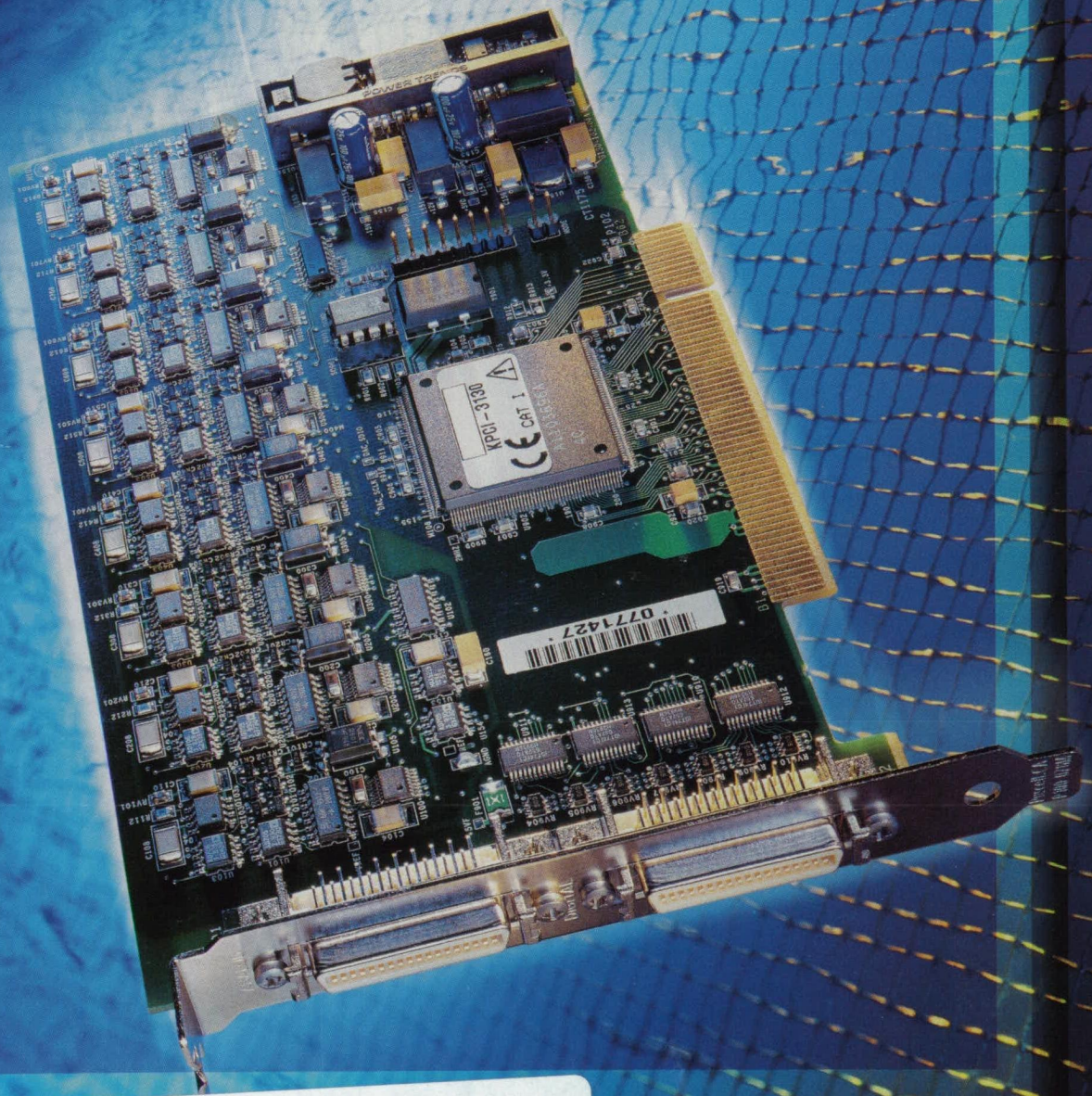
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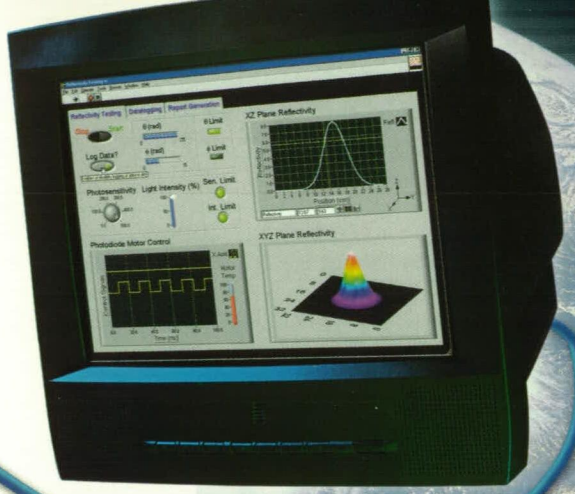
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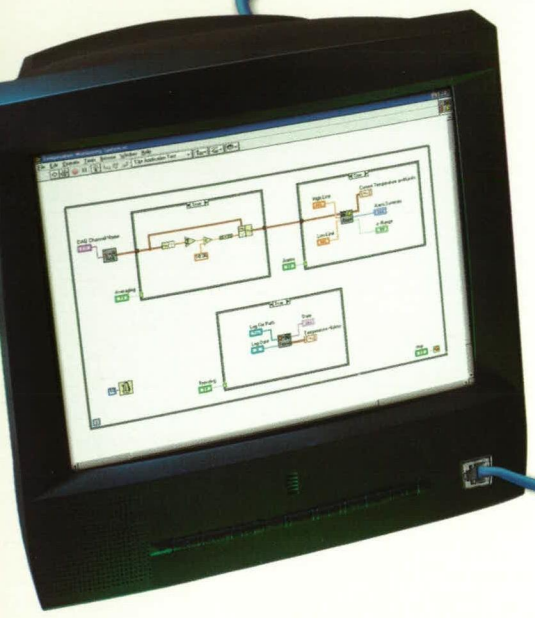


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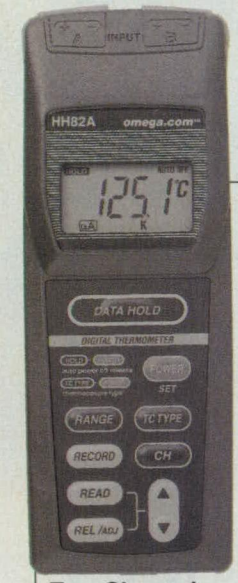
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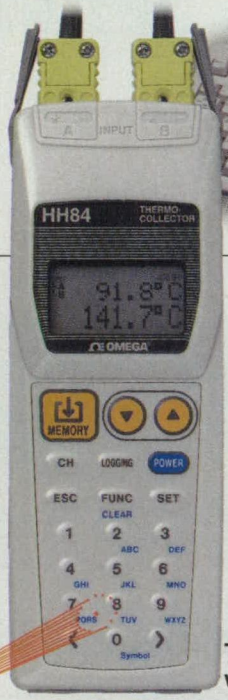
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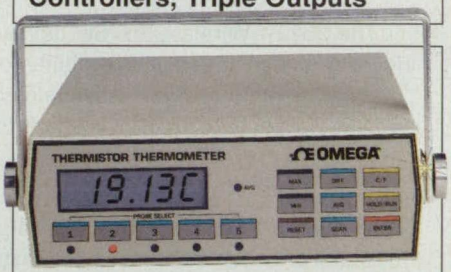
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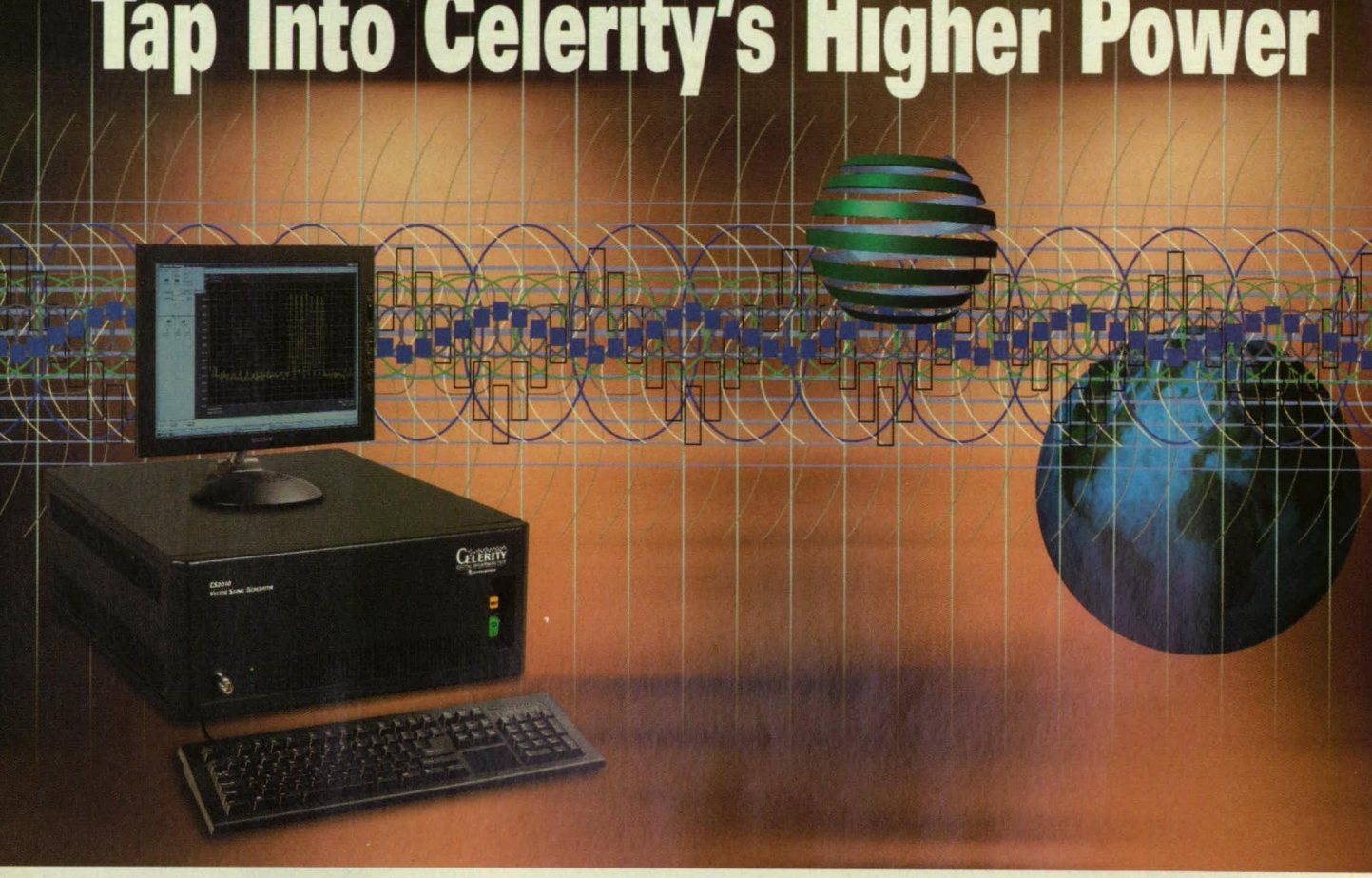
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FEATURES

22 **Application Briefs**

26 **National Design Engineering Show Preview**

66 **Marketing Inventions to Increase Income**

BRIEFS

34 Special Coverage: Computers & Peripherals

34 A Personal-Computer-Based Physiological Training System

36 Reconfigurable Arrays of Transistors for Evolvable Hardware

37 Active Tactile Display Device for Reading by a Blind Person

38 Program Automates Management of IBM VM Computer Systems

38 System for Monitoring the Environment of a Spacecraft Launch

40 Test and Measurement

40 Measurement of Stresses and Strains in Muscles and Tendons

42 Optical Measurement of Temperatures in Muscles and Tendons

43 Small Low-Temperature Thermometer With Nanokelvin Resolution

44 Electronic Components and Systems

44 Heterodyne Interferometer With Phase-Modulated Carrier

46 Rechargeable Batteries Based on Intercalation in Graphite

48 Signal Processor for Doppler Measurements in Icing Research

50 Software

50 Model Optimizes Drying of Wet Sheets

52 Materials

52 High-Performance POSS-Modified Polymeric Composites

52 Model Simulates Semi-Solid Material Processing

54 Modular Cryogenic Insulation

55 Mechanics

55 Passive Venting for Alleviating Helicopter Tail-Boom Loads

56 Computer Program Predicts Rocket Noise

DEPARTMENTS

14 **Commercial Technology Team**

16 **UpFront**

18 **Reader Forum**

20 **Who's Who at NASA**

24 **Commercialization Opportunities**

39 **Special Coverage Products: Computers & Peripherals**

70 **New on the Web**

71 **New on the Market**

72 **New on Disk**

73 **New Literature**

75 **Advertisers Index**

SPECIAL SUPPLEMENTS



1a - 10a
Photonics Tech Briefs

Follows page 24 in selected editions only.



1b - 10b
Motion Control Tech Briefs

Follows page 60 in selected editions only.

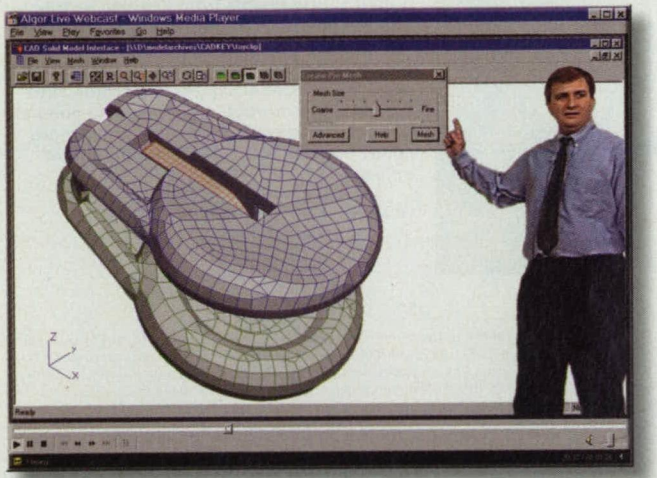
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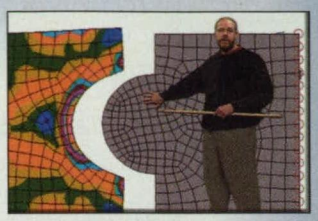
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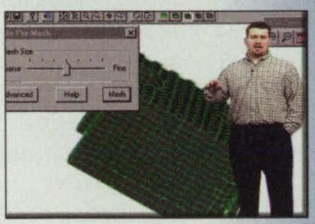
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Contents *continued*

58 Manufacturing/Fabrication

58 Process for Polishing Bare Aluminum to High Optical Quality

60 External Adhesive Pressure-Wall Patch

61 Information Sciences

61 Java Implementation of Information-Sharing Protocol

62 Electronic Bulletin Board Publishes Schedules in Real Time

64 Books and Reports

64 Apparatus Would Extract Water From the Martian Atmosphere

64 Review of Research on Supercritical vs. Subcritical Fluids

64 Hybrid Regenerative Water-Recycling System

65 Study of Fusion-Driven Plasma Thruster With Magnetic Nozzle

65 Liquid/Vapor-Hydrazine Thruster Would Produce Small Impulses

65 Thruster Based on Sublimation of Solid Hydrazine

PRODUCT OF THE MONTH

The OM-DL portable data loggers from OMEGA Engineering, Stamford, CT, connect to a PC's parallel port and can store more than 8,000 readings.

16



ON THE COVER



The KPCI-3130 Series of universal analog output source boards from Keithley Instruments, Cleveland, OH (www.keithley.com), is designed for applications requiring analog output and digital I/O control. The PCI boards are used by OEM designers in machine automation, servo control, programmable voltage sources, and simulation testing. Learn more about these boards in New on the Market on page 71.

(Image courtesy of Keithley Instruments)

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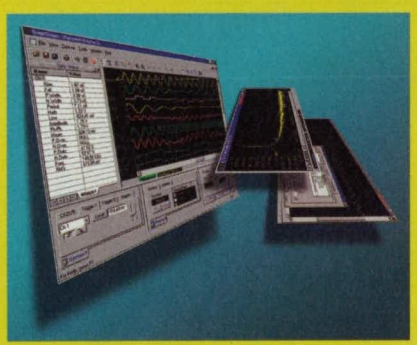
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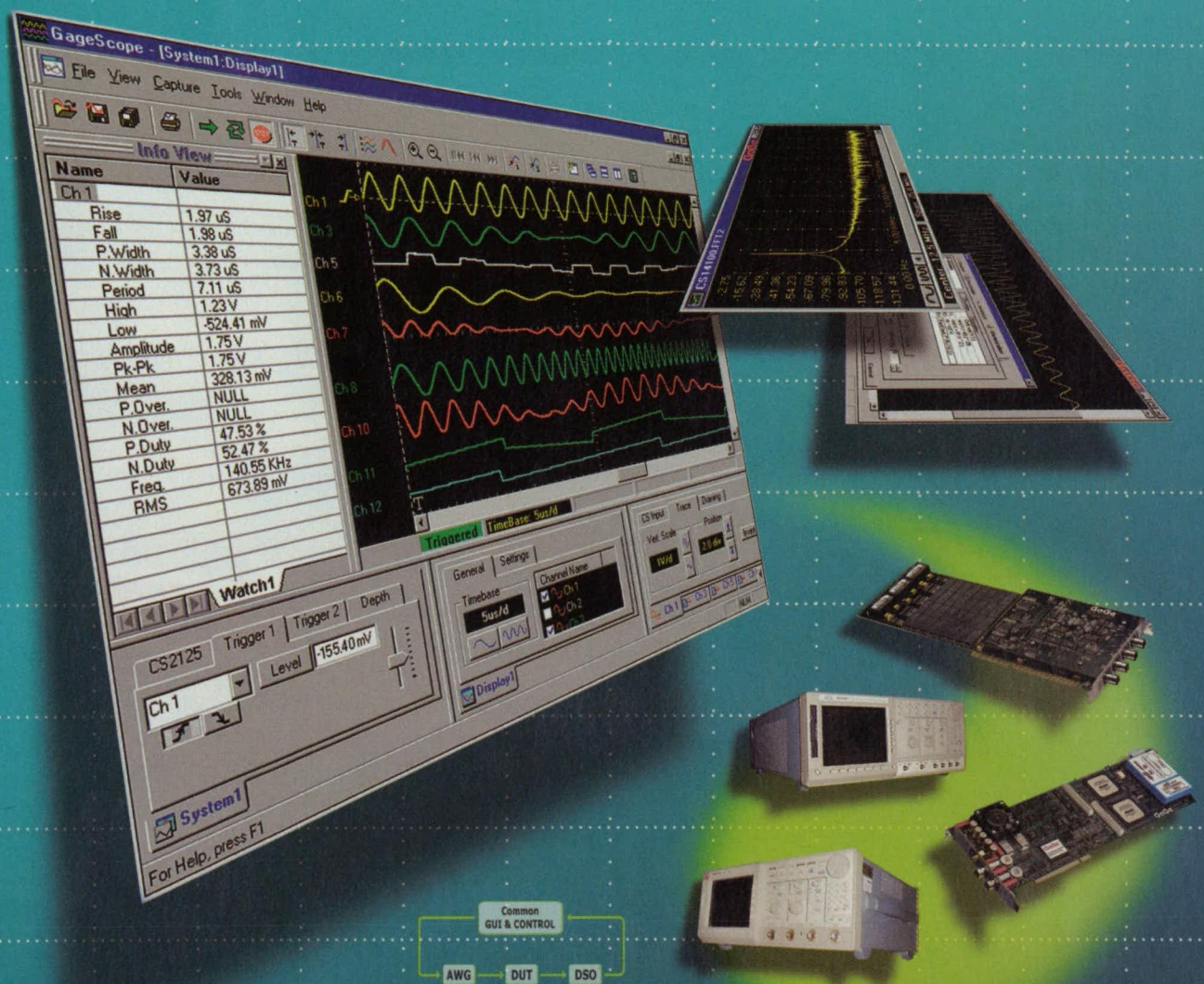
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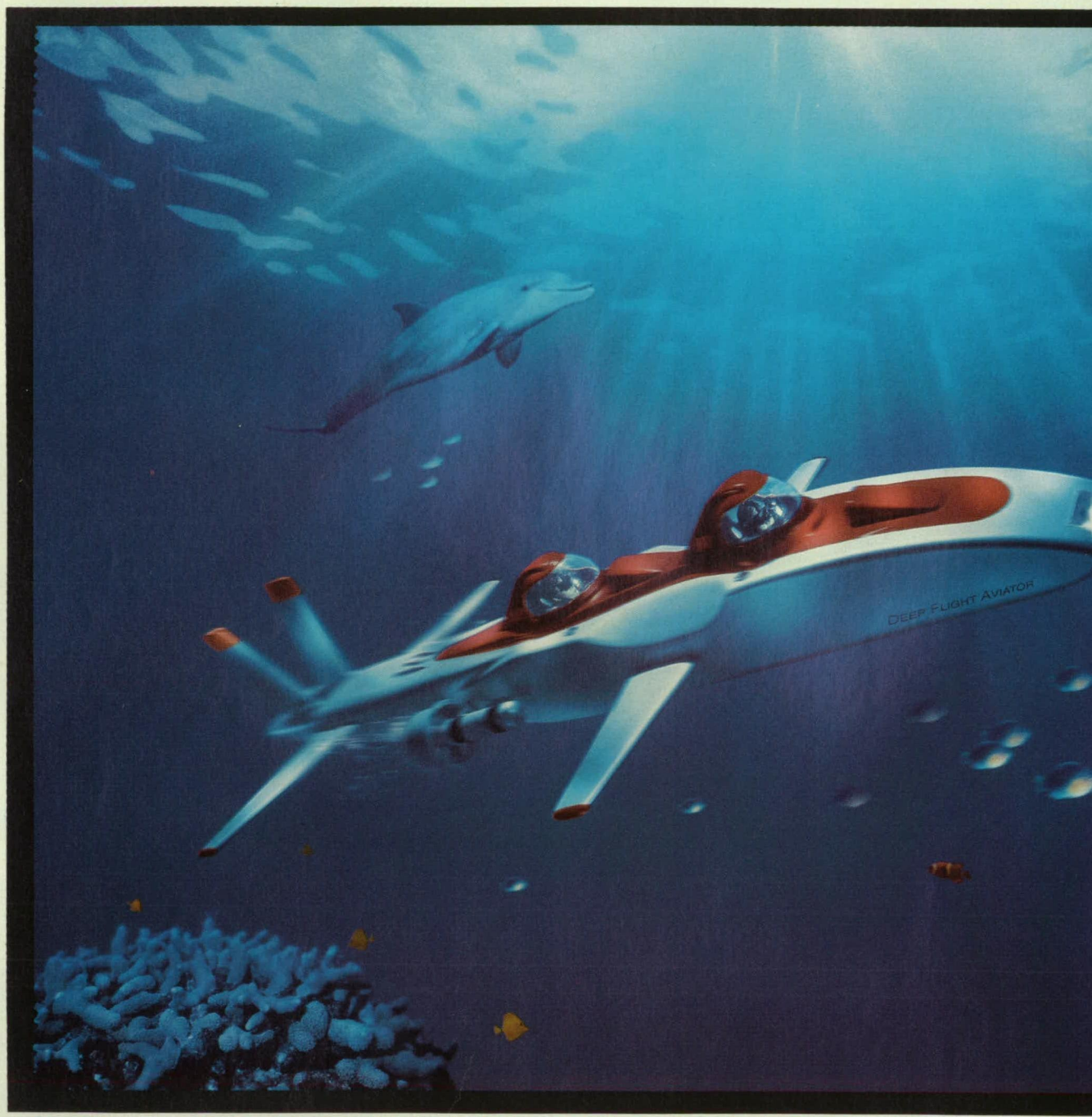
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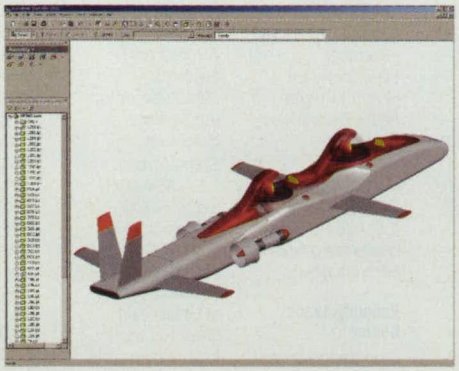
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These organizations were established to provide rapid access to NASA and other federal R&D and foster collaboration between public and private sector organizations. They also can direct you to the appropriate point of contact within the Federal Laboratory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

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

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

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

J. Ronald Thornton
Southern Technology Applications Center
University of Florida
(352) 294-7822

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

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

Chris Coburn
Great Lakes Industrial Technology Transfer Center
Battelle Memorial Institute
(440) 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 Commercial Technology (Code RW)
(202) 358-2320 morwood@mail.hq.nasa.gov

John Mankins
Office of Space Flight (Code MP)
(202) 358-4659 jmankins@mail.hq.nasa.gov

Terry Hertz
Office of Aero-Space Technology (Code RS)
(202) 358-4636 thertz@mail.hq.nasa.gov

Glen Mucklow
Office of Space Sciences (Code SM)
(202) 358-2235 gmucklow@mail.hq.nasa.gov

Roger Crouch
Office of Microgravity Science Applications (Code U)
(202) 358-0689 rcrouch@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.

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

B. Greg Hinkebein
Mississippi Enterprise for Technology
Stennis Space Center, MS (800) 746-4699

Julie Holland
NASA Commercialization Center
Pomona, CA (909) 869-4477

Bridgette Smalley
UH-NASA Technology Commercialization Incubator
Houston, TX (713) 743-9155

John Fini
Goddard Space Flight Center Incubator
Baltimore, MD (410) 327-9150 x1034

Thomas G. Rainey
NASA KSC Business Incubation Center
Titusville, FL (407) 383-5200

Joanne W. Randolph
BizTech
Huntsville, AL (256) 704-6000

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

Marty Kaszubowski
Hampton Roads Technology Incubator (Langley Research Center)
Hampton, VA (757) 865-2140

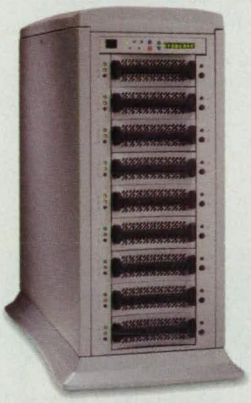
If you are interested in information, applications, and services relating to satellite and aerial data for Earth resources, contact: Dr. Stan Morain, **Earth Analysis Center,** (505) 277-3622.



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For More Information Circle No. 532

UpFront

PRODUCT OF THE MONTH



OMEGA Engineering, Stamford, CT, has introduced the OM-DL Series of portable dataloggers that measure and record temperature, relative humidity, 4 to 20mA AC voltage, AC current, voltage event, light event, and sound event. The tamperproof units can store more than 8,000 readings, and are connected to a PC's parallel printer point. Available Windows software sets up the parameters for a recording session. Once the logger is set up, it can be disconnected and taken into the field to record data. When recording is complete, it can be reconnected to a PC for data download. The dataloggers feature a selectable recording interval from 5 seconds to 60 minutes, and operate in temperatures from -40 to 76°C.

For More Information Circle No. 730

Computing Consortium Formed

NASA and Carnegie Mellon University have announced the formation of the High Dependability Computing Consortium (HDCC), which is designed to eliminate failures in computing systems critical to the welfare of society.



The consortium includes 12 information technology companies: Adobe Systems, Compaq Computer, Hewlett-Packard, IBM, ILOG, Marimba, Microsoft, Novell, SGI, Siebel Systems, Sybase, and Sun Microsystems. The companies will promote and conduct research on developing affordable software systems.

Improved computing capability is critical to areas such as the nation's air traffic control system, Internet communication, power generation, space exploration, health care, and highway safety. Dependable computer systems also are necessary to ensure that the software created for space missions, defense, health care, e-commerce, and other systems affecting human safety or well-being functions properly.

"Carnegie Mellon's expertise in robotics has played a major role in the success of numerous NASA research projects," said Dr. Henry McDonald, director of NASA's Ames Research Center, Moffett Field, CA. "We look forward to working with the university and our industry partners to advance NASA's computing capabilities for future research projects."

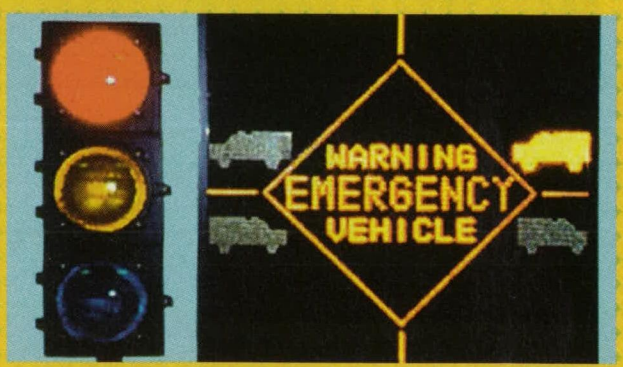
For more information, visit the NASA Ames web site at www.arc.nasa.gov.

NASA Technology Tested on California Roads

The City Council of Monrovia, CA, is implementing an Emergency Vehicle Intersection Early Warning System at eight intersections that will alert drivers to approaching emergency vehicles to reduce the potential for traffic collisions. The system — manufactured by E-Views and developed with NASA's Jet Propulsion Laboratory's (JPL) Technology Affiliates Program in Pasadena, CA — involves the installation of transponders in 20 police and ten fire vehicles, and the installation of visual display boards on traffic signal mastarms above the intersections.

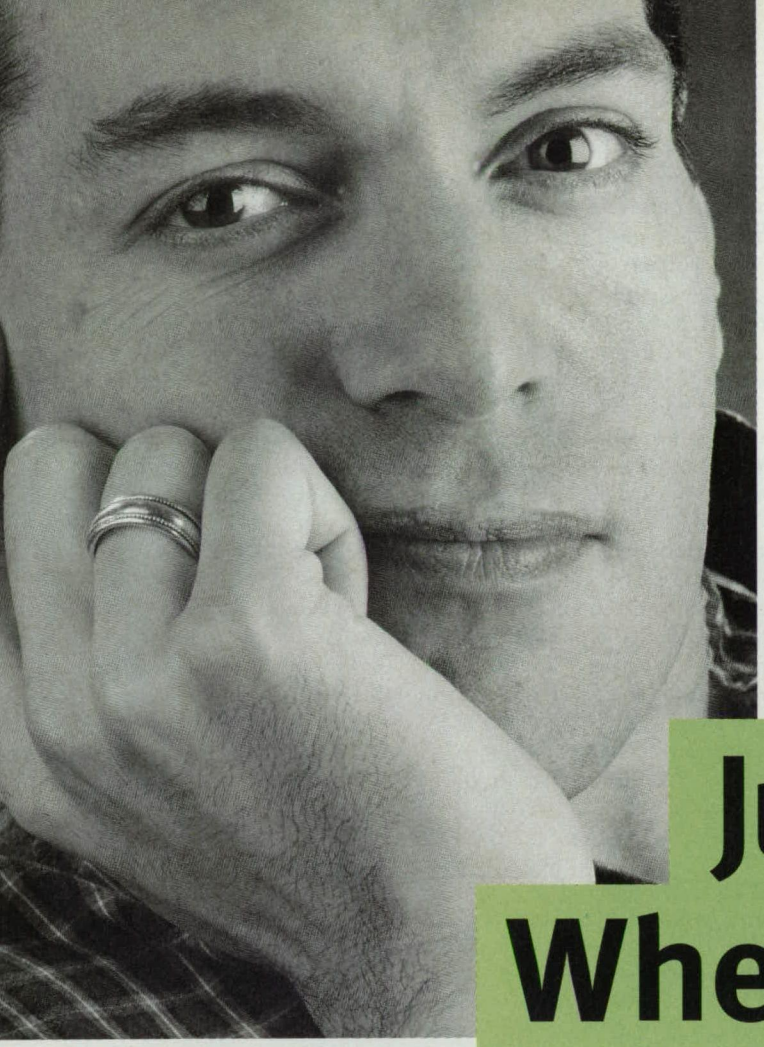
The transponders communicate via microwave with receivers on the display boards. As the emergency vehicle approaches, the police officer or firefighter activates the transponder, which automatically turns the traffic light yellow, then red, for cross-traffic. Approaching drivers will see bright, flashing vehicle warning symbols (see photo) telling them from which direction the emergency traffic is coming.

E-Views engineers paired with JPL engineers with specialized expertise to solve engineering design issues, including customized transponders and comprehensive designs that blend with existing city communications infrastructures.



Monrovia Chief of Police Joe Santoro said that more than 156,000 accidents involving emergency vehicles occurred at intersections in the US from the early 1980s to 1995, resulting in 6,550 deaths. About 40% of the firefighters killed in the line of duty die in accidents on the way to a fire call. Santoro believes that the system could help reduce the number of fatalities.

For more information, visit the NASA JPL web site at www.jpl.nasa.gov.



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For More Information Circle No. 566

Reader Forum

Reader Forum is dedicated to the thoughts, concerns, questions, and comments of our readers. If you have a comment, a question regarding a technical problem, or an answer to a previously published question, post your letter to Reader Forum on-line at **www.nasatech.com,** or send to: Editor, *NASA Tech Briefs*, 317 Madison Ave., New York, NY 10017; Fax: 212-986-7864. Please include your name, company (if applicable), address, and e-mail address or phone number.

I'm writing in response to a letter from Mohammed Haseeb in the November 2000 Reader Forum. Mr. Haseeb was looking for information on inflatable antennas. NASA's Langley Research Center in Hampton, VA, has developed a family of colorless polyimide materials used for space applications including inflatable antennas. This technology has been licensed to SRS Technologies of Huntsville, AL (www.stg.srs.com). For additional information, visit the Success Stories area of NASA's TechTracs web site at http://technology.nasa.gov or contact me directly.

Greg Manuel
NASA Langley
g.s.manuel@larc.nasa.gov

On behalf of the Rehabilitation Engineering Research Center on Technology Transfer (T^2RERC), we wish to thank *NASA Tech Briefs* for its contributions to the field of assistive technology for people with disabilities. You generously published summaries of problem statements representing the highest priority needs of the wheeled mobility industry in the Reader Forum last year. In response, we have received highly promising submissions from your readers for each of the problem statements. Leading wheelchair and scooter manufacturers are currently considering these submissions for transfer. *NASA Tech Briefs* is clearly demonstrating its effective outreach to scientists and technologists, and its genuine interest in transferring advanced technologies to areas of national need. We are grateful for your critical role in accomplishing our mission.

Joseph P. Lane, Director
Dr. Stephen M. Bauer, Co-Director
T^2RERC
http://wings.buffalo.edu/ot/cat

I'm looking for the company or companies that manufacture the heat shielding materials used on the Space Shuttle orbiter. I am trying to manufacture a new series of human protective tents used by the US Forest Service and national parks fire crews in the US and Canada. I've heard that the shuttle material is light, durable, and can sustain very high temperatures. My design needs to be able to protect human life for at least 15 minutes at temperatures reaching up to 3000°F. The weight should be no more than 12 pounds.

Richard Morris
morris@cyberport.com

***(Editor's Note:** Richard, information on the Space Shuttle's Thermal Protection System (TPS) material can be found at NASA Kennedy Space Center's shuttle web site at www.ksc.nasa.gov/shuttle/technology.)*

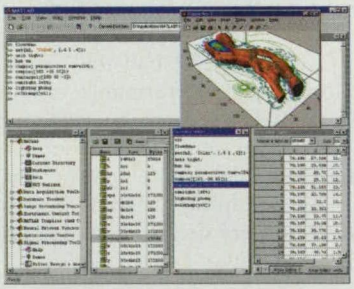


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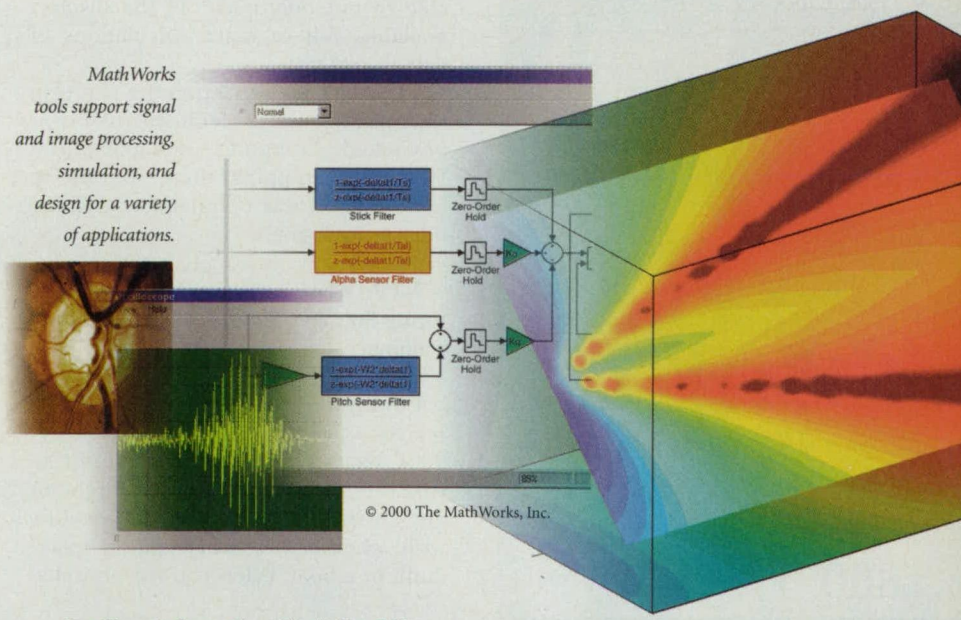
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Who's Who at NASA

Patricia Cowings, Psychologist, NASA Ames Research Center



Patricia Cowings is a psychologist working on the Autogenic Clinical/Lab System (ACLS) and Autogenic-Feedback Training Exercise (AFTE) at NASA's Ames Research Center in Moffett Field, CA. (A detailed description of the ACLS is provided in the tech brief on page 34 of this issue.)

***NASA Tech Briefs:* What are the ACLS and AFTE, and where did they originate?**

Patricia Cowings: The Autogenic Clinical/Lab System (ACLS) is a computer-based instrumentation system for physiological training. It is used to implement physiological conditioning known as Autogenic-Feedback Training Exercise (ATFE). The objective of both is to develop countermeasures to minimize the effects of microgravity on the human body. We're attempting to use ATFE to eliminate or reduce space motion sickness and dizziness when astronauts return to gravity.

Back in the very beginning, our work was a way for people to control multiple physiological responses. We first had instruments built in-house to show us heart rates and beats per minute. As the experiments grew in complexity, the equipment grew in complexity. And then Windows 95 came into the world and changed the way we do our experiments for the better. We needed a true multi-tasking operating system to be able to not only make all the displays available, but to make calculations of data in real time.

We ended up with a training platform that allows us to teach 20 different physiological responses simultaneously. We're not stopping there, but we've found that it was optimal for reaching our research goals.

NTB: What is the Ambulatory Monitoring Suit and how does it fit into your training?

Cowings: The Ambulatory Monitoring Suit (see *NASA Tech Briefs*, January 2001, page 48) allows us to monitor astronauts throughout a space flight or any environment the subject is dealing with, whether it is an aircraft, a spacecraft, or a boat. It lets you see what that environment is doing to that person. And, it helps us tailor our training to help those people contend with their environment. We've concluded that people don't need to wear the suit forever and that after about six hours of training, they understand their own responses enough to correct them themselves. The self-contained, battery-operated suit contains sensors that continuously monitor, display, and record up to nine channels of physiological data for up to 12 hours.

NTB: What type of real-world applications can this suit be used for?

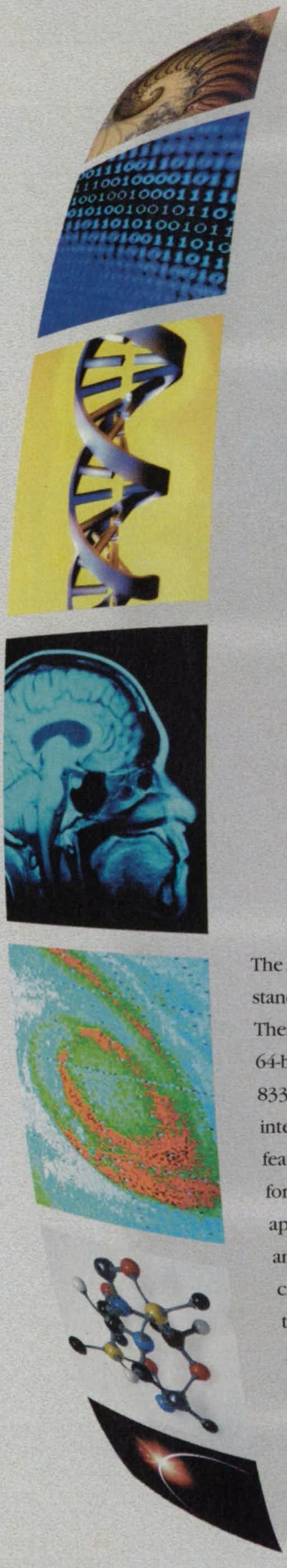
Cowings: We've had this garment on pilots in high-performance aircraft and we've helped them to recognize responses that were washing them out during flights. So, we helped the Air Force set up a training program to return pilots who were dealing with this problem to active duty.

NTB: Has your training been used in any other areas?

Cowings: We were approached by doctors while visiting the Mayo Clinic. They asked us if this kind of training would work in a damaged nervous system. So, we presented our research to doctors working with a group of patients who suffer from disturbances in the autonomic nervous system. One example is chronic intestinal pseudo-obstruction syndrome. It means that you act like you've got a tumor in your abdomen, but you don't have an abdomen. And when they look at your abdomen, it clamps down like someone is squeezing it with a fist.

The way the training has been constructed, the doctors at the clinic have been able to help people significantly improve their reactions and responses to these systems. They're now running the program with subjects ranging in age from 9 to 70. It's very encouraging that this type of training and this type of technology can work in a damaged nervous system, and it expands the potential applications of it.

A full transcript of this interview appears online at ***www.nasatech.com****. Ms. Cowings can be reached at pcowings@mail.arc.nasa.gov.*





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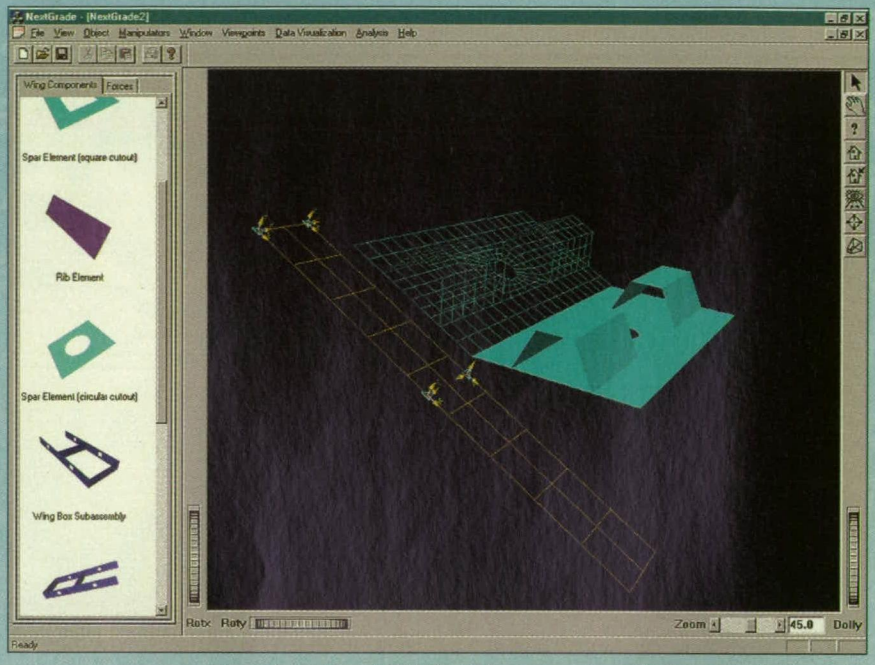
Api NetWorks

Do the math.

For More Information Circle No. 563

New User Interface for NASA System Simulation

AP 209 data translator
STEP Tools
Troy, NY
518-687-2848
www.steptools.com



STEP Tools, working in cooperation with Applied Research Associates (ARA) of Albuquerque, NM, is developing data translators for NASA's NextGRADE Prototype Graphical User Interface. The NextGRADE GUI is a Windows-based environment for rapid modeling, assembly, and analysis of intelligent component models for system simulation. The work is in support of NASA's Intelligent Synthesis Environment (ISE) Initiative.

When fully developed, ISE will enable geographically dispersed teams of engineers and scientists to collaborate in a full sensory, immersive, virtual environment in which humans and computers can interact through 3-dimensional sight, sound, and touch in a mission life-cycle simulation. ISE will allow NASA to develop and operate missions in a virtual space before a piece of actual hardware is cut.

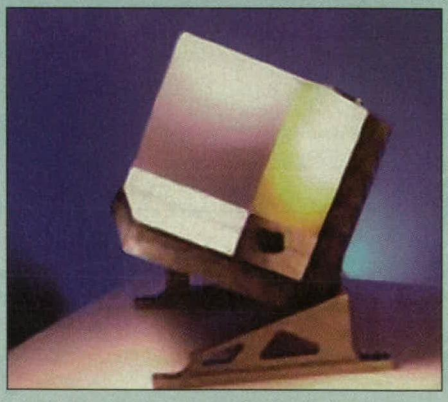
STEP is implementing an AP 209 data translator that must be able to import 3D model data as well as analysis results data from the STEP file. The company will first develop a specification for the mappings between the NextGRADE data structures and the STEP AP 209 entity types. STEP will execute the mapping process and deliver source code for a bi-directional STEP AP 209-to-NextGRADE translator. Using sample files from NASA, STEP will work with ARA to test the data translator in all scenarios.

For More Information Circle No. 751

Optical Instruments Will Help See Troposphere

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NASA's Jet Propulsion Laboratory (JPL) in Pasadena, CA, is scheduled to launch into polar orbit the Tropospheric Emission Spectrometer (TES) in 2002. TES will view Earth's troposphere and obtain data on tropospheric ozone and other gas molecules that lead to ozone formation. TES is a high-resolution infrared imaging FTIR spectrometer that will be launched aboard NASA's Earth Science Enterprise EOS Aura spacecraft. The Earth Science Enterprise (formerly called Mission to Planet Earth) is a series of satellite missions that will examine the Earth's environment and how it is changing. The data collected by TES will be used to create a three-dimensional model depicting tropospheric chemistry, troposphere-biosphere interactions, and troposphere-stratosphere exchanges.



JPL chose PLX to build the principal optical interferometer mirror assemblies for TES. The self-compensating mirrors are insensitive to position and movement. Parallel incident light that hits the retroreflector is returned to the light source, regardless of the instrument's physical orientation.

The instruments include back-to-back hollow retroreflector assemblies, hollow roof mirror assemblies, and various folding mirrors, all made of beryllium. The hollow, monolithic optical structures provide accuracy better than 1 arc second maximum deviation and lambda/20 surface flatness. They also operate without distortion at cryogenic temperatures down to -100°C.

For More Information Circle No. 750

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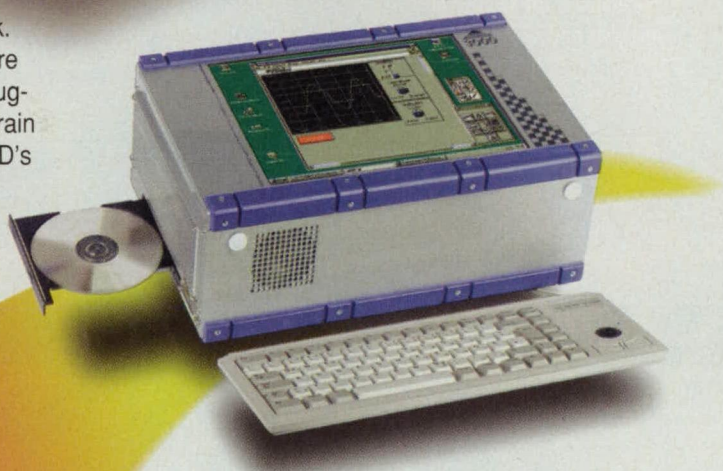
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For More Information Circle No. 534

Commercialization Opportunities

A Personal-Computer-Based Physiological Training System

Instead of using dedicated instrumentation, this system is based on digital processing of physiological and other data on a PC, a less costly, more flexible, and more compact alternative, which can be easily customized through changes in software.
(See page 34.)

Active Tactile Display Device for Reading by a Blind Person

Under computer control, reading pins would be lowered individually or in groups to present the highs and lows according to the information one wants to convey to a blind person. The blind person would sense this information via fingertips as in Braille.
(See page 37.)

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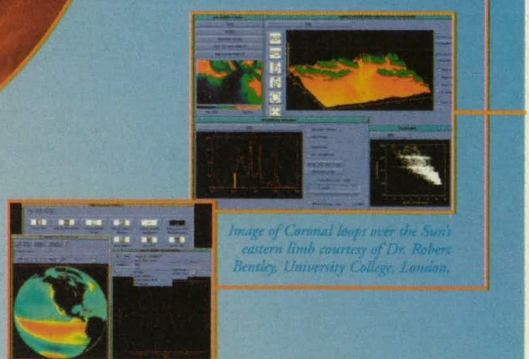


Image of Coronal loops over the Sun's eastern limb courtesy of Dr. Robert Bentley, University College, London.

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(See page 43.)

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(See page 44.)

Signal Processor for Doppler Measurements in Icing Research

An advanced signal processor performs high-resolution measurements in real time, enabling ground-breaking research in icing of airplanes and combustion of liquid fuels.
(See page 48.)

High-Performance POSS-Modified Polymeric Composites

These formulations are expected to be useful as high-performance matrix resins for advanced fiber/matrix composite materials for diverse applications that could include spacecraft structures, prosthetics, sporting goods, and general consumer goods.
(See page 52.)

Modular Cryogenic Insulation

This insulating chaff features long life and low density as opposed to low-density powders. Some of the latter tend to settle over time, reducing the effectiveness of the insulation.
(See page 54.)

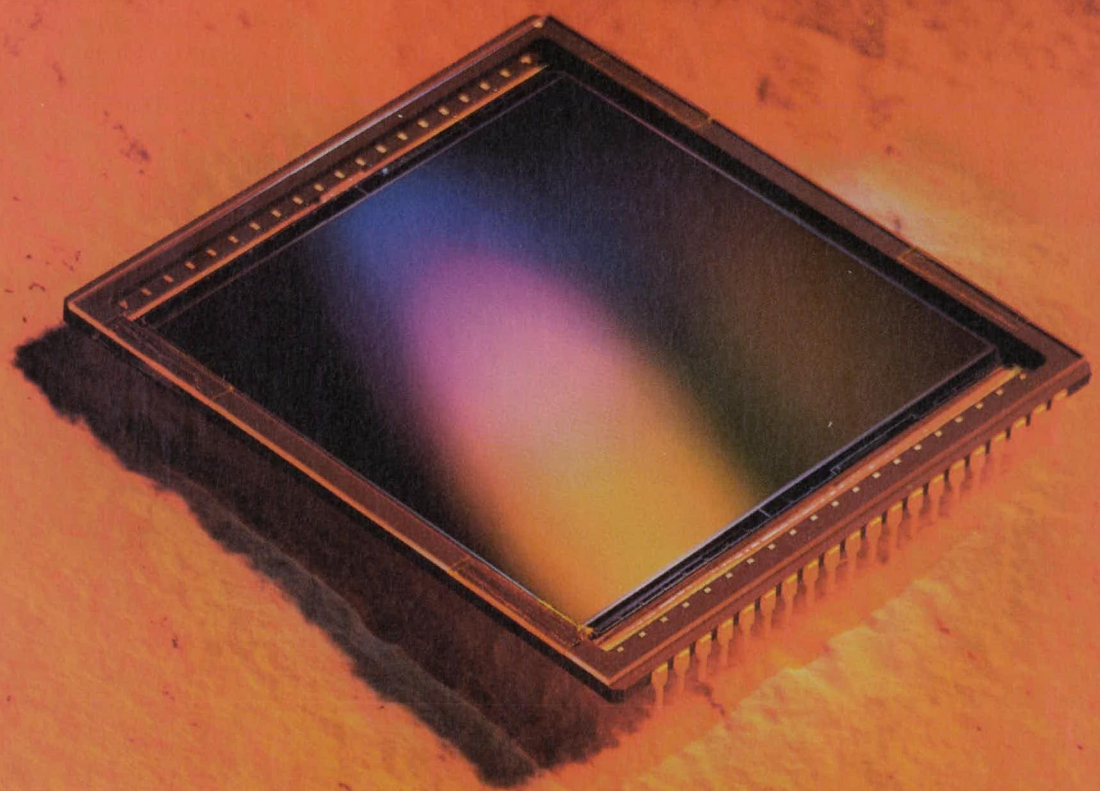
Passive Venting for Alleviating Helicopter Tail-Boom Loads

Porosity of surfaces could be used to advantage in passive venting to alleviate helicopter tail-boom loads. The results indicate that passive venting of a helicopter tail boom can alleviate some of the adverse side forces that are generated in hover and in sideward flight.
(See page 55.)

February 2001

PHOTONICS Tech Briefs

PHOTONICS SOLUTIONS FOR THE DESIGN ENGINEER



Automation Aids Robotic Welding ..... IIa
Kodak Sets Sights on World Imager Market 2a
Optical Fiber Communication Conference 2001 Preview 4a
OEOs With Carrier Suppression for Reduction of Phase Noise 6a
Nanometer-Level Control Scheme for Nulling Interferometry 7a
Time-Delay Interferometry in an Unequal-Arm Interferometer 8a
Improved Dynamic Holographic Optical-Interconnection System 9a
New Products 10a

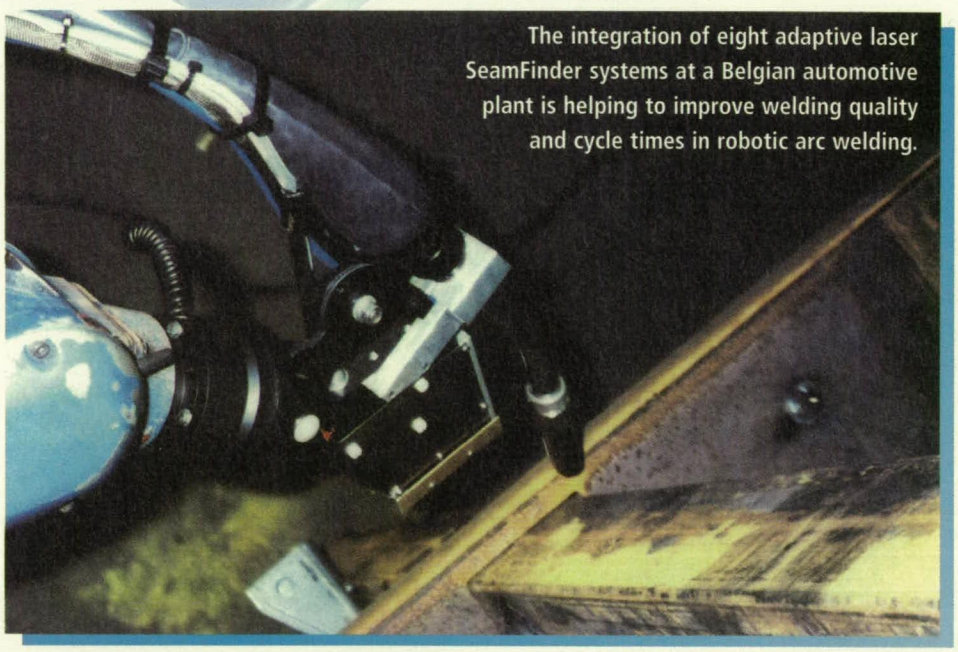
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AUTOMATION AIDS ROBOTIC WELDING

At a Benelux automotive plant, laser SeamFinders™ give robotic arc welding a boost.

At a Benelux automotive assembly plant in Ghent, Belgium, eight adaptive SeamFinder™ systems have joined robots from ABB Robot of Sweden to improve welding quality and cycle times in robotic arc welding of door hinges on car bodies, by accurately and rapidly locating the actual seam position to be welded. The systems, from LMI Selcom, were installed in 1999 at the Belgian facility and interfaced with eight ABB Model 2400 robots. They were installed by ABB Flexible Automation and programmed with ABB Robot's Teach pendant.

The key to optimum welding quality is accurately locating seam positions to be welded, using optical laser triangulation. The SeamFinder sensor heads are mounted close to the robot's welding torch. Once the actual position is located by the system, the result is rapidly reported back to the robot's controller. The robot precisely determines the position for the welding seam and corrects the welding torch, finding the actual position to be welded. The robot then corrects the welding parameters and quickly adapts to varying gaps and measurements, thus assuring a perfect weld.



The integration of eight adaptive laser SeamFinder systems at a Belgian automotive plant is helping to improve welding quality and cycle times in robotic arc welding.

Four of the eight SeamFinder systems at the Belgian plant are used during the prewelding stage to assure quality weldments on the auto's door frame. The other four are used to weld the door hinges onto the car body.

The SeamFinder locates three dimensions, or positions, that are required to properly position the door hinge within search times of under one second. The ABB robot positions the welding tip at the exact spot for the job. Search accuracy of the system is ± 0.1 mm (±0.004 in.). Sampling frequency for the laser sensor is 16 kHz and bandwidth 2 kHz. The SeamFinder system has made it possible to automate the arc-welding cycle in the final stage of the door production line.

"In practice, components and fixtures can be less than 100 percent accurate," Martin Sanden, business area manager for LMI Selcom Robotic Guidance, in Gothenburg, Sweden, said. "This is normal, especially when welding large objects. Since the tolerances in this application are too large, it would have been difficult to robot-weld without a robotic guidance system. By giving the robot eyes, the quality of weldments desired is easily achievable."

Sanden added that robots are normally preprogrammed to follow a theoretical weld path where torch positions and torch angles are specified according to a very narrow mechanical tolerance on the work's setup piece. The main drawback to this type of production, he noted, is that it is difficult to maintain the narrow mechanical tolerances needed to produce high-quality welds over long periods of time.

"To reach a high-quality weld, no mechanical deviations on workpieces or fixtures can be tolerated, since nothing will compensate for an incorrect seam position," Sanden said. "With SeamFinder, higher-quality production and more consistent welds are achieved, along with a reduction of scrap and rework time, as well as the reduction in trimming and fixturing requirements."

The SeamFinder system includes a Class IIIB noncontact LMI Selcom SLS 2301 sensor system, whose compact design allows its use in small work areas. The sensor's visible laser light also makes it easier to position the robot precisely. The sensor head is integrated with an SLS Controller and to most robot systems with standard digital interface for maximum flexibility. The sensor is also

not affected by normal welding smoke, excessive electromagnetic interference generated by high alternating currents, or the nature of the object's surface. A pneumatic shutter over the sensor's head protects it from normal welding smoke and welding spatter. A standard cooling and air-purge system further enhances use in harsh environments for optimum functionality.

Seam types that the system can accommodate include fillets, butts, and edge/overlap joints. Distance measurement can also be given for real-time Z-height positioning. Enclosure in a NEMA-12 (IPO 50) aluminum housing assures optimum airtight sealing and protection from moisture and dirt.

Other features of the sensor include a measuring range of 26 mm (1.02 in.) and resolution of 6.5 µm (0.002 in.) from a standoff of 180 mm (7.1 in.). A unique dynamic laser feedback loop allows accurate, virtually error-free measurement that is not affected by material, color, or smoke, with total reliability and repeatability up to 16,000 times a second within a well defined spot using little power.

The robot is programmed with parameters such as type of joint and plate thickness. During the search process, points along the joint are defined in two or three dimensions. Searches are accomplished without the arc being activated.

Applications for the SeamFinder are numerous for the aerospace, automotive, appliance, and other related industries for robotic arc welding of objects such as car and truck frames, underbodies, door hinges, rear axle housings, pressure vessels, tubes, containers, car bodies and others.

For more information on the SeamFinder system, contact LMI Selcom at 21666 Melrose Ave., Southfield, MI 48075; (810) 355-5900; fax (810) 355-3283; www.lasersensors.lmint.com.

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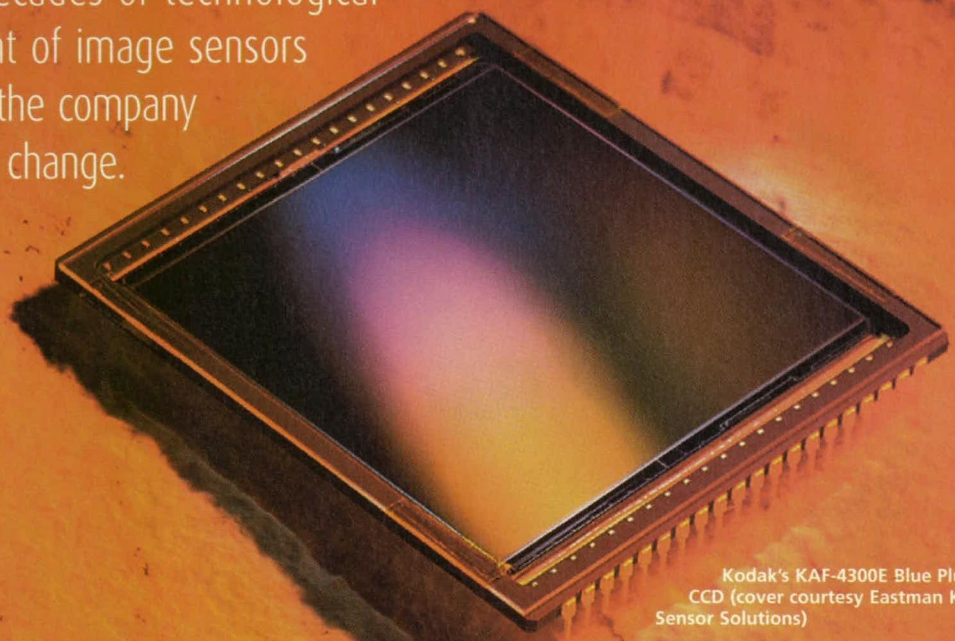
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Kodak Sets Sights on World Imager Market

With two decades of technological development of image sensors to boast of, the company works a sea change.



Kodak's KAF-4300E Blue Plus full-frame CCD (cover courtesy Eastman Kodak Image Sensor Solutions)

According to Frost and Sullivan, an international marketing company, the worldwide market for image sensor integrated circuits in 1999 was approximately $1 billion and is estimated to grow to more than $1.7 billion by 2003. For the past twenty years and more, the division of Eastman Kodak then called the Microelectronics Technology Division (MTD) existed primarily to supply products and services to other Kodak divisions for use in professional digital cameras, film and paper scanners, and various government programs. But last year the company shifted its sights. Renaming the division Image Sensors Solutions (ISS), Kodak announced plans to market its line of image sensors worldwide.

Chris McNiffe, vice president of sales and marketing for ISS, says that the decision, and the new organizational structure it entailed, was dictated by the rate at which Kodak's core business was changing from film to digital technology. Now ISS is a full profit-and-loss center within the company, driven by commercial pressures and customers' needs. To signal the change, Kodak announced the availability of five new image sensors, including its first two embodying the complementary metal oxide semiconductor (CMOS) technology and a 16-million-pixel device that the company says has the highest resolution of any sensor on the market. The last is expected to find applications in astronomy, high-end studio cameras, and portrait cameras.

Though Kodak's product offerings range across full-frame, interline, and linear CCDs, along with their new line of CMOS imagers, it was the MTD's concentration on performance and features not found in other commercially available sensors, including higher-resolution, large-pixel devices with high dynamic range, that laid the groundwork for ISS's current position. By focusing initially on full-frame technology, ISS developed multi-megapixel imagers, and the digital replacement of film became a reality.

Last summer's introductions included two new CCDs for digital cameras: the aforementioned KAF-16801CE, a 16.8-million pixel device that is targeted at studio camera developers, and the KAF5100CE, a 5.1-million-pixel device designed for digital cameras used by professionals and advanced amateurs. All of Kodak's full-frame CCDs encompass the patented Blue Plus process, which, coupled with on-chip color filter arrays, provides significantly enhanced photoresponsivity, according to the company. This results in very high equivalent film speeds — up to 1600 and higher. Other features include a range of pixel sizes, from 6.8, 9, and 11 microns up to 13; ultralow dark current for improved dynamic range; antiblooming control for high light conditions; and enhanced blue sensitivity.

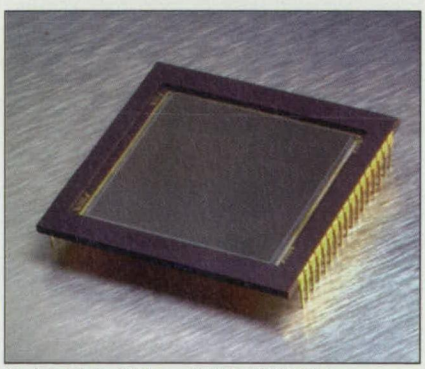
Launching CMOS

Along with these two devices, the summer introduction saw the most recent additions to the line of Kodak Digital

Science image sensors and the first to be based on CMOS technology. The CMOS devices are highly integrated image sensors that feature on-chip timing, programming control, analog signal processing and a 10-bit analog-to-digital converter — the "camera-on-a-chip" approach that results in smaller systems that consume less power. The KAC-0310 VGA sensor is a 640-x-480-pixel array in a 1/3-inch optical format using a 7.8-micron pinned photodiode active pixel structure. Developed for the CMOS line, and patented by Kodak, the pinned photodiode architecture separates the photodetector from the part of the pixel that transfers the charge, yielding, Kodak says, a better dynamic range and thus a higher ISO rating. (According to McNiffe, the average ISO for CMOS devices these days is ISO 60, where Kodak delivers ISO 200.) The sensor incorporates Kodak's patented "global shutter" technology that reduces image blur by simultaneously exposing the entire pixel array rather than sequencing the exposure line by line, as is typical.

The KAC-1310 VGA 1.3-megapixel CMOS sensor shares many features with the KAC-0310. It is a 1280-x-1024-pixel array in a half-inch optical format using a 6-micron pinned photodiode pixel structure. With a sensor output of 8 or 10 digital bits, it supports both progressive or interlace scan modes.

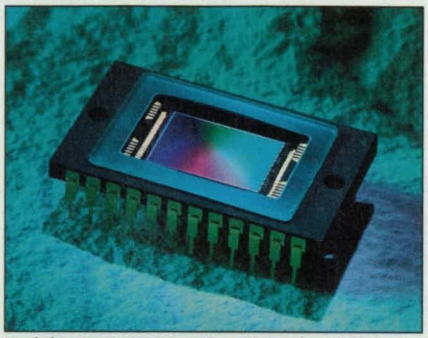
Kodak's CMOS imagers are the first commercial sensors to be produced through a joint development agreement by Kodak and Motorola. Both are fabricated in the ImageMOS process jointly developed and patented by the two companies. It sprang from well-established technology originally fashioned for dealing with the ever smaller linewidths on semiconductors; the companies introduced small improvements that enable the CMOS devices to combine Kodak's digital imaging experience with Motorola's semiconductor manufacturing and integration capabilities.



Kodak Digital Science™ KAF-16801CE image sensor, with 16.8-million pixels.

CCD vs. CMOS

According to McNiffe, the differences between the CCD and the CMOS technologies result in a series of tradeoffs. CMOS devices use less power, and are therefore suitable for handheld devices with smaller batteries or whenever smaller means better. The level of integration in CMOS devices is greater, and they can approach the design goal of a "camera-on-a-chip." These factors, along with economies of scale in fabrication, mean that CMOS is the technology of choice where cost and high-volume production are issues.



Kodak's KAF-1602E series Blue Plus full frame CCD.

CCDs, however, have two current advantages over their CMOS counterparts: they are capable of much higher resolution (resolution of CMOS devices is generally in the vicinity of 1.3 megapixels, whereas that of CCDs ranges from 3 to 16 megapixels and higher), and because they have much less noise and dark current than what the CMOS manufacturing process imposes on the latter devices, CCDs have much better dynamic range. Thus CCDs are suitable for any application where image quality is the most important factor: camcorders, spy satellites, radiographic and other biomedical products; CMOS technology finds its niches in such low-end devices as consumer cameras and machine vision, where high resolution is secondary to cost and ease of integration. In fact, McNiffe predicts, "within two to four years CMOS will own the consumer digital camera market."

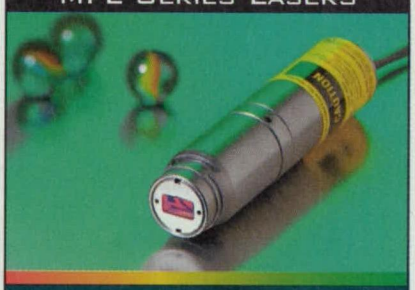
In the new millennium ahead, Eastman Kodak is well armed to make the company felt in the imaging marketplace. The company has a contract with Motorola to produce the high-volume CMOS sensors, and its Rochester, NY, facility can expand for the production of CCDs. As McNiffe puts it, "Now Kodak is out there in the thick of things."

For more information, please contact Chris McNiffe at 1990 Lake Ave., Rochester, NY 14650; (716) 722-7888; chris.mcniffe@kodak.com; www.kodak.com/go/ccd.

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Optical Fiber Communication Conference 2001

Last year's record-setting attendance and a leading-edge technical program combine to promise much for the first OFC of the new millennium.

Riding the wave of last year's extraordinary expansion, the Optical Fiber Communication Conference and Exhibit moves to roomier quarters for its 2001 session March 17-22: the Anaheim Convention Center, Anaheim, CA, said to be the West Coast's largest. Produced as a partnership of the Optical Society of America (OSA), the Institute of Electrical and Electronics Engineers/Communications Society (IEEE/ ComSoc), and the Institute of Electrical and Electronics Engineers' Laser and Electro-Optics Society (IEEE/LEOS), OFC expects the upcoming show to have more than 800 exhibitors, topping last year's mark of almost 475, and to exceed last year's record-breaking attendance of 16,500.

The invited and peer-reviewed oral and poster presentations represent the leading edge of fiber optics research and technology. OFC representatives say the 2001 show will address fundamental research in the field, landmark advances in system applications, and significant issues in manufacturing, reliability, and commercial technology. The Technical Program Committee has solicited contributed papers that deal with the development and deployment of tele- and data-communications networks, including both backbone and access.

OFC supplements the technical program with a extensive choice of educational and training opportunities. More than 100 half-day short courses, one-hour tutorials, product presentations, commercial technology sessions, and technical workshops are scheduled. The OFC commercial technology sessions have been expanded to include more technology showcases and business sessions for the end user and entrepreneur.

The technical program is divided into seven principal categories:

- Fiber, fiber amplifiers, and propagation;
- Fiber and waveguide components;
- Optoelectronic devices;
- Digital transmission systems;
- Subsystems, network elements, and analog systems;
- Networks: switching, access, and routing; and
- Applications.

Invited speakers in each of these categories represent a cross section of leading academics and manufacturers from the fiber optics industry, including NTT Japan, Nortel, Corning, the UK's Southampton University, Lucent's Bell Labs, New Focus, NIST, Alcatel, DARPA, Agilent, and Cisco Systems. Each of the seven technical categories is matched with a one-hour tutorial, open to those who have paid the full conference registration fee. These too are taught by internationally known specialists from AT&T Labs, Lucent, the UK's Bath University, Carnegie Mellon University, Corning, Cisco Systems, and others.

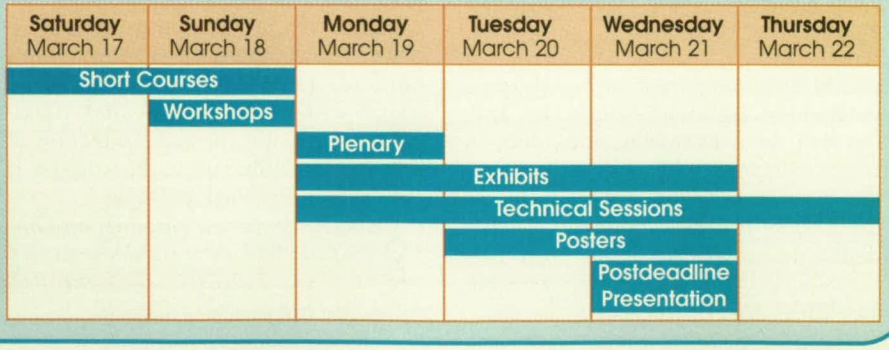
Short Courses, Workshops Offered

More than 70 short courses — three to four hours in duration — will be held on Saturday, March 17, and Sunday, March 18, and thus do not conflict with the technical sessions and the exhibit. In addition, five workshops, participatory in nature, will be held March 18 from 4:30 to 8 p.m. Organizers Jack Tomlinson of JDS Uniphase and Robert Sargent of OCLI will lead a discussion of "Gain flattening and control for optical amplifiers;" organizer Robert Jopson of Lucent's Bell Labs will lead "PMD mitigation;" organizer Chris Pfistner of Terawave Communications will lead "Broadband optical access: The next frontier;" organizers Krishna Bala of Tellium USA and Andy Wright of Williams Communications will lead "Optical networking-Lessons learned;" and organizers Dipak Chowdhury of Corning, Curtis Menyuk of the University of Maryland, and Alan Willner of the University of Southern California will lead "Simulation tools for systems, device and network modeling."

This year's Plenary and Awards session will take place on March 19. One keynote speaker is venture capitalist Vab Goel, a Venture Partner at Norwest Venture Partners. In "New Network and Service Paradigms, USA," Goel will address the emerging opportunities in the networking industry. At Norwest, Goel focuses on emerging communications systems, communications services, and Internet services companies. Previously, Goel served as vice president of emerging technologies at Qwest.

The second keynote address is to come from Robert W. Lucky, corporate vice president for applied research at Telcordia Technologies. He will speak on "Trends and Uncertainties in the Future of Telecom." Lucky began his career at AT&T's Bell Labs, where he invented the adaptive equalizer, a technique for correcting distortion in telephone signals that is used in all high-speed data transmission today. Also at the Plenary, Tatsuo Izawa, president and CEO of NTT Electronics Corporation, Japan, will be presented with the 2001 John Tyndall Award, for pioneering, highly significant, or continuing technical or leadership contributions to fiber optics technology.

For more information on the meeting or registration, please contact OFC management at (202) 416-1907; fax: (202) 416-6140; e-mail: cust.serv@osa.org; OSA web site: www.osa.org/ofc. For more information on exhibits, product presentations, corporate sponsorship, or advertising sales, please contact OFC management at (202) 416-1950; fax: (202) 416-6100; e-mail: OFCexhibits@ osa.org.

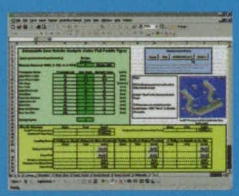


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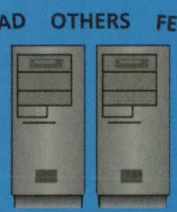
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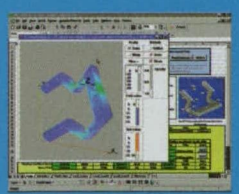
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OEOs With Carrier Suppression for Reduction of Phase Noise

A technique previously applied to microwave oscillators has been extended to OEOs.

NASA's Jet Propulsion Laboratory, Pasadena, California

Optoelectronic oscillators (OEOs) that incorporate carrier-suppression subsystems for reduction of close-to-carrier phase noise are undergoing development. The carrier-suppression phase-noise-reduction technique has previously been applied to microwave oscillators. The close-to-carrier phase noise in a microwave oscillator consists mainly of a component that is generated in an amplifier in the oscillator feedback loop and that has a spectral amplitude proportional to $1/f$, where f is the difference between the frequency of interest and the carrier frequency. In the case of an OEO, one can use the carrier-suppression technique to reduce not only the component of phase noise generated in the amplifier but also the component of phase noise associated with laser relative-intensity noise.

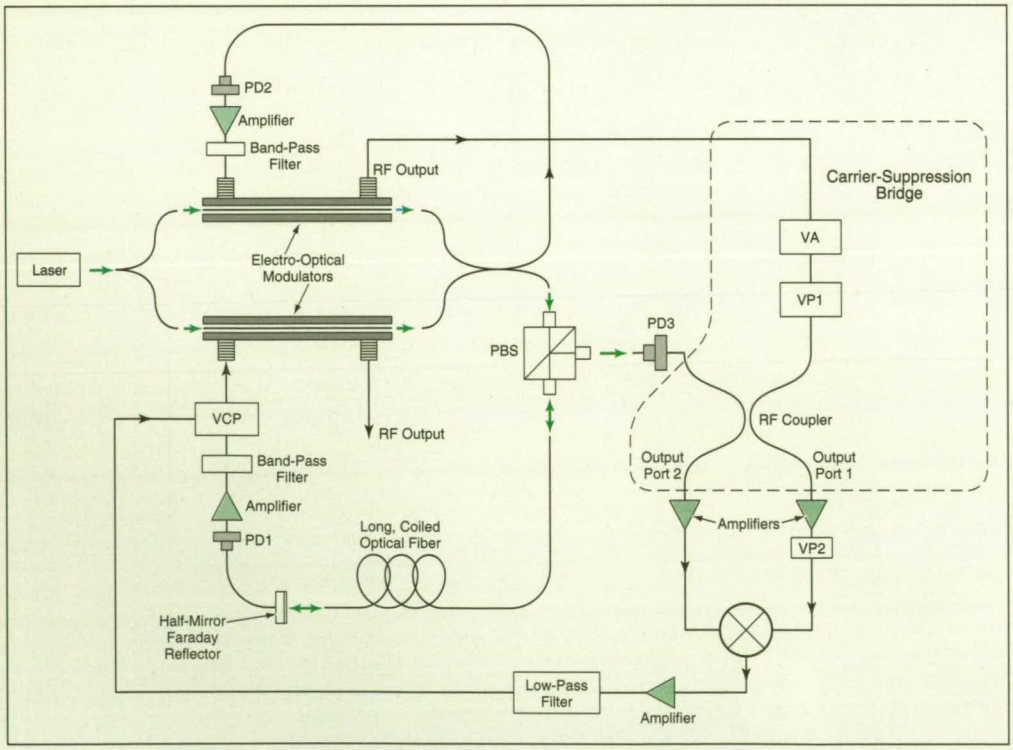
The figure schematically depicts a double-loop OEO with a carrier-suppression bridge for reduction of phase noise. The long oscillator loop includes a polarizing beam splitter (PBS), a long optical fiber wound into a coil, a half-mirror Faraday polarization rotator, a photodetector (PD1), a radio-frequency (RF) amplifier, a band-pass filter, a voltage-controlled phase shifter (VCP), and an electro-optical modulator. The short oscillator loop contains only a short optical fiber and does not include a VCP or a PBS.

The polarization of the light entering the PBS is adjusted so that all of this light passes through the PBS and into the long optical fiber. At the output end of the long optical fiber, part of the light passes through the Faraday half-mirror and travels on to PD1; another part of the light is reflected by the Faraday half-mirror with a polarization that, everywhere in the long optical fiber, is orthogonal to the polarization of the light traveling forward. The orthogonality minimizes the interaction between the forward-going and reflected light beams, thereby reducing noise.

The carrier-suppression bridge functions as follows: The reflected light in the long oscillator loop is further reflected by the PBS and thereby made to enter a photodiode (PD3), which detects RF amplitude modulation of the light. Another RF signal is obtained from the RF output port of the short oscillator loop, then processed through a variable attenuator (VA) and variable phase shifter (VP1), then made to interfere with the RF output of PD3. The VA and VP1 are adjusted so that output port 1 of the bridge passes minimum power while output port 2 of the bridge passes maximum power.

The signals from the two ports are amplified, and the amplified signal at port 1 is further processed by another variable phase shifter (VP2) to set the phase difference between the two signals at either 0 or π radians. The signals are then mixed with each other in a balanced mixer. As explained in more detail below, the mixer output is processed into an error signal that is fed back to VCP to control the frequency of oscillation.

The long optical fiber in the long oscillator loop acts as both a high-Q (where Q is the resonance quality factor) storage component for the oscillator and as a frequency-discriminator component for the carrier-suppression bridge. The bridge acts as a frequency discriminator in that it converts the frequency jitter of the OEO into amplitude jitter in the output of the bridge. The role of the mixer is to detect this amplitude jitter. The output of the mixer is amplified, filtered, and fed back to VCP to reduce the frequency jitter (and thus the phase noise) of the OEO.



This **Double-Loop Optoelectronic Oscillator** incorporates a carrier-suppression bridge, which acts, in conjunction with the long optical fiber, as a frequency discriminator to reduce frequency jitter and thus phase noise.

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

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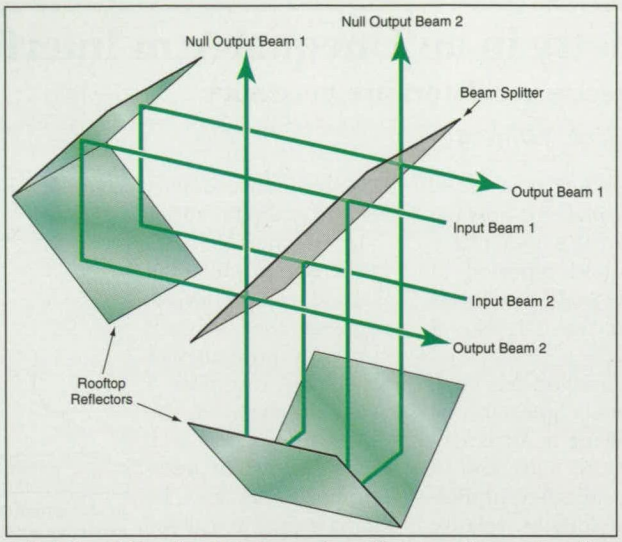
Nanometer-Level Control Scheme for Nulling Interferometry

Path lengths in an interferometric beam combiner are offset to maximize an off-null error signal.

NASA's Jet Propulsion Laboratory, Pasadena, California

A control scheme for nulling interferometry has been devised to make it possible to stabilize interferometric optical-path-length differences to within approximately a nanometer. This degree of stabilization is an order of magnitude finer than that achieved previously in typical optical interferometers.

Nulling interferometry is a promising technique for reducing the apparent brightness of a star relative to its surroundings. As such, nulling interferometry has the potential to enable direct detection of extrasolar planets and zodiacal light. Nulling interferometry is based on the precise cancellation, or "nulling," of the starlight received from the same star by two side-by-side telescopes. To cancel on-axis starlight, the electric fields from the two telescopes must be combined in opposite phase at all wavelengths across the waveband of interest. The required degree of cancellation (to the 10^{-6} level in the infrared) translates to a requirement to stabilize optical-path-length differences at or below the nanometer level.



A **Rotational Shearing Interferometer** with two orthogonal rooftop reflectors is used as an interferometric beam combiner. With a proper choice of internal and external optical-path-length offsets, it is possible to convert one of the null output beams into a relatively bright off-null indicator for use as feedback in maintaining the null of the other null output beam.

In the present technique, the required achromatic π-radian phase shift between the beams from the two telescopes is introduced by geometrically flipping the electric-field vector of one beam, relative to the other, by use of a rotational shearing interferometer (RSI). The figure schematically depicts aspects of an RSI. The two interferometer arms contain orthogonal rooftop reflectors, and the arms intersect at a beam splitter. Each rooftop flips one of two orthogonal components of the electric-field vector. This RSI generates two null output beams that are balanced in the sense that the intensity of the light in both of them is proportional to rt, where r and t are the reflection and transmission coefficients, respectively, of the beam splitter. This RSI also generates two bright outputs that are unbalanced in the sense that they are proportional to r^2 and t^2, respectively.

In order to generate a sufficiently strong feedback signal for controlling the optical-path-length difference between the two arms to maintain the null, one must find a source other than the nominally nulled star itself. The present control scheme exploits a hitherto unrecognized property of interferometric beam combiners in general and of this RSI in particular to generate a sufficiently strong control signal. The scheme involves the insertion of a path offset of $\lambda_m/8$ (where λ_m is approximately the mean wavelength in the wavelength band of interest) into one of the interferometer arms and the insertion of another path offset of $\lambda_m/8$ into the path (outside the interferometer) of one of the input beams.

Because the path-length offsets add in one nulled output and subtract in the other, these offsets make it possible to preserve the achromatic null in one of the two nominally balanced output beams while converting the other beam into a bright off-null error signal, in which the fractional change in power level is given by

$$2\pi\frac{\Delta x}{\lambda_m},$$

where Δx is the path-length difference that one seeks to minimize. For exam-

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ple, at a wavelength of 628 nm, this scheme yields an error signal with a fractional power change of 1 percent per nanometer of path-length difference; even at a path-length difference of only 1 nm, this fractional power is much greater than the fractional power remaining in the nominally nulled output signal. Although the error-signal beam is chromatic, this is not of concern because achromaticity is needed only in the null output beam.

This work was done by Gene Serabyn 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 Physical Sciences category. NPO-20758*

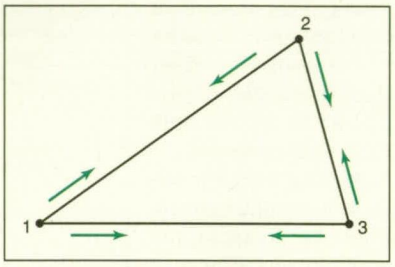
Time-Delay Interferometry in an Unequal-Arm Interferometer

Neither equal arm lengths nor precise oscillators are necessary.

NASA's Jet Propulsion Laboratory, Pasadena, California

A method of processing phase measurements in a large, unequal-arm laser Michelson interferometer makes it possible to measure phase effects much smaller than the laser phase noise. This method is related to the method reported in "Cancellation of Laser Noise in an Unequal-Arm Interferometer" (NPO-20611) *NASA Tech Briefs*, Vol 24, No. 3 (March 2000), page 22a.

In the original application for which the method has been proposed, the interferometer, used to detect gravitational waves, would be based on three spacecraft flying in a triangular formation with arm lengths of the order of 5×10^6 km. In principle, the method could also be utilized in other applications in which one seeks to measure relative lengths, relative velocities, phases, or frequencies interferometrically with high precision. The method is fundamentally different from conventional interferometric methods in which one relies on equal arm lengths to cancel laser phase noise. The method is also fundamentally different from conventional two-way Doppler interferometry, in which one relies on a precise oscillator to maintain coherence.



In this **Unequal-Arm Interferometer**, a laser at each corner is used to transmit light to, and as a local oscillator in receiving light from, the other two corners.

In an interferometer of the type to which the method applies, a free-running laser at each corner of the triangular formation transmits a beam to each of the other two corners (see figure). Thus, the interferometer can also be characterized as a closed triangular array of six one-arm delay lines between the corners. The transmitting laser at each corner also serves as a local oscillator for reception of the beams transmitted by the lasers at the other two corners. The raw data output of the receiver at each corner consists of two Doppler time series — one for each of the two interferometer arms that intersect at that corner. Each of the total of six Doppler time series embodies phase and frequency contributions that include laser phase noise, phase noise from secondary sources, and the phase effect of interest. Typically, the phase effect of interest is a Doppler effect caused by changing arm length and/or a gravitational wave that crosses the interferometer. The laser phase noise is the largest source of noise in these measurements.

In this method, the Doppler time series are recorded and post-processed to cancel all laser phase noise and extract the phase effect of interest. The line of reasoning that leads to the post-processing algorithm begins with recognition of the following fact concerning each of the delay lines: The Doppler time series generated at the receiving corner at a given time, t, contains the difference between (1) the phase or frequency noise of the laser at the receiving corner at time t and (2) the phase or frequency noise of the laser at the transmitting corner at time $t - L/c$, where L is the length of the delay line and c is the speed of light.

By a lengthy but straightforward mathematical derivation, it can be shown that by (1) delaying each Doppler time series by a suitable interval equal to the delay in the same delay line, a different delay line, or some combination of delay lines and (2) forming suitable linear combinations of the variously delayed Doppler time series, one can obtain complete cancellation of the effects of the phase noises in all three lasers. The phase effect of interest (e.g., of a gravitational wave) is not canceled; instead, it appears in the linear combination as a multipulse response that depends on the specific linear combination and the interferometer geometry.

This work was done by John Armstrong, Frank Estabrook, and Massimo Tinto 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 Physical Sciences category. NPO-20739*

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Improved Dynamic Holographic Optical-Interconnection System

Dynamic HOE switches can be constructed more simply than was previously possible.

Lyndon B. Johnson Space Center, Houston, Texas

An improved visual display system for a helmet produces two- and three-dimensional images by use of the limited domain of spatial light modulation (SLM) values. One especially notable improvement incorporated into the design of this system is a simplification in the design of dynamic holographic optical element (HOE) switches. This system can be expected to afford immediate and calculable benefits to the United States space program; similar benefits for the military and private industry are also anticipated.

This system generates small volumes of three-dimensional images, satisfies the size constraints of space-related applications, and offers significant improvements over pre-existing holographic helmet displays. Visual display systems that render two- and three-dimensional images for space applications offer a major advantage over pre-existing systems: it is possible to develop distinct and specifiable phase relationships between the elements of either two- or three-dimensional arrays. As an extension of the work that produced the present system, a more efficient means of storing holographic images was created. This system is a major improvement over prior means for storing holographic images, in that it significantly refines holographic helmet displays and the information that can be generated from them.

Holographic images are used most often in helmet visual displays. In the design of the present system, the required optical interconnections are made when SLMs direct coherent light beams into the light patterns needed for applications. In this way, optical reciprocity, which enables a single receiver to obtain light from a reprogrammable array of source locations, is achieved.Optical reciprocity takes advantage of the complex nature of SLMs and enables the use of continuously variable modulators with coupled phase and amplitude characteristics. One application involves focusing of light from a single source placed at arbitrary locations in a three-dimensional array, enabling spatial addressing of nonlinear optical storage media; a second application involves the creation of two-dimensional arrays of spots for optical interconnections.

In broadband communications, signals with very large bandwidths are often transported on light carriers. The connections between sources and destinations must be reconfigurable so that light can be distributed to the intended destinations. Although a great deal of work has already been done on switching light signals, the utility of SLMs as switches has been limited by conflicts among requirements and capabilities that pertain to speed and complex values: A fast SLM is often restricted to a binary set rather than a continuum; a continuously variable SLM is restricted to, at most, the curvilinear subset of a complex unit disk. In the design of the present system, the limited domain of SLM values is maximized, creating a dynamic HOE switch with a design simpler than that of any such switch constructed previously.

To simplify the switch design, the researcher who developed the present system first had to simplify some computation-intensive annealing techniques. He devised an innovative method of optimizing a metric, the value of which is related monotonically to a measure of the quality with which an HOE performs an optical switch function. By doing this, he discovered that HOEs can be computed for the curvilinear continuum of complex values typical of readily available SLMs, but this was only a single improvement. He also examined conventional HOE computation techniques to discover ways of improving these as well.

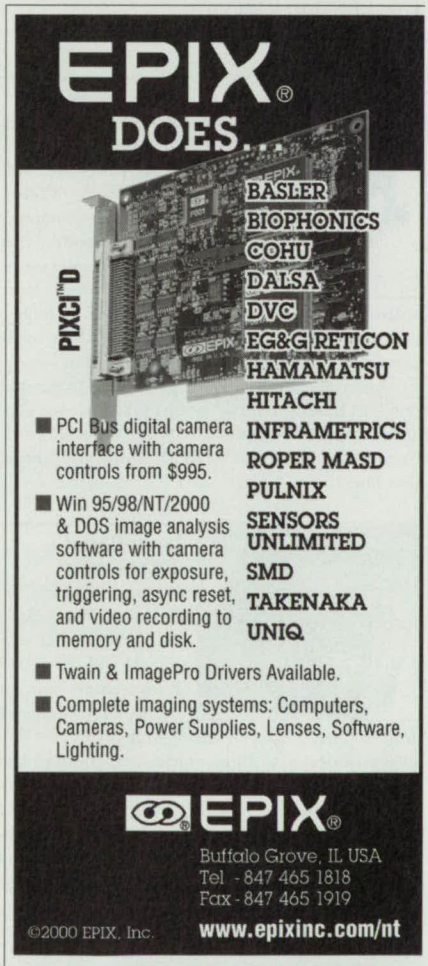
Since conventional HOE computation techniques are often iterative, problems can arise. To ameliorate any problems, the researcher developed a means of directing light from a single source to many receivers. This made it possible to specify and optimally realize the intensity and phase of light sent to receivers. The receivers can be detectors that convert light into other forms (electrical signals or photographs), locations in a photo-addressed nonlinear optical information storage device, or ducts that can transmit more light.

The optical setup devised for the receivers is simple: An SLM is disposed in a beam of light, where its complex characteristics are used to change an arriving light wave into an approximation of an ideal departing light wave. The single departing light wave is separated into three light waves that converge on different locations that need not be coplanar. The incoming beam of light is directed to a pattern of three spots. A collimating lens is not necessary but can be used if convenient.

After simplifying the setup, the researcher next determined the optimum set of values of transmittance. For a given value of k, the ideal values of the light-wave phasor were optically represented on a curvilinear SLM domain by the Euclidean closest values. (For this purpose, the SLM domain was represented as a curvilinear continuum; it was not restricted to a binary set.) Next for a given value of k, the ideal values of the light-wave phasor were represented on a discrete SLM domain by the Euclidean closest values. Although the SLM is a ternary (three-valued) domain, the ideal values are the same as the non-restricted binary values.

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 Electronic Components and Systems category.*

This invention has been patented by NASA (U.S. Patent No. 5,768,242). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-22746.



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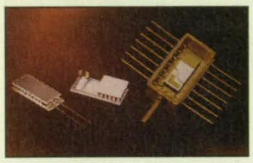
Micro-Focus Laser

StockerYale, St.-Laurent, PQ, Canada, introduces what it calls the world's thinnest laser line. This model of the Lasiris Micro-Focus Laser Series projects a 5.5-µm ±0.75-µm line at $1/e^2$, out of a fully operational 5-degree fan-angle laser line projector (670 nm at 5 mW). The company says the laser will find applications in semiconductor and microelectronics inspection as well as contour mapping and defect inspection of very small parts.



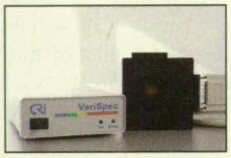
157-nm Broadband Reflective Coating

The ARC 1570 broadband reflective coating from Acton Research Corp., Acton, MA, is optimized to deliver superior reflectance (84-86 percent) at 157 nm (at normal incidence), while also providing high reflectance (88-90 percent) throughout the UV and visible spectral regions. It can be customized for other angles of incidence, and is available on customer-supplied materials or as a complete mirror on one of Acton's substrates. Applications include semiconductor metrology instrumentation and laser exposure systems that require 157-nm optimization for lithography.



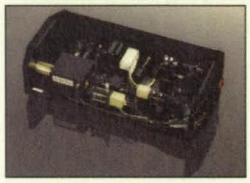
Thermoelectric Coolers for Telecom/ Fiber Optics

Melcor Corp., Trenton, NJ, introduces the OptoTEC™ line of thermoelectric coolers, including a new class built with tin-antimony solder, which melts at 232 °C. Melcor designates the new line ET, standing for "elevated temperature." The expanded line now includes thermoelectrics constructed with three different solder temperatures: 138 °C, 232 °C, and above 270 °C. Options available in the product line include wire-bondable posts or pads, aluminum nitride ceramics, and custom metallization patterns on the ceramic.



Liquid Crystal Tunable Filter

Cambridge Research and Instrumentation (CRI), Boston, MA, announces its latest device for multispectral imaging, the VariSpec™ MIR liquid crystal tunable filter. Developed for airborne remote sensing in collaboration with NASA's Jet Propulsion Laboratory and Lawrence Livermore National Laboratory, the filter has a working range of 800-1700 nm, which, the company says, enables researchers to gain insights using uncooled InGaAs CCD cameras. CRI says the filter provides interactive computer control over critical wavelengths used in new biological, diagnostic, and semiconductor research applications.



Optical Parametric Oscillator

LINOS Photonics, Göttingen, Germany, is offering the OS 4000, which it calls the first commercially available, widely tunable, continuous-wave optical parametric oscillator (OPO). The signal and idler radiation is tunable in the range of 1.45-2 micrometers and 2.3-4 micrometers respectively. Output power is up to 100 mW. LINOS says the output radiation is single-frequency and has a narrow linewidth and low noise, making the OS 4000 suitable for spectroscopy and optical metrology. The compact, completely solid-state device has an integrated pump laser and control unit.



15-to-100-W Air-Cooled CO_2 Laser

Universal Laser Systems, Scottsdale, AZ, announces the X2-600, which the company says is the world's first 15-to-100-W air-cooled carbon dioxide laser platform/configuration. The proprietary multilaser air-cooled technology eliminates the need for costly laser source water cooling, according to the company. Universal calls the X2-600 part of its "Integrated Family of Laser Products," noting that it is cross-platform compatible with its Quick Change Laser Cartridges™ that make up its engraving and cutting laser lines.



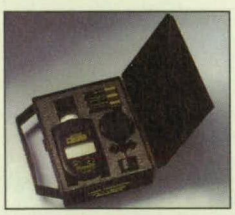
Lead Sulfide Focal Plane Array

The 320-x-240 lead sulfide (PbS) focal plane array from Litton Electro-Optical Systems, Tempe, AZ, consists of an array of PbS detectors monolithically deposited on Litton's advanced CMOS multiplexer. The array, sensitive in the 1-3-micron spectral region, fills the gap between the visible and the mid-wave (3-5-micron) sensors currently in the field, Litton says. Pixel size is 30 by 30 microns. Litton says performance is enhanced by the use of the self-contained thermoelectric cooler. The CMOS multiplexer provides snapshot operation, and a chopper is used to cancel the detector bias current prior to signal current integration.



Photometric Filter/Detector

Gamma Scientific, San Diego, CA, announces a new photometric filter/detector combination that it says is ideal for measuring blue and white LEDs. Designed for use with the Gamma Scientific line of radiometers/photometers, the filter/detector provides photometric measurements that the company calls a near-perfect match to the CIE human eye response curve. Gamma Scientific adds that the device architecture allows measurements to more accurately parallel CIE 127-1997 measurement geometry requirements. The filter/detector can be configured with Gamma Scientific's models 450, DR250, DR2000, or DR2550 radiometer/photometers.



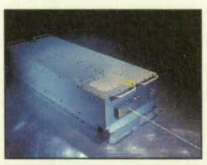
Laser-Based Tachometer

Pioneer Electric & Research, Wood Dale, IL, makes available the Model PLT-5000 Pocket-Laser Tach, an industrial tachometer using a Class 1 laser as the light source. The PLT 5000 provides up to 14 memories, and allows single-button selection of measurement units such as RPM, meters per minute (velocity), feet/minute, yards/minute, inches/minute, and length in meters, yards, and feet. Three AA batteries provide up to 40 hours of continuous use, and low-battery and over-range indicators provide operational feedback.



Laser for Particle Image Velocimetry

New Wave Research, Fremont, CA, adds the Gemini PIV 200 to its Gemini particle image velocimetry (PIV) product line. New Wave calls the PIV 200 the smallest 200-mJ Nd:YAG laser on the market today. Designed for air- and water-flow PIV, the compact dual-head laser produces 200 mJ of energy at 532 nm and operates at a maximum repetition rate of 15 Hz per head. Housed in the same small package as the existing Gemini, the PIV 200 produces 67 percent higher energy, allowing users to expand interrogation areas by 30 percent. The Gemini PIV has three trigger controls: single-shot, continuous, and TTL.



UV Laser with Quasi-CW Output

Spectra-Physics, Mountain View, CA, releasesthe Vanguard™ solid-state laser that provides more than 4 W of quasi-continuous-wave output at 355 nm. The company says that the Vanguard is the first high-power commercial laser to utilize saturable Bragg reflector technology, under license from Lucent Technologies. This mode-locking mechanism produces a pulsed high-repetition-rate output that is suitable for applications currently using continuous-wave gas lasers. A frequency-tripled Nd:$YV0_4$ laser, the Vanguard has a repetition rate of 80 MHz and pulse duration of 10 picoseconds. It is based on Spectra-Physics' FC*bar*™ diode-pumping design and has TEM_{00} output (M^2=<1.2).

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811	812	813	814	815	816	817	818	819	820
821	822	823	824	825	826	827	828	829	830
831	832	833	834	835	836	837	838	839	840

National Design Engineering Show Preview

Now in its 11th year, National Manufacturing Week — held March 5-8 at McCormick Place in Chicago — attracts more than 2,000 exhibitors and is attended by more than 56,000 buyers and sellers of products, services, and technologies that support and integrate all of the functions of the manufacturing process. The event covers everything from design engineering to manufacturing enterprise-wide integration.

Within National Manufacturing Week, the National Design Engineering Show (NDES) features the latest tools, components, and materials used in mechanical and electromechanical design and product development. Special pavilions will be featured for CAD/CAM, contract manufacturing, medical design, and rapid prototyping. Visit the NASA Solutions Center, where you'll see product demos and learn about technology transfer, which could help your company implement NASA resources to develop and commercialize new products. More than 1,000 exhibitors at NDES will display new ideas, technologies, and products, including those we profile in this feature section.



Animatics, Santa Clara, CA (www.animatics.com), will be displaying the SM2315 SmartMotor integrated servo control system, which includes a controller, amplifier, and encoder built into a brushless DC servo motor. The Motion Control Chip microcontroller handles processing functions such as PID loop, trajectory generator, user program execution, I/O control, and communications over as many as three serial channels simultaneously. The motor can be programmed as a standalone, or to operate as part of an RS-232 or RS-485 network. The system delivers speeds up to 10,000 RPM, and has an expansion slot for additional or custom electronics.

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MSC.Software, Los Angeles, CA (www.mscsoftware.com), develops, markets, and supports software tools that simulate performance of product designs before manufacture. Among those tools on display will be MSC.Dytran, a 3D program for simulating the response of solids, structures, and fluids; and MSC.Patran for Linux — part of the MSC.visualNastran enterprise family — that provides a visual simulation environment on the Linux platform. Other principle products to be shown include MSC.Nastran, MSC.Marc, and the Engineering-e.com business-to-business e-commerce marketplace that provides products, services, and knowledge to the engineering community.

Booth 7516

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Booth 7402

ALGOR, Inc., Pittsburgh, PA (www.algor.com) will focus on "Driving Motion" as it introduces its new KinePak kinematic modeling utility that enables engineers to work out the motion of common types of mechanisms. KinePak offers a wizard-style interface for parametrically building line drawings of common mechanisms such as 4-bar linkages and toggles. It provides "click-and-drag" animation of mechanism motion so that engineers can check for interference, eliminate errors, and optimize moving assemblies. ALGOR also will demonstrate its proprietary technologies for modeling and performing FEA-based motion and stress analysis, including kinematic elements for performing faster simulations, actuator elements for simulating the motion of hydraulic and pneumatic cylinders and electric solenoids, rotational actuator elements for simulating motors, and slider elements for simulating slots.



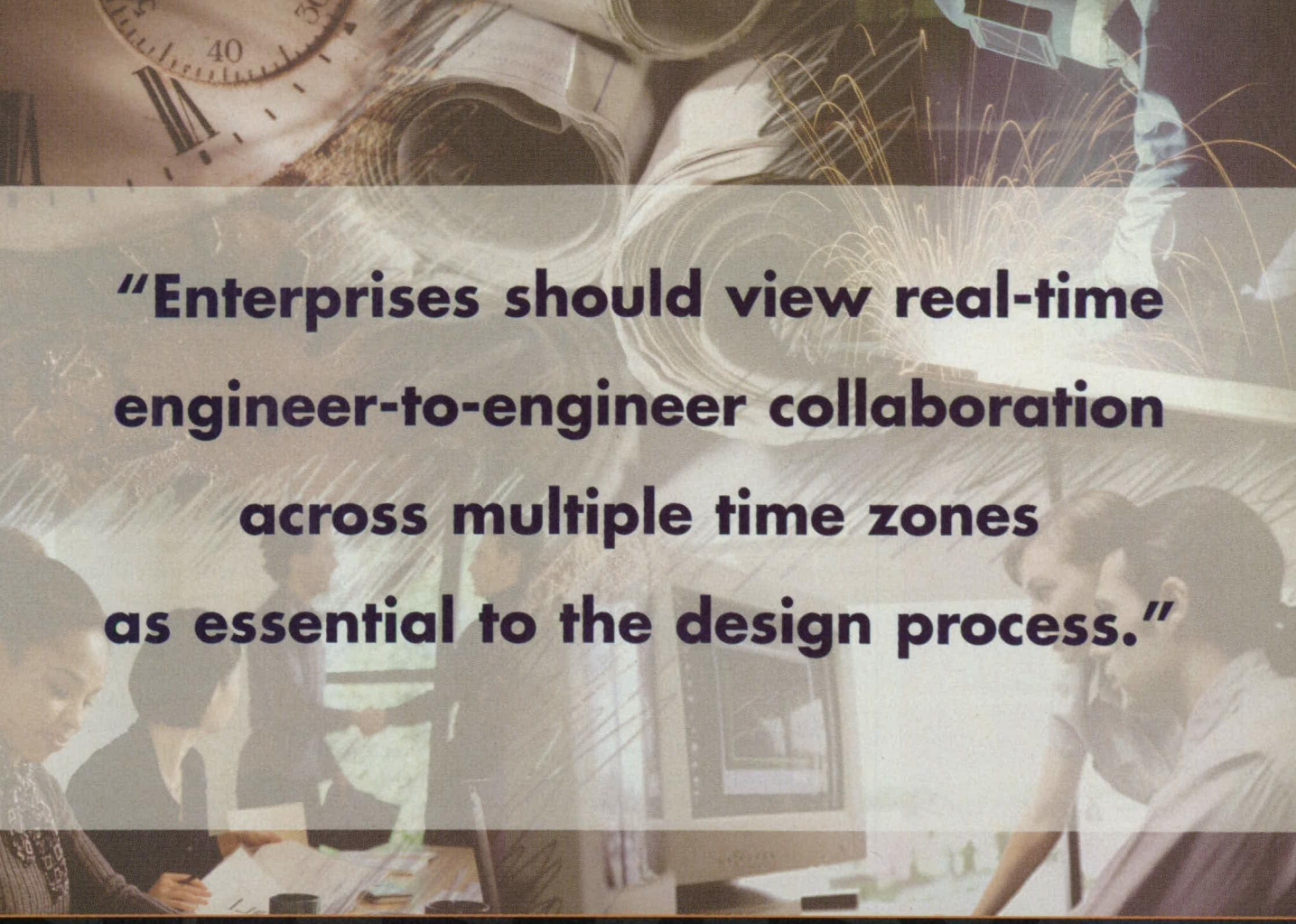
Circle No. 741



Bal Seal Engineering, Foothill Ranch, CA (www.balseal.com), will showcase its Rotary Seal products that provide universal chemical compatibility, high temperature capability, and low friction. A metal holding ring supports the plastic against the housing for OD sealing and retention. The holding ring also makes it suitable for components and sub-assemblies that need to be autoclaved. Available in small diameters and cross-sections, the seals are used in high- and low-speed hand pieces with bone drills, surgical saws, motors and pumps, and centrifuges.

Booth 9072

Circle No. 757



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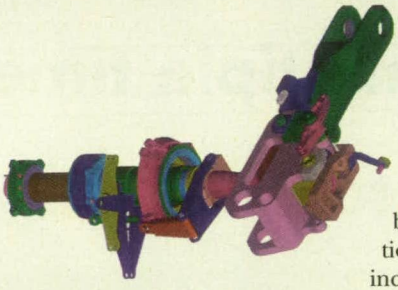
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Photoetched metal parts, flexible printed circuits, precision stamping, and RFI/EMI shielding strips will be exhibited by Tech-Etch, Plymouth, MA (www.tech-etch.com). Custom light-gauge parts can be manufactured with intricate patterns, precise tolerances, and burr-free edges. The company uses corrosion-resistant materials such as titanium, Elgiloy, stainless steel, and polyimide films to produce parts for medical devices, equipment, and implants. Other metals include beryllium copper, aluminum, molybdenum, brass, and spring steels for parts in other applications. ***Circle No. 763***

Booth 8873



CADKEY Corp., Marlborough, MA (www.cadkey.com), will demonstrate CADKEY 19, the latest version of its Windows-based mechanical CAD software. Enhancements are featured in hybrid modeling and blending, 2D drawing and detailing, data translation, display, and graphics. The software also includes six new CADKEY Dynamic Extension Utilities with hundreds of productivity tools to enhance 2D layout, dimensioning, plotting, and file management. Data translation capabilities include support of ACIS-SAT 6.2 import and export of solid models. The DWG/DSF translators offer AutoCAD 2000 file support. Users have the option of repairing less precise imported model geometry, or working directly with imprecise models. Demonstrations of CADKEY 19, CADKEY Parametrics, and other CADKEY products will be scheduled throughout show hours. ***Circle No. 764***

Booth 7916



ManufacturingQuote.com, Smyrna, GA (www.MfgQuote.com), will demonstrate its eProcurement technology, as well as its MfgQuote Network that connects buyers and supplier members. The collaborative procurement management service enables members to manage the business of procuring and selling custom manufacturing services such as machining, molding, casting, and rapid prototyping. The service creates a transparent e-marketplace for buyer-seller collaboration, automates procurement practices, and streamlines the quoting process. The company will introduce new technology for production monitoring and visual collaboration. ***Circle No. 762***

Booth 7311



Solutions for test and measurement, data acquisition, and automation will be exhibited by National Instruments, Austin, TX (www.ni.com), which will highlight its LabVIEW 6i, the latest version of the company's measurement software package. The new version features graphical programming that leverages the latest technologies in computing, networking, and measurements. Machine monitoring and control, pilot plant measurement and automation, quality control, laboratory automation, and emerging PC technology all will be addressed with NI products. The company offers solutions in data I/O, industrial communications such as DeviceNet, Internet technology, and automation software such as BridgeVIEW and Lookout. ***Circle No. 754***

Booth 5126



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IBM, Armonk, NY (www.ibm.com), will highlight Version 5 Release 5 of CATIA CAD/CAM software, the company's design, analysis, and manufacturing software solution for Windows and UNIX platforms. The new version incorporates ten new products to expand its application in areas such as mechanical design, shape design and styling, analysis, equipment and system engineering, NC manufacturing, and product synthesis.

Booth 8330

IBM's Product Lifecycle Management solutions include a range of products and services to support product development processes, including solutions from SmarTeam and Enovia for product data management. ***Circle No. 745***

SolidWorks, Concord, MA, will introduce SolidWorks 2001 solid modeling software. The ninth release of the SolidWorks program includes a new set of visual display and mouse-driven control capabilities that reduce design steps and minimize dialog boxes. These tools include a Property Manager with more than 30 commands, drag handles, and context-sensitive callouts. The new version also includes sheet metal functionality and more than 150 enhancements in assemblies, drawings, parts, and modeling. The 3D Instant Website feature lets users instantly create and publish live web pages with SolidWorks models and drawings. ***Circle No. 758***

Booth 6900



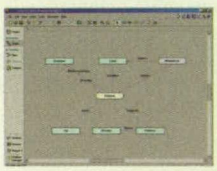
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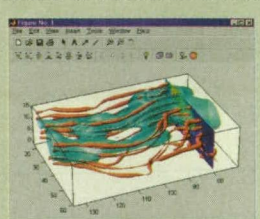
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TechOptimizer, from Invention Machine, Boston, MA (www.invention-machine.com), is a suite of knowledge-based innovation tools designed to help users state and solve engineering problems across many different fields. It includes modules for product and process analysis, functional modeling, problem solving, scientific principles, and prediction analysis, as well as a knowledge base of scientific effects and examples. TechOptimizer helps engineers state their problems correctly, create new concepts, and manage their technical knowledge. ***Circle No. 759***

Booth 7307

The MathWorks, Natick, MA (www.mathworks.com), will demonstrate version 6 of MATLAB technical computing software, part of Release 12 of its product family. MATLAB 6 includes a new desktop front-end and integrated tools that provide access to the software's math, analysis, visualization, and programming capabilities. Also featured are optimizations to the product's core matrix computing and signal processing engines, and access to hardware devices and Java directly from MATLAB. New functions enable viewing of 2D images, surfaces, and volumes as transparent objects; and visual tools for controlling point of view. ***Circle No. 755***



Booth 6152

Carlo Gavazzi Automation Components, Buffalo Grove, IL (www.carlogavazzi.com), offers brick programmable logic controllers that feature eight inputs and six outputs. The PLCs feature DC voltage inputs and relay outputs up to 60 I/O, eight PID control loops with auto-tuning, and eight pulse catch inputs. Free ladder programming software also is included.

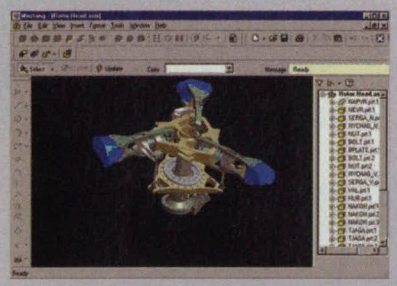
Booth 4920

Circle No. 770

EMKA, Middletown, PA (www.emka.com), will display a hinge that features a 180° opening, a lift-off option, and easy alignment on flush or projected doors. Other hinges are available for other door configurations. The hinges are made of zinc die casting with black powder coating, and the pivot pin is stainless steel. Locking pins are made of glass-reinforced nylon.

Booth 8238

Circle No. 774



A range of mechanical solutions, from 2D drafting to 3D modeling, will be shown by Autodesk, San Rafael, CA (www.autodesk.com). Products on display will include Autodesk Inventor, a 3D mechanical design system based on adaptive technology. The technology is a new mechanical CAD platform that allows engineers to transition from 2D to 3D design. Release 4 of Inventor includes more than 150 enhancements including DWG file compatibility, allowing AutoCAD customers to use their legacy data with Autodesk Inventor software. Surface design and sheet metal capabilities, as well as multilevel adaptive solving, are enhanced. Autodesk partners and developers also will showcase their manufacturing solutions.

Booth 6501

Circle No. 747

Booth 7760

Green Motor Blowers from Sunon, Brea, CA (www.sunon.com), are DC brushless blowers for use in laptops and other portable equipment. They measure 4.8 mm, operate at up to 90°C, and are available in seven sizes from 35 x 35 x 4 mm to 45 x 45 x 9 mm. The company also will show a series of CPU coolers for high-power chips. The four models come with the company's Vapo bearing system, and are designed to cool Pentium III and AMD Athlon chips up to 1 GHz. They also cool Intel Celeron and AMD K6 chips. *Circle No. 773*



Unigraphics Solutions, Maryland Heights, MO (www.ugsolutions.com), will demonstrate its Solid Edge Version 9 mechanical design software that features more than 300 enhancements for 3D CAD. New assembly modeling capabilities include a weldment design environment for modeling welded components in large machinery assemblies. Solid Edge Web Publisher, an integrated module of the program, enables users to create web content from Solid Edge design data. The module creates web pages with compact 3D product models that can be viewed and manipulated with the Microsoft Internet Explorer browser. The company also will feature software solutions for product design, manufacturing, visualization, data management, and e-business.

Booth 7511

Circle No. 748



The V530-R150 2D code reader from Omron Electronics, Schaumburg, IL (www.omron.com), reads bar codes on labels, printed circuit boards, metal, and glass. It features a teach mode for set-up and onscreen viewing, and an image analysis mode, which provides viewable decoding information. The unit stores up to 24 reading failures, allowing it to detect defective codes. Ten preset configurations or scenes permit adaptation to new reading conditions. A handheld programmer lets the user set up the system, read the 2D code, and know when errors are occurring in the code. It offers connectivity with its RS-232C interface, and three inputs and nine outputs.

Booth 4511

Circle No. 761

PlanetCAD, Boulder, CO (www.planetcad.com), provides infrastructure and software applications to automate the engineering data interchange across the manufacturing supply chain. Online applications include PrescientQA® design-quality software; 3Dshare.com™, a web-based application that automatically translates and heals 3D CAD models over the Internet; PlanetCAD Connect, which manages the delivery of project data to engineers in the supply chain; and Bits2Parts.com™, which streamlines the communication and data transmission between manufacturers and rapid prototyping service bureaus online.

Booth 6781

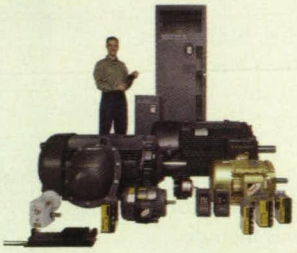


Circle No. 746

NASA, Washington, DC (www.nasa.gov), invites attendees to discover how technologies originally developed for the aerospace program can improve any company's bottom line. NASA has partnered with thousands of companies to help in the development of new products. There are hundreds of NASA technologies available for commercialization, and NASA will have information on some of those technologies available at the booth. The most commercially viable technologies can be viewed at www.nasatechnology.com.

Booth 9311

Circle No. 739

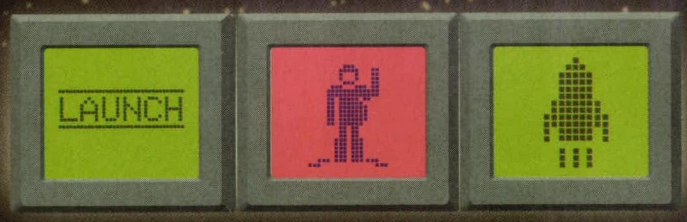


Motors and drives will be on display by Baldor Electric, Fort Smith, AR (www.baldor.com). AC induction linear motors, DC brush and brushless linear motors, linear motor controls, Lin-Drive, Lin+ Drive, and MintDrive product lines will be featured. Mini and micro inverter families of products will be highlighted with single and multi-axis servo and vector drives using a common keypad language. The MINT™ display of products will showcase the MINT motion control programming language, as well as the FlexDrive, Flex+Drive, and MINTDrive servo and positioning drives. *Circle No. 742*

Booth 6533

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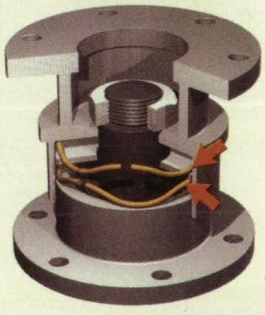
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NKK Switches, Scottsdale, AZ (www.nkkswitches.com), will showcase the IS series of software-controlled pushbutton switches that can be programmed to display an infinite variety of text, still images, or moving images. When grouped together, they also can display sequential information. They facilitate both side-by-side vertical and horizontal mounting, and feature backlit red/green illumination and 36 x 24 pixel resolution. The IS series switches provide a minimum of 3 million mechanical/electrical actuations. *Circle No. 743*



Booth 9152

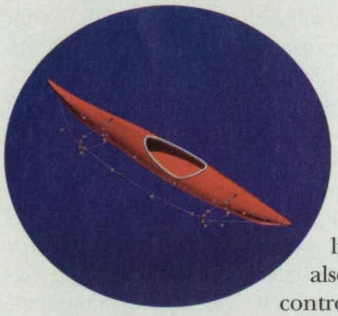


Wavo™ Springs, a line of compact round wire wave springs, will be showcased by Smalley Steel Ring, Wheeling, IL (www.smalley.com). The springs are designed to fit into tight radial and axial spaces. They are available in carbon and stainless steel in diameters from 1/2" to 6", and maintain their dimensional stability and load/deflection characteristics. Custom designs are available with diameters to 84". *Circle No. 744*

Booth 7351

Raindrop Geomagic, Research Triangle Park, NC (www.geomagic.com), will demonstrate Geomagic Qualify, an inspection tool that gives users the ability to compare a design model or original object to an as-produced part. Users can overlay, evaluate, and report the deviation between the ideal geometry of a design and the object built from the design. Features include automatic alignment for scanning data and CAD models, IGES and STEP import, tolerance and deviation computation, color mapping results, and HTML report generation for sharing inspection results in web-ready HTML documents. ***Circle No. 740***

Booth 7412



thinkdesign 6.0 3D mechanical design software will be exhibited by think3, Santa Clara, CA (www.think3.com). The software is designed to increase productivity by incorporating a new graphical user interface that eliminates command-line-driven user interfaces and dialog boxes. Users also have the option of speech-enabled command and control of the system. New 3D functions include Precision Shape Modeling, which allows users to make changes to CAD models very late in the design process and create complex surfaces through intuitive physical definitions of those surfaces. Smart Objects enable users to capture and reuse intelligent design elements, including profiles, solids, and shapes, and to build custom libraries by extracting geometry and design relationships from current or previous projects. ***Circle No. 738***

Booth 7901

Booth 9255

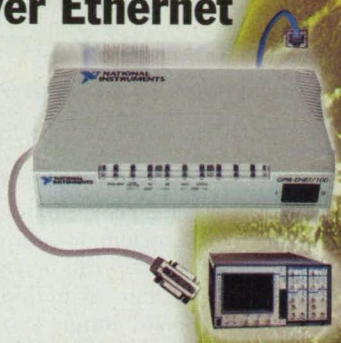
Surfware, Westlake Village, CA (www.surfware.com), will demonstrate SURFCAM® Design Plus modeling software for mechanical design and machining. The software is powered by the ParaLogix® OEM, a Parasolid®-based modeling kernel developed by Applied 3D Science. The Design Plus modeling design system automates the construction and editing of 2D and 3D models. Each aspect of a procedure, including its sketches, geometric relationships, features, and parameters are fully associative. Parametric solid modeling functions include compound extrusions, revolves, sweeps, lofts, constant and variable radius fillets, shells, and primitives for creating complex parts. Dimensions, equations, and calculations can be accessed and applied to any operation to modify the design. ***Circle No. 736***



Custom molded products on display by Sorbothane, Kent, OH (www.sorbothane.com), include molded products for applications requiring shock absorption, vibration isolation, and acoustic damping. Also on display will be sheet goods and an array of standard shock mounts and vibration isolators. Sorbothane is a proprietary material with vibration and shock absorption characteristics. It exhibits high damping properties over a wide temperature and frequency range, and may be cast into custom geometries. ***Circle No. 735***

Booth 7436

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A Personal-Computer-Based Physiological Training System

This system is an improved means of implementing autogenic-feedback training exercise.

Ames Research Center, Moffett Field, California

The Autogenic Clinical/Lab System (ACLS) is a personal-computer-based instrumentation system for physiological training. This system can be used to implement a program of multiparameter physiological conditioning known as autogenic-feedback training exercise (AFTE).

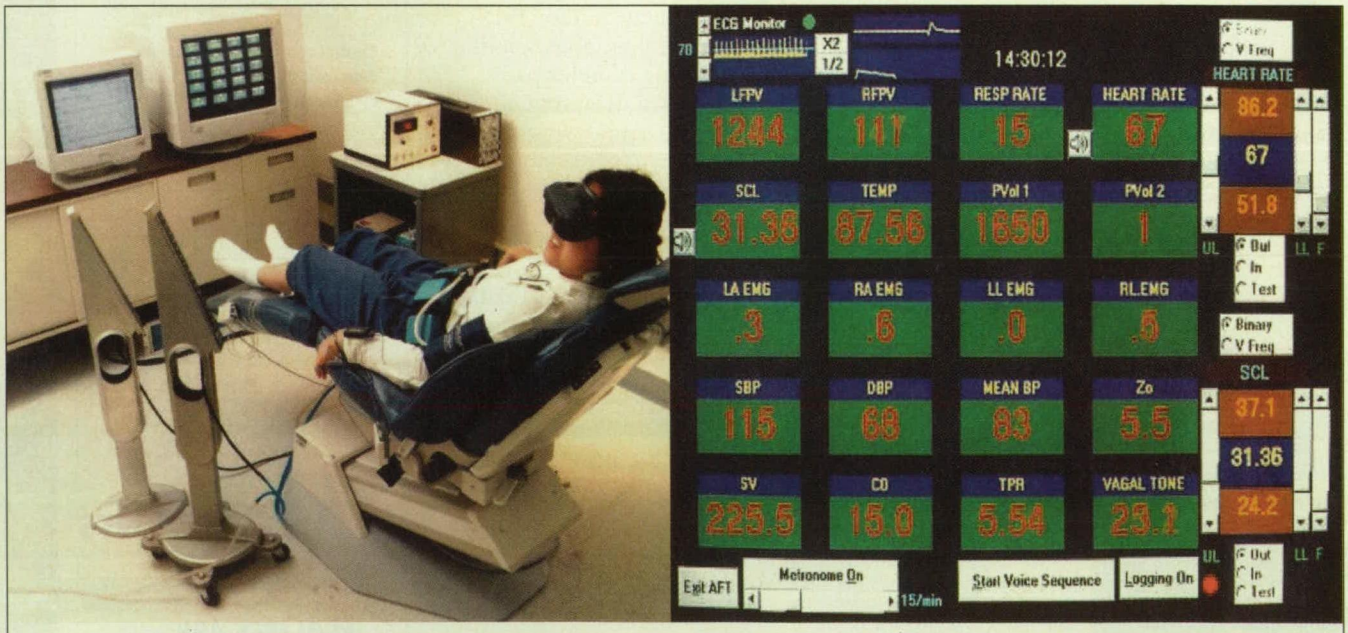
Ground-based research to study the physiological effects of microgravity is dependent upon the acquisition and processing of physiological data. In the past, the real-time processing of these data has been difficult to achieve because of a need for dedicated instrumentation to calculate and display such derived variables as cardiac output, vascular resistance, thoracic fluid changes, and vagus-nerve activity. The dedicated instrumentation tends to be physically large (nonportable) and expensive (because of engineering input needed to design and build specific functions), and it is difficult to modify algorithms. However, by changing from a design approach based on dedicated instrumentation to one based on digital processing of physiological and other data in a Pentium/100 or similar computer, it has been possible to construct a physically smaller system (the ACLS) that costs less and can be modified more easily through changes in software.

In both the U.S. and Russian space programs, a great deal of effort is being spent studying the effects of long-term exposure to reduced gravitational fields. The objective is to develop effective countermeasures that will minimize the deleterious effects of microgravity on the human body. The approach used by NASA/Ames researchers involves the use of AFTE to eliminate or reduce space motion sickness and the dizziness that can occur when flight crews return to the gravitational effects of a terrestrial existence.

AFTE in its current form is a six-hour training program based on a highly efficient and effective training method of enabling people to control voluntarily several of their own physiological responses to a variety of environmental stressors. The AFTE approach has been successful in combating intractable airsickness in pilots, and for improving pilot performance during search and rescue missions. In clinical studies with patients, substantial relief from symptoms of nausea, syncope, and severe abdominal pain has been observed.

AFTE, as implemented by use of the ACLS, involves the real-time acquisition and display of 16 input variables, 20 digitally displayed output variables (see figure), and printed averages, plus the generation of coupled audible tones, voice commands, and respiratory pacing signals. The software for the ACLS was written for the Windows 98 operating system, using Microsoft Visual BASIC. This software combination was chosen because of the ease with which one can develop visual displays and user interfaces.

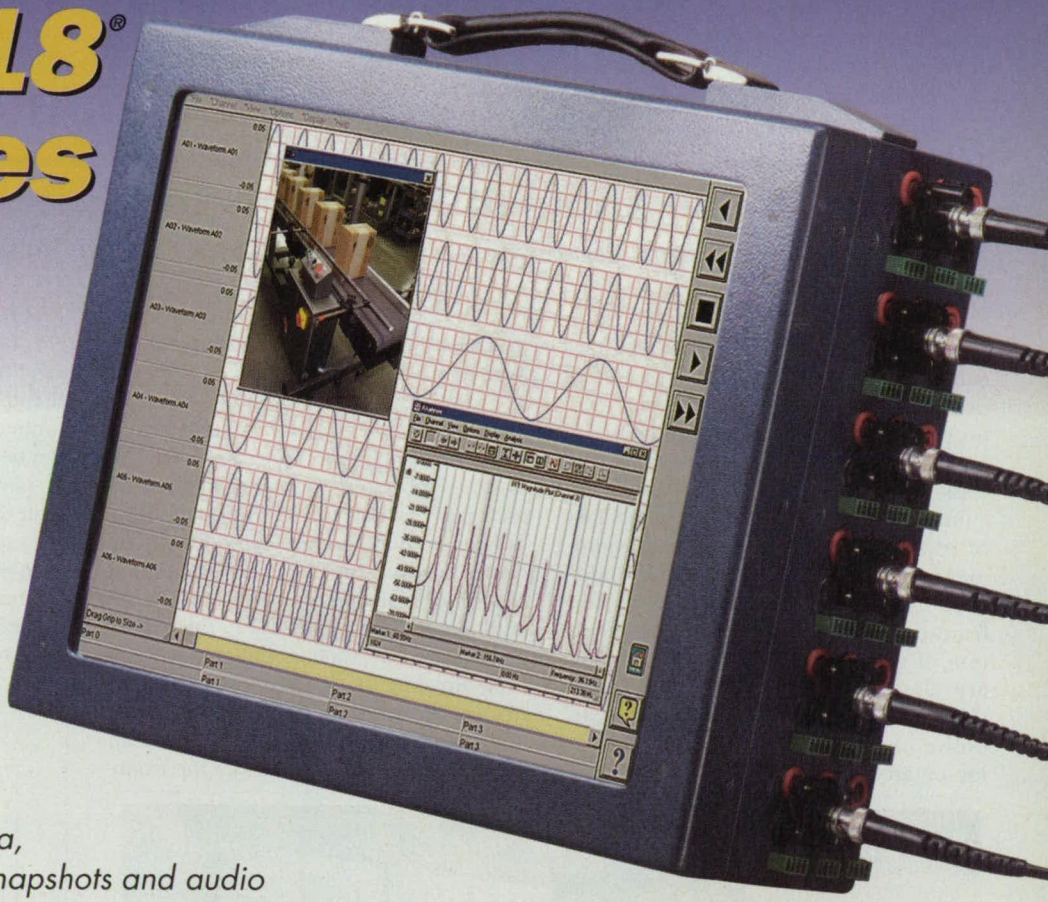
Analog data are collected by use of a commercial DI-200 data-acquisition board and WinDaq/200 data-acquisition software. Four video display adapters have been installed to enable the use of four video monitors on a single computer. The four monitors are configured to display various subsets of the available data, as follows: Each of monitors 1 and 2 makes as many as 16 channels of analog data available to the researcher and the subject; monitor 3 presents to the researcher digital meters of all calculated



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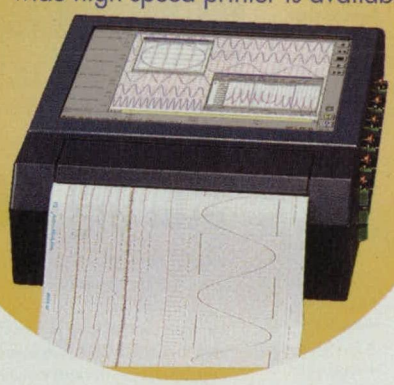


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variables; and in effectuating part of the training process monitor 4 shows selected digital meters to the subject.

Audible tones, coupled to any two of 20 derived parameters, can be selected by the researcher and presented to the subject. The tones are generated on the internal sound card of the personal computer by use of software developed in the C computing language and implemented under Visual BASIC.

This work was done by Patricia Cowings, Bruce Taylor, and William Toscano of **Ames Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

This invention has been patented by NASA (U.S. Patent No. 5,694,939). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Ames Research Center, (650) 604-5104. Refer to ARC-14048-2.

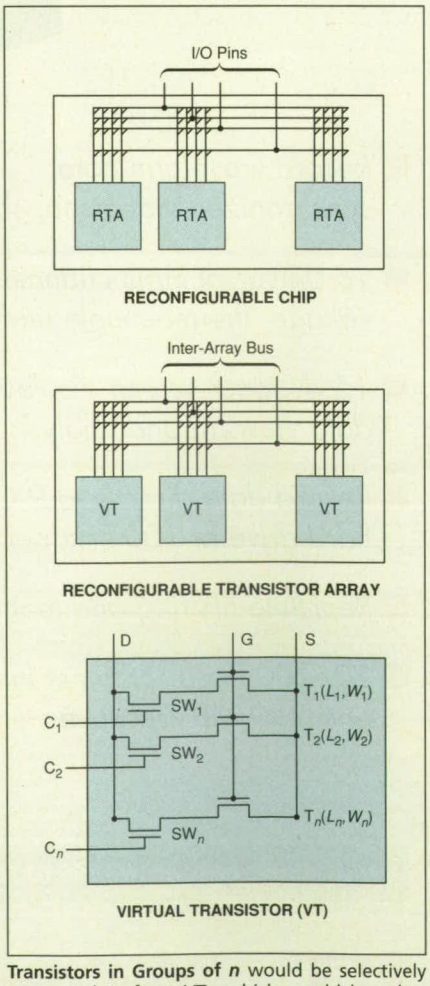
Reconfigurable Arrays of Transistors for Evolvable Hardware

Transistors in hierarchical arrays would be connected according to hierarchical control signals.

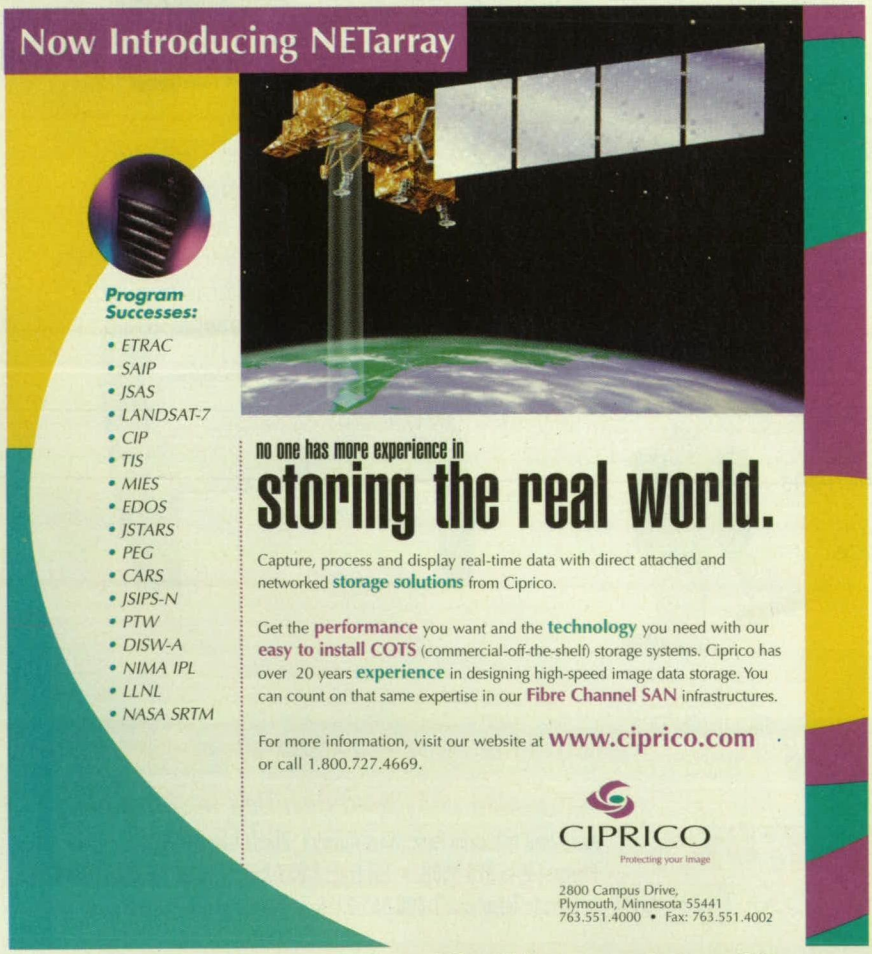
NASA's Jet Propulsion Laboratory, Pasadena, California

Very-large-scale integrated (VLSI) circuits containing electronically reconfigurable arrays of transistors have been proposed as means to implement a forthcoming generation of a special class of digital/analog electronic circuits. The class in question is a subclass of advanced electronic and other equipment of a type called "evolvable hardware" (EHW). The major distinguishing feature of EHW is that under the direction of genetic and/or other evolutionary algorithms, its configuration and thus its functionality can be made to evolve until it exhibits a desired behavior or adapts to the environment in a prescribed way. An EHW system is said to be extrinsic if its evolution is directed and evaluated by a computer or other external system. An EHW system is said to be intrinsic if it includes an electronic or other subsystem that automatically directs and evaluates its evolution.

The evolution of an EHW system includes selective, repetitive reconfiguration of a set of available resources and/or the addition of building blocks. In the case of electronic EHW, such reconfiguration typically involves the connection or disconnection of transistors, amplifiers, inverters, and/or other circuit building blocks in an array of such building blocks. One example of electronic EHW is a programmable logic device (PLD), which contains logic-circuit building blocks. A pattern of interconnections among the building blocks can be downloaded to configure the PLD to perform desired logic functions. In some PLDs, the interconnection patterns are established by irreversible means; in most others, interconnection patterns can be changed reversibly by coupling appropriate signals to designated electronic (e.g., transistor) switches.



Transistors in Groups of *n* would be selectively connected to form VTs, which would be selectively connected into RTAs, and so forth up the hierarchy.



For More Information Circle No. 416 or Visit www.nasatech.com/416

A VLSI circuit of the type proposed would be fabricated in complementary metal oxide/semiconductor (CMOS). It would contain hierarchical arrays and subarrays of transistors (see figure). Each subarray at the lowest level of the hierarchy would contain transistors T_i ($i = 1$ through n), each with a different combination of channel length and width (L_i and W_i, respectively). The sources and gates of all n transistors in the subarray would be connected to a common source (S) and a common gate (G) line, respectively. The gate of the ith transistor could optionally be connected to a common drain (D) line via an analog transistor switch SW_i by applying the corresponding control signal C_i.

Various combinations of electrical parameters would be associated with the various channel lengths and widths. Thus, one could choose one or more control signal(s) to connect one or more of the transistors T_i to make the subarray behave as though it were a single transistor [denoted a "virtual transistor" (VT)] with a desired analog or digital electrical behavior.

The VTs would be grouped into reconfigurable transistor arrays (RTAs), linked by inter-array buses. The RTAs could be similarly clustered on the chip with a bus connected to input/output (I/O) pins; alternatively, the hierarchy could be extended to one or more additional levels, ending in I/O pins at the highest level. The connections at the various levels of the hierarchy would be governed by a corresponding hierarchy of on/off control signals, ending in the previously mentioned control signals C_i at the lowest (transistor) level. With respect to a genetic algorithm for evolution of the overall configuration of circuitry on the VLSI chip, the portion of this hierarchy that ended at each transistor could be regarded as a chromosome fragment containing the genetic information for that transistor.

This work was done by Adrian Stoica of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free online at www.nasatech.com*** *under the Electronic Components and Systems category.*
NPO-20078

Active Tactile Display Device for Reading by a Blind Person

Heights of numerous pins would be varied to form patterns that could be felt.

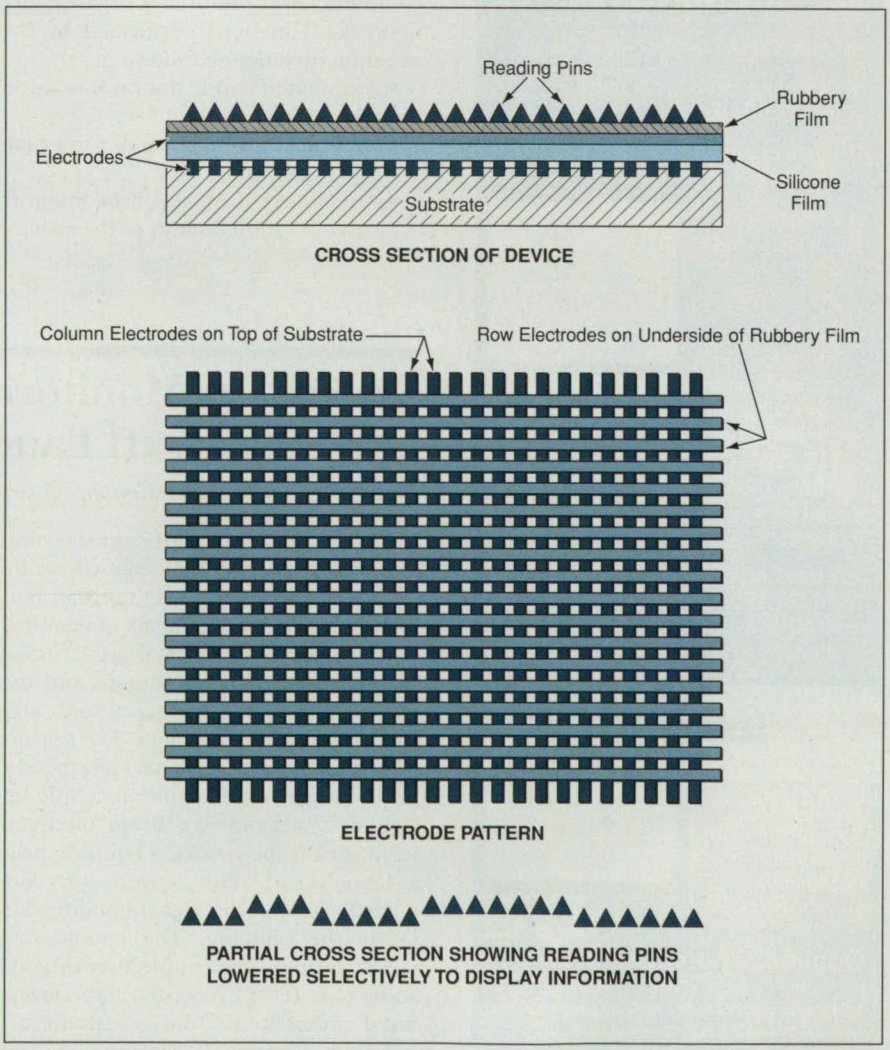
NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed active tactile display device would present textual and graphical information to a blind person. The concept of this device is a byproduct of recent research on the use of electroactive polymers to generate forces and displacements in novel robotic actuators.

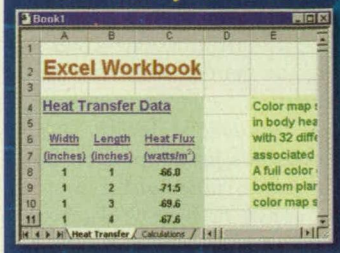
The display medium would be a planar array of small cones called "reading pins" (see figure). Under computer control, reading pins would be lowered individually or in groups to produce a tactile pattern of highs and lows representing the information to be read. A person would read the pattern by scanning with fingertips, as in reading conventional Braille print.

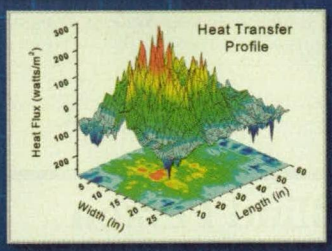
The pins would be lowered by use of an electroactive polymer; specifically, a silicone that, in film form, has been found to contract by as much as 30 percent when subjected to an electric field. The reading pins would be mounted on an electrically insulating rubbery film on top of a silicone film on top of a rigid, highly electrically resistive substrate.

A given reading pin would be lowered by applying a voltage across the thickness of the silicone film at the location directly under the pin. Electrodes to apply voltages at such locations would be formed on the top and bottom surfaces of the silicone film. The electrodes on each surface would be evenly spaced, parallel metal film strips, and the top and bottom electrode arrays would be crossed to obtain a square grid corresponding to the locations of pins to be

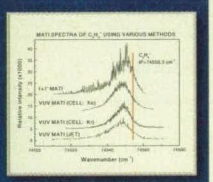
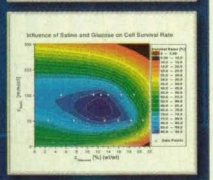
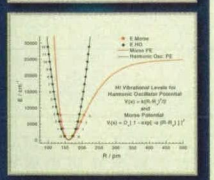
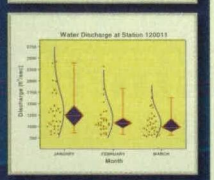


Reading Pins Would Be Pulled Down Selectively by electrostriction in the silicone film at intersections between selected row and column electrodes to which a voltage would be applied.

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lowered. The electrode films would be formed before assembling the layers by sputtering, onto the substrate and onto the rubbery sheet, a layer of chromium 50 Å thick followed by a gold layer 1,500 to 2,500 Å thick. The electrode films would be formed into the required patterns by photolithography or ink printing techniques.

Because the actuated pins would be pulled down, the information to be displayed would have to be formatted analogously to an image on negative film; for example, ridges representing lines in an image would be formed by pulling down pins to form valleys between the ridges. The resolution of the display could be selected by choosing the pixel widths of letters, numbers, and other characters.

This work was done by Yoseph Bar-Cohen of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*
NPO-20410

Program Automates Management of IBM VM Computer Systems

John F. Kennedy Space Center, Florida

The VM Automated System computer program was developed to satisfy a need for efficient management of operations in a large client/server computer network that includes multiple mainframe computers and multiple local-area subnetworks. Functions performed by the program include the following:

- Automated and operator-assisted scheduling,
- Graphical user interfaces for scheduling and monitoring,
- Automated diagnosis of the integrity and operational status of the system,
- Management of client/server application programs that depend on data and/or software that reside on other computers, and
- System-management functions (including shutting down or starting up a subsystem and/or system, with automation making it unnecessary for the system operator to memorize the proper sequence of commands).

This work was done by Stephen Scott Tribbey, Debra S. Sheets, Scott C. McIlroy, and Kirk P. Matthews of **Kennedy Space Center**.
KSC-11901

System for Monitoring the Environment of a Spacecraft Launch

John F. Kennedy Space Center, Florida

A system that includes sensors and computers that communicate via an intranet enables both real-time monitoring and subsequent analysis of acoustic, overpressure, and thermal aspects of a spacecraft-launch environment and the structural response (vibration and strain) to that environment. The sensors include microphones, accelerometers, strain gauges, and a thermocouple attached to a cantilever beam mounted vertically on the roof of a building near a launch pad. The sensors are connected via cables to signal conditioners inside the building. The conditioned sensor outputs are coupled to a digital audio tape (DAT) recorder that is monitored and controlled by a computer denoted the "remote" computer. A host computer in a different building communicates with the remote computer via the intranet, using the Transmission Control Protocol/Internet Protocol. Ambient test conditions can be monitored in real time before a launch. Last-minute adjustments can be accomplished remotely and dynamically. A few minutes before the launch, the DAT recorder is turned on to record launch events. Data can be monitored in real time during the launch. After the launch, data can be copied from the DAT recorder onto the remote computer and then transferred to the host computer for plotting and analysis.

This work was done by Raoul E. Caimi of **Kennedy Space Center** *and Ravi N. Margasahayam of Dynacs Engineering Co., Inc.*
KSC-12060



Greco Systems, El Cajon, CA, offers the RCS 10000 **rugged portable computer** that is MIL-STD-810E tested and certified to withstand heat, shock, and vibration. It features a trackball keyboard that is hinged to close while the system is operational, or is manually removable for remote data entry. The unit also is TEMPEST Level II qualified for data security.

The system prevents RFI and EMI emissions, and also eliminates electrical interference with other equipment. An airflow design keeps the system cool, and an auto-seeking power supply with optional battery backup and DC capability are included in the event of power failure. A modular component design allows easy maintenance and repair.

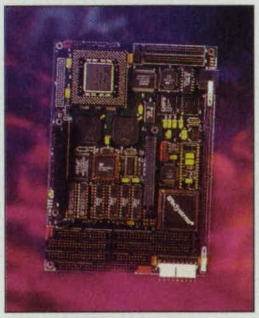
For More Information Circle No. 718



Measurement Computing Corp., Middleboro, MA, has introduced the Satellite Series **PCI expansion chassis** that is compatible with PC, Macintosh, or Sun systems. The rugged aluminum unit includes an internal monitoring system that continually measures power supply voltages, air temperature between each slot, and cooling fan functionality. Software supplied with the chassis allows users to monitor the system.

The chassis adds eight slots to any PCI-compatible computer. The tabletop PCI chassis provides access to system boards with the removal of two screws, and provides front-access connections for field wiring. Each chassis has a 32-bit and 33-MHz embedded Intel 21150-AC bridge chip for compatibility with all PCI computers.

For More Information Circle No. 719



WinSystems, Arlington, TX, offers the EBC-TXPlus **single-board computer** that features an Intel 166-MHz CPU and an operating temperature from -40 to 85°C. The computer includes a video controller with CRT and flat-panel support, 10/100 Mbps Ethernet controller, four serial channels, 48 bi-directional digital I/O lines, and solid-state disk support. A 16-bit PC/104 and PC/104Plus connector supports additional expansion modules such as modems and frame grabbers.

The CPU chipset includes the DRAM controller, internal PCI bus, external PC/104 bus, real-time clock, and integrated peripherals including a timer, interrupt, and keyboard controllers. A 3.5/5.25" floppy disk controller and PCI EIDE hard disk interface are included. The board features up to 128 MB of system SDRAM with standard 72-pin SIMM devices. Windows, Linux, and other operating systems are supported.

For More Information Circle No. 720



The DS1957B iButton® from Dallas Semiconductor, Dallas, TX, is a Java™-based **wearable computer** that serves as a physical key for touch-and-go access to buildings, as well as computer key for secure network log-on. The 16-mm steel-encased unit is a Java computer with a 64-byte ROM and 134-byte RAM that can store more than 30 public-key certificates. It also can store hundreds of user names and passwords, a color photo, and application programs.

The computer can have multiple Java applets residing at the same time for applications such as rapid Internet form-filing, digital signatures for e-commerce, user names and passwords, and secure network log-on. The unit can be worn on a keychain, watch, badge holder, metal card, or other accessory. The device features a USB connector that can be connected to any computer with a USB port.

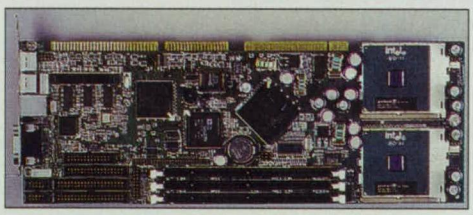
For More Information Circle No. 716



Stacoswitch, Costa Mesa, CA, has introduced a molded elastomer **panel-mount keyboard and pointer mouse** for rugged applications in computer control and instrumentation. The full-size QWERTY keyboard features 104 keys and has a built-in pointer mouse. The mouse is a pressure-sensitive device compatible with most user interfaces. Both devices are PS/2 compatible and may be lighted.

The unit comes in charcoal black or gray base colors and features plastic keycaps. The keyboard is sealed to resist dust and water to NEMA-4 ratings. Custom legends for foreign markets are available, as well as a military-grade version.

For More Information Circle No. 715



The NuPRO-800 side-by-side **single-board computer** from ADLINK Technology America, Irvine, CA, features two Intel® Pentium® III FC-PGA processors using the 443BX embedded chipset. The board is designed for fault-resistant applications in motion control, process control, automation, medical, and other industries.

Both processors are placed on the tail of the board, allowing use of additional slots for other single-board computers or application cards. The board uses an AGP-bus VGA/LCD controller, and features 1600 x 1200 resolution. It supports 66 and 100 MHz bus speeds, and offers two USB ports, a floppy interface supporting two floppy drives, a parallel port, two serial ports, and a standard 10/100 BaseTX interface.

For More Information Circle No. 717

Measurement of Stresses and Strains in Muscles and Tendons

Small, electrically and chemically neutral sensors would be implanted surgically.

NASA's Jet Propulsion Laboratory, Pasadena, California

Miniature fiber-optic-coupled sensors based on optically excited, self-resonant microbeams are being developed for measuring stresses and strains within muscle fascicles and tendons. These sensors could be used in medical and biological research on humans and other animals, or to obtain data for the design of lifelike robots.

Each sensor has typical dimensions of about 1 by 1 by 0.1 mm. These dimensions are suitable for surgical implantation in muscle and tendon tissues; these dimensions are also comparable to diameters of cores of multimode optical fibers, making the sensors amenable to fiber-optic coupling.

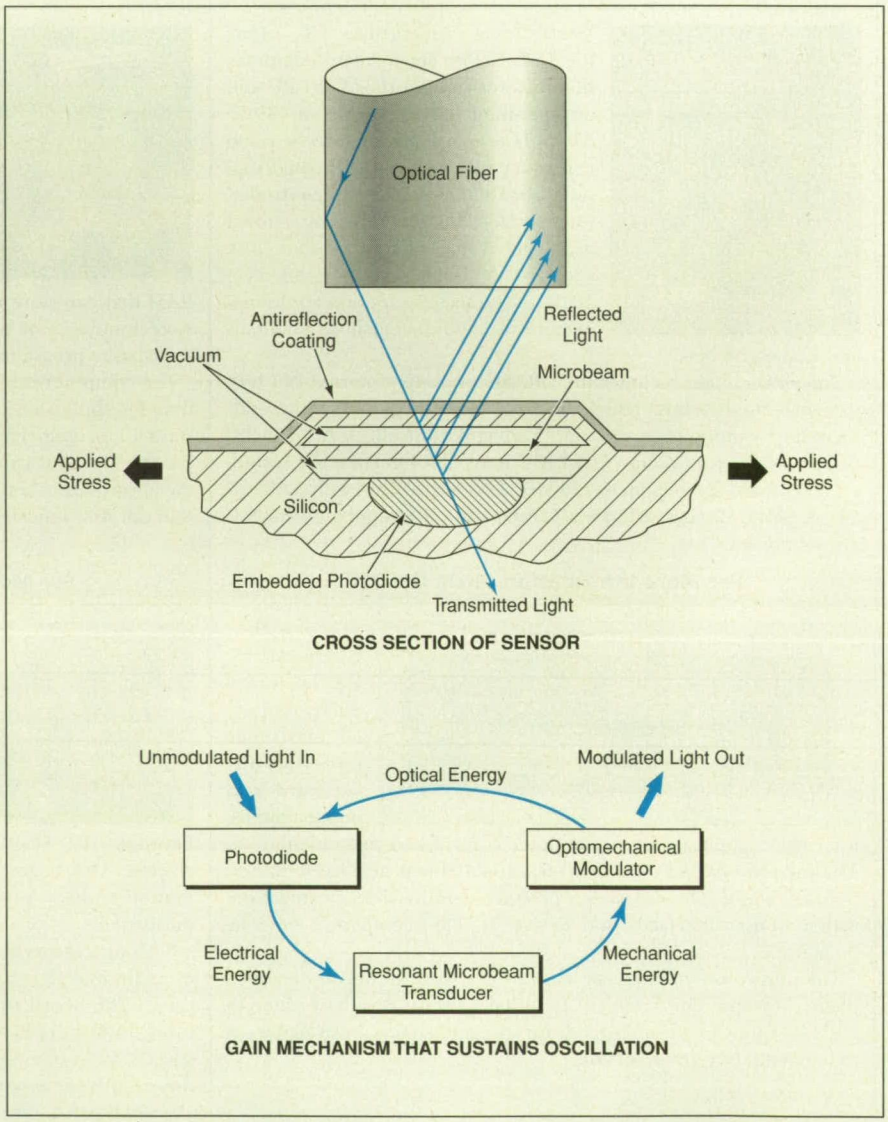
The figure depicts the main transducer portion of a sensor of this type and its mode of operation. The sensor contains a microbeam that has been micromachined as an integral part of a polysilicon housing. The microbeam is suspended in a vacuum cavity in the housing, over an embedded photodiode. The microbeam vibrates at a resonance frequency of the order of a megahertz, with a resonance quality factor (Q) of about 10^5.

The sensor exploits a unique gain mechanism that involves the exchange of optical, electrical, and mechanical energy during each cycle of oscillation: When the sensor is irradiated with infrared light via an optical fiber, the electric charge photogenerated in the diode electrostatically deflects the beam, setting the beam into vibration at its resonance frequency. Because the microbeam-and-cavity structure constitutes a Fabry-Perot interferometer, vibration of the beam modulates the transmitted light, thereby modulating the photovoltage and thereby, further, sustaining the oscillation.

Vibration of the beam also modulates the infrared light reflected back along the optical fiber. The reflected light is converted to a quasi-digital pulse stream by a photodetector, and the pulse-repetition frequency (equal to the frequency of vibration) is measured to obtain an indication of the physical quantity of interest (stress or strain).

For measuring stress or strain, the microbeam and housing must be configured such that the resonance frequency varies with longitudinal stress applied to the housing. The stress could be applied to the sensor via fibers or ribbons attached to a tendon. If the sensor is to be used to measure strain in a tendon, then both fibers or ribbons must be nonextensible and are attached to the tendon. If muscular tension is to be measured, then both fibers or ribbons must be nonextensible and attached to the loose ends of a severed tendon. If muscle extension/retraction is to be measured, then one fiber or ribbon must be nonextensible while the other is extensible by a known amount.

This work was done by James Weiss and Frank Hartley 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 Test and Measurement category.*
NPO-20464



An **Optically Excited, Self-Resonant Microbeam** vibrates when illuminated by infrared light via an optical fiber. Light reflected back along the fiber is modulated at the vibrational frequency, which varies with the stress applied to the silicon housing.

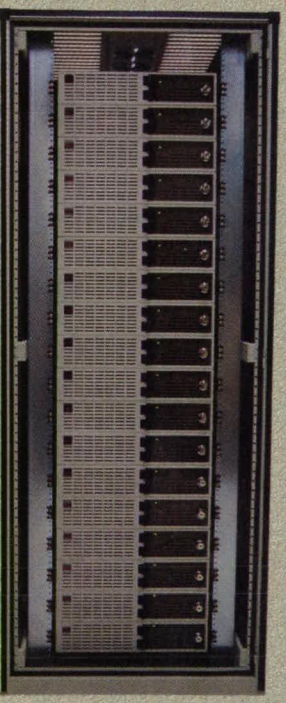
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For More Information Circle No. 538

Optical Measurement of Temperatures in Muscles and Tendons

Small, electrically and chemically neutral sensors would be implanted surgically.

NASA's Jet Propulsion Laboratory, Pasadena, California

Miniature fiber-optic-coupled sensors based on optically excited, self-resonant microbeams have been proposed for measuring temperatures within muscle fascicles and tendons. The proposed sensors could be used in medical and biological research on humans and other animals. The proposed sensors would be variants of those described in several previous articles in *NASA Tech Briefs*: "Proximity Measurement of Pressure and Temperature" (NPO-20223), Vol. 22, No. 1 (January 1998), page 48; and "Measurement of Stresses and Strains in Muscles and Tendons" elsewhere in this issue.

Each sensor would be made of electrically nonconductive materials that are chemically and galvanically inert with respect to living tissue. Typical sensor dimensions would be about 0.5 by 0.5 by 0.1 mm. These dimensions are suitable for surgical implantation in muscle and tendon tissues; these dimensions are also comparable to diameters of cores of multimode optical fibers, making the sensors amenable to fiber-optic coupling.

Each sensor would contain a cantilever microbeam located in a vacuum cavity in a housing. The beam would serve as an optomechanical resonator (as explained below) with a resonance frequency of the order of a megahertz and a resonance quality factor (Q) of the order of 105. The beam would face an integral, embedded photodiode that would be coupled to external instrumentation via a multimode optical fiber. Taken together, the beam and vacuum cavity would constitute a quarter-wave Fabry-Perot interferometric structure.

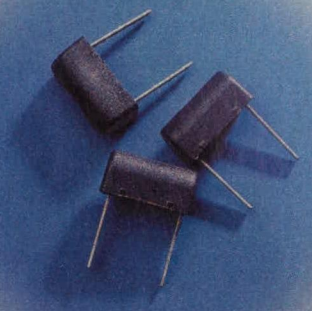
Optical excitation supplied via the optical fiber would cause the photodiode to generate a voltage that would bend the beam via electrostatic attraction. Following initial bending, the beam would vibrate at its natural resonance frequency. Because the beam and vacuum cavity would constitute a quarter-wave Fabry-Perot interferometric structure, the vibrations would give rise to modulation of the incident light reflected from the beam. The modulation of the light would alter the photovoltage and thereby contribute to a feedback mechanism that would sustain the resonant vibration. In addition, the modulated light reflected into the fiber would travel to the far end of the fiber, where a photodetector would convert the modulation to a quasi-digital stream of electrical pulses. The pulse stream would be fed to a counting circuit to determine the frequency of vibration.

The beam would be made of polycrystalline silicon doped to have a high thermal coefficient of stiffness, so that its resonance frequency would vary appreciably with temperature. Typically, the temperature coefficient would be such that measurements of frequency could be converted to temperature measurements with resolutions as small as a millidegree. The dynamic range of the sensor would be of the order of 108.

This work was done by Frank Hartley of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Test and Measurement category.*
NPO-20562

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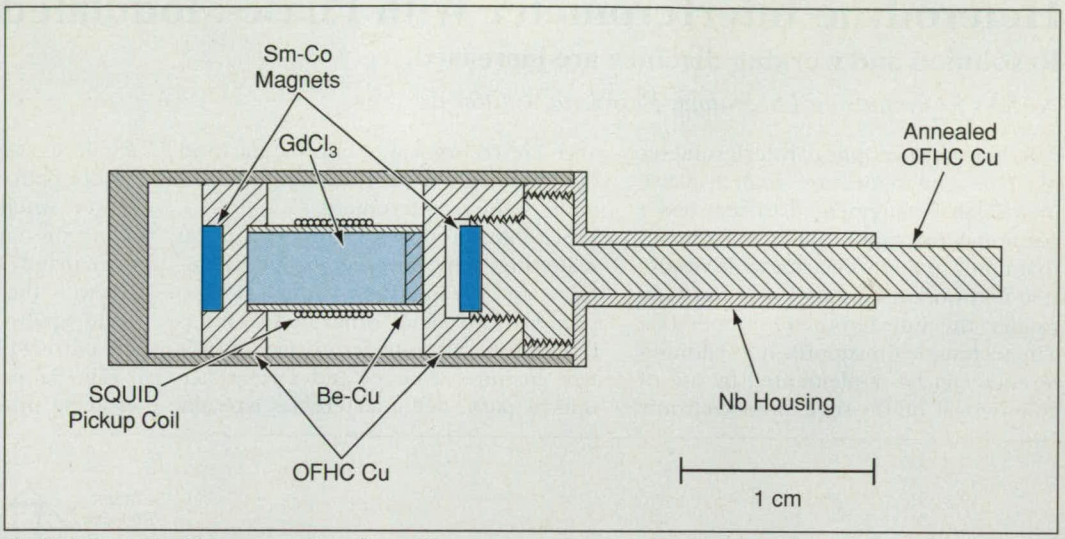
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Small Low-Temperature Thermometer With Nanokelvin Resolution

The magnetic field is generated by permanent magnets instead of a solenoid.

NASA's Jet Propulsion Laboratory, Pasadena, California

An improved high-resolution thermometer (HRT) for use in scientific experiments at temperatures <4 K has been developed. Like other, previously developed low-temperature HRTs, this device is based on the strong temperature dependence of the magnetization of a paramagnetic salt exposed to a magnetic field. However, in comparison with other paramagnetic-salt HRTs, this one is smaller and less massive; hence, it is denoted "sHRT" — short for "small HRT."



This **High-Resolution Thermometer** is smaller and less massive, relative to prior thermometers based on paramagnetic salts.

The temperature-sensitive part of an HRT of this type is a pill-like piece of the paramagnetic salt $GdCl_3$. The magnetization of the salt pill is measured by use of a superconducting quantum interference device (SQUID). In an older device of this type, the magnetic field needed to magnetize the pill is trapped in a long superconducting tube (flux tube) that must be charged by use of a superconducting solenoid; typically, the overall length and mass of such an HRT are ≈0.3 m and ≈10 kg, respectively. In contrast, the length and mass of the sHRT are ≈3 cm and ≈7 g, respectively.

The reductions in size and mass are made possible by using permanent magnets instead of a charging solenoid and flux tube to impose the magnetic field. In the sHRT (see figure), two small samarium cobalt permanent magnets are placed near opposite ends of a beryllium copper cylinder filled with $GdCl_3$. To enhance the thermal link between the $GdCl_3$ and the immediate surroundings, the ends of the Be-Cu cylinder are capped with oxygen-free high-conductivity (OFHC) copper blocks, into which numerous chimney-shaped fins have been machined. A SQUID pickup coil made of Nb-Ti wire is wound on the Be-Cu cylinder. The sHRT housing is made of Nb, which is a superconductor and thus effective in shielding the pickup coil against any ambient magnetic field.

In tests, the sHRT was found to yield measurements with a temperature resolution of $\approx 10^{-9}$ K at a temperature near the liquid-gas critical point of ^{3}He (≈3.31 K). The drift rate of the sHRT was found to be $< 2 \times 10^{-13}$ K/s.

This work was done by Inseob Hahn 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 Test and Measurement category.*

NPO-20903

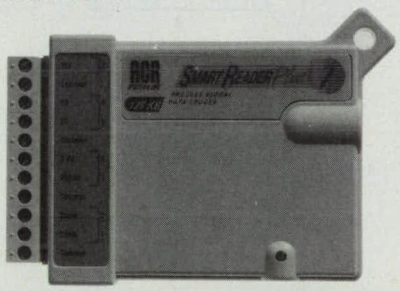
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Heterodyne Interferometer With Phase-Modulated Carrier

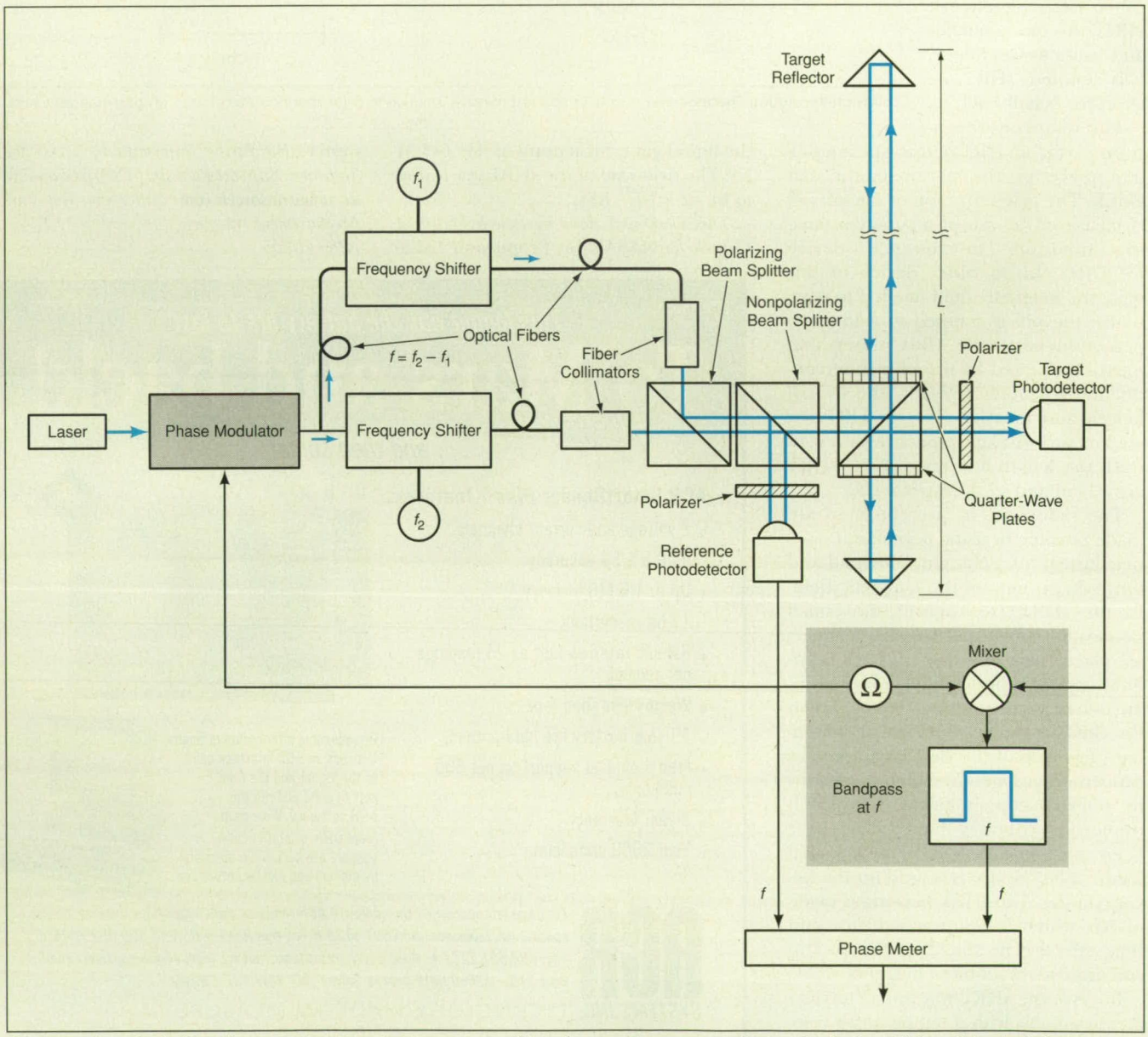
Resolution and working distance are increased.

NASA's Jet Propulsion Laboratory, Pasadena, California

A heterodyne optical interferometer of a type used to measure small displacements can be augmented to suppress a phenomenon, called "self-interference," that tends to limit the achievable resolution and working distance and can even render the interferometer inoperable. The technique for suppressing self-interference can be implemented by use of commercial off-the-shelf optoelectronic and electro-optical components, and does not degrade the fundamental operation of the interferometer.

Self-interference is caused by optical scattering, imperfections in optical surfaces, and misalignment of optical components. Like many other optical interferometers, an interferometer of this type includes a target and a reference optical path. Self-interference typically manifests itself as leakage, along the reference path, of part of the optical signal power intended to propagate solely along the target path. This leakage, in turn, manifests itself as a heterodyne signal with the incorrect phase that competes against the heterodyne signal with the correct phase.

The figure schematically depicts a heterodyne interferometer configured for



This **Heterodyne Optical Interferometer** is augmented to suppress self-interference. The augmentation consists in the addition of the shaded parts.



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• Ohms	100μΩ – 120MΩ	1μΩ – 120MΩ	1μΩ – 1GΩ	100nΩ – 1GΩ
• DC amps	10nA – 3A	1nA – 3A	10pA – 2.1A	10pA – 2.1A
• AC amps	1μA – 3A	1μA – 3A	100pA – 2.1A	100pA – 2.1A

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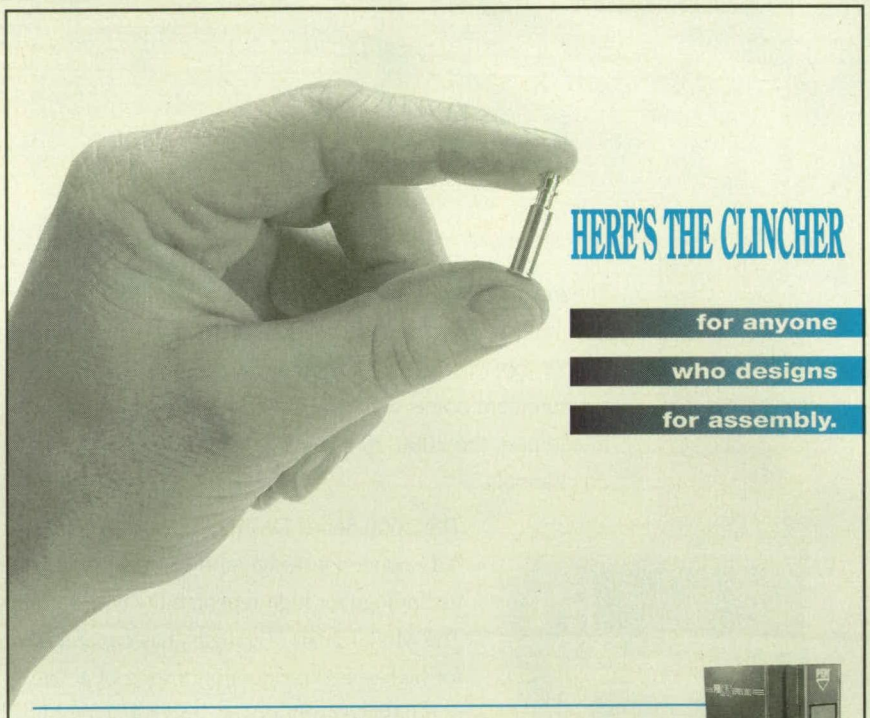
measuring a target path of length L. This interferometer is augmented to suppress self-interference by using phase modulation to distinguish between the leaked signal and the signal returning from the target. The following is a summary of the self-interference-suppression technique, omitting some details for the sake of brevity:

The optical carrier wave (that is, the beam coming out of the laser) is phase modulated at an angular frequency Ω before it is sent along the two paths of the interferometer. The phase modulation, by itself, is invisible to the photodetectors at the reference and target photodetectors unless it is converted, by the phase delay of one path of the interferometer relative to the other, to intensity modulation at the modulation angular frequency Ω. The self-interference signal is associated with light that does not go to the target and thus does not undergo the differential delay that would give rise to this intensity modulation.

The "good" signal is associated with the optical beam that goes to the target and thus does undergo the differential delay that gives rise to intensity modulated at angular frequency Ω. Thus, demodulation by mixing with the oscillator signal at angular frequency Ω results in discrimination against all but the "good" signal.

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

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, NASA Management Office–JPL (818) 354-4770. Refer to NPO-20740.



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Rechargeable Batteries Based on Intercalation in Graphite

Batteries could be recharged thermally or electrically.

NASA's Jet Propulsion Laboratory, Pasadena, California

Storage batteries based on intercalation of lithium and bromine in graphite have been proposed. Like other storage batteries, these could be recharged electrically. Optionally, these batteries could also be recharged thermally at relatively low temperatures — by use of solar or waste heat, for example. In comparison with thermocouples and thermionic devices, the proposed batteries would generate much greater potentials (about 4 V per cell versus millivolts per thermocouple or thermionic device) and would convert heat to electricity with greater efficiencies.

A cell in a battery of this type would include a graphite anode and a graphite cathode surrounded by lithium bromide dissolved in a nonaqueous solvent like diethyl carbonate, dimethyl carbonate, dioxane, propylene carbonate, ethylene carbonate, or a mixture of two or more of these compounds. The two electrodes would be separated by an ion-exchange membrane impermeable to bromine [or Br_3^- ions (see Figure 1)]. It is known from prior research that graphite forms intercalation compounds with halogens and with alkali metals. It is also known from prior research that intercalation of a halogen (in this case, bromine) leads to a posi-

tive charge on the graphite and negative charge on the halogen atoms, while intercalation of alkali metal (in this case, lithium) leads to a negative charge on the graphite and positive charge on the alkali metal atoms.

In the fully charged state, the anode would be loaded with lithium, and there would be free liquid bromine in the compartment surrounding the cathode. During discharge, bromine would become intercalated into the cathode, while lithium would come out of the anode. At the end of the discharge, the anode would not contain an appreciable amount of lithium, while the cathode would contain the intercalation compound CBr_x. The discharge processes at the anode and cathode could be driven electrically in reverse to charge the cell in the customary way.

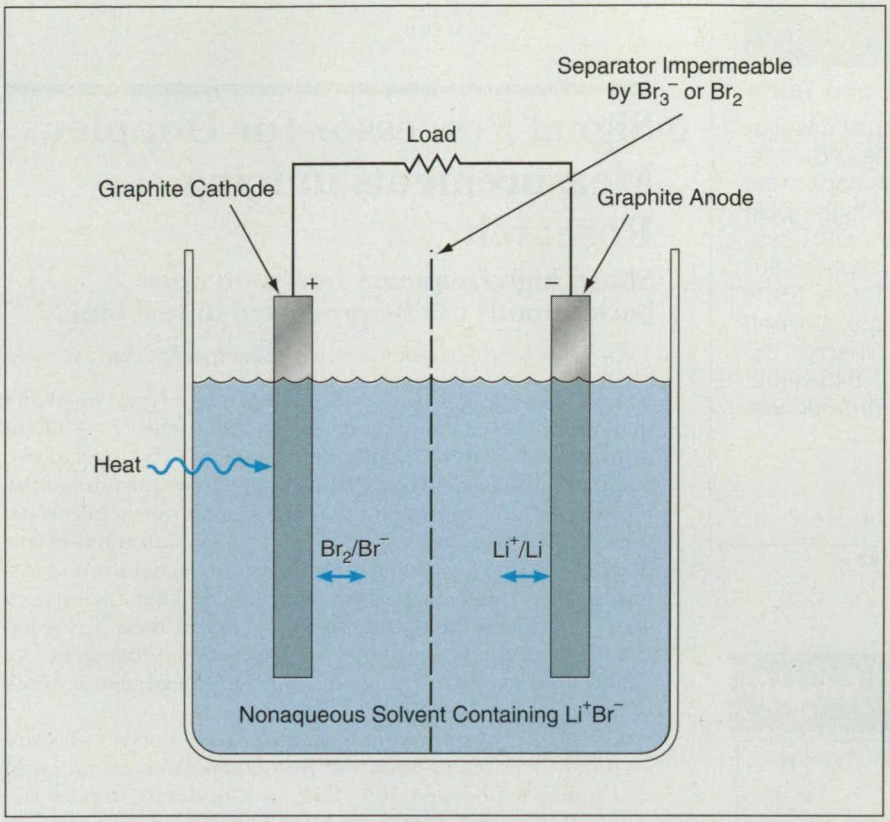


Figure 1. This **Rechargeable Electrochemical Cell** would exploit the reversible intercalation of lithium and bromine in graphite.

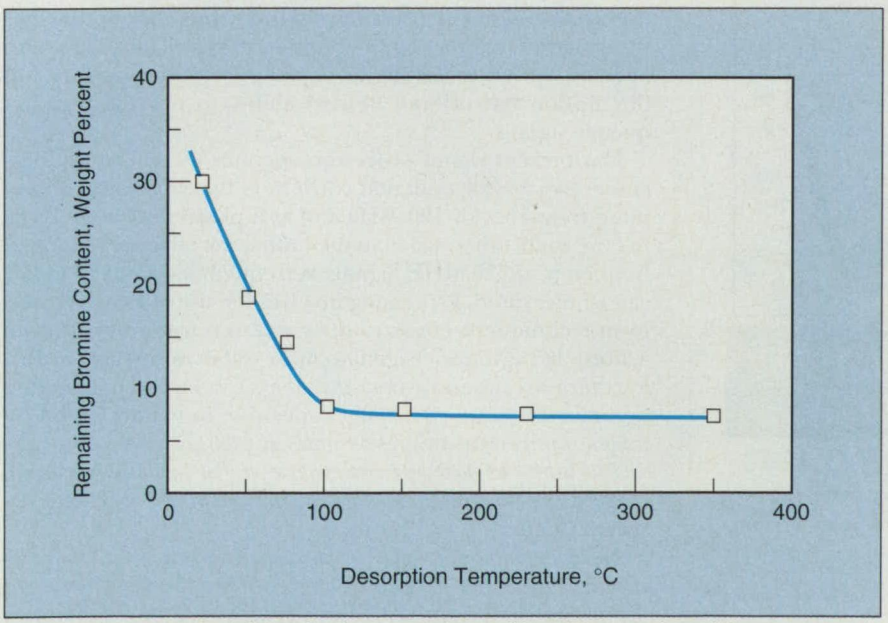
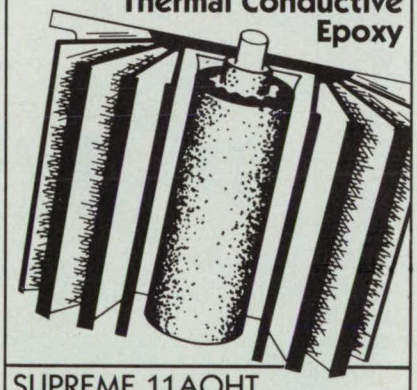


Figure 2. The **Desorption of Bromine** from a specimen of bromine-treated graphite was measured while the specimen was heated to progressively higher temperatures in vacuum.

The expectation that one could also recharge the cell thermally is based on the observed temperature dependence of the intercalation of bromine in graphite. Figure 2 illustrates the results of an experiment in which most of the bromine previously intercalated in a graphite specimen was driven out by heating to a temperature of 120 °C. To utilize this phenomenon to recharge the cell, one would first make an external electrical connection between the cathode and anode, then heat the cathode to drive out the bromine. The resultant electrical current through the external connection would cause lithium to become intercalated into the cathode. One would then break the external electrical connection, then allow the cathode to cool to ambient temperature, at which point the cell would be ready for discharge.

Also, during the process of thermal recharging, a voltage equal and opposite to the reversible potential of the cell must be included in the charging circuit in order to enable recharge. If such a voltage is provided by another cell of the same type, then such a two-cell system will operate as a thermally regenerative device with one cell being charged and the other undergoing discharge. The

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cell undergoing charge would be kept at a higher temperature compared to the cell being discharged.

This work was done by Pramod K. Sharma, Sekharipuram Narayanan, and Gregory S. Hickey of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

This invention has been patented by NASA (U.S. Patent No. 6,042,964). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office–JPL (818) 354-4770. Refer to NPO-19824.

Signal Processor for Doppler Measurements in Icing Research

Short, high-frequency bursts on noisy backgrounds can be processed in real time.

John H. Glenn Research Center, Cleveland, Ohio

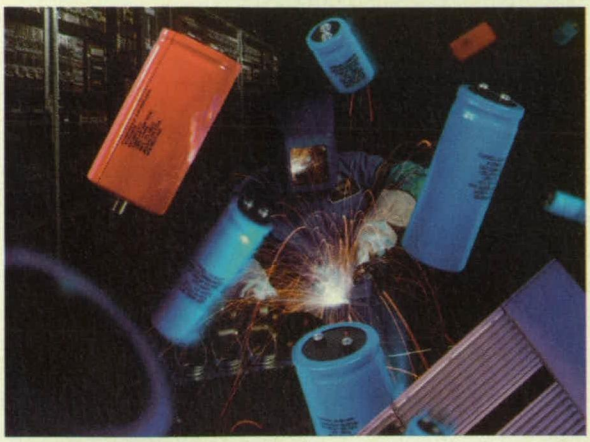
An advanced signal processor has been developed to enable high-resolution measurement of the frequency and phase shifts of noisy laser Doppler velocimeter (LDV) and phase Doppler particle analyzer (PDPA) signals. The purpose of the measurements is to exploit the phase Doppler principle to determine the sizes and velocities of droplets entrained in airflows. By enabling such measurements, this signal processor is making it possible to perform ground-breaking research in icing of airplanes and combustion of liquid fuels, involving (1) water-droplet-laden, high-speed airflows that simulate clouds flowing past airplanes and (2) high-speed, dense sprays of liquid fuels, respectively.

The phase Doppler signals of interest are bursts with transit times <1 μs, components at frequencies that range up to and somewhat beyond 100 MHz, and moderate-to-poor signal-to-noise ratios. Heretofore, there has been an option to postprocess the signals in a computer; of course, this option precludes real-time processing. There has been an option to use analog signal-processing circuitry, but this option has necessitated higher signal-to-noise ratios. There has also been an option to use digital signal-processing circuitry, but this option has offered limited ability to process high-frequency signals.

The present signal processor operates in real time. It includes two analog-to-digital converters that operate at a sampling frequency of 160 MHz and at a phase shift of 90° relative to each other, so that they offer an effective sampling frequency of 320 MHz. Signals at frequencies up to 150 MHz can be measured. Processing involves the use of Fourier-transform techniques to detect bursts and to retrieve signals from a noisy background (signal-to-noise ratio as low as –5 dB). Furthermore, accurate measurements can be taken in limited numbers of samples, making it possible to extract useful information in transit times as small as 0.25 μs.

This work was done by Larry Berkner of TSI Inc. and Khalid M. Ibrahim and William D. Bachalo formerly of TSI Inc. for **Glenn Research Center.**

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16993.



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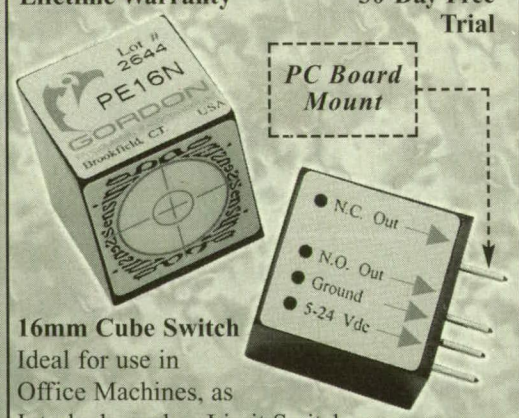
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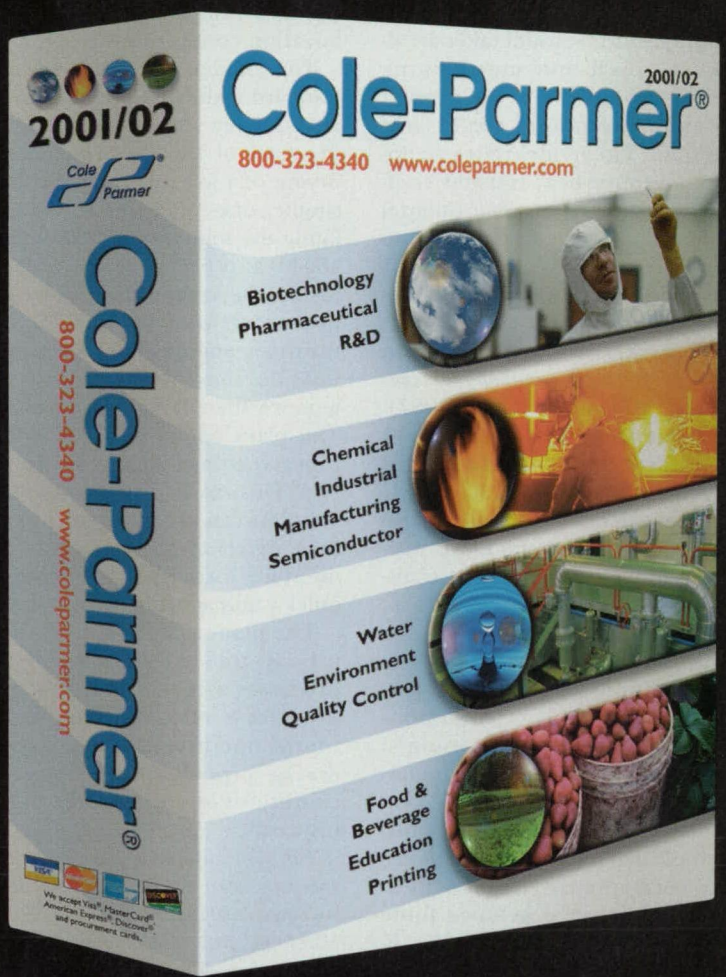
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Model Optimizes Drying of Wet Sheets

TECH BRIEFS
MODEL AND SIMULATION EXCHANGE

Inefficient drying tunnels waste power, time, and inventory.

Beam Technologies, Waltham, Massachusetts

Paper, tea, tobacco, and other food and industrial goods use drying tunnels to remove moisture from wet product sheets during manufacture. The tunnels operate using a fan to supply drying air to the product sheet through an orifice plate. Unfortunately, under some supply conditions, little or no drying occurs. However, by running the tunnels under optimized conditions, one drying tunnel can save up to 10% of the cost of power alone. Inventory control benefits can add to the savings. A model has been created (http://nasatech.innovationchain.com/solution.asp?SN=201) that determines the settings necessary to achieve these optimum conditions.

Computational Fluid Dynamics (CFD) engineers faced with the challenge of simulating the drying tunnel typically grid the whole tunnel geometry and attempt to solve the discretized governing equations over the whole domain. This approach suffers from the difficulty of successfully capturing all the turbulence length scales involved in the process: a drying tunnel can be more than a hundred meters long, whereas the smallest turbulence length scales could be as small as a few millimeters. Currently, CFD engineers use DNS (direct numerical simulation), LES (large eddy simulation), or some turbulent closure model coupled with the governing equations. All of these simulation methods are computationally very intensive and time-consuming.

The drying tunnel model takes an alternative approach and uses existing engineering correlations to predict the heat and mass-transfer coefficients for the tunnel. The model relies on applying a convective heat transfer coefficient determined from experimental data and on prescribed orifice plate array geometry. The relationship currently applied is referenced and presented in Hollworth and Cole's "Heat Transfer to Arrays of Impinging Jets in Crossflow" from the *Journal of Turbomachinery* (Vol. 109, pp 564-571, 1987). Similarly, one can implement other convective heat transfer predictions for different orifice plate geometries.

The model calculates the mass transfer coefficient based on the Lewis relationship between heat and mass transfer. The model then solves a simple set of (coupled) governing equations for temperature and moisture to get the product conditions in the drying tunnel. It estimates the air conditions through the drying tunnel using a lumped mass approach. Air characteristics at discrete nodes in the flow loop are calculated using loss coefficients, which are estimated from standard engineering correlations. The model features an indigenously developed finite element solver that is a C++ class library whose object-oriented design enables customizing the solution procedure to a specific problem. The end result is a fast and accurate set of optimization conditions.

The model was validated against a standard industrial application and the results agree very closely. Figure 1 shows the result of one such simulation for the drying of a wet tobacco sheet through a simple, one-zone drying tunnel. Calculating the solution took 30 seconds on a 450-MHz processor with 256 Mbytes of RAM. The results show that condensation occurs over the first 2.5 meters of the dryer, and for the given input conditions the amount of moisture condensed is more than the moisture evaporated. The plant engineer has to change the process settings to increase the evaporation. This example illustrates that manufacturers can use this model to optimize their dryers to get the required output moisture loading (kgwater/kgproduct) quickly and accurately.

The plant and design engineers can use this tool to better understand the processes within the drying tunnel. It provides a means for estimating the tunnel operating set points to run the drying process at the most optimal conditions and to reduce the processing costs.

For more information on creating or distributing lean models, contact Beam Technologies, 404 Wyman St., Suite 355, Waltham, MA 02451; Tel: 781-890-5091, or visit the web site at www.beamtech.com.

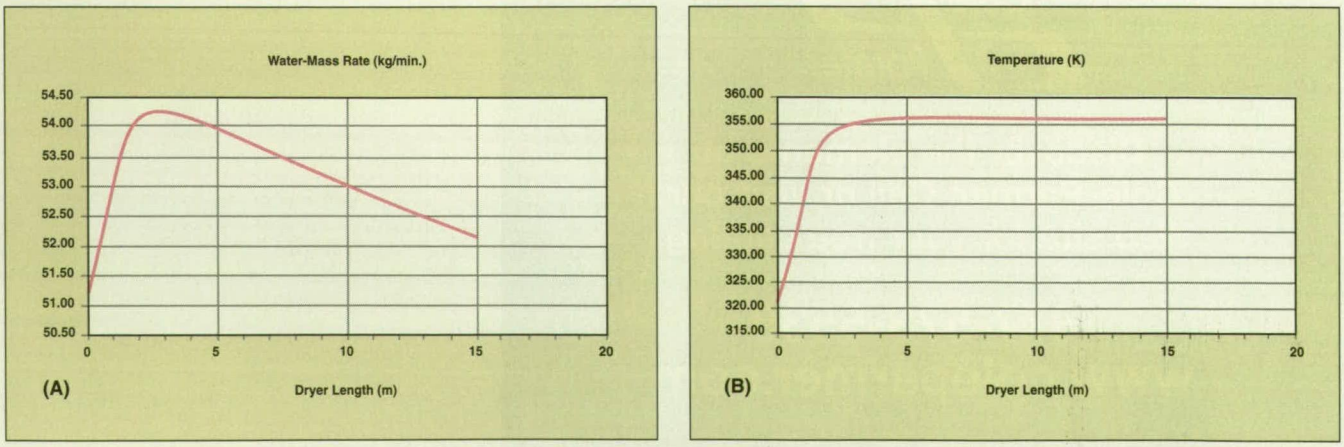
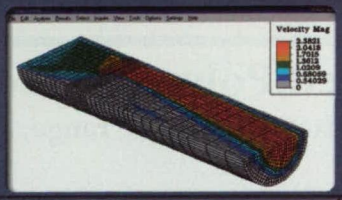


Figure 1. The **Drying Tunnel Model** simulates the (A) Water-Mass rate and (B) temperature of the wet tobacco.

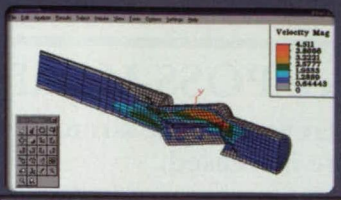
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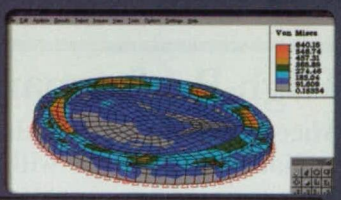
Linear Static Stress - Algor's linear static stress product enables you to capture complex assemblies, such as this valve assembly, from a CAD solid modeler and run a finite element analysis using fast solver technology. Typical loadings are pressure, acceleration, temperature, force and prescribed displacements.



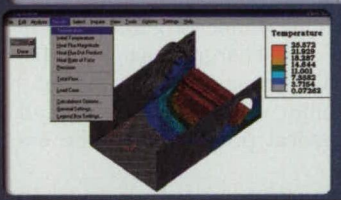
Steady Fluid Flow - Prescribed velocities and pressures provide the loading for this 3-D steady fluid flow analysis of a pipe with a gate valve. Algor's multiple load curves allow for easy data entry for adding loading such as gravity.



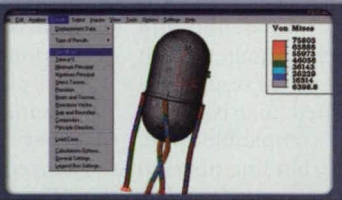
Unsteady Fluid Flow - Unsteady fluid flow of this ball valve system was analyzed using a 3-D CAD solid model. Algor's unique processor solves for velocities and pressures throughout the dynamic event, using a specialized meshing algorithm for high velocity gradients.



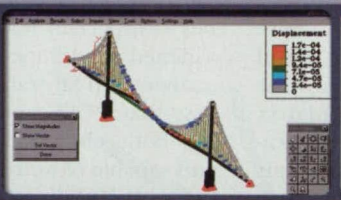
DDAM - Algor's Dynamic Design Analysis Method enables you to analyze the shock response at the mountings of shipboard equipment such as watertight doors, masts, propulsion shafts, rudders, exhaust uptakes and portholes, as shown above.



Transient Heat Transfer - The dynamic effects of a transient heat transfer analysis were needed for the time-dependent temperature loading of this heat sink assembly. Algor's multiple load curves for various loading conditions allow for the simulation of the thermal event.



Nonlinear Static Stress - Algor's nonlinear product helps to accurately predict large deformation and large strains caused by static loading. As seen by this water tank, buckling of a structure is one type of failure that can be exposed.



Linear Dynamic Stress- A modal analysis is one of the linear dynamic stress analyses performed on this suspension bridge. Failure can occur when the loading frequency is at the structure's resonant frequency. Algor's linear dynamic analyses accurately predict these frequencies and dynamic effects.



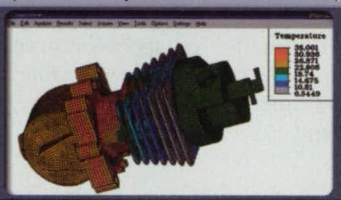
Mechanical Event Simulation (MES) with Nonlinear Material Models - Algor's MES extends full dynamic analysis capabilities to large strain/deformation analyses of nonlinear materials, as shown by this landing gear assembly. Kinematic elements can be used for quicker processing.



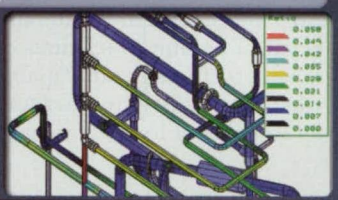
Mechanical Event Simulation (MES) with Linear Material Models - Algor's MES with linear material models allows you to represent a dynamic analysis while solving for kinematics, deflections and stresses of the structure. Analyses using large CAD assemblies, such as this rocker arm assembly model, can be expedited by using kinematic elements.



Multiphysics - Algor's multiphysics products enable you to combine multiple analysis types into one event. Resultant forces from flow around this turbine were calculated and then projected onto the object for a structural analysis. Other multiphysics capabilities include combining heat transfer with fluid flow, heat transfer with static/transient stress and heat transfer with fluid flow and stress.



Steady-State Heat Transfer - Algor's steady-state thermal processor helps predict temperature distribution due to thermal loading. Loading such as convection, radiation, conduction, applied temperatures and surface heat fluxes can be added to an analysis for fast, accurate results. In the case of this engine casing, both conduction and convection were part of the analysis of this 3-D solid model.



Piping Design and Analysis - Algor's piping design and analysis product enables you to calculate the deflections and stresses of this plant piping system and then compare the results with ASME/ANSI code allowables. Loadings can include: dead weight, thermal differences, pressure, wind loads, earthquake loads, time history of forces/displacements, response spectrum, natural frequencies and pitch and roll.

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High-Performance POSS-Modified Polymeric Composites

Mass densities will be decreased, while strength, use-temperature range, and radiation resistance will be increased.

NASA's Jet Propulsion Laboratory, Pasadena, California

Epoxies and/or cyanate esters that incorporate polyhedral oligomeric silsesquioxane (POSS) compounds are undergoing development at Air Force Research Laboratory (AFRL). These formulations are expected to be useful as high-performance matrix resins for advanced, lightweight fiber/matrix composite materials for diverse applications that could include spacecraft structures, automotive structures, prosthetics, sporting goods, and general consumer goods. In comparison with the corresponding unmodified matrix resins and composite materials made with those resins, the POSS-modified resins and composite materials are expected to exhibit lower mass densities, greater stiffness, and capabilities to withstand higher temperatures and higher levels of ionizing radiation.

Preliminary experiments have confirmed expectations that in comparison with unmodified resins, POSS-modified epoxy resins exhibit enhanced properties — especially lower mass density and widened use-temperature ranges. Both analyses and favorable initial results suggest that POSS-modified matrix resins are both chemically compatible with, and capable of wetting, binding fibers to desirably high degrees.

Specific quantitative goals in the development of POSS-modified polymeric composites, relative to unmodified ones, include the following:

- Parameters that represent such matrix-dominated mechanical properties as compression strength, durability under heat/load cycling, and resistance to impact and damage, will be increased by 10 to 50 percent.
- Mass densities will be reduced by at least 15 percent.
- Use-temperature ranges will be extended by >80 °C.
- Resistance to atomic oxygen and to ultraviolet and charged-particle radiation will be increased by 100 percent.
- Flammability will be decreased and other physical properties will be enhanced.

(This concept has not been reduced to practice.)

This work was done by Witold Sokolowski and Tim O'Donnell of Caltech, Joseph Lichtenhan of Hybrid Plastics Co., and Shawn Phillips of AFRL Edwards for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Materials category.*

NPO-20734

Model Simulates Semi-Solid Material Processing

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Processing materials in the semi-solid state has many advantages over conventional processing methods.

Beam Technologies, Waltham, Massachusetts

David Spencer (MIT) developed semi-solid material processing through an accidental observation he made while dealing with the processing of metals in their mushy state. The semi-solid material process basically consists of two stages: pre-processing and processing. During pre-processing, the manufacturer heats the material to a liquid state. While it cools, the manufacturer breaks the material up, usually by mechanical means. The result is a mushy material with a very uniform microstructure consisting mainly of round crystals. Then, in the processing stage, the manufacturer forces the mushy material into a die where it is allowed to fully cool.

Semi-solid processing has numerous advantages over liquid casting. With liquid casting, the material is heated to extremely high temperatures to reach a liquid state. Then, while the material is hot, it is injected into a die to create a part. This approach potentially introduces tiny gas bubbles into the material, degrading structural integrity, increasing the possibility of shrinkage and cracking while cooling, and putting considerable wear on the die due to the high processing temperatures.

Semi-solid processing attempts to eliminate these problems. The lower processing temperature causes less shrinkage and cracking while the die-cast product cools. The lower temperature also results in less wear on the die because the conditions are less extreme. Another advantage is that the finished product has better material properties due to the material's microstructure and the lower likelihood of gas-bubble entrapment. Though the advantages over traditional methods are clear, understanding the complex behavior of materials in this state has been the stumbling block to the advancement of this technology. Being able to effectively model these processes is vital to the development of this concept.

The case studied here examines numerically a simple 2D flow from a larger reservoir region into a die. The model (http://nasatech.innovationchain.com/solution.asp?SN=200) uses a continuous Herschel-Bulkley fluid model that is based on the continuous Bingham model Papanastasiou (1987) proposed. Alexandrou, at Worcester Polytechnic Institute, pioneered the use of this model to simulate the material behavior during these processes. The Herschel-Bulkley model combines both the non-linear deformation and the existence of a finite yield stress shown by many experimental studies with semi-solid metals during processing. The model is a combination of the power-law model, for non-linear de-

formation, and the Bingham model, for the existence of the finite yield stress.

For simplicity of calculation, it is assumed that the flow was steady state and isothermal. Although the material properties depend on temperature — and in a full analysis one would include temperature dependence for completeness — for the purpose of this work , inclusion of temperature was unnecessary. Also, most die filling processes occur very quickly, therefore excluding the steady-state case for direct comparison. However, it is intended that the case studied here allow examination, in a simple way, of the bulk flow characteristics and identify where problem areas may occur during an actual die filling process. With that in mind, the case studied provides results that serve this purpose fairly well.

In the past, researchers have modeled semi-solid materials in many different ways, including complex two-phase analysis. These models have proven deficient in numerically capturing the full behavior of the material, which is solid-like in some regions, and liquid in others. Many experimental studies have shown that the Herschel-Bulkley fluid model approximates general flow characteristics well, but the discontinuity of the finite yield stress has made numerical study difficult. The continuous, or "regularized" Herschel-Bulkley model smoothes over this discontinuity with an exponential term in the shear stress relation. A model parameter, known as the stress growth exponent, controls how closely the relation captures the discontinuity. The higher the parameter is, the closer the approximation to the ideal behavior, with a correspondingly higher difficulty of convergence.

The continuous Herschel-Bulkley model does a very good job of capturing one of the most interesting and important flow characteristics — the yield surface — for this type of problem. Yield surface is the interfacial boundary between regions of materials that behave and deform as a liquid, and those that experience virtually no deformation and behave as a solid. Knowing where the solid-like, or "unyielded" regions exist is extremely important to processing. Large, unyielded zones lying on walls, for example, can result in large amounts of material becoming thermally welded in place. Therefore, knowing where these problem areas could arise is crucial for flow control during the process.

For more information on creating or distributing lean models, contact Beam Technologies, 404 Wyman St., Suite 355, Waltham, MA 02451; Tel: 781-890-5091, or visit the web site at www.beamtech.com.

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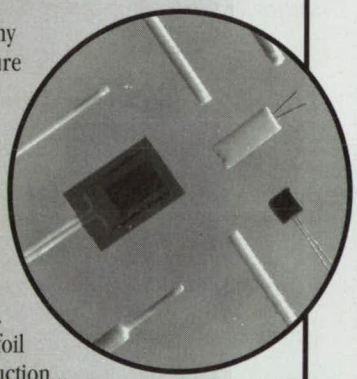
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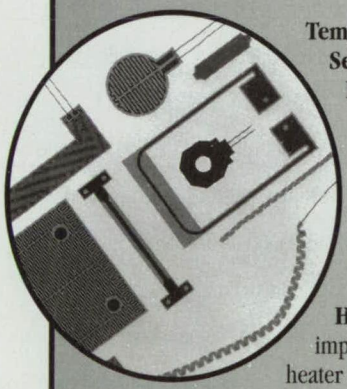
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Modular Cryogenic Insulation

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John F. Kennedy Space Center, Florida

"Modular cryogenic insulation" denotes a chaff for installation in the partially evacuated annular spaces between the inner and outer walls of tanks used to store and transport liquid nitrogen and other cryogenic liquids. The insulating chaff was developed to replace low-density powders (e.g., perlite, silica aerogel, carbon black, or diatomaceous earth) that have been used to insulate cryogenic tanks. Thermal cycling of a tank causes some of the powder to fall to the bottom of the annular space; over time, the powder accumulates in the bottom and becomes compacted there, with consequent loss of thermal-insulation performance. In addition, the compaction generates stresses that can damage the tank. The chaff was selected from among several candidate materials that were investigated to find one that would not settle with thermal cycling, would be readily manufacturable, would offer the requisite thermal-insulation performance, would thermally expand and contract along with the tank walls, and could be installed easily.

The starting material for the manufacture of the chaff is Mylar (or equivalent polyethylene terephthalate) coated on both sides with thin film of aluminum. The material comes in rolls and is conventionally used to form multilayer insulation (MLI) blankets for some cryogenic applications. The rolled Mylar is unwound and processed through a cross-cut shredder to produce the chaff. Like an insulating powder, the chaff is poured into the annular space of a tank through a hole on the top of the outer tank wall.

The thermal performance of the chaff approximates that of perlite powder within 10 percent. Although the initial cost of the chaff is higher than that of perlite powder, the life-cycle cost of the chaff is lower, because settling of the powder makes it necessary to replace the powder during the life of a typical cryogenic tank, whereas there is no need to replace the chaff because it does not settle. Moreover, because the chaff does not settle, a tank insulated with the chaff does not exhibit the increased heat leakage observed in a powder-insulated tank after a few years of the useful life of the powder. Yet another advantage of the chaff is low density — less than 10 percent of the density of a typical insulating powder.

This work was done by Richard L. Jetley of Aerospace Design & Development, Inc., for **Kennedy Space Center**.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Technology Programs and Commercialization Office, Kennedy Space Center, (407) 867-6373. Refer to KSC-11912.

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Passive Venting for Alleviating Helicopter Tail-Boom Loads

Preliminary results indicate that venting could be used to advantage.

Dryden Flight Research Center, Edwards, California

The tail boom of a single-rotor helicopter is subjected to a complex flow field that includes the wakes of the main and tail rotors, the freestream, and the wake from the forward fuselage. Hovering and sideward flight present the operational regimes that are most critical with respect to adverse sideward and downward loads on the tail boom. These adverse loads necessitate additional engine power, thereby reducing payload, performance, and available yaw-control margins. In addition, nonlinear side-force gradients near conditions of boom stall can make precise yaw control very difficult for the pilot. The addition of strakes to the tail boom is one method that has been used to modify the flow field and reduce these adverse loads.



Figure 1. **The UH-60 Helicopter** was used as the baseline helicopter in a study of the effect of venting the tail boom.

In recent research on fixed-wing aircraft, porosity of surfaces has been used to alter distributions of pressure (and thus loads) on the surfaces. It was postulated that, by passively venting portions of a helicopter tail boom (generally represented as a blunt body), the pressure distribution and therefore the loads on the boom could be modified in a favorable manner. Various venting schemes are possible, and vents could be used in conjunction with other devices, including strakes. The venting schemes include, but are not limited to, the use of porous material on all or parts of the boom connected to a specific plenum or open to the boom cavity, and the use of doors, grilles, slots, or other such openings. Further, it may be possible to capture a portion of the relatively high-speed downwash from the main rotor as it impinges on the upper surface of the boom and channel that flow to another area on the boom.

A wind-tunnel investigation was conducted to obtain some preliminary indications of the effectiveness of venting the boom for reducing adverse forces and

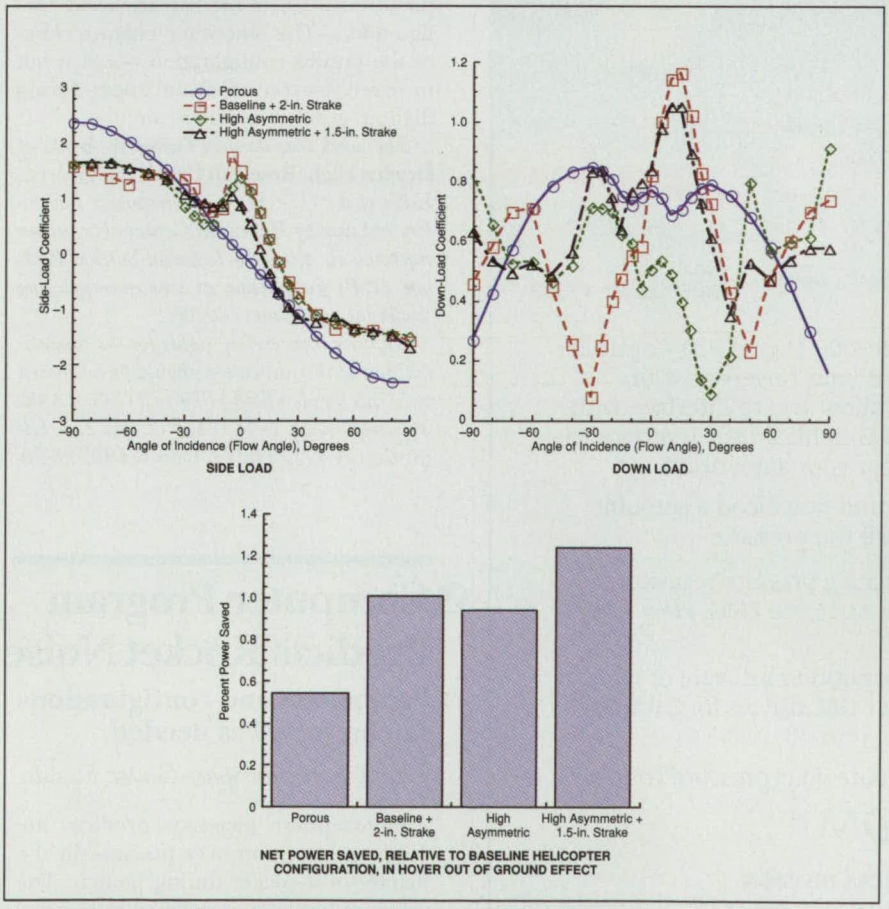
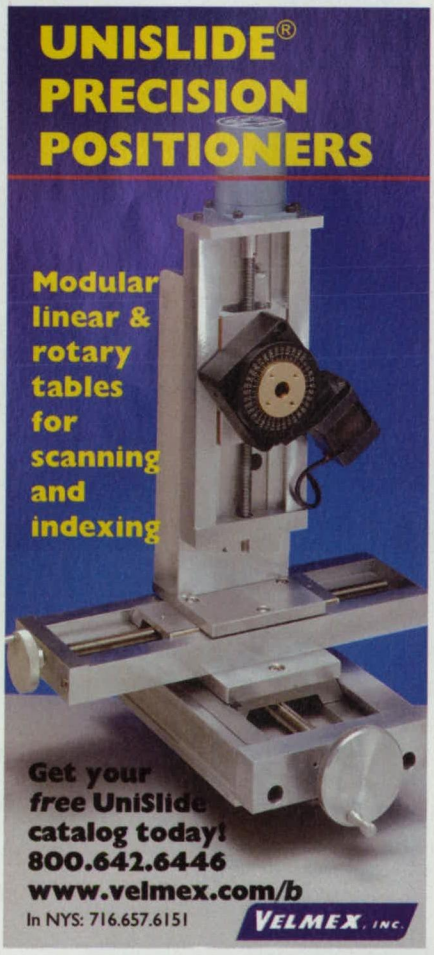


Figure 2. These **Preliminary Results of Experiments and Calculations** indicate that porosity could be useful for reducing adverse helicopter tail-boom loads.



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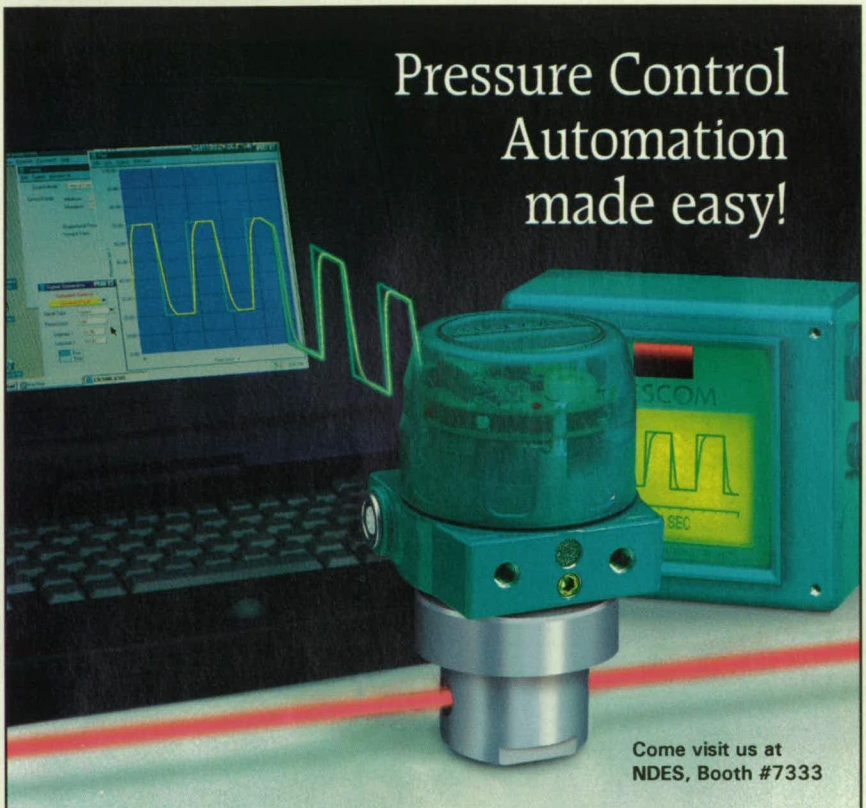
moments. This study was conducted with two-dimensional tail-boom shapes in the 14-by-22-ft (4.3-by-6.7-m) subsonic wind tunnel at NASA Langley Research Center. The shape that was tested most extensively was representative of the tail boom of a UH-60 helicopter (see Figure 1) with the tail-rotor drive-shaft cover on. The aerodynamic forces, including the down load and side force, were measured at freestream dynamic pressures up to 30 psf (1.4 kPa), at full-scale Reynolds numbers, and at angles of incidence (wind azimuth angles) from –90° to +90° to simulate left and right cross winds. Calculations were performed, using the normal-force and side-force coefficients, to determine the trends of the aerodynamic forces on the boom of a full-scale UH-60 helicopter and to estimate the main-rotor and tail-rotor power needed to trim those forces in the presence and absence of venting.

The results indicate that passively venting a helicopter tail boom can alleviate some of the adverse side forces that are generated in hover and in sideward flight. There was found to be a mild penalty in increased down load that is partly attributed to the increased skin friction associated with the nonoptimal porous surface (a commercially available material) that was used in the experiments. It was found that for the same loading, it takes more power to overcome a side load than to overcome a down load because the tail rotor is much more heavily loaded and less efficient than is the main rotor. Therefore, the penalty in down load was found to be less than the beneficial reduction in side load. The overall result was found to be reductions in the adverse forces and the calculated power demand, similar to the reductions afforded by the application of strakes.

Other venting arrangements or more optimal porous material could reduce the down-load penalty while also alleviating the side force. Plots of the side-load coefficient (C_y) and the down-load coefficient (C_z) are shown in the upper part of Figure 2. Calculated trends in the power demand are shown in the lower part of Figure 2. Although the calculated trends in the power demand were found to vary widely among different configurations, the net result was found to be a reduction for the porous configuration, relative to the baseline solid configuration. Also, for the porous configuration, the character of the plots of C_y versus the angle of incidence was smoother, without the discontinuous nature and a less abrupt boom stall, as compared with that of the baseline solid configuration. The smoother characteristics of the porous configuration would result in fewer yaw-control disturbances during flight in gusty or turbulent air.

This work was done by Daniel W. Banks of **Dryden Flight Research Center** *and Henry L. Kelley of the U.S. Army Aeromechanics Laboratory at* **Langley Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category.*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Dryden Flight Research Center, Attn: Yvonne Kellogg, D-4839A, P.O. Box 273, Edwards, CA 93523-0273. Refer to DRC-98-96.



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Computer Program Predicts Rocket Noise

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John F. Kennedy Space Center, Florida

A computer program predicts the noise and ignition over pressure in the vicinity of a rocket during launch. The program has been developed to complement the vibroacoustic-prediction effort

for rockets now in use and to provide the capability for prediction of vibroacoustic loads associated with next-generation rockets. Programs like this one are vital parts of the implementation of NASA's "better, faster, cheaper" philosophy; they are needed because full-scale acoustic and vibration testing of launch vehicles or payloads is often difficult, time-consuming, and prohibitively expensive.

This program implements an empirical model based partly on recognition that noise in each frequency band of interest is generated throughout the rocket-engine flow. The empirical model utilizes accumulated data from noise and structural-vibration measurements performed on the space-shuttle launch pad since 1984.

The program is user-friendly. It provides for interactive modification of various parameters that affect the noise environment. Predictions can be made for any position on a launch vehicle and for both near- and far-field positions on the ground. Predictions can be made for both flight-readiness firing and liftoff, for a variety of vehicle and launch-mount configurations (including single or multiple engines and open or closed duct), and for any altitude of the vehicle during ascent.

The program can be represented, in simplified form, by the following set of instructions:

1. Determine the flow axis relative to the vehicle and stand.
2. Estimate the overall acoustic power (in watts) from engine thrust, number of nozzles, fully expanded exit velocity, and acoustic-efficiency values.
3. Convert the overall acoustic power level from watts to decibels.
4. In the case of a rocket with multiple nozzles, calculate the effective nozzle-exit diameter.
5. Compute the core length of the plume or the normalized plume core length (normalized to the effective nozzle-exit diameter).
6. Estimate the number of identical slices of the plume for analysis.
7. Determine the normalized acoustic power per unit of the plume core length for each identical slice along the plume.
8. Calculate the overall acoustic power for each of the plume slices.
9. Convert the normalized spectrum for rockets to a conventional acoustic bandwidth (i.e., the power spectrum per hertz or per 1/3 octave band, as desired) for each slice of the plume.
10. Compute the sound-pressure level at any given position on the vehicle for each plume slice and for each 1/3-octave band, inclusive of the effects of directivity.
11. Calculate the sound-pressure level at any given position on the vehicle for all plume slices by logarithmic summation of contributions from each slice.
12. Finally, compute the overall sound-pressure level (OASPL) by logarithmic summation for all plume slices and all 1/3 octave bands.

The program includes the input parameters and the computed outputs. Among the computed outputs are the 1/3-octave band number, the center frequency of each band, the width of the frequency band, and the sound-pressure level in that band. A plot of sound-pressure level for each 1/3-octave band number is also generated for use in developing specifications for qualification tests.

This work was done Raoul E. Caimi of **Kennedy Space Center** *and Ravi N. Margasahayam of Dynacs, Inc. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category.*
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Process for Polishing Bare Aluminum to High Optical Quality

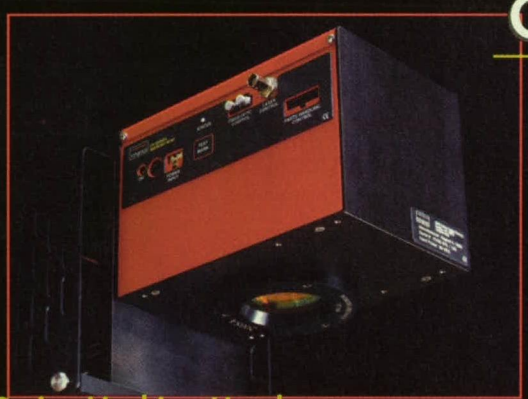
India-ink polishing following single-point diamond turning yields superior aluminum optics.

Goddard Space Flight Center, Greenbelt, Maryland

A process for making precise, high-quality curved or flat mirror surfaces on bare aluminum substrates has been devised. The process consists of (1) diamond turning to establish the desired surface figure, followed by (2) a polishing subprocess that is mostly conventional except for the composition of the polishing compound. This process can maintain a surface figure accurate to within a peak-to-valley error of as little as 1/8 wavelength (at a wavelength of 6,328 Å) and can produce a finish characterized by a root-mean-square roughness of <8 Å. Hence, the process creates possibilities for the fabrication of precise scientific-instrument mirrors (see figure) that, because they could be made entirely of aluminum, would be lightweight, relatively inexpensive, and thermally stable over wide temperature ranges.

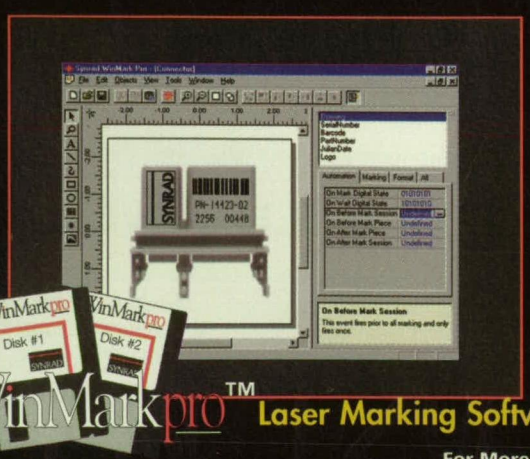
Because of the relative softness of aluminum, heretofore, there has been no way to polish bare aluminum to an optical quality adequate for precise scientific instrumentation. Under optimum conditions, diamond turning can be used to obtain a surface figure within an error of no less than about 0.5 wavelength and surface roughness of no less than about 50 Å on an aluminum substrate. To obtain higher optical surface quality, it has been necessary to deposit a thin coat of electroless nickel on a diamond-turned aluminum substrate, then conventionally polish the nickel coat. The disadvantages of this approach are that plating nickel onto aluminum is difficult and expensive, bimetallic thermal stresses can distort the optical surface of the mirror, and there is risk of polishing through the nickel coat in one or more spots. In the latter case, it is necessary to strip the entire coat, redeposit a new nickel coat, and begin polishing anew.

In both conventional practice and the present process, polishing involves the use of a lap that is coated with a polishing compound and liquid carrier and is moved semirandomly and repeatedly over the substrate surface. Conventionally, the liquid carrier is often water. The



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major distinguishing feature of the present polishing subprocess is that India ink (either alone or diluted with water) is used as both a polishing compound and the liquid carrier. (India ink has been used in the past in this way to polish metals, but not, until now, as an ingredient in an integrated diamond-turning/polishing process for finishing aluminum to precise surface figure and high optical quality.)

The present polishing subprocess consists of two stages. In the first stage, the diamond-turned surface is polished with a mixture of 0.25-μm diamond powder, distilled water, and India ink. In the second stage, polishing is started with pure India ink, and then the ink is slowly diluted with water. Polishing is continued until the desired specification is achieved.

The success of this process has been attributed partly to the carbon particles in India ink. These particles are small and hard enough to provide the correct action between the substrate and lap so as not to cause severe scratching or cold flow of the substrate. In addition, the liquid portion of the ink includes an oily base that acts as an excellent lubricant during polishing. After years of experimentation with known conventional polishing materials and combinations thereof, India ink is thus far the only material known to be effective for polishing bare aluminum.

This work was done by James J. Lyons and John J. Zaniewski of **Goddard Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Manufacturing/Fabrication category.*

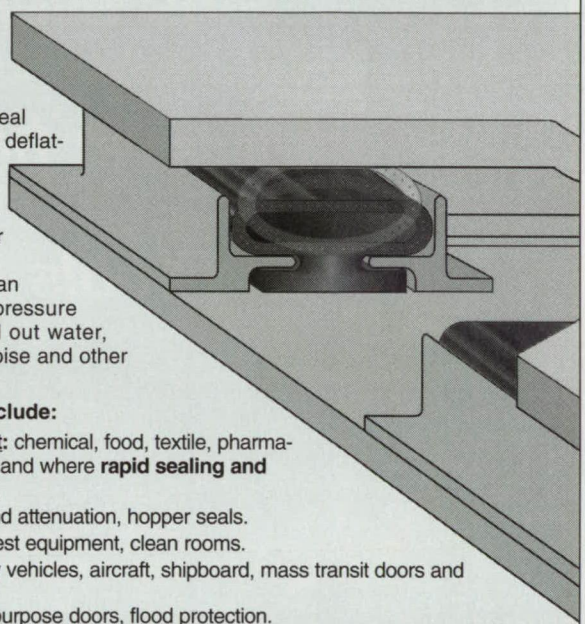
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External Adhesive Pressure-Wall Patch

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Marshall Space Flight Center, Alabama

A mechanical device has been developed for applying an adhesive patch, from the outside, to the wall of a spacecraft module that has lost pressure because of penetration by a meteoroid or a piece of orbital debris. This device will make it possible to seal and re-pressurize the affected module during space flight. Devices identical or similar to this one might also prove useful in the repair of other pressurized bodies and similar objects, including gas and oil pipes and ship hulls, for example.

The device includes a patch frame, which is moved toward the hole to be patched from the exterior side of the damaged wall by use of handles. The device also includes a flexible outer sealing ring that becomes molded against the wall. Another component of the device is a probe that includes a right-hand-threaded shank and is equipped with an assembly of spring-loaded sprags at its penetrating tip.

The probe is inserted in the hole. When the probe has passed through the hole in the wall to the interior side, the sprags spring outward. Next, the probe is turned counterclockwise to draw the sprag assembly toward the patch frame; as a result, the sprags are forced against the inside edge of the hole in the wall. As the probe continues to turn, the sprag assembly stays in place and the flexible outer sealing ring on the patch frame becomes pushed against the wall on the outside; this action creates a seal between the patch frame and the wall.

Next, the volume enclosed by the patch frame, wall, and outer sealing ring (called the "patch body volume" for short) is filled with a liquid adhesive sealant material to create a permanent seal and strong adhesion between the patch and the wall. The adhesive sealant is injected into the patch body volume through quick-connect/quick-disconnect fittings that are similar to automotive grease fittings and that are located in several positions on the patch frame. Although the patch is not a substitute for the loss of structural strength caused by the penetration, the adhesive bond between the patch frame and the wall is strengthened by an adhesive-interface plate on the patch frame: as the adhesive flows into the patch body volume, it flows onto and around hooks that protrude from the adhesive-interface plate. Once the adhesive hardens, the patch is held in place against the tensile loads induced by re-pressurization of the interior of the spacecraft module, pipeline, or other volume enclosed by the wall.

Success in the use of the patching device does not depend on the prior installation of structural fastening devices on the wall to be repaired. Another advantage of this device is that its flexible outer sealing ring makes it adaptable to a variety of external wall configurations, structures, and radii.

This work was done by Joel Williamsen, Kathryn Horton, and Bruce Weddendorf of **Marshall Space Flight Center**.

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 Sammy Nabors, MSFC Commercialization Assistance Lead, at (256) 544-5226 or sammy.nabors@msfc.nasa.gov. Refer to MFS-31173.



February 2001

Motion CONTROL Tech Briefs



Automating Fiber Optic Inspection ..... IIb
Inertial/GPS Pointing and Positioning System 4b
Temporary Fullerene Films in Microelectromechanical Devices 6b
First-Order Theory of Control of Motion of a Crane and Load 7b
Conformably Stowable Canard 8b
New Products 10b

Cover photo courtesy Animatics Corp.

Automating Fiber Optic Inspection

An integrated system from National Instruments yields nanometer accuracy in fiber inspection, alignment, and bonding.

Fiber optic technology is quickly moving out of the research laboratory and into mainstream communication systems. This transition from theoretical research design to practical consumer use has elevated the need for efficient and powerful fiber optic systems. Such systems employ a vast array of components responsible for the transmission and retrieval of information. As such, manufacturers face a daunting task of producing very complex and small devices that meet consumer demand.

Automating the manufacturing process of these components is still in its infancy: most of the assembly and testing is done by hand. The majority of the employees at leading fiber optic companies are employed in manufacturing. These labor-intensive techniques cannot keep up with the ever-increasing demand. The article below describes common fiber measurement techniques and illustrates equipment necessary to build a photonics inspection system.

Fiber optics provide a significant advantage over standard copper transmission lines. The potential information-carrying capacity of a single fiber strand is much greater than that of a single copper wire. In addition, with modulation schemes, a single carrier frequency can carry numerous channels of information. The carrier frequencies used in light waveguides are far superior to those deployed in copper lines; light is composed of different wavelengths, each of which can carry a separate data channel. The advantages do not end there, however. Optical fiber is very light and has a very small diameter, typically smaller than the diameter of a human hair.

Optical fiber is the workhorse of any optical communication system. It is basically the conduit for all of the system's information and ends up linking all of the other components together. A typical fiber consists of the core, which is the actual conduit of light; the cladding, a glass material that has achieved a certain index of refraction, through doping, that allows for total internal reflection; and other layers to provide strength and protection from harsh conditions.

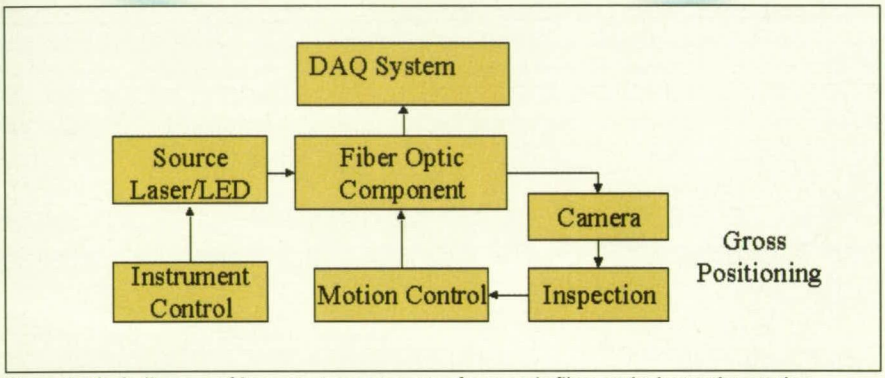


Figure 1. Block diagram of important components of a generic fiber optics inspection station.

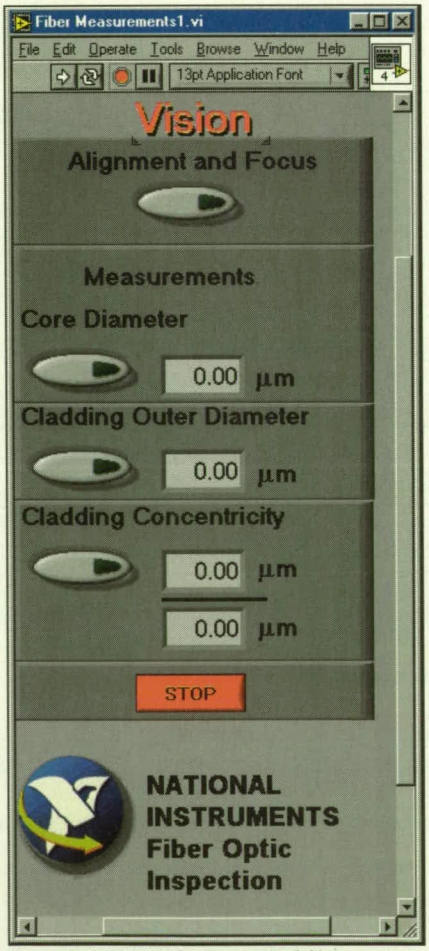
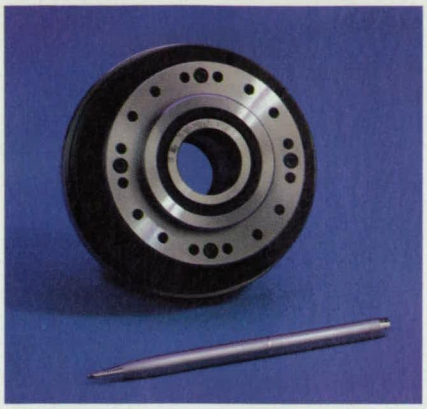


Figure 2. LabVIEW front panel of fiber optic inspection system, which allows precise measurements of important fiber parameters.

Transmission takes place because the difference in index of refraction between the fiber's core and its cladding, combined with the angle of reflection, enables the light to travel down the fiber with minimal attenuation. Optical fibers can come in either multimode or single-mode. Multimode fiber has a larger core diameter than single-mode, typically 50 microns to a few millimeters for multimode, and 5 to 9 microns for a single-mode fiber. These measurements must be accurate, because the diameter and the concentricity of core and cladding would affect such things as the modes of light that can travel in the fiber, the numerical aperture through which the fiber can receive light, and the coupling of light both in and out of the fiber.

The approach to inspecting the fiber is to use vision-guided motion control to perform gross alignment of the fiber and lens (see Figure 1). The camera and the inspection algorithms look at the core and cladding and perform vision measurements to determine if diameters fall within tolerances. In addition, a National Instruments Data Acquisition System (DAQ) board can be used to measure the light signal's attenuation through the fiber to determine optical loss and other characteristics.

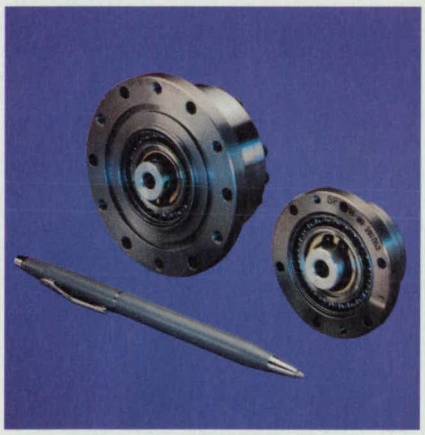


New, Hollow Shaft Gearing SHF Series

Featuring a through-bore up to 70 mm in diameter, the SHF Series component sets and gearheads enable the design engineer to pass shafting, wire bundles, or other components directly through the center of the gear. The new SHF Series provides high accuracy in a compact design. This unit design is both axially shorter and lower in weight, as compared to conventional harmonic drive gearing. This is accomplished by using HD Systems patented "S" tooth profile. Rated torques up to 6590 in-lb and positional accuracy better than 2 arc-min can be achieved. Gear reduction ratios of 50:1 through 160:1 are available in a single stage.

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CSF Series Gearing

HD Systems offers higher performance harmonic drive component sets and gearheads using its patented "S" tooth profile. The CSF Series provides higher torque, higher torsional stiffness, and longer life, all in a smaller package while maintaining accuracy and efficiency. Reduction ratios of 50:1 through 160:1 are available with rated output torques ranging from 48 in-lbs to 31,400 in-lbs, depending on unit size.

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Circle No. 657

Mini DC Servo Actuators RH Mini Series

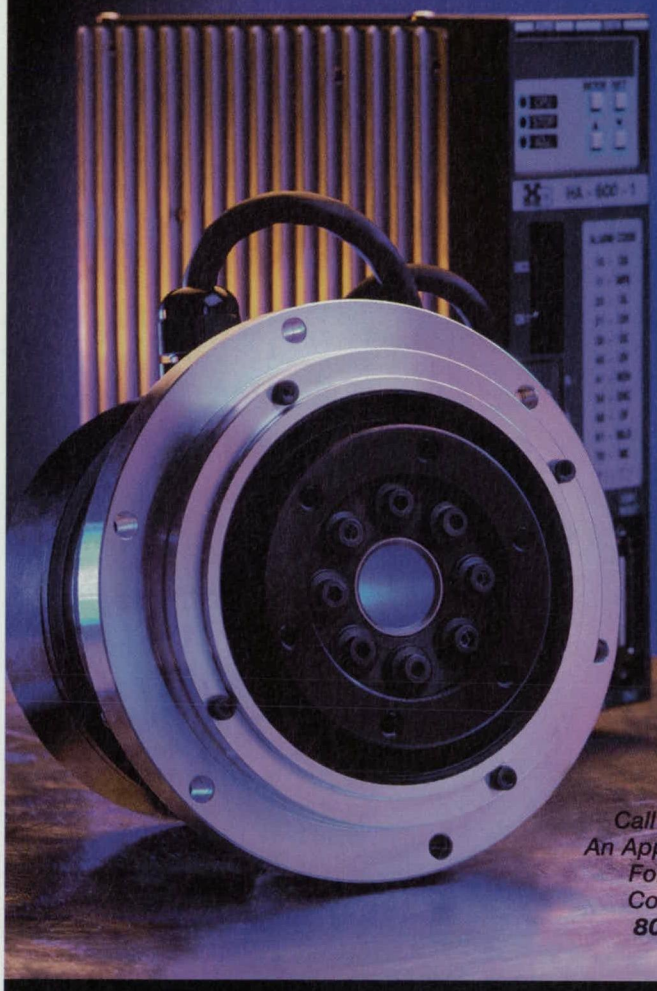


HD Systems offers a line of miniature DC servo actuators for use in applications such as robotics, instrumentation, and factory automation where precise motion control is required. The actuators combine zero backlash harmonic drive gearing with rare-earth magnet DC servo motors to provide both high torque and positional accuracy better than 2 arc-minutes. Rated torques of 2.6 thru 56 in-lb and rated speed of 15 thru 60 rpm are available depending on frame size and gear ratio. The smallest actuator measures just 20 mm in diameter. Encoders and/or tachometers are available as an integral part of the actuator.

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Hollow Shaft Brushless DC Actuators feature a through-bore up to 45 mm in diameter and provide high torque and exceptional positioning accuracy. This performance is achieved in a compact design using a patented "S" tooth harmonic drive gear coupled to a brushless DC pancake motor with integral electronic commutation and a high resolution encoder. Rated torques up to 1730 in-lb and positional accuracy better than 1 arc-minute can be achieved. The FHA Series is available in six frame sizes, ranging from 120 to 300 mm in diameter, and 90 to 248 mm in length.

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HD SYSTEMS

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Typical inspection measurements such as core and cladding circularities and core-cladding concentricity can be measured using optical inspection techniques (see Figure 2). Also, using thresholding and blob analysis techniques, surface blemishes can be detected.

Optical Inspection Overview

Using a CCD camera, an optical inspection system can measure the core and cladding diameters using edge detection, crossing through the core and cladding boundaries; functions within National Instruments' IMAQ Vision software can locate the edges. With IMAQ Vision, the user can utilize the annulus region of interest tool to draw an inner and outer circle around a boundary, as shown in Figure 3. Line profiles are automatically placed perpendicular to the cladding boundary between the regions of interest. IMAQ Vision edge-detection functions precisely locate the boundary of the cladding. Once the user has located the cladding boundary, the center of the fiber, circularity, and diameter are all calculated using built-in IMAQ Vision functions. An example of LabVIEW and IMAQ Vision code is shown in Figure 4.

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22mm motor shown with planetary gear box. Actual size.

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To automate the process completely, the user turns to IMAQ Vision's pattern-matching tools to locate the core and then automatically position the region of interest. Also, he can use standard threshold and blob analysis techniques to locate and count the defects within the core.

Image information can be misleading at times because these measurements are typically recorded in pixel values. For fiber optic applications, it is important to record measurements in real-world units such as microns. National Instruments IMAQ Vision contains easy-to-use functions to calibrate data so that image output and measurement are done in microns rather than pixels.

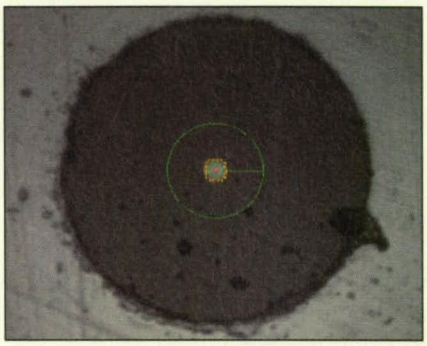


Figure 3. IMAQ Vision for LabVIEW functions draws two concentric circles and places line profiles for edge detection.

IMAQ Vision Functions

- (Motion & Vision>>Machine Vision>>Select Region of Interest>>IMAQ Select Annulus.vi) Allows the user to specify an annulus area in an image. IMAQ Select Annulus displays the image in the specified window, provides the annulus tool, and returns the coordinates of the annulus selected when you click OK.
- (Motion & Vision>>Machine Vision>>Locate Edges>>IMAQ Find Circular Edge.vi) Locates a circular edge in a search area. This VI locates the intersection points between a set of search lines defined by a spoke and the edge of an object. The intersection points are determined based on their contrast and slope.
- (Motion & Vision>>Machine Vision>>Caliper>>IMAQ Edge Tool.vi) Finds edges along a path defined in the image. Edges are determined based on their contrast, slope, and steepness.
- (Motion & Vision>>Machine Vision>>Analytic Geometry>>IMAQ Point Distances.vi) Computes the distance between consecutive pairs of points.
- (Motion & Vision>>Vision Utilities>>Calibration>>IMAQ Convert Pixel to Real World.vi) Transforms pixel coordinates to real world coordinates, according to the calibration information

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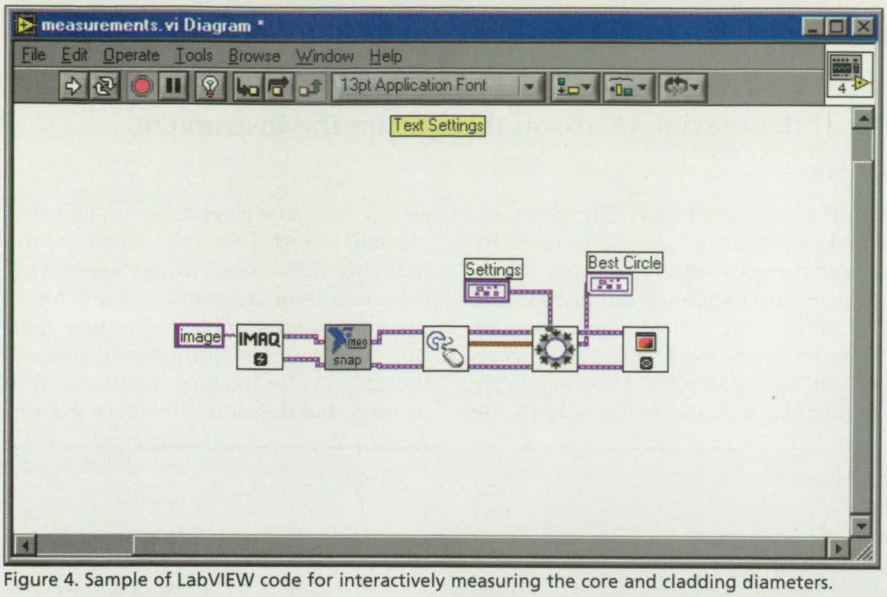


Figure 4. Sample of LabVIEW code for interactively measuring the core and cladding diameters.

contained in the image. Calibration information is attached to this image by IMAQ Learn Calibration Template, IMAQ Set Simple Calibration, or IMAQ Set Calibration Info.

Motion Control

Precision is key to a photonics components inspection solution. When fiber measurements are rated in the micrometer range, it is imperative that alignment is very accurate. National Instruments motion control hardware (see Figure 5) and software coupled with a third-party stage allow the precise micrometer and nanometer accuracy necessary for fiber inspection or alignment and bonding. This motion can all be controlled from the same interface where the visual measurements are being acquired. This seamless integration of National Instruments' FlexMotion and IMAQ Vision software decreases development time considerably.

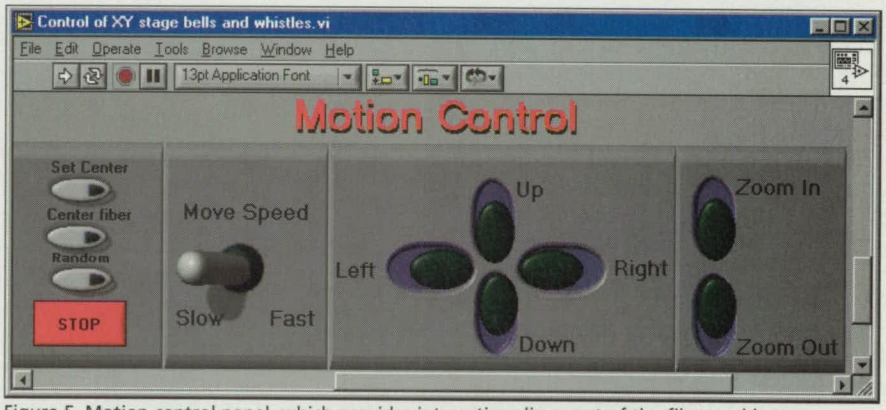


Figure 5. Motion control panel, which provides interactive alignment of the fiber and lens.

Software and Hardware Components

The software components include National Instruments' LabVIEW Application Software as the development environment. Motion control software and IMAQ Vision software seamlessly integrate with LabVIEW to provide faster development time. Statistical process control software for LabVIEW provides the functionality to determine manufacturing yields, statistical trends, and process analysis. The hardware gear used in a fiber optics components inspection system is shown in the table.

Device	Company	Model
Instrumentation Platform	National Instruments	PXI-102/8156B
Image Acquisition Hardware	National Instruments	IMAQ PXI-1047
Camera	JAI	CV-M50
Lens	Infinity	OBJ 18-mm WD, 2.00X, 4X Adaptor, 1.5X Main Body
Motion Control	National Instruments	PXI-7344
Stages	National Aperture	MM-3M-F-0.5
Amplifier	National Aperture	MC-3SA

Automation through Integration

By tightly integrating different test and manufacturing functions and processes, photonics component manufacturers can build highly automated systems, resulting in cost savings, shorter lead times, higher yield, and better quality. The main advantage of this integrated and automated approach lies in removing pressure from labor-intensive procedures. Productivity increases as a result of higher quality. An open-ended system using National Instruments' LabVIEW, Flexmotion, and IMAQ Vision can easily be augmented with National Instruments' Data Acquisition hardware and instrument control. For example, DAQ hardware coupled with a light-emitting source can perform beam profile analysis and quantify power dissipation. If a new parameter arises that needs inspection or test, the user can easily modify the system because he has used a flexible open platform based on off-the-shelf components such as PXI and LabVIEW. Complete turnkey solutions for fiber optic inspection can be achieved through local integrators; ask National Instruments for a complete list of integrators.

For more information on the automated fiber optics inspection system, contact the coauthor of this article, Jason Mulliner, vision products manager, at (512) 683-5364; jason.mulliner@ni.com. For more information about National Instruments motion control boards, image acquisition boards, PXI, LabVIEW, IMAQ Vision software, and other National Instruments products, please see www.ni.com.

Inertial/GPS Pointing and Positioning System

This system operates independently of the moving platform that carries the instrument.

Ames Research Center, Moffett Field, California

A data system generates information on the position and orientation of a pointing instrument (e.g., a telescope or a laser) that could be mounted on a moving platform (e.g., an aircraft) and generate platform-steering commands for pointing the instrument at a known target (e.g., a target on the ground, a celestial body, or an artificial satellite). The subsystems of this system include an inertial navigation system (INS) and a Global Positioning System (GPS) antenna and receiver.

Unlike other instrument-pointing systems, the INS mounts directly on the pointing instrument instead of on the platform. As a result, the INS decouples from the platform in the sense that it determines the position and orientation of the instrument independently of the platform. In further contradistinction to other instrument-pointing systems, the pointing instrument is not slaved to the platform; instead, as explained below, the platform is slaved to the pointing instrument and the INS.

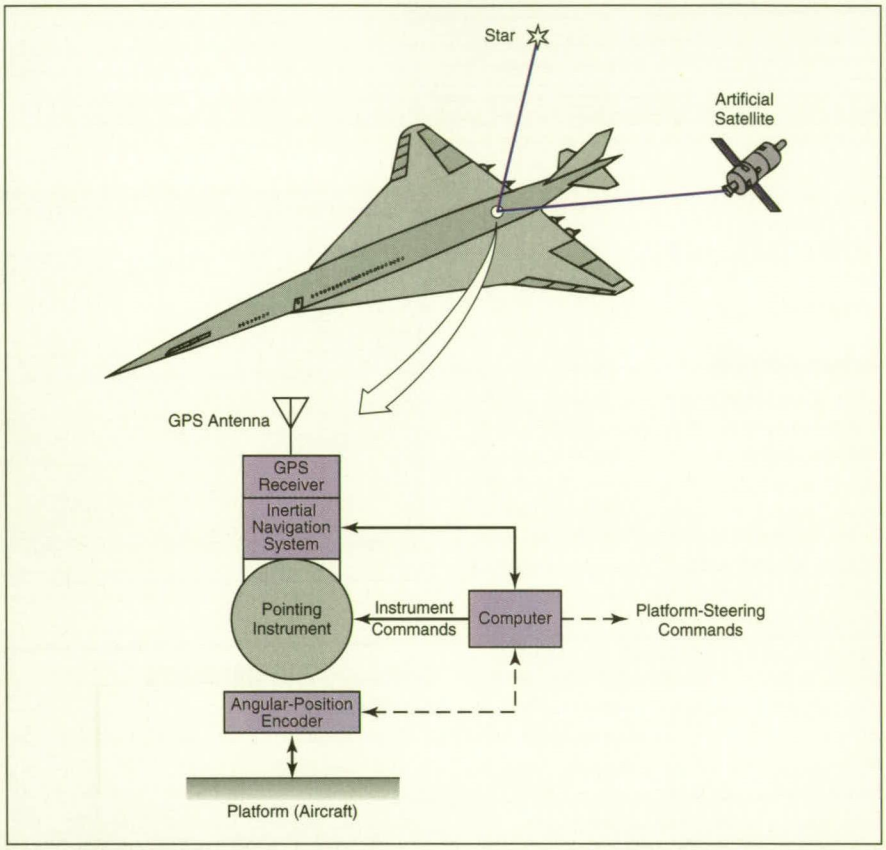
The position and orientation of the INS relative to the pointing instrument are known and remain fixed, unlike in other systems, in which INSs are located elsewhere and it is necessary to measure suspension angles and to utilize multiple platform and suspension coordinate transformations subject to buildup of platform-bending and misalignment errors. The direct-mounting scheme thus eliminates several sources of instrument-pointing error and simplifies design and operation (thereby also reducing cost).

The INS contains triads of gyroscopes and accelerometers and associated analog and digital electronic circuits. The GPS antenna and receiver are mounted on the pointing instrument along with the INS. The GPS signals are used to correct drift errors in the INS position and orientation outputs. The position and orientation data (including GPS corrections) from the INS are sent to a computer, along with GPS time data. The computer selects the relevant data and processes these data through a series of transformation routines to generate command angles or instructions, in a preferred navigation coordinate frame, for pointing the instrument at a known stationary or moving target.

The computer calculates the required instrument-pointing angles in the navigation coordinate frame. The computer then compares the required instrument-pointing angles with the actual instrument-pointing angles determined by the INS. Next, using control logic, the computer processes the results of this comparison into corrected pointing angle commands. It is desirable to keep the corrected pointing angle commands as close to zero as possible. These commands are used for fine pointing of the instrument as the platform moves.

In some applications, steering instructions from this system are used for navigating the platform. In such an application, an angular-position encoder provides data on the orientation of the platform relative to the instrument. The encoder may, if necessary, be far less accurate than the encoders used in other instrument-pointing and navigation system; its accuracy need not exceed that of the platform autopilot or steering control subsystem.

In normal operation with respect to a celestial target viewed from an aircraft, an operator first gives the computer the celestial coordinates (e.g., right ascension and declination) of the target. The computer then generates a command to steer the aircraft onto a heading that will enable the instrument to acquire the target. The heading command can be routed to the autopilot. Once the aircraft is on the desired heading, the computer commands the pointing instrument to turn to the required elevation, azimuth, and line-of-sight angles for tracking the target.



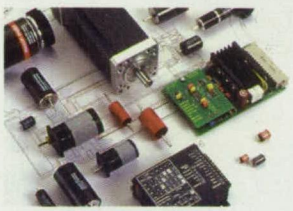
The **INS Is Mounted Directly on the Pointing Instrument** instead of on the platform as in other systems. This direct-mounting scheme affords the advantages of less complexity, greater accuracy, and lower cost, relative to other instrument-pointing systems.

This work was done by Robert Yee and Fred Robbins of **Ames Research Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

This invention has been patented by NASA (U.S. Patent No. 5,809,457). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Ames Research Center, (650) 604-5104. Refer to ARC-14060.

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The Maxon product line consists of quality high efficiency DC motors, which are available with gearheads, encoders, tachometers, and controllers. Our products range from cost-effective ferrite magnet motors to current state of the art rare earth magnet motors. Brushless motors also are offered.



Our patented rhombic wound moving coil motors offer several advantages over conventional DC motors such as much longer brush life and extremely low electrical noise, low mechanical time constant for fast acceleration, low current consumption for extending battery life, no cogging for smooth rotation even at low speeds, and linear speed-torque constants for simple, accurate control.

Typical applications include air samplers, chart recorders, miniature pumps, chopper wheels, laser measuring devices, microscope stages, surgical devices, data storage devices, vision systems, and printers/labelers.

For more information, call or fax Mr. James Talent, Maxon Precision Motors, Inc., Burlingame, CA. Tel: 800-865-7540, Fax: 650-697-2887.

Circle No. 663

12 mm REDUCED COST MOVING COIL MOTOR



Maxon's new A-max 12 mm (0.47 in) diameter motor delivers the performance and lifetime of a moving coil motor, but at a reduced cost due to improved automated manufacturing processes. The patented rhombic moving coil design provides for long life, low electrical noise, fast acceleration and high efficiency. The ironless rotor allows for zero cogging and simple accurate control. The motor is available either with a single shaft or with a passing shaft, and is rated at .5 or .75 watts. Other standard options include ball bearings/sleeve bearings, and terminals/leads. The motor length is 20.6 mm (0.81 in) and weighs in at 10 to 12 g (.35 to .42 oz) depending on configuration. Several different windings are available to match desired speed with available voltage. Ambient temperature range is from -30° to 85° C (-22° to 185° F), while the maximum efficiency is up to 71% depending on the winding. The maximum continuous torque from the motor alone is up to .99 mNm (.14 oz-in). Matching gearheads are also available with ratios ranging from 4:1 to 1,118:1 capable of delivering up to 530 mNm (75 oz-in) of intermittent torque. Matching encoders are also available.

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Circle No. 662

500 WATT BRUSHLESS MOTOR



Maxon's new "EC" series of brushless motors are electronically commutated, thus enabling extremely long motor life, since there are simply no mechanical brushes to wear out. Hall effect sensors are built in to the motor in order to provide feedback to the control electronics. By assembling the motor such that the coils are outside the rotor, good heat dissipation and high overload capability are attained. Diameter is 60 mm (2.4 in) while the length is 173 mm (6.8 in). Continuous output power is 500 watts, while maximum speed is 7,000 RPM. Ambient temperature range is -20° to 125° C (-4° to 257° F). Utilizing high-energy neodymium magnets results in a very responsive mechanical time constant of 4 ms, while minimizing overall size. Using electronic commutation allows for minimum electrical noise; in fact these motors are CE approved, signifying electromagnetic compatibility in the European market. Motors are offered with both "Y" or "delta" configurations to optimize performance. Complementing the motors are gearheads with ratios from 3.7:1 to 307.5:1 capable of 180 Nm (132 ft-lb) of intermittent torque. Also offered are encoders, resolvers and brakes.

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Our Maxon Selection Program (MSP) software calculates your drive solutions for you. With thousands of motor combinations – MSP analyzes your needs based on speed, torque, voltage, diameter, and length – and generates detailed data and diagrams – it weighs the options and delivers the solution, eliminating uncertainty without compromise and error.



Our comprehensive catalog covers Maxon's complete product line of DC brush and brushless high precision motors ranging in size from 6mm (0.2") – 75mm (3"), and from 0.5 – 500 watts output power.

Maxon's approach to supporting your total drive solution includes our extensive selection of gearheads, tachometers, encoders, resolvers, and velocity amplifiers. If your application demands a cost-effective or custom motor, we can manufacture it and deliver anywhere in the world.

Our consistent quality is attested by ISO 9001 certification, which applies not only to proven quality in production, but also in design/development and servicing.

We're confident you'll find at Maxon the combination of expertise, responsiveness, and personal commitment that ensures the best possible motion solution.

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PRECISION MOTORS

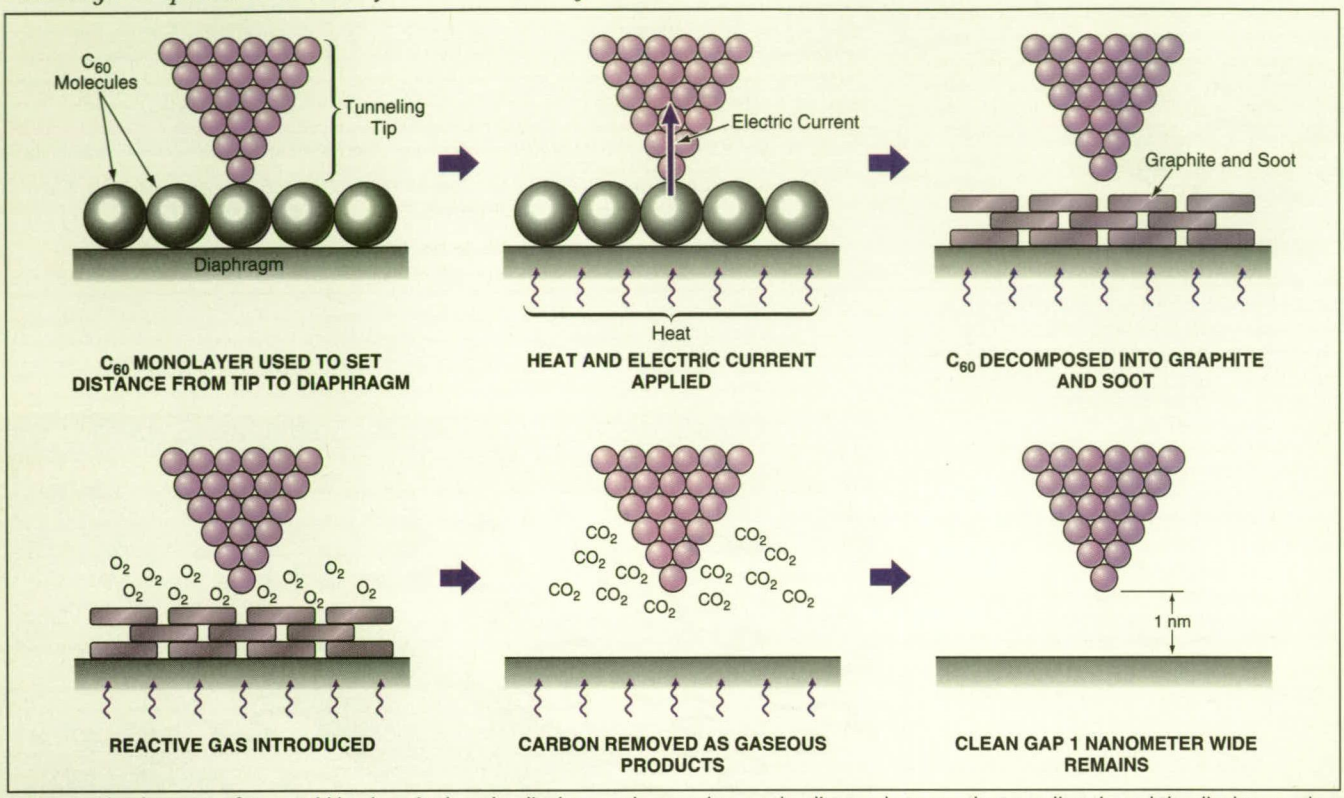
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Temporary Fullerene Films in Microelectromechanical Devices

These films would be used to protect and position quantum-mechanical-tunneling tips.

NASA's Jet Propulsion Laboratory, Pasadena, California



A **Monomolecular Layer of C_{60}** would be deposited on the diaphragm, then used to set the distance between the tunneling tip and the diaphragm, then removed thermochemically.

In a proposed technique for fabrication of microelectromechanical devices, thin films of fullerenes would be used as temporary packaging to protect and position delicate components. The initial application of this technique would likely occur in the fabrication of devices in which quantum-mechanical tunneling of electrons across gaps about 1 nm wide would be exploited to measure subnanometer displacements of the components facing each other across the gaps.

Typically, a tunneling device of this type includes a pyramidal metal tip that faces a gold-coated diaphragm across the tunneling gap. In present fabrication practice, the initial gap is set by moving the tip and diaphragm toward each other under manual control until a tunneling current is measured. Often, the tip and diaphragm are accidentally brought into contact, with consequent damage to either or both.

The proposed technique calls for deposition of a monomolecular layer of the fullerene C_{60} on the diaphragm prior to setting the gap (see figure). The C_{60} molecular unit is approximately spherical and, fortuitously, is 1 nm wide. Thus, the monomolecular layer of C_{60} would not only prevent contact between the tip and diaphragm but would also automatically establish the desired gap thickness. It would still be necessary to position the tip and diaphragm as in current fabrication practice, but tunneling current would no longer be used as the position indicator; instead, exploiting the electrical conductivity of C_{60}, one would simply monitor for contact between the tip and the C_{60} film, as indicated by the onset of electrical conductance between them.

Once the fullerene film had served its purpose, it would be removed (either during fabrication or at any suitable time thereafter). If the film were weakly chemisorbed on the diaphragm, it might be removable by simple heating. Otherwise, a more complex removal process would include the application of both externally generated heat and an electrical current through the tip/C_{60}-film contact; the combination of externally supplied heat flux and current would have to be large enough to heat the C_{60} film in the vicinity of the tip sufficiently to break down the C_{60} into graphite and soot, but not so large as to damage the tip or the diaphragm. The resulting hot carbonaceous contaminants would be removed by chemical reaction with O_2 (or perhaps with Cl_2 and/or H_2) to form CO_2 and/or other gaseous species.

The O_2 or other reactive gas could be supplied via a channel with a one-event valve; such channels and valves are commonly included in microelectromechanical devices and systems. The CO_2 and/or other gaseous product(s) could be adsorbed onto a sacrificial (getter) surface that had been fabricated previously as an integral part of the device. As a result, the region around the tip would be free of fullerene, carbonaceous contaminants, or adsorbed gas.

This work was done by John D. Olivas 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.*

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, NASA Management Office–JPL; (818) 354-2240. Refer to NPO-20148.

First-Order Theory of Control of Motion of a Crane and Load

Suitably modulated motion of the crane could prevent swinging of the load.

John F. Kennedy Space Center, Florida

A first-order mathematical model has been developed in a theoretical study of the dynamics of a load suspended by a cable from a crane that moves along a straight track. The model is the basis of a proposed method of computer control of the velocity as well as the position of the crane to minimize or prevent swinging of the load. (Traditionally, only the position of the crane is controlled; there is no engineering provision against swinging of the load.) Velocity and position control to prevent swinging would be highly desirable, especially in situations in which there are requirements for precise placement of large loads and/or the delays incurred in waiting for damping of pendulum oscillations of loads are unacceptable. Because most modern cranes are already controlled by computers and include position-indicating control subsystems, the implementation of this method of control would entail little or no additional equipment and thus should be relatively inexpensive.

The mathematical model describes the coupled motions of the crane head, cable, and load, with simplifying assumptions that (1) friction on the cable and load is negligible, (2) the mass of the cable is negligible compared to that of the load, (3) the load acts like a point mass, (4) the length of the cable remains constant during the controlled motion, and (5) the angle between the cable and the vertical is never more than a few degrees, so that the first-order pendulum approximation is justified. The basic equation of the model is

$$V_p(t) = V_m + \left(\frac{l}{g}\right)\frac{d^2V_m(t)}{dt^2},$$

where Vp is the velocity of the crane head (which can be controlled), $V_m(t)$ is the velocity of the load mass, l is the distance (approximately equal to the length of the cable) between the center of mass of the load and the point of attachment of the cable to the crane head, g is the gravitational acceleration, and t is time.

Mathematically, the control problem for accelerating (or, equivalently, decelerating) the load without inducing pendulum oscillations is to choose a crane-head velocity function $V_p(t)$ such that the load velocity will be a desired function $V_m(t)$, subject to the boundary conditions that, at the end of the acceleration and or deceleration interval, both the crane and the load must be at the same horizontal position and velocity and must not be accelerating.

Suppose, for example, that the crane head and the load mass are initially moving together at a constant velocity with the load mass directly under the crane head, and it is desired that the load mass be stopped smoothly at a given location. In principle, there are infinitely many velocity functions $V_p(t)$ that can produce this effect. Essentially all of them start by decelerating the crane head first. This causes the load mass to move in front of the crane head, so that the cable pulls back on the load mass, decelerating it.

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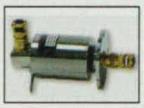


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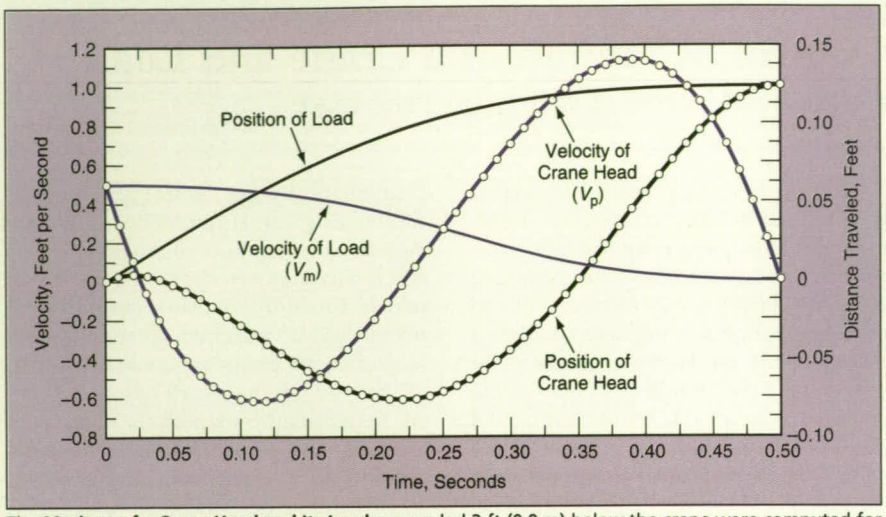


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Netzer Precision Motion Sensors presents the new, all-color brochures and product sheets featuring detailed electrical and mechanical specifications of the Rotary, Linear, X-Y, and the Wireless Read-Head Linear Electric Encoder™, in addition to customization options. Low weight and power consumption along with high precision make them particularly suitable for aerospace applications. Netzer Precision Motion Sensors, Turag Bldg., Teradion Industrial Park, PO Box 1359, D. N. Misgav, 20179, Israel.

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For More Information Circle No. 653



The **Motions of a Crane Head and Its Load** suspended 3 ft (0.9 m) below the crane were computed for a case in which the initial velocity of the crane and load was 0.5 ft/s (0.15 m/s) and it was required to bring both the crane head and the load to a stop within a time of 0.5 s.

Then, after substantial deceleration by the load mass, the crane head is made to move forward faster than the load mass, moving back over the load mass and stopping the deceleration of the load mass just as $V_m(t)$ reaches zero (see figure).

There are many variations on this theme; in all of them, the crane head is made to move back and forth in order to make the cable exert acceleration and deceleration forces on the load mass and the crane head is repositioned to prevent the load mass from swinging or starting any other motion not desired. Of course, one should choose a desired $V_m(t)$ with acceleration and/or deceleration gentle enough that the $V_p(t)$ needed to obtain it is not so jerky and/or does not require so much precision as to lie outside the operational range of the crane motor and its control system.

Some aspects of the theory remain to be addressed. In particular, it would be desirable to generalize the mathematical model to the cases in which the length of the cable changes during the controlled motion, the angle is large enough that the model must include the full nonlinearity of the dynamics, and/or the crane can be moved along either or both of two orthogonal horizontal axes. A further problem to be considered is that of the degree to which the position and velocity of the crane can be measured and controlled and the effect to which limitations in control degrade the desired motion.

This work was done by Robert C. Youngquist, James P. Strobel, and Stan Starr of I-NET for **Kennedy Space Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category. KSC-11942*

Conformably Stowable Canard

Low-speed performance can be improved without incurring a high-speed wave-drag penalty.

Ames Research Center, Moffett Field, California

An improved secondary wing system of the canard type has been invented to improve performance and increase efficiency of airplanes capable of flight at supersonic and high subsonic speeds. Canards, including small forward-mounted secondary wings, are used to increase the total wing surface areas of airplanes in order to improve their low-speed lift-to-drag ratios and trim characteristics. Although canards have been used on supersonic airplanes to increase low-speed performance, heretofore the designs of canards have not provided for optimal high-speed performance and aerodynamic efficiency.

The present secondary wing system includes a single canard that can be pivoted about a vertical axis at its spanwise midpoint (see Figure 1). By such pivoting in conjunction with retraction or extension of fairings, the canard can be either (1) deployed to augment the lift, stability, and control of an airplane during lower-speed flight or (2) retracted conformally into the fuselage in order to minimize drag at higher speeds. The canard is equipped with leading- and trailing-edge control surfaces to enhance the aerodynamic performance of the airplane during use of the canard at low speed.

This invention is applicable to an airplane, the fuselage of which is area-ruled and includes a bulbous forward portion. A unique feature of this secondary wing system is that the secondary wing has a quasi-elliptical planform shape derived from an imaginary horizontal planar cut through an upper portion of the bulbous forward portion of the fuselage. The elliptical planform shape favors aerodynamic efficiency at low speed, thereby making it possible to reduce the engine power (and thus also noise) during low-speed operations, including takeoff, climb, and landing.

The lower surface of the canard is substantially flat as defined by the imaginary cut through the fuselage. When the canard is stowed, the upper surface of the canard (except at its edges) constitutes the surface of the upper portion of the fuselage from which the canard planform and loft was derived. When the fairings are extended at the leading and trailing edges of the canard to complete the stowage of the canard, the combination of the upper surface of the canard and the fairings define a streamlined surface contour that blends smoothly with the surface contour of the rest of the fuselage (see Figure 2), thereby promoting aerodynamic efficiency in high-speed flight. The characteristic fuselage shape that results from designing according to the area rule makes it possible to incorporate a canard that can be used at low speed and conformally stowed in the fuselage without incurring a significant wave-drag penalty at high speed.

The canard is connected to the fuselage by a ring-and-track mechanism, which includes (1) a submechanism for rotating the canard about a vertical axis for deployment or stowage as described above and (2) an actuated hinge submechanism that can be used to vary the angle of incidence of the canard when the canard is deployed. The design of this mechanism is such as to minimize its intrusion into the interior volume of the fuselage. The secondary wing system can

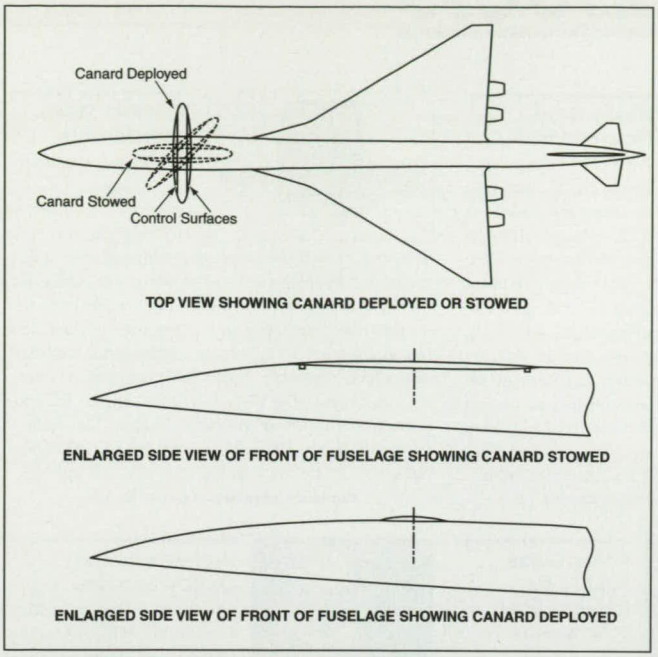


Figure 1. The **Canard Is Deployed** by rotating it so that its spanwise axis lies perpendicular to the longitudinal axis of the fuselage, and is stowed by rotating it so that its spanwise axis lies parallel to the longitudinal axis of the fuselage.

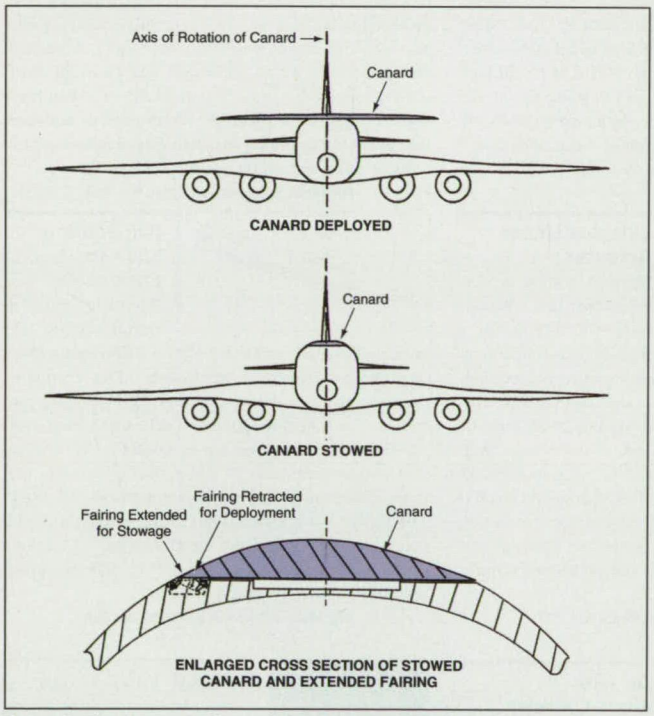


Figure 2. The **Upper Surface of the Canard and Fairing** blend conformally with the adjacent upper fuselage surface.

include additional mechanisms for securing the tips of canard to the fuselage when stowed to prevent flutter and flutter-induced damage that could otherwise be caused by the aerodynamic loads that are present during high-speed flight.

This work was done by Brian E. Smith of **Ames Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Mechanics category.*

This invention has been patented by NASA (U.S. Patent No. 5,992,796). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Ames Research Center, (650) 604-5104. Refer to ARC-14122.

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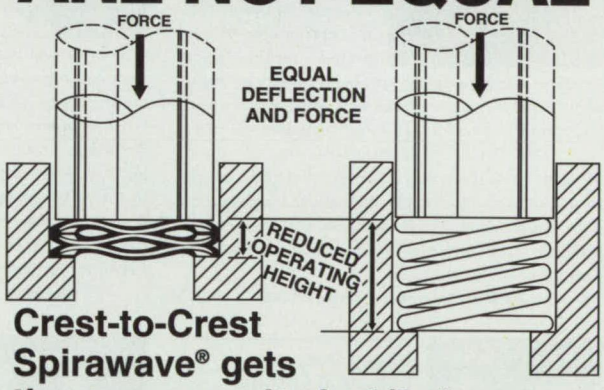
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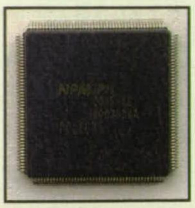
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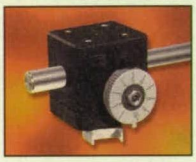
NEW PRODUCTS



Four-Axis Motion Control Chip

Nippon Pulse Motor Co., Radford, VA, offers the PCL-6045, a four-axis independent motion control chip in a 176-pin QFP. It allows positioning and speed to be changed on the fly. Features include damping oscillation control, prebuffer for the next motion control profile, automatic correction of operating speed, backlash correction, and out-of-step detection. Maximum speed output is 6.5 Mp/sec, and the operating temperature range is 0-70 °C. The PCL-6045 supports linear interpolation, circular interpolation, and the option of having a combination of the two.

For More Information Circle No. 780



Linear Actuator for Reciprocating Applications

Amacoil/Uhing, Aston, PA, makes available a new version of its Kinemax linear actuator that provides infinitely variable pitch control for light-duty reciprocating linear motion applications. Utilizing the company's "Rolling Ring Technology," it produces a 20-percent increase in thrust over the earlier version. The technology converts rotary input into linear output on a smooth unthreaded shaft for reciprocating, positioning, and indexing linear motion systems. Equipped with a dial-in adjustment knob, the Kinemax provides incremental control of pitch from 0.62 to 6.2 millimeters per shaft rotation, and all points in between.

For More Information Circle No. 783



Screw-Clamp Connectors

Hirschmann Inc., Pine Brook, NJ, says its new CA series of power connectors features an integrated strain relief device to ensure reliable, trouble-free, quick disconnects. The series also features a special screw-lock technique to provide optimum resistance to vibration. The CA series connectors are adjustable through 90 degrees, and its strain relief gland adapts to a wide variety of cable diameters. Wrap-around seals protect against dust and moisture. The series is available in 3+ ground (4 screw contacts) and 6+ ground (7 solder contacts).

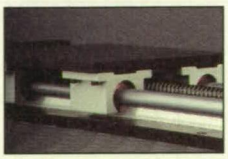
For More Information Circle No. 786



Heavy Duty Industrial Encoder

Danaher Controls, Gurnee, IL, offers a new line of hazardous-duty rotary encoders designed for use in speed-feedback, cut-to-length measurement, and positioning applications in corrosive and/or explosive atmospheres. The Series X25 encoders are incremental optical encoders featuring environmentally sealed cast aluminum housings and a stainless steel shaft. Electrical outputs are electronically compatible with almost all drives and PLCs. Differential line driver outputs are available for long cable runs and higher noise immunity.

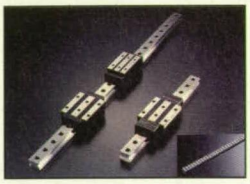
For More Information Circle No. 789



Heavy Duty Linear Slides

Pacific Bearing Co., Rockford, IL, says that its slides are based on its Simplicity self-lubricated bearings that have a Frelon® bearing surface that increases load capacity to more than five times that of traditional rolling-element bearings. The bearing material wipes the shafting clean as it travels, so that any particulate that migrates into the bearing is embedded into the bearing material. There are no mechanical components to become locked or gall the shafting. The slides can withstand temperatures from -400 to +500 °F, and come in standard sizes from 1/2- to 2-in. shafting and lengths up to 96 in.

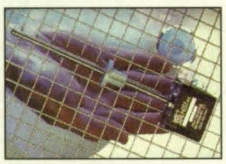
For More Information Circle No. 781



Roller Guide Said to be Industry First

THK America Inc., Schaumburg, IL, says that its Type SRG is the industry's first caged roller guide. Employing design elements from its Caged Ball™ technology, the Type SRG incorporates an elastomeric cage to isolate rollers, thus eliminating roller-to-roller contact and roller skewing, the company says. THK's QZ lubricator, for automatic oil replenishment, and LaCS contact scraper, to clear debris from the rail while the guide moves, are available as options. Side, inner, and end seals are standard to prevent penetration of debris.

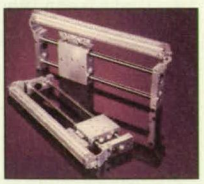
For More Information Circle No. 784



External Linear Actuator

Haydon Switch & Instrument Inc., Waterbury, CT, introduces a Size 17 external linear actuator, a rotating leadscrew design using a stainless steel Acme leadscrew incorporated directly into the motor's rotor. Thus, the company says, shaft-to-leadscrew couplers are not needed, saving setup time. Resolutions range from 0.00012 in./step to 0.00192 in./step. A standard external linear actuator has 6.0 in. of visible leadscrew, but Haydon says leadscrew dimension and termination, as well as external nut design, can be customized to the purchaser's application requirements.

For More Information Circle No. 787



Slide with Rodless Cylinder

PHD Inc., Fort Wayne, IN, is making the Series SG slide with rodless cylinder available. The units are offered in four sizes with travels up to 36 in. (915 mm) for a wide variety of saddle slide applications. These SGxM slides come with built-in adjustable cushions for reduction of end-of-travel impact on both ends. A standard magnetic piston used with Reed or Hall-effect switches provides end-of-travel sensing, and facilitates interface to electronic controls. Other options include shock absorbers, shock pads, proximity switches, and corrosion-resistant shafts.

For More Information Circle No. 790



Stainless Steel Flow Sensors

McMillan Company, Georgetown, TX, introduces the Series 104 stainless steel flow sensors for low-flow-rate corrosive liquids. They use a miniature Pelton-type turbine wheel to determine the flow rate. Rated for operation up to 500 psi, the sensors have accuracies of ±1 percent full scale and repeatability of ±0.2 percent. They come standard with a NIST-traceable certificate of calibration. There are two outputs: 0-5 VDC and pulse outputs for connection to a variety of available displays. The company says the Series 104 can measure extremely low flow rates from 13 ml/min. to 5 l/min. or 1-100 gph.

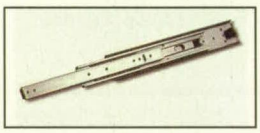
For More Information Circle No. 782



High-Resolution Optical Encoder

Quantum Devices Inc., Barneveld, WI, offers the QD145 high-resolution optical encoder, which it calls the "Size 1.45-in." It is a complete operational unit with an integrated dual ABEC 5, ball-bearing, insert-molded hollow shaft support that provides the mechanical stability for the low-profile encoder package (0.87-in. high by 1.45-in. diameter). Standard resolutions are up to 4096 ppr, and through shaft sizes are available up to 10 mm (0.395 in.) diameter. Product options include 120 °C continuous ambient operating temperature and 4- to 12-pole three-phase commutation signals for brushless motors.

For More Information Circle No. 785



Ball Bearing Slide for Enclosures

Accuride International, Santa Fe Springs, CA, calls its Model 3307 a ball-bearing slide created for electronic enclosures. The company points to the fact that the Model 3307 requires just one-half inch of side space and offers one inch over travel for maximum access to contents. To ensure that components stay in place during service, the slide secures in a lockout position when extended. The device has a 150-lb. load rating with substantial proof loading at two times the chassis load. The slide comes in even lengths of 12 to 28 in., and its chassis member features lever disconnect.

For More Information Circle No. 788



Solenoid Valve Series

Valcor Scientific, Springfield, NJ, says that its SV12 solenoid valve series is specifically engineered to permit the high flow of noncorrosive fluids, light industrial liquids, slurries, and gases. The series is direct acting, two-way, normally closed valves that permit high flow with minimum pressure differential: less than 10-in. water-head pressure differential in the direction of flow for drip-tight sealing. Valcor says the design uses its Floating Seal, which utilizes an optically flat Teflon seal disc against an equally flat stainless steel seat.

For More Information Circle No. 791

Java Implementation of Information-Sharing Protocol

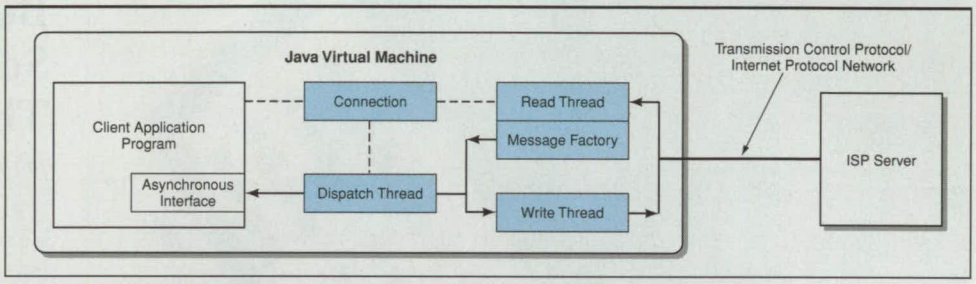
The Java-language ISPresso software enables real-time access to mission data via home and office personal computers.

Lyndon B. Johnson Space Center, Houston, Texas

Johnson Space Center's (JSC's) growing operations community requires new ways to distribute and process mission information. The Mission Control Center uses flight-control application programs based on an information-sharing protocol (ISP) to process and distribute real-time mission telemetry, trajectory, and computation data. ISP application programs provide multiple users synchronous, rapid access to mission data and programs. The ISPresso ISP software package is designed in Java, which is rapidly becoming the language of choice because of its ability to work on almost any platform. ISPresso plays a substantial role in the remote-access platforms now being implemented for space-shuttle and space-station operations and is used for Hubble Space Telescope operations. The portability of ISPresso enables deployment of mission-data-processing application programs to desktop computers and makes it possible to package application software for convenient access through web browsers. Such accessibility will prove useful in many additional process-control settings, from powerplants to all types of manufacturing.

Current ISP client software libraries are written in the C computing language for UNIX; consequently, all telemetry application programs must also run on UNIX platforms. The advantage afforded by Java is that, once written, a Java application program can run anywhere a compliant Java virtual machine (VM) is available. Because ISPresso is written in Java, it can run on any platform that includes a Java VM.

ISPresso is a product of a complete redesign and rewrite of ISP client software libraries to take advantage of the easy-to-use, synchronous (threaded), Internet-friendly nature of Java for creating ISP client programs. The ISPresso library consists of seven Java software packages. The essential functional elements of ISPresso are shown in the figure. The Read Thread, Message Factory, and Write Thread constitute the primary interface to the ISP server. They provide generic input/output and event-based message-passing and specific message-passing. The Connection and Dispatch Thread functions are performed by the ISP client interface software package, with ISP updates encapsulated into the Value, Message, and Status classes. The Connection function includes mode control over the other functional elements, as indicated by the dashed lines. Solid lines denote data flow within ISPresso. The Dispatch Thread delivers updates asynchronously to the client application program via the Observer interfaces in the ISP client interface software package.



The **Functional Elements of ISPresso** are established within a Java virtual machine.

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The portability of Java gives ISPresso several advantages over the C/UNIX version of ISP:

- Unlike C/UNIX ISP application programs, ISPresso can run from desktop computers.
- Unlike C/UNIX application programs, ISPresso application programs can run on desktop personal computers or on the JavaStation — a Java-only platform that is configured entirely from servers and therefore costs almost nothing to maintain.
- Although C/UNIX ISP application programs can usually be transferred from one system to another with minimal rework, certain transfers do necessitate spending significant time and effort to restore compatibility. Developers of ISPresso code need to produce and maintain only one set of code for all platforms, inasmuch as any computing system with the Java VM accepts the code readily.
- Java is becoming a language of choice for the software industry; the number of Java software products will soon surpass that of software products in the C++ language and will likely eclipse that of programs in the C language. Java VMs are distributed widely via Java-enabled web browsers. Universities are adopting Java as their standard "teaching language" for computer-science courses. The number of software tools available, the variety of types of products, and the number of qualified programmers will make it easier and more economical to equip and staff development teams for Java-based software products than for C/UNIX software products.

This work was done by James C. Thompson and Steven P. Weismuller of United Space Alliance for **Johnson Space Center**. *MSC-22942*



Electronic Bulletin Board Publishes Schedules in Real Time

John F. Kennedy Space Center, Florida

Real Time Schedule Publisher (RTSP) is a computer program that generates a report of the current schedules of as many as about 25 users within an organization. The report is refreshed every 5 minutes and displayed in a common area on a flat-panel computer monitor that serves as an "in/out" bulletin board. The report is displayed in a five-column tabular format and includes color-coded legends that describe the status (with respect to availability) of each user. Each row of the table reflects a single event for a single user; the five columns represent, respectively, the name of the user, the event start time, the event end time, the location, and the subject. The display also includes the current date, day of the week, and time. In addition to the common display, an interactive view of the scheduling information is available, through a standard web browser, on any desktop computer connected to the organization's computer network. The interactive view provides an interface for administering users' accounts. RTSP is based on the active-server architecture of the Windows NT Server operating system and is integrable with similarly based commercial-off-the-shelf scheduling programs.

This work was done by James Aliberti of **Kennedy Space Center** *and James B. McSorley, Roger B. Right, Jeffrey S. Hixson, David S. Metcalf, and Michael Hallberg of RWD Technologies, Inc. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Information Sciences category. KSC-12095*

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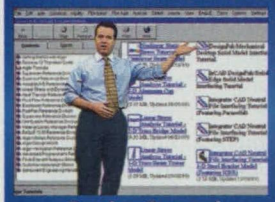


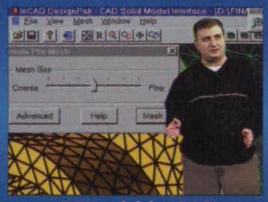
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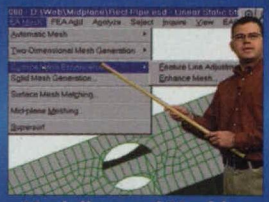
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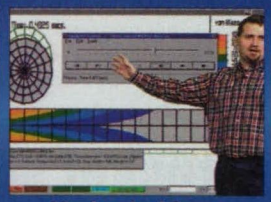
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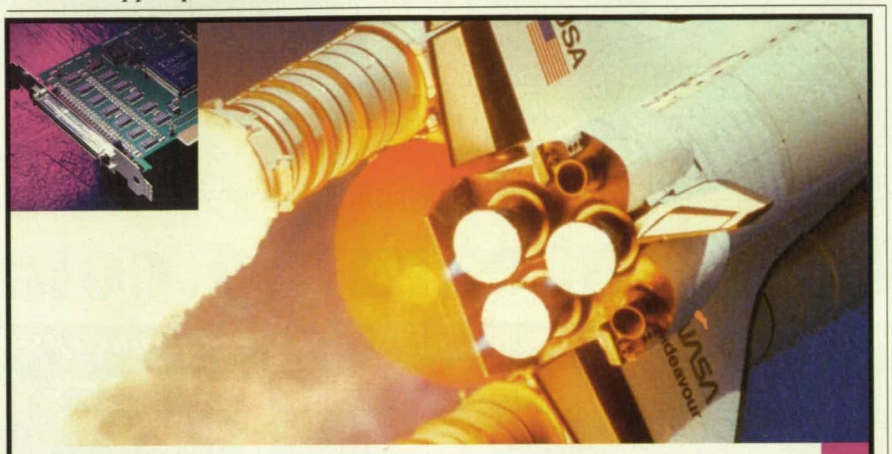
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Apparatus Would Extract Water From the Martian Atmosphere

A report proposes an apparatus that would extract water from the atmosphere of Mars and would consume little energy in doing so. The apparatus would include a set of copper plates surrounded by a thermal shield with slots through which atmospheric gas could circulate. At night, the slots would be open and the plates would be cooled to a temperature ≤170 K by thermally coupling them to a radiator facing the sky. Assuming that in the nighttime Martian atmosphere at ground level, the temperature is ≈200 K and the concentration of water vapor is at or near saturation, the vapor would condense and freeze on the plates. During the day, the slots would be closed and plates would be heated by thermally coupling them to a small solar collector; this would cause the ice to melt, and the water thus produced would be collected.

This work was done by Pramod K. Sharma of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "A Passively Operated Unit for Extraction of Water from the Mars Atmosphere," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*

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Review of Research on Supercritical vs. Subcritical Fluids

A paper reviews theoretical and experimental research on the behaviors of supercritical fluids and, for comparison, subcritical fluids. Experiments with drops, isolated or in groups, streams, shear layers, mixing layers, jets, and sprays are tabulated and discussed as a precursor to forming a concept of fluid behavior. The physics of the supercritical and subcritical regimes is discussed, and major differences between observations in the two regimes are identified and explained.

This work was done by Josette Bellan of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the paper, "Supercritical (and Subcritical) Fluid Behavior and Modeling: Drops, Streams, Shear and Mixing Layers, Jets and Sprays," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*

NPO-20893

Hybrid Regenerative Water-Recycling System

A wastewater-recycling system contains biological and physicochemical water-treatment units. The system is suitable for use in environments in which clean water supplies are limited. Waste streams containing urine and washwater are purified into potable water with a recovery rate of 99 percent. The system includes a two-stage trickling-filter bioreactor, a reverse-osmosis unit, and a photocatalytic post-treatment subsystem. The first stage of the bioreactor reduces the concentra-

tions of organic (carbon-based) compounds, while the second stage removes nitrogen compounds. The effluent from the reactor is sent to the reverse-osmosis unit, which passes 85 percent of the water and diverts the other 15 percent into a concentrated brine. Water is recovered from the brine by evaporation. Finally, the water is treated by ultraviolet light and titanium oxide for disinfection and for oxidation of any organic residue. The system can treat small amounts of very concentrated wastewater, without use of pretreatment chemicals, at low power consumption.

This work was done by Marybeth Edeen, Charles Verostko, and Mary Cleave of **Johnson Space Center** *and Nigel Packham of Lockheed. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category.*
MSC-22622

Study of Fusion-Driven Plasma Thruster With Magnetic Nozzle

A report presents a computational study of a proposed plasma thruster for a spacecraft. The behavior of the plasma was computationally simulated by use of a mathematical model of magnetohydrodynamic flow implemented in the previously developed MACH2 computer program. To increase the accuracy of modeling of the magnetic field, MACH2 was modified by providing for an arbitrary number of current loops used to generate the applied magnetic field and by splitting the total magnetic field into applied and plasma-induced components. The results of the computational simulations contribute to understanding of the appropriate parameter regimes for the electron beam, the in-flowing working fluid, and the applied magnetic field.

This work was done by Michael H. Frese, John J. Watrous, and Richard A. Gerwin of NumerEx for **Marshall Space Flight Center**. *To obtain a copy of the report, "A Fusion-Driven Earth to Orbit Thruster," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*
MFS-31390

Liquid/Vapor-Hydrazine Thruster Would Produce Small Impulses

A report proposes a liquid/vapor-hydrazine thruster for use in controlling the attitude of a small spacecraft. From the upstream to the downstream end, the thruster would include a tank containing liquid hydrazine, a fast liquid valve, a heated prevaporizing plenum, a fast gas valve, and a heated catalytic bed. In one mode of operation (the conventional mode), heat would not be supplied to the prevaporizing plenum; instead, liquid hydrazine would be fed directly to the heated catalytic bed. In another mode of operation, heat would be supplied to the prevaporizing plenum, and the gas valve would be opened in brief pulses to pass the hydrazine vapor to the heated catalytic bed to produce small pulses of thrust. The use of vapor (as compared with liquid) feed in the pulse mode would make it possible to generate smaller impulses, which are better suited for highly precise spacecraft maneuvers.

This work was done by Larry Roe of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Liquid/Vapor Millinewton Hydrazine Thruster," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category.*
NPO-20541

Thruster Based on Sublimation of Solid Hydrazine

A report proposes a small spacecraft attitude-control thruster in which the propellant material would be hydrazine that would be stored frozen until sublimed at the instant of use. From the upstream to the downstream end, the main components of the thruster would include a plug of solid hydrazine in a container, a rapid source of radiant heat (e.g., a laser diode or a flash lamp), and a heated-catalyst-and-nozzle assembly like that of a conventional hydrazine thruster. In operation, each pulse of radiant heat would cause a small amount of frozen hydrazine to sublime. The puff of hydrazine vapor thus generated would become chemically decomposed in the heated catalyst, and an impulse would be generated by the expansion of the puff of decomposition products in the nozzle. This thruster would be attractive for generating small impulses (impulse "bits") on command for precise maneuvering of a spacecraft that either remains below the freezing temperature of hydrazine (≈274 K) or that contains equipment to keep the hydrazine refrigerated.

This work was done by Larry Roe of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Subliming Solid Hydrazine Thruster," access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Machinery/Automation category.*
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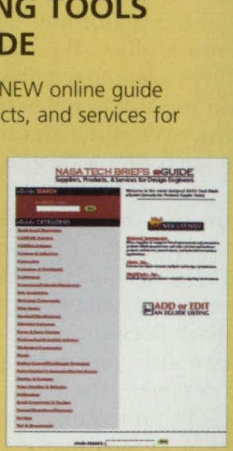


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If you work within a large organization, such as in a university or a research lab, you may have a dedicated technology licensing office. You could let them do the work. Unfortunately, they won't let you off the hook that easily. According to a 1999 study that looked at source data from five universities and one national lab, 54% of the leads that led to the signing of 1,140 licenses came from the inventors ("Where do the Leads for Licenses Come From" by Christina Jansen and Harrison Dillon in the 1999 Journal of the Association of University Technology Managers, http://www.autm.net/pubs/journal/99/leads.cfm). Even when the technology licensing office's marketing efforts are successful — which is 19% of the time, according to Jansen and Dillon's data — many of those licensees were initially identified by the inventor and targeted by the licensing office. Because most licensing offices are understaffed, underfunded, and use few broad-based marketing efforts, even when an invention seems to be languishing on the shelf, you need to get involved in promoting your efforts to ensure they are rewarded.

Suppose you operate in a small-company environment where you are the inventor and need to act as your own technology licensing office. Or, you want to make sure "your baby" gets the attention it deserves. Then you'll need to learn how to promote and market your innovation in ways that get the attention of potential customers and licensees — even potential customers that you may not know about.

The first step is to decide whether you need patent protection. Filing and defending a patent is expensive, so your decision should reflect the commercial potential of your invention and the difficulty others would have in reproducing or reverse-engineering it. Once you've filed your application (or not), you should recognize the valuable lesson in Jansen and Dillon's research: There is an even chance you already know the appropriate licensee for your technology. Use your network of friends and associates. You've met these people at trade shows, seminars, conferences, and other events where your common interests have put you together — perhaps they'll share your enthusiasm and euphoria over your innovation and want to license it. If not, perhaps they can recommend someone else who might. Talk to your research sponsors, too. In Jansen and Dillon's study, 7% of the licensees sponsored the research they later licensed.

Exchange Information

At the same time, you should make a broader audience aware of your innovation. *NASA Tech Briefs*, for example, is a publication with a mission to share information on the development of new technology with engineers for their use in designing, prototyping, testing, and manufacturing new or improved products. While you also can use other publications to spread awareness of your innovation, *NASA Tech Briefs* makes available to its readers the Model and Simulation Exchange through its relationship with Innovation Chain. You can use this Exchange to make available to potential licensees a model of your efforts.

Your model benefits from some unique technical and promotional features of the Exchange. On the technical side, the user never gets access to your valuable intellectual property. The Exchange allows the user to communicate with your model via a Microsoft Excel



Pointing readers of *NASA Tech Briefs* to an operational model in the Model and Simulation Exchange provides a unique and valuable way to increase awareness of your efforts while simultaneously accelerating the reader's evaluation of your technology and capabilities.

spreadsheet that the user has turned into a Web-enabled control panel by downloading and installing a free plug-in. With the plug-in, the Excel control panel is capable of sending and receiving simple (numbers, relationships, Booleans) and complex (fields, meshes) data, while Excel acts as an abstraction and insulation layer to the real models. This lets users understand and interact with the model without having access to the underlying intellectual property.

Publishing an article and pointing Tech Briefs' readers to a model, algorithm, or software program lets them play with your innovation or illustrates its value in calculating results. In this way, you accelerate your licensing efforts by answering some preliminary questions and insuring your own credibility. Think about it: Are you more likely to believe something you can see or get your hands on than a textual description?

You can make the models in the Exchange accessible in two modes: "free running," where the user enters their input values and boundary conditions and the model calculates results; and "archive look-up," where you pre-simulate several input states and the Exchange provides the best match of results to a user's particular input conditions. Though the feature doesn't generate precise results to the user's input conditions, archive look-up protects the user (and the engineering servers on which the models live) from long run times. The feature also gives you the ability to deliver more precise results for a fee, if the user wants them, or along with a sales pitch if you want to set it up that way.

The technology behind the Model and Simulation Exchange initially was developed by a consulting firm looking to deliver access to its models to its partners and clients without giving away the intellectual property in any of its models. The result is a technology that Innovation Chain adapts to serve the needs of small, medium, and large consulting operations; tech-transfer organizations; and corporations hoping to share access to models with their various constituencies, without giving away the underlying expertise. Centralizing the models provides two other significant benefits: you only need to maintain one version of the model to ensure that users have the latest version, and you can easily monitor usage.

NASA Tech Briefs' Model and Simulation Exchange helps you raise awareness through the coordinated publishing of your efforts in a written tech brief and posted model. The technology is also available in other forms. The Tech Transfer Accelerator package allows tech-transfer organizations to demonstrate models of products and technologies. The Engineering Channel Prospector package helps consultants who may be looking at a delivery vehicle for their expertise that will broaden their markets and customer base. Innovation Chain's technology can be useful to market your inventions.

We strongly encourage you to register, install the Plug-In, examine some of the models in the emerging site, and contribute to its growth. Feel free to submit a model in coordination with a tech brief, to share a model with friends or colleagues, or use the models whenever you find a link to a model in Tech Briefs that demands further inspection. Let us know what you think.

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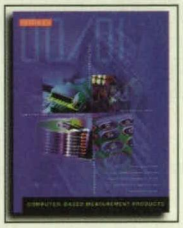
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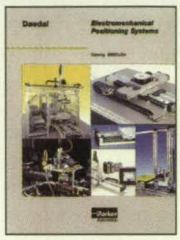


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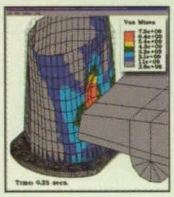


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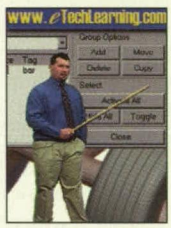


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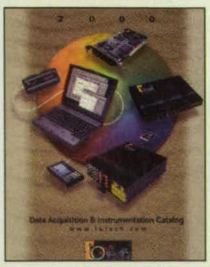


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DATA ACQUISITION CATALOG

IOtech's Data Acquisition & Instrumentation Catalog. This free 320-page catalog features our complete line of products pictured for the first time in full color. New products include an Ethernet-based recorder, plug-in PCI board, and temperature and voltage instruments. A wide range of data acquisition systems and signal conditioning options, as well as IEEE 488 instruments and controllers are also featured. IOtech, Inc.; Tel: 440-439-4091; Fax: 440-439-4093; e-mail: sales@iotech.com; www.iotech.com

IOtech, Inc.

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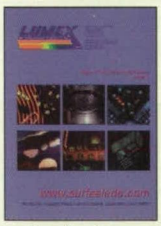


LCR METERS

The SR700 Series LCR meters measure R+Q, L+Q, C+R, and C+D with a basic accuracy as high as 0.05%. Features include variable test frequencies from 100 Hz to 100 kHz, internal or external DC bias, series and parallel equivalent circuits, and external capacitor biasing. An RS-232 computer interface is standard. GPIB (IEEE-488) and parts handler interfaces are optional. SR715 (0.2% basic accuracy), U.S. list price: $1,295; SR720 (0.05% basic accuracy), U.S. list price, $1,995. Stanford Research Systems, Tel: 408-744-9040; Fax: 408-744-9049; e-mail: info@thinkSRS.com; www.thinkSRS.com

Stanford Research Systems

For More Information Circle No. 607



NEW SMT LED CATALOG

Lumex has rolled out a 60+ page expanded version of its surface mount catalog. Like its predecessor, the new surfeeleds™ catalog offers the world's largest selection of SMT LEDs, from bare LED chips — die and wafer form — all the way to high reliability, two layer ceramic styles. AlInGap, GaInN, and GaN die compositions available for most packages. A wide selection of standard light pipes and custom solutions is also available. For more information, visit www.surfeeleds.com. Lumex, Inc., Palatine, IL 60067; Phone: 847-359-2790; Fax: 847-359-8904; email: sales@lumex.com; www.lumex.com

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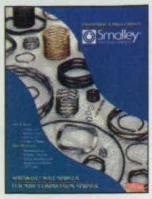


PATENTED SELF-LOCKING CLAMPING SYSTEM

New Amacoil datasheet covers patented, GripFast™ clamping system that enables fast-action, secure attachment and quick release for a wide variety of items on a smooth, unhardened shaft. The GripFast self-locking collar fastening system is designed to increase production and decrease downtime in spooling, fastening, joining, machine tooling and other applications. Amacoil, Inc., Tel: 800-252-2645; e-mail: amacoil@aol.com; www.amacoil.com

Amacoil, Inc.

For More Information Circle No. 609



WAVE/COMPRESSION SPRING CATALOG

The new 2000 edition catalog, #WS-2000, contains thousands of stock-size wave springs (hundreds of new sizes added), design formulas, a materials guide, and typical applications. This 40-page engineering and parts manual describes the advantages of wave springs and helps engineers solve problems. All springs are not equal! Smalley springs, available from 3/8" to 84" in diameter, fit in tight radial and axial applications. Work heights can be reduced by 50% using a wave spring. Smalley engineers are available for free assistance. Smalley Steel Ring Co., 385 Gilman Ave., Wheeling, IL 60090; Tel: 847-537-7600; Fax: 847-537-7698; e-mail: info@smalley.com; www.smalley.com

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MEASUREMENT & AUTOMATION CATALOG 2001

The National Instruments Measurement and Automation Catalog 2001 is the leading resource for engineers and scientists seeking the most effective customer-defined measurement and automation solutions. The catalog details the complete line of NI products with comprehensive tutorials, product specifications, and selection advice, all designed to help engineers and scientists develop integrated networked measurement and automation applications. Call for a FREE 2001 catalog or find it online at www.ni.com/info/catalog. National Instruments; Tel: 800-433-3488; Fax: 512-683-9300; e-mail: info@ni.com; www.ni.com/info/catalog

National Instruments

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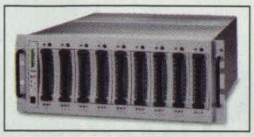


DEVICE DATA INTO WINDOWS APPLICATIONS

WinWedge instantly inputs serial (RS232-RS485) or TCP/IP data into any Windows application: Excel, Access, MMIs, etc. Collect data from and control gauges, micrometers, balances, meters, bar-code scanners, measuring instruments ... any device. Easily perform graphing and analysis of your instrument data in any program. TalTech, 2027 Wallace St., Philadelphia, PA 19130; Tel: 800-722-6004, 215-763-7900; Fax: 215-763-9711; www.taltech.com

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SCSI ENCLOSURES

StorCase™ Technology is pleased to announce the release of a new line of external expansion chassis, the InfoStation™ backplane-design SCSI enclosure. Its direct connect backplane supports up to 9 high-density, high-speed, 3.5" SCSI single-ended, Ultra2, or Ultra160 SCA devices for RAID or JBOD applications. With upgrade slots for adding RAID and SAF-TE controller modules, the InfoStation is ready for the future when you are. StorCase Technology, a Kingston Technology Co.; www.storcase.com

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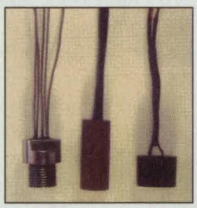


FREE CATALOG OF TOOLING COMPONENTS

The Reid Tool Supply catalog offers more than 40,000 items, including handwheels, handles, knobs, spring and ball plungers, vibration-isolation items, leveling pads, clamps, set-up accessories, locating devices, linear motion slides, latches, hinges, thread inserts, bearings, and more. Most items are available in inch and metric. All items are in stock for same-day shipment with no minimum-order requirement. Reid Tool Supply Co., 2265 Black Creek Rd., Muskegon, MI 49444; Tel: 800-253-0421; Fax: 800-438-1145; www.reidtool.com; NDS Booth # 9322

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"SELF-RENEWING" THERMOCOUPLE

NANMAC Corp.'s line of "Self-Renewing" thermocouples contains a flat two-dimensional thermal junction that can measure surface temperature with microsecond response times. This patented, revolutionary design will measure surface temperature even while the surface is subjected to wear or ablation. The thermowell can be made out of any machinable material such as metal, plastic, graphite, or phenolic to match the precise thermal properties of the test wall. Ask for catalog E1. Contact Doug Claffey, NANMAC Corp.; Tel: 508-872-4811; Fax: 508-879-5450.

NANMAC Corporation

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FREE DATA ACQUISITION STARTER KIT

Maybe you've always wanted to try PC-based data acquisition. Or maybe you acquire data now but aren't pleased with the results or performance. Here's your chance to try our solution absolutely FREE. Sign up to receive our WinDaq Starter Kit that includes data acquisition hardware, and a CD-ROM containing WinDaq software, a multimedia tutorial, and electronic catalog. Visit DATAQ Instruments on the web at www.dataq.com/nlit to register.

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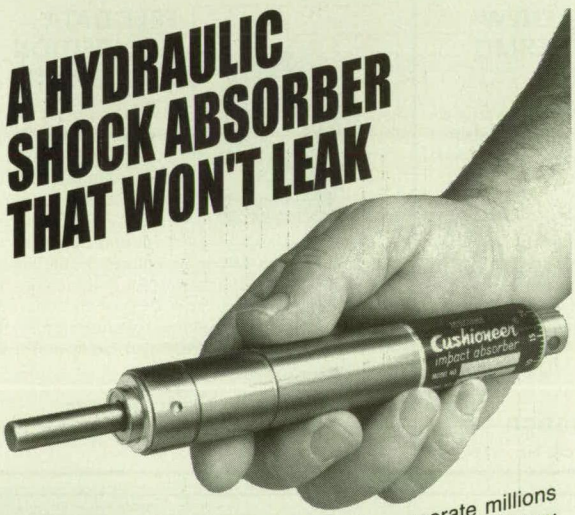
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For More Information Circle No. 442

New on the WEB

Test and Measurement



TestMart™, San Bruno, CA, has introduced an online configuration tool for test and measurement instruments. The functionality helps customers select options for more than 1,700 models of test and measurement equipment and instruments across 72 categories from 34 manufacturers. The configuration tool is based on proprietary logic algorithms that use a manufacturer's configuration rules. It also lists available options for any instrument and calculates total cost for a user-defined configuration. **www.testmart.com**

Measurement/Automation



National Instruments, Austin, TX, allows visitors to its web site to personalize the measurement and automation information most important to them. Users can create personal web pages that provide news, business services, and product information tailored to their preferences, and can receive personalized news via e-mail. At the site, users can search their preferred parts of the company site, and based on their geographic location, see the names and addresses of their local NI support staff, as well as events in their area. **www.my.ni.com**

Spectral Search

A new web site, sponsored by Nicolet Instrument Corp., Madison, WI, allows analytical labs to search spectral databases. Site features include Review Last Search Results, which lets users review the results of their last online spectral search; and the option to purchase spectral search credits through online purchase orders. Indices are attached to many of the libraries of spectral data on the sight, so users can see if compounds and materials exist in the databases by opening a PDF file of the library's index. **www.ftirsearch.com**

FTIR search.com
Spectral data online, all the time...

Instrumentation



Information on instrumentation for vibration, shock, inertial motion, and dynamic pressure measurement is available on a new site from Endevco Corp., San Juan Capistrano, CA. Also included are links to product information, technical manuals, and seminars and events. The Dynamic Instrumentation Guide section is a resource for selecting the correct accelerometer and associated signal conditioning for a specific application. **www.endevco.com**

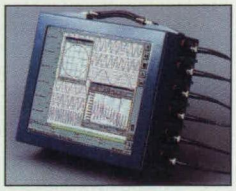
Procurement Management

A new Non-disclosure Agreement (NDA) functionality has been added to the Collaborative Procurement Management system at the web-based marketplace site offered by ManufacturingQuote.com, Smyrna, GA. Buyer members use the site to manage the procurement and selling of custom manufacturing services such as rapid prototyping and machining. With the new feature, members have the ability to upload their company's NDA to the ManufacturingQuote.com site as part of their member profile. The site then can track the suppliers who have accepted NDAs. **www.MfgQuote.com**



New on the MARKET

Data Acquisition Recorder



The 18-channel Dash 18 portable data acquisition system from Astro-Med, West Warwick, RI, features a built-in touch panel display; 18 universal inputs for voltage, thermocouple, and bridge measurements; a 100-kHz sample rate per channel; and a 9-GB hard drive for capturing data. The system is equipped with a 15.4" diagonal monitor for touchscreen control and real-time data viewing and analysis, and includes an onboard 250-MB Zip drive. A split screen display allows historical data to be viewed without interrupting real-time acquisition. **Circle No. 722**

Signal Conditioning System



Signal Processing Solutions, Redondo Beach, CA, has introduced the Versa-Filter System, a DSP-based electronic filter and signal-conditioning system with two independent channels of analog I/O. Features include a signal generator, programmable-gain amplifiers, and tunable low-pass, high-pass, band-pass, band-stop, notch, and inverse-notch filters that operate from DC to 20 KHz with a 1 Hz tuning resolution. Settings can be stored and recalled from five memory locations. An LCD display shows system settings. **Circle No. 723**

PCI Boards



Keithley Instruments, Cleveland, OH, has introduced the KPCI-3130 Series universal analog output source boards for applications where high-performance analog output and industrial digital I/O control are required. The boards use high-resolution digital-to-analog converters operating over a single ±10V range. They can be wired in a two- or four-wire mode and offer remote and local sensing. Each channel can source or sink up to 20mA of current for 4-20mA current loop applications. The boards are bundled with software programs, drivers, and utilities. **Circle No. 726**

Rivet Nuts



MaxTite™ threaded rivet nuts from Atlas Engineering, Tallmadge, OH, are designed to provide strong, permanent metal threads in "blind" attachment applications, where only one side of the workpiece is accessible for fastener installation and final component assembly. The rivet nuts can be used in panels as thin as 0.020". Available types include flathead and countersunk. Rib or key features are offered for high-torque applications. Thread sizes range from #4-40 through ½"-13, and M3 through M12. **Circle No. 727**

Torque Sensor

The Model 1806-110-17K torque sensor for dynamometer test stands from Lebow Products, Troy, MI, is made of a one-piece housing design with a foot mount to eliminate the potential for the foot mount loosening under severe test conditions. Other features include a rotary transformer design with a carrier frequency excitation for increased signal/noise immunity. It has a maximum speed rating of 10,000 RPM and uses an oil-drip-lubricated bearing design. **Circle No. 725**

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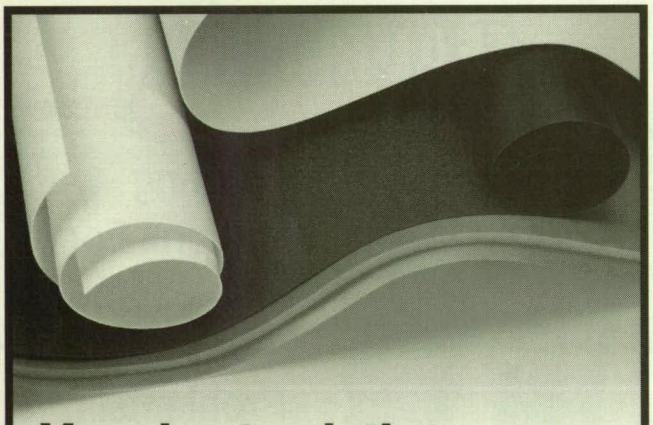
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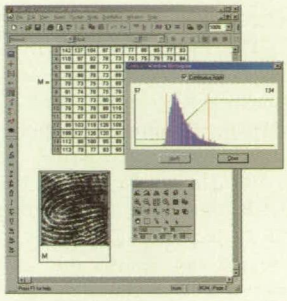
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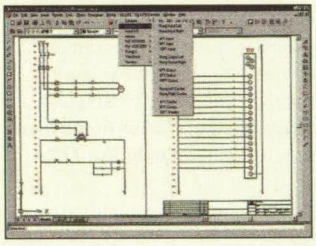
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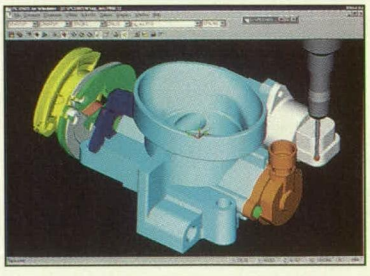
MathSoft, Cambridge, MA, has announced Mathcad® 2001 mathematics software that offers new development tools, simulation capabilities, and full support of MathML (Mathematical Mark-up Language), the first XML standard to be approved by the World Wide Web Consortium. Features include an add-on for Visio, and add-ins for AutoCAD and Excel; real-time data acquisition from National Instruments analog I/O boards; WAV file support for reading audio files; and a new calculation engine. Enhanced web publishing and documentation capabilities, and a new Software Development kit for building custom Mathcad components also are featured. **Circle No. 713**

Electrical Controls Design



VIA Development Corp., Marion, IN, offers VIA Schematic LITE Suite Version 3.0, a set of software tools that automates many tasks linked to creating electrical controls schematics in AutoCAD. The software automates AutoCAD functions and replaces drawing tasks with pre-drawn symbols, circuits, and diagrams. New features include nearly two-dozen pre-drawn blocks and devices, ten new three-phase motor circuits, and a free library of I/O wiring diagrams. **Circle No. 701**

Measurement and Inspection



Brown & Sharpe, North Kingstown, RI, offers PC-DMIS™ V3.2 measurement and inspection software that provides a DIRECT-CAD™ Interface to programs such as CATIA, Unigraphics, Pro/E, SDRC, and ACIS. The interface eliminates the need for the software to translate the original CAD model. Users can create part programs directly on the CAD model. A new graphical user interface, 3D animation capability, and Interactive Hyper Reporting for data handling are included. **Circle No. 703**

Workload Management

Veridian, Mountain View, CA, has released the professional edition of the Portable Batch System: PBS Pro™ 5.0 workload management software that offers flexible scheduling capabilities to provide increased utilization of valuable computer resources. New features include multiple user interfaces, cross-system scheduling, dynamic load balancing and management of both batch and interactive work, job-interdependency, and chaining. The software provides job tracking capabilities across multiple systems, as well as a common user interface on all UNIX platforms including workstations, supercomputers, and UNIX PC clusters. **Circle No. 700**

New LITERATURE

Electromechanical Automation



Parker Hannifin's Automation Group, Cleveland, OH, has released a CD-ROM catalog of electromechanical automation products, including motors, drives, controllers, actuators, and structural framing systems. The catalog contains product and technical information for designing, specifying, and ordering a complete system for machine automation. **Circle No. 706**



Automotive Seal Rings

A 12-page brochure from DuPont Engineering Polymers, Newark, DE, features automotive uses of Vespel® resin in designing and manufacturing seal rings, thrust washers, bearings, and valve components. Included is a description of microcut precision gap manufacturing technology, and material characteristics of Vespel. **Circle No. 707**

PC Systems Handbook



CyberResearch, Branford, CT, offers the New Product Preview Edition of the PC Systems Handbook, a 148-page publication that combines a buyer's guide, a how-to handbook, and a special interest catalog. The handbook includes descriptions of industrial PC systems and data acquisition and control products, including portable and rack-mount PCs, flat-panel LCD displays, cards, software, and serial communications products. **Circle No. 708**



Signal Conditioning

A brochure from National Instruments, Austin, TX, details the use of the SCXI™ front-end signal conditioning platform for data acquisition applications ranging from durability testing and quality control, to environmental monitoring and industrial control. **Circle No. 709**

Plastics and Rubber



Pawling Corp., Pawling, NY, offers a six-page brochure highlighting its plastic and rubber extruded profiles and fabrication technology. The brochure offers a guide to equipment, manufacturing, and product selection. Also described are custom mixing capabilities and advanced sealing systems. **Circle No. 710**



Servo Drives

A selection guide from Pacific Scientific, Rockford, IL, describes the PC832 servo drive, a 400-Hz drive that provides high velocity-loop bandwidth. The guide also includes connection diagrams, specifications, and performance specs for the PC800 and SC/SCE900 families of motors and drives. **Circle No. 711**

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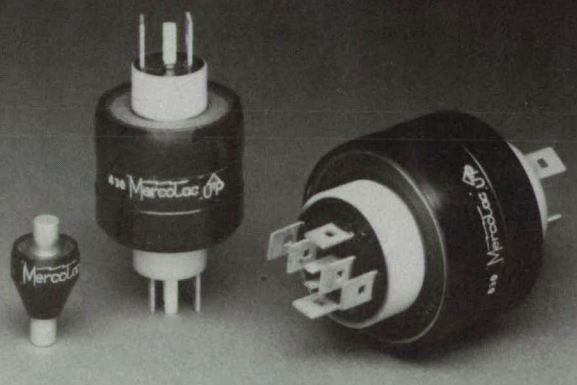
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401	402	403	404	405	406	407	408	409	410
411	412	413	414	415	416	417	418	419	420
421	422	423	424	425	426	427	428	429	430
431	432	433	434	435	436	437	438	439	440
441	442	443	444	445	446	447	448	449	450
451	452	453	454	455	456	457	458	459	460
461	462	463	464	465	466	467	468	469	470
471	472	473	474	475	476	477	478	479	480
481	482	483	484	485	486	487	488	489	490
491	492	493	494	495	496	497	498	499	500
501	502	503	504	505	506	507	508	509	510
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531	532	533	534	535	536	537	538	539	540
541	542	543	544	545	546	547	548	549	550
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701	702	703	704	705	706	707	708	709	710
711	712	713	714	715	716	717	718	719	720
721	722	723	724	725	726	727	728	729	730
731	732	733	734	735	736	737	738	739	740
741	742	743	744	745	746	747	748	749	750
751	752	753	754	755	756	757	758	759	760
761	762	763	764	765	766	767	768	769	770
771	772	773	774	775	776	777	778	779	780
781	782	783	784	785	786	787	788	789	790
791	792	793	794	795	796	797	798	799	800
801	802	803	804	805	806	807	808	809	810
811	812	813	814	815	816	817	818	819	820
821	822	823	824	825	826	827	828	829	830
831	832	833	834	835	836	837	838	839	840

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Gordon Products, Incorporated	www.gordonproducts.com	418, 419	48
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Lake Shore	www.lakeshore.com	430	62
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NKK Switches	**www.lcdswitch.com**		**32**
Numerical Algorithms Group	www.nag.com/info/ntb	422	53
NuSil Silicone Technology	www.nusil.com	421	54
Omega Engineering, Inc.	www.omega. com	508, 601	1, 68
OriginLab	www.orginLab.com	411	38
Parker Hannifin Corp., Daedal Division	www.phdaedal.com/tblf	602	68
Penn Engineering	www.pemnet.com	415	46
Pittman-A Penn Engineering Company	www.pittmannet.com	660	2b
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Quantum Magnetics	www.qm.com	440	61
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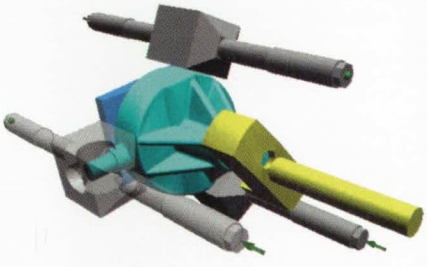
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