solving demanding heater applications for over 70 years, and in response to customer needs, we have developed a large heater product line to meet temperature requirements to 2300°F (1260°C). Our temperature sensor line can handle anything from cryogenic -328°F (-200°C) to 4200°F (2315°C). Watlow temperature controls, from simple ON/OFF, non-indicating devices to microprocessor-based ramping controls, are built to withstand hostile environments: heat, electrical noise, static discharge, humidity, and vibration. Power controls range from MDRs to sophisticated SCRs. Many of our control products can be networked together, or connected to other industrial control devices, using serial communication protocols such as Modbus™.

Our experience is reflected in our design of over a million different heaters, sensors, and controls for such industries as plastics processing, food equipment, packaging, medical equipment, aerospace, scientific equipment, and nuclear power generation. So when you have an application problem, we can draw upon our diverse experience for a better solution instead of being confined to the standard answers of one industry.

Watlow high-performance thermocouples.

High-Performance Thermocouple Technology

Technological advances in industry have created a demand for thermocouple materials with unusually high performance characteristics and superior quality. Watlow Gordon has kept the pace with these demands. A long-time leader in the field of temperature measurement, Watlow has the modern facilities necessary to comply with today's complex specifications, standards, and industrial or governmental regulatory requirements. Watlow Gordon also provides testing and certification services to document compliance with agency standards. Watlow's products are proof that the challenge of reliability and high performance is met.

Performance Capabilities

- Compliance with recognized agency tolerances and specifications
- Temperature ranges up to 4200°F (2315°C)
- NIST-traceable calibration certificates
- Thermocouple limits set to ITS-90 reference standards

Features

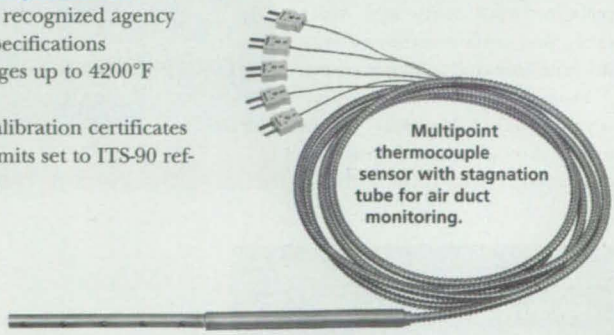
- Type B, R, S, C*, E, J, N, T and K thermocouple conductors for all temperature applications
- Wide selection of sheath materials to meet specific application requirements
- Insulation materials to meet demanding application temperatures
- Grounded and ungrounded junctions to meet electrical configurations
- Multipoint temperature sensor assemblies measure temperature gradients without multiple, individual sensors
- Hybrid thermocouples withstand extreme vibration and humidity
- Testing and certification services for demanding applications

*Not an ANSI symbol.

Applications

- Semiconductor manufacturing
- Diesel engines
- Jet engines
- Laboratory research
- Nuclear environments
- Power stations and steam generators
- Rocket engines
- Turbines
- Vacuum furnaces
- Exhaust gas sensing

Modbus™ is a trademark of AEG Schneider Automation



Multipoint thermocouple sensor with stagnation tube for air duct monitoring.

Watlow Electric Manufacturing Co.
12001 Lackland Road
St. Louis, MO 63146
Tel: 314-878-4600
Fax: 314-878-6814
http://www.watlow.com

Circle No. 681

Digi-Key®

Mark Larson, President/COO

It started in 1972 — an idea, a new concept in distribution. Today, Digi-Key Corporation is one of the fastest-growing electronic component distributors in the United States. The concept that fueled this growth was to provide the highest level of service possible to Digi-Key's customers.

It all begins with the Digi-Key catalog. This 500-page technical resource, with more than 180 manufacturers represented, is updated and expanded every 60 days, reaching proven and prospective customers across the entire United States and Canada.

Once the phone rings, Digi-Key's leading-edge operational efficiencies go into effect. It continues with a computer system able to perform 24 million instructions per second and support 600 active. The customer is provided with real-time stock status and order entry, and instant access to hundreds of thousands of transactions.

From there, an intelligent conveyor system flawlessly routes orders through more than a mile of conveyor. From point of induction, orders are selectively diverted to each potentially relevant picking zone.

Once the order is filled, it goes to packing, where it is checked for accuracy and properly packaged. Then on to shipping, where the customer has more than 40 standard delivery options from which to choose.

This highly automated approach to order fulfillment allows orders to be processed — from order entry to shipping — in as little as 30 minutes! The end result of this kind of turnaround time is that orders placed by 5:00 p.m. Central time are shipped the same day! To ensure the customer of the absolute highest-quality standards, this entire process — from order entry to shipping — is ISO 9002 certified.

Digi-Key's certification is comprehensive, covering "the purchasing, warehousing, and distribution of electronic components, computer products, and accessories, including value-added assembly processes." This covers all facilities.

"ISO 9002 certification assures Digi-Key's customers that we have systems in place to provide them with a consistently high level of service," said Digi-Key President Mark Larson. "With audits required every six months to retain certification, it requires a sustained commitment to quality. To our customers, ISO 9002 certification means they will continue to get quality they can count on."

This commitment to quality service is confirmed by independent industry studies. Based on independent research conducted each year, Digi-Key rates:

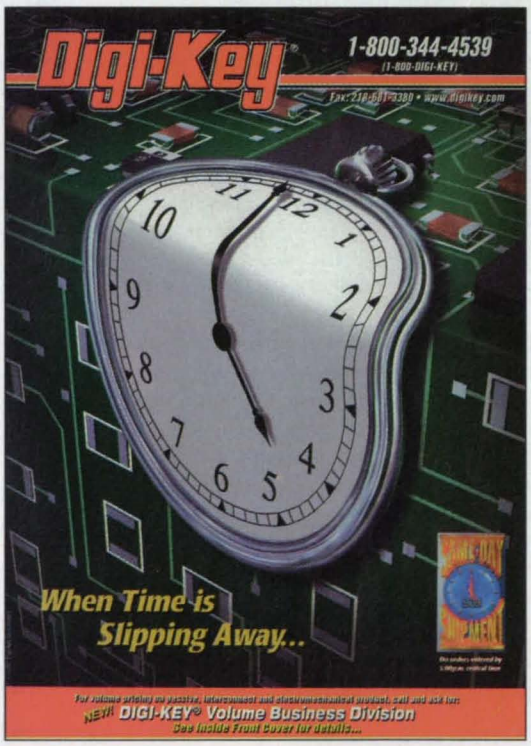
- #1 for delivery
- #1 for availability of product
- #1 for pricing
- #1 for responsiveness
- #1 for overall performance

In this qualitative industry report card, Digi-Key has earned the highest rating in all five categories, five years (1992-1996) in a row! When evaluated head-to-head with other distributors, Digi-Key is clearly the leader when it comes to service!

The word "service" is an easy one to throw around. In electronic distribution, everyone claims to be dedicated to service. But Digi-Key supports it with measurable performance that is confirmed time after time by simply asking our customers.

"We believe Digi-Key provides the best service in the industry," says Larson. "Our growth rate over the past 20 years and the industry studies are perhaps the strongest testimony to that fact."

Service is what differentiates one distributor from another. Service is what differentiates Digi-Key from other electronic component distributors.



Digi-Key Corporation
701 Brooks Avenue South
Thief River Falls, MN 56701
Tel: 800-344-4539
Fax: 218-681-3380
www.digikey.com

Circle No. 682

DRS TECHNOLOGIES

DRS Laurel Technologies, a division of DRS Technologies, is a world-class electronics contract manufacturer serving the needs of commercial OEMs and defense sector prime contractors. Our client list includes AlliedSignal, Northrop Grumman, Boeing Company, Lockheed Martin, United Defense, and many other respected names. They know us for on-time manufacture and delivery of a wide range of value-added, quality products, including wire harness and cable assemblies, printed circuit boards, complex electromechanical subassemblies, and COTS technology display systems. A technically astute company, we offer a full range of assembly, integration, and test solutions for electromechanical and electronic systems. This "total turnkey" approach allows us to take a product from concept through design, prototype validation, and full-scale production.

In January 1997, we received ISO 9002 certification. In addition, we are fully compliant with ANSI-J-Std-001B, Mil-Q-9858A, ANSI-J/IPC-A-610B, and other well-recognized commercial and military standards and practices.

We are an industry leader today, in no small measure because of our preference to forge long-term partnering relationships with our customers. At heart, we are a problem-solving company, one which knows that our customers' success is our success. Accordingly, we don't just manufacture products. Our quality assurance staff evaluates each customer's manufacturing needs in much the same way it evaluates our own, with an eye towards making every product better. We've learned that any manufacturer can build products inexpensively. Drawing upon our key technical strengths, we believe we provide each customer with the very best value manufacturing solution.

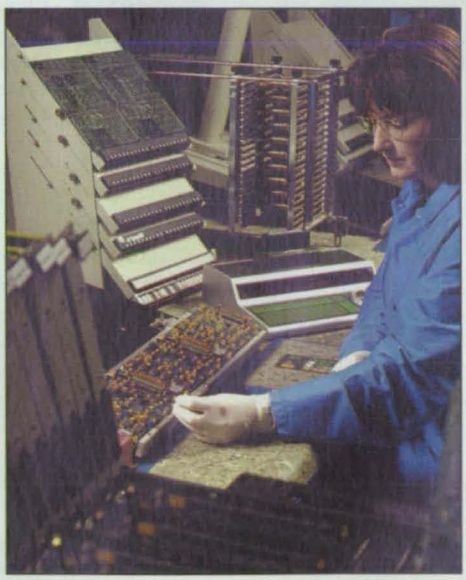
A fine example of this "build it better" philosophy is our newly available PCS Plus solid-state power conditioner. Far lighter and more compact than competing power conditioners, this versatile unit is less expensive and more efficient, too. It will allow our customers to improve upon the wide array of power-demanding applications in which it may be used, including mainframe computers, air- and shipboard control consoles, and more.

Typical power supplies found in today's electronic systems transmit high-frequency electrical noise back onto the AC utility input. These emissions can interfere with the operation of other equipment sharing the utility. They can also induce over-currents that may not be detected by conventional circuit breakers. In addition, these traditional power supplies and conditioners generate multiple harmonic load currents, which in turn propagate unnecessary circulating currents. These currents do nothing to satisfy the actual load requirements, and must instead be dissipated as waste heat, a serious problem for many applications.

The PCS Plus practically eliminates all harmonic distortion, allowing a near-perfect Power Factor of 0.99. And by stopping EMI/RFI problems at the AC source, the unit also obviates the need for external EMI/RFI filtering solutions.

Unlike other power conditioning systems, which require separate assemblies for DC to DC conversion or multiple output DC supply, the PCS Plus is completely versatile. Using a single part number, it accepts unfiltered single-phase or three-phase AC line voltage anywhere in the world, conditions it, and converts it to multi-output DC power. An integral charging system provides an uninterrupted source of power for dependent systems.

By replacing up to three separate assemblies in a single housing, the PCS Plus reduces final manufacturing cost in typical installations. Weighing nearly 80 lbs. less than competing designs, the PCS Plus offers considerable flexibility anywhere that size and weight represent critical design issues.



DRS Laurel Technologies
423 Walters Avenue
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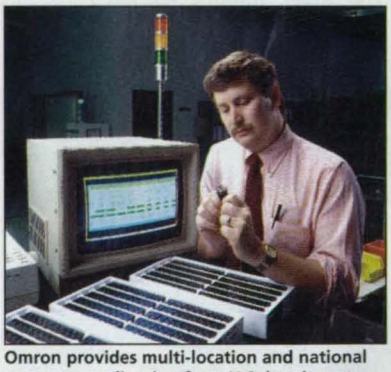
e-mail: rclark@lrltech.com
http://www.lrltech.com

Circle No. 683

OMRON®

Applying Technology for Advanced Control Solutions

Omron Corporation is one of the world's premier manufacturers of automation components, equipment, and systems with advanced computer, communications, and control technologies. Stringent international quality standards are our mandate. Omron offers one of the world's widest and most technically advanced selections of products for use in factory automation, office, healthcare, telecom, banking, and retail systems. Our "Quality First" motto is reflected in all of our products, from initial product planning and design through production, quality testing, and warranty documentation. No other automation supplier is as focused on providing the total automation and electronics package for the 21st century and beyond.



Omron provides multi-location and national account coordination from U.S. headquarters, exclusive inventory arrangements, customized testing reports to eliminate incoming inspections, custom bar coding, and next-flight-out emergency shipment of parts.

Sales and Support Facilities

The Americas headquarters for Omron are in Schaumburg, IL. Omron Canada in Scarborough, Ontario and Omron Brazil are subsidiaries. Visit our Technology Showrooms in the U.S. and Canada. Training facilities are located in Schaumburg, Toronto, regional U.S. offices, and at certified distributors. Omron manufactures relays, photoelectric sensors, and other controls at Omron Manufacturing of America in St. Charles, IL. Our R&D centers are located in Japan, Singapore, UK, Netherlands, Germany, and the U.S.

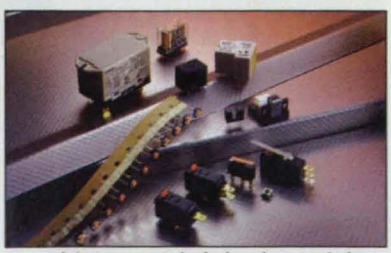
Omron Electronics, Inc.
One East Commerce Drive
Schaumburg, IL 60173
Tel: 847-843-7900
Fax: 847-843-7787
www.oei.omron.com

Key Data

Omron Corporation 1996 revenues were $5.6 billion. Omron employs 23,000 worldwide. There are 55 international subsidiaries and more than 40 factories worldwide, all with ISO 9000 certification. Omron was founded in 1933 in Kyoto, Japan. Omron Electronics, Inc., responsible for North American marketing, was started in 1973. It employs 700 divided among 34 branch and regional offices, training facilities, and application labs.

Products

- Relays - low signal, PCB power, general-purpose, solid state
- Switches - basic, mechanical, optical DIP, pushbutton, thumbwheel
- Sensors - proximity, capacitive, photoelectric, limit switches, measurement and inspection
- Magnetic stripe and IC chip card readers - insert, swipe, motorized
- Radio frequency and bar code automatic identification and data collection systems
- Machine vision systems
- Programmable controllers
- Timers, counters, panel meters, power supplies
- Operator interface terminals
- Process and temperature controllers
- Software for PLCs, operator interfaces, and process control monitoring



Control Components include relays, switches, small optical switches and sensors, and card readers. For a CC Standard Products Catalog, fax to 847-839-2280 or e-mail: omroninfo@omron.com

Recent Advances

- Strap-on liquid level sensor EE-SPX613 detects aqueous fluids in clear and translucent tubing and pipes.
- Photo MOS relay G3VM includes an ultra-small 4-pin version, in surface-mount and through hole types.
- Color mark sensor E3MC combines RGB light sources, free angle optics, position sensing diodes, and fiber-optic light pipes to provide accurate color comparison, regardless of luster. They perform reliably exposed to machine vibration.
- Off-line circuit board inspection system VT-WIN uses color vision to provide 3D views of solder joints, captures defect views, records date/time to reduce time and operator fatigue in quality control process.
- Micro PLC SRM1 uses networked inputs and outputs to provide high-speed processing for up to 256 points, scattered in 4-, 8-, and 16-point blocks over a 100-meter distance.
- RF-based V600 automatic identification data collection system encodes batch and routing data onto industrially hardened tags for read/write access to data at the point of use.
- Ethernet gateway for mid-sized PLCs on a plug-in PCMCIA card.

Factory Automation controls and systems that are simple to integrate include machine vision, RFID and bar code data handling systems; programmable controllers and operator interface terminals; software; DeviceNet components; process and temperature controllers; timers; counters; and panel meters. For a Short-Form FA Catalog, fax to 847-839-2280 or e-mail: omroninfo@omron.com

See Omron's products in action by visiting the Factory Automation Plaza Technology Showroom in Schaumburg. Fax a visit request to 847-839-2345.

Circle No. 684

The Evans Hybrid® capacitor is half the weight and one-tenth the volume of aluminum capacitors. It is made as either a prismatic design in a polymer package (right, in photo) or a hermetic MIL-type design in a tantalum package (left, in photo). Evans Hybrid® capacitors range from 1mF to 100mF, 3V to 125V, 20g to 60g, and 5cc to 15cc.

Contact Information:

Evans Capacitor Company, 33 Eastern Ave., East Providence, RI 02914-2107; Tel: 401-434-5600; Fax: 401-434-6908; www.evanscap.com

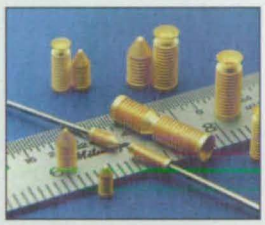
Circle No. 685

Ross Engineering Corporation designs and manufactures HV Relays, HV Switches, HV Contactors & Circuit Breakers, HV DC-10MHz Digital Multimeters, HV Voltage Dividers, Hi-Z® Voltmeters, Wideband HV Oscilloscope & Voltmeter Probes, Spark Gaps, Toroids, Spheres, Corona Nuts, Personal Grounding Rods, Fiber Optic transmitter systems. Typical applications are in HV power supplies, HV power line and underground cable voltage measurement and phasing, HV power quality, and disturbance monitoring for most industrial plants, labs, or utilities.

Contact Information:

Ross Engineering Corporation, Hugh Ross, President; Tel: 408-377-4621; Fax: 408-377-5182; http://home.navisoft.com/rossengineering/index.htm

Circle No. 686



Interconnectric®: The New Name in Reliable Interconnections

Servometer introduces the Interconnectric line of miniature gold-plated bellows contact springs for dynamic interconnections. They can be used individually or as pairs in critical applications. These unique contacts come with either a convex conical or concave conical tip, which when paired, will allow them to self-align at interconnection. Diameters range from 0.037" O.D. to 0.125" O.D.

Contact Information:

Tom Guarino, Engineering Sales Mgr., Servometer Corporation, 501 Little Falls Rd., Cedar Grove, NJ 07009-1291; Tel: 973-785-4630; Fax: 973-785-0756; www.servometer.com

Circle No. 687

RGB Spectrum develops and manufactures products which integrate computer and video signals for display and communications. Products include the RGB/Videolink® video scan converters, the ComputerWall® multi-screen processor, the RGB/View® and SuperView™ lines of real-time video windowing systems, the SynchroMaster® computer signal synchronizers, and other specialized scan converters and processors. External peripherals and VME boards. Applications include command-and-control, simulation and training, remote surveillance, video conferencing, large-screen communications, and virtual reality.

Contact Information:

RGB Spectrum, 950 Marina Village Pkwy., Alameda, CA 94501; Tel: 510-814-7000; Fax: 510-814-7026; e-mail: sales@rgb.com; http://www.rgb.com

Circle No. 688

Rolyn 1998 Catalog of Off-the-Shelf Optics

Rolyn Optics announces their 1998 catalog, "Optics for Industry" with 140 pages of product data, photos, performance graphs, and ordering information. Included are simple and compound lenses, prisms, optical flats/flat glass, flat and concave mirrors, absorption and thin-film filters, beamsplitters, reticles, instruments, and much more. One of the largest and oldest suppliers of off-the-shelf optics, Rolyn offers 24-hour delivery on stock items. The firm provides custom cutting, coating, edging, or complete fabrication.

Contact Information:

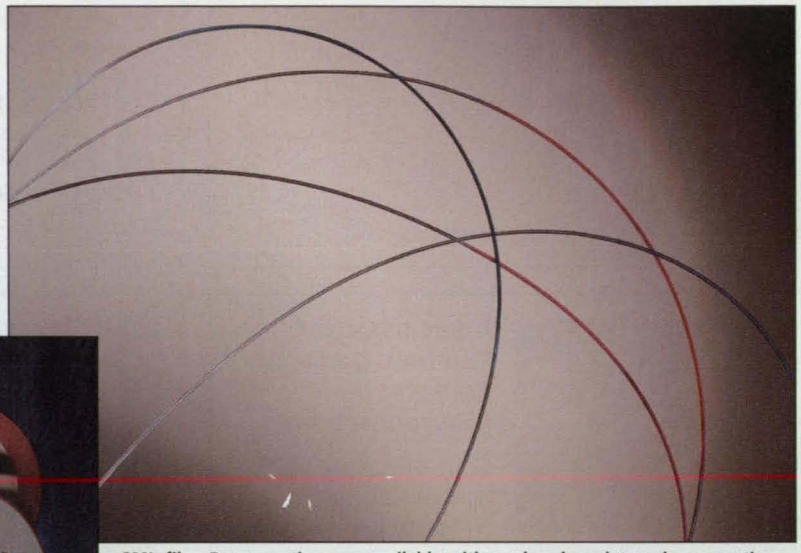
Rolyn Optics Co., 706 Arrowgrand Circle, Covina, CA 91722; Tel: 626-915-5707; Fax: 626-915-1379; e-mail: info@rolyn.com; http://www.rolyn.com

Circle No. 689

3M Specialty Optical Fibers
3M Bragg Grating Technologies

Optical Fibers and Bragg Gratings Backed By the Resources of 3M

3M Specialty Optical Fibers/Bragg Grating Technologies is a vertically integrated manufacturer providing world-class specialty optical fibers and gratings. Our capabilities in fiber preforms, coating, waveguide design, and terminations allow us to meet virtually any need. 3M's fiber Bragg gratings, specialty single-mode fibers, and large-core multi-mode fibers represent the most complete line of specialty optical fiber products in the world. And, they're backed by the technological, engineering, and manufacturing resources of 3M.



3M's fiber Bragg gratings are available with a colored acrylate polymer coating over the reclad region.

We maintain active, ongoing fiber optics research and development programs, and we take advantage of the vast resources and technological information within 3M. Our facilities in West Haven and Bloomfield, Connecticut house state-of-the-art production equipment, and we provide to you the very latest technology 3M has to offer.

3M Specialty Optical Fibers
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West Haven, CT 06516
Tel: 203-934-7961
Fax: 203-932-3883

Fiber Bragg Gratings

As a fully licensed Bragg grating supplier, 3M focuses on the design, development, and manufacture of fiber gratings for the telecommunications, sensor, and research markets. Through the integration of 3M's fiber and grating resources, you now have commercial availability of gratings written in fiber designed specifically for gratings fabrication, along with the research capabilities, volume manufacturing strength and product quality that 3M is famous for.

Specialty Single-Mode Fibers

3M's leadership in polarization-control fiber technology is based on our "shaped-cladding" fiber. Our investment in this technology has resulted in fibers of unparalleled consistency and high tolerance. Products such as our single-polarization fiber, polarization-maintaining fibers from 500 to 1550nm, and assemblies are used for aerospace, military, and advanced communication applications. In addition to polarization-controlling fibers, 3M manufactures high NA fibers and fibers operating in the visible as well as other non-telecommunications wavelengths.

Large-Core Multi-Mode Fiber

This broad line of step-index PowerCore fibers and assemblies are designed and manufactured to meet a wide variety of transmission and environmental requirements found in the medical, industrial, spectroscopy, military, and data communications markets. Products include the popular TECS™ hard-clad fiber and high-power SMA 905 assemblies.

Emphasis on Technical Support

3M's full-service customer support helps you with everything from application planning to system start-up. Our engineers will work with you to determine which fiber or fiber grating is right for your application. Or, we'll custom design a fiber or grating to provide the best solution for your application.

3M has extensive experience in fiber optics; a dedication to research and development; and a commitment to work closely with our customers from start to finish. They're all good reasons to put 3M to work for you.

Circle No. 690

Digital Particle-Image Velocimetry Enhanced by Fuzzy Logic

Particle velocities can be measured with high spatial resolution over a broad range of seeding densities.

Lewis Research Center, Cleveland, Ohio

A method of digital particle-image velocimetry (digital PIV) involves the use of a combination of fuzzy-logic, cross-correlation, and particle-tracking techniques. As in other PIV methods, the overall task is to estimate the velocity field in one plane of a flowing gas or liquid by (1) seeding the flow with small, highly reflective particles, (2) illuminating the plane of interest with intense light from a pulsed laser or other source, (3) recording a sequence of images of the illuminated particles (see figure), and (4) processing the image data to determine local velocity vectors from displacements of particle images. Older PIV methods described previously in *NASA Tech Briefs* involve various degrees of manual and/or automated processing of image data by hardware and/or software. The present method is a product of a continuing effort to develop a capability for all-electronic, fully automated, software-based processing of digitized seed-particle images to extract the maximum available information about velocities.

In the present method, the same scene

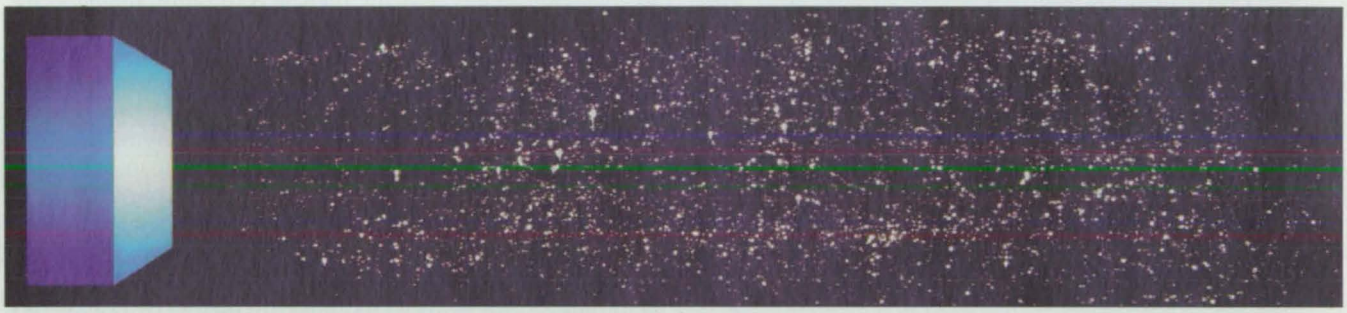


Figure 1. **Seed Particles Entrained in Supersonic Flow** from a convergent nozzle can be seen clearly when illuminated by a sheet of pulsed laser light. This is one of two images that are recorded a short time apart so that velocity vectors can be extracted from displacements between the first- and second-image positions of the particles.

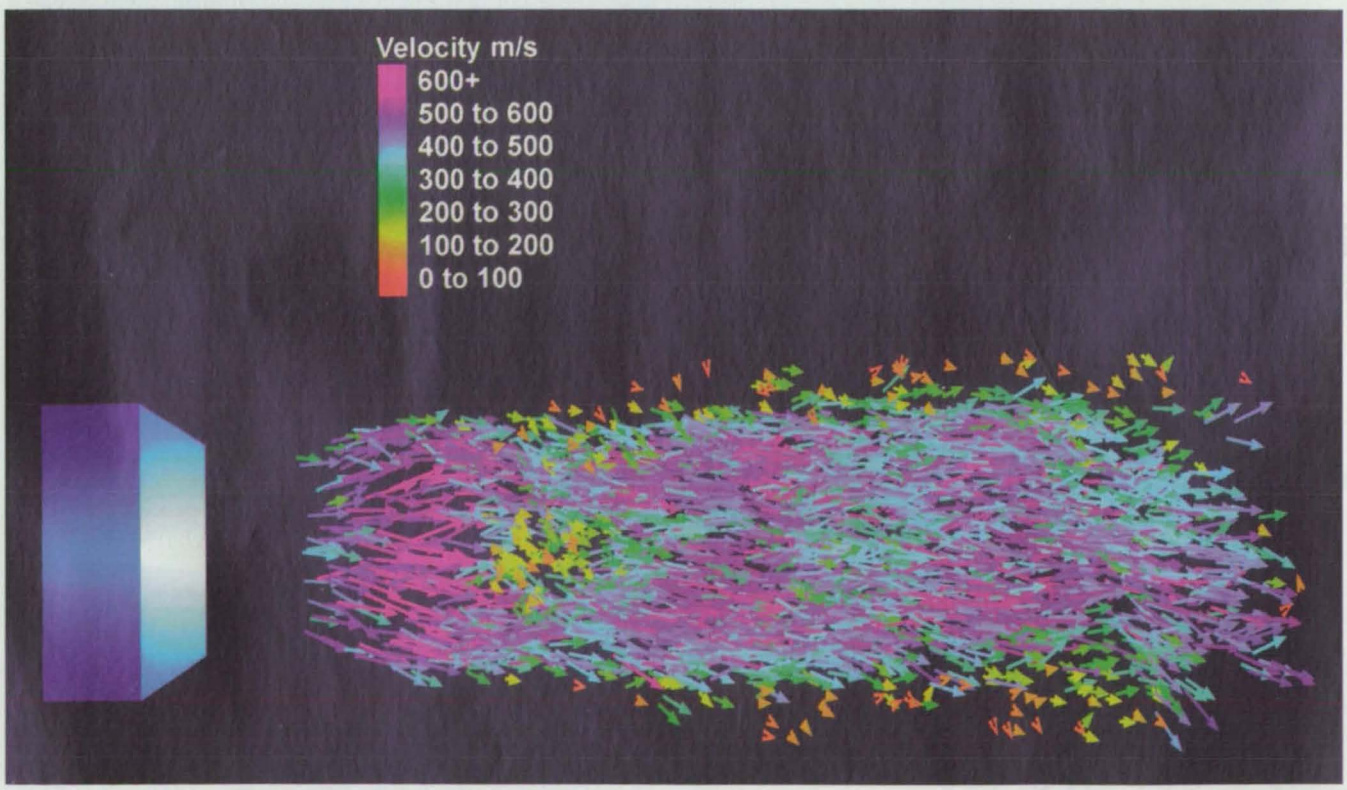


Figure 2. This **Velocity-Vector Map** was generated in the second stage (fuzzy-inference particle tracking) of processing of two consecutive images like that of Figure 1.

is both illuminated by two pulsed lasers via a beam combiner and observed by two charge-coupled-device cameras via a beam splitter. Each camera acquires a single-exposure image. The reason for using two cameras and two lasers is simply to make it possible to record the two images as close together or as far apart in time as necessary to obtain particle-image displacements in the right size range for extraction of velocity data.

The image data are then analyzed in a two-stage process. In the first stage, the images from the two cameras are divided into equal-size regions, cross-correlations between corresponding regions are computed, and a fuzzy-logic inference engine is used to maximize the recovery of information from the correlation plane: Ideally, the peak of greatest amplitude on the correlation plane for each region would represent the average particle displacement and thus the average particle velocity in the region. However, when the seed density is low or there is out-of-plane particle motion, image noise, or a velocity gradient, a number of correlation peaks can arise. In an effort to select the correlation peak that represents the true velocity, a fuzzy inference operation is performed. The essence of this operation is to compare the velocity vectors of the five highest correlation peaks in each region with those of the five highest correlation peaks in each of the four surrounding regions and to select, for each region, the velocity vector most similar to the velocity vectors of the selected correlation peaks of the other regions according to a confidence-weighting numerical criterion. The justification for selecting velocity vectors on the basis of similarity to adjacent velocity vectors lies in the fundamental continuity of flow. Of course, because it represents velocities averaged over regions, the resulting velocity map inherently has low spatial resolution.

The second stage of the image-analysis process involves particle-tracking velocimetry, in which (1) the data from each frame are processed independently to determine the particle-image centroids, (2) the centroid locations are used to determine candidate displacement vectors, and (3) velocity vectors are calculated by dividing the displacement vectors by the interexposure time. The major problem in selecting the displacement vectors is to determine which particle-image centroids in the second frame represent the subsequent positions of which particle-image centroids in the first frame. In the present method, this problem is solved by invoking two schemes, the first being a fuzzy-logic scheme with a selection criterion that is also based on continuity of flow; this scheme was described in "Particle-Tracking Velocimetry With Fuzzy Logic" (LEW-16205), *NASA Tech Briefs*, Vol. 20, No. 8 (August 1996), page 62.

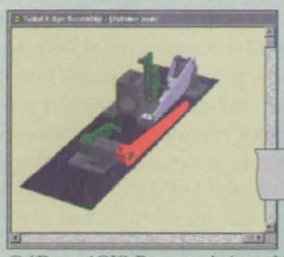
In the second scheme, which also involves fuzzy logic, the low-resolution velocity map generated in the first stage is used as a further guide to selection of vectors: For each initial particle location, the four first-stage nearest-neighbor velocity vectors are used to compute a spatially weighted mean vector called the "benchmark" vector, which is then used in pairwise fuzzy comparison with all of the candidate vectors for the particle in question. The candidate vector most similar to the benchmark vector according to a confidence-weighting numerical criterion is selected as the velocity vector for that particle. This process is repeated for each initial particle location, yielding a high-resolution velocity-vector map (see Figure 2).

This work was done by Mark P. Wernet of **Lewis Research Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category,* ***or circle no. 180*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

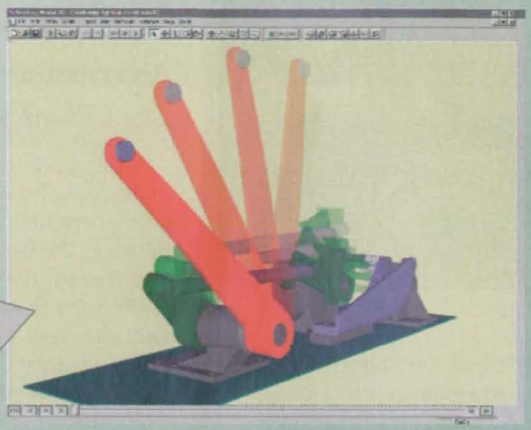
Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Lewis Research Center, Commercial Technology Office, Attn: Tech Brief Patent Status, Mail Stop 7–3, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16415.

Mechanical Simulation for Better Products™

Build



CAD or ACIS Parts and Assemblies



Functioning Working Model Subway Door Mechanism
Modeled by Sean Taffert, Vapor Canada Inc., Quebec, Canada

Build your "Working Model®" by putting together real physical components like motors, actuators, springs, and mechanical joints. No programming is required. You can design parts and assemblies in Working Model, or directly in your CAD environment.

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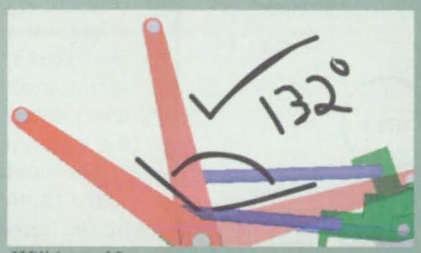
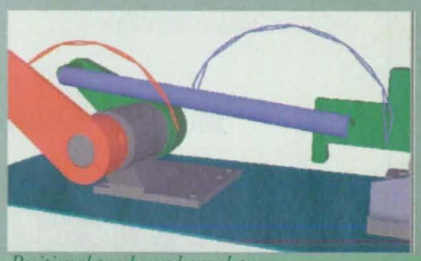
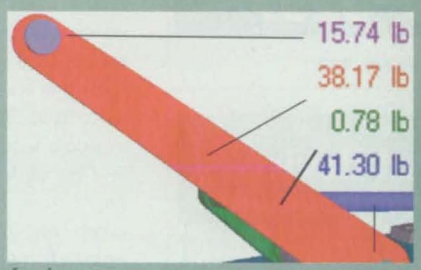


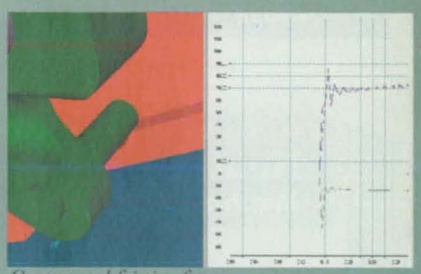
Will it work?



Positional tracks and envelopes

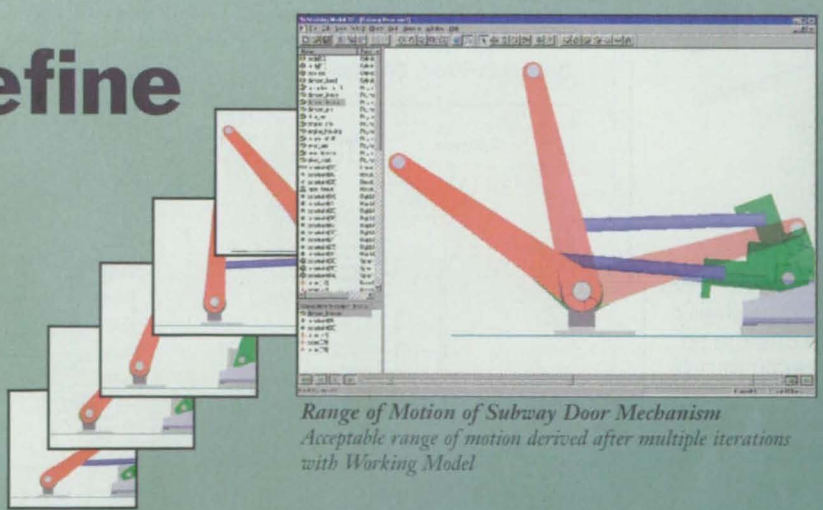


Loads on any part



Contact and friction forces

Refine



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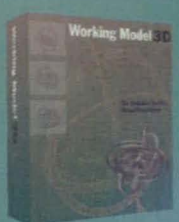

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** subway photo simulation*

Solenoid Valve Modified To Prevent Leakage During Vibration

An armature is redesigned, and a spring is added.

Lewis Research Center, Cleveland, Ohio

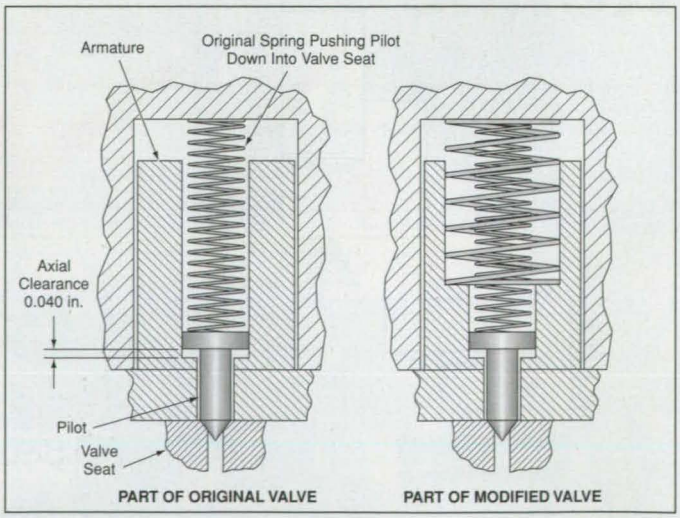
A solenoid valve has been modified to suppress chatter, which made the valve susceptible to leakage in a vibratory environment. In the original design, an axial clearance of 0.040 in. (1 mm) between the armature and the pilot (see figure) left the armature free to chatter. Sometimes, the chatter knocked the pilot out of the valve seat, thereby causing leakage. Even though the pilot and seat were configured for pressure-assisted seating, a differential pressure across the valve seat of 1,800 psi (12 MPa) was insufficient to prevent leakage during vibration of the valve.

Elimination of the armature/pilot clearance was not an option because during normal operation, the clearance is utilized to develop momentum of the armature for a hammering effect that assists in opening the valve; with the help of the hammering effect, the valve can be opened at a differential pressure up to the rated value of 2,500 psi (17 MPa). Installation of a stiffer spring pushing down on the pilot from inside the armature was also not an option because it would reduce the maximum opening differential pressure below the rated value.

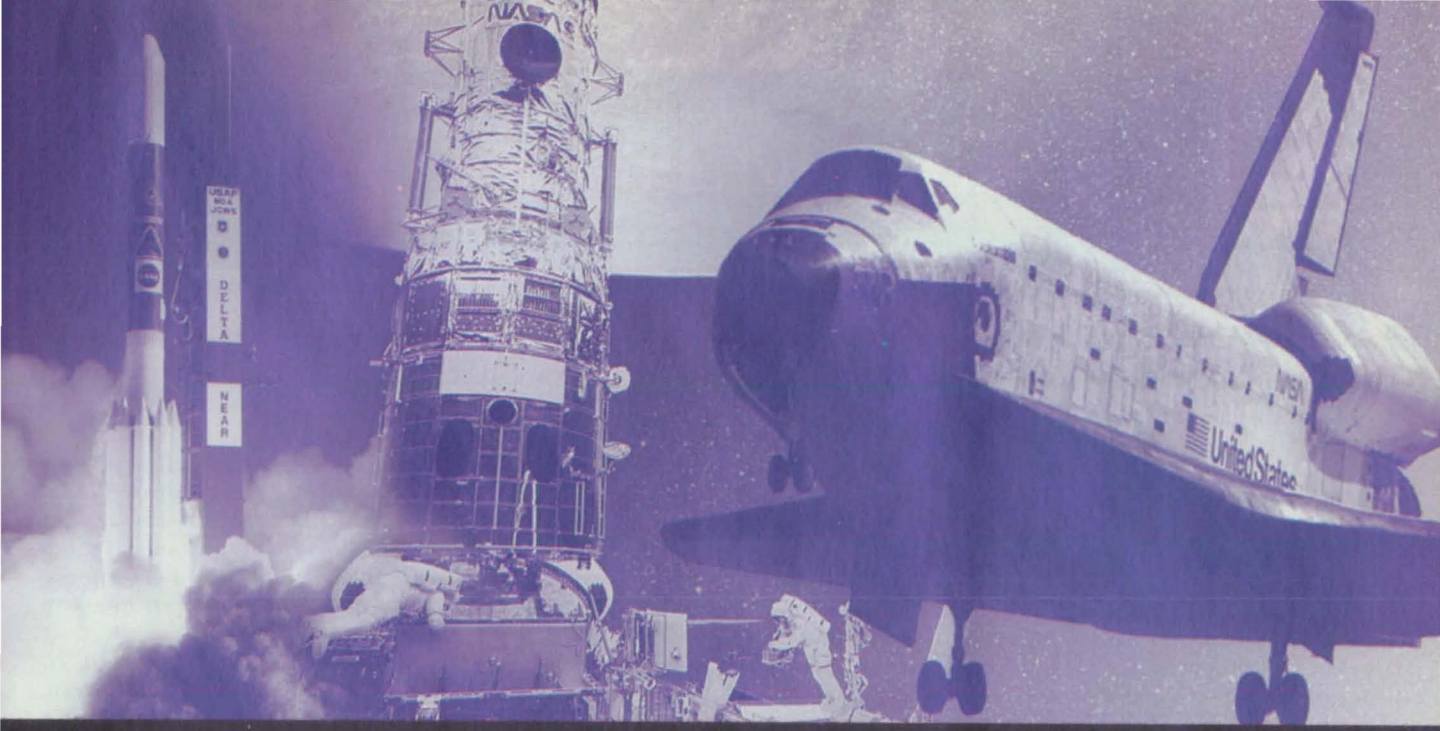
The modification that was finally chosen was one that eliminated chatter while not impairing the ability of the valve to open at the rated differential pressure. The original armature was replaced by a new armature containing an additional counterbore wider than the original counterbore. The new counterbore accepts a spring that has a diameter greater than that of the original spring and that surrounds the original spring. The original spring is retained and is still used to push the pilot down into the valve seat. The new spring pushes the armature down with just enough force to prevent chatter during vibration.

This work was done by Michael W. Henry of Aerospace Design & Fabrication, Inc., for **Lewis Research Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category,* ***or circle no. 185*** *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-16344.



The **Additional Spring in the Modified Valve** pushes the armature down with just enough force to prevent chatter within the axial clearance. This figure presents a simplified view to illustrate the basic principle of the modification; the actual design is somewhat more complex.



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Arc-Burn-Suppression System for Manual Resistance Welding

This monitor system prevents the formation of an arc column during weld operations.

Marshall Space Flight Center, Alabama

A weld-force monitor system is now being used to prevent arcing should there be a loss of contact between a weld electrode and the weldment during the resistance-welding process. Previously, resistance welding involved the manual application of the weld force. Slipping of the weldment during the welding operation often resulted in an arc, which damaged the weldment. Also, in previous welding processes, the achievement of proper welds depended on the skill and endurance of technicians.

The arc-burn-suppression system (see figure) incorporates a pressure transducer, which is mounted behind a low-mass collet assembly in a welding gun, to measure the welding force. A wide-band amplifier drives a welding-trigger circuit and shuts down this circuit within a brief response time when it detects loss of contact.

The signal from the pressure transducer is sent to a wide-band amplifier. This amplifier provides a low-noise, high-gain input signal to a welding-force display unit, which triggers the welding sequence at the required welding force. The shutdown circuit, which is based on an LM311 integrated circuit, compares the incoming voltage from the wide-band amplifier with a reference or threshold voltage representative of the minimum allowable welding force. The shutdown circuit terminates the weld sequence when it detects that the force decreases to less than the minimum allowable welding force.

The originally specified response time of this arc-burn-suppression system was 12 milliseconds. However, the actual response time has proved to be less than 4 milliseconds. The trigger threshold of the shutdown circuit is adjustable to minimize the response time (normally set at 5 percent above the minimum weld force).

This work was done by Francis H. Nguyen, John Geddes, Gene Vanreenen, and Gregg Ffolkes of Boeing North American, Inc., for **Marshall Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing/Fabrication category,* ***or circle no. 123*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*

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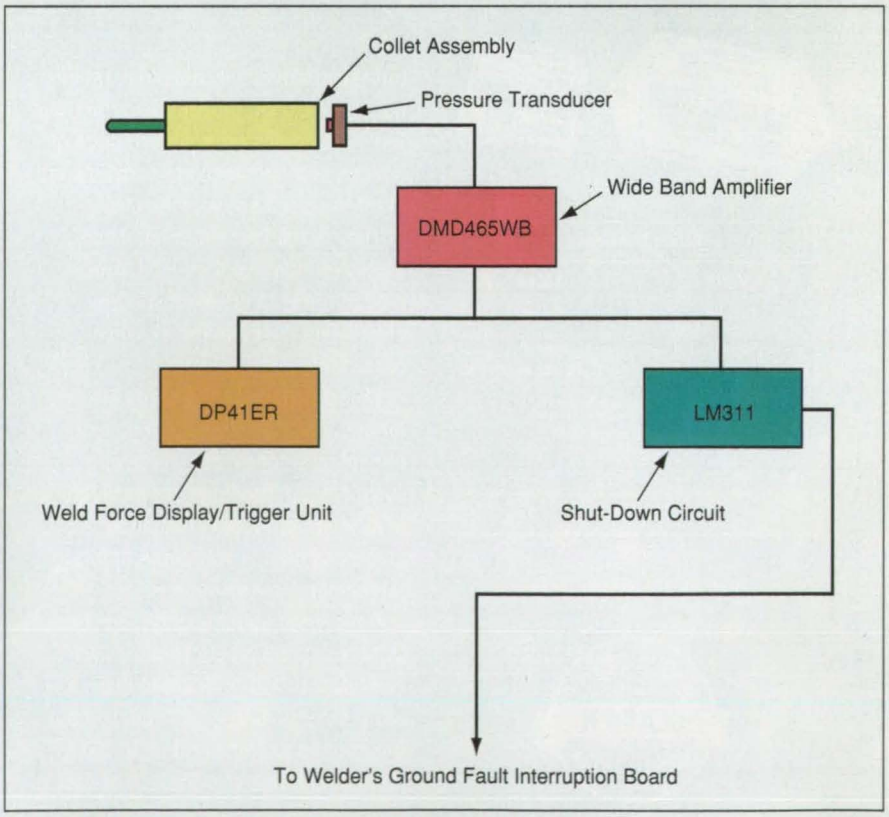

The **Arc-Burn-Suppression System** prevents the formation of an arc column at the tip of a weld electrode during the manual resistance-welding process.

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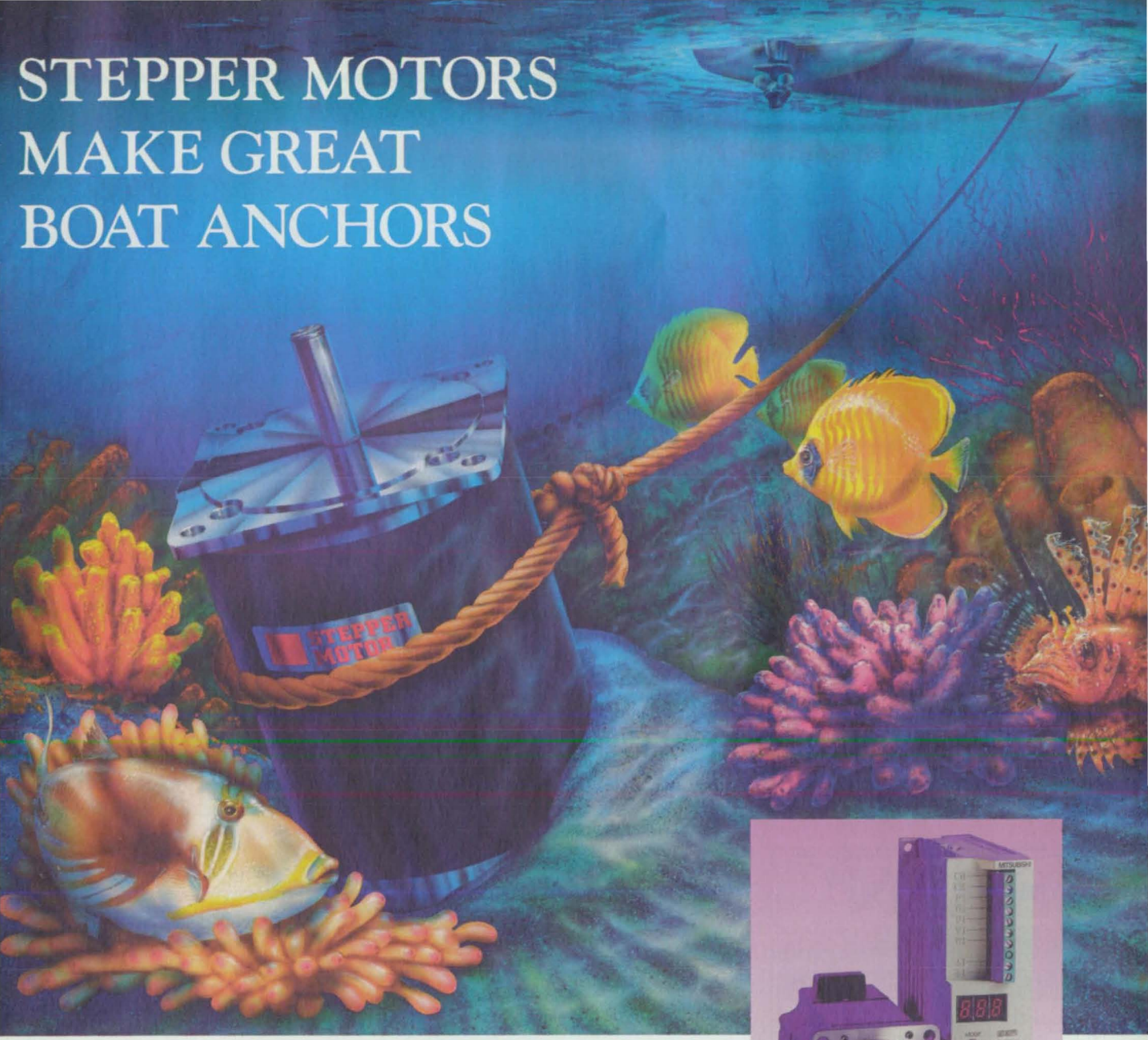

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Forming Waveguide-Cooling Jackets by Extrusion

Fabrication time, cost, and difficulty would be reduced.

NASA's Jet Propulsion Laboratory, Pasadena, California

High-power waveguides with integral cooling jackets would be fabricated by extrusion, according to a proposal. At present, a waveguide with cooling jackets is fabricated by one of two alternative methods (see figure): (1) the waveguide and tubular cooling jackets are fabricated separately, then joined by soldering or brazing; or (2) the waveguide and its cooling jackets are formed in one piece by electrodeposition of metal on wax or aluminum mandrels with the cross sections of the waveguide and cooling jackets, then the mandrels are removed by melting or chemical etching. The first method is difficult, time-consuming, and expensive, and the discontinuities in thermal conductivity at the solder or braze joints in the cooling paths reduce cooling efficiency. In the second method, one obtains a single piece without thermal-conductivity discontinuities, but the second method is even more expensive and time-consuming, and is limited to materials that can be electrodeposited.

Fabrication of a waveguide and cooling jackets in one piece by extrusion would be easier, faster, and less expensive, in comparison with fabrication by the current methods. Like electrodeposition, extrusion would form the waveguide and cooling jackets as one piece, providing continuity of high thermal conductivity along the cooling paths and thus high cooling efficiency.

This work was done by Raul M. Perez 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 Manufacturing/Fabrication 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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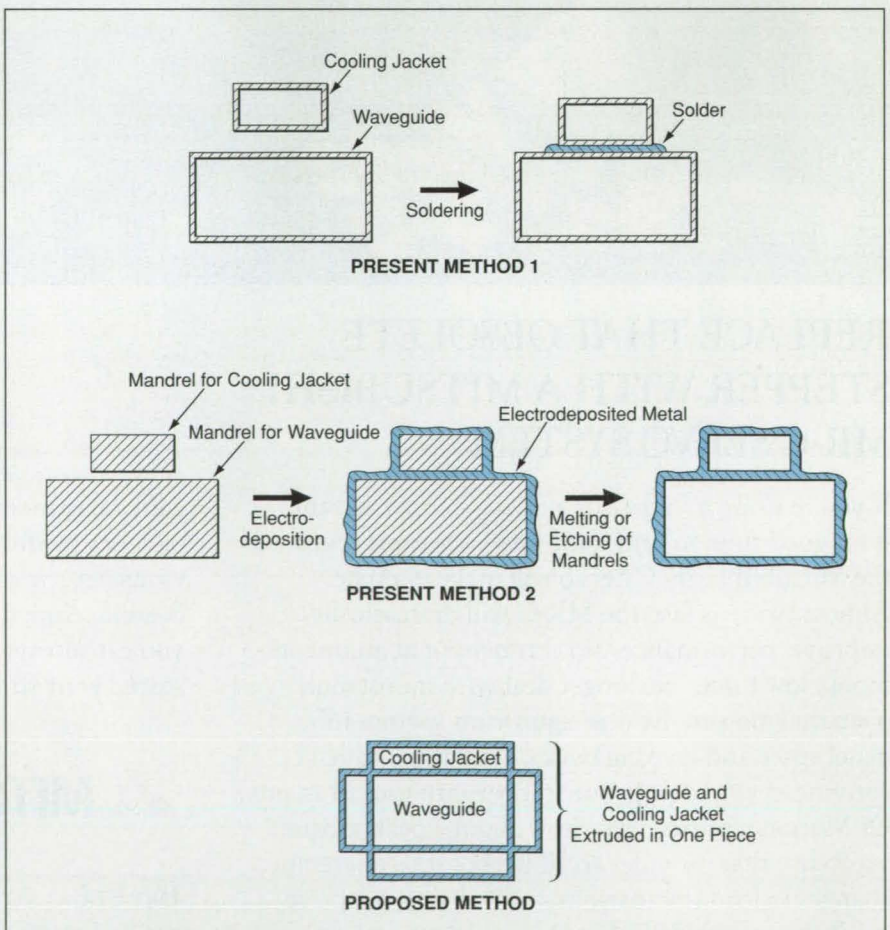


A **Waveguide With Cooling Jackets** would be extruded as a single piece in the proposed method.

Computing Optimal Vibration-Sensor Configurations

Locations of sensors are chosen with the help of optimal full control synthesis.

Dryden Flight Research Center, Edwards, California

Choosing effective sets of sensor measurements is essential for designing controllers to satisfy stringent performance and robustness requirements. Often, control requirements are not anticipated at the design stages in the development of physical systems, and sensor configurations are chosen in an *ad hoc* manner. The choice of locations of vibration sensors for use in controlling or suppressing vibrations in flexible structures is an especially challenging problem because of the large number of vibration modes. Also, it is necessary to trade off (a) the number of sensors needed to observe a large number of closely spaced vibration modes against (b) the weight and cost of additional sensors.

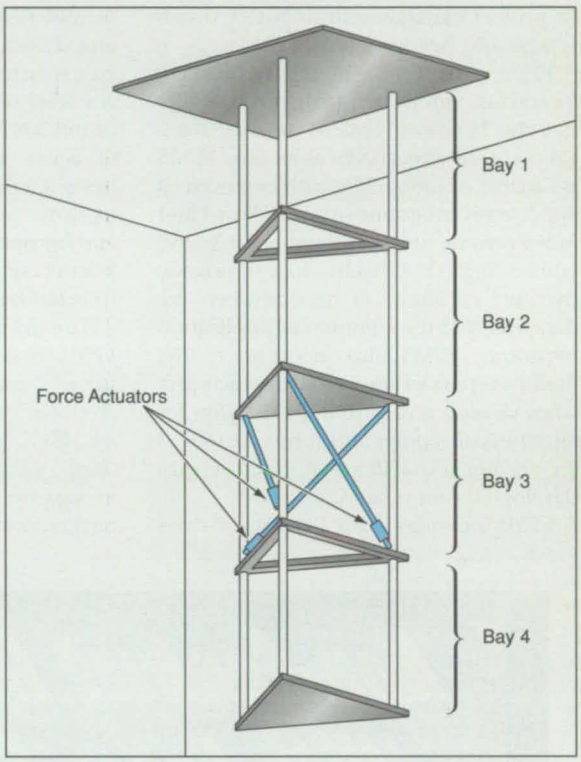
The effectiveness of a sensor configuration can be analyzed by considering closed-loop-performance measures. Typically, in designing a controller, one uses feedback from each of a number of different configurations, seeking the configuration that maximizes these performance measures. A typical measure is the attenuation of vibration-mode responses. The optimal sensor configuration, according to this measure, is the one that maximizes the attenuation.

A method of computing optimal sensor configurations has been formulated by use of a method called "full control synthesis." Full control compensators are the optimal controllers for a given sensor configuration, since each state and error signal can be independently affected. The optimal full control synthesis is derived as a single linear matrix inequality condition, which can be solved by use of standard convex optimization algorithms.

Sensor configurations are chosen with this method by considering a set of feasible configurations. Globally optimal full control compensators are computed for each member of the set to determine the achievable performance level. The configuration associated with the highest performance for a full control compensator is optimal among the members of the set. There is no guarantee that this configuration will also be optimal for output feedback controllers; however, experiments indicate that this method can result in the choice of effective configurations for a physical system.

The method has been used to determine accelerometer configurations for attenuating vibrations in a four-bay flexible aluminum structure at the University of Minnesota (see figure). Force actuators were located along diagonal beams in bay 3, while accelerometers were considered, to be located, alternatively, along the edges of plates in bay 3 or bay 4. The achievable predicted vibration-attenuation performance levels for each configuration with a full control compensator are shown in the table.

Output feedback controllers were implemented for each configuration. Experimental results demonstrated that configurations in which all accelerometers were in either bay 3 or bay 4 were nearly equally effective in attenuating vibrations, in agreement with the table. Also, bay-4 attenuation in the experiments was found to be better when feedback was obtained from bay-4 sensors (either alone or in combination with bay-3 sensors) than when feedback was obtained from bay-3 sensors only; this observation correlates with the predictions in the table.



A Flexible Structure instrumented with force actuators and accelerometers was used to demonstrate the present method of selecting sensor locations to optimize active attenuation of vibrations.

Feedback Accelerometers	Bay-3 Performance	Bay-4 Performance
$3_1, 3_2$	1.378	3.031
$3_1, 3_2, 3_3$	0.299	0.719
$4_1, 4_2$	1.641	3.656
$4_1, 4_2, 4_3$	0.299	0.511
$3_1, 4_1$	3.281	1.312
$3_1, 4_2$	1.641	0.609

Performance Levels, in terms of vibrational-response levels (in g units of acceleration) as they would be measured in bays 3 and 4, were predicted for various accelerometer configurations. Each numerical symbol X_i denotes a sensor on the ith plate edge in bay X.

This work was done by Rick Lind of **Dryden Flight Research Center** *and Gary Balas and Volkan Nalbantoglu of the University of Minnesota. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mathematics and Information Sciences category,* ***or circle no. 187*** *on the TSP Order card in this issue to receive a copy by mail ($5 charge).*

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Facilities Project Management System

This software provides interactive access to accurate, timely information.

John F. Kennedy Space Center, Florida

The Facilities Project Management System (FPMS) computer program implements an automated data-base-management system for planning, budgeting, overseeing, and otherwise managing the construction of facilities under the NASA Facility Program. It provides a flexible data base, adaptable to all levels of project management at NASA installations and headquarters.

FPMS is a server-based, fully networked, interactive application program that utilizes the Microsoft FoxPro database-management software system as its core. FPMS is capable of interacting with commercial application programs (e.g., MS Word and MS Project), using object linking and embedding (OLE) technology to provide dynamic exchange of data between the data base and the commercial application programs. FPMS also incorporates the FoxPro report writer software, which provides viewing and printing capability for all standard reports and forms, as well as an ad hoc capability for end users to develop custom reports.

FPMS operates on a PC 486/33-compatible (or better) server at each NASA center and NASA Headquarters. It can be configured to work with either PC- or Macintosh-compatible workstations or both, and to use several types of networking software. FPMS also provides the functionality for electronic extraction and forwarding of information to accelerate status and financial reporting to headquarters. FPMS incorporates a flexible data-base structure to enable tracking at almost any level of detail desired by each NASA center, and makes possible a high degree of access control. The system can be designed to fit the flow of business information, making it possible to enter and/or update information as it becomes known and to view the information anytime before printing forms.

The primary functions offered on the FPMS main menu are denoted "planning," "management," "contracts," and "reports." Other menu selections denoted "file," "edit," "admin," "tables," and "help" provide maintenance capabilities in support of the primary functions. A navigational button screen has been implemented to assist users in maneuvering between modules. This button screen displays the primary functions needed by most users. Selecting any of the primary menu functions reveals a list of screens applicable to that function. By highlighting any entry in the list, the user can cause the screen thus selected to be displayed. Such functions as "edit," "save," "cancel," and "new" are activated by selecting the corresponding button at the bottom of the screen. A keyboard or mouse can be used to place the cursor on any input field to enter or modify data. Any of the standard reports can be selected from the "reports" menu and viewed on the screen or printed by selecting the print option. An ad hoc reporting capability in the "reports" menu enables users to develop their own reports and save report setups for repetitive use. FPMS utilizes an export capability where users can choose custom data configurations and export the data to spreadsheet, data-base, or text files. A "Data Warehouse" contortion of flat files provides a flatter, simpler view of the data

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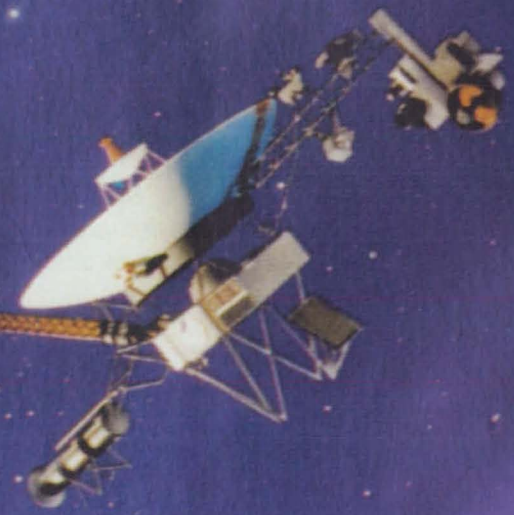

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for ad hoc reporting and data exporting.

During the development of FPMS, it was found necessary to develop new OLE software for integrating the commercial application programs. The word-processing and scheduling documents are stored in the general field of the FPMS data base. Key fields in the word-processing and scheduling documents are dynamically linked with data resident in the data base, so that updating a field automatically results in a corresponding update in any report or screen in which that field appears. FPMS software uses OLE functions to call the commercial application programs to work on the documents stored in the General Field in the data base. Such information as the scheduling date fields is also stored in the data base.

The "general field" data type is also used to support a graphics notepad feature. This feature allows the user to copy images, pictures, charts, and the like, into the FPMS data base for specific reporting functions as well as any ad hoc requirements. The users have the option of copying their own Gantt chart into the specific reporting fields or letting FPMS generate one automatically. The ad hoc graphics notepad field can be used in ad hoc reports or export tasks, as determined by each of the centers. FPMS and the commercial applications are all accessed through selections from the FPMS main menu. Options on the FPMS menu include "start" modules that handle communication with outside application programs. Once the commercial application programs are loaded, the transition from FPMS to those programs is quick and efficient.

An Internet home page has been created to keep the NASA centers up to date with FPMS development. This home page contains a user-comments area, tips and tricks section, and a download-files section, where base tables, release notes, and other documentation are retrieved as files. New FPMS releases are also distributed using the FPMS home page.

This work was done by Patricia F. Hatch of **Kennedy Space Center** *and Dennis Weaver, Patricia N. Daniel, Lawrence A. Geiger Kenneth E. McMillen, Jr., Christina L. Walker, Brian W. Brumfield, Rosa Machado-Wilson, and Robin E. Zachas of I-NET. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mathematics and Information Sciences category,* ***or circle no. 130*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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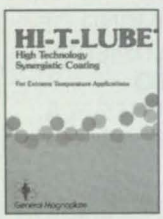

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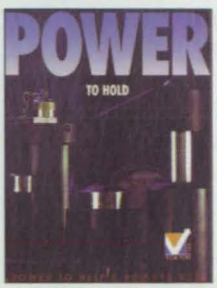

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NEW CAMERA REFERENCE CATALOG

Hitachi Denshi America has released a new catalog featuring its line of video cameras for industrial and scientific use. The catalog includes specifications for color, monochrome, progressive scan, line scan, and digital output cameras. Handy comparison charts are provided to aid in camera selection. Hitachi Denshi America, Ltd., 150 Crossways Park Dr., Woodbury, NY 11797; Tel: 516-921-7200.

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LITERATURE SPOTLIGHT

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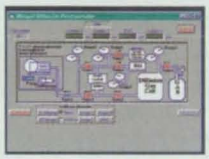

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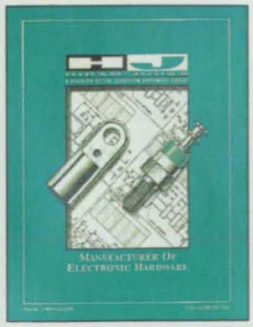

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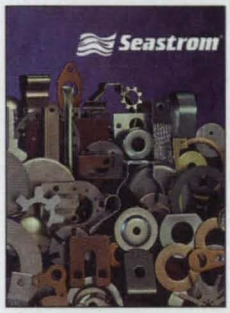

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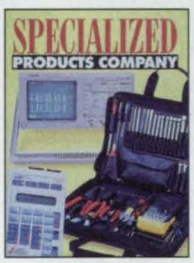

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DLS Sizing of Particles in Hanging Liquid Drops

A report describes an advanced fiber-optic dynamic-light-scattering (DLS) probe and experiments in which the probe was used to measure, noninvasively, the sizes of bovine serum albumin protein molecules and polystyrene latex colloidal particles suspended in small hanging liquid drops. These experiments were performed to verify and demonstrate an emerging capability to use DLS to acquire quantitative information on the nucleation and growth of protein molecules in real time in automated hanging-drop protein-growth apparatuses.

This work was done by Rafat R. Ansari of Case Western Reserve University and Kwang I. Suh of the National Research Council for **Lewis Research Center.** *To obtain a copy of the report, "Sizing of Colloidal Particles and Protein Molecules in a Hanging Fluid Drop," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 111*** *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-16515.

X-Ray-Based Strain Measurements at High Temperatures

A report discusses a method of noncontact extensometry of objects in hot or otherwise hostile environments by use of focusing and scanning of x rays. The method was reported in two previous articles in *NASA Tech Briefs;* "X-Ray Measurements of Displacements in Hostile Environments" (LEW-15905), Vol. 19, No. 6 (June 1995), page 18a and "Progress in X-Ray-Based Displacement and Strain Measurements" (LEW-16001), Vol. 20, No. 10 (October 1996), page 10a.

This work was done by Howard A. Canistraro, Eric H. Jordan, and Douglas M. Pease of the University of Connecticut for **Lewis Research Center.** *To obtain a copy of the report, "High Resolution X-Ray Based Strain Measurements for Hostile Environments," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category,* ***or circle no. 166*** *on the TSP Order Card in this issue to receive a copy by mail ($5 charge).*

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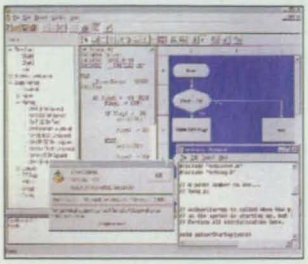
New on Disk



NemaSoft, a subsidiary of Nematron Corp., Ann Arbor, MI, has released OpenControl™ version 4.1 **machine control software** that features a new software developer's toolkit, additional device driver interfaces, Windows NT crash detection, and radio frequency tag support. Other enhancements include bit manipulation of word data types and string manipulation.

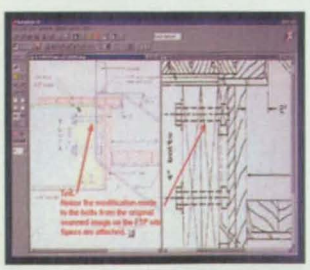
For More Information Circle No. 715

ForReview 3.3 **view and mark-up software** from Allegria Software, Laguna Hills, CA, supports leading CAD systems, file formats, and document management systems. It allows access, review, mark-up, and printing of documents through a heterogeneous computing environment. An optional 3D Solid Model feature provides support for stereolithography file formats.

For More Information Circle No. 716

Materialise, Ann Arbor, MI, offers Magics RP 4.2 **rapid prototyping software** that starts with IGES or STL files and prepares parts for the rapid prototyping machine. For use with Windows 95/NT and Windows NT for DEC Alpha and Silicon Graphics, the program includes repair tools, visualization and measuring tools, and editing, slicing, and nesting features.

For More Information Circle No. 717

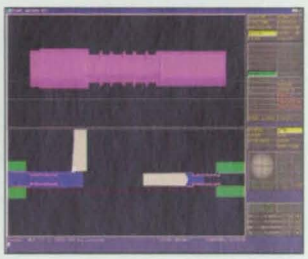


Expert Graphics, Atlanta, GA, has released RxView 97 and RxHighlight 97 **viewing, plotting, and redlining software** for documents, images, and CAD files. Enhancements include 32-bit technology, as well as support for the Internet and AutoCAD R14. Other features include more file filters, enhanced printing, and compatibility with Windows 95/NT/3.1.

For More Information Circle No. 718

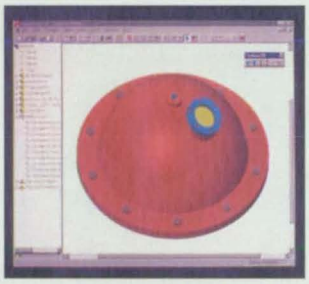
ExpertEASE **manufacturing standards development software** from EASE, Mission Viejo, CA, is a rules-based program for development of manufacturing standards. Users have the option of developing a predetermined path to any piece of standard data existing in the EASE knowledge base.

For More Information Circle No. 719



Version 10 of ESPRIT **CAM software** from DP Technology, Camarillo, CA, was designed for handling 3D machining, advanced milling, and multiple-axis turning operations. Running on Windows NT and HP and Sun UNIX platforms, the software features simultaneous five-axis machining capabilities for multi-surface machining and Z-level machining functionality.

For More Information Circle No. 720



Toolbox/SE version 4.0 for SolidWorks 97 and SolidWorks 97Plus **design automation software** from Cimlogic, Nashua, NH, runs entirely within SolidWorks to automate and streamline frequently used tasks. Enhancements include solid threads for bolts and screws, a groove feature, support for holes and hardware in assemblies, and configuration wizards.

For More Information Circle No. 722

Coreco, St. Laurent, Quebec, Canada, has released DimensionPro **gauging software** for industrial measurement applications. Features include camera calibration, measurement initiated by an external event, image acquisition and enhancement, subpixel accuracy, spreadsheet measurement analysis, and measurement annotation. It runs on Windows 95/NT operating systems.

For More Information Circle No. 721

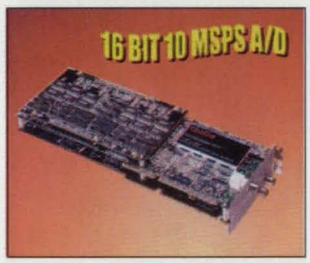
New on the Market

Parker Hannifin Corp., Compumotor Div., Rohnert Park, CA, has introduced the NeoMetric Series of **brushless servo motors** available in 70-mm, 92-mm, and size 34 frame sizes. They feature continuous torque output from 6 to 62 lb-in. and utilize neodymium magnets. Hall effect, 1,000 line encoder, and resolver feedback options are available.

For More Information Circle No. 700

Network Technologies, Aurora, OH, offers the ST-8UX **multi-platform server switch** that enables one user to access a combination of eight PC, Sun, and Macintosh computers. The switch has a find feature to locate attached computers. After the computers are booted without keyboards and mice attached, PC, Sun, or Macintosh devices can be hot-plugged to operate the computers.

For More Information Circle No. 714



The CompuScope 1016 **A/D conversion board** from Gage Applied Sciences, South Burlington, VT, samples at speeds of 10 MSPS while maintaining an 85 dB Spurious Free Dynamic Range. The IBM-compatible, ISA bus card can perform 16-bit A/D conversion on one channel with a bandwidth of 5 MHz. Features include up to eight million samples of on-board memory, a multiple record mode, and free GageScope software.

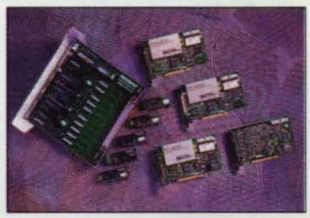
For More Information Circle No. 701

Avcon, Woodland Hills, CA, has released a range of **linear electric motors** with strokes of up to six inches possible on the low end of the range and 16 inches at the upper end. The one-moving-part linear actuators provide force levels in the range of 40 to 2,200 pounds. The motors are available with a controller and power supply unit to plug into a 110 VAC power supply.

For More Information Circle No. 711

3D Systems Corp., Valencia, CA, has announced the SLA-5000 **stereolithography** system for rapid prototyping and tooling. The system features a solid-state ultraviolet laser to produce 0.05 mm layer thickness for many geometries used in detailed parts of computer housings, tooling and castings, and electronic chassis. Windows NT buildstation software is included.

For More Information Circle No. 702



National Instruments, Austin, TX, offers the E Series **PCI data acquisition boards** featuring bus mastering for high throughput across the PCI bus. The PCI-6071E is a 12-bit, 1.25 MS/s multifunction plug-in board with 64 analog input channels and two 12-bit analog output channels; the PCI-6031E, PCI-6032E, and PCI-6033E are 16-bit, 100kS/s plug-in boards with 64, 16, and 64 channels, respectively. All boards feature two 24-bit, 20 MHz counter-timers and eight digital I/O lines.

For More Information Circle No. 706

Eagle Stainless Tube Corp., Franklin, MA, offers a range of miniature to large **precision machined parts** with diameters from 0.040" to 1.5". Threads, slots, external/internal hexes, and tapered parts flat on one side can be machined from stainless steel, aluminum, titanium, Monel®, Inconel®, brass, or plastics.

For More Information Circle No. 708

New on the Market

The PM180, PM280, and PM380 ThermaCAM™ handheld **thermal imaging systems** from Inframetrics, North Billerica, MA, are focal plane array radiometers that include a multi-color isotherm mode, Auto-Spot® measurement mode, an integrated 3" color LCD display, and storage of up to 400 images on a single 80 MB FLASH PCMCIA card. The units weigh 3.7 pounds and operate for more than two hours on a single camcorder battery.

For More Information Circle No. 707

The FW Series **phase monitors** from Crouzet Corp., Carrollton, TX, protect against phase loss, reversal, and imbalance as well as low voltage conditions in three-phase power distribution systems. Features include a 48 mm DIN-rail mount/surface mount enclosure, LED power-on and relay output status indicators, and DPDT-10A output relay.

For More Information Circle No. 709

The GY-2120 DTF™ **digital tape drive** from Sony Electronics, Park Ridge, NJ, is a one-piece unit based on the company's Digital Betacam® technology. Features include Adaptive Lossless Data Compression, automatic alignment, and an intelligent unloading system. The unit has a transfer rate of 12 MB/sec and storage capacity to 42 GB of uncompressed data on a single cassette.

For More Information Circle No. 703

Ferrous component parts from Phillips Plastics Corp., Menomonie, WI, are powder metal molded using Metal Injection Molding (MIM) technology. Parts are produced to finished dimensions and sintered to near theoretical densities. A variety of materials is available, including 316L stainless steel, 17-4 PH stainless, and iron-nickel steels.

For More Information Circle No. 704

A line of mercury-free **motion switches and sensors** is available from Aerodyne Controls Corp., Ronkonkoma, NY. The switches are environmentally or hermetically sealed. Sensitivities are available from fractions of a gram to thousandths of a gram in damped and undamped, momentary, normally open, and normally closed configurations.

For More Information Circle No. 712

Barksdale, Los Angeles, CA, offers the Series 420X **pressure transducers and transmitters** in stainless steel NEMA 4X, 7, 9 explosion-proof housings. The Series 423X is a 5-volt transducer; the Series 426X is a 10-volt transducer; and the Series 425X is a 20 mA transmitter. All operate in process pressure ranges from 0-15 psia and 0-10,000 psig.

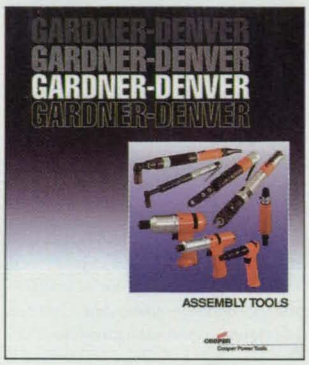
For More Information Circle No. 710

Hewlett-Packard, Palo Alto, CA, has introduced the HP Kayak PC Workstation family of Windows NT-based **PC workstations** featuring system architecture built on the Pentium II 440LX AGPset. Features include HP UltraFLOW, a cooling system that maintains critical components within specified operating temperatures, and HP TopTools DMI management software. The Kayak XA is for compute-intensive applications like CAD; the Kayak XU is for information-intensive applications such as 2D mechanical design; and the Kayak XW is for 3D tasks such as real-time modeling and visualization.

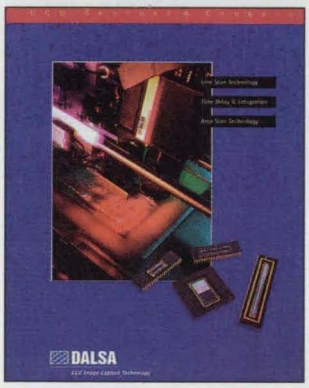
For More Information Circle No. 747

New Literature

Astro-Med, West Warwick, RI, offers a ten-page brochure describing the Dash 8 **field and lab recorder.** The unit records and displays eight channels of real-time data, including voltage, current, temperature, strain, pressure, and motion.
For More Information Circle No. 725



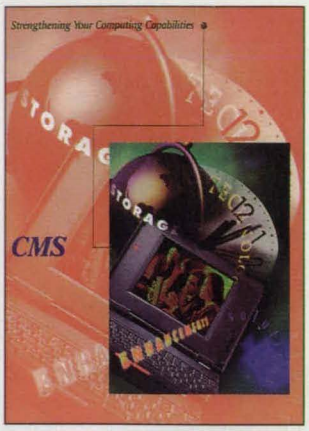
Gardner-Denver **assembly tools** are described in a 72-page catalog from Cooper Power Tools, Lexington, SC. Pulse nutsetters, screwdrivers, nutsetters, ratchet wrenches, instrumented screwdrivers and nutsetters, and fixture mounted screwdrivers are featured.
For More Information Circle No. 732



CCD sensors, scanners, and cameras are described in a brochure from DALSA, Waterloo, Ontario, Canada. Featured is information on line scan technology, area scan technology, and connectivity compatibility.
For More Information Circle No. 726

An eight-page brochure from EAO Switch Corp., Milford, CT, describes **switching products** such as pushbutton, keylock, rotary, and toggle switches. Keypads, flush panel mounting models, and multiple switch assemblies also are featured.
For More Information Circle No. 730

A 30-page brochure describing **DC/DC converters** is available from TDK Corp. of America, Mt. Prospect, IL. Isolated and non-isolated, general-purpose, telecom-specific, and LCD bias converters are among 600 standard models offered.
For More Information Circle No. 728



CMS, Costa Mesa, CA, has released a four-page brochure describing **mass storage products.** Included are Easy-Plug Easy-Go notebook hard drive upgrades, Eclipse CD server towers for networks, and EasyMove data transfer and external hard drive kits for notebooks.
For More Information Circle No. 729

I-Bus, San Diego, CA, offers a 68-page catalog of **computer platform products,** including passive backplane CPU boards, system enclosures, rack mount display products, and fault tolerant platforms. Also described are system component and integration services.
For More Information Circle No. 731

Tinius Olsen Testing Machine, Willow Grove, PA, has released a six-page brochure describing **materials testing equipment** for determining mechanical properties of metals, plastics, composites, and other materials. Universal testing machines, melt indexers, impact testers, and tensile testers are included.
For More Information Circle No. 733

Jensen Tools, Phoenix, AZ, has released its 1997-1998 master catalog of **tool kits and test instruments.** Included are electronics installation and maintenance tool kits, testers, probes, meters, analyzers, function generators, and universal counters.
For More Information Circle No. 727

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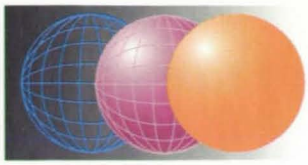

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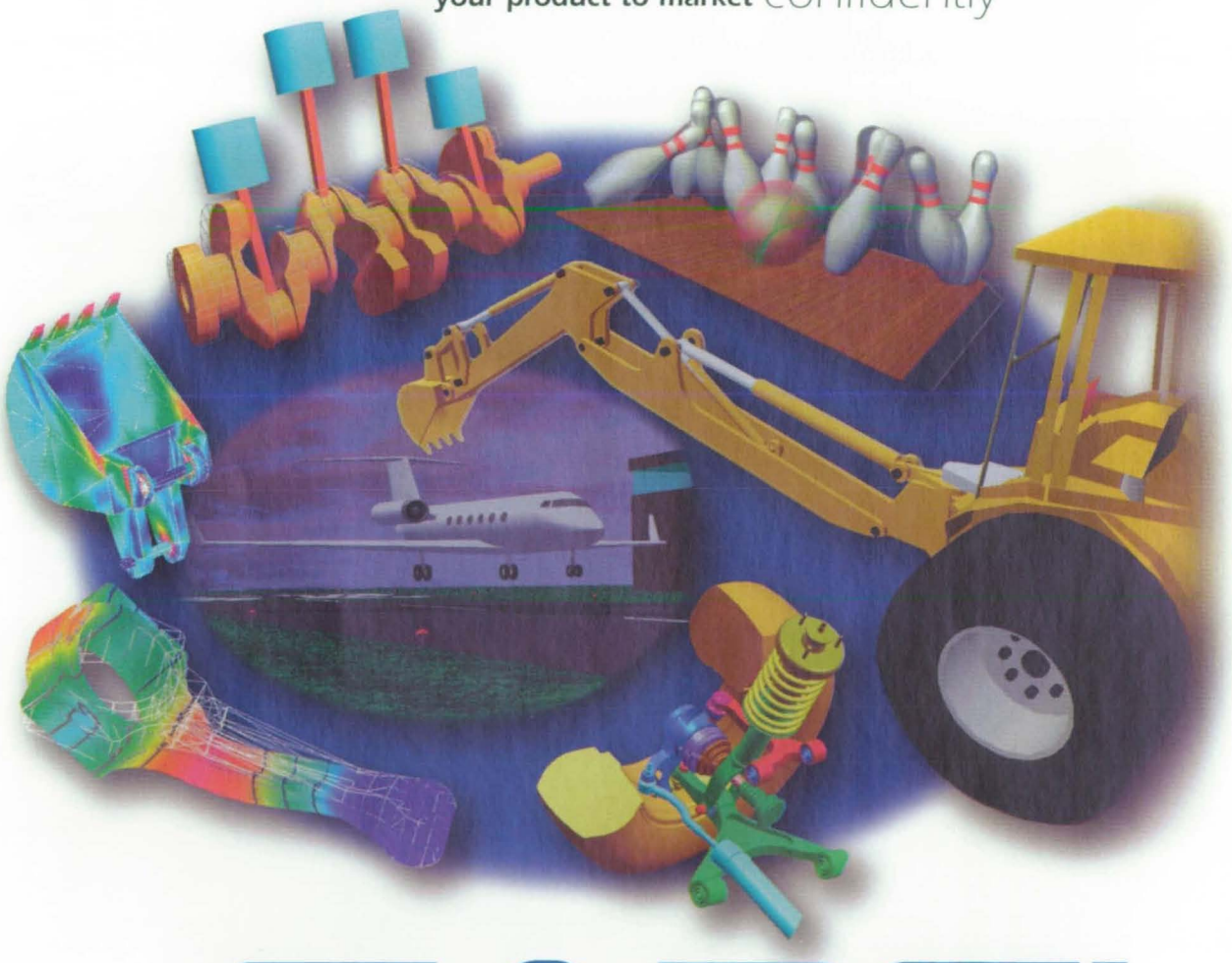

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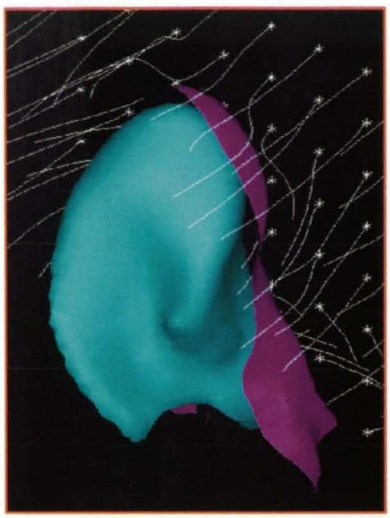

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