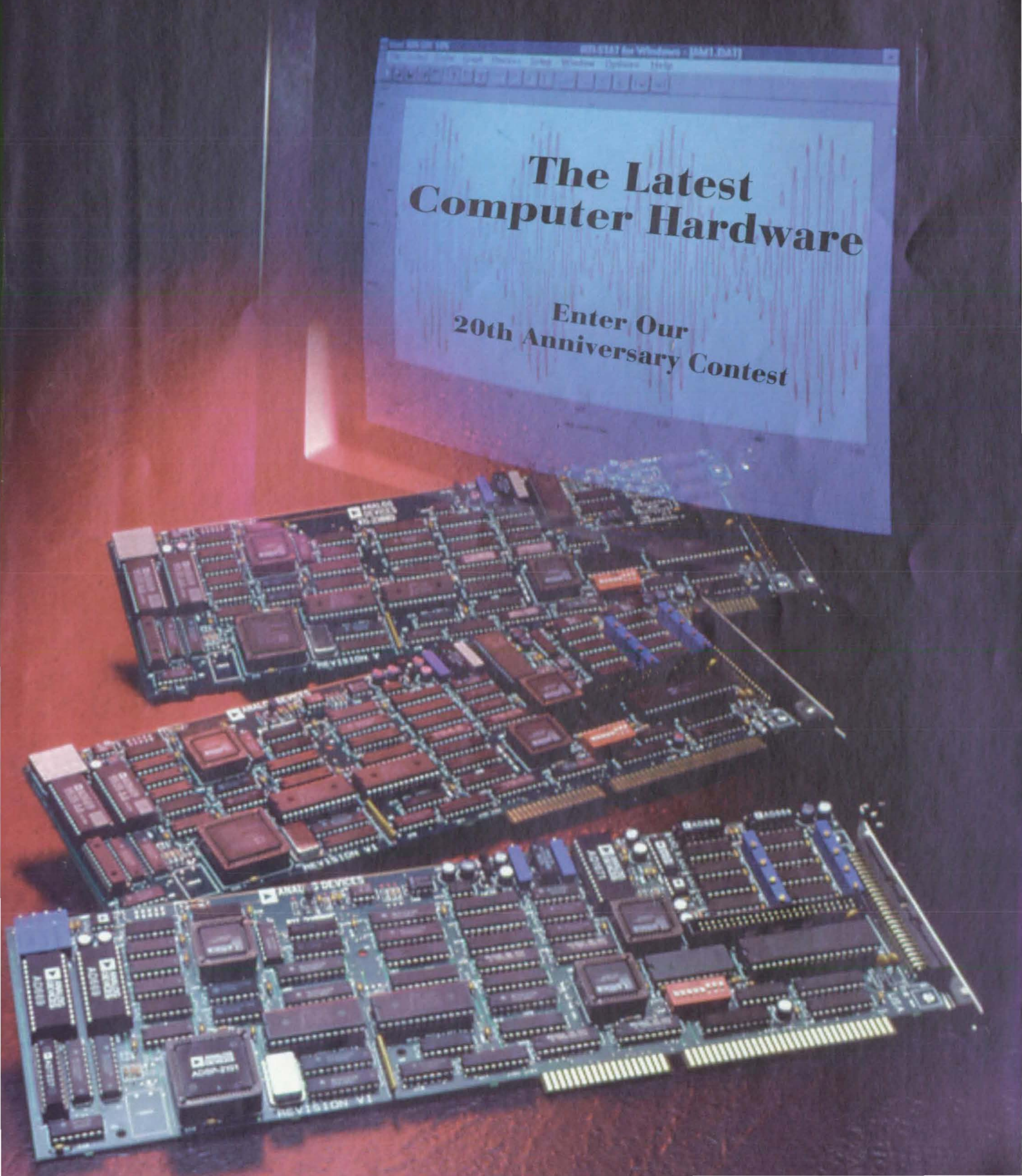
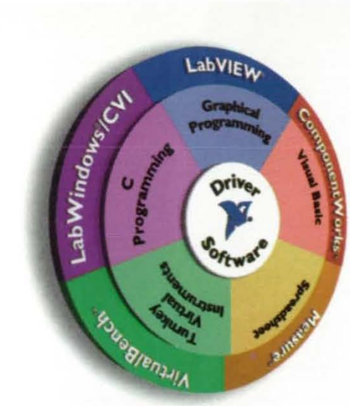
June 1996

Vol. 20 No. 6

NASA Tech Briefs

The Design/Engineering Technology Digest





Instrumentation Software News.

NEW LABVIEW® 4.0 – GRAPHICAL PROGRAMMING FOR INSTRUMENTATION

LabVIEW Version 4.0 is here and it's designed just for you! Whether your application is large or small, simple or complex, LabVIEW 4.0 has features designed to improve your productivity, simplify your development tasks, and integrate your application throughout your organization. LabVIEW 4.0 features a customizable development environment, powerful editing and debugging tools, open connectivity tools through OLE Automation, and the new CodeLink utility to import C code directly into your VIs.

LabVIEW

NEW LABWINDOWS®/CVI 4.0 – TOOLS FOR C/C++

LabWindows/CVI, an interactive C programming environment to build virtual instruments for data acquisition and instrument control, now extends its powerful tools to other C/C++ programming environments. LabWindows/CVI Version 4.0 libraries work with compilers from Microsoft, Borland, Symantec, and WATCOM. In addition, you can automatically compile your C code in LabWindows/CVI into dynamic link libraries (DLLs) for use with C/C++, Visual Basic, or LabVIEW.

CVI

NEW COMPONENTWORKS™ – ACTIVEX CONTROLS FOR VISUAL BASIC

ComponentWorks is a new collection of ActiveX (OLE) controls and libraries for building virtual instruments in Visual Basic, Visual C++, and Borland Delphi. With ComponentWorks, you can acquire data from National Instruments DAQ products, control GPIB instruments with instrument drivers, perform advanced statistical analysis and signal processing routines, and build virtual instrument front panels in Visual Basic.

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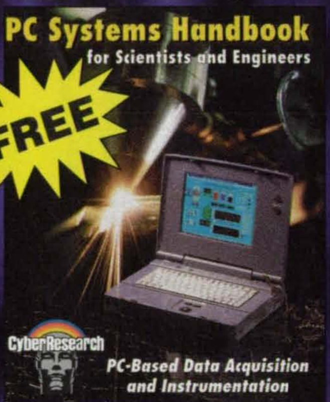

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20MHz 12-Bit A/D

Data Acquisition Card Breaks Old Speed Records by an Order of Magnitude

If you've been looking for a 12-bit A/D board with the fastest possible conversion rate, then you know that there just aren't any out there faster than 1MHz – 2MHz. Until now. Our new **CompuScope™** bursts through the old limits. It doesn't just improve the old record by 10% or even by 100%. It achieves sampling rates **10 times faster than anything on the market.**

Our **DSO 2012** uses 2 monolithic flash converters, each running at 10MHz. In single-channel mode, the 2 ADC's are clocked in a "ping-pong" mode to achieve up to 20 MSamples/second. Programmable gain amplifiers and offset control circuits ensure measurement accuracy. On-board memory is mapped in the PC's own system memory for the fastest possible data transfers.

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Breakthrough 1MHz A/D Board with DSP

Over 1 million samples per second, for only $1,250!

The high performance **WIN 30D** A/D architecture offers:

- **High speed data transfer modes** (Burst Mode DMA & REP INSW) allow 1MHz data transfer direct to PC memory. No need for expensive RAM buffers.
- Data packing fits four 12-bit A/D samples into three 16-bit Words.
- Software configured, with user-defined channel scan listing.
- **Includes:** ***Status 30*** Menu-Driven Software, Source code in C, and Drivers for DOS & Windows, DasyLab, NOTEBOOK, LabVIEW® & SnapMaster.

#WIN 30D 1MHz 12-Bit Data Acquisition (A/D) Board................................ **$1250**
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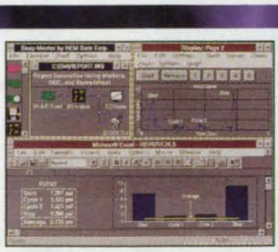
Special SnapMaster™ Offer



As the first and pre-eminent Windows software for data acquisition, **SnapMaster** has become the leader of a new generation of products which take advantage of important benefits offered by Windows:

- Larger memory arrays — up to 16MB
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- Shared real-time information (DDE)

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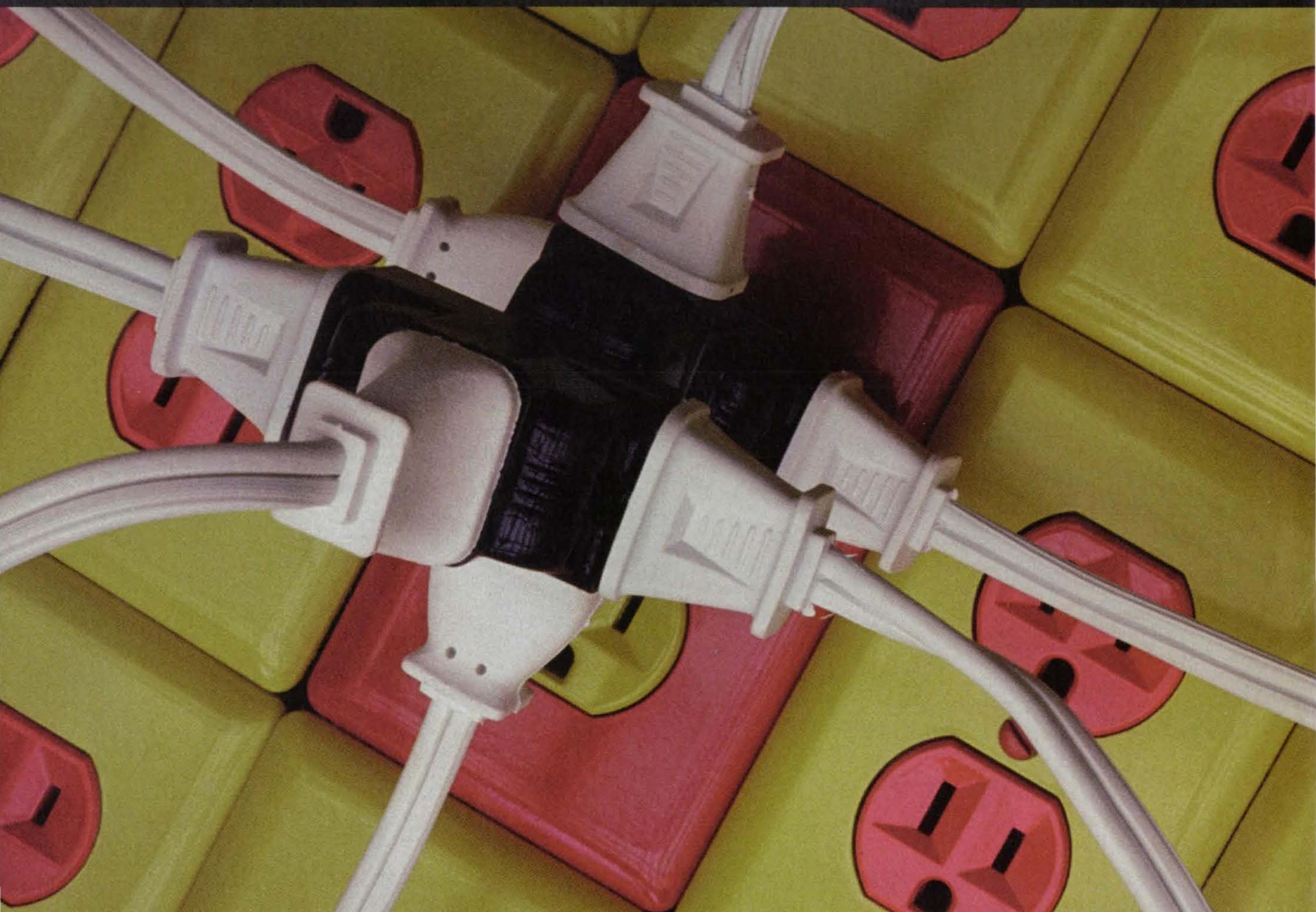
Alacron's FT-SHARC
Architecture PREVENTS Bus Overloading



Parallel Data Paths MAXIMIZE SHARC Processor Performance

The **Alacron FT-SHARC** architecture buffers each SHARC processor with dedicated dual-ported RAM, while data flow is managed by an i960 RISC controller. Processors run continuously at peak capacity, achieving sustained throughput of nearly 1 gigaFLOPS.

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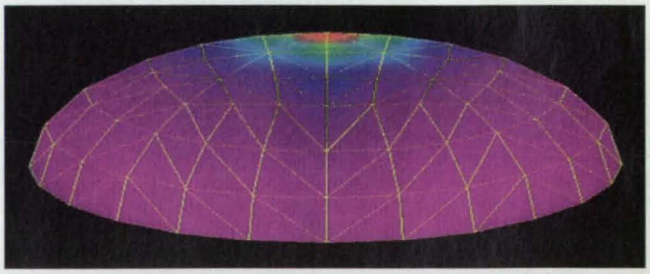
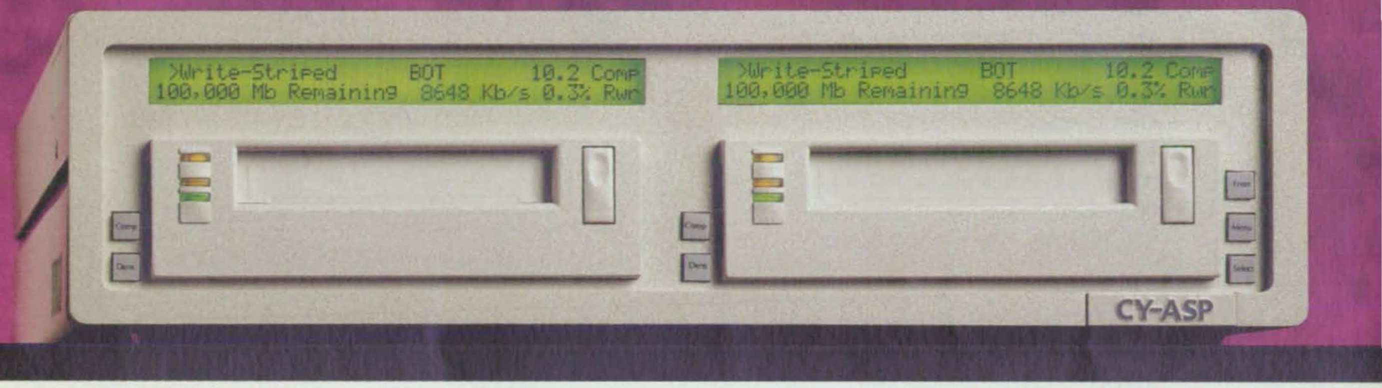


Stress distribution in a half-dome with composite material is one application of the materials discipline in STARS, a NASA-developed, finite-element-based analysis software package for nonlinear and linear engineering problem-solving. STARS is a licensed program available through NASA's Computer Software Management and Information Center (COSMIC). For more information on COSMIC, see the Resource Report on page 24.

Photo courtesy of COSMIC

Write 200 GB At 18 MBS



The CY-8900 8mm tape drive delivers a rare thing: a 185% increase in capacity, a 500% increase in speed, and backward read compatibility with earlier generations.

Now, you can store 20 GB per tape at 3 MBS, uncompressed.

Up to ***100 GB*** per tape at ***9 MBS*** with optional data compression.

With the technology that has set the standard in reliability and data integrity since 1987.

But performance and flexibility hit the ceiling when two or more drives work together with the Advanced SCSI Processor.

Plug Compatibility With:

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DEC	PC	Wang
Gould/Encore	Pertec	Windows NT
HP	PICK	— and more
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Striping Write data to two or more tape drives at a time, to maximize throughput

Mirroring Write the same data to multiple tapes, to add fault tolerance or to make duplicate tapes

Cascade Data automatically writes to the next tape when the previous tape is full

Independent Write data to one drive while you restore with another

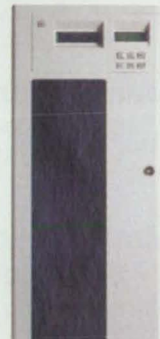
Offline Copy/Verify Make duplicate tapes without tying up the host

With the Advanced SCSI Processor, up to six drives can be configured in a powerful desktop tape array. Striping data, you can achieve an 18 MBS throughput uncompressed — up to 40 MBS with data compression.

No other tape drive can match it.

Other options include Accelerated File Access to speed file restore; Data Encryption to protect sensitive corporate data; and the Digital Data Recorder Interface, for data collection applications.

With a Fast SCSI interface, the CY-8900 is plug compatible with virtually every computer system and network running. It's available in a single or multi-drive desktop or rack mount configuration, or as part of an automated tape library with a capacity of up to ***12 terabytes***.



The CY-TL8-2020 features up to two drives and 20 tapes and can store between 400 GB and 2 TB.

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Contents *(continued)*

DEPARTMENTS

On the cover:
New advances in modules, boards, networks, touchscreens, and other components are described in the Special Focus on New Computer Hardware, which opens on page 27. Beginning this month, the Special Focus section is expanded to include not only NASA briefs, but related new products as well. This month, the Special Focus Products include the RTI-2100 data acquisition board from Analog Devices, Norwood, MA.

Photo courtesy of Analog Devices

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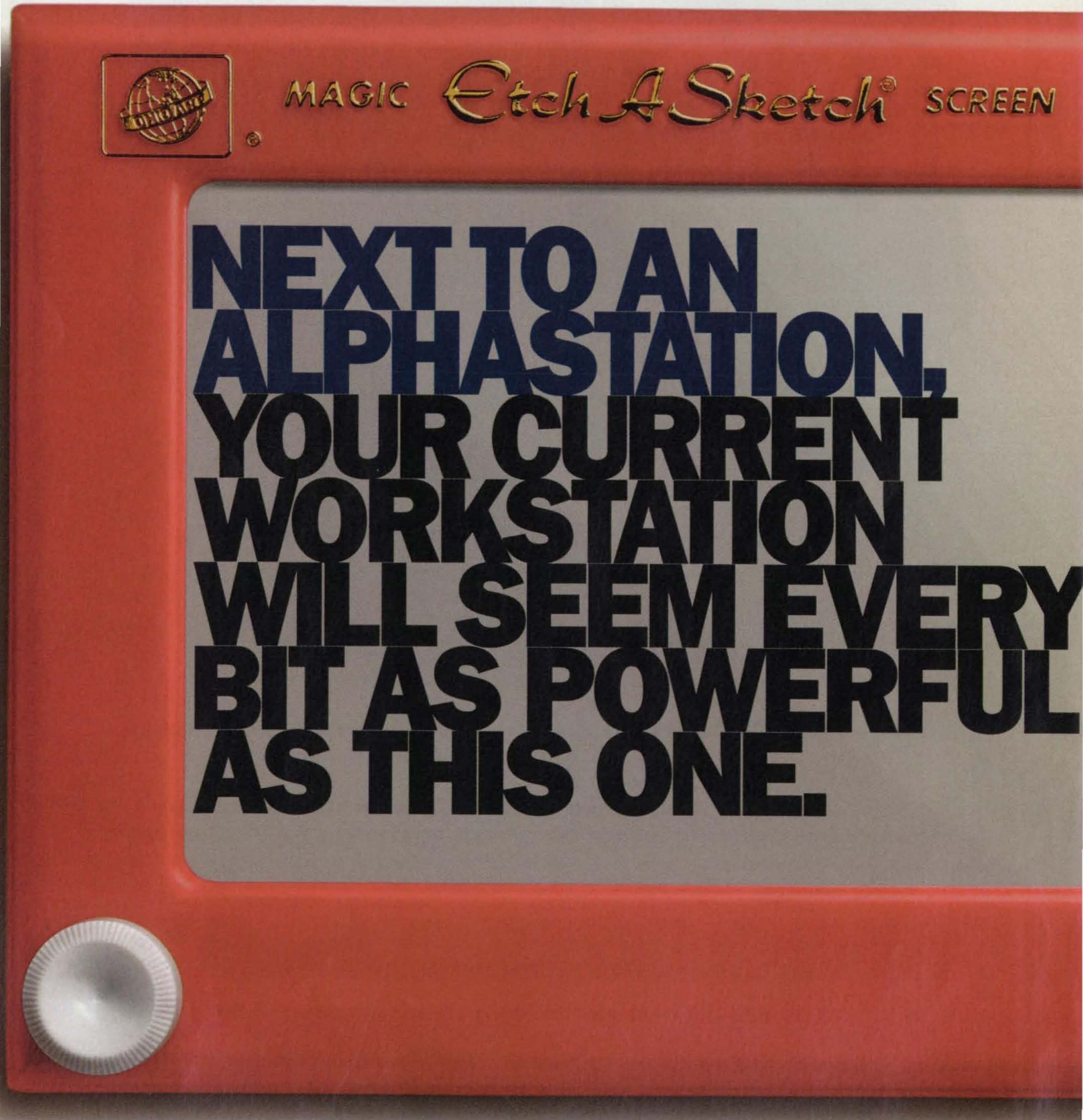
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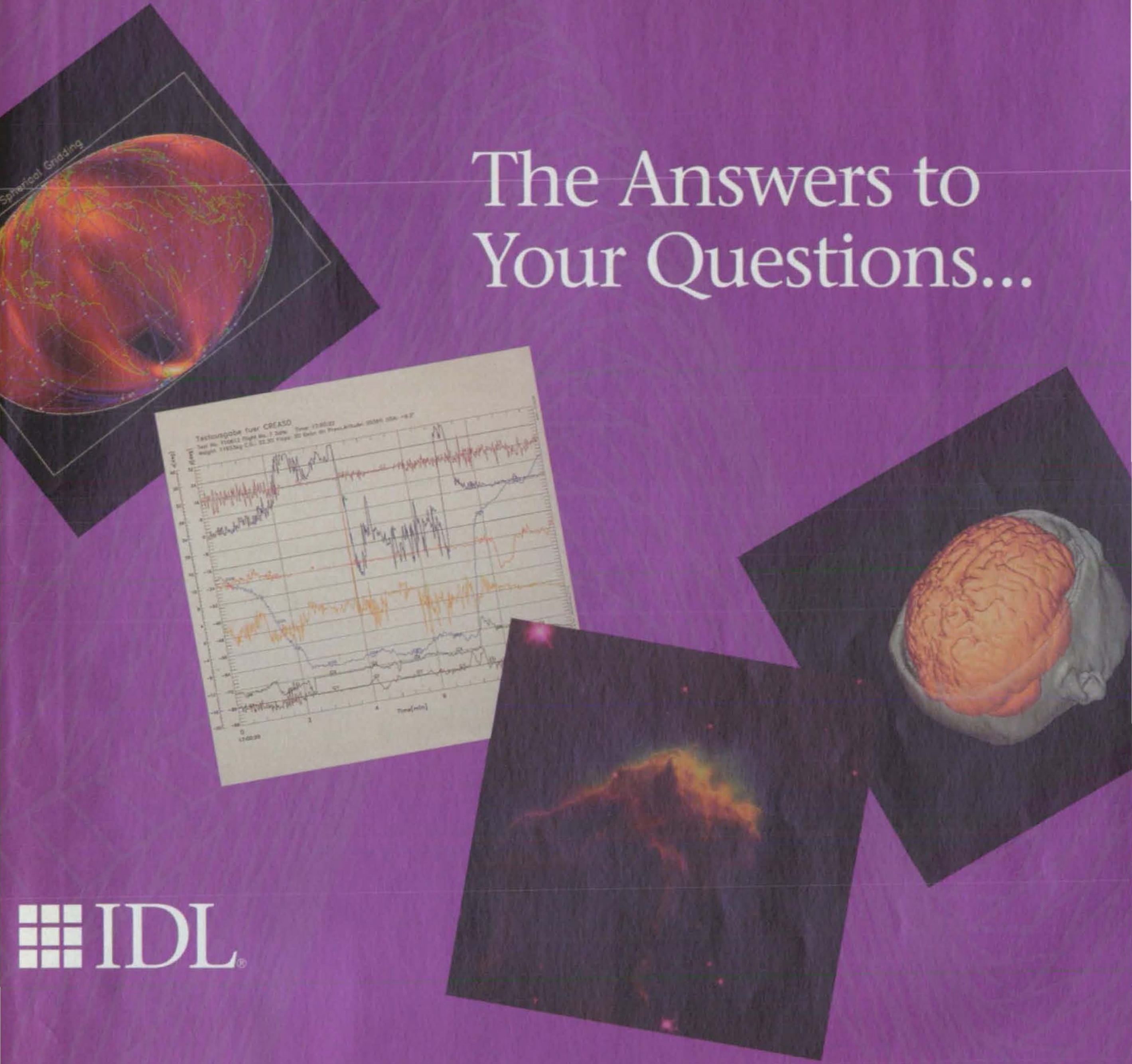

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galcorn@gsfc.nasa.gov

Jet Propulsion Laboratory
Selected technological strengths: Near/Deep-Space Mission Engineering; Microspacecraft; Space Communications; Information Systems; Remote Sensing; Robotics.
Wayne Schober
(818) 354-2240
wayne.r.schober@jpl.nasa.gov

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

Kennedy Space Center
Selected technological strengths: Emissions and Contamination Monitoring; Sensors; Corrosion Protection; Bio-Sciences.
Bill Sheehan
(407) 867-2544
billsheehan-1@ksc.nasa.gov

Langley Research Center
Selected technological strengths: Aerodynamics; Flight Systems; Materials; Structures; Sensors; Measurements; Information Sciences.
Dr. Joseph S. Heyman
(804) 864-6005
j.s.heyman@larc.nasa.gov

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

Marshall Space Flight Center
Selected technological strengths: Materials; Manufacturing; Nondestructive Evaluation; Biotechnology; Space Propulsion; Controls and Dynamics; Structures; Microgravity Processing.
Harry Craft
(202) 544-5419
harry.craft@msfc.nasa.gov

Stennis Space Center
Selected technological strengths: Propulsion Systems; Test/Monitoring; Remote Sensing; Nonintrusive Instrumentation.
Anne Johnson
(601) 688-3757
ajohnson@wpogate.ssc.nasa.gov

NASA-Sponsored Commercial Technology Organizations

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

Ismail Akbay
National Technology Transfer Center
(800) 678-6882

Robert Stark
Far-West Technology Transfer Center
University of Southern California
(213) 743-2353

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

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

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

Lani S. Hummel
Mid-Atlantic Technology Applications Center
University of Pittsburgh
(412) 648-7000

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

Easy Access To The FLC: Call (206) 683-1005 for the name of the Federal Laboratory Consortium Regional Coordinator in your area. The Regional Coordinator, working with the FLC Locator, can help you locate a specific laboratory to respond to your needs.

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.

Gene Pawlik
Small Business Innovation Research Program (SBIR)
(202) 358-4661
gpawlik@oact.hq.nasa.gov

Robert Norwood
Office of Space Access and Technology (Code X)
(202) 358-2320
rnorwood@oact.hq.nasa.gov

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

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

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

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

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

NASA's Business Facilitators

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

Dr. Stephen Gomes
American Technology Initiative
Menlo Park, CA
(415) 325-5353

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

John Gee
Ames Technology Commercialization Center
Sunnyvale, CA
(408) 734-4700

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

If you are interested in information, applications, and services relating to satellite and aerial data for Earth resources, contact: Dr. Stan Morain, **Earth Analysis Center,** (505) 277-3622. For software developed with NASA funding, contact **NASA's Computer Software Management and Information Center (COSMIC)** at phone: (706) 542-3265; Fax: (706) 542-4807; E-mail: http://www.cosmic.uga.edu or service@cosmic.uga.edu. If you have questions...**NASA's Center for AeroSpace Information** can answer questions about NASA's Commercial Technology Network and its services and documents. Use the Feedback Card in this issue or call (410) 859-5300, ext. 245.

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For More Information Write In No. 575

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New Product Ideas

New Product Ideas are just a few of the many innovations described in this issue of *NASA Tech Briefs* and having promising commercial applications. Each is discussed further on the referenced page in the appropriate section in this issue. If you are interested in developing a product from these or other NASA innovations, you can receive further technical information by requesting the TSP referenced at the end of the full-length article or by writing the Commercial Technology Office of the sponsoring NASA center (see page 14).

Meteorological Monitoring and Warning Computer Network

The meteorological monitoring system at Kennedy Space Center is a unique computer network that tracks the weather and issues warnings when hazards are about to occur. If the weather violates a restriction, the network generates audible and visible alarms to alert people involved in the activity.
(See page 28.)

Interconnections for Stacked Parallel Computer Modules

A concept for interconnecting modules in parallel computers would lead to cheaper, smaller, lighter, lower-power computing systems for aerospace, industrial, business, and consumer applications. Computer modules would be stacked and interconnected in various configurations.
(See page 30.)

Imaging Invisible Flames Without Additives

Image-intensifying cameras and associated image-data-processing equipment have been put to use in research on combustion. These imaging systems make it possible to view and analyze methane, hydrogen, and other flames that are dim or invisible to the human eye and difficult to image by use of conventional photographic and video cameras.
(See page 62.)

Materials for Improved Josephson-Junction Devices

Higher-temperature superconductors open the possibility for higher operating frequencies up into the terahertz range. Such devices could be particularly useful as the electrically nonlinear circuit elements of mixers and local oscillators in heterodyne receivers.
(See page 67.)

Propellers and Fans Based on the Möbius Strip

The Möbius strip has been proposed as the basis for optimally shaped airplane and boat propellers, fans, helicopter rotors, mixing screws, coffee grinders, and concrete mixers. Conventional devices of this type consist mostly of two-sided blades, which are not optimal.
(See page 72.)

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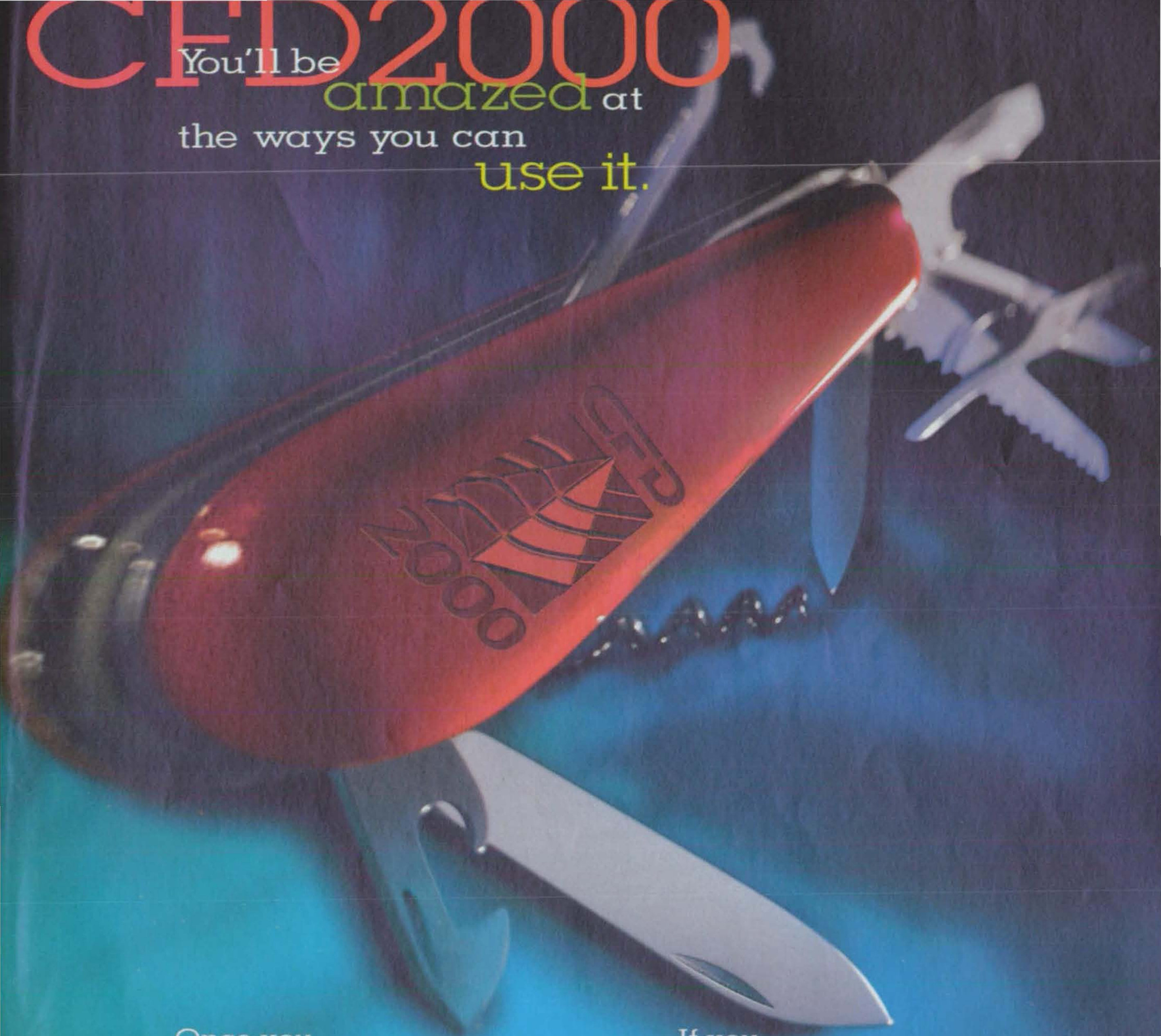

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For More Information Write In No. 608

20th Anniversary Letter-Writing Contest

NASA Tech Briefs 20 Years

Dear Reader:

NASA Tech Briefs debuted as a magazine in 1976, evolving from NASA's dissemination of single-sheet reports detailing its novel, commercially-viable technologies for transfer to the engineering community. Since then, readership and reader response have grown dramatically. More than 12,000 briefs have been published over the last 20 years, generating about 1.8 million requests for Technical Support Packages. Through privatization (beginning in 1985), the magazine's circulation has nearly tripled — from 75,000 to over 207,000. (Counting pass-along copies, *NASA Tech Briefs*' readership exceeds 450,000 each month.)

Help us to celebrate these first two decades by entering a contest just for you — the readers of *NASA Tech Briefs* — who have made this success possible. Whether you have been reading the magazine for two years or 20, you are eligible to enter. Three grand winners will be named, but everyone who participates will be a winner.

To enter, write a letter of 500 words or less describing how *NASA Tech Briefs* has impacted your work and your life. For example:

- How have the technologies and products featured in *NASA Tech Briefs* over the years helped you to solve specific problems and grow your business?
- As a result of information found in *NASA Tech Briefs*, have you or your company established partnerships with NASA or licensed NASA technologies?
- Have you or your company benefitted from the *NASA Tech Briefs*-sponsored Technology 2000 national tech transfer conferences?
- Which technologies or products you are reading about today in *NASA Tech Briefs* do you think will drive important innovations in the next two decades?
- Be sure to indicate how many years you have been reading the magazine.

All entrants will receive a Certificate of Recognition and will be included in an Honor Roll published in the December issue, which will be distributed to all members of Congress and the White House. Further, entrants will earn special discounts on *NASA Tech Briefs* events and products.

Good luck!

Cordially,

Linda L. Bell

Linda L. Bell
Chief Editor

Contest Requirements

- Your letter must be 500 words or less
- Include the information specified on the facing page
- Be sure to indicate how many years you've been reading *NASA Tech Briefs*
- You must include your name, address, and daytime phone number
- Your entry must be postmarked by September 1, 1996

Prizes

Three Grand Winners will each receive a trip (transportation and hotel) to Anaheim, California for the Technology 2006 conference (October 29-31, 1996) at the Anaheim Convention Center.

The Grand Winners will be our guests at the prestigious 1996 Technology Transfer Awards Dinner for the formal announcement and presentation of their awards.

The Grand Winners and five finalists will each receive the *NASA Tech Briefs* CD-ROM, a resource of searchable databases and computer programs representing the best of the past 20 years of NASA technology, and will have the opportunity to receive a free company profile on the *NASA Tech Briefs* World Wide Web site.

The three winning letters will be printed in their entirety in the December issue of *NASA Tech Briefs*.

Send your letter to:

NASA Tech Briefs
Letter-Writing Contest
317 Madison Avenue
New York, NY 10017

Fax: (212) 986-7864

E-mail: ntb_edit@interramp.com

Your letter must be postmarked (or date-stamped for E-mail entries) by:

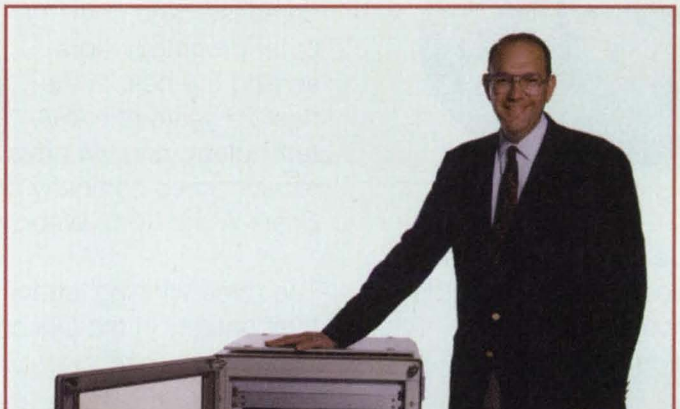
September 1, 1996

Mission Accomplished

In the mid-1980s, officials at NASA's Goddard Space Flight Center realized that the next generation of satellites would have to be able to transmit space data back to Earth at rates far beyond the capabilities of available ground data-receiving systems. To meet these increasingly sophisticated processing requirements, Goddard's James Chesney was presented with the task of developing new telemetry systems and technology. As a result, in 1985, Chesney founded Goddard's Microelectronic Systems Branch to research and develop advanced telemetry data systems.

Budget restrictions at that time demanded that the systems incorporate commonality, reusability, and interoperability, inspiring an innovative design and system architecture which provided the technical capability, modularity, and flexibility NASA needed. Using microelectronic technology to minimize the cost and size and ensure acceptance as a standard platform, Chesney and his team successfully built a ground system capable of receiving, handling, and processing data received from space at 20 MB per second. The High Data Rate Telemetry Receiving and Processing System (HDRTRPS) was field-tested in 1992 with Goddard, Jet Propulsion Laboratory (JPL), and a number of aerospace firms in attendance. Later that year, Goddard conducted a commercialization conference for more than 40 companies that expressed interest in commercializing the system. Known today as the Functional Components Architecture, the design was perfected by Chesney's team, and a number of individual circuit boards derived from the HDRTRPS appeared on the space-data-handling market.

The Microelectronic Systems Branch grew during those ten years to become an 80-person, multimillion-dollar "company within NASA," having developed, manufactured, delivered, and maintained more than 150 high-performance, low-cost telemetry data systems to NASA and its contractors. Along the way, Chesney and his team received several key awards. In 1989, NASA's Group Achievement Award was presented to Chesney and the Very Large Scale Integration (VLSI) System Design & Development Team for telemetry data systems development for space missions. NASA's Medal for Exceptional Engineering Achievement was presented to Chesney in 1990 for his "vision and leadership in applying electronics technology and advanced architectures to the development of a new generation of NASA telemetry systems."



Following 26 years with NASA, James Chesney founded TSI TelSys Inc., which designs and manufactures Gateway System products that autonomously perform CCSDS telemetry data processing and distribution for satellite imaging.

A Successful Transfer

After 26 years with NASA, Chesney retired in 1994 to form TSI TelSys Inc.—of which he serves as president—in Columbia, MD, which commercialized HDRTRPS components and systems with NASA's support through the technology transfer process. A wholly-owned subsidiary of TSI TelSys Corporation of Vancouver, BC, Canada, the company officially commenced commercial business operations in October of 1995 to design, manufacture, and market satellite telecommunication systems that acquire and process satellite telemetry data and perform network functions required to interconnect local/wide-area networks to space communications networks. Supporting two-way, high-speed, space-data communications for satellite remote sensing and satellite communications (SatCom) applications, the company also set a goal to develop third-generation commercial Gateway Systems which upgrade the speed and data-handling performance of transferred technology.

TelSys signed a Supply and Product Pricing Agreement with Government Technology Services to be a subcontractor equipment provider to NASA through the Indefinite Delivery/Indefinite Quantity (ID/IQ) procurement vehicle called Scientific Engineering Workstation Procurement (SEWP). The agreement made TelSys products available to all NASA centers with product pricing, configurations, and maintenance pricing and terms pre-negotiated. As a result, TelSys products can be ordered directly under the SEWP contract without being subject to any further bidding process.

"I consider myself extraordinarily lucky to have come across investors who believed that the founder and visionary (of a company) should be the one leading the company," Chesney said. "Most of the time, the knee-jerk reaction is to find a 'real' manager or a 'real' executive to run the company. But there is a much more important aspect than making sure the dollars get spent well, and that is the ability to motivate people to do well beyond what they would normally do, simply because you ask them to do it," he added.

Chesney's ability to motivate people prompted many of his NASA colleagues at Goddard to accept positions at TelSys. "I have people here who have followed me through NASA for 25 years. Today, of the 40 or so people in the company, the core technical staff—of which there are about 20—are all people from Goddard, most of whom worked for me or with me. Of those people, the least amount of time they've been with me is five years. The most is about 25 or 30 years," Chesney explained. In fact, three of Chesney's top management team are Goddard veterans. Toby Bennett, vice president of R&D engineering, was responsible for developing and deploying advanced space communications systems at Goddard; Charles Kozlowski, director of applications engineering, has more than 15 years of NASA experience and was responsible for a 35-person team within Chesney's Microelectronic Systems Branch at Goddard; and James O'Brien, director of manufacturing engineering, has 27 years of NASA experience, including Chesney's Goddard team.

The combined experience of his team helped Chesney's company get a fast start. "That's one of the reasons we were able to take a company that essentially was funded about six months ago and ship $2 million worth of equipment to NASA's Marshall Space Flight Center for their premier ground acquisition system. We took the material we received from NASA under the technology transfer program and added to it almost another generation of innovation and turned it around into actual hardware for delivery in less than five months," said Chesney.

A New Generation of Products

TelSys products span a range of capabilities based on the original NASA functional components architecture. The company's commercial telemetry systems are composed of a hierarchy of standard functional components (chip and board-level subsystems) that can be augmented with project-unique software and hardware to meet nonstandard requirements.

TelSys' initial product line includes second-generation communication processing switches that support space programs such as JPL's Deep Space Network and NASA's Mission to Planet Earth. Their Gateway Systems are used by NASA to reduce ground-segment development costs of the Earth Observation System (EOS) and the International Space Station. The company claims a competitive advantage in real-time software development and VLSI design techniques that produce ASIC chip sets, which drive down the cost-performance characteristics of their systems. Gateway System products such as the Satellite Communications Gateway System perform telemetry data processing and distribution for satellite imaging and synthetic aperture radar applications at data rates to more than 300 Mbps; the Consultative Committee for Space Data Systems (CCSDS) Gateway System; and the International Space Station Gateway System. Other products include a telemetry frame synchronizer card, a data verification and scoring card, a CCSDS service processing card, a data simulator card, a CCSDS Reed-Solomon card, a telecommand interface card, Gateway Management Software, and SimGen software for Gateway System products.

TelSys products and technology were developed for satellite telemetry applications. However, the ability of the products to process high-rate streams of multimedia (voice, image, and text) data, as well as standard network interfaces, make the products suitable for interconnecting broadband networks using commercial communications satellites. Industry interest in the space-data-receiving system is high because of potential applications in operating Asynchronous Transfer Mode (ATM) ground protocol with moderate redesign effort.

While TelSys appears to be well on its way to becoming a successful commercial company, Chesney recognizes the important role NASA played in getting him to this point. "What NASA gave me that I will always appreciate is the opportunity to do the best I could possibly do, and provided the environment that allowed me to expand my horizons—to go as far as I could possibly go. They gave me enormous opportunities to work on projects that I could never imagine working on anyplace else. It was an early experience that was not lost on me."

He added: "To witness what I consider to be some of the finest people I've ever worked with do things that were just amazing set me on track for the next five to ten years. It was an incredible growing experience."

For more information, contact Michael Crumlin, director of marketing, at TSI TelSys Inc., 7100 Columbia Gateway Drive, Columbia, MD 21046; Tel: 410-872-3900; Fax: 410-872-3901; http://www.tsi-telsys.com; E-mail: mcrumlin@tsi-telsys.com.

COSMIC: An Era of Change

For 30 years, NASA's Computer Software Management and Information Center (COSMIC), operated by the University of Georgia at Athens, has been a contractor to NASA, distributing software developed with NASA funding to industry, academia, and other government agencies. But by the end of the year, a Space Act Agreement currently being negotiated between NASA and the center will effect a fundamental change in the latter's status. When the agreement is complete in November, COSMIC will be a contractually independent, self-funding business partner helping NASA to commercialize its software.

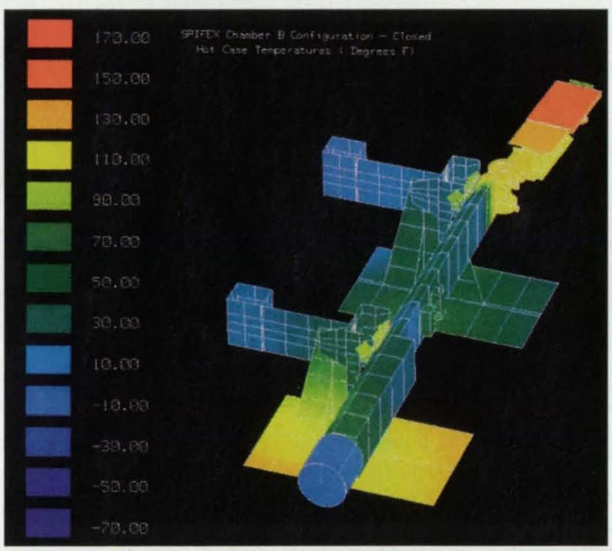
Director Tim Peacock stresses that COSMIC will take the initiative in forging strategic partnerships with NASA's commercial technology centers. He plans a series of visits to each of them to get the process under way. In addition, he is already engaged in exploratory talks with the Departments of Defense and Energy. COSMIC also has cemented an agreement with the Georgia State Board of Regents to provide software systems configuration and installation, performance validation, support, and training for several state agencies.

COSMIC has recast its mission with this new relationship in mind. New guidelines outline a seven-point agenda:

- *Peer review:* COSMIC will check and verify software programs, insuring that they are complete and free of embedded copyrights. It will also identify the hardware/software requirements for program use.
- *Electronic cataloging:* The center will prepare and update regularly a catalog that includes abstracts, key words, subject categories, machine types, and distribution media.
- *Tech brief evaluation and TSP preparation:* COSMIC will evaluate code and documentation for possible submission to *NASA Tech Briefs*, prepare the brief and the Technical Support Package (TSP), and distribute the latter.
- *Archive library:* The center will develop and maintain a library of software packages that are deemed not suitable for marketing, but are technically significant or valuable.
- *Program support:* COSMIC can act as initial point of contact, reducing call volume to the author. It can supply listserve accounts and post answers on-line about a product.
- *Author feedback:* The center will give the author sales, customer, and marketing data, and survey customers about NASA enhancements to make the product more useful to industry.
- *Update notification:* Sparing the centers much administrative work, COSMIC will notify customers of updates, revisions, and bug fixes.

A Variety of Services

COSMIC has always been a not-for-profit entity, but the end of the NASA contract mandates cost recovery for its operations. Though it will not charge the centers for its basic services, it will secure distribution rights to the software and recoup its costs through sales. Among its services will be maintenance of full records on software sales, identification of strategic markets, and preparation of reports documenting the successful use of NASA technology in a commercial enterprise.



COSMIC issues a software catalog, available on paper or diskette, in tandem with the Energy Science and Technology Software Center in Oak Ridge, TN, software disseminator for the Department of Energy and the Nuclear Regulatory Commission. Typical of the 1880 computer programs available for reuse and commercialization under the Federal Technology Transfer Program is NASA Johnson Space Center's Thermal Synthesizer System (Version 3.0). Its powerful interactive color graphics and geometric modelling capability seen above are matched by UNIX functionality and ease of use.

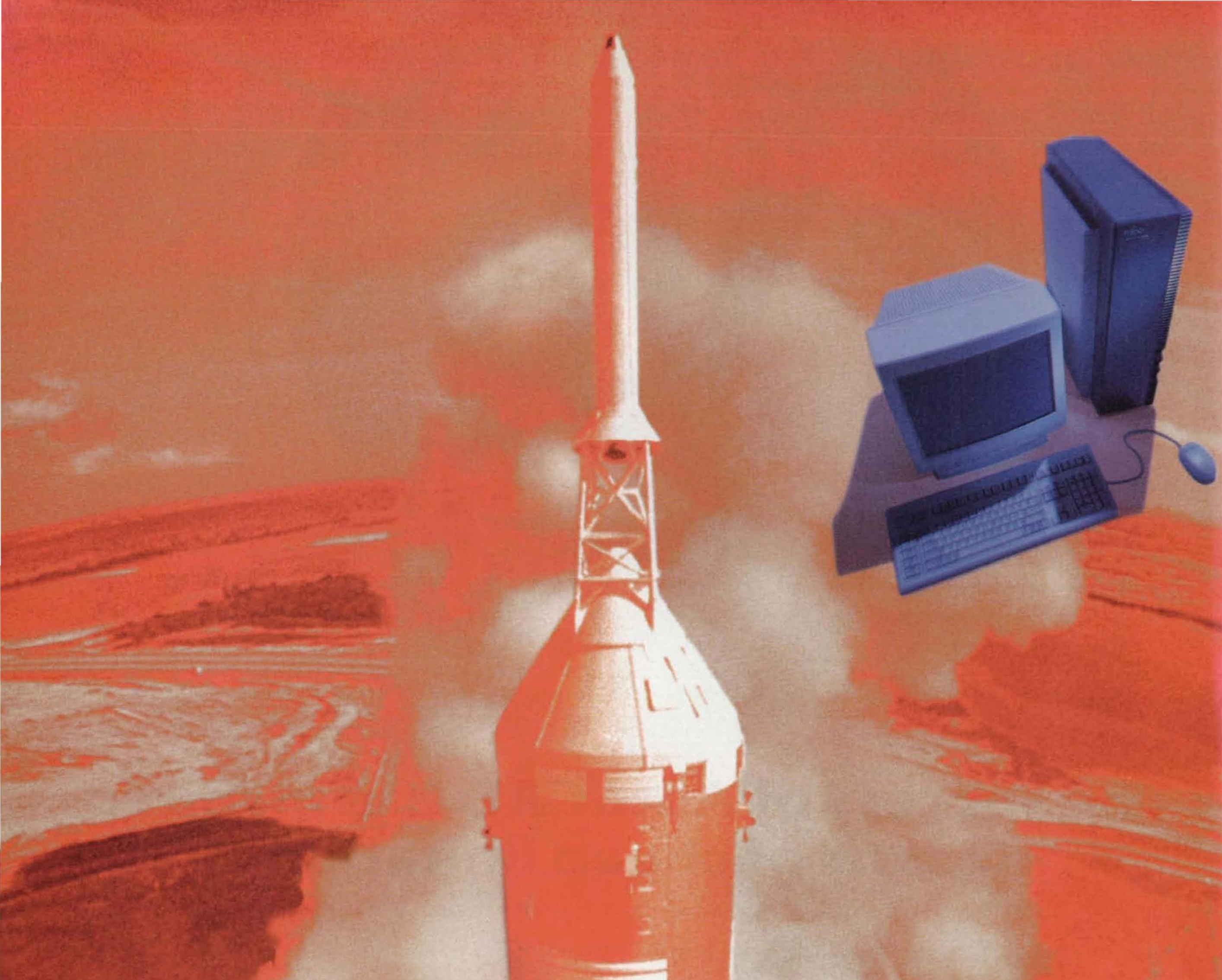
COSMIC representatives say that one area being actively expanded is in porting code. In the past, only those versions of programs submitted by the NASA centers were offered. COSMIC is now porting programs to new platforms at no additional cost to the customer or the centers. Porting, formatting, and alternate media services will be provided to NASA and industry on a fee basis. The typical program port involves moving a program from one type of UNIX to another, but COSMIC will evaluate all porting requests, including these operating systems: VAX/VMS, DEC UNIX, Ultrix, SunOS, Solaris, Irix, AIX, Linux, NetBSD, HPUX, DOS, Windows, and Windows NT. Its expertise in languages and 4GLs extends to C, C++, Pascal, FORTRAN, Ada, SQL, and various database products.

But COSMIC's services do not stop there. The center's technology transfer staff does presubmittal analyses of new technology for its adaptability to commercial uses. For conferences, workshops, training seminars, and user group meetings, COSMIC can obtain space, help with the agenda and program announcements, provide registration personnel, and arrange for audio-visual equipment. It can support authors in preparing documentation of computer programs, ranging from reformatting for visual effect to writing the user manual. Centers will be able to contract COSMIC to prepare marketing material for their distribution, including demonstration diskettes, special promotional flyers, and brochures.

The process of commercialization also lies within COSMIC's purview, including everything from locating potential partners to negotiating agreements. As a special service, it can supply copies of other NASA programs and documentation to NASA centers, in most cases electronically, thus providing software both conveniently and at minimum cost.

Peacock says COSMIC is looking forward to its new relationship with NASA headquarters and the field centers. "In this time of rapidly changing computer technology," he said, "organizations must change equally rapidly to remain viable. Our services to NASA and our software inventory empower our customers to adapt to this changing environment...and by customers, I mean both NASA and consumers of NASA software."

For more information on COSMIC and its programs, call Tim Peacock, Director, at (706) 542-3265, or send E-mail to timp@cosmic.uga.edu; http://www.cosmic.uga.edu.



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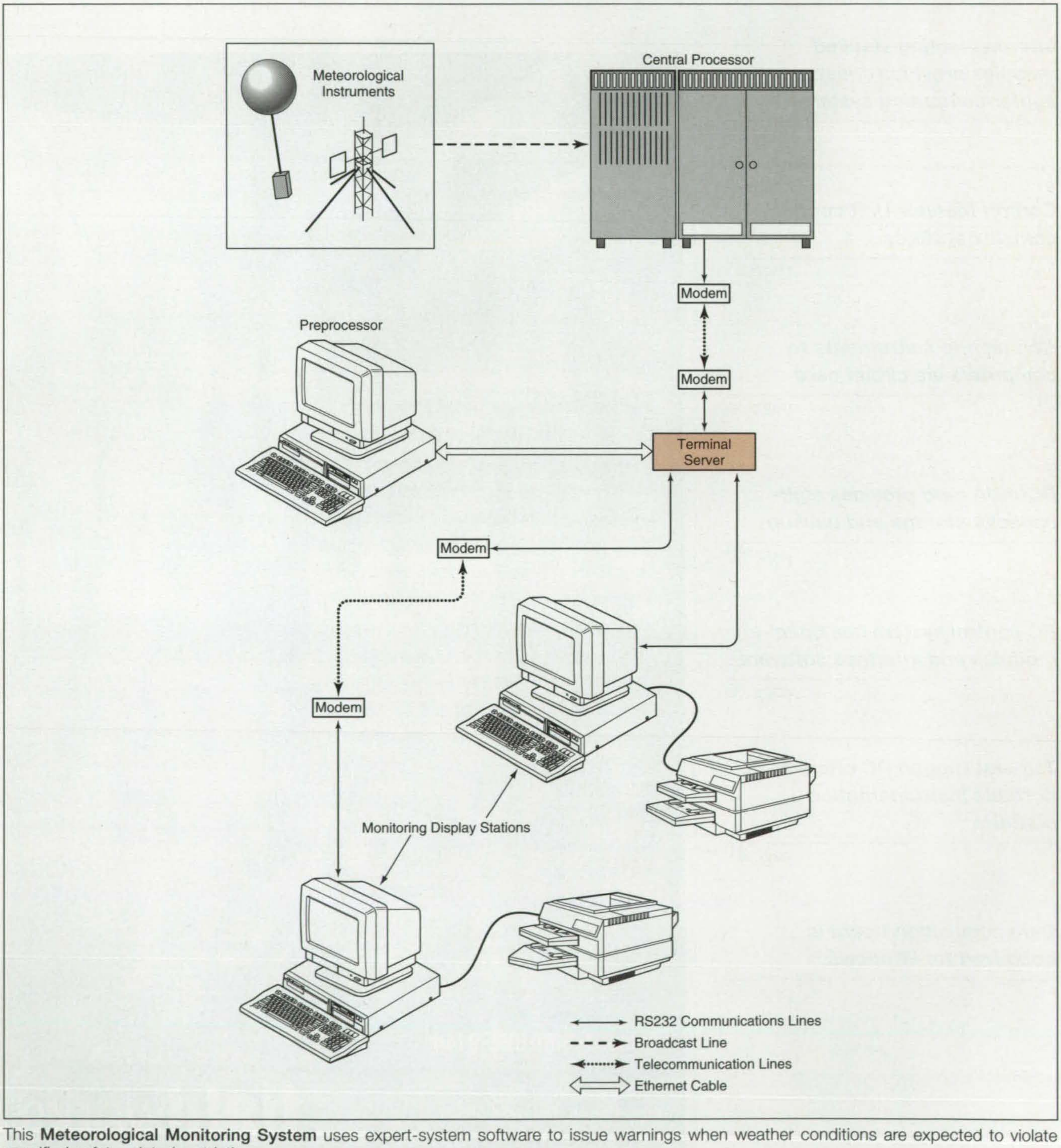
Meteorological Monitoring and Warning Computer Network

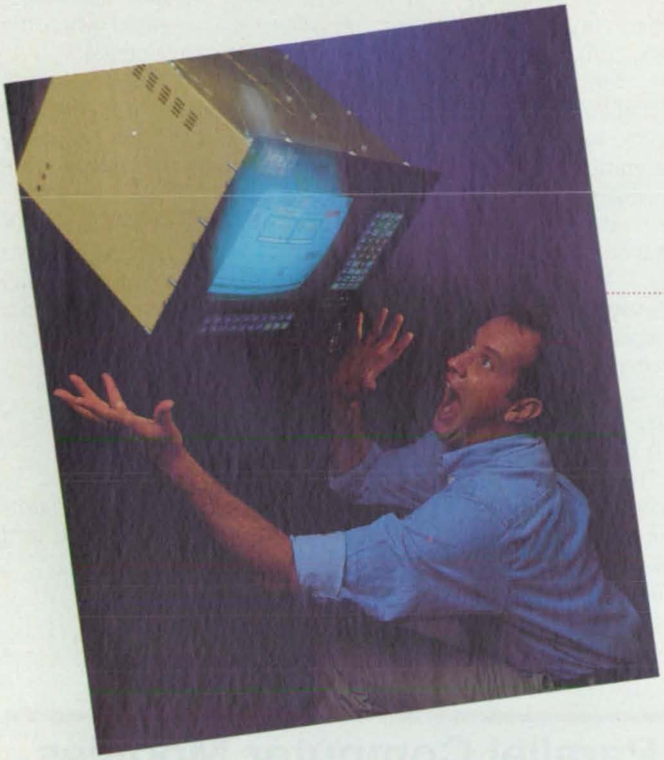
Expert-system software and interactive displays provide timely advisories and warnings.

John F. Kennedy Space Center, Florida

The meteorological monitoring system (MMS) at Kennedy Space Center and the Cape Canaveral Air Force Station is a unique computer network that tracks weather conditions and issues warnings when weather hazards are about to occur. The MMS receives data from such meteorological instruments as wind sensors on towers and lightning detectors, and compares the data with weather restrictions specified for outdoor activities like moving the space shuttle to the launch pad. If the weather violates a restriction [e.g., lightning strikes within 5 miles (8 km)],



This **Meteorological Monitoring System** uses expert-system software to issue warnings when weather conditions are expected to violate specified safety-related restrictions.



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the network generates audible and visible alarms to alert people involved in the activity. The system also displays weather and toxic diffusion data and disseminates weather forecasts, advisories, and warnings to workstations.

The MMS augments a manually operated system in which weather forecasters monitor weather instruments, then inform the affected persons of potentially hazardous weather by telephone calls relayed through chains of command. The MMS eliminates the occasional lapses of attention and the delays in communication that inevitably occur in such a system.

As now configured, the MMS (see figure) consists of a terminal server, a computer workstation that preprocesses meteorological data in conjunction with the terminal server, and two monitoring display computer workstations located at the work sites that could be adversely affected by weather conditions. The preprocessor and terminal server receive inquiries from, and send data to, the monitoring display stations. Raw data from the meteorological instruments are fed into the terminal server. The raw data are immediately sent to the preprocessor, which formats the raw data and stores them in a shared memory for dissemination to the monitoring display stations.

The monitoring display workstations provide interactive displays and alarms generated from processed weather data; the displays and alarms include graphs, maps, icons, flashing lights, textual warnings (e.g., "LIGHTNING"), and audible beeps. The software resident in each monitoring display station includes the C Language Integrated Production System (CLIPS) expert-system program, which is used to compare meteorological data with corresponding data that represent the specified restrictions. An alarm is generated when the weather violates the restrictions.

This work was done by Randolph J. Evans, Allan V. Dianic, and Lien N. Moore of ENSCO, Inc., for **Kennedy Space Center**. *For further information,* ***write in 64*** *on the TSP Request Card.*

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

Allan V. Dianic
ENSCO, Inc.
445 Pineda Court
Melbourne, FL 32940
(407) 254-4122

Refer to KSC-11709, volume and number of this NASA Tech Briefs *issue, and the page number.*

Interconnections for Stacked Parallel Computer Modules

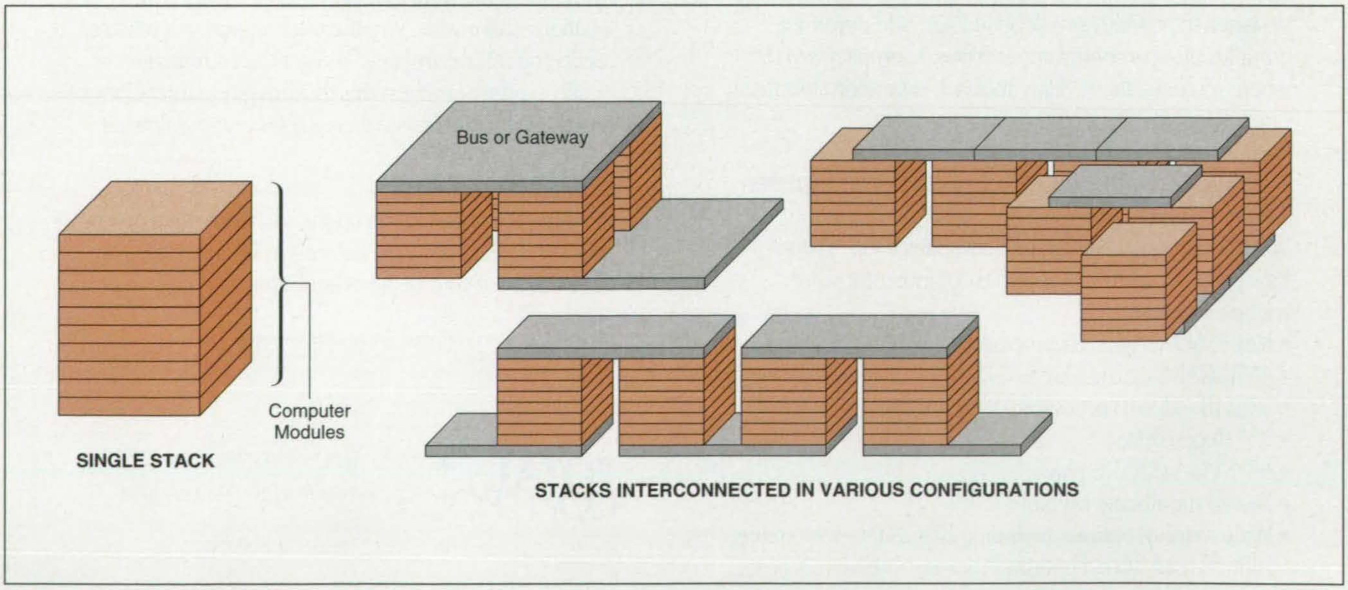
Switching gateways and side buses would provide access to computer modules.

NASA's Jet Propulsion Laboratory, Pasadena, California

A concept for interconnecting modules in parallel computers would lead to cheaper, smaller, lighter, lower-power computing systems for aerospace, industrial, business, and consumer applications. Central processing units, random-access memories, and other computer modules would be stacked, and the stacks would be interconnected via standard modular gateways. A related concept for stacking of computer modules with interconnections via polygonal ring buses is presented in the following brief.

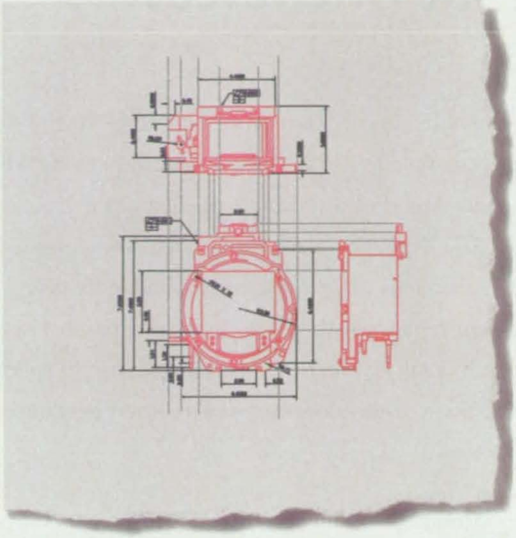
The modules within each stack would be connected to each other via a bus; the bus connections to each module in a stack could be located on any or all of the sides of the stack. Each stack would be connected to one or more other stacks via another bus or via a switching gateway on one of its sides. The gateways and/or buses between stacks could be configured in a variety of ways (see figure) to implement various computer architectures.

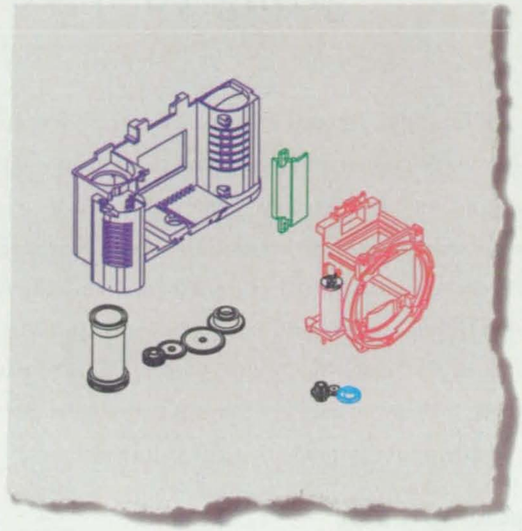
This work was done by Richard T. Johannesson of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 27*** *on the TSP Request Card.* *NPO-19562*



Computer Modules Would Be Stacked and interconnected in various configurations. The connections among stacks would be controlled by switching within gateways and/or by addresses on the buses.

To anyone who is choosing between designing in 2D or 3D, we offer the following advice.





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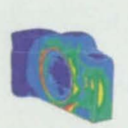

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Stackable Electronic Computer Modules and Interconnections

Interconnections would be made via regular polygonal rings.

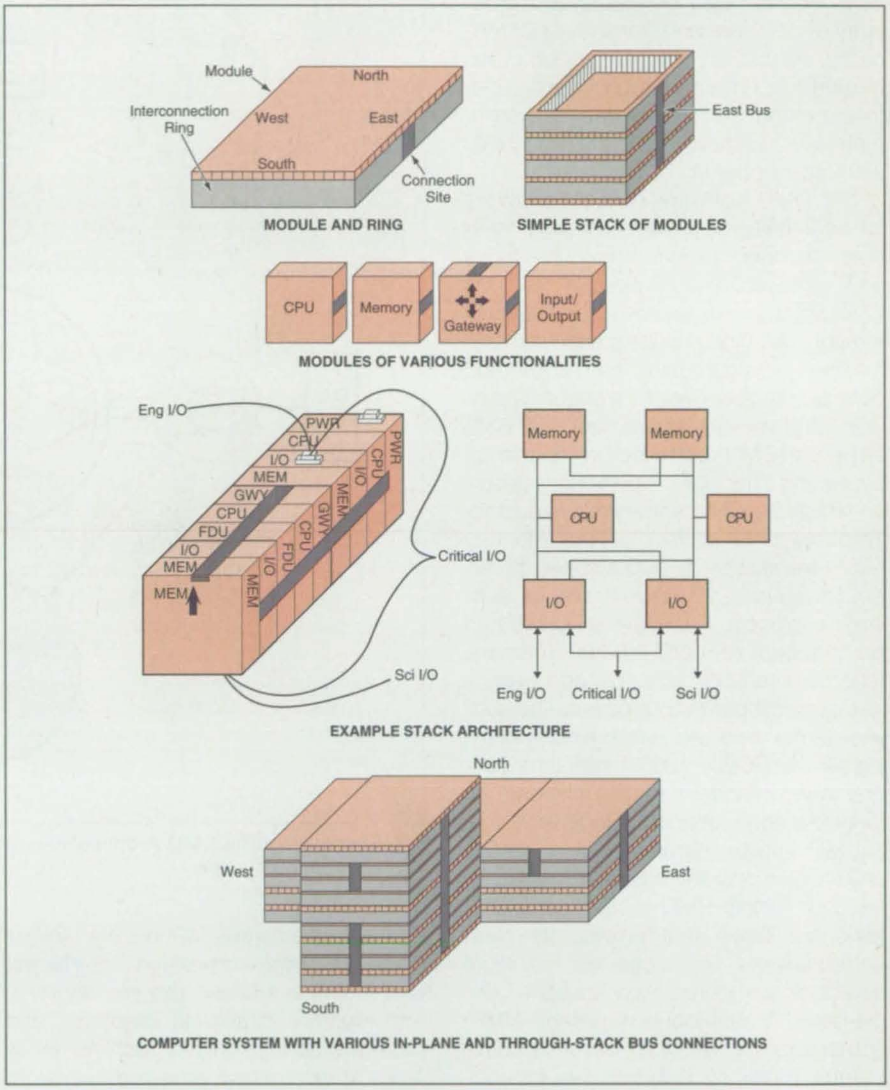
NASA's Jet Propulsion Laboratory, Pasadena, California

A design concept for a multiprocessor computer system calls for digital electronic processing circuits of various functionalities to be contained within identically shaped and sized regular polygonal modules that could be interconnected and stacked by use of rings around their edges. The rings would contain wide-band bus circuits that could be configured to provide connections to adjacent modules in the same layer of the stack and/or to modules in different layers. Thus, the concept provides flexibility of configuration to implement any of a large variety of designs.

Most likely, the regular polygons would be squares (see figure), with edges designated as north, east, south, and west. The circuits within each module would be connected to bus circuit(s) in the interconnection ring on one or more sides of the square. A bus could be constituted on one face (e.g., the east face) of a stack by taking advantage of connections among the east edges of all the rings in the stack. Two modules adjacent to each other in the same plane could be connected at a common edge; e.g., via the east edge of one and the west edge of the other.

For the most part, the circuits within the modules would include commercial integrated computer circuits like central processing units (CPUs), memories, and input/output circuits. In some applications, it could be necessary to use gateway modules, which would be four-port units unique to this design concept; a gateway module would provide a connection from the bus on any one of its edges to a bus on any of its other three edges.

This work was done by Gary S. Bolotin of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 3*** *on the TSP Request Card. NPO-19521*



Modules Would Be Connected at Their Edges via rings containing bus circuits.

Configurable Hardware and Software for Multiple Related Uses

Modularity and reusability reduce development costs.

John F. Kennedy Space Center, Florida

The name "Control Monitor Unit" (CMU) denotes, loosely, a system (or a subsystem or component of the system) of configurable hardware and software that are undergoing development for use in controlling and monitoring complex systems of equipment. The CMU provides a comprehensive array of capabilities for such functions as processing equipment-test data for calibration and diagnosis, controlling the operation of the equipment in real time, simulating the operation of the equipment, and processing large streams of scientific-measurement data. In the initial intended application, the CMU would automate many of the ground operations involved in preparing and testing spacecraft prior to launch. Because of its inherent configurability, the CMU should also be useful in a variety of similar applications; for example, testing aircraft, ships, power plants, and automated production lines.

The development of the CMU is proceeding with a view toward minimizing both the cost of development and the cost of configuring the CMU for a given application. Accordingly, the CMU concept incorporates concepts of modularity of software and hardware components, reusability of the various components in different applications, and, to the extent possible, the use of commercially available hardware and software components.

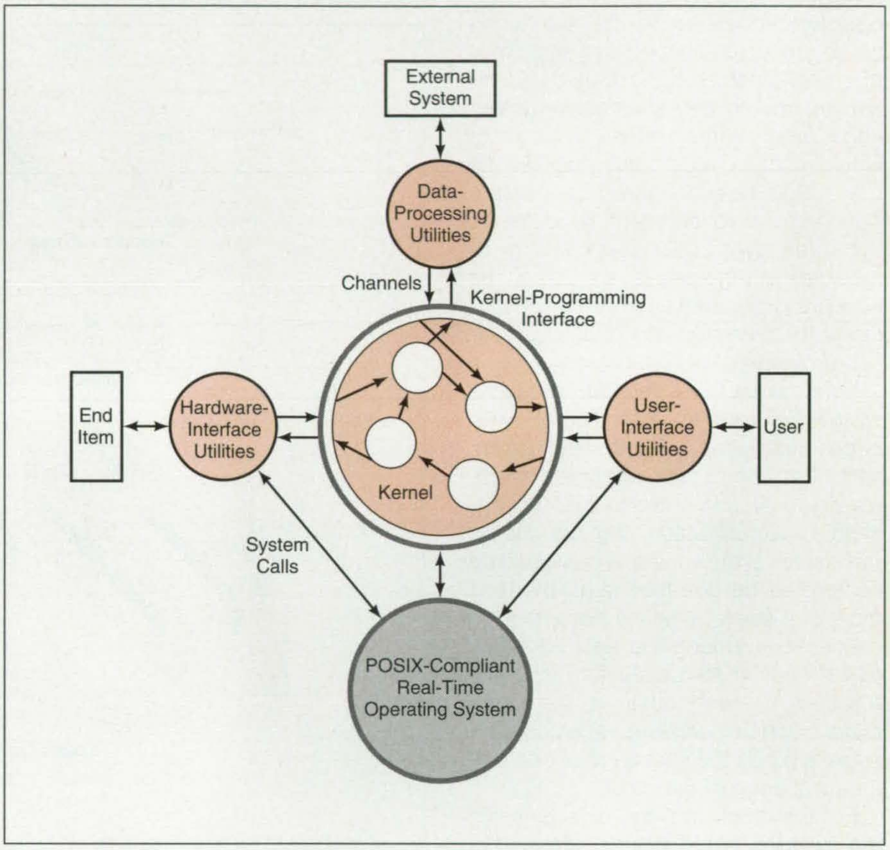
The CMU software concept provides for scalability of systems through "real-time channel" programming interfaces and associated configuration files. All CMU software components communicate through real-time channels and memory-mapped measurement and command definition tables. Real-time channels provide high-speed movement of data between CMU software components, bypassing the UNIX operating system, on which the CMU software is executed. Throughput is limited by the memory hardware and/or by a low-speed Ethernet (or equivalent) network and its software protocols. Real-time channels can be mapped to UNIX shared memory, reflective memory networks, and memory-mapped input/output buses. The software is portable and is designed according to the POSIX 1003.4 real-time programming standard of the Institute for Electrical and Electronics Engineers.

CMU software components are configured to use only the hardware resources needed. Simple CMU system configurations are those that provide for such computational resources as individual notebook computers, workstations, single-board VersaModule Eurocard (VME) computers, or multiprocessor servers. Parallel copies of CMU software components can be configured to take advantage of multiple processors. CMU systems with complex configurations are assembled by use of multiple VME single-board computers and chassis, workstations, and servers connected by reflective memory or other memory-mapped communication circuits like bus adapters and bus repeaters. CMU software components and real-time channels are configured in a text file to connect the elements of the system together. Real-time CMU software components could be allocated to VME single-board computers for acquisition of data while database and display components are allocated to a multiprocessor server.

The architecture of the CMU software (see figure) includes four main elements: the kernel, utilities, kernel programming interface (KPI), and the channels. The kernel contains most of the common system-independent functions, while utility software components are more system-specific. The kernel comprises several UNIX processes. Utilities are generally contained within a single UNIX process. Hardware utilities are unique hardware data-acquisition interfaces; user-interface utilities provide common and custom graphical displays; and data-processing utilities act as interfaces to external systems and to custom processing functions. The KPI is a high-level interface for developing utilities that communicate with the kernel. All communication between the kernel and utilities occurs through the channels.

One of the principal novel features of the CMU is scalability. The basic cost of a CMU system (in 1995 prices) can range from \$15,000 to \$500,000; the performance of the system (in terms of measurement throughput) can range from 10^4 to 10^6 measurements per second; and the system hardware can range from a notebook computer to a distributed system that includes hundreds of computers. The functionality of the CMU is also scalable: A simple text file, instead of a full Oracle data base, can be used as a measurement-and-command data base. All commercial software elements of the CMU can be included or excluded as needed, thereby scaling cost and functionality to appropriate levels.

A second novel feature of the CMU is the real-time Oracle data base and real-time table design. This design enables a user to add, modify, and delete measurement or command definitions in real time, without shutting the system down and going through a lengthy system-build process. This feature enhances flexibility of scheduling in responding to unplanned problems related to definitions of measurements and commands.



The **Elements of the CMU Architecture** combine to provide a software capability for reconfiguration of the system.

This work was done by David R. Uhrlaub, James M. Gaines, William E. Snoddy, Richard D. Bard, and Lawrence W. Robinson of McDonnell Douglas Space & Defense Systems for **Kennedy Space Center**. *For further information,* ***write in 17*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center; (407) 867-2544. Refer to KSC-11830.

"The Quiet Company" Continues to Sign Major New Business

CAD/CAM/CAE Master Model Approach and PDM Implementation Expertise Help Drive EDS Unigraphics Sales

Industry analysts, press representatives and even many of its own customers agree that EDS Unigraphics is a quiet company with remarkable technology and expertise. The company's vision of virtual product development represents the ultimate "build-it and break-it process" — the ability to design (or build), then analyze (or break) a digital model until it meet specifications. Today's manufacturers face critical issues, especially the paradox of mass customization and mass production. These manufacturers are partnering with EDS Unigraphics to manage this complexity through the intelligent use of information technology, turning hurdles into competitive advantage. Here is a sampling of companies that have recently employed the unique strengths of what insiders often describe as the industry's best kept secret.

Donaldson Company, headquartered in Bloomington, Minn., USA, has signed an agreement for the enterprise-wide global implementation of Unigraphics CAD/CAM technology with on-site support and services. Donaldson is a worldwide leader and manufacturer of filtration products for heavy-duty mobile and stationary equipment as well as specialized filters for applications like computer disk drives. Donaldson selected Unigraphics based on its flexible hybrid modeling approach to solving design problems, powerful assembly modeling capabilities and integrated manufacturing solution.

Pratt & Whitney of East Hartford, Conn., USA, continues its Unigraphics tradition, making UG the worldwide foundation of its computerized product development. All manufacturing facilities, partners and suppliers must now be capable of sending and receiving UG files electronically, producing the product in Unigraphics and assuring it meets P & W's specifications.

Philips Display Components—the world's largest manufacturer of color picture tubes—has signed a multiyear agreement for IMAN PDM software with implementation and customization services. The agreement spans five years with an initial purchase of 750 IMAN licenses. The selection of IMAN for Philips' Technical Product Information (TPI) project follows an extensive competitive evaluation and a worldwide "demonstrator" project centered in Eindhoven, Netherlands, and involving Philips' operations in France, USA, Taiwan and Brazil.

The Philips TPI project provides a long-term IT foundation for lowering costs and improving time to market. By providing true global access to engineering data and ongoing development through the implementation of an electronic PDM system, Philips will shorten the engineering cycle and increase the flexibility of its manufacturing operations.

> ***"Perhaps because of the close association with GM, EDS Unigraphics does not seem to get the attention other CAD/CAM vendors do. Yet the company's worldwide software reveneues grew by nearly 20 percent in 1995 and were up over 35 percent in Europe."***
>
> Engineering Automation Report
> *EDS Unigraphics—A Quiet Success Story*
> February 1996

Hyosung Motors and Machinery Inc. in Changwon, Korea, builds motorcycles for Suzuki in Korea as well as designs its own motorbikes, including small cc motorcycles and scooters. Hyosung will take advantage of UG's feature modeling for analytical components and freeform modeling for stylized components. The company will also develop virtual prototypes, further reducing lead times.

For More Information Write In No. 540

UG UNIGRAPHICS

Analyst Perspective

"...Unigraphics becomes a 'must see' product for all prospective MCAD customers."

"...the EDS Unigraphics approach to interaction between a user and a surface model represents the best found by DHBA in high-end MCAD products today. Unigraphics champions the concept of a surface 'sheet' body."

"EDS Unigraphics ranks among the leaders in concurrent assembly modeling. Of particular note, simultaneous access of model components by multiple members of a design team embodies important concepts rarely matched in the high-end MCAD industry."

"Companies who depend heavily on assembly structures and who require that a diverse set of engineers interact with a design during its full life cycle will discover Unigraphics* a powerful asset."

*Based on testing of Unigraphics V10.5

D.H. Brown Associates

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EDS Unigraphics

Extender and Multiplexer for a MIL-STD-1553B Bus

A fiber-optic system enables bidirectional communication between separately located buses.

John F. Kennedy Space Center, Florida

A fiber-optic digital communication system connects two separately located MIL-STD-1553 data buses. The system is comprised of identical transmitting and receiving subsystems. Two fiber-optic cables are required for bidirectional communication. With the exception of propagation delay, the two buses behave as though they were a single, extended bus. By using first-in, first-out (FIFO) storage logic prior to the transmitters, data from the commercial 1553 bus receivers is regenerated to the MIL-STD-1553B specification. Time-division multiplexing of eight 1553 data streams is performed prior to data encoding within the fiber-optic transmitter subsystem. Demultiplexing is done after decoding the serial data from the fiber-optic receiver subsystem. The serial data rate on each fiber-optic cable is 132Mb/s. System propagation delay is dependent on the length of the fiber-optic cable and the time required to regenerate the 1553 bus inputs.

This work was done by Marshall R. Bird, Danny B. Sylvester, and Henry W. Krafft of McDonnell Douglas Corp. for **Kennedy Space Center.** *For further information,* ***write in 57*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center; (407) 867-2544. Refer to KSC-11829.

Interface Circuit for Connecting Instruments to Computers

An interface circuit card provides standard connection features.

Goddard Space Flight Center, Greenbelt, Maryland

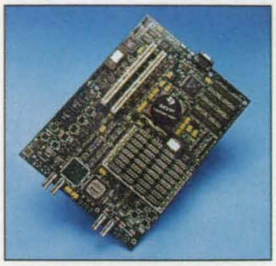
A circuit card has been designed to act as an interface between a K-bus (a bidirectional data bus used to connect space-flight science instruments and a MIL-STD-1553B (or a MIL-STD-1773) remote terminal. The circuit enables digital communication between (1) electronic instrumentation designed to communicate with other equipment via a K-bus and (2) a control and telemetry-monitoring computer designed to communicate with other equipment via a MIL-STD-1553B (or MIL-STD-1773) bus. This interface circuit card provides a K-bus interface for as many as four instrumentation circuit cards.

This interface card provides 16 status inputs that can be read directly and four discrete outputs. Embedded sequences can be programmed and executed on command from the MIL-STD-1553B (or MIL-STD-1773) bus controller. The card includes a loop-back register to enable testing of the communication system and data bus on the card. The bus controller can query a built-in test register on the board to check such components on the card as transceivers and an integrated circuit that implements the bus protocols.

A hardware power-on reset occurs when power is initially applied to the card; the bus controller can also command a software power-on reset. Frequencies derived from the 16 MHz oscillator are made available for use by the instrumentation cards. The card is powered by a single 5-volt supply.

This work was done by Richard B. Katz of **Goddard Space Flight Center.** *For further information,* ***write in 51*** *on the TSP Request Card.*
GSC-13694

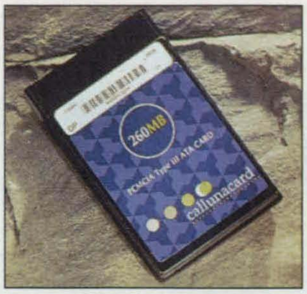
New Computer Hardware



Wintriss Engineering, San Diego, CA, has introduced the Master 'C80 MVP **multimedia video processor** for real-time image processing, 3D graphics, and telecommunications applications. The system is based on the Texas Instruments TMS320C80 multimedia video processor, which performs more than two billion operations per second. The Master is a standalone unit that provides accelerated MVP code development on either a Sun SPARC or a PC. It features up to 24 MB of SRAM, 4 MB of VRAM, dual daughter card connectors, and up to four 330 MB/second Cypress HOTlinks.

Digital serial links provide a point-to-point communications link between the system and Wintriss area- or line-scan digital CCD cameras. The Master is compatible with TI's line of MVP code development tools. Image processing routines for the MVP will be available within a Wintriss graphical user interface running under Windows NT. Pricing begins at $6950 for the baseline configuration.

For More Information Write In No. 701



The 260 MB *callunacard* **data storage card** from Calluna Technology, San Jose, CA, provides high-capacity storage for mobile professionals traveling with a notebook computer. Data stored on the card is accessible by inserting the card into the Type III PCMCIA slot of a portable computer, or by using an industry-standard IDE or PCMCIA interface on a desktop system. The card provides data transfer rates to 11 Mb/second and an average seek time of 16 ms/second.

The card serves as a faster backup system than tapes or floppy disks, according to the company. A two-level password protection utility, called *callunacode*, protects data from viruses and unauthorized reads and writes. In the event of computer failure, files are accessible by plugging the card into another computer.

The 260 MB model costs $599; 170 MB and 130 MB versions also are available.

For More Information Write In No. 702

Lucas Control System Products, Hayward, CA, has introduced the Deeco ST-x130 486/Pentium-based **rack-mount computer** for use in high humidity, shock, and vibration conditions. The unit is compatible with IBM PC/AT software and operates all MS-DOS and Windows software. The 486 CPU is available in versions from SX to DX4 (100 MHz); an optional Intel P24T Pentium Overdrive processor is available. All versions are provided with two 72-pin SIMM sockets for up to 64 MB of DRAM.

The computer's operator interface features an 8.4" Sharp color LCD 640 x 480 pixel display with an optional Scaltouch™ infrared touch controller. A standard keyboard or mouse also can be used. The computer can be installed in any standard 19" rack mount and includes three full-size and one half-size ISA card slots, shock-mounted internal hard drives, and a 3.5" 1.44 MB floppy disk drive. Local bus Ethernet and a 1.5 MB semiconductor disk are optional. One RS232C serial port, one parallel port, and a keyboard port are included. An internal 32-bit VESA local bus is provided for color graphics and mass storage data transfers.

For More Information Write In No. 712

Analog Devices, Norwood, MA, offers the RTI-2100 PC-based ISA bus **data acquisition board**, which provides onboard simultaneous sample and hold, as well as programmable gain amplifiers on each input channel. Sampling ranges from 500 kHz to 1 MHz at 12-bit resolution can be achieved. Programmable gain amplification accommodates full-scale signal ranges from millivolts to ±5 volts. Other features include 12- and 16-bit digital-to-analog channels and 24-bit digital I/O lines.

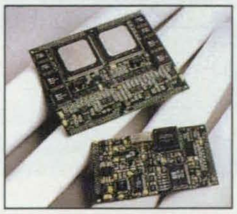
The board uses the ADSP-2101 digital signal processor, which controls channel and gain switching, data movement, and data packing. Repeat string operations permit data to be input to main system memory faster than typical direct memory access transfer. Standard software for DOS, Windows 3.1, and Windows 95 is included; optional software supports compiled languages such as Microsoft C/C++, QuickC, QuickBASIC, Visual C/C++, Visual Basic, and FORTRAN. Also supported are third-party applications software such as LabVIEW™, LabWindows™/CVI, and DasyLab™.

For More Information Write In No. 704

The VIPer805 **single-board computer** from Teknor Industrial Computers, Boisbriand, Quebec, Canada, features 486DX2, DX4, and 5x86 microprocessor designs and operates as a standalone unit or on an ISA passive backplane system. It comes standard with local bus IDE support, keyboard/floppy disk controllers, and one parallel and two serial ports. The system supports up to 4 MB of bootable Flash EPROM and up to 128 MB of DRAM using two 72-pin SIMMs. Additional onboard integration is possible through the PC/104 expansion header.

Designed for embedded applications requiring high reliability and performance, the board can be used in applications such as portable test and measurement equipment, mobile computer systems, compact process control units, and military-grade and industrial portable computers. User-definable features include auto configuration, programmable CPU/memory wait states, a watchdog timer, a power fail/low battery detector, variable suspend and sleep modes, and extensions for operation without disks or a keyboard installed. Single-unit price with 486DX2/66 MHz configuration is $742.

For More Information Write In No. 705



Spectrum Signal Processing, Burnaby, BC, Canada, has announced a **digital receiver module set** based on Texas Instruments' TMS320C44 parallel digital signal processors. The MDC44DDC Quad Digital Down Converter TIM Module and the MD70MAI 70 MS/s Analog Input TIM Module form a narrow band receiver set, which performs digital demodulation of radio signals up to 30 MHz. The modules offer design engineers a PC, VME, or VXI single-slot set with high density and flexible modular system design.

Radio signals from high frequency to microwave frequency can be monitored. The signals are down-converted to the 12 kHz to 30 kHz intermediate frequency range using conventional analog radio circuitry, including a local oscillator, mixer, and filters.

The modules are supported by Spectrum's DSP software tools and can be used for military, surveillance, and communications applications. They are integrated with Spectrum's PC and VME development toolsets, allowing parallel-processing code development using standard industry tools. The MDC44DDC Narrow Band Receiver is priced at $7900; the MD70MAI Analog Input module costs $2900.

For More Information Write In No. 706

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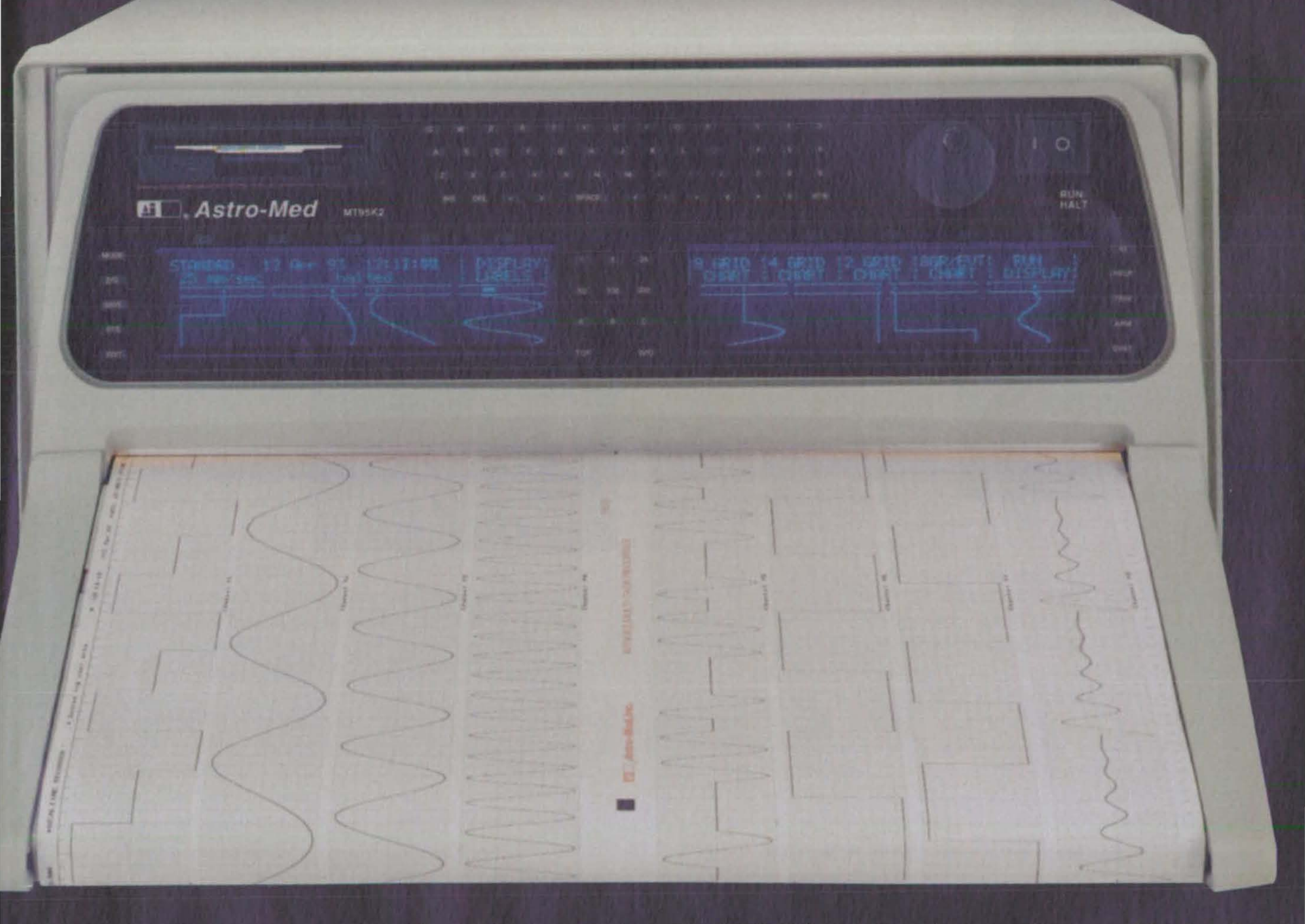

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For More Information Write In No. 531

New Computer Hardware

The Smart Distributed System from Honeywell's Micro Switch Division, Freeport, IL, provides an open and modular **integrated PC control system** for manufacturing applications. The system integrates an industrial PC; software needed to program, test, control, display, and interface to higher-level networks; a CAN-based device network; a high-density I/O system; a selection of smart devices; cables and wiring accessories; and integration and support services. The system uses a real-time engine designed by Intel that enables control functions to take priority over other functions in the PC. A Windows-based logic editor includes development and run-time versions—the development version features flow-chart programming and a product model library browser.

A Windows-based human-machine interface (HMI) features user-friendly graphics and connects to the control platform and I/O drivers. Other features include a DDE server, which provides connectivity to off-the-shelf software.

A bench- or rack-mount version is available for standalone applications.

For More Information Write In No. 707

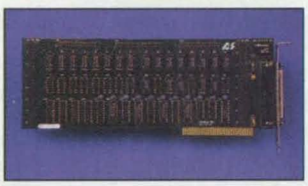
Ascension Technology Corp., Burlington, VT, has introduced the PC/BIRD **motion tracking board**, which plugs into the ISA slot of any PC. The position and orientation motion tracker provides six degrees of freedom tracking of head and body motions for real-time interaction with PC software programs in virtual reality, simulation, and CAD.

The system's receiver can be mounted on any non-metallic object for tracking position and orientation in free space.The device makes up to 144 measurements per second for each receiver being tracked. Accuracy is 0.08" for translations and 0.5° for rotations.

The system consists of the PC card, receiver, and either a standard or extended-range transmitter, which sends out pulsed DC magnetic-field signals detectable by the receiver. Additional cards and receivers may be added to track multiple targets simultaneously.

An optional 3D mouse allows the device to be used as a 2D mouse or 3D image controller. The PC/BIRD is available for $2475.

For More Information Write In No. 708



The Master Control 64/32 **switch card** from AccuSys, Reno, NV, allows any PC with an ISA bus slot to switch up to 64 signals on a single card, enabling the computer to turn industrial equipment or lights on or off, or to connect test samples to a single data source. The card contains 32 relays operated with software commands that can be issued from most applications. Operating software for Windows and DOS is provided to toggle relays on and off. Users can operate one or more relays with the click of a mouse.

Users can replace relays, change signal access, modify wiring, and change board address selection. The card supports dry reed, mercury wetted, normally open, normally closed, and TTL drivers, all of which can be mixed on the same board. Relays can be configured for discrete or common access. The card also includes wire wrap option headers that allow users to rewire the board into any array of special relay/signal interactions.

The card costs $395 in a base configuration, with normally open, single-pole, single-throw dry reed relays. The B-side, C-side, and D-side off-board connectors sell for $29 each.

For More Information Write In No. 709

Wang Federal, McLean, VA, has introduced the ZONE Pentium and TEMPEST Pentium Secure System **desktop computers** equipped with security features to safeguard system integrity. The ZONE Pentium is available in 75, 100, 120, and 133 MHz Intel Pentium™ desktop configurations; the TEMPEST Pentium is available with 75, 100, 120, and 133 MHz Pentium CPUs and three pre-configured desktop models: 1.44 MB single-drive; diskless; and full configuration. PCMCIA reader interfaces and removable disk drives are available.

The systems protect information from being radiated electronically, providing protection from unauthorized access. They also can reduce the susceptibility to radiated attacks such as High Energy Radio Frequency. ZONE systems are unmodified commercial systems tested to U.S. government specifications and were developed as a lower-cost alternative to TEMPEST systems, which were developed and tested in National Security Agency environments, and meet U.S. government specifications.

For More Information Write In No. 710

LumineCKS **illuminated keyboards** from Computer Keyboard Systems, Santa Monica, CA, were designed for computer use in low-light environments. Compatible with IBM, Digital Equipment, and other standard computers, the ruggedized keyboards eliminate poor tactile feedback, lack of repairability, and other problems associated with standard membrane keyboards.

When equipped with an RS232 interface, they provide user-addressable LED backlit keys to enunciate instructions or instruct user activity, such as responding to alarm conditions. The keyboards are protected by a 2mm-thick steel plate, and a wear- and chemical-resistant polyester front sheet. Overall construction forms a Faraday cage, ensuring that the keyboard complies with EMC/EMI requirements. The IBM-format keyboard is available for $919.

For More Information Write In No. 711

Fujitsu Microelectronics, San Jose, CA, has announced the Sapphire 3D Designer Pro **accelerator boards** in a variety of memory configurations. Targeted at CAD, visual simulation, and engineering design applications, the boards feature 3Dlabs' GLINT Delta processor, a companion chip designed to break bottlenecks in 3D geometry on PCs. The chip performs floating point-intensive calculations previously performed by a systems' CPU, reducing the load on the CPU and increasing system performance.

When used with a 3D rendering engine, the processor provides an increase in 3D graphics acceleration of two to three times faster than previously available, according to the company.

For More Information Write In No. 703

New Computer Hardware

Two miniature **rugged mouses** from CTI Electronics Corp., Stratford, CT, are available for all popular computers and workstations. The Industrial Mouse™ products are available in handheld or panel-mount versions, and are NEMA 4X rated for industrial environments. The handheld mouse measures 4" x 3" x 1.3", not including the pointing device. The panel-mount unit measures 3.45" x 2.38", with a joystick extension of 1.575" above the panel. Both mouses offer a full-travel, inductive joystick in either pencil or thumb-actuated styles. The joystick features a noncontacting inductive pickup and no moving electrical parts.

Operating temperature range for both units is 0° C to 70° C. Environmental boot and gasket seals provide resistance to water, oil, solvents, liquids, dirt, and chemicals. Three sealed, full-travel switches emulate all mouse functions. The mouses are supplied with 6-foot shielded cable and require no recalibration or adjustment. Applications include space-restricted control panels, remote operator terminals, computer controls, and compact keyboards. The handheld mouse costs $299; the panel-mount unit is $289.

For More Information Write In No. 713

Falcon Systems, Sacramento, CA, has introduced the ReelTime RAID (Redundant Array of Inexpensive Disks) high-capacity **storage system** for Silicon Graphics Onyx and Challenge workstations. It provides high-capacity storage, high-speed I/O throughput, and multiple, hot-swappable components for users in the video, CAD, and database fields. The system is designed with a dual-controller architecture; each controller supports seven drives per disk channel for a total of 28 internal devices. This provides more than 240 GB of RAID 0 or 204 GB or RAID 3 equivalent or RAID 5 storage. Additional drives and a second controller can be installed.

Users can assign one drive as an automatic replacement for a failed redundant RAID set drive. The rack-mount device supports 5-1/4" full-height drives, as well as full- or half-height, single-ended, and differential drives. All drives are hot-swappable.

Numerical readouts and audible alarms indicate faulty devices. If a disk failure occurs, the system continues operations without slowing down.

For More Information Write In No. 714

The IBM 7592 Machine Interface from IBM, White Plains, NY, is an **industrial notebook computer** consisting of a full-function AT®-bus PC system with a flat-panel touchscreen. It supports standard operating systems and applications, and resists dust, water, and temperatures from 0 to 45° C. Solid-state files installed in the PCMCIA slots enable the system to withstand shock and vibration.

The computer can monitor sensors and operations to provide users with animated graphical displays and trending charts. It also alerts operators to fault conditions through messages and alarms, and provides diagnostic information for problem determination.

The computer features an Intel 486DX2 50 MHz processor with 4 MB of RAM; serial, parallel, and keyboard ports; two Type II or one Type III PCMCIA slots; and a 10.4" TFT display, 1 MB video memory color display flat panel. A startup kit consists of a Port Replicator II, which attaches to the base of the system; an external floppy disk drive with cable; a Quiet Touch TrackPoint II™ keyboard; and an AC adapter. The computer measures 11.9" x 8.5" x 2.24" and weighs 5.9 pounds.

For More Information Write In No. 715

Dolch Computer Systems, Fremont, CA, has introduced the MegaPAC™ **portable computer** that provides 10 full-size add-in slots—six ISA, three PCI, and one ISA/PCI—and a fold-down/removable keyboard with an integrated pointing device. Slot power is provided from a range of universal AC and DC power supplies with capacities from 200 to 350 watts.

The internal structure of the system is isolated from shock and vibration via a floating inner chassis. A positive-pressure cooling system drives filtered air past the CPU and add-in boards to protect against high temperatures.

Integrated rear-standing feet allow the unit to be operated without the need for a work surface; the keyboard automatically rests in the 180° position. An integrated handle acts as a tilt stand with 15° incremental adjustments. The computer also features a 10.4" color active matrix TFT display and a choice of Pentium™ CPUs to 150 MHz, memory configurations to 128 MB, hard drives to 9 GB, and peripherals such as CD-ROM tape backup. Prices range from $6995 for a Pentium-based TFT VGA system to $7495 for an SVGA TFT system.

For More Information Write In No. 716

Kontron Elektronik Corp., Newport Beach, CA, offers the IP Lite **industrial portable computer**, which features a choice of Intel 586/90 or 586/120 processors, up to 128 MB DRAM, a 1 GB EIDE, 2 GB or 4 GB SCSI hard drive, and a backlit 9.4" STN, 10.4" TFT VGA, or 12.1" XVGA color display. Seven AT/PCI expansion slots are provided; five slots are available for user-installed feature cards. An internal CD-ROM drive or magnito optical drive are optional.

The computer's shock- and vibration-resistant design incorporates a full magnesium case, allowing operation in EMI/EMC conditions. The unit complies with international EMC standards and is CE certified. Prices start under $10,000.

For More Information Write In No. 717

American Data Acquisition Corp., Woburn, MA, has introduced the 5803HR **data acquisition board**, which features both 16-bit analog inputs and 16-bit analog outputs. It is a hardware/software system optimized for running in a Windows environment. Windows-specific hardware features include dual DMA, a 1024 Word FIFO, and onboard RAM for channel gain list storage. Windows software includes Direct View for Windows and a data acquisition package with board setup software.

Other features are 16-bit 100kHz A/D; multiple triggering modes; 16-bit ISA interface; 40 digital I/O lines; programmable gain of 1, 2, 4, 8, or 1, 10, 100, 500; and an optional screw terminal panel for connecting to all I/O on the card. The 5803HR with gain of 1, 2, 4, 8 is priced at $995; the 5804HR with gain of 1, 10, 100, 500 is priced at $1095.

For More Information Write In No. 718

Electronic Components and Circuits

PtSi/Si LWIR Detectors Made With p+ Doping Spikes

Cutoff wavelengths as large as 22 μm have been achieved.

NASA's Jet Propulsion Laboratory, Pasadena, California

PtSi/Si Schottky-barrier devices that detect long-wavelength infrared (LWIR) photons have been demonstrated. An essential feature of one of these devices is a p+ "doping spike"; a layer of Si that is (a) about 10 Å thick, (b) located at the PtSi/Si interface, and (c) doped with electron acceptors (boron atoms) at a concentration between 5×10^{19} and 2×10^{20} cm^{-3}. The doping spikes extend the cutoff wavelengths of these devices to greater values than would otherwise be possible.

A device of this type is fabricated in a multistep process that includes the formation of the p+ doping spike by molecular-beam epitaxy (MBE) of boron on a (100)-oriented silicon substrate at a temperature of 450 °C. Advanced techniques of MBE make it possible to achieve an atomically abrupt, degenerately doped layer and to use this relatively low temperature (traditional MBE temperatures are higher). The use of a relatively low temperature is also essential to preservation of the atomically abrupt doping profile. After formation of the doped layer, the PtSi layer is formed by deposition of undoped Si and Pt, followed by annealing at 400 °C.

Previous attempts to extend the cutoff wavelengths of PtSi/Si infrared detectors involved the use of relatively thick (>50 Å) p+ doping spikes formed, variously, by ion implantation or MBE at the PtSi/Si interfaces. These relatively thick doping spikes created potential spikes near the interfaces, resulting in (1) large increases in dark currents because of quantum-mechanical tunneling and (2) significant reductions in the responses of the detectors because additional tunneling processes were then needed for collection of photoexcited holes.

The present thin doping spikes extend cutoff wavelengths via the combined effects of the Schottky image forces and the increased electric fields induced by the doping spikes (see Figure 1). The height of a Schottky barrier is determined by the combined effects of the image force and the electric field of the depletion region. The effective height of the Schottky barrier can be reduced by introducing a doping spike of some thickness. In the case of a thicker doping spike like those tried previously, the enhanced electric field of the doping spike can give rise to potential spike near the Pt/Si interface, allowing photoexcited holes to tunnel into the substrate and thereby lowering the effective

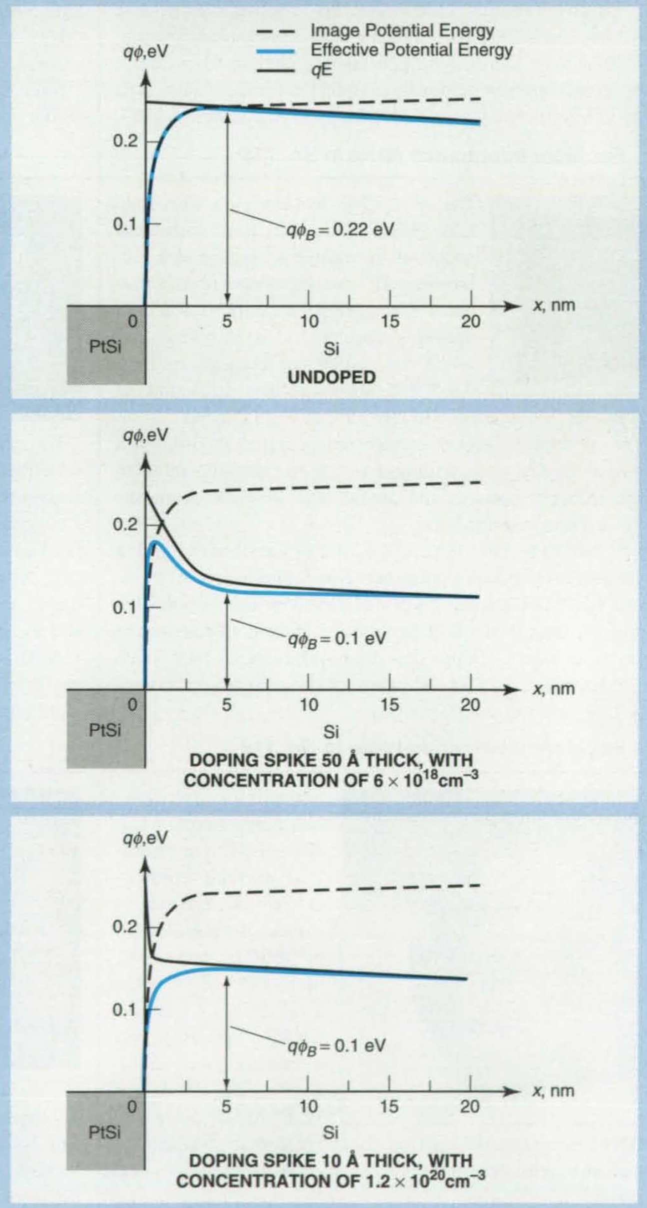


Figure 1. These **Energy-Band Diagrams** show the effects of three doping schemes on potentials and electric fields at a PtSi/Si interface. Note: q = the fundamental unit of electric charge, ϕ = the electrostatic potential field, ϕ_B = the height of the Schottky barrier, and E = the electric field along the x-axis.

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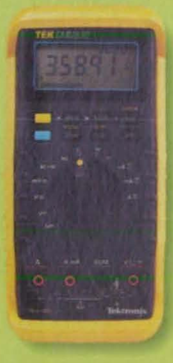

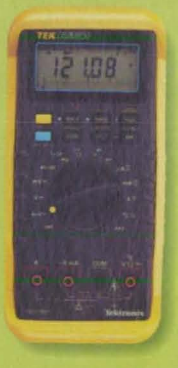

Feature	Tek DMM830	Fluke 83
Display count	40,000	4,000
True RMS	Yes	No
Basic DC volts accuracy	0.2%	0.3%
MSRP*	$199	$265

Feature	Tek DMM850	Fluke 85
Display count	40,000	4,000
True RMS	Yes	No
Basic DC volts accuracy	0.1%	0.1%
MSRP*	$249	$305

Feature	Tek DMM870	Fluke 87
Display count	40,000	4,000/20,000
True RMS	Yes	Yes
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potential barrier. By reducing the thickness of the doping spike, one can reduce the effective potential barrier without forming a potential spike, thereby eliminating the undesired tunneling.

Figure 2 shows spectral responses of some detectors of the present type. Cutoff wavelengths can be tailored by varying the concentrations of dopant in the spikes; cutoff wavelengths of 14, 18, and 22 μm have been achieved in experimental units. These units have exhibited thermionic-emission current-vs.-voltage characteristics and Fowler-dependent photoresponses, which signify the absence of an undesired tunneling mechanism.

This work was done by True-Lon Lin, Jin S. Park, Thomas George, Robert W. Fathauer, Eric W. Jones, and Joseph Maserjian of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 1*** *on the TSP Request Card.*

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 Resident Office–JPL; (818) 354-5179. Refer to NPO-19143.

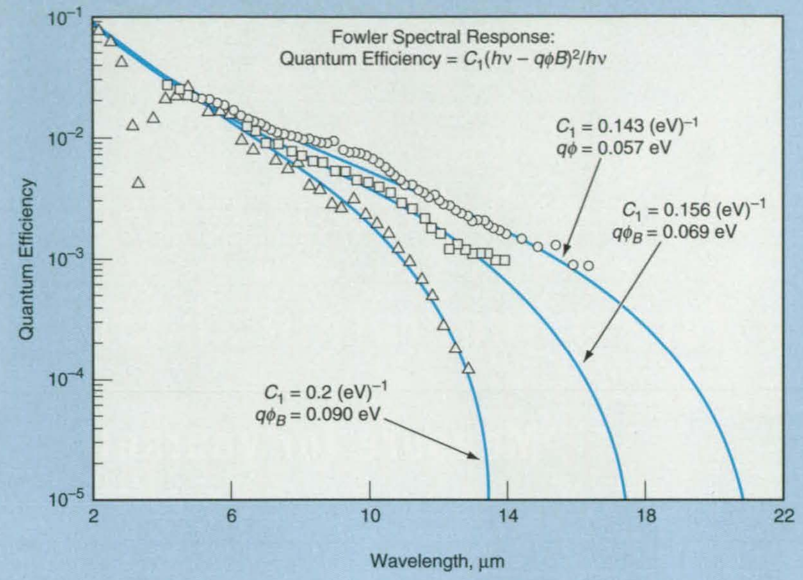


Figure 2. These **Quantum Efficiencies** were measured in three PtSi/Si detectors containing 10-Å-thick doping spikes, at a temperature of 40 K. The parameters q and ϕ_B (which have the same meanings as in Figure 1) and the parameter C_1 on each set of data are those of the Fowler spectral response fitted to that set of data and indicated by the associated solid curve. Note: h = Planck's constant and ν = photon frequency.

PtSi/Si MWIR Detectors Made With p+ Doping Spikes

Cutoff wavelengths are extended to 7 μm and dark currents are reduced.

NASA's Jet Propulsion Laboratory, Pasadena, California

PtSi/Si Schottky-barrier devices that detect medium-wavelength infrared (MWIR) photons have been demonstrated. The dark currents of these devices are low enough that when cooled to the temperature of liquid nitrogen (77 K), the devices are suitable for night imaging of scenes that are at temperatures < 0 °C.

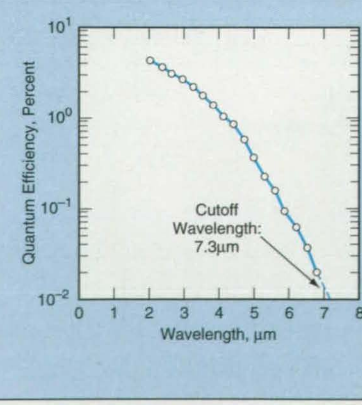
An essential feature of one of these devices is a p+ "doping spike," which is a thin layer of Si that is heavily doped with electron-acceptor atoms and is located at the Pt/Si interface. The doping spike extends the cutoff wavelength beyond the typical cutoff wavelength (between 5.1 and 5.9 μm) of a conventional PtSi/Si detector. [The use of doping spikes to extend cutoff wavelengths was described in more detail in the previous brief.]

In the present case, the doping spikes are between 0.7 and 1.1 nm thick, and the dopant consists of boron atoms at a concentration of about 5×10^{19} cm^{-3}. In experimental units, cutoff wavelengths of 5.74, 6.56, and 7.3 μm (see figure) were obtained by use of doping spikes with thicknesses of 0.7, 0.9, and 1.1 nm, respectively.

Dark currents much smaller than those of conventional PtSi/Si devices are achieved by choice of the fabrication process. The experimental units were fabricated on double-side-polished Si (100) substrates with a resistivity of 30 Ω·cm. First, the doping spikes were formed by molecular-beam epitaxy with the substrates heated to 450 °C, as described in the noted prior article. Then, with the substrates at 450 °C, the PtSi layers were deposited on the doping spikes by coevaporation of Pt and Si in equal concentrations. The device structures incorporate n-doped guard rings, which define the peripheries of the active device areas to suppress edge leakage.

This work was done by True-Lon Lin, Sarath Gunapala, Hector Del Castillo, Jin S. Park, and Eric Jones of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information,* ***write in 32*** *on the TSP Request Card.*

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 Resident Office–JPL; (818) 354-5179. Refer to NPO-19434.



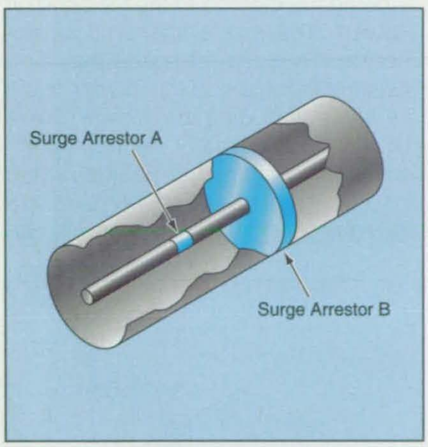
The **Spectral Response** of an experimental detector cooled to 40 K and biased at –0.5 V was measured with back-side illumination from a black-body source. Neither an antireflection coat nor an optical cavity was used.

Two Electrical Switching Phenomena in a Silver-Filled Epoxy

Improved understanding of these phenomena could lead to design of new and improved surge arrestors.

NASA's Jet Propulsion Laboratory, Pasadena, California

Two distinct electrical switching phenomena have been observed in experiments on a commercial silver-filled epoxy: Depending on the geometry of an epoxy layer or strip and of metal electrical contacts, there is either (1) a transition from an "off" (high-resistance) state at low applied electric field to an "on" (low-resistance) state at high applied electric field; or (2) a transition from "on" (low resistance) at low applied electric field to "off" (high resistance) at high applied electric field. These phenomena appear not to involve damage to the material (although they can be accompanied by some incidental damage). They occur at voltage and current levels below those of electric breakdown. They can be exploited in surge arrestors — devices that protect delicate electronic equipment against damage by transient excessive voltages and currents (e.g., caused by lightning) on signal and power lines.



Surge Arrestors based on switching phenomena in silver-filled epoxy could be installed in a coaxial cable. Surge arrestor A would normally behave as part of the center conductor, but would prevent excessive current from flowing in the center conductor; surge arrestor B would normally behave as an insulator, but would short-circuit high-voltage pulses.

It has been conjectured that instead of being limited to the particular silver-filled epoxy, these switching phenomena are characteristic, in general, of composite materials that comprise tiny metal particles in electrically insulating matrices. The switching phenomena are believed to be the observable results of a complex combination of more fundamental physical phenomena that include quantum-mechanical tunneling, defect centers in the epoxy matrix that trap charge carriers, and space-charge effects. In an effort to improve understanding of the basic physics, experiments continue. Improved understanding could lead to new and improved surge arrestors.

The first-mentioned phenomenon is already the basis of a type of commercial surge arrestor that protects against high-voltage pulses. In a device of this type, the silver-filled epoxy is placed across the gap between two conductors that carry the signal or power in question. Normally, the device remains in the high-resistance state, behaving essentially as an insulator between the conductors. However, the device goes into the low-resistance state in the presence of high-voltage pulses, thereby short-circuiting the pulses to prevent them from reaching the equipment to be protected.

The second-mentioned phenomenon could be exploited in other surge-arrestors that would protect against excessive currents. In a device of this type, the silver-filled epoxy would be placed in series with either or both conductors of a signal or power line. Normally, the silver-filled epoxy would remain in the low-resistance state. However, a current surge would give rise to a high electric field, in the silver-filled epoxy, causing a transition to the high-resistance state. This transition would damp the current surge. The figure illustrates a coaxial cable that contains surge arrestors of both types.

This work was done by Hamid Javadi of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 42*** *on the TSP Request Card.*

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 Resident Office–JPL; (818) 354-5179. Refer to NPO-19442.

Computing Radiation From Axisymmetric Waveguide Feed Horns

Effects of dielectric bodies can be modeled readily.

NASA's Jet Propulsion Laboratory, Pasadena, California

A hybrid finite-element method has been developed for computing radiation patterns and reflection coefficients of axisymmetric waveguide feed horns that include dielectric bodies like rods and radomes (see Figure 1). The dielectric inhomogeneities introduced by such bodies and even the anisotropies of some dielectric materials pose no special problem in this method because the requisite dielectric properties can readily be incorporated into the finite elements used to model the bodies.

Figure 2 illustrates the spatial regions and their boundaries as configured in applying the method to the feed horn in Figure 1. The finite-element model represents the region of space that contains the radome and the interior of the feed horn, including the coaxial dielectric rod. The excitatory electromagnetic field is considered to be supplied to the interior of the feed horn from a waveguide below the horn and is cal-

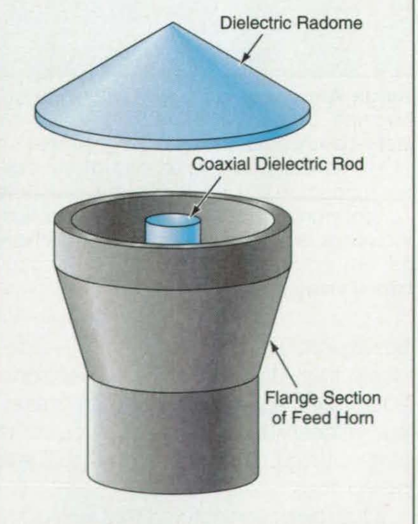


Figure 1. **Dielectric Inhomogeneities** like the coaxial dielectric rod and the dielectric radome pose no special mathematical-modeling problem in the hybrid finite-element method described in the text.

culated by a mode-matching (MM) technique; waveguide modes are coupled to the finite-element-model (FEM) electromagnetic field at the FEM/MM boundary, which is an imaginary surface that separates the interior of the feed horn from the waveguide below. The electromagnetic field radiated into the exterior space is represented by the method of moments (MoM) and is cou-

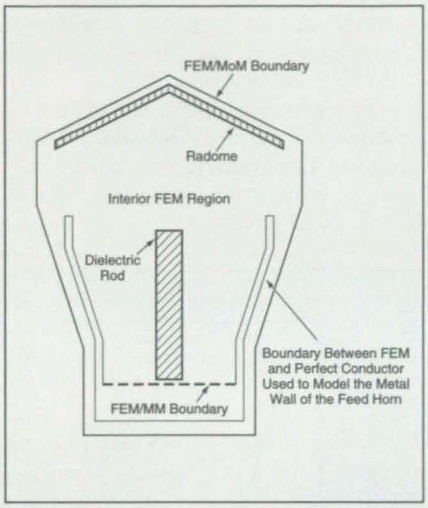


Figure 2. **Various Regions and Boundaries** are used in mathematical modeling of the electromagnetic fields in the waveguide, the interior of the feed horn, and exterior space.

pled to the FEM electromagnetic field at the FEM/MoM boundary, which is an imaginary surface that covers the feed horn (including the radome).

The coupling of electromagnetic fields at the boundaries is mathematically modeled by use of two boundary integrals derived from two equations: the wave equation for the electric field and the equation of matching of tangential electric fields at the boundaries. The boundary-integral equations can be shown to lead to a matrix-vector system of equations in which components of the vector that one seeks as a solution are the amplitudes of the electric field within the FEM region, the electric and magnetic surface currents on the FEM/MoM surface, and the coefficients of the waveguide modes reflected at the FEM/MM interface. The matrix of this system of equations is complex-symmetric, sparse, and diagonally dominant; as such, it can be solved with standard available software.

This work was done by Gilbert C. Chinn, Larry W. Epp, and Daniel J. Hoppe of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 94*** *on the TSP Request Card. NPO-19558*

All-Metal Low-Pass Dichroic Microwave Reflector

Resonant slots would allow through-transmission at the low-pass frequency.

NASA's Jet Propulsion Laboratory, Pasadena, California

Figure 1 illustrates a proposed all-metal low-pass dichroic microwave reflector. The reflector would be a moderately thick metal plate containing a periodic pattern of resonant slots that would make the plate effectively transparent at the frequency of resonance. The dimensions of the slots would be chosen so that this frequency would equal the desired low-pass frequency. Because most of the broad face of the plate would be metal, the plate would be predominantly reflective at higher frequencies.

If no other features were incorporated into the design, then the reflectivity loss at frequencies significantly above the low-pass frequency would be approximately equal to the fraction of area occupied by the slots. However, the reflectivity of the plate at a selected higher frequency or frequencies could be enhanced by redesigning the slots to insert or incorporate high-frequency chokes.

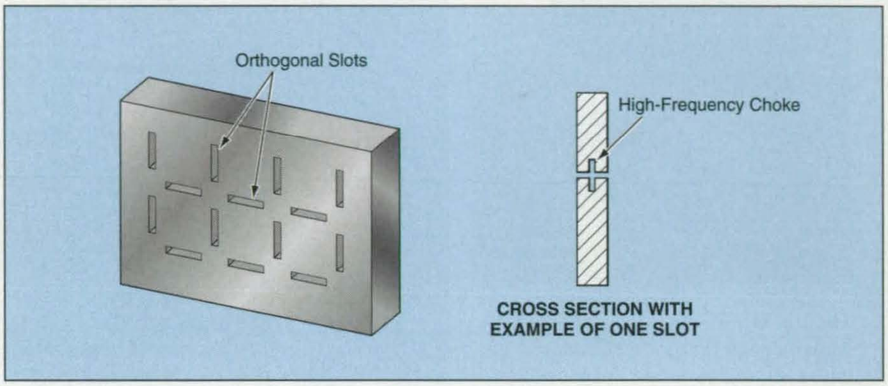


Figure 1. **Spatially Periodic Slots in a Metal Plate** would make the plate appear transparent at the frequency of resonance of the slots. The plate would appear mostly reflective at higher frequencies. Orthogonal slots would accommodate circular polarization; one of the two orthogonal slots in each pair could be eliminated if only one known linear polarization were needed.

Choke geometries of various degrees of complexity could be used to tailor the high-frequency response. Figure 2 illustrates the theoretically calculated performance of a plate containing chokes, with dimensions chosen to provide high transparency in the S-band and high reflectivity in the X-band.

This work was done by William A. Imbriale of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information,* ***write in 48*** *on the TSP Request Card. NPO-19451*

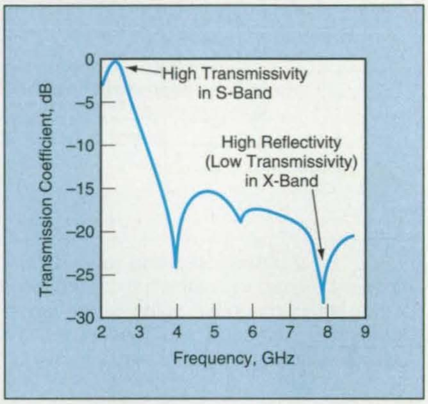


Figure 2. The **Spectral Response** of a plate like that of Figure 1 can be tailored by choice of the dimensions of the slots.

AlN-Coated Al_2O_3 Substrates for Electronic Circuits

The AlN surface layers afford increased thermal conductivity for improved dissipation of heat.

NASA's Jet Propulsion Laboratory, Pasadena, California

A type of improved ceramic substrate for high-frequency, high-power electronic circuits combines the relatively high thermal conductivity of aluminum nitride with the surface smoothness of alumina. This substrate consists of a 15-μm layer of AlN deposited on highly polished alumina. The substrate can be used for packaging millimeter-wave gallium arsenide transmitter chips, power silicon chips, and the like.

All-alumina substrates have been used in semiconductor-device packages. Their smooth surfaces, with roughnesses no greater than 1 μin. (25.4 μm), accommodate efficient microstrip interconnections. However, the thermal conductivity of alumina [25 W/(m·K)] is too low for adequate dissipation of the heat produced by high-power, high-frequency electronic devices. On the other hand, aluminum nitride offers a high thermal conductivity [220 W/(m·K)], however, surface roughnesses of commercial substrates have been on the order of 3 μin. (76.2 μm) until recently. Microstrip transmission lines on aluminum nitride require smooth surfaces to minimize loss at high frequencies (> 10 GHz).

The present substrates exploit the best properties of both ceramics. The aluminum nitride top layer is thin enough to take on the same surface smoothness as that of the alumina base but thick enough to carry appreciable heat away from electronic devices mounted on the substrate.

A surface layer of aluminum nitride is deposited on an alumina baseplate by magnetron reactive sputtering from an aluminum target in an argon/nitrogen plasma. Prior to the deposition process, the alumina baseplate must be thoroughly cleaned. During the first 30 s of the deposition process, a negative bias is applied to the baseplate to enhance the adhesion of the deposited film. The forward sputtering power, total gas pressure, and nitrogen/argon flow ratio are adjusted to obtain rapid deposition of a high-purity, stoichiometric film of AlN. The density of the deposited AlN film is within 5 percent of the theoretical density. The film can readily be coated with a Cr/Au film by standard metallization techniques.

This work was done by Elzbieta Kolawa, Lynn Lowry, Martin Herman, and Karen Lee of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information,* ***write in 34*** *on the TSP Request Card. NPO-19363*

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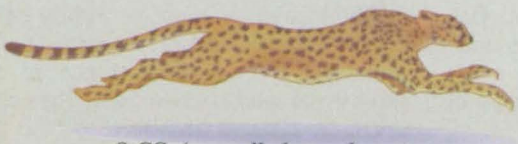

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John F. Kennedy Space Center, Florida

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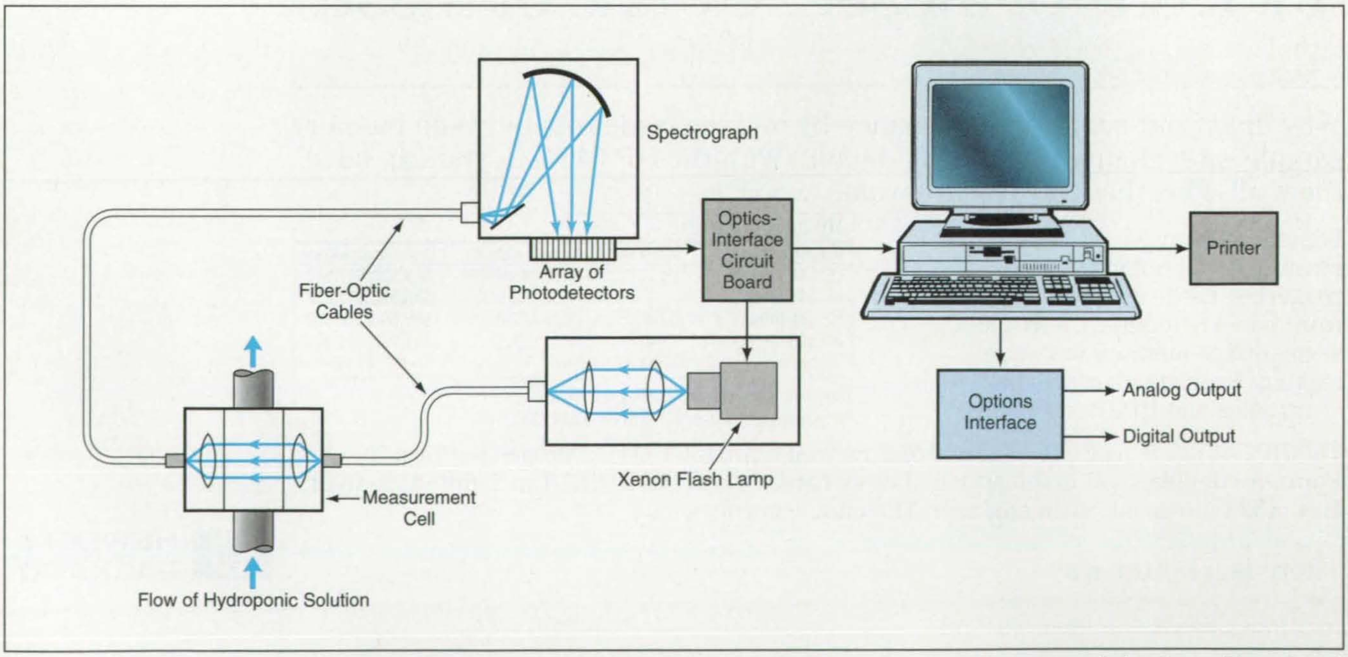
In the instrument, the solution flows through two measurement cells: (1) an absorbance spectrometric cell in which the illumination to be absorbed is supplied by a xenon flash lamp (see figure) via a fiber-optic cable and (2) a liquid atomic emission spectrometry cell in which the emission of light is excited by applying a voltage across the solution between gold electrodes. The luminous output of each spectrometric cell is transmitted by a fiber-optic cable to a spectrometer that includes a fixed holographic diffraction grating. The light diffracted by the grating strikes a linear array of 1,024 photodiodes; this provides for resolution of the absorbance or emission spectrum into wavelength increments of about 1 nm over the range of 200 to 1,100 nm.

The outputs of the photodiodes constitute the raw spectral data related to the concentrations to be measured. These outputs are digitized and processed by a pattern-recognition algorithm that determines the concentrations of the individual solutes from the overlapping spectra of all of the solutes. For each nutrient of interest, the algorithm requires a file of data relating the spectral characteristics of known concentrations of the nutrient in the presence of a random distribution of other chemical constituents. The algorithm compares the spectral characteristics of a solution to those in the data files to compute the concentrations of the nutrients. The concentrations of the nutrients mentioned above can be determined with various average errors ranging from 0.8 to 24.3 percent, depending on the species.

The instrument must be initially calibrated for each nutrient and zeroed periodically to compensate for buildup of films in the measurement cells. The cells must be cleaned from time to time to prevent excessive buildup of films.

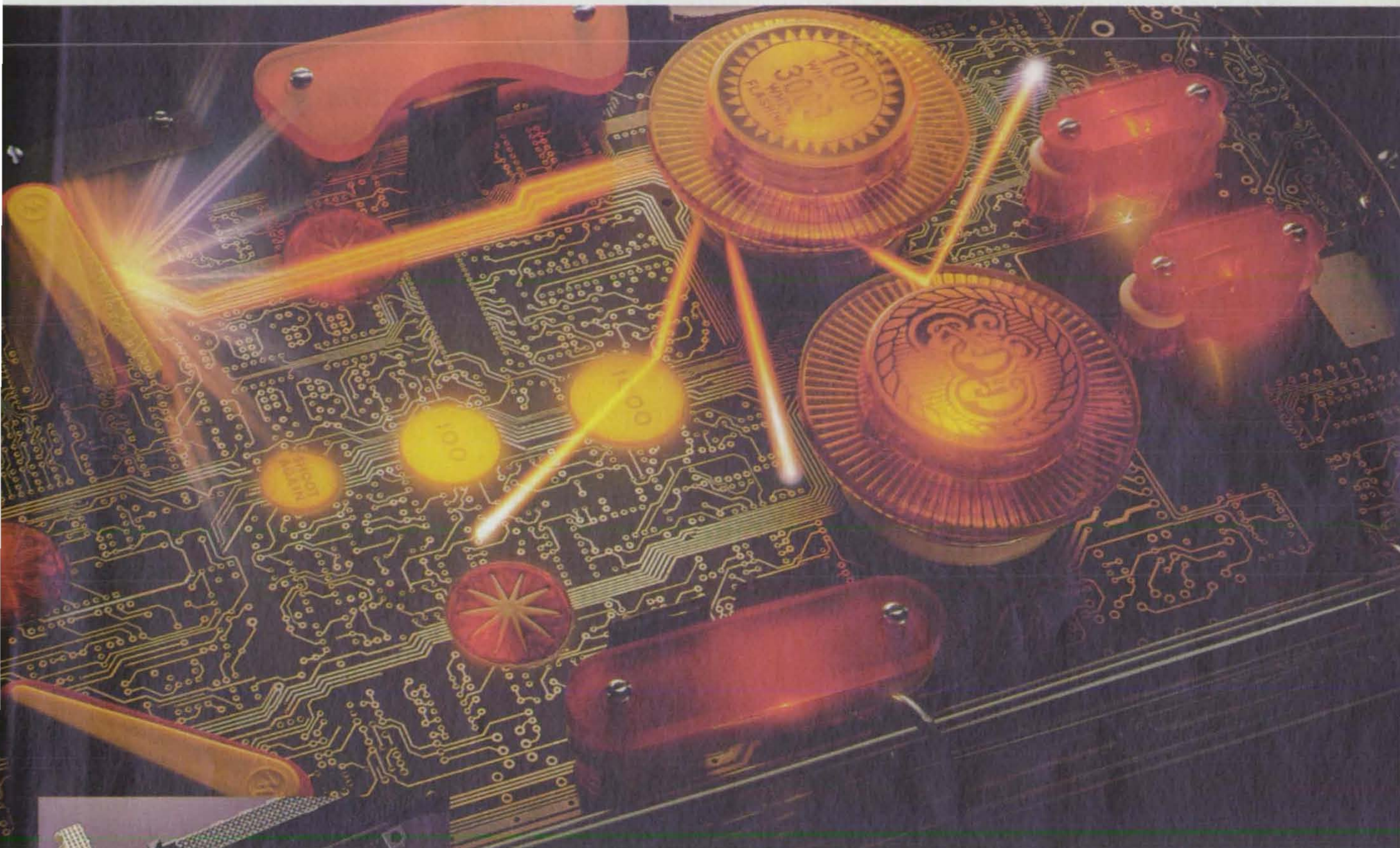
This work was done by Kenneth J. Schlager, Scott J. Kahle, Monica A. Wilson, and Michelle Boehlen of Biotronics Technologies, Inc., for **Kennedy Space Center**. *For further information,* ***write in 65*** *on the TSP Request Card.*

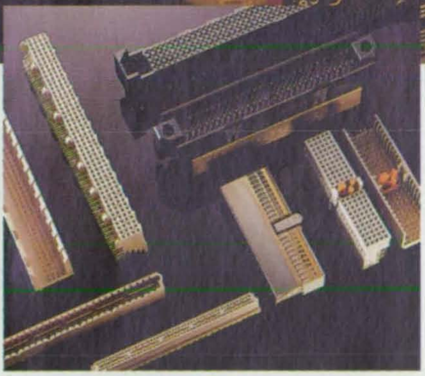
Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center; (407) 867-2544. Refer to KSC-11682.



The **Instrument Measures the Absorption Spectrum** of the hydroponic solution flowing through a measurement cell. Another cell (not shown) is also used to measure the emission spectrum.

At fast edge rates, the wrong interface takes on unexpected qualities.





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Advanced Support Equipment for Remote Experiments

Features include modularity of hardware and software and a user-friendly operating environment.

Goddard Space Flight Center, Greenbelt, Maryland

The Advanced Carrier Customer Equipment Support System (ACCESS) is a system of electronic communication and data-processing equipment for controlling remote scientific instruments and monitoring the readings of the instruments via telemetry. ACCESS was designed primarily as a relatively inexpensive, high-performance unit of ground support equipment for the Hitchhiker avionic equipment, which in turn supports as many as 32 instruments operating simultaneously aboard the space shuttle. However, ACCESS was also designed to incorporate modular hardware and software to make it adaptable to other uses (which could include terrestrial ones) with minimal modifications.

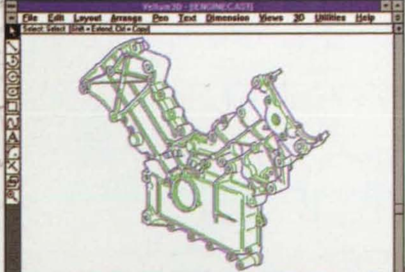
ACCESS is to replace an older system of ground support communication equipment and features a number of enhancements over the older system, including an increase in the number of instruments (the previous number was 8), an increase in the maximum data rate from 8 kb/s to an assortment of higher rates, window displays for the users, and processing medium-rate data.

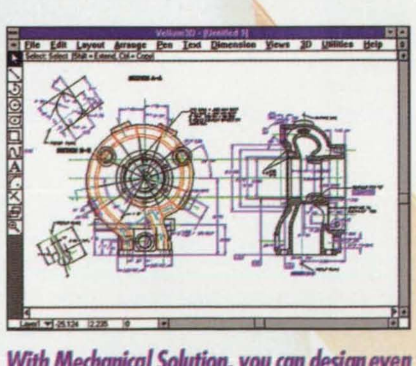
The modular ACCESS software comprises four major software subsystems. One of these subsystems implements an operator-interface language called "STOL" (Systems Test and Operation Language), which enhances the ability of an operator to control the remote avionics. The other three software subsystems are for telemetry, command, and display functions, respectively. Each of these subsystems runs independently of the others and shares information via interprocess communication.

ACCESS (see figure) is responsible for commanding the remote avionics and the instruments, monitoring the overall remote system of equipment, recording data telemetry from the instruments, processing some of these data, and distributing the data. ACCESS receives two telemetry streams from the remote avionics: one at a low rate (8, 16, or 32 kb/s) and one at a medium rate (2 Mb/s). ACCESS can process a telemetry stream in either of two formats: pulse-code modulation compatible with the older avionics and a packet data format compatible with newer avionics.

ACCESS provides up to 32 serial (RS232 or RS422) connections to units of customer ground support equipment (CGSEs) that are dedicated to individual instruments. These CGSEs are where the commands for the instruments originate and where the user/experimenters can monitor the telemetry from their instruments. Upon receiving the commands from the CGSEs, ACCESS validates and prioritizes them and forwards them to the remote avionics.

The remote avionics sends (1) scientific data from the instruments, (2) data on the integrity of, and operating conditions in, the overall remote system of equipment, and (3) command-verification data to ACCESS via the low-rate



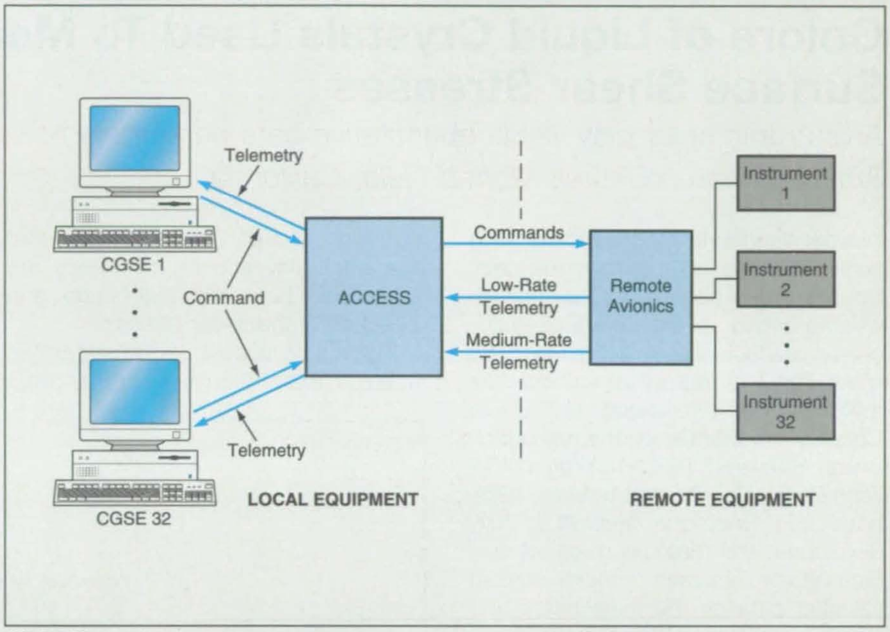


telemetry stream. ACCESS displays the operating-condition and integrity data and forwards the scientific data to the CGSEs through the serial connections. The medium-rate telemetry link is used whenever the needed composite data rate exceeds 32 kb/s. In that case, the remote avionics equipment multiplexes all the scientific data into the medium-rate telemetry channel.

ACCESS consists of a core group of computers and a number of data-display computers connected with each other through a local-area network. All of these computers run SCO Unix and DOS/Windows operating systems. The core computers process both low- and medium-rate data and displays the status of the remote avionics by use of the SCO/Open Desktop (SCO version of X Windows) software. Through X Windows, various pages can be brought up for display of status and for control. The data for each page are obtained directly from the display software subsystem. Data displayed on the pages can be printed at any time.

Through each of the data-display computers, a user can request various data from the core computers. The data are displayed on these computers in a windows software environment (Microsoft Windows 3.1), in which multiple pages of data can be shown at the same time. Data that are displayed on the screens of these computers can also be printed. Multiple data-display computers can be connected to the core computers simultaneously. For more information on ACCESS, visit the WWW site at the following address: http://sunland.gsfc.nasa.gov/access/access.html

This work was done by Ben Y. Lui of **Goddard Space Flight Center**. *For further information,* ***write in 22*** *on the TSP Request Card.* *GSC-13666*



ACCESS mediates communications between remote scientific instruments and the CGSEs, each of which is dedicated to one of the instruments.

Colors of Liquid Crystals Used To Measure Surface Shear Stresses

Anisotropic color play yields quantitative data on surface flows.

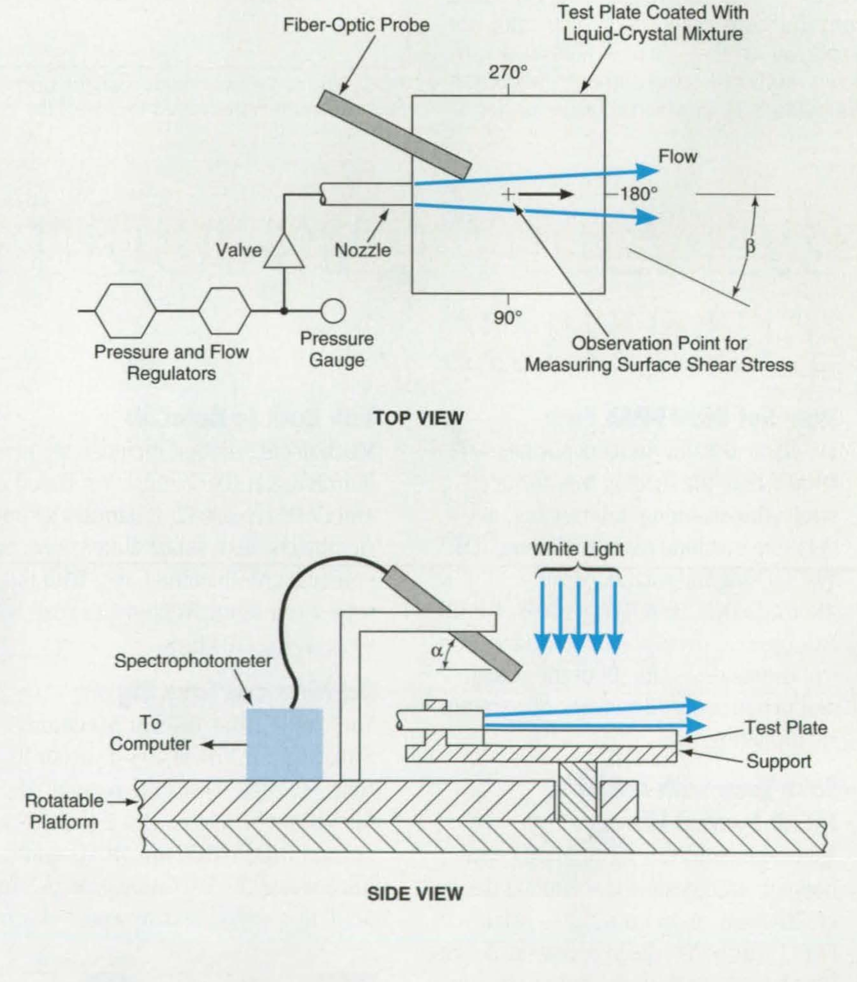
Ames Research Center, Moffett Field, California

A developmental method of mapping shear stresses on aerodynamic surfaces involves observation, at multiple viewing angles, of the colors of liquid-crystal surface coats illuminated by white light. (A report describing this method was referenced in "Liquid Crystals Indicate Directions of Surface Shear Stresses" (ARC-13379), *NASA Tech Briefs*, Vol. 20, No. 5 (May 1996), page 89.) Once the method is fully developed, the resulting maps of surface shear stresses should contain valuable data on the magnitudes and directions of skin friction forces associated with surface flows; these data could be used to refine mathematical models of aerodynamics for research and design purposes.

When shear is applied to a surface layer of a cholesteric liquid crystal, the molecules become aligned. The aligned molecules scatter white light into a spectrum of colors, each color at a different orientation relative to the surface. The resulting changes in color observed at a given viewing angle under illumination from a fixed angle are called "color play."

Initial efforts in the late 1960s to determine the magnitudes of surface shear stresses from the colors of liquid-crystal coats were not successful. Of course, surface shear stresses can be measured by use of transducers, but each transducer indicates the shear stress at one point only. The present method overcomes the limitations of both prior approaches and goes beyond them; it yields data on both the magnitudes and directions of shear stresses over surface areas, without the expense and complication of covering the areas with large numbers of transducers. The present method is made possible, in part, by two recent advances: (1) the development of liquid-crystal mixtures that exhibit enhanced color play in response to shear stresses but little or no color response to changes in temperature; and (2) the observation that the color play and its anisotropy are related to both the magnitude and direction of the shear stress.

The figure illustrates the apparatus used in experiments to gather data to develop and verify the method. In the experiments, a liquid-crystal-coated plate was exposed to wall-jet shear flows under white light directed perpendicularly onto the plate, and the spectrum of scattered light was



Spectra of Light Scattered at Various Angles from the liquid-crystal-coated test plate were measured. The dominant wavelength seen at a given viewing angle was found to shift by an amount proportional to both the magnitude of the flow-induced surface shear stress and the orientation of the line of sight with respect to the direction of the surface shear stress.

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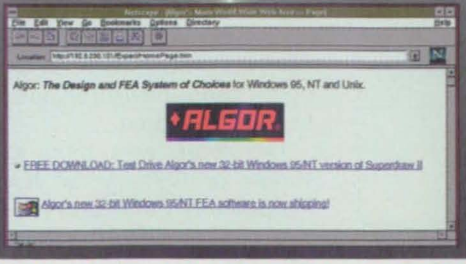

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measured by use of a fiber-optic probe connected to a spectrophotometer. Measurements were taken at a number of different orientations of the probe to characterize the spectra of light scattered in various directions with respect to the surface and to the flow. In addition, color video images were obtained at a number of different viewing angles.

The maximum and minimum color-play responses were found to occur when the shear vector pointed away from and toward the probe ($\beta = 0$ and 180°, respectively, in the figure). Intermediate responses were observed at intermediate angles; for a given above-plane viewing angle, α, the shift in the dominant wavelength of scattered light was found to be approximated fairly closely by a Gaussian function of β. At $\beta = 0°$, the shift in the dominant wavelength of scattered light was found to increase linearly with the magnitude of the shear stress over an eightfold range.

The essence of the method is to invert sets of data like those obtained in the foregoing experiments. In a typical application, one would perform the desired flow experiment on the surface of interest while taking color-play measurements at a fixed above-plane viewing angle and several different values of the in-plane viewing angle. A three-chip CCD color video camera and frame grabber would be used for this purpose. Next, one would curve-fit the data on the shift in dominant wavelength as a function of the in-plane viewing angle to find the in-plane viewing angle of maximum color change and thus the orientation of the shear-stress vector. Finally, the magnitude of the shift in dominant wavelength at the peak of the fitted curve would be taken as an indication of the magnitude of the surface shear stress. Initial tests have shown that this method yields the shear-stress orientation with a resolution of ±1° and shear-stress magnitude with a resolution of ±5 percent.

This work was done by D. C. Reda and J. J. Muratore, Jr., of **Ames Research Center.** *For further information,* ***write in 9*** *on the TSP Request Card.*

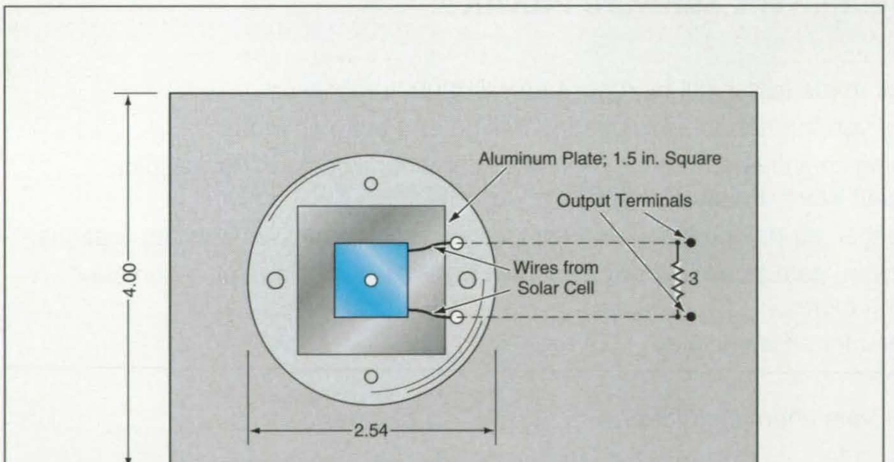
This invention has been patented by NASA (U.S. Patent No. 5,438,879). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Ames Research Center; (415) 604-5104. Refer to ARC-12052.

Inexpensive Pyranometer

This device performs almost as well as does an instrument that costs much more.

NASA's Jet Propulsion Laboratory, Pasadena, California

The figure illustrates a relatively cheap pyranometer that generates an output potential of about 300 mV in maximum sunlight. This pyranometer is designed to monitor insolation at an accuracy within 5 percent of the accuracy of the instruments that are ordinarily used for this purpose and typically cost about $2,000 each (1994 prices). [A slightly more complex pyranometer intended primarily for use in an agricultural setting was described in "Inexpensive Meter for Total Solar Radiation" (NPO-16741), *NASA Tech Briefs*, Vol. 11, No. 1 (January, 1987), page 38.]



The **Inexpensive Pyranometer** is suitable for use in school laboratories and perhaps in commercial facilities where the expense of a more precise instrument is not justified.

This pyranometer can be used in conjunction with an old computer serving as an inexpensive data logger. The pyranometer alone or in combination with a computer could be used in one of the school sites participating in the international network of monitoring stations of the Mission to Planet Earth.

The pyranometer includes a silicon solar photovoltaic cell mounted on an aluminum plate, which acts as a heat sink to prevent overheating of the cell. The 3-Ω resistor prevents significant changes in load conditions and maintains a near "short-circuit" condition. The cell is protected by a cheap, easily replaceable plastic weather dome.

This work was done by Gilbert Yanow of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 33*** *on the TSP Request Card.* *NPO-19435*

Ballistic Mass and Velocity Analyzer

Electric fields would disperse incident ions according to charge-to-mass ratios and velocities.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed device for measuring the distribution of masses and velocities of ions in a plasma or an ion beam would be of the general type denoted variously as mass, velocity, and energy analyzers. More precisely, like other devices of this type, the proposed device would yield indications of charge-to-mass ratios and velocities; from these quantities, one can compute masses and energies if one also either (a) measures the charges of the ions by other means or else (b) makes the realistic assumption that each ion carries a small number (usually 1) of fundamental units of electric charge. In comparison with older devices of this type, the proposed device would be smaller and would operate faster, yielding simultaneous indications of both charge-to-mass ratios and velocities.

The device is called a "ballistic" mass and velocity analyzer because it would feature crossed electric fields that would disperse ions along parabolic trajectories and because ballistic trajectories are approximately parabolic. The device would consist mainly of a rectangular parallel-piped chamber with dimensions x_0 by y_0 by z_0 and corresponding axes of Cartesian coordinate system (x, y, z) with its origin at the center of the chamber (see figure). Uniform electric fields ξ_y and ξ_z along the y and z axes, respectively, would be established in the chamber by applying voltages to electrodes (omitted from the figure for clarity).

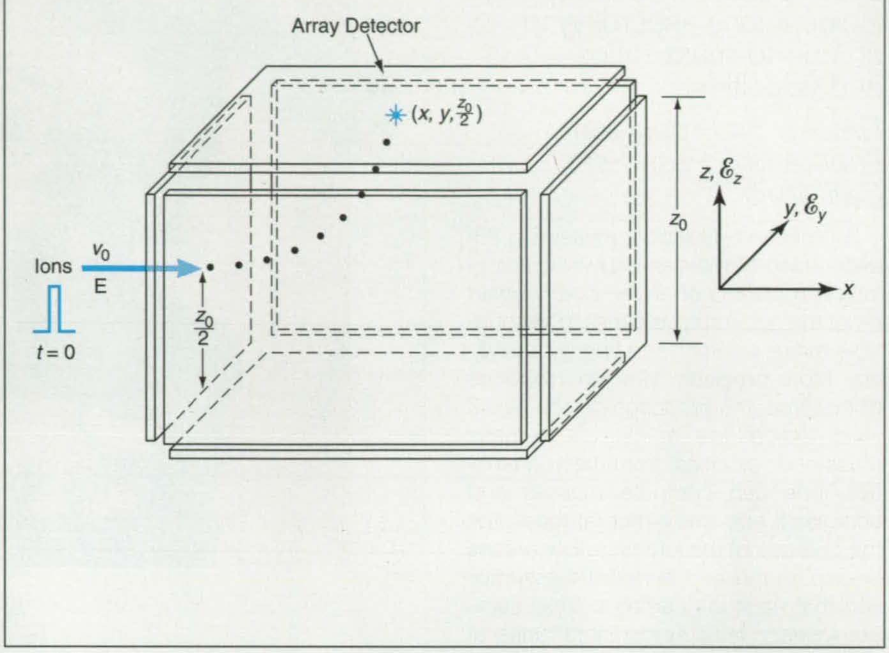
Ions with velocity preselected to lie along the x axis would be introduced into the chamber, as gated pulses, through a small opening on the x axis. The crossed electric fields would then deflect the ions onto their parabolic trajectories: for an ion of charge e and mass m that entered with velocity v_0 along the x axis, its coordinates at time t after entering the chamber would be given by

$x = v_0t$, $y = (e/2m)\xi_y t^2$, and
$z = (e/2m)\xi_z t^2$.

The upper z inner wall of the chamber would be lined with an array detector that would measure the spatial distribution of ions incident on it: This detector would be gated on at selected times to obtain "snapshots" indicative of the e/m and v_0 distributions of the ions admitted in the initial pulse. The numbers of ion hits on the detector, their x and y coordinates, and the gate times would be stored in computer memory.

The gate times and detector x and y readouts would contain partly redundant information on e/m and v_0, which could be extracted in several different ways by use of the three equations above. From the x-coordinate detector readout at time t, one could compute $v_0 = x/t$. From the equation for z and the fact that the z coordinate of the array detector would be $z_0/2$, it is easily shown that the charge-to-mass ratio of the ions detected at time t would be given by $e/m = z_0/\xi_z t^2$. Alternatively, one could obtain e/m from the y-coordinate detector readout at time t via $e/m = 2y/\xi_y t^2$.

This work was done by Ara Chutjian, Steven J. Smith, and Michael Hecht of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information,* ***write in 24*** *on the TSP Request Card.* *NPO-19235*



Ions Would Travel Along Parabolic Trajectories under the influence of crossed electric fields until they struck the array detector in the plane $z = z_0/2$.

Barriers Keep Drops of Water Out of Infrared Gas Sensors

The gases pass through hydrophobic membranes.

Lyndon B. Johnson Space Center, Houston, Texas

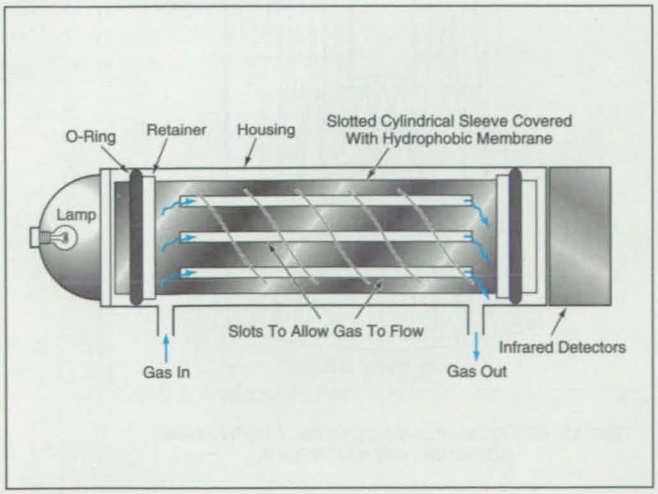
Infrared-sensor cells used for measuring the partial pressures of CO_2 and other breathable gases have been modified to prevent the entry of liquid water into the sensory optical paths of the cells. Liquid water must be kept out of the sensory optical paths because it distorts the infrared readings of the gases that one seeks to measure. Condensation of water vapor can cause occasional drops of water to be entrained in the flows of air or other gases to be sampled.

The figure illustrates an infrared-sensor cell equipped to exclude liquid water from the sensory optical path. The optical path is surrounded by a cylindrical metal sleeve inside a housing. Longitudinal slots have been made to allow the sampled gas to flow through the inner volume that contains the sensory optical path. Infrared light from a lamp at one end of the cylinder travels along the optical path to infrared detectors at the other end of the cylinder.

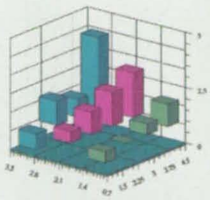
The longitudinal slots in the metal sleeve are covered with a hydrophobic membrane that offers little resistance to the flow of gas. The membrane can be made, for example, of polytetrafluoroethylene. The membrane completely covers the outer surface of the cylinder. The membrane is sealed at the seam and sealed to the ends of the cylinder by use of a thermal adhesive or an epoxy.

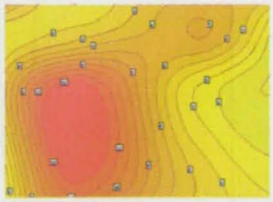
Flowing gas containing entrained drops of water enters the housing. The gas flows into and out of the sensory region via the membrane. The drops of water remain on the outside of the membrane, where they are swept along by the flow from the inlet to the outlet. The drops of water are then swept away by the outlet flow of gas.

This work was done by Sean K. Murray of United Technologies Corp., Hamilton Standard Division, for **Johnson Space Center**. *For further information,* ***write in 12*** *on the TSP Request Card. MSC-22457*



The **Hydrophobic Membrane** prevents drops of water entrained in the flow from entering the optical path from the lamp to the infrared detectors.





Scanning Offner Relay Simplifies Fine Pointing of Large Telescopes

Scanning can be done with a relatively simple, inexpensive mechanism.

NASA's Jet Propulsion Laboratory, Pasadena, California

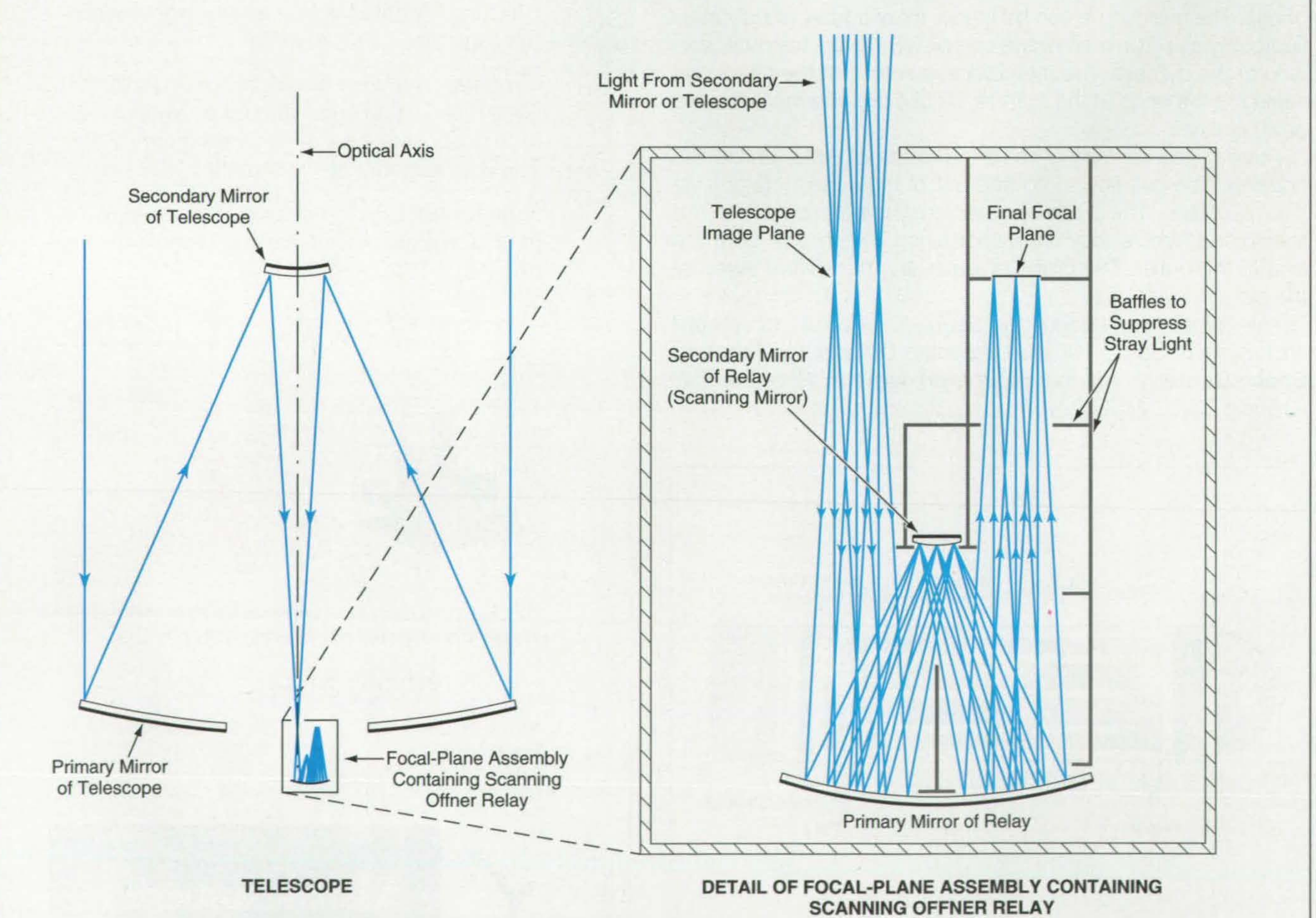
Offner relay optics have been added to a large spaceborne telescope design (see figure) to provide an improved capability for fine pointing. In this design, a relatively small scan mirror optically corrects telescope pointing. Implementing this system in the studied telescope design resulted in synergistic spacecraft cost and mass reductions.

Ordinarily, a large telescope is equipped with primary pointing machinery that aims the entire main telescope body to the required angle. In particular, space telescope designs often require precision structures and Attitude Control Systems (ACS) to meet pointing stability requirements. The scanning relay reduces spacecraft-pointing requirements, saving cost and mass, since a small mirror is moved for fine pointing and pointing stabilization, instead of the entire main telescope. This mass reduction further eases the burden on the spacecraft ACS design.

The relay also provides a real, demagnified image of the entrance pupil. This has advantages. First, the scan mirror is located near the reimaged pupil, minimizing its size and scan-induced vibration effects. Also, a physical stop placed near the demagnified pupil image and baffles in the relay assembly allows cost-effective stray-light control.

The beauty of the Offner relay optical design exists in its simplicity and use of symmetry to cancel aberrations. The design consists of two relatively inexpensive spherical mirror surfaces. The primary surface is used twice. (The design can also be implemented as three surfaces, with each surface used once.) The Offner relay does not affect the size of the telescope image since its overall magnification is 1. The achromatic, all-reflective nature of the relay optics makes the scanning Offner relay potentially suitable for use at wavelengths from submillimeter through ultraviolet. The particular design studied exhibits diffraction-limited performance in a 5-meter, *f*/8.2 telescope at 10-μm wavelength, with a 1-arc-minute scan radius.

This work was done by Hiroshi Kadogawa and Lawrence A. Wade of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information,* ***write in 44*** *on the TSP Request Card.* *NPO-19567*



The **Offner Relay Optics** make it possible to perform telescope fine pointing by tilting a relatively small relay secondary mirror, instead of pointing the entire telescope. The reimaged pupil within the relay also allows for cost-effective stray-light control.

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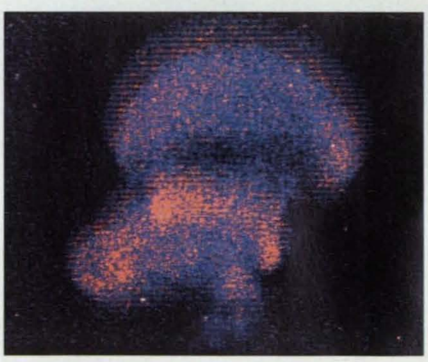
Imaging Invisible Flames Without Additives

Image intensifiers, video cameras, and image-data-processing computers are used to study combustion.

Lewis Research Center, Cleveland, Ohio

Image-intensifying video cameras and associated image-data-processing equipment have been put to use in research on combustion at Lewis Research Center. These imaging systems make it possible to view and analyze methane, hydrogen, and other flames that are dim or invisible to the human eye and difficult to image by use of conventional photographic and video cameras. It is no longer necessary, as it often was prior to the introduction of image-intensifying cameras, to distort observations by adding extraneous chemicals to make the flames emit sufficient light to make them observable.

An image-intensifying camera of the type used in this research includes a lens that images flames onto a photocathode. The cathode is on one side of a multichannel-plate electron multiplier, which serves as the image intensifier. The multiplied electrons impinge on a phosphor anode, forming the intensified image in visible light. An array of charge-coupled devices or charge-injection devices detects the intensified image and is connected to readout circuitry to generate a video signal. A typical camera of this type is capable of producing a visible image from an input image at an illuminance as low as 10^{-6} lux.



A **Premixed Hydrogen Flame** (7 percent hydrogen in air) is shown at 0.2 seconds after spark ignition in a closed vessel. The bright portions signify mostly infrared emission from hot water formed in the flame.

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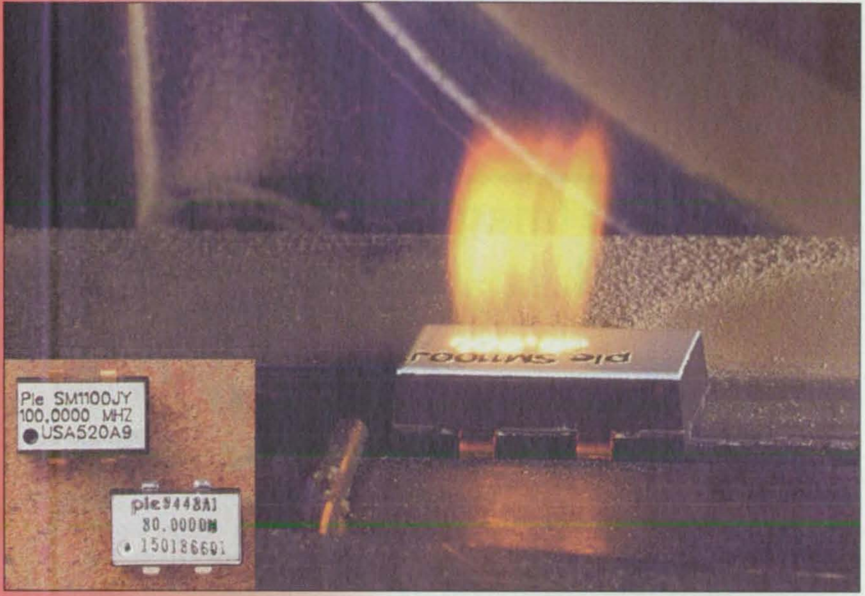

Inset: Comparison of print quality on ink-marked (lower) and laser-marked (upper) chips

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For More Information Write In No. 520

Photocathodes sensitive in the wavelength range from 250 to 650 nm (ultraviolet to visible) and in the wavelength range from 400 to 900 nm (visible to near infrared) have been used in these cameras. Hitherto unseen and unsuspected flame structures and behaviors have been observed. For example, when used with a premixed hydrogen flame, a near-infrared camera detects emission at a wavelength of about 800 nm from the hot water or steam produced in the flame (see figure), while an ultraviolet camera detects emission from OH radicals at wavelengths around 308 nm. Cameras of this type have also been used to image Bunsen-type methane flames, gas-jet diffusion flames, flames on solid surfaces, and burning of droplets under low pressure.

This work was done by Karen J. Weiland of **Lewis Research Center.** *For further information,* ***write in 49*** *on the TSP Request Card. LEW-15989*

Holographic Imaging in Dense Artificial Fog

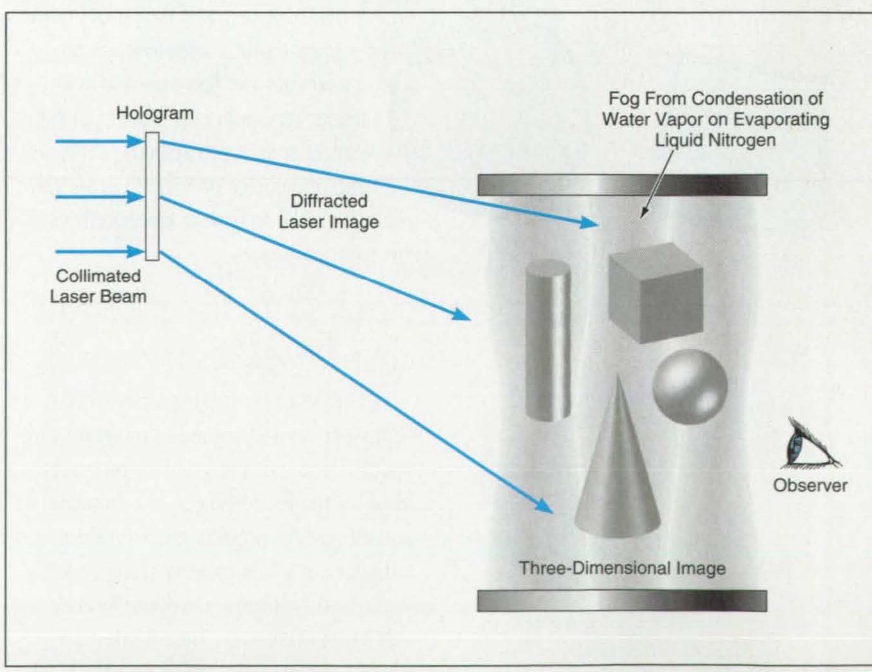
Condensation of water vapor on cold nitrogen forms a projection medium.

NASA's Jet Propulsion Laboratory, Pasadena, California

Experiments have shown that three-dimensional static images can be displayed by projection from holograms into dense artificial fog. The fog in the experiments was generated by condensation of water vapor from air onto liquid nitrogen and onto cold nitrogen gas that evaporates from liquid nitrogen (see figure).

In the experiments, the images were formed within a volume of only 2 × 30 × 30 cm, but with further development, the volume of the display medium can be greatly increased, (i.e., orders of magnitude larger). Hence, this projection technique may enable the display of much larger images for a variety of purposes, possibly including entertainment, indoor and outdoor advertising, medical diagnostics and image representations for surgical procedures, and education. Other volume-projection media that were also tested in the experiments include smoke, water, and diluted milk. Of the media tested, fog from liquid nitrogen appeared to offer the best contrast and showmanship.

This work was done by Hua-Kuang Liu and Neville Marzwell of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information,* ***write in 66*** *on the TSP Request Card. NPO-19350*



Artificial Fog Serves as a Volume-Projection Medium for the display of a three-dimensional image.

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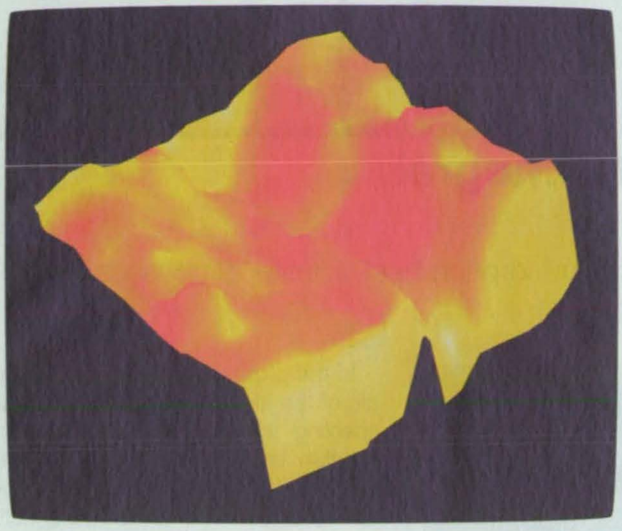

Empirical data is routinely used in SIMULINK block diagrams. Here, a lookup table has been plotted showing a correction surface for manifold pressure as a function of engine speed.

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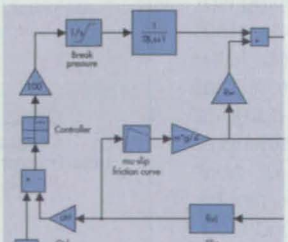

Portion of an ABS block diagram, chosen from one of five example cases in the new SIMULINK Automotive Examples *booklet (call us for your copy).*

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Activated-Carbon Sorbent With Integral Heat-Transfer Device

These concepts should be applicable to other rapid-adsorption heat-transfer processes.

NASA's Jet Propulsion Laboratory, Pasadena, California

Figure 1 shows a prototype adsorption device that could be used, for example, in an adsorption heat pump, to store natural gas to power an automobile, or to separate components of fluid mixtures. The device includes activated carbon held together by a binder and molded into a finned heat-transfer device that provides rapid heating or cooling to enable rapid adsorption or desorption of fluids.

In preparation for fabrication of the prototype device, a solution of a commercial resol binder in isopropanol was mixed with a commercial dry activated carbon that had been wetted with isopropanol, and more isopropanol was added to ensure adequate mixing. The isopropanol was then partially evaporated, and the resulting thick tarlike mixture was pressed into a finned aluminum extrusion, as shown in Figure 1. The outer diameter of the fins is 2.65 in. (6.73 cm), and the diameter of the internal tube to which the fins are attached is 1.25 in. (3.18 cm). There are approximately 9.5 fins per inch (0.4 fin per centimeter) of length. The average thickness of the fins is about 0.010 in. (0.025 cm). The length of the tube is 1.65 in. (4.19 cm).

The material between the fins was then dried and pyrolyzed by heating the device in a nitrogen atmosphere up to a temperature of about 600 °C at a rate of about 100 °C/h, then maintaining 600 °C for 18 h. The remaining isopropanol was thus fully evaporated, and the resol was decomposed, leaving behind a carbon skeleton that holds the activated carbon particles together in contact with the aluminum, thus providing for transfer of heat between the carbon and the aluminum.

The concepts of the design and fabrication of this device are believed to be equally valid for such other highly thermally conductive devices as copper-finned tubes, and for such other high-surface-area sorbents as zeolites or silicates. The adsorbed fluid can be, for example, ammonia (as in a heat pump) or

Figure 1. The **Finned Aluminum Extrusion With Activated Carbon and Binder** enables the effective transfer of heat from or to the sorbent as it adsorbs or desorbs a gas.

natural gas to be used as fuel. The binder could be, for example, methyl cellulose (depending on chemical compatibility requirements) or a resin that can be pyrolyzed into a carbon skeleton. The dissolving agent can be alcohol or any other suitable fluid that dissolves the binder. The amount of pressure imposed to mold the carbon into the fins can be increased or decreased to increase or decrease the effective density of the carbon.

In the prototype, the tube in the middle of the aluminum extrusion is hollow, enabling the use of water or another suitable heat-transfer fluid to heat or cool the extrusion and carbon matrix rapidly. In the case of storage of natural gas in an automobile, it would be beneficial to fill the hollow space in the tube with a phase-change material; for example, *n*-docosane ($C_{22}H_{46}$), which melts at about 44 °C. The absorption of heat in this material would enable rapid filling, that is, adsorption of natural gas.

This work was done by Jack A. Jones and Andre Yavrouian of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* **write in 73** *on the TSP Request Card.*

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

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Refer to NPO-18802, volume and number of this NASA Tech Briefs *issue, and the page number.*

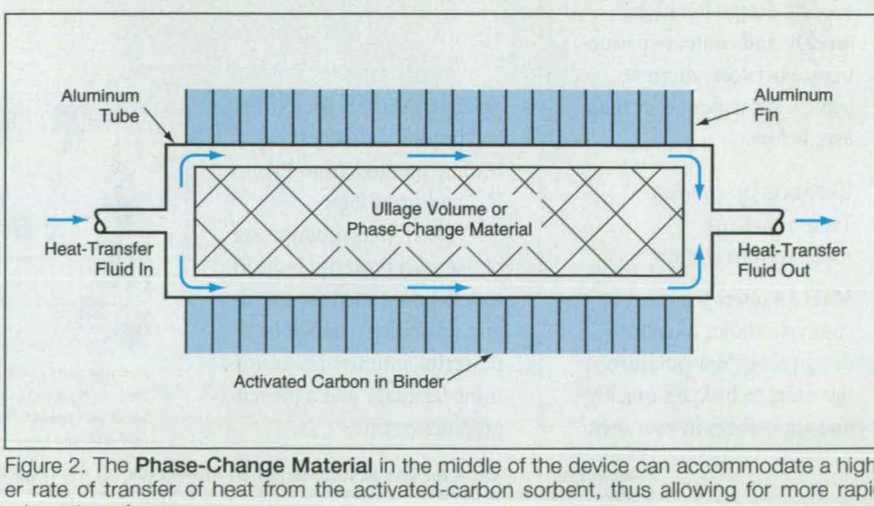

Figure 2. The **Phase-Change Material** in the middle of the device can accommodate a higher rate of transfer of heat from the activated-carbon sorbent, thus allowing for more rapid adsorption of a gas.

Materials for Improved Josephson-Junction Devices

Higher-temperature superconductors open the possibility for higher operating frequencies.

NASA's Jet Propulsion Laboratory, Pasadena, California

A number of superconductive, normally conductive, and insulating materials have been proposed for use in fabricating improved superconductor/insulator/superconductor (SIS) and superconductor/normal conductor/superconductor (SNS) electronic devices capable of operation at frequencies up into the terahertz range. Such devices could be particularly useful as the electrically nonlinear circuit elements of mixers and local oscillators in heterodyne receivers.

Heretofore, SIS devices have typically been made with Nb, which is considered a low-temperature superconductor because the critical temperature (T_C) of its transition to superconductivity is only ≈9 K. The operating frequencies of these devices have generally been limited to ≈730 GHz, at which the photon energy equals that of the superconducting energy gap of Nb. Higher superconducting energy gaps and thus superconducting materials with higher TCs are needed to enable operation at higher frequencies.

The proposed materials include $YBa_2Cu_3O_{7-x}$, plus a number of others that were known previously but have been largely neglected since the much publicized discovery of high-TC superconductivity in $YBa_2Cu_3O_{7-x}$. The general chemical formulas of the proposed superconducting materials are $La_{2-x}M_xCuO_4$ and $La_{1-x}M_xLnCuO_4$, where M denotes Ca, Sr, or Ba and Ln denotes Sm, Eu, or Gd. In the case of $La_{2-x}M_xCuO_4$, the highest T_C (38 K) is obtained by choosing M = Sr and $x \approx 0.15$. Compatible insulating materials for use in SIS devices are of the general formulas (a) Ln_2CuO_4, where Ln denotes Pr, Nd, Sm, Eu, or Gd and (b) $LnLn'CuO_4$, where Ln denotes La, Pr, Nd, Sm, or Eu and Ln' denotes Pr, Nd, Sm, Eu, Gd, Tb, or Dy. Other insulating materials as well as normal conductors could be made of similar copper oxide compounds.

The fabrication of SNS and SIS devices would likely involve deposition of these materials by laser ablation and/or radio-frequency magnetron sputtering. Edge geometry would be preferred for devices containing c-axis-oriented heterojunctions, while sandwich geometry would be preferred for devices containing *a*-axis-oriented heterojunctions.

This work was done by Richard P. Vasquez and Jeffrey B. Barner of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 41*** *on the TSP Request Card.* *NPO-19369*

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Physical Sciences

Computing Fluxes of Molecules on and Near a Spacecraft

A free-molecular-flow mathematical model with perturbations accounts for nearly free flow.

The Molecular Flux (MOLFLUX) computer code is a versatile program that can be used to compute the following conditions on and near a spacecraft: (1) fluxes of molecules to, and deposition of molecules on, surfaces; (2) densities and column densities of molecules in surrounding space, and (3) return fluxes of molecules to surfaces caused by both collisions of the molecules with the ambient atmosphere and by self-scattering. MOLFLUX includes the capability to predict the buildup in the density of ambient gas in front of surfaces exposed to ram conditions by specifying the ambient flux rates for all species impinging on the surfaces, modifying these rates for surface chemical reactions, and applying these rates to the surfaces as rates of emission. The user has the option to modify spacecraft configurations and sources of contamination and to choose which critical surfaces to examine.

MOLFLUX implements a free-molecular-flow mathematical model with perturbations to account for nearly free flow, and therefore appears to be adequate to deal with most applications related to outer space. "Nearly free flow," as used here, includes the mass flow in thruster plumes, with the exception of small plume volumes of viscous and transition flows close to the nozzles from which the plumes issue.

The transport function for all species can include a small perturbation (due to molecular collisions) from the free-molecular-flow case, and can be used to calculate backscattering return flux and attenuation of flux. The perturbation of the basic model is based on a numerical integration of the Bhatnagar, Gross, Krook (BGK)-model approximation of the Boltzmann kinetic equation for a mixture of gases. As a result, MOLFLUX is a program of reasonable size and accuracy with maximum flexibility. Because a computational model is only as good as the input data used, the capability to introduce input data as well as to evaluate output data is left very general and adaptable to the needs of the user.

Mathematical modeling of contamination generally requires addressing the following: (1) the geometry of the spacecraft or other structure, (2) the processes of emission from all sources of contamination, (3) the transport of emitted contaminants, and (4) the induced effects of the contaminants upon critical surfaces and upon scientific observation objectives. The first three of these concerns are handled analytically in MOLFLUX. Once contamination levels have been established, other computer programs and analytical techniques can be used to determine the induced effects.

In general, the input of a new spacecraft configuration involves development of the necessary geometric relationships and mass-transport factors for that configuration. The most efficient approach is to use a thermal-radiation program like the Thermal Radiation Analyzer System (TRASYS) program to generate new mass-transport-factor input data for MOLFLUX. Configurations can be geometrically synthesized with TRASYS by use of basic geometrical surfaces and shapes; for example, cones, cylinders, and spheres. The level of detail is selected to assure accurate surface shadowing and to establish adequate surface resolution for compatibility with the various spacecraft-surface materials and available thermal-profile data. It is not necessary to run TRASYS to use MOLFLUX if the mass-transport-factor data have been precalculated and are available as permanent input data files. These input files must be regenerated only when new configurations are to be evaluated or existing configurations are to be modified.

MOLFLUX is written in FORTRAN and C language. Three machine versions are available from COSMIC. Sample input and output data files and sample batch files for compiling and linking are included on each distribution medium. The VAX version is for DEC VAX-series computers running VMS, and was described in "Computing Fluxes of Molecules on and Near a Spacecraft" (MSC-22260), *NASA Tech Briefs*, Vol. 19, No. 4 (April 1995), page 60. The executable code for the VAX version was compiled using VMS FORTRAN 5.5.1. The HP version (MSC-22565) is for HP9000 series 700/800 computers running HP-UX 8.07. The executable code for the HP version was compiled using the FORTRAN/9000 compiler. The Cray version (MSC-22566) is for Cray computers running UNICOS 8.0.3.4. The executable code for the Cray version was compiled using the CF77 6.0.4.1 compiler. The standard distribution medium for the VAX VMS version of MOLFLUX is a TK50 tape cartridge in DEC VAX BACKUP format. The standard distribution medium for the HP and Cray versions is a 0.25-in. (6.35-mm) streaming-magnetic-tape cartridge (Sun QIC-24) in UNIX tar format. Alternate distribution media and formats are available upon request. MOLFLUX has been under development since 1989 and the current versions were released to COSMIC in 1994 and 1995.

This program was written by H. K. Ehlers of **Johnson Space Center** *and E. R. Rios, C. L. Hakes, and B. D. Bui of Lockheed Engineering & Sciences Co.*

For further information on MSC-22565, ***write in 30*** *on the TSP Request Card.*

For further information on MSC-22566, ***write in 31*** *on the TSP Request Card. MSC-22565/66*

Right-Angle Mechanized Electrical Connector

The mechanism can be actuated by a technician with a gloved hand or by a robot.

Lewis Research Center, Cleveland, Ohio

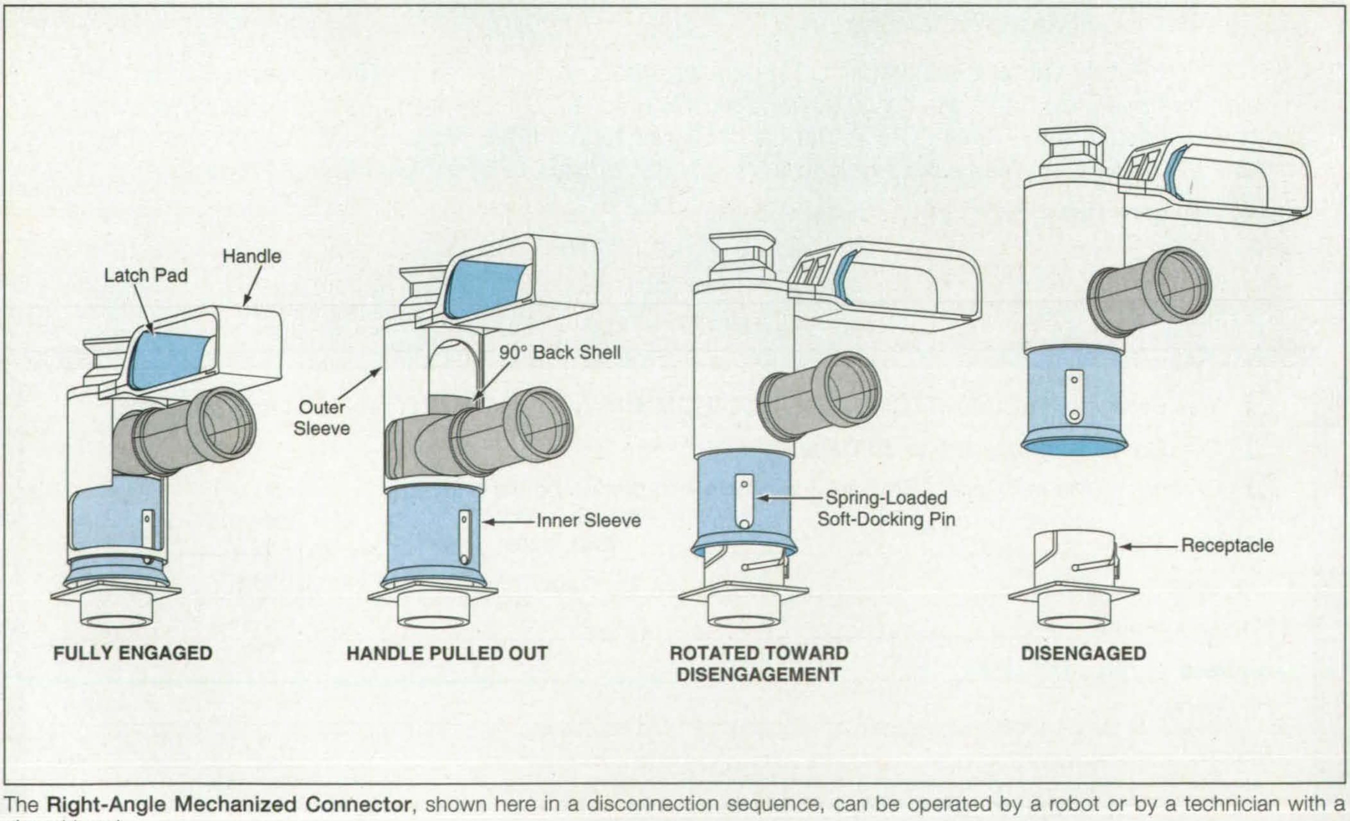
A right-angle electrical connector is embedded in a mechanism that accommodates some initial misalignment and aligns itself. Connection and disconnection can be effected with relatively small forces and torques and simple movements. The mechanism can be actuated by one gloved hand or by a robotic manipulator. Connectors like this one could be useful in underwater, nuclear, hot, cold, or toxic environments in which connections would have to be made or broken by heavily clothed technicians or by robots.

The mechanized connector mates with a stationary receptacle. The figure illustrates the mechanized connector in a disconnection sequence. Initially, the mechanized connector is locked in engagement with the receptacle in a relatively compact configuration. Pressing the latch pad in the handle disengages an internal latch, allowing the handle to be pulled outward to a second latching position in which the electrical connection is still maintained. Pressing the latch pad in this position allows the handle to be rotated to the left, driving the inner sleeve along a compound helical groove in the receptacle, toward disengagement. At the end of rotation, the handle becomes latched in a third position; in this position, the handle can be simply pulled outward (upward in the figure) to complete disengagement.

The electrical connections are made by pin and socket inserts in the mechanized connector and the receptacle, respectively. The connector-pin insert is mounted in the right-angle back shell. A slot on the socket insert engages a feature on the connector-pin insert to maintain alignment of these two inserts.

The connection sequence is essentially the opposite of the disconnection sequence, except for the initial alignment motions. By means of tapered ramps, the mechanism tolerates and corrects an initial lateral misalignment of 0.25 in. (≈6.4 mm) and an initial angular misalignment of 5°. At the completion of engagement of the tapered ramps, the soft-docking pins become engaged. At that point, the latch pad is depressed, and the subsequent motions are in the reverse of the previously described disconnection sequence.

This work was done by Clint A. Collins and David T. Blackler of Rockwell International Corp. for **Lewis Research Center.** *For further information,* ***write in 74*** *on the TSP Request Card.*
LEW-15465



The **Right-Angle Mechanized Connector**, shown here in a disconnection sequence, can be operated by a robot or by a technician with a gloved hand.

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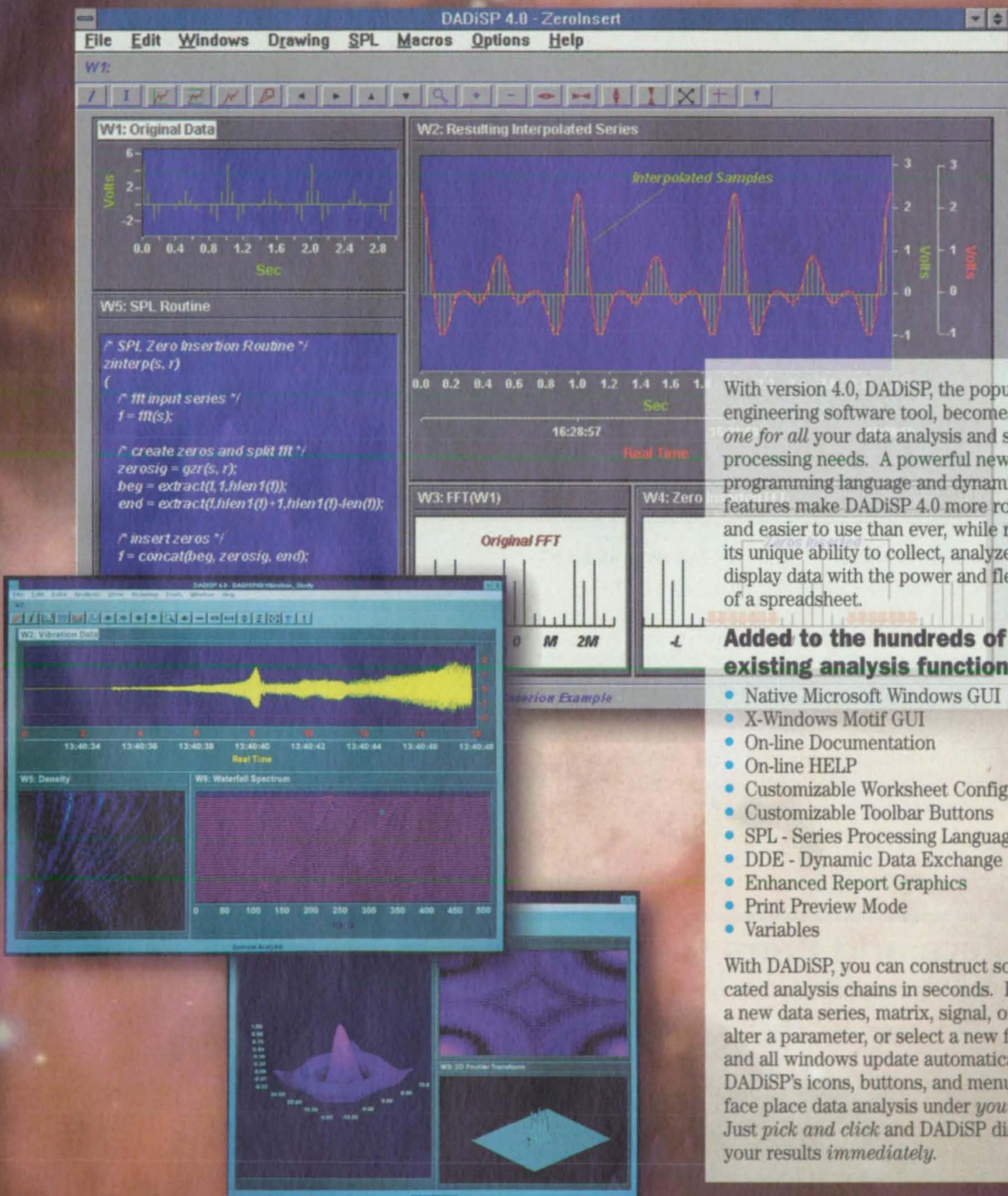

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For More Information Write In No. 522

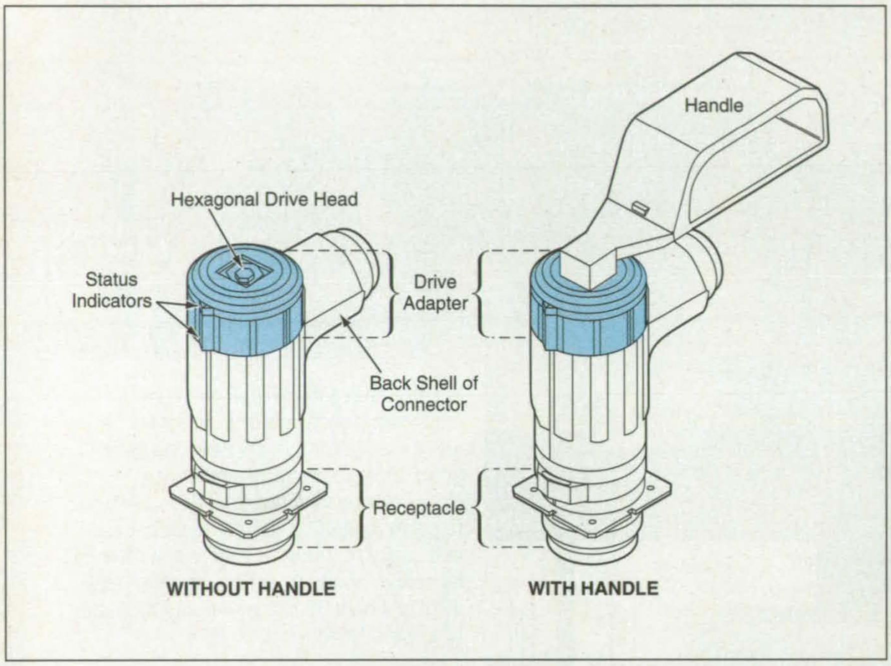
Mechanized Electrical Connector With Drive Adapter

The connector can be actuated manually or robotically.

Lewis Research Center, Cleveland, Ohio

The figure illustrates a mechanized right-angle electrical connector configured with and without a removable handle. The connector resembles (but does not operate in the same way as) the one described in the preceding article, "Right-Angle Mechanized Electrical Connector" (LEW-15465). This connector incorporates a drive adapter for attachment or detachment of the handle.

Normally, the handle would be attached to the drive adapter via a square hole in the top, and the connector would be actuated (that is, engaged with, or disengaged from, a receptacle) by use of the handle. The handle includes a hexagonal wrench socket that mates with a recessed hexagonal drive nut. Optionally, an auxiliary interface mechanism could be installed in the square hole to enable actuation by a robot.



The **Handle Can Be Attached** to engage the mechanized connector with, or disengage it from, the receptacle. If the handle is removed while the connector is fully engaged with the receptacle, then the connector and receptacle remain locked in engagement.

When the connector is engaged with the socket and the handle is not present, a lever in the connector mechanism locks the mechanism against rotation. The handle includes a latching submechanism that interacts with the antirotation lever in such a way that when the handle is inserted and latched, the antirotation lever becomes disengaged and the connector mechanism can be rotated by use of the handle.

The mechanism includes status indicators. By use of the handle, the connector mechanism can be rotated from an engaged-and-locked status to an engaged-but-unlocked status. Then the handle can be pulled up into a soft-docking status. Further pulling frees the connector from the receptacle. Engagement involves the opposite sequence of actions.

This work was done by Clinton A. Collins of Rockwell International Corp. for **Lewis Research Center.** *For further information,* ***write in 70*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Lewis Research Center; (216) 433-2320. Refer to LEW-15787.

Propellers and Fans Based on the Möbius Strip

Working efficiency could be increased.

Langley Research Center, Hampton, Virginia

The Möbius strip has been proposed as the basis for optimally shaped airplane and boat propellers, fans, helicopter rotors, mixing screws, coffee grinders, and concrete mixers. The basic idea of optimal shaping of such a device is to increase working efficiency by increasing the area for capture of the still medium (e.g., air, water, concrete, coffee beans) without increasing the power needed for rotation. Conventional (non-Möbius) devices of this type consist mostly of two-sided blades, which are not optimal.

A Möbius strip is made by giving a half twist to a strip of elastic material, then joining the ends to obtain a smooth surface (see Figure 1). A Möbius strip is one-sided in the sense that in principle, one can trace out a continuous line along the strip from any point on its surface to any other point on the surface, without leaving or penetrating the surface. The one-sided, smooth shape of a Möbius strip provides a large capture area while generating the least possible turbulence in three-dimensional flow, and thus maximizes working efficiency.

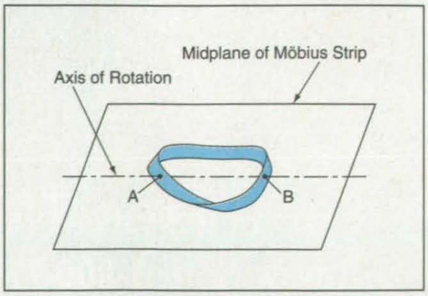


Figure 1. A **Möbius Strip** supported at points A and B on a suitably chosen axis of rotation can act as an efficient propeller or fan blade.

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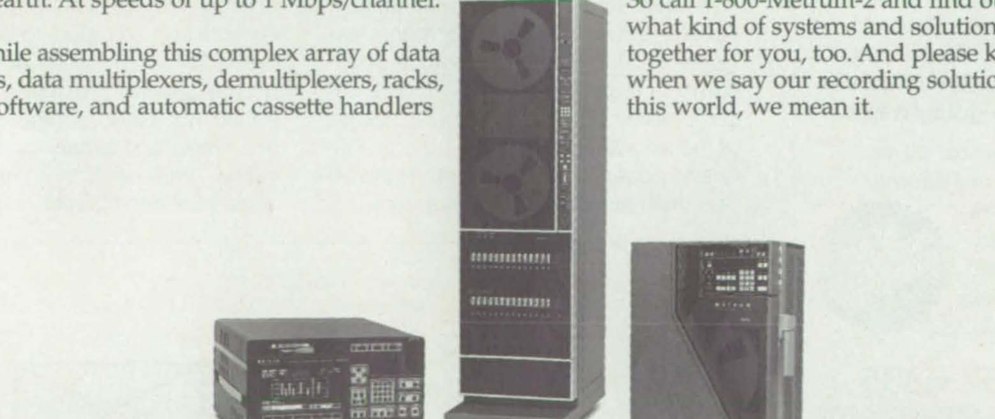

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Propeller shapes based on the Möbius strip, and their orientations with respect to axes of rotation, can be varied and extended to suit the requirements of specific applications. For example, a propeller or fan blade could be made as a single basic Möbius strip shape as in Figure 1, held at points A and B spaced apart along the axis or pinned together at a point on the axis. Figure 2 shows another example, in which the ends of a single strip were twisted and joined at an axis of rotation to form two fan blades, each of which is the equivalent of a single Möbius strip that has been folded and joined to the axis at the fold. Other potential variations include multiple strips fastened in the same plane or different planes, rotating about the same axis or different axes; and strips made wholly or partly of circular, elliptical, or otherwise curved sections.

This work was done by John Milton Seiner of **Langley Research Center** *and Mikhail Markovich Gilinsky of the National Research Council. No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Langley Research Center; (804) 864-3521. Refer to LAR-15146.

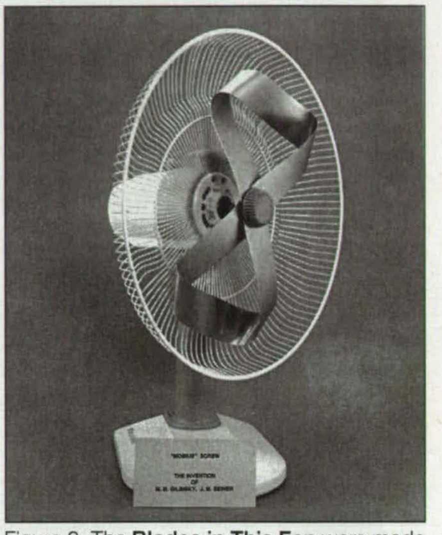


Figure 2. The **Blades in This Fan** were made by twisting a strip of elastic material into the equivalent of two Möbius strips with folds.

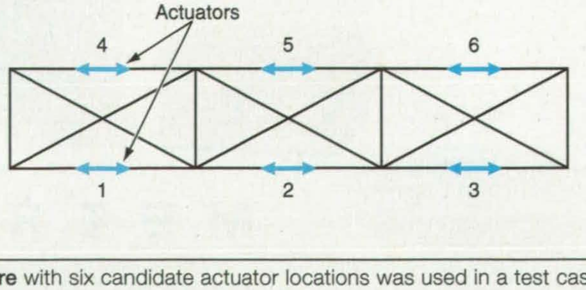
Balanced Placement of Vibration Sensors and Actuators

A reduced set of sensors and actuators can be positioned for maximum effectiveness.

NASA's Jet Propulsion Laboratory, Pasadena, California

A mathematical approach that involves Hankel singular values leads to a method for estimation of an optimal placement of relatively few vibration sensors and actuators in a multivariable flexible structure. This approach extends and complements previous developments regarding the approximate decomposition, to Hankel singular values, of the singular values of the controllability and observability grammian matrices of a multivariable flexible structure.

Two problems can arise in conjunction with the placement of vibration sensors and actuators on a flexible structure. The first problem is to determine the minimal numbers and the placements of sensors and actuators to satisfy requirements for controllability and observability. The second problem can be stated as follows: Given a large candidate set of sensors and actuators, find a minimal subset that exhibits controllability and observability properties close to those of



A **Truss Structure** with six candidate actuator locations was used in a test case in which the problem was to select the two best locations. Application of the method described in the text showed that two actuators would be most effective at locations 1 and 4.

the original set (see figure). The effort to solve the second problem led to the development of the present method.

Because of the complexity of the underlying mathematical constructs, only a brief summary of the method is possible in this article. For an explanation of these constructs (including definitions of "Hankel singular values" and "grammian matrices" and the special meaning of "balanced" in this special context), the reader is referred to the information described at the end of this article. In addition, these constructs were described in "Designing an Approximately Balanced LQG Compensator" (NPO-19000), *NASA Tech Briefs*, Vol. 18, No. 9 (September 1994), page 74.

Hankel singular values are used in this method to construct metrics for the placement of sensors and actuators because these values quantify the joint observability and controllability properties of the system (comprising the structure, sensors, and actuators). It was previously known that the addition of sensors and actuators increases controllability and observability in all principal directions and thus increases all Hankel singular values. However, prior to the development of the present method, the complexity of the problem had prevented the derivation of an explicit relationship between the sensor and actuator locations and the Hankel singular values.

The main finding reached by following the present approach is that if vibrations of the structure are lightly damped, then the Hankel singular values of individual pairs of actuators and sensors can be summed to approximate the Hankel singular values of the system; that is, one can obtain an explicit approximate relationship between the sensor and actuator locations and the Hankel singular values of the system. The Hankel singular values can be used to construct various metrics that quantify degrees of controllability and observability in balanced coordinates. Depending on which metric is chosen, a corresponding placement strategy can be derived. In the special case in which the trace of the Hankel singular-value matrix is used as the metric, the actuator-placement problem becomes simple.

This work was done by Wodek Gawronski of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 76*** *on the TSP Request Card. NPO-19864*

Internal Temperature Control for Vibration Testers

Lyndon B. Johnson Space Center, Houston, TX

Vibration test fixtures with internal thermal-transfer capabilities have been developed. These fixtures are made of aluminum for rapid thermal transfer. Liquid nitrogen is used for cooling and electric heating units with glycol/water heat-transfer solutions for heating. Internal channels are formed in the fixtures to duct the cold and hot fluids to the specimens under test. The fixtures are smaller than those used heretofore in environmental chambers. The small size gives rapid response to changing temperatures, with better thermal control. Setup is quicker and the internal ducting facilitates access to the parts being tested. In addition, internal flows are smaller, so that less energy is consumed in maintaining desired temperature settings.

This work was done by Richard J. Dean of **Johnson Space Center**. *For further information,* ***write in 2*** *on the TSP Request Card. MSC-22415*

F-18 HARV With Nose Strakes for Forebody Vortex Control

This modified system provides the means to evaluate design tradeoffs.

Dryden Flight Research Center, Edwards, California

The NASA F-18 High Alpha Research Vehicle (HARV) is a test-bed for demonstration of technology in the high-angle-of-attack flight regime [α (alpha) is commonly used in aeronautical engineering as a symbol for angle of attack]. The F-18 HARV program has been executed in three phases. The first phase involved the documentation of the baseline F-18 aerodynamic configuration with stock F-18 control laws. The second phase involved significant modifications of the aircraft systems with the addition of thrust vectoring and flight-control computers; this enabled rapid testing of different flight-control laws, with retention of the stock F-18 control laws for safety of flight and takeoff and landing. The third and final phase, which has just begun, involves the testing of forebody vortex control with control laws to evaluate engineering tradeoffs between thrust vectoring and forebody vortex control.

The NASA Langley Research Center modified the nose of the F-18 HARV with conformal, mechanically actuated nose strakes for enhanced rolling (ANSER). The NASA Dryden Flight Research Center performed the integration of aircraft systems and has started flight testing. Envelope expansion has been completed, as has the first flight of a 70-flight ANSER research program in which strakes, strakes with thrust vectoring, and thrust vectoring alone will be evaluated. Using the data from these flights, aircraft designers can determine the tradeoffs of the advantages and disadvantages of each control scheme.

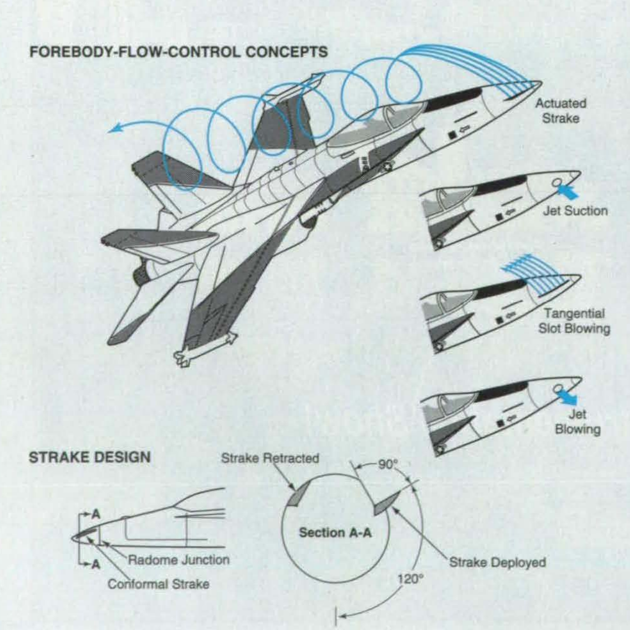


Figure 1. **Forebody Vortex Control** can be effected by use of actuated strakes and/or other flow-control devices.

Forebody vortex control (see Figure 1) is effected by moving the forebody vortices in a controlled manner. At high α, strong vortices form over the nose of the aircraft. These vortices, left to their own, can cause significant nose "slicing" and wing rock; neither motion is commanded by the pilot, and these motions result in degraded handling of the aircraft. The addition of actuated strakes enables control of these vortices. Opening one side or the other (see Figure 2) pushes one vortex away from the nose, giving rise to a side force on the nose (in effect, the aircraft behaves as though there were a rudder on the nose), causing the characteristic yawing motion of high-a rolling about the velocity vector. This returns control of the motion of the aircraft to the pilot's commands.

Devices based on other concepts and intended to do the same thing have been proposed and flown. The most notable example of this was the forebody-blowing experiment done on the X-29A aircraft. In this case, air was used to blow the vortex into a new location pneumatically, with exactly the same effect.

The first flight of the forebody with closed strakes took place on March 15, 1995; the first flight to open the strakes occurred

Figure 2. **One Strake Has Been Turned Outward** for forebody vortex control.

on July 11, 1995. Flights to complete the ANSER research are planned in December of 1995.

This work was done by Albion H. Bowers of **Dryden Flight Research Center.** *For further information,* ***write in 10*** *on the TSP Request Card. DRC-95-30*

Dual Spark Plugs for Stratified-Charge Rotary Engine

Fuel efficiency is increased.

Lewis Research Center, Cleveland, Ohio

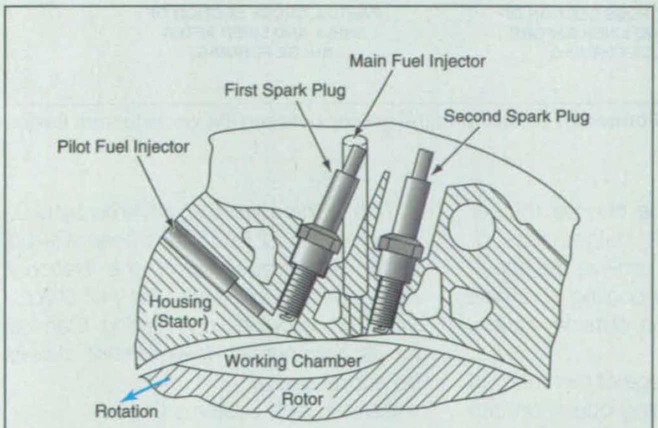
The fuel efficiency of a stratified-charge, rotary, internal-combustion engine can be increased by an improved design that features dual spark plugs. The figure shows a cross section of the affected part of the engine. Both the baseline and improved designs involve a pilot fuel injector on the downstream side, a first spark plug, and a main fuel injector. In both designs, the first spark plug ignites the charge of fuel injected into the working chamber by the pilot fuel injector; then this burning pilot fuel ignites the fuel injected by the main fuel injector.

The baseline design is partly deficient in the following sense: The fuel/air mixture in the middle of the working chamber is too rich to be flammable and therefore retards the upstream propagation of the flame from the pilot end. As a result, the fuel burns slowly. Under some conditions, this can reduce the efficiency of the engine.

There is a flammable fuel/air mixture upstream of the main fuel injector. In the improved design, a second spark plug is positioned so that its tip is exposed to this mixture. By igniting the flammable mixture on the upstream side, the second spark plug causes the fuel to burn faster, and the efficiency of the engine is increased accordingly.

This work was done by John Abraham of John Deere Technologies International, Inc., and Frediano V. Bracco of Princeton University for **Lewis Research Center**. *For further information,* ***write in 11*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Lewis Research Center; (216) 433-2320. Refer to LEW-15923.



The **Second Spark Plug** ignites fuel on the upstream side of the main fuel injector; this enables faster burning and more nearly complete utilization of fuel.

Bulge-Formed Cooling Channels in a Wall

Advantages include easier fabrication and greater flexibility of design.

Marshall Space Flight Center, Alabama

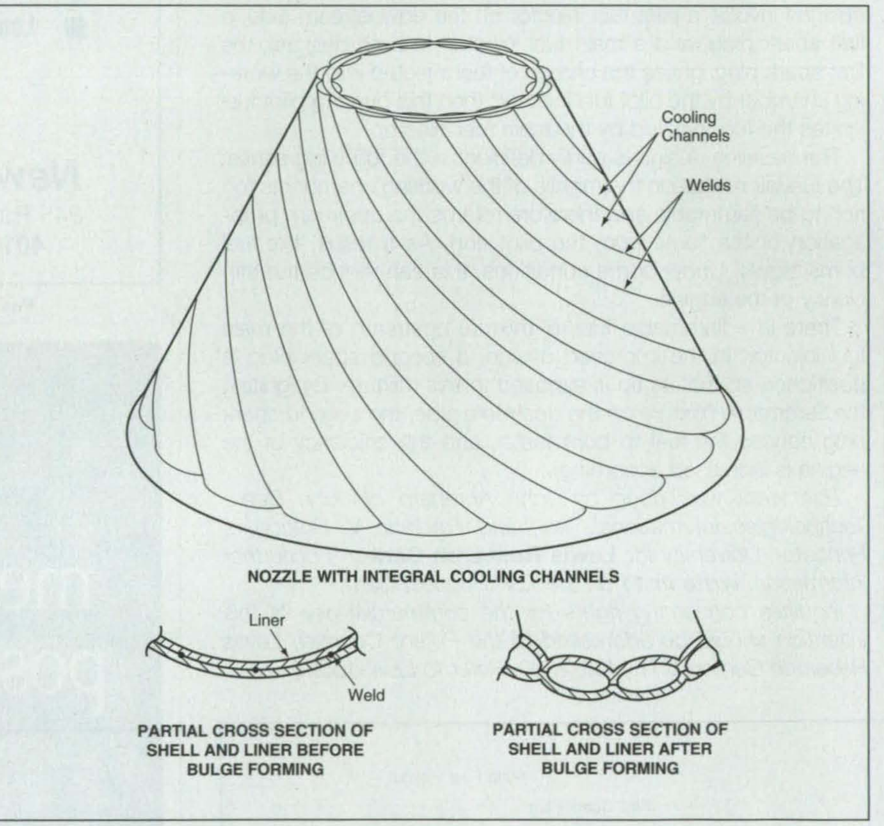
Vessels bounded by walls that are shaped as surfaces of revolution and that contain integral cooling channels can be fabricated by an improved method that involves a combination of welding and bulge forming. The method was devised to make rocket nozzles; it may also be useful in the fabrication of heat exchangers, stationary combustion chambers, and chemical-reactor vessels.

Heretofore, the standard practice in fabricating the cooling channels of a rocket nozzle was to braze specially formed cooling tubes to a liner that defined the basic shape of the nozzle (typically, conical, ellipsoidal, or paraboloidal). The present method eliminates the difficulty and expense of forming and brazing individual tubes. As shown in the figure, the main body of a rocket nozzle can be made according to this method from only two pieces of relatively inexpensive sheet metal: a liner plus a shell that fits onto the liner.

The shell and liner are welded together along multiple lines that define the boundaries between adjacent cooling channels. Welding can be done from the inside or outside, by any of a variety of standard welding techniques; the electron-beam technique has been found to be particularly useful. To aid in the subsequent bulge-forming step, additional welds could be made to seal the forward or aft end of the channels temporarily. Alternatively or in addition, one or more manifold(s), which could be the same as the coolant-flow manifold(s) to be used in subsequent operation, could be added. After welding, a gas or liquid at suitably high pressure is injected into all of the channels simultaneously to bulge them out to the desired cross section. Optionally, the shell and liner can be heated to increase the deformability of the shell and liner materials and thereby reduce the pressure needed for bulge forming.

The welding process can be automated easily to produce consistent welds along specified lines to make the coolant flow in a specified pattern (e.g., recirculating flow or flow that vents to the atmosphere at the aft end). The pattern of welds (e.g., a spiral pattern like that of the figure) can also be chosen so that after the bulge-forming operation, the channels have specified cross sections (e.g., constant cross-sectional area along the length of each channel). Additional design flexibility is afforded by the thickness of the liner and shell: each can be chosen thicker or thinner so that it bulges less or more, respectively, to achieve the specified shape. Thus, the cooling channels can be formed on the outside, inside, or both.

Yet another advantage of this method is that the bulge-forming operation can provide a proof test of the integrity of the channels. This is because the temperatures and pressures used in bulge forming can be chosen to exceed those expected in service.



Cooling Channels Are Formed by pressurizing the spaces between the welds to form bulges in the shell and/or liner.

This work was done by Michael D. McAninch, Richard L. Holbrook, and Dale F. Lacount of Babcock & Wilcox Co. and Chester M. Kawashige, John M. Crapuchettes, and James Scala of Aerojet Tech Systems for **Marshall Space Flight Center**. *For further information,* ***write in 21*** *on the TSP Request Card.*

Title to this invention, covered by U.S. Patent No. 5,221,045, has been waived under the provisions of the National Aeronautics and Space Act {42 U.S.C. 2457 (f)}. Inquiries concerning licenses for its commercial development should be addressed to

Aerojet Tech Systems Co.
P. O. Box 13222
Sacramento, CA 95813

Refer to MFS-28866, volume and number of this NASA Tech Briefs *issue, and the page number.*

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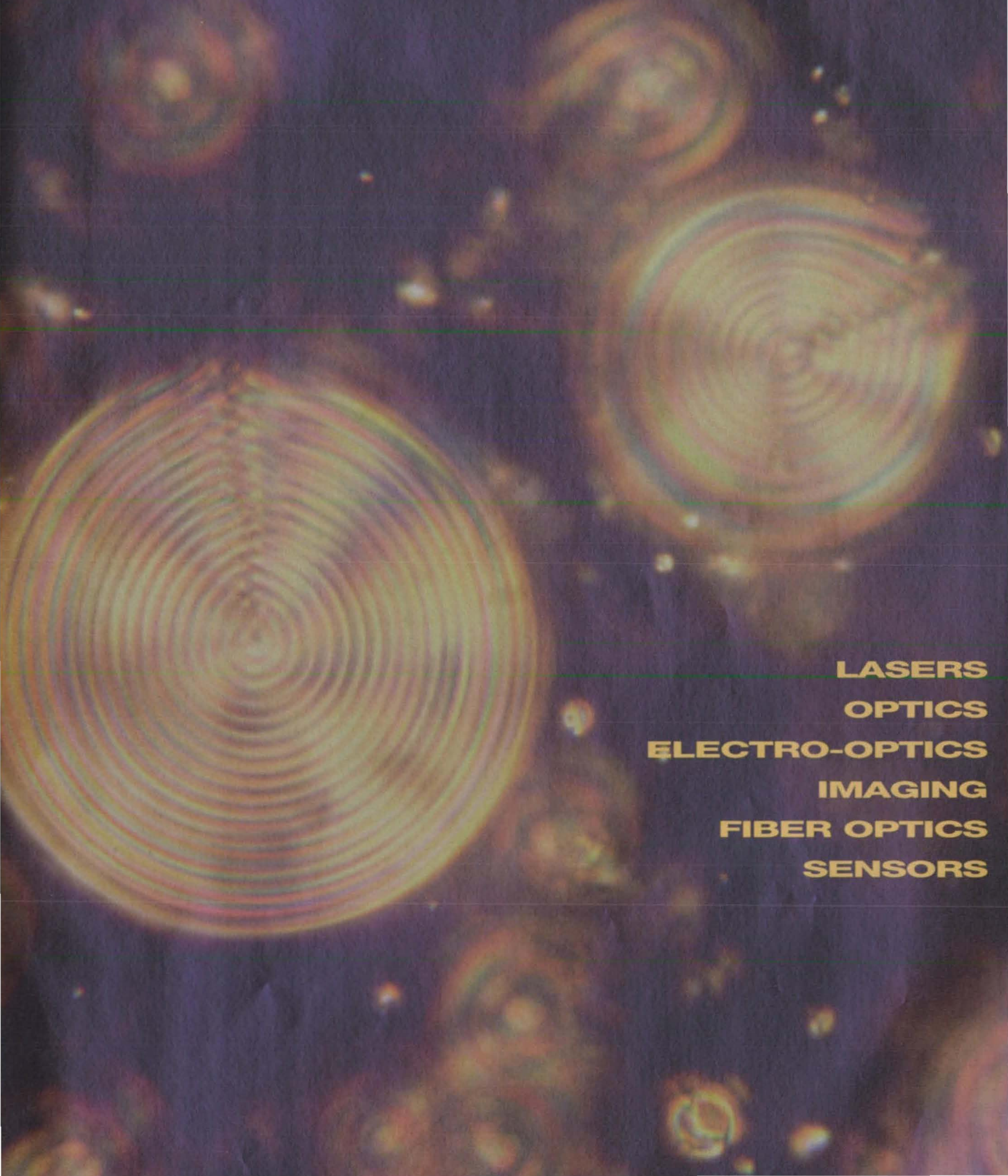

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FEATURE

DEPARTMENTS

On the cover:
The photomicrograph shows liquid-crystal microdroplets suspended in glycerol after undergoing a phase change triggered by light. Researchers at Georgia Institute of Technology believe such materials could be the basis of a rewritable three-dimensional data storage system, and are working on an optical switch in which phase changes would be detected by passing polarized light through it. Multiple phase-transition switches could therefore be used together to store digital information. *Photo courtesy Georgia Institute of Technology.*

NEWS BRIEFS

Notes from Industry and the Laboratories

The Midcourse Space Experiment (MSX), an advanced imaging satellite that will gather data vital to the future design of space-based and ground-based missile defense systems, launched April 21 on a Delta II rocket from Vandenberg Air Force Base in California.

Built and operated for the Ballistic Missile Defense Organization (BMDO) by the Johns Hopkins University Applied Physics Laboratory (JHU/APL), MSX will be the first system demonstration in space of methods for characterizing missile signatures during midcourse flight—that is, between booster burnout and missile reentry—and for collecting data on the backgrounds against which targets are seen.

During the four years it is expected to be in Earth orbit, MSX will detect, track, and discriminate realistic targets against terrestrial, Earth-limb, and celestial backgrounds. Its sensor suite will also do dual-use image collection, monitoring atmospheric gases such as ozone, CFCs, carbon dioxide, and methane. It will measure on-orbit contamination of optical instruments, assess the population of small space debris, and do observations in very-long-infrared and ultraviolet astronomy. The mission altitude for the $325-million observatory-class satellite will be 560 miles (900 kilometers), in a high-inclination, circular, near-Sun-synchronous orbit.

MSX can observe at many wavelengths from the far-IR to the far-UV, and thus represents an advance in hyperspectral space imaging technology. Its instruments have a total of 11 optical sensors, precisely aligned so that targets can be viewed simultaneously with multiple sensors.

Its three primary instruments stretch across the spectrum. The Spatial Infrared Imaging Telescope (Spirit III), built by the Space Dynamics Laboratory of Utah State University, consists of a scanning radiometer, interferometer/spectrometer, and 14-in. telescope.

The Ultraviolet Visible Imagers and Spectrographic Imagers (UVISI), built by JHU/APL, includes five spectrographic imagers and four ultraviolet and visible imagers. The Space-Based Vehicle (SBV), built by the Massachusetts Institute of Technology Lincoln Laboratory, is a visible-band telescope with a six-inch aperture and image processing electronics.

In addition, MSX will carry on-board signal and data processors, and a contamination experiment, another JHU/APL-built instrument. The experiment's sensors include a mass spectrometer, quartz crystal microbalances, a total pressure sensor, and xenon and krypton flashlamps.

The 1996 Edwin H. Land Medal has gone to Donald R. Scifres, president and CEO of SDL Inc., for his pioneering scientific and entrepreneurial contributions to the field of high-power semiconductor lasers. The Land Medal is a joint award of the Optical Society of America and the Society for Imaging Science and Technology, and is supported by the Polaroid Foundation. Named for the founder of Polaroid, it recognizes scientific and technological creativity that leads to achievement in industry, public policy, or education.

Scifres, who has more than 300 publications and more than 100 issued patents to his credit, joined Xerox Palo Alto Research Center in 1972. Eleven years later he and Xerox, in a joint venture with Spectra Physics, founded Spectra Diode Laboratories (now SDL Inc.) as the sole supplier of high-power semiconductor lasers. In 1992, SDL became independent after Scifres arranged a recapitalization to redeem ownership from Spectra Physics and Xerox.

Marshall Takes the Lead in Tomorrow's Optics

With its record of achievement in fabrication and metrology, MSFC was a clear choice to be recently designated NASA's Center of Excellence for Space Optical Systems.

NASA's Marshall Space Flight Center in Alabama has long been active in advanced space optics, so it was only natural that, early this year, NASA recognized its capabilities by designating it the Center of Excellence for Space Optical Systems. Its charter mandates that it will "identify the technologies required to affordably produce the large space telescope optical systems required for future missions, confirming that the U.S. will possess these capabilities when needed by NASA."

NASA anticipates that by the early years of the new millennium it must initiate development for missions requiring large, lightweight telescopes in space capable of observing at all wavelengths from gamma-ray through infrared (IR). Two classes in particular will be of prime importance: a space observatory with an aperture of approximately 4 meters or larger, capable of operating in the visible (500 nm) through the IR (20 microns) portion of the spectrum; and an observatory with throughput significantly greater than the Advanced X-Ray Astrophysics Facility (AXAF), currently under development with Marshall as manager, and with comparable spatial resolving power, operating across the x-ray spectrum from about 2 keV to 100 keV.

Though it takes cognizance of the Center's primary strength in optical surface fabrication and associated metrology, the charter specifies that the full range of technologies needed to implement the contemplated missions be considered, and that other NASA centers, government agencies, industry, and academia be drawn into the process. It calls for the Center to develop a NASA optics technology working group to assure maximum use of existing capabilities, skills, and facilities throughout government, industry, and academia; to rely as much as possible on the competitive process to control taxpayer cost; and to transfer technology to both the federal and the private sectors.

Marshall's competence in optics goes back to its early days. From its established foundation in fabrication and metrology, it has branched out into a number of key advanced areas. One of these is diamond turning: MSFC has two sophisticated diamond-turning machines. The Center formed a joint laboratory with the Army Missile Command to marry disciplines for producing hybrid geometric-diffractive-integrated optics. In both stray light testing and coherent lidar, MSFC has unique facilities. For x-ray telescope and instrument calibration, Marshall has both the world's largest and third largest test facilities. Finally, in partnership with the University of Alabama at Huntsville, MSFC has demonstrated what it calls the most advanced techniques for the replication of x-ray mirrors in the country.

At Marshall Space Flight Center, researchers are replicating the x-ray optic seen here, with a nickel shell and a gold-plated internal reflecting surface.

Photo courtesy ***Marshall Space Flight Center****, Optics and Radio Frequency Div.*

MSFC's management of the Advanced X-Ray Astrophysics Facility (AXAF) project has positioned it for its leadership role. AXAF is a NASA observatory for studying x-ray emissions from all kinds of astronomical objects and phenomena ranging from stars and quasars to the distribution of "dark matter" in galaxies and galaxy clusters. The AXAF's two focal plane instruments, a high-resolution camera and a CCD imaging spectrometer, will each have two detectors. The first of these will image the x-rays that pass through the optics, and the second will image those that are dispersed by two objective transmission gratings that can be moved into position behind the mirror assembly. These instruments will provide better angular resolution by a factor of about 10, and high-resolution spectroscopy over the x-ray band from 0.1 to 10 keV.

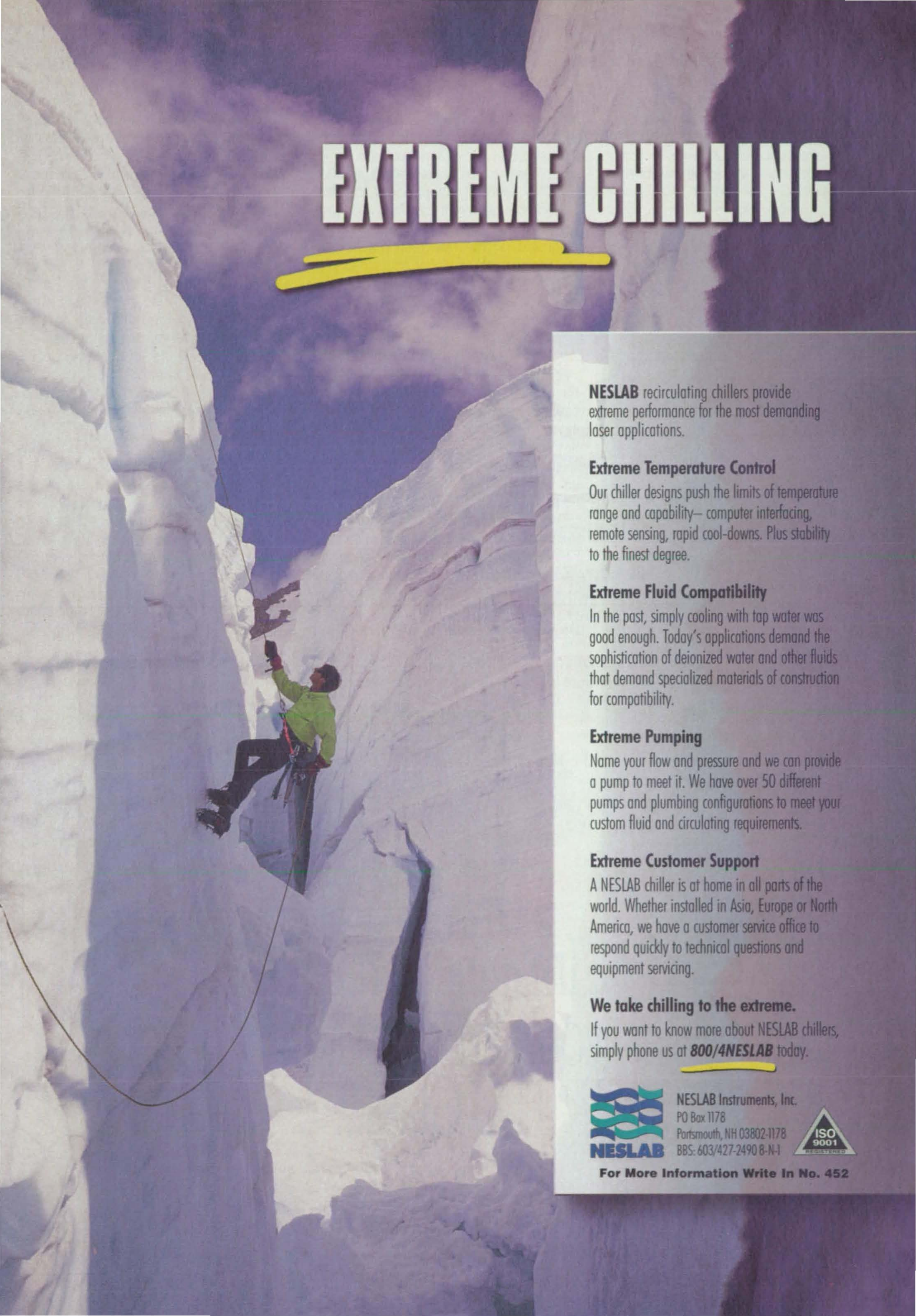
MSFC receives technical and scientific support on the project from the Smithsonian Astrophysical Observatory. The prime contractor, responsible for systems engineering and integration, is TRW's Space and Electronics Group. Other contractors include Eastman Kodak Co., which will mount and align the mirror assembly; Hughes Danbury Optical Systems, which fabricated the mirror elements; Optical Coating Laboratory Inc., which coated the mirrors with sputtered iridium; Ball Aerospace & Technologies, which is constructing a visible-light aspect camera to orient the observatory; and MIT's Center for Space Research and Lincoln Laboratories, which are collaborating on the AXAF CCD imaging spectrometer (ACIS). Plans call for the mirror assembly to go to Marshall this fall for final x-ray calibration, and then to TRW for integration into the spacecraft. Launch is planned for late 1998.

Catching the X-Rays

With the ground broken first by the development of focusing optics for the Einstein Observatory (1978) and now potentially by AXAF, successive x-ray missions will require greater collecting areas and better high-energy response. Both the cost of figuring massive pieces of glass and their weight rule them out as alternatives. Therefore, a key Marshall team is concentrating on development of high-resolution replicated optics in lightweight materials.

Now just over two years into their three-year technology development program, the team aims to produce grazing-incidence optics using electroformed-nickel replication off an electroless-nickel-coated aluminum mandrel. Within nine months of the program's inception, testing of a monolithic shell 33 cm in diameter and 60 cm long showed an excellent geometric figure. The team's subsequent goals were to improve techniques for figuring, polishing, and coating the mandrel, plating and separating the mirror shell, controlling contamination, and testing the optic in x-rays. They report significant progress in each of these areas.

The process of replication begins with the turning of the mandrel, a stress-relieved high-purity aluminum cylinder, close to the desired optical figure. It is plated with an electroless-nickel/phosphorus layer typically 0.16 mm thick, and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machined to the precise figure. After polishing, it is coated with a weakly adhering gold layer, which is later separated and becomes the inner reflecting surface of the x-ray optic.

When the research began, the team could produce a mandrel with a surface microroughness of about 300 angstroms rms after diamond turning and about 25 angstroms rms after extensive polishing. But matters improved greatly as a result of two years of experiments in replicating 1/10-scale models of the AXAF's smallest pair of optics, 6.5 cm in diameter, 17.6 cm long, and with a focal length of 1 m.

Concluding that high-quality diamond turning was the critical factor in producing both the figure and a surface suitable for polishing, the team moved its Moore M-40 machine from an unregulated shop environment to a clean, temperature-controlled, vibration-isolated facility, adding a state-of-the-art Zygo interferometer for process control. They also acquired a Precitech Optimum 4200 diamond turning machine that can produce even higher accuracy and smoothness for smaller optics—0.3 mm in diameter and 0.5 m long—and installed it in the same controlled facility. They have obtained mandrels with surface microroughness of less than 25 angstroms rms directly from the Precitech machine.

A second critical factor is the deposition of a high-quality electroless-nickel phosphorus layer on the mandrel. After extensive tests, the Marshall team determined that an Enthone plating solution with 11 percent phosphorus content yielded the best results. With this prescription, the team polished a mandrel generated on the Precitech machine to an approximately 5-angstrom surface.

Standard nickel electroforming intrinsically produces a shell with high internal stress, typically several thousand psi, which causes it to deform after separation from the mandrel. The Marshall group, in collaboration with University of Alabama Center for Applied Optics researchers, improved the method for electroformed nickel plating by using thin-membrane sensors to monitor stress in the plating, and to reduce average internal stress to zero by controlling the plating current density.

The final step in replicating these optics is to separate the mirror shell from the mandrel by cryogenically cooling the mandrel until differential contraction causes detachment from the gold layer and nickel shell. Initially the team found it difficult to separate the mirror without scratching the gold reflecting surface or the polished mandrel. Also, the extremely cold surfaces condensed atmospheric water vapor, leading to contamination. The group designed and built a separation fixture that allows the shell to be precisely drawn away from the mandrel without scraping, while keeping both fixture and optic in clean, dry air. They have now successfully produced mirror shells from several mandrels, with surface finishes of 5-6 angstroms rms.

According to Jim Bilbro, chief of the optics and radio frequency division and director of the Center of Excellence, the Marshall team is confident that replication can meet the challenges of the future. "We are currently working on the concept, design, and technical assessment of the optical-telescope assembly for the next-generation space telescope," he said. This eight-meter follow-on to Hubble, a project led by the Goddard Space Flight Center, is targeted to launch in 2005. And the group will extend its techniques beyond grazing-incidence optics for x-rays to normal-incidence optics for the next-generation space telescope as well.

For more information, contact Jim Bilbro at (205) 544-3467; Fax (205) 544-2659.

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LASER TECH BRIEFS

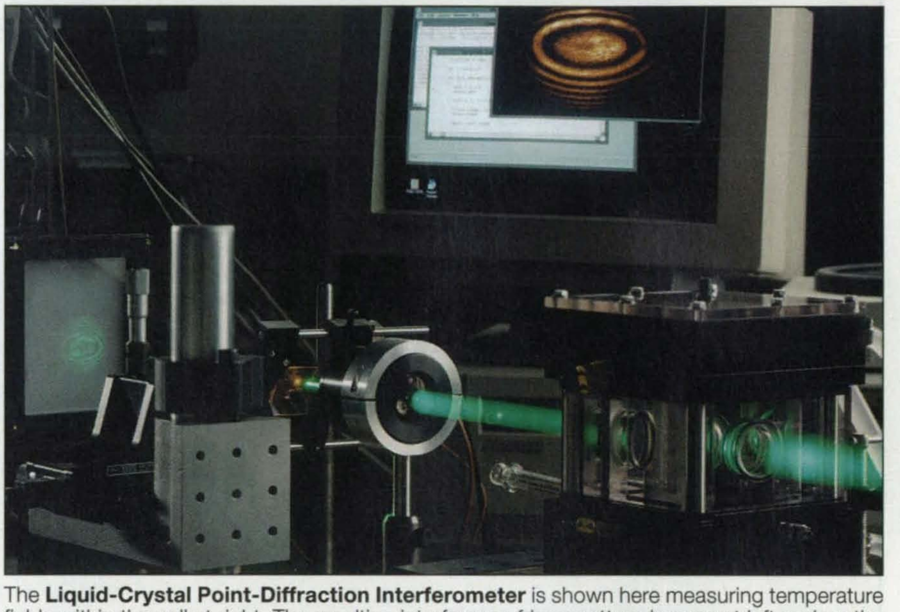
Liquid-Crystal Point-Diffraction Interferometer

Interferograms are made with various phase shifts to obtain phase maps of wavefronts.

Lewis Research Center, Cleveland, Ohio

A liquid-crystal point-diffraction interferometer (LCPDI) has been invented to combine the flexible control of liquid-crystal phase-shifts with the robustness of point-diffraction interferometers. Like other interferometers, this produces interferograms indicative of the shapes of wavefronts of laser beams that have passed through or been reflected from objects of interest. The interferograms are combined in computers to produce phase maps that describe the wavefronts.

If the object of interest is transparent (e.g., a lens or a transparent flow), then the wavefront is directly related to the spatial distribution of the index of refraction in the object; if the object is a reflective surface (e.g., a mirror), then the wavefront is directly related to its shape. Thus, measurement of the wavefront yields information about the quality of a lens or mirror or about the spatial distribution of physical and chemical characteristics of a transparent flow.



The **Liquid-Crystal Point-Diffraction Interferometer** is shown here measuring temperature fields within the cell at right. The resulting interference fringe pattern is seen at left and on the computer screen above.

The advantage of the present LCPDI over older point-diffraction interferometers is that the phase of one of the two beams used to produce each interferogram can be controlled more easily, making it possible to obtain phase steps at suitable intervals (e.g., 5 steps of $\pi/2$ radians apiece). This, in turn, makes it possible to determine the shape of the wavefront more accurately. LCPDIs can be constructed according to several alternative designs, a typical one of which is illustrated in Figure 1. A mixture of nematic liquid crystals and dye molecules is encapsulated between two glass plates with the liquid-crystal molecules oriented parallel to the plates. Transparent microspheres with a diameter of about 5 μm are placed between the plates at locations convenient for focusing in the optical setup in which the LCPDI is to be used. The inner surfaces of the glass plates are coated with transparent electrodes, between which an alternating voltage from a sine-wave generator is applied.

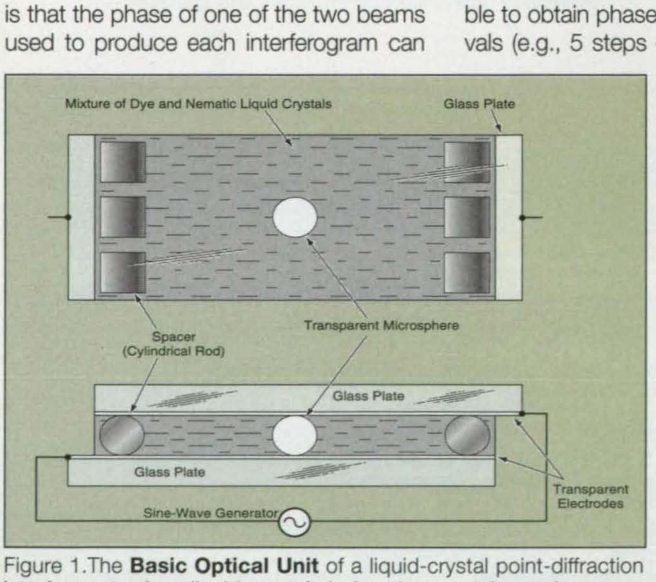


Figure 1.The **Basic Optical Unit** of a liquid-crystal point-diffraction interferometer is a liquid-crystal device that contains at least one transparent microsphere.

Figure 2 illustrates an optical setup in which the LCPDI is used to probe a transparent flow. Laser light from a point source is collimated by a high-quality lens, then passes into the flow region through a linear polarizer, which aligns the electric field of the light with the axes of the relaxed liquid crystals. After passage through the flow region, the light is focused onto the microsphere in the LCPDI.

The width of the beam in the focal region is somewhat greater than the diameter of the microsphere, so that some of the light passes through the liquid-crystal/dye layer and some passes through the microsphere. The portion that passes through the microsphere becomes spatially filtered and thereby formed into a beam that emerges with a spherical wavefront. The portion that passes through the liquid-crystal/dye layer is phase-shifted by the liquid crystals and attenuated by the dye; this portion carries the wavefront information about the object and is therefore called the "object beam." The concentration of dye is nominally chosen so that the amount of attenuation is just sufficient to equalize the amplitudes of the spherical-wavefront and object beams. These interfere with each other, producing the desired interferogram, which is made visible by projecting the beams onto a diffusing screen. A video camera records the interferogram and sends it to a computer for processing into the desired wavefront phase map.

The phase shift of the object beam in passing through the liquid-crystal/dye layer is $2\pi nD/\lambda$ radians, where n is the index of refraction, D is the thickness of the layer, and λ is the wavelength of the light. The alternating voltage applied to the transparent electrodes alters the orientation of the liquid crystals and thereby alters n and the phase shift by an amount that depends on the amplitude of the applied voltage. However, the phase shift of the spherical-wavefront beam is independent of the applied voltage.

Thus, the phase of the object beam relative to that of the spherical-wavefront beam can be shifted by changing the amplitude of the applied voltage. To obtain the desired sequence of phase shifts coordinated with the processing of data from interferometric images, the computer generates the corresponding sequence of amplitude commands for the sine-wave generator.

A typical amplitude range needed to obtain five $\pi/2$-radian phase steps is 1.0 to 1.6 volts. In practice, the amount of attenuation in the dye varies with the applied voltage; the resultant amplitude modulation of the object beam gives rise to a periodic error in the computed phase of the wavefront because the phase-stepping and wavefront-computation algorithms now in use were formulated under the assumption of phase modulation only. The algorithms have been modified to compensate for this source of error.

This work was done by Carolyn R. Mercer of **Lewis Research Center**. *For further information,* ***write in 60*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Lewis Research Center [216-433-2320]. Refer to LEW-15810.

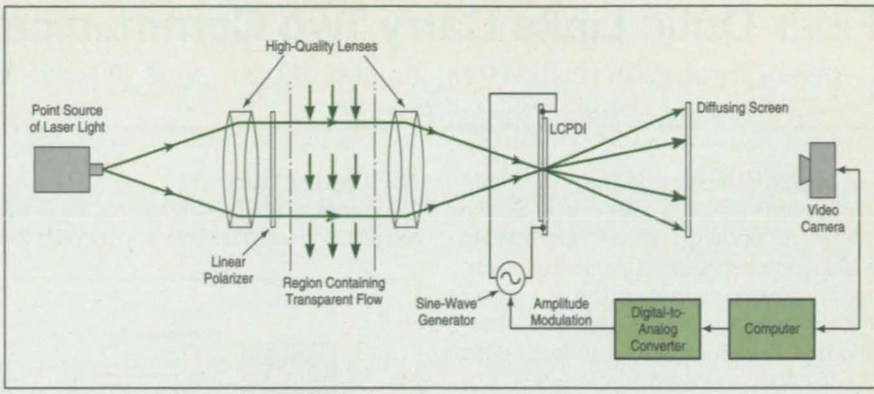


Figure 2. A **Liquid-Crystal Point-Diffraction Interferometer** is used to probe a transparent flow.

Fiber-Optic Links Carry Two Communication Channels Apiece

Wavelength-division multiplexing is used at both ends of each fiber.

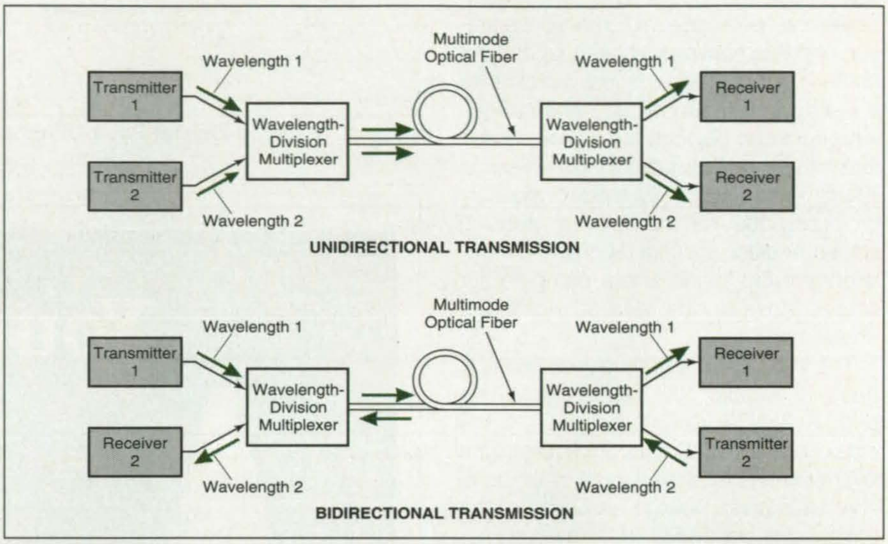
John F. Kennedy Space Center, Florida

A system of multimode fiber-optic communication links at Kennedy Space Center is undergoing an upgrade to enable simultaneous communication on two channels in each fiber. The essence of the upgrade is to incorporate two-wavelength-division multiplexing at both ends of each fiber (see figure), so that two signals can be transmitted, either in the same direction or in opposite directions.

The two nominal wavelengths are 1,300 and 1,550 μm. The signals at these two wavelengths are generated, by light-emitting diodes in the transmitters. Optical band-pass filters help to suppress crosstalk between the two wavelength channels; the degree of crosstalk suppression is at least 22 dB. The insertion loss of a fiber-optic link (including the loss at one connector interface) is less than 1.5 dB. The directivity is ≥ 50 dB.

This work was done by Po T. Huang, Larry J. Hand, Jr., and Robert A. Stute of **Kennedy Space Center** *and F. Houston Galloway and Robert W. Swindle of I-NET. For further information,* ***write in 68*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center [407-867-2544]. Refer to KSC-11732.



Two Signals Can Be Transmitted Simultaneously by modulating the outputs of two light-emitting diodes that operate at different wavelengths. Band-pass optical filters in the wavelength-division multiplexers suppress crosstalk between the two channels.

Laser Diode Illumination System

A new device increases effectiveness and efficiency of Special Operations searchlights.

US Air Force Phillips Laboratory, Laser Applications Group, Albuquerque, New Mexico

The LX-5 laser diode illuminator is a compact, lightweight, reliable system for illuminating the battlefield in the near-infrared region. The system was designed to replace the USAF H-53 SX-5 lamp, and was field-tested for more than 60 hours by the US Coast Guard to illuminate the ocean surface for craft and personnel detection with night vision goggles.

The LX-5 requires 230 W of power at 28 V, which is relatively small when compared with the 1100 W of power needed for its predecessor. Unlike the SX-5, the LX-5 has a negligible heat signature. The LX-5 provides up to 9.5 W of illumination, adjustable from spot to flood. Completely self-contained, the LX-5 has a battery pack that can provide 30 minutes of continuous operation. The LX-5 can also be plugged into a vehicle's primary power bus for extended use. Additionally, the main hardware for the LX-5 can be stowed anywhere in an airborne or ground vehicle, while fiber optic cables allow the lens system to be mounted externally. This option eliminates the necessity of mounting the entire system outside the platform.

US Coast Guard testing in the fall of 1994 produced exceptional results. Using the HH-60J helicopter as the test platform, the USCG Research and Development Center conducted realistic mock searches of targets such as small water craft, life rafts, and mannequins for person-in-water detection.

The detection tests all were done using night vision goggles (NVG), and compared probability of detection (POD) rates with and without the LX-5 operating. Even in bright moonlight, the LX-5 produced significant gains in POD over NVG gear alone. With more than 60 flight hours of extensive testing, the LX-5 laser illuminator has proven itself to be a compact, efficient, and reliable system with far-reaching application possibilities.

For more information on this work, contact Lt. Matt Gurney and Michael Allen, Laser Applications Group, **US Air Force Phillips Laboratory**, *LIDA, DSN 246-5860; (505) 846-5860; FAX: (505) 846-4313.*

Electron Cyclotron Resonance (ECR) Etching of Semiconductor Lasers

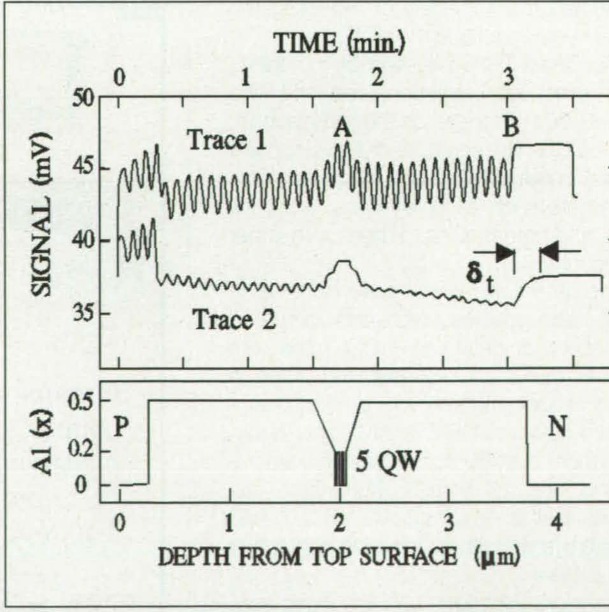
Laser reflectometer monitoring of ECR etching of III-V semiconductor in-plane laser heterostructures allows etch depth control to better than 500 Å.

Rome Laboratory, Photonics Center, Griffiss Air Force Base, New York

Dry etching of semiconductor heterostructures is common for fabricating optoelectronic components such as semiconductor lasers and field-effect transistors. However, it is difficult to accurately and repeatably etch to a specific depth. A Rome Laboratory team used a laser reflectometer as an *in situ* monitor for ECR etching, applying a modified version of a previously developed technique to a GaAs/AlGaAs laser heterostructure to ascertain (i) the etch depth, (ii) the etch rate, and (iii) the quality of the post-etch surface, and (iv) also to determine or verify the composition of a wafer without knowledge of its precise structure (*i.e.*, "reverse engineering").

A laser diode reflects off the sample onto a photodetector during etching. To utilize this method, one must correlate the laser diode's optical power reflected from the $Al_xGa_{1-x}As$ surface with the heterostructure's composition. Since the aluminum mole fraction x varies from layer to layer within the heterostructure, so does the index of refraction n, and the reflected power as the structure etches.

The primary detected signal consists of the optical power reflected from the surface of the wafer as it etches. A secondary detected signal consists of the interference between the light reflecting from the exposed surface and from the buried heterostructure interfaces. The total detected power, a superposition of the primary and secondary signals, constitutes a reflectivity-versus-depth map (see figure) for the entire epi-



Trace 1 is the superposition of primary (envelope) and secondary (interference fringes) signals, as recorded by the strip chart recorder. The scaled heterostructure aluminum composition is shown for comparison. Trace 2 (displaced downward by 5 mV for clarity) shows the effects of etch-induced surface roughness on the detected signals.

taxial structure. Once the map of the heterostructure is obtained, it is possible to stop the etch at any of the predetermined features, with a resolution better than 500 Å.

From the index of refraction as a function of x, and the primary signal power reflection coefficient for the TE-polarized light, the etch depth, rate, and quality can be readily determined. One can therefore reverse-engineer a wafer since, if the modulation is experimentally determined, then the mole-fraction x can be calculated. When etching through relatively thick epilayers (thousands of angstroms), it is the secondary interference signal that enables accurate depth control. The etch depth for adjacent interference fringes is approximately $\Delta z = \lambda/2n$. For $Al_{0.5}Ga_{0.5}As$ cladding layers, and 780-nm emission, this yields Δz = 0.1 mm.

The technique was tested on an in-plane laser heterostructure. The etch is performed in a Plasma Quest 357 Electron Cyclotron Resonance (ECR) etcher. An optical bandpass filter is inserted before the photodetector to help eliminate the quiescent signal due to the plasma emission. The figure shows the grower's specifications for the aluminum composition in the heterostructure and two strip-chart recordings of the detector output for different surface conditions. The actual thickness of the layers may vary by +/-20% from the grower's target profile. The detector output shows very distinct interference fringes, and the gradual rise and fall at point A indicate the surface reflection from the quantum wells. The highly absorbing n-layer is reached at point B. The first trace is the strip-chart recording for a sample with a high-quality etched surface. The second trace in the figure is produced by a specimen from the same heterostructure as the first but with inferior post-etch surface quality as determined by visual inspection.

A comparison of the two traces suggests that the etch quality can be ascertained from the modulation ratios. The peak-to-peak power for the interference fringes divided by the power reflected from a GaAs (x=0) surface is an indicator of the quality of the etched surface, since surface roughness tends to average out the interference effect. The apparent thickness of an interface, such as the n-GaAs/$Al_{0.5}Ga_{0.5}As$ interface, is given by the distance dt obtained from the map. It was found that the product of dt with the modulation ratio for the lower cladding is on the order of 30 Å for test pieces taken from the same wafer.

Both the primary and secondary signals are affected by etched-surface roughness. As the etch partially exposes an interface, the depth variation causes the index of refraction of the exposed surface to be an average over the two materials. As the etch progresses, the average index, and hence the primary reflected power, rises to that for GaAs. Thus, the time dt required for the surface to change from $Al_xGa_{1-x}As$ to GaAs yields a value for dt that is larger than the actual thickness of the interface. In addition, a rough or nonplanar surface produces a small secondary signal modulation ratio by averaging out the coherence between the surface-reflected and internally reflected signals.

This work was done by J.S. Kimmet, M.A. Parker, R.J. Michalak, and H.S. Wang of **Rome Laboratory, Photonics Center**, *D.B. Shire and C.L. Tang of Cornell University School of Electrical Engineering, and J. P. Drumheller of Cornell Nanofabrication Facility. No further information is available. Inquiries concerning rights to this technology should be addressed to RL/XP, Rome Laboratory, Griffiss Air Force Base, Rome, NY 13441.*

Multiple-Wavelength Pyrometry Independent of Emissivity

Temperatures can be measured, without knowing emissivity, by an uncalibrated spectral radiometer.

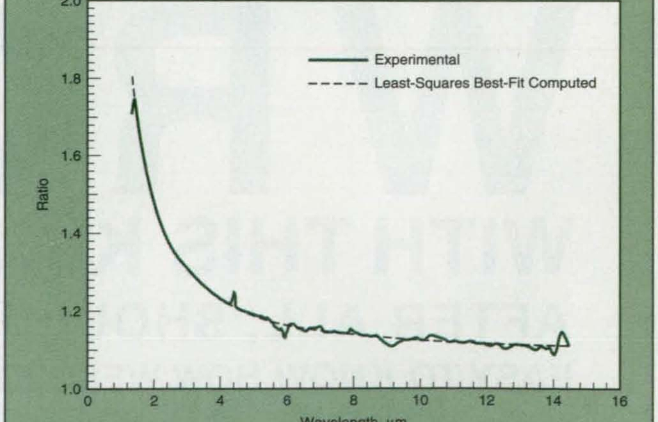
Lewis Research Center, Cleveland, Ohio

A multiple-wavelength pyrometric method provides for determination of two sequential temperatures of the same surface or the temperatures of two surfaces made of the same material. In this method, it is not necessary to know the emissivity of the material. The pyrometric instrument in this method is a spectral radiometer, and it can be used without calibration.

The method is based on the equation for gray-body thermal radiation, which is a modified version of Planck's radiation law: the spectral intensity L of the radiation at wavelength λ at absolute temperature T is given by $L(\lambda,T) = [\varepsilon(\lambda,T)][c_1/\lambda^5]/\{[\exp(c_2/\lambda T)] - 1\}$, where ε is the emissivity of the radiating surface and c_1 and c_2 are fundamental constants. The ratio R between the intensities of the gray-body spectra at temperatures T_1 and T_2 is given by $R(\lambda) = [\varepsilon(\lambda,T_1)/\varepsilon(\lambda,T_2)]\{[\exp(c_2/\lambda T_2)] - 1\}/\{[\exp(c_2/\lambda T_2)] - 1\}$.

Provided that the emissivity does not vary with temperature or that the two temperatures are close enough that the emissivities in the numerator and denominator can be considered equal, the ratio becomes $R(\lambda) = \{[\exp(c_2/\lambda T_2)] - 1\}/\{[\exp(c_2/\lambda T_1)] - 1\}$. Thus, one no longer needs to know the emissivities because the ratio between the two spectral intensities depends only on the two temperatures.

Provided further that the response of the spectral radiometer is directly proportional to $L(\lambda,T)$, it is not necessary to calibrate the spectral radiometer. This is because when one computes a ratio between the two readings of the instrument under this circumstance, the calibration factors in the numerator and denominator cancel each other, causing the ratio to equal $R(\lambda)$. In other words, one can use the ratio between instrument readings as the value of $R(\lambda)$ in the equation for $R(\lambda)$ as a function of T_1 and T_2, ignoring the calibration factors. Provided still further that the temperatures are not equal, one can determine the temperatures by obtaining



The **Experimental Ratio Spectrum** was obtained by use of a spectral radiometer observing a black-body furnace at temperatures of 1,352.4 and 1,262.4 K (as measured by thermocouples). The least-squares best-fit computed ratio spectrum was obtained by using temperatures of 1,343.02 and 1,253.59 K — both within 1 percent of the corresponding measured values.

a least-squares best fit between values computed by the equation and a plot of experimentally determined values of $R(\lambda)$ vs. λ (see figure).

This work was done by Daniel Ng of **Lewis Research Center**. *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Lewis Research Center [216-433-2320]. Refer to LEW-15999.

Self-Illuminating Optical Alignment Target

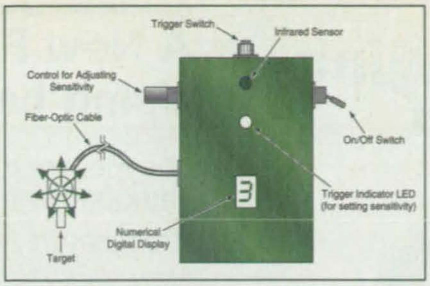
This instrument is easy to use and reduces job time.

John F. Kennedy Space Center, Florida

An optoelectronic instrument is designed for use as a self-illuminating optical alignment target. The instrument facilitates and accelerates optical alignment by providing a small, bright reference spot of light that is easily visible, without having to supply illumination from an external source, without concern for shadowing, and without need for antiglare adjustments, all of which can arise in the use of a non-self-illuminating target.

Called a "fiber-optic remote target" (FORT), this instrument (see figure) includes a small aluminum box that contains a bright yellow light-emitting diode (LED) plus associated power and control circuitry. By use of a fiber-optic cable that runs from the output face of the LED, out of the box, and into the rear face of the target, a bright spot of light is provided on the front face of the target.

The illumination supplied to the target can be set to a level low enough to prevent the "bloom" that could arise when viewing too bright a light at too close a range. A digitized measure of the level of illumination is indicated by a red LED numerical display, which can be triggered by aiming a flashlight at an infrared sensor on the aluminum box, or by use of a momentary-contact trigger switch on top of the box. Because the numerical display is the most power-hungry part of the instrument, an energy-saving circuit feature automatically turns off the numerical display after thirty seconds, providing more than enough time to read the display. The instrument is powered by four standard AA cells, which last several days in continuous operation. The FORT was originally designed for use in the critical alignment operations of the Solid Rocket Booster (SRB) holddown posts.



The **Fiber-Optic Cable** brings light from a yellow LED in the box to the central spot on the front face of the target. The trigger indicator assists the technician in adjusting the sensitivity of the infrared-sensor circuit so that the numerical display is not triggered by ambient light but can be triggered remotely by shining a flashlight on the sensor.

This work was done by Carl D. Ashcraft and David A. Trenn of Lockheed Space Operations for **Kennedy Space Center**. *For further information,* ***write in 69*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center [407-867-2544]. Refer to KSC-11786.

A New Flat-Panel Display Using Laser Illumination

The Planar Optic Display (POD) may replace cathode-ray tubes in some applications.

Brookhaven National Laboratory, Upton, New York

Researchers at Brookhaven have developed a unique flat-panel display screen that can be used to replace bulky cathode-ray picture tubes (CRTs) in computers and other video-type displays. This display, known as the Planar Optic Display (POD), uses laser light in conjunction with a laminated planar optic waveguide structure to display video images on a flat black screen only one inch thick. Although lasers have been used for projection displays, they have never before been used to make a video display in a compact flat package. This is not simply a permutation of an existing display technology; it is an entirely new approach to displaying video information.

This display uses light from a laser, preferably a miniature diode laser, and directs the beam to an X-Y scanner. Video information is fed to this scanner, which then directs the light beam into the proper sector of the laminated waveguide so that a video image is displayed on its front face. The light from the scanner enters the waveguide at the bottom and exits at the front viewing face. The front face is diffused to make the system totally eyesafe and to provide an exceptionally wide viewing angle. Since the screen is black, the contrast is exceptional.

The Planar Optic Display operates on the principle of total internal reflection (TIR). The display is made up of hundreds of optical waveguides that look like paper-thin sheets of glass. A layer of cladding having a lower refractive index than the glass is placed on each side of the glass sheet. Any light beam that enters the sheet at the bottom will travel without loss to the front viewing face. This makes for a high-brightness, extremely sharp image.

Although this technology is in its infancy, it has several advantages over the current AMLCD displays from Japan being used in

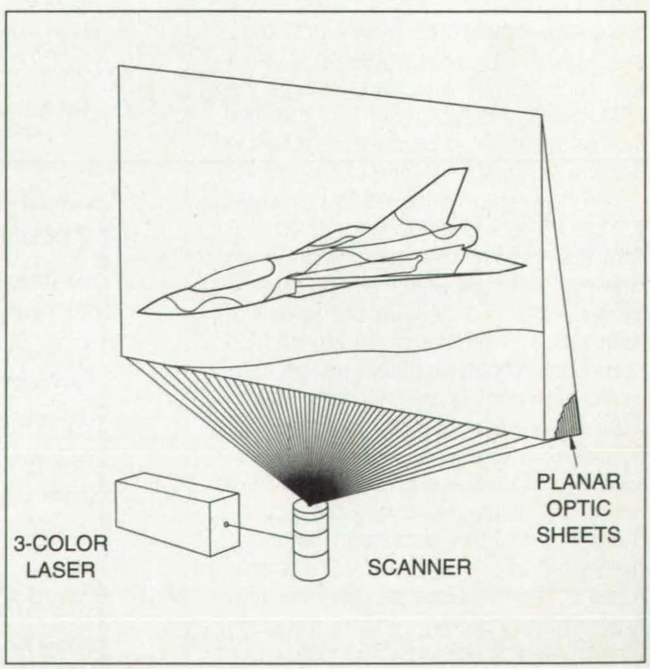


Figure 1. **Planar Optic Sheets** 50 microns thick can be combined to make a high-resolution video screen.

today's notebook computers. Unlike the latter, the POD uses a "low-tech" manufacturing process: The screen will simply be a specialized plastic extrusion. Another major advantage is viewing angle. The POD screen has the same wide-viewing angle as conventional CRTs (160°). High brightness is also achievable since the illumination source is a laser.

In order to understand the principle of operation, it is helpful to briefly discuss fiber optics. A fiber optic waveguide is made up of a core (refractive index n) surrounded by a cladding (refractive index <n), so that light entering the fiber within a known acceptance angle is confined inside the fiber. This confinement occurs because of the phenomenon of total internal reflection, which also applies when the core is a sheet of glass rather than a fiber. When constructed with sheets or planes of glass, the device is called a planar optic device. It is analogous to a fiber optic device, but there are a few important distinctions.

In fiber optics, the angular information of the incident light beam is lost as the light exits the fiber. In a planar optic device, the angle of the incident light (in the plane of the sheet) is preserved at the exit of the sheet. Thus one has the capacity to scan a laser beam across the entrance of a planar optic sheet and have the same scanning beam appear at a known location at the exit of the sheet. This is crucial to understanding the operation of this flat-panel screen.

Another difference between fiber optics and planar optics is the effect of diffraction on the propagating laser beam within the device. In a fiber optic the beam diameter as confined by the fiber can never be larger than the fiber diameter. But in the planar optic sheet, a propagating laser beam will continue to expand in one direction because of the effect of diffraction. Therefore, to achieve maximum diffraction-limited resolution, the laser beam's shape must be optimized for a given display size.

A single planar optic sheet is not very useful by itself, but if you

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PRINCETON INSTRUMENTS, INC.

NEW PentaMAX: HIGHEST-PERFORMANCE COOLED CCD CAMERA ON THE MARKET

Princeton Instruments' PentaMAX cooled CCD camera

Princeton Instruments announces the release of the PentaMAX, the highest-performance cooled CCD camera on the market. It combines the premium features of cooled cameras with the speed advantages of video cameras. The PentaMAX features an ultrahigh-rate, low-noise, 12-bit A/D converter with a throughput of 5 million pixels per second for the maximum in speed (allowing a sustained 15 frames/sec at 512-x-512-pixel resolution), as well as a slower channel running at 1 million pixels per second for higher-sensitivity data collection. The data is transferred via a high-speed bus, placing the images directly into the host RAM on multiple platforms, ranging from PCs to workstations. Using the PentaMAX, larger images can be acquired at faster rates, allowing the user to monitor dynamic events with exceedingly high spatial resolution. Even higher rates of imaging can be achieved by reading out the whole array with binning (combining adjacent pixels to make "super-pixels"), or by reading out only a subregion of the array. In addition, the PentaMAX simultaneously produces an RS-170-type video signal, enabling the user to focus the image in real time. Using an efficient air-cooling mechanism removes the need for cumbersome water circulators while still achieving -40 °C for optimal cooled operation.

For more information contact Al Mottola, Princeton Instruments, Inc., 3660 Quakerbridge Road, Trenton, NJ 08619; (609) 587-9797; Fax: (609) 587-1970.

were to stack 1000 of these sheets together, as indicated in Figure 1, a new type of flat-panel screen becomes evident. If each sheet is 50 microns thick and 6 feet diagonal, the result is a 6-ft. TV screen that is only 2.5 in. thick.

Figure 2 shows a detail of a section of the planar optic screen. The laser beam enters the display from the bottom. Each planar sheet corresponds to one vertical line of resolution: thus, an HDTV format with 1000 lines of resolution would contain the same number of planar sheets. The laser light exits each sheet at the front frosted face, which diffuses the beam to provide an extremely wide viewing angle, like conventional CRTs. This diffusive face also makes the screen totally eyesafe even if the scanner fails and the laser beam were fixed at a single spot.

When using a POD screen for three-dimensional TV, a second set of diode lasers with opposite polarization would be integrated with the scanner such that the two polarizations are time-interlaced on the surface of the screen. For example, the horizontally polarized lasers might produce the right eye image and the vertically polarized lasers the left. A diffuser on the screen's surface would then be embossed with a microsphere structure that would retain the polarization information necessary for the 3D effect.

The display screens to date have been handmade from glass. But Dow Chemical Company has a patented coextrusion process for mass production of the planar optic material. They have developed an inexpensive process to coextrude alternating layers of transparent PC/styrene-acrylonitrile with alternating indices of refraction. A description of the process is contained in the *Journal of Plastic Film and Sheeting*, Vol. 4, 1988, pages 104-115.

Although the current displays are using lasers as the optical source, work is under way to couple light from other types of projectors into the POD. For example it may be possible to have a large display screen for slide projectors that will no longer require a large projector-to-screen distance. The projector and screen can be integrated into a single unit. Recently, a new class of AMLCD video projectors has appeared on the market, with the capability to project real-time video onto a large screen. Here again the POD display can shrink this large projection system into a flat-panel display.

This work was done by James Veligdan and colleagues at **Brookhaven National Laboratory**. *For more technical information, call Jim Veligdan at (516) 282-5400; E-mail: Veligdan@bnl.gov.*

For licensing and technology transfer information, call David Langiulli at (516) 282-5217; E-mail: DavidL@bnl.gov.

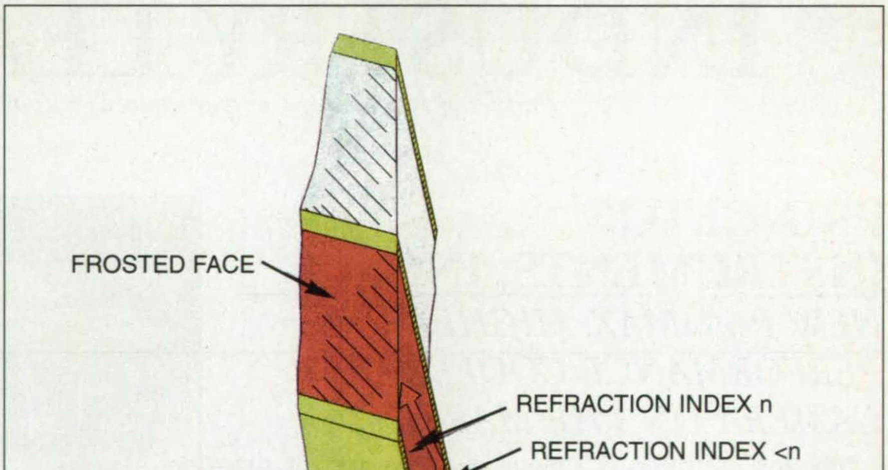
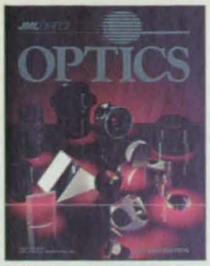


Figure 2. The principle of planar optics rests on the phenomenon of **Total Internal Reflection** of discrete light beams within sheets bounded by cladding of higher refractive index.



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JML's second-edition catalog offers thousands of "off-the-shelf" precision optics. Products include lenses, prisms, cylinders, mirrors, multielement systems, aspheres and irises. Antireflective and reflective dielectric and metallic coatings are also available from JML. JML Optical Industries, Inc., 690 Portland Ave., Rochester, NY 14621-5196; (716) 342-9482; Fax: (716) 342-6125. Visit our new home page on the Internet: http://www.jmlopt.com; E-mail: jml@jmlopt.com

JML Optical Industries

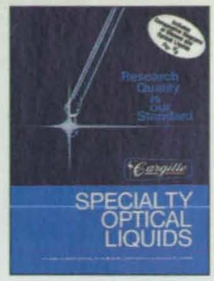
For More Information Write In No. 370

PRODUCTS FOR MICRO-POSITIONING

Polytec PI's 300-page 1996 catalog of piezoelectric technology covers general properties, applications, dynamic performance, power requirements, and position-controlled operations. It details Polytec's full range of micropositioning products: piezoelectric actuators, tilting platforms, fiber positioners and flexure stages, motorized rotary and linear stages, and control electronics. The catalog gives dimensions, specifications, and options. Polytec PI Inc., 3152 Redhill Ave., Suite 110, Costa Mesa, CA 92626; (714) 850-1835; Fax: (714) 850-1831.

Polytec PI

For More Information Write In No. 371



OPTICAL LIQUIDS

R. P. Cargille's Specialty Optical Liquids catalog features high-transmission, safe-handling laser liquids plus fused silica matching liquids and specific refractive-index liquids (1.300 to 2.11 n_D). The catalog now includes comparative diagrams of glasses and optical liquids. R. P. Cargille Laboratories, Inc., 55 Commerce Road, Cedar Grove, NJ 07009-1289; (201) 239-6633; (201) 239-6096.

R. P. Cargille Laboratories

For More Information Write In No. 372

CCD CAMERA WITH MANY OPTIONS

A 128-page full-color catalog of "High-Performance Digital CCD Cameras" from Princeton Instruments outlines the company's line, with applications from microscopy to astronomy. The cooled slow-scan imaging CCD cameras have spectral response from x-ray to the near infrared. The catalog has specifications for the more than 30 CCD chips offered in the cameras, and application notes to help in selecting from the line. Princeton Instruments, Inc., 3660 Quakerbridge Road, Trenton, NJ 08619; (609) 587-9797; Fax: (609) 587-1970.

Princeton Instruments

For More Information Write In No. 373

NEW PRODUCTS FOR LIGHT RESEARCH

Oriel's "New Products for Light Research" catalog features pulsed sources, nitrogen lasers, calibrated irradiance sources, monochromators, spectrographs, and imaging spectrographs. You'll also find a comprehensive line of UV-IR detectors and detection systems, including cooled PMT systems, DSP lock-in amplifiers, CCDs, ICCDs, and fiber optics. The product guide includes valuable technical information, application notes, and specifications. Contact Oriel for your free copy; (203) 377-8282; Fax: (203) 375-0851; E-mail: res_sales@oriel.com. Or look at our Home Page: URL http://www.oriel.com.

Oriel Corp.

For More Information Write In No. 374

NEW IMAGING SPECTROGRAPHS

Send for information on ARC's new SpectraPro-300i 300-mm-focal-length imaging spectrograph/monochromator featuring a large, flat 14-X-27-mm focal plane for CCDs. The automated spectrograph includes built-in RS232 and IEEE-488 computer interfaces, multiport optical system, and triple indexable gratings for optimum performance and versatility. Acton Research Corp., PO Box 2215, Acton, MA 01720; (508) 263-3584; Fax: (508) 263-5086; Internet: http://www.acton-research.com.

Acton Research Corp.

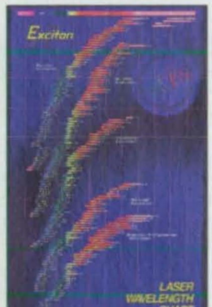
For More Information Write In No. 375

VideoMTF IMAGE ANALYSIS SYSTEM

VideoMTF Image Analysis System is a modular tool for analyzing the performance of optical systems. This low-cost product incorporates new software which measures image quality, MTF, resolution, energy distribution, and image motion (distortion). Coupled with Optikos's line of lens benches or other laboratory hardware, VideoMTF's modular design makes it perfect for research, production, and QC applications. Optikos Corp., 286 Cardinal Medeiros Ave., Cambridge, MA 02141; (617) 354-7557; Fax (617) 354-5946.

Optikos

For More Information Write In No. 376



LASER DYES

With Exciton, you get a specialized team of professionals knowledgeable in the field of laser dyes. Since more than one dye may cover a given spectral region, we provide the latest information concerning the best dye selection for a specific laser system and application. Exciton Inc., PO Box 31126, Overlook Station, Dayton, OH 45437; Tel: 513-252-2989.

Exciton Inc.

For More Information Write In No. 377

CD-ROM HOLDS BEST OF NASA TECHNOLOGY

JB Data announces *The NASA Technology CD-ROM*, containing 800 previously unpublished NASA software programs, abstracts of 90,000 NASA technical reports, front pages and claims to more than 2800 NASA patents, and more. Source code listings for expert systems, CAD/CAM, aerospace analysis, robotics, and materials analysis programs. **Special Bonus:** 5700 *NASA Tech Briefs* published over 8 years; NASA's CLIPS expert system, a $350 value if purchased separately. Runs on Windows. Price for a limited time: $195. JB Data, 317 Madison Ave., New York, NY 10017; (212) 490-3999; Fax: (212) 986-7864; E-mail: pp000531@interramp.com

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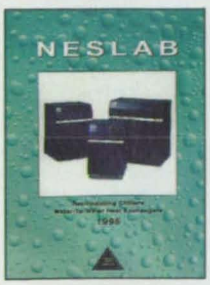

RECIRCULATING CHILLERS

64-page catalog features a complete line of recirculating chillers for cooling water-cooled equipment. These chillers offer steady cooling with heat load removal up to 75 kW, spanning temperature ranges of +5 °C to +35 °C. Chillers feature: 1) ozone-friendly refrigeration-systems, 2) LED display, 3) operating status gauges, and 4) easy access to internal components. Also available is CFC-free Constant Temperature Equipment. Call toll-free at 1-800-258-0830.

NESLAB Instruments, Inc.

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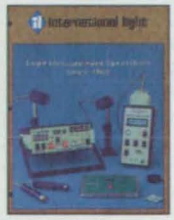

LIGHT MEASUREMENT CATALOG

International Light offers their latest version full-line catalog describing light measurement instrumentation, applications, and basic concepts of Radiometry/Photometry. Many new products are introduced covering a wide range of UV-VIS-IR applications. All technical details such as spectral and spatial responses, measurement ranges, and descriptions have been either updated, enlarged, or expanded in scope. International Light, Inc., 17 Graf Rd., Newburyport, MA 01950-4092; (508) 465-5983; Fax (508) 462-0759; E-mail: ilsales@intl-light.com; Internet: http://www.intl-light.com/

International Light

For More Information Write In No. 380

FREE CATALOG "OPTICS FOR INDUSTRY"

Free 130 page catalog from Rolyn, world's largest supplier of "Off-the-Shelf" optics. 24-hour delivery of simple or compound lenses, filters, prisms, mirrors, beamsplitters, reticles, objectives, eyepieces, plus thousands of other stock items. At off-the-shelf prices. Rolyn also supplies custom products and coatings in prototype or production quantities.

Rolyn Optics
706 Arrow Grand Circle, Covina, CA 91722-2199
Tel: 818-915-5707; Fax: 818-915-1379.

For More Information Write In No. 381

NEW LITERATURE

Wide Choice of Fiber Optic Solutions

SpecTran Specialty Optics Co., Avon, CT, offers a 28-page color catalog showcasing its broad line of silica fiber, with brief sections devoted to plastic and fluoride (IR) fibers. Preceded by a technical overview of optical and mechanical principles and properties, the booklet's main sections focus on single-mode specialty, communications, polarization-maintaining, and rare-earth doped fibers, and multimode graded-index and step-index fibers. It concludes with a glossary of fiber optic terms and a fiber specification worksheet.

For More Information Write In No. 820

Guide to Silicon Avalanche Photodiodes

Hamamatsu Corp., Bridgewater, NJ, intends its "Silicon Avalanche Photodiode Selection Guide" to aid optical system designers in matching silicon APDs to applications. The guide gives performance specifications for active area, breakdown voltage, cutoff frequency, dark current, terminal capacitance, excess noise figures, gain, peak sensitivity wavelength, and quantum efficiency. APD types covered include low-temperature-coefficient, low-bias-voltage, and short-wavelength types. A series of operating notes provides performance guidelines, including an APD readout circuit example, and advice for proper handling.

For More Information Write In No. 821

Optical Filter Specification Sheet

The five-page "Optical Filter Specification Guide" from Spectro-Film, Woburn, MA, outlines recognized standard tolerances and specifications for a variety of thin-film filters. Intended to aid users in specifying completely and accurately, the guide provides analysis and pointers on significant parameters for bandpass, edge, neutral density, and notch filters and color-absorbing glass. A separate section deals with mechanical tolerances. Included is a worksheet that Spectro-Film says will prompt the user to record all the specifications needed to obtain a quote.

For More Information Write In No. 822

Standard and Custom Optical Tables

A full-color 24-page brochure from Kinetic Systems, Inc., Boston, MA, covers its complete line of custom and standard optical tables and accessories. The tables feature the proprietary "Spillpruf" design, called by the company the industry's only true spill management system that drains spills away from the tabletop. Preceded by a section on capabilities, the brochure discusses considerations for table selection, and gives product information on more than 3500 standard table options and the support systems available for them.

For More Information Write In No. 823

Optoelectronic Products for the Designer

The 110-page catalog from Methode Electronics, Chicago, IL, covers its full line of simplex and duplex transmitters and receivers, optical link cards and modules, and fiber optic cable assemblies and connectors. The catalog contains product descriptions and data sheets, and a section devoted to analog interface guidelines and using the diagnostic test ports of the cards and modules. Featured is the MTR-8510 duplex transceiver for bidirectional communication over multimode fiber at up to 1.5 Gb/s. Methode also offers quarter-speed and full-speed Fibre Channel gigabit link modules with what it calls the lowest power consumption in the industry at less than 800 mA.

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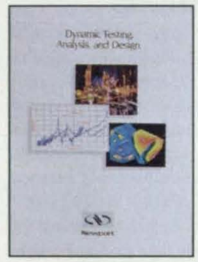


Innovative Methods for Vibration Control

"Dynamic Testing, Analysis and Design" from Newport Corp., Irvine, CA, is a 4-page full-color booklet describing vibration control solutions and technologies. The publication grows from the strategic alliance of Newport and CSA Engineering, reflecting their expertise in structural dynamics, active and passive vibration suppression, acoustics, stress and numerical analysis, and other disciplines. With photos, graphs, and illustrations, it details practical solutions that draw on advanced methods and broad industry experience.

For More Information Write In No. 825

Carbon Dioxide Laser Processing Systems

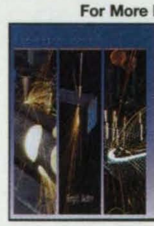
Mitsubishi Laser, Wood Dale, IL, has produced a 4-page full-color capabilities brochure on the ML2512LX/LXP carbon dioxide laser two-dimensional processing systems. It describes the series' 3-axis flying optics, static capacitance sensor head, and 3-axis cross-flow silent-discharge gas excitation system, as well as the LXP's automatic pallet changer. Standard layout diagrams and laser and mechanical specifications are provided.

For More Information Write In No. 826

Infrared Crystals, Components, Coatings

"Infrared Technology," a six-page full-color statement of capabilities from Exotic Materials, Inc. (EMI), Murrieta, CA, highlights the full range of its fabrication facilities and services. Founded 35 years ago, EMI has vertically integrated its germanium and silicon crystal growth, optical fabrication and coating production, and mechanical fabrication into complex assemblies. Producibility engineering, preproduction models, and state-of-the-art testing, repair and maintenance are also among its capabilities.

For More Information Write In No. 827



Lasers for Drilling, Cutting, Welding

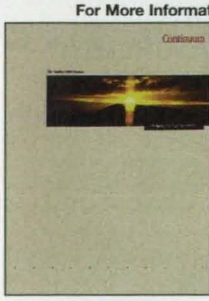
A 32-page full-color booklet from Convergent Energy, Sturbridge, MA, has details on the company's lasers for drilling, cutting, welding, and cladding. Representing a merger of the former Coherent General and United Technologies Industrial Lasers, the Convergent Energy line includes carbon dioxide and Nd:YAG lasers with rated powers from 50 W to 45 kW. The booklet describes each major product line, with schematics, specification tables, and performance data: included are the Diamond, Arrow, Vulcan, SM High-Power, and Aurora lines, as well as descriptions of turnkey systems and workcells the company has produced.

For More Information Write In No. 828

Instrumentation for Measurement and Analysis

Stanford Research Systems, Sunnyvale, CA, has published "1996-1997 Scientific and Engineering Instruments," a 215-page guide to its instrumentation, test, and research products. Included are sections on FFT spectrum analyzers, function and digital delay generators, time interval counters, high-voltage power supplies, lock-in amplifiers, choppers, and preamplifiers, gated integrators and boxcar averagers, photon counters, and more. Two-page "tech notes" appear throughout in related sections, and the book concludes with a series of application notes.

For More Information Write In No. 829



Optical Parametric Oscillator

A 12-page color brochure from Continuum, Santa Clara, CA, outlines the design and features of the Sunlite series of optical parametric oscillators. The patented ExtRA™ (Extraordinary Resonance Architecture) design of its BBO-based oscillator is explained, and the Windows-based interface is highlighted. The booklet has descriptions and optical schematics, and a discussion of an ultraviolet option that enables coverage of a broad portion of the UV spectrum.

For More Information Write In No. 830

Optical Glass Catalog on Diskette

Schott Glass Technologies, Duryea, PA, releases an updated version of its optical glass catalog on diskette. Programmed for use with Windows 3.x or 95, the catalog can be searched and comparisons made according to 73 parameters such as refractive index, Abbe value, thermal expansion, stain resistance, and transmittance. The complete text, tables, and charts from the print version are on the disk, along with transmittance curves at 5 mm and 25 mm for all glasses. A PC-AT 80486 or higher with 4 MB of RAM and VGA graphics are required.

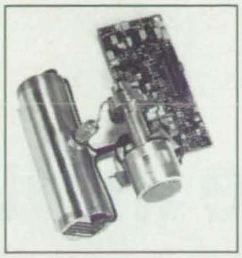
For More Information Write In No. 831

NEW PRODUCTS

Multimode Transceiver with VCSEL Source

Hewlett-Packard Co., Santa Clara, CA, says its new transceiver using vertical-cavity surface-emitting laser (VCSEL) technology enables MMF transceivers to achieve gigabit and higher data-rate performance on MMF links up to 500 m. The transmitter section consists of the 850-nm VCSEL driven by a custom silicon bipolar IC that converts differential positive electron-coupled logic signals into an analog drive current. The receiver uses a PIN photodiode and a custom silicon bipolar transimpedance amplifier. The company says the gigabit-per-second speed suits the unit for full-motion video and other multimedia-information transmissions.

For More Information Write In No. 800



Integrated IR Detector Assembly

Infrared Components Corp., Utica, NY, introduces IRES, an infrared staring focal plane array engine. It features a detector, a long-life dewar, and a 12-bit digital data output on a single 5-V power supply. The detector is a Kodak model KIR-0077 328-X-252 platinum silicide interlaced CCD focal plane array.

For More Information Write In No. 801

Intermediate-Range Duplex SC Transceiver

The OC-12 fiber optic transceiver family from AMP Inc., Harrisburg, PA, provides logic-to-light serial data transmission for intermediate-range SONET/ATM performance. With an industry-standard form factor that allows for upgrades from AMP OC-3 modules, the compact 9-pin duplex SC package uses AMP 1300-nm sources and detectors. Operating at 622 Mb/s, the single-mode version adheres to Class 1 laser safety standards, and the multimode unit complies with the 500-m power budget as defined by the ATM Forum's UNI recommendation. The OC-12 multisourced footprints match existing multimode and single-mode ATM transceivers.

For More Information Write In No. 802

Room-Temperature Near-IR Camera

The 128-X-128-pixel focal plane array at the heart of the new SU128-1.7RT camera from Sensors Unlimited, Inc., Princeton, NJ, is an InGaAs photodiode array integrated to a silicon readout multiplexer using indium bump-bonding technology. Dark current is low enough to support room-temperature detectivity greater than $D=10^{13}$ cm-√Hz/W. The camera's response is to 0.9-1.7 µm, and its quantum efficiency exceeds 65 percent from below 1.0µm to beyond 1.6µm.

For More Information Write In No. 803

Eight-Channel Bandpass WDM

E-TEK Dynamics Inc., San Jose, CA, announces an eight-channel bandpass wavelength division multiplexer (WDM). Filters have a wide passband, allowing for relaxed laser wavelength tolerances. A stable interference filter with near-square-shape bandpass spectrum is packaged individually for each user-selected wavelength. A minimum of 25 dB channel isolation is guaranteed over the eight wavelengths, with channel spacing of 3.2 nm. The unit is bidirectional, and can be used as either a multiplexer or demultiplexer.

For More Information Write In No. 810

Three-Chip Color Camera

Dage-MTI Inc., Michigan City, IN, says its DC-330 three-chip color camera was designed specifically for biomedical and industrial applications. With a small remote head and a C-mount, it features 10-bit digital processing and resolutions up to 750 TV lines. On-screen programming of more than 40 internal functions is complemented by the ability to save camera-setting combinations in three user-defined memories. The device has an automatic shutter to 1/50,000 s, automatic black balance, digital shading correction, and outputs of RGB, Y/C, NTSC, or B/W.

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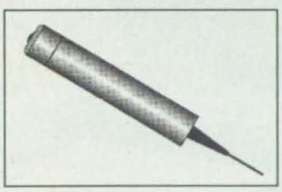


Pigtailed Laser-Coupling Isolators

Princeton Optics, Princeton, NJ, says that laser diode beams are easily coupled into single-mode fibers with the company's isolator. The pigtailed device has typical coupling efficiency of between 45-55%. A single isolator provides 40 dB isolation, and a double isolator 60 dB. The standard package measures 6 mm in diameter and 23.5 mm in length. Hermetically sealed packages are also available.

For More Information Write In No. 806

Pneumatic Vibration Isolation Systems

Three new vibration control products offered by Newport Corp., Irvine, CA, stem from its strategic alliance with Barry Controls, Brighton, MA. The VIP™ active electro-pneumatic system controls the height and damping of pneumatic vibration isolation systems. The Electro-Damp™ is an electronic servo-controlled vibration isolation system offering active vibration control with six degrees of freedom. The Stabl-Level™ Mount (SLM) low-frequency low-profile elastomeric pneumatic spring mounts provide vibration, shock, and noise protection. Prices begin at $9995 for the VIP, $45,000 for Electro-Damp, and $60 per SLM.

For More Information Write In No. 807

3D Triangulation Profiling at 700 FPS

With a PCI interface card, the Integrated Vision Products RS2200 Ranger, available from Metolius Inc., Kirkland, WA, can obtain 3D profiles at more than 700 frames per second (200,000 range values/second). It is based on the MAPP2200 256-X-256-pixel "smart" optical sensor with on-chip parallel image processing. Metolius says applications include high-speed parts inspection and measurement, volume and contour measurement, defect detection and measurement, and robotics.

For More Information Write In No. 808

Moving Magnet Optical Scanner

Cambridge Technology, Inc., Watertown, MA, says the new position detector design (patent pending) incorporated in its 6800HP moving magnet optical scanner yields linearity of 0.5% and positioning repeatability to 20 µrad. A new ball bearing technology is also expected to improve the lifetime of the 6800HP by a factor of two, Cambridge says. The new position detector design is also utilized in the 6810P and 6850P moving magnet scanners, and all are compatible with the company's standard 658X servo electronics.

For More Information Write In. No. 804

CVD Silicon Carbide Reflective Optics

Of its new CVD silicon carbide optics Morton Advanced Materials, Woburn, MA, says that they satisfy the optical engineer's need for a highly polishable, extremely stiff, lightweight material that is thermally and dimensionally stable. Using Morton's large-scale chemical vapor deposition process, mirror blanks can be produced in diameters up to 1.5 m by near-net-shape techniques or conventional machining and subsequently polished into mirrors using conventional techniques.

For More Information Write In No. 809

Compact Center-Drive Positioning Stage

The NE-MS 3½-in.-wide single-axis positioning stage is the latest addition to the NE Series of high-precision stages from MikroPrecision Instruments, Golden Valley, MN. The center-drive stage is available in 2 ½, 4 ½, and 6 ½-in. travel and with linear-encoder resolutions ranging from 1 to 0.1 micron. It comes with either a stepper or DC servo motor. The company says this design is well suited to the data storage industry for servo track writing and other applications.

For More Information Write In No. 811

Mathematics and Information Sciences

Using Statistical Penalties in the Tsai-Wu Failure Criterion

Careful consideration of statistics should lead to better safety factors.

Marshall Space Flight Center, Alabama

Improved methods of applying statistical penalties when using the Tsai-Wu failure criterion (which is described below) should lead to more accurate predictions of failures of composite-material (e.g., matrix/fiber) structural components under stress, and thereby provide better safety factors for designing such components. Statistical penalties have been applied with relative ease in safety-factor calculations for conservative design of components made of isotropic materials, but the safety-factor problem in composite materials is complicated by anisotropy. The improved methods are intermediate products of continuing efforts to develop improved methods of analysis and design.

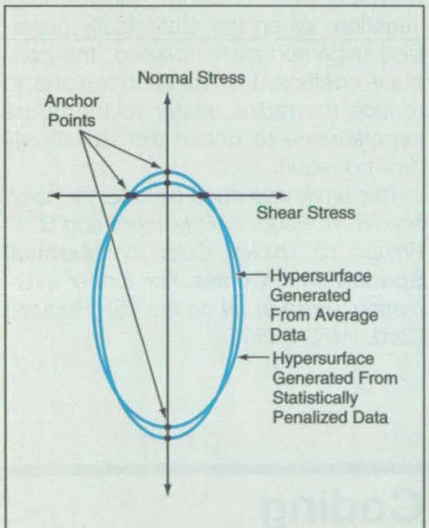


Figure 1. A **Tsai-Wu Failure Hypersurface** generated from statistically penalized experimental strength data does not necessarily lie, as desired, within the hypersurface generated from average data.

A discussion of the technical background is necessary to give meaning to even a brief description of the improved methods. The failure theory developed by S. W. Tsai and E. M. Wu — the Tsai-Wu failure criterion — is commonly applied to composite materials. This theory involves the use of tensor quantities, which can be regarded as defining a failure hypersurface in a six-dimensional stress space. The application of statistical penalties to this failure hypersurface is not trivial: if used improperly, statistical penalties can result in incorrect or inaccurate safety-factor predictions. The improved methods are intended to ensure proper use of statistical penalties with respect to the failure hypersurface.

The Tsai-Wu failure criterion predicts that a component will not fail if

$$\sum_{i=1}^{3}\sum_{j=1}^{5}\left[F_{ij}\sigma_i\sigma_j + F_i\sigma_i\right] < 1,$$

where σ_i denotes a tensile or compressive stress when $i = 1, 2,$ or 3; σ_i denotes a shear stress when $i = 4, 5,$ or 6; and F_{ij} and F_i are constants which can be determined by very simple uniaxial-, biaxial-, and shear-stress tests. Because of the quadratic nature of the equation, the failure hypersurface is either elliptical or hyperbolic in the six-dimensional stress space.

At first glance, one would be tempted to use statistically penalized experimental data to determine F_{ij} and F_i. In most cases in which the statistical penalties are not extreme, this approach can lead to conservative predictions of safety factors. In cases in which statistical penalties are not consistent, this approach can lead to unconservative predictions of margins of safety. For example, if slightly statistically penalized shear-strength data are used along with substantially statistically penalized tensile- and compressive-strength data in determining the failure hypersurface, something like what is shown in Figure 1 may occur: In

For More Information Write In No. 422

this case, the hypersurface generated from statistically penalized experimental data is not circumscribed by the hypersurface generated from average experimental data. This is disadvantageous as explained below.

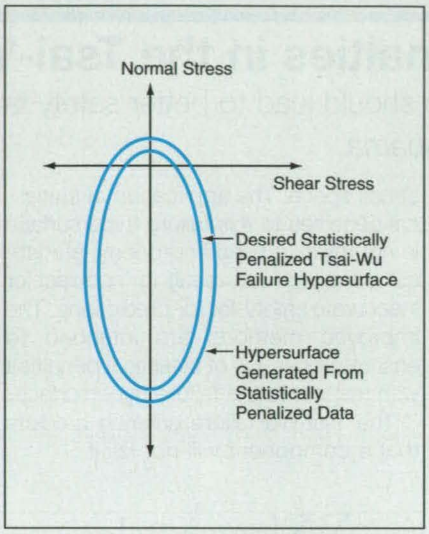


Figure 2. These **Tsai-Wu Failure Hypersurfaces** exhibit the desired relationship.

A safety factor is commonly defined as a multiplicative factor that extends a stress vector to the failure hypersurface. The intent in using statistically penalized experimental data is ordinarily to obtain a hypersurface associated with a specified probability and degree of confidence such that all components subjected to stresses that lie within the hypersurface will not fail. The example of Figure 1 does not meet this goal. In some areas of the curve, the hypersurface generated from the statistically penalized data exhibits a probability of failure greater than 50 percent. This completes the long but necessary discussion of the technical background.

The improved methods can be used to generate the desired statistically penalized hypersurfaces (for example, see Figure 2) from poor statistical data. One of the methods involves an interpolation scheme in which one calculates knock-down factors at various anchor points on the failure hypersurface (points of pure tension, compression, or shear). Knock-down factors are the penalized data divided by the unpenalized data. The statistically penalized curve is generated by reducing the radius vector to the average failure curve by an interpolated knock-down factor. This factor is calculated by interpolating between the knock-down factors at the anchor points. Interpolation can be performed by a linear technique or by a technique that involves direction cosines.

Other improved methods involve ways of determining F_{ij} and F_i and appropriately statistically penalized hypersurfaces from curve fits. A curve-fitting procedure could include minimization of a constant coefficient of variation. When the statistically penalized hypersurface is created, the constant coefficient of variation is used to reduce the radius vector to the failure hypersurface to obtain the statistically desired result.

This work was done by D. E. Richardson, R. R. Regl, M. P. Iverson, and B. E. Phipps of Thiokol Corp for **Marshall Space Flight Center.** *For further information,* ***write in 54*** *on the TSP Request Card. MFS-28895*

Bit-Wise Arithmetic Coding for Compression of Data

Code words are of fixed length, and bits are treated as being independent.

NASA's Jet Propulsion Laboratory, Pasadena, California

Bit-wise arithmetic coding is a data-compression scheme intended especially for use with uniformly quantized data from a source with a Gaussian, Laplacian, or similar probability distribution function. This scheme can serve as a means of progressive transmission or of overcoming the buffer-overflow or rate constraint limitations which sometimes arise when data compression is used.

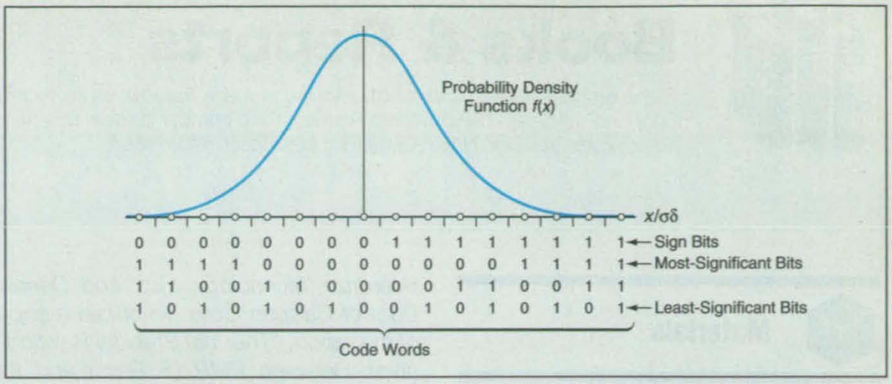
Traditionally data are compressed by substituting a binary code word for each source symbol, with shorter code words representing the more probable symbol. By contrast, under bit-wise arithmetic coding all code words are of the same length, but the more probable symbols are represented by code words containing more zeros. An arithmetic encoder exploits this imbalance to compress blocks of code words.

This first step in bit-wise arithmetic encoding is to map each quantizer output symbol to a *b*-bit code word. The first bit indicates whether the quantizer reconstruction point (the quantized value) is positive or negative. The remaining bits are assigned to quantizer levels in lexicographic order that increases with the magnitude of the input datum, *x* (see figure). Because of the symmetry of the assumed probability density function *f(x)* and the decrease in *f(x)* with increasing |x|, a 0 is more likely than is a 1 in every bit position.

Code words that correspond to *N* successive (in time) or adjacent (in space) samples of source data are grouped together. The *N* sign bits of the resulting sequence of *N* code words are encoded by use of a block-adaptive binary arithmetic encoder, a description of which would exceed the scope of this article. Then the *N* next most significant bits are encoded, and so on. This can be viewed as a simple progressive transmission scheme in that each subsequent code-word bit gives a further level of detail about the source data. Each sequence of bits is encoded independently. At the *i*th stage of each such sequence, the encoder calculates an approximation of the unconditional probability that the *i*th code-word bit is a 0. This is a potential inefficiency not suffered by Huffman coding: in general, the probability that a given bit = 0 can depend on the value of the preceding bit, but, in order to minimize overhead, this dependence is ignored in the present scheme and thus not used to advantage.

Despite this theoretical drawback, bit-wise arithmetic coding turns out to be surprisingly efficient when applied to many practical data sources. The performance of bit-wise arithmetic coding is often superior to that of Huffman coding, especially at low bit rate, because the arithmetic coder is not required to produce an output symbol for every input symbol. Finally, bit-wise arithmetic coding offers the advantage of lower overhead for the following reasons: Because the number of code words is 2^b, the overhead of block-adaptive Huffman coding increases exponentially with *b* unless one has a way of cleverly exploiting information about the source. In contrast, the overhead required for bit-wise arithmetic coding increases only linearly with *b* because the code-word bits are treated independently.

This work was done by Aaron Kiely of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 72*** *on the TSP Request Card.* *NPO-19397*



Binary Code-Word Assignments for a four-bit quantizer illustrate the first step in bit-wise arithmetic coding. The symbol denotes the standard deviation of the probability density function *f(x)*, while denotes the increment between successive quantization levels.

Books & Reports

These reports, studies, and handbooks are available from NASA as Technical Support Packages (TSPs) when a Request Card number is cited; otherwise they are available from the NASA Center for AeroSpace Information.

Materials

Thermooxidative Stability of PMR-15 Resin Composites

The purpose of this study was to look at some variables that could affect the thermooxidative stability (TOS) of PMR-15 composites. Three areas were investigated. The first was the effect of fiber/matrix interfacial bond strength on the isothermal aging weight loss of composites. The aging degradation of PMR-15 neat resin and its unidirectional composites is a reaction that is controlled by the exposed surface area of the specimens.

This work was done by Kenneth J. Bowles of **Lewis Research Center**, *Douglas Jayne of Case Western Reserve University, Todd A. Leonhardt of Sverdrup Technology, Inc., and Dennis Bors of Calspan Corp. To obtain a copy of the report, "Thermal Stability Relationships Between PMR-15 Resin and Its Composites,"* ***write in 35*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Lewis Research Center; (216) 433-2320. Refer to LEW-16202.

Manufacturing/ Fabrication

More About Brazing or Welding NiAl Without Filler

Two reports present additional information about two processes for joining, brazing, or welding workpieces made of nickel aluminide alloys, without use of filler metal. These are joining processes that involve uniform heating in a vacuum-controlled furnace. This eliminates internal thermal gradients in the workpieces to be joined and greatly reduces the tendency toward cracking.

This work was done by Thomas J. Moore of **Lewis Research Center** *and Joseph M. Kalinowski of Sverdrup Technology, Inc. To obtain copies of the reports, both entitled "Brazing With Self-Generated Filler Metal,"* ***write in 67*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Lewis Research Center; (216) 433-2320. Refer to LEW-15671.

Life Sciences

Thirst, Drinking Behavior, and Dehydration

A report describes a review of the physiological mechanisms of involuntary dehydration. The researchers considered cellular dehydration and the effects of sodium on thirst, as well as extracellular dehydration and restoration of vascular volume, the effect of renin on thirst, and the effects of heat. Involuntary dehydration occurs primarily in conjunction with physiological stress, whether caused by the environment, exercise, or other factors. Involuntary dehydration was controlled by fluid consumption, gastric capacity, the rate of absorption of fluid, and the degree of cellular hydration.

This work was done by John Greenleaf of **Ames Research Center**. *To obtain a copy of the report, "Problem: Thirst, Drinking Behavior and Involuntary Dehydration,"* ***write in 56*** *on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Ames Research Center; (415) 604-5104. Refer to ARC-13228.

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MID-WEST EXPRESS STOCK SPRINGS CATALOG

New, 56-page catalog describes over 1,500 different stock springs and spring kits available for immediate delivery. Compression, extension, torsion, continuous, hot wound, die, extension and specialty springs are described. Mid-West Express, a division of Mid-West Spring Manufacturing Company, 1404 Joliet Road, Unit C, Romeoville, IL 60441; Tel: 800-619-0909.

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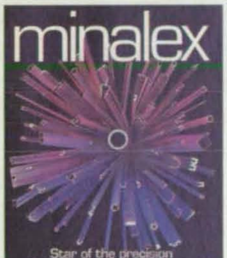

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WORLD OF CLAMPING

The World of Clamping Catalog 5/95 describes and illustrates toggle and special clamps with vertical and horizontal hold-down, straight-line, latch, and squeeze action. Spacing products, hydraulic devices, and CAD databases are covered, along with applications. De-Sta-Co, Box 2800, Troy, MI 48007; Tel: 800-245-2759.

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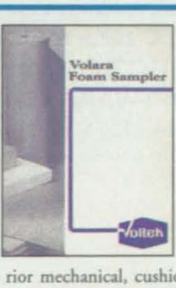

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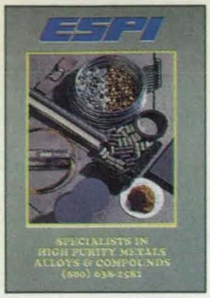

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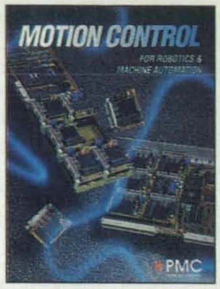

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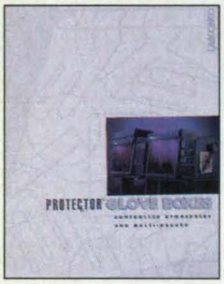

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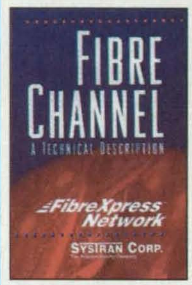

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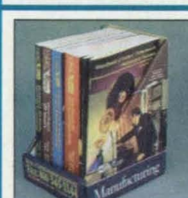

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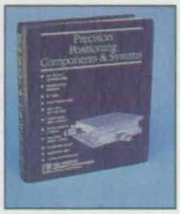

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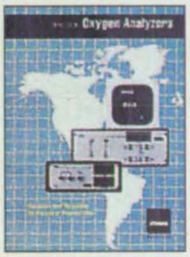

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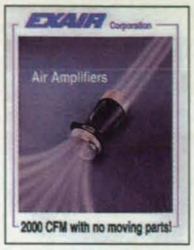

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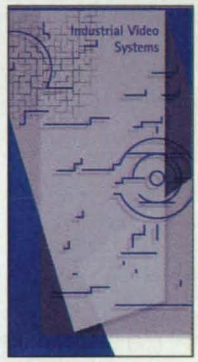

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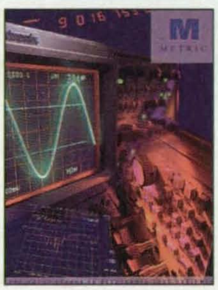


INSTRUMENT CATALOG 1996

Metric sells, rents and buys the latest in refurbished electronic test and measurement instruments from Hewlett Packard, Tektronix, Fluke, Keithley, etc. All products are tested in our lab to insure compliance to original manufacturers' specifications and are traceable to N.I.S.T. Six-month warranty on most models, five-day free trial, complete with accessories and manuals. BIG SAVINGS 20% to 60% off list. For free catalog call Metric; Tel: 800-432-3424; Fax: 415-341-8874.

Metric Equipment Sales, Inc.

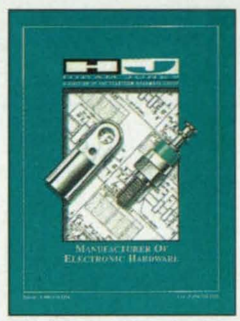
For More Information Write In No. 339

FREE EXTRUDED POLYMER SEAL DESIGNER'S GUIDE

Our new 32-page guide gives OEM designers the basic facts needed to develop effective extruded polymer seals, gaskets and weather stripping. It features sections on sponge and solid extrusions, color matching, adhesive fastening systems, seal/gasket design, and RMA tolerance tables. Lauren Manufacturing, 2228 Reiser Ave. SE, New Philadelphia, OH 44663; Tel: 800-683-0676 or 330-339-3373; Fax: 330-339-7166.

Lauren Manufacturing

For More Information Write In No. 340



Hiram Jones Electronics, Inc./A Division of the Seastrom Hardware Group manufactures a complete line of standard miniature and subminiature terminals including: insulated test jacks, assembled standoffs and press-type terminals. All standard catalog items are available for immediate pricing and delivery. Call today for your free 27-page catalog: 800-634-2356.

Hiram Jones Electronics, Inc.

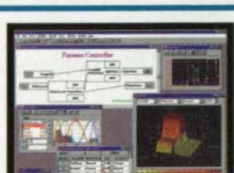
For More Information Write In No. 341

COMPOSITE BEARING MATERIALS

Orkot Inc. offers three full-color brochures featuring the complete line of composite bearing materials covering a wide range of bearing applications in the marine, hydroelectric and industrial industries. These materials offer unique mechanical and physical properties that make it an ideal bearing material. Orkot is self-lubricating and manufactured in tubes, sheet and finished product. Complete specs and prices are available for all products. Orkot Incorporated, 2535 Prairie Rd., Eugene, OR 97402; Tel: 541-688-5529; Fax: 541-688-2079.

Orkot Incorporated

For More Information Write In No. 342

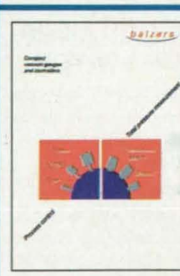


CONTROL THE WORLD WITH VISSIM/FUZZY-TECH

VisSim/fuzzyTECH works seamlessly with VisSim™ to create an ideal environment for fuzzy control development and simulation. Additional VisSim add-ons include C code generation, communication design, real-time I/O, neural networking, constrained optimization, and frequency domain analysis. VisSim is used for 6-DOF guidance, anti-lock braking, servo and drive motor control, web processes, winders, gas turbines, and data communications.

Visual Solutions, Inc.
487 Groton Road
Westford, MA 01886
Tel: 508-392-0100 Fax: 508-692-3102

For More Information Write In No. 343



LOW-COST COMPACT GAUGES

Balzers-Pfeiffer offers a complete line of low-cost, compact gauges and controllers to meet all total pressure measurement needs. It includes capacitance, Piezo, Pirani, Cold Cathode and FullRange™ gauges. The popular FullRange gauge combines two gauges in one compact housing to measure from atm. to UHV with or without a controller. Contact: Craig Lazinsky, Balzers-Pfeiffer North America, 8 Sagamore Park Rd., Hudson, NH 03051; Tel: 603-595-3200; Fax: 603-595-3250.

Balzers-Pfeiffer North America

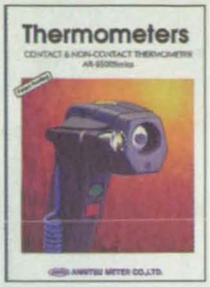
For More Information Write In No. 344

MAGNETIC FIELD MEASUREMENT MADE EASY

Literature describes the MG-4D, a handheld Hall effect gaussmeter. Designed as a self-contained instrument for DC and AC (RMS) magnetic field measurements from 10Hz to 20kHz. It provides both the convenience of handheld portability and the accuracy associated with laboratory instruments. Three full-scale bipolar ranges of ±100.0 gauss, ±1000 gauss, and ±10.00kG with 100% over-range and resolution of 0.01% provides DC and AC field readings from ±0.1 gauss to ±150kG with select probes. Walker Scientific Inc., Rockdale St., Worcester, MA 01606; Tel: 508-852-3674 or 800-962-4638; Fax: 508-856-9931.

Walker Scientific Inc.

For More Information Write In No. 345



PRECISION TEMPERATURE MEASUREMENT

Over 5,000 models are detailed in a 90-page catalog. Accuracy of 0.2% and response time down to 200 msec. Temperature of fluids and gases, stationary and moving surfaces. Anritsu Meter Co., 795 Franklin Ave., Franklin Lakes, NJ 07417; Tel: 800-457-2999 or 201-848-0033.

Anritsu Meter Co.

For More Information Write In No. 346

REMOTE VIEWING INSTRUMENTS

Inspecting inaccessible areas or hostile environments is easy with ITI's 1800+ rigid & flexible instruments, specially built to suit aviation & aerospace needs. Custom work a specialty. Instrument Technology, Inc. - The Leader in Remote Viewing, PO Box 381, Westfield, MA 01086; Tel: 413-562-3606; Fax: 413-568-9809; E-mail: iti@scopes.com; http://www.scopes.com.

Instrument Technology, Inc.

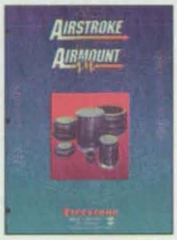
For More Information Write In No. 347

ESDU CATALOG

18-page catalog summarizing the content of more than 230 volumes of validated engineering design data and over 160 associated computer programs for aeronautical, mechanical, structural, and chemical engineers. The aeronautical subjects include: aerodynamics, composites, dynamics, fatigue, noise, performance, structures, transonic aerodynamics, vibration & acoustic fatigue, and metallic material properties. ESDU International PLC, PO Box 1633, Manassas, VA 22110; Tel: 703-631-4187; Fax: 703-330-1642.

ESDU International PLC

For More Information Write In No. 348



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Firestone Industrial Products Company has prepared product specification brochures on its Airstroke® actuators/Airmount® isolators, and its Airpicker® and Airgripper® pneumatic devices. For free copies, contact: Firestone Industrial Products Co., 701 Congressional Blvd., Carmel, IN 46032; Tel: 800-888-0650; Fax: 317-580-2345.

Firestone Industrial Products Co.

For More Information Write In No. 349

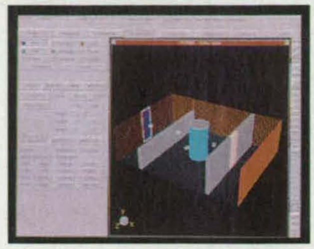
FLEXIBLE BORESCOPES

Visual inspections can be made easy with the use of a flexible borescope. Machida, Inc.'s color brochure details their complete line of quality flexible borescopes designed for various industrial inspections. Machida borescopes can accommodate most any inspection when the elimination of costly tear down is necessary. Also highlighted are specialized turbine inspection kits, bending borescopes, scopes with channels and working tools, video systems, light sources, and related accessories. Machida Inc., 40 Ramland Rd. South, Orangeburg, NY 10962-2698; Tel: 914-365-0600; Fax: 914-365-0620.

Machida Inc.

For More Information Write In No. 350

New on Disk



Adaptive Research, Huntsville, AL, has introduced a Windows version of CFD2000® **computational fluid dynamics simulation and analysis software** for aerodynamics, electronics, metallurgical, and environmental flow applications. For use with Windows 95 and NT, the program integrates automatic mesh generation, 3D turbulent Navier-Stokes equation solvers, and visualization tools. The cost is $9995.

For More Information Write In No. 740

FORMTEK, a Lockheed Martin company, Palo Alto, CA, has announced Stellar TDM **electronic product information management software**, which provides data management, ad hoc workflow and Internet access, and an integrator tool kit for viewing, editing, redlining, conversion, and plotting. The program combines FORMTEK:TDM™ for data access, management, and version control; plug-in modules for review, security, distribution, and annotation management; and an imaging product suite. The package price ranges from $200 to $2500.

For More Information Write In No. 742

Algor Inc., Pittsburgh, PA, has announced DocuTech **information resource software**, which provides software documentation, educational, and product information through an Internet-style search engine. The CD-ROM program includes software user documentation, accuracy verification problems, case histories, educational materials, and general product information. It is included with all Algor software for Windows 95, Windows NT, and UNIX platforms.

For More Information Write In No. 750

CAD/3X, Boulder, CO, offers CAD/3X Drafter **2D CAD software** for sketching and drafting of 2D designs. Features include geometry editing, parametric parts, on-line graphical help, and a selection of lines, arcs, curves, and symbols. The program is available for a limited time at $129.

For More Information Write In No. 744

GraphiC for Windows 95 **scientific drawing software** from Scientific Endeavors Corp., Kingston, TN, is a C library of more than 240 functions that enables users to write scientific graphing programs without GUI programming. Linear and logarithmic X-Y plots, 3D surfaces, and a variety of charts can be created. The program is priced at $495.

For More Information Write In No. 745

Version 2.5 of Scientific WorkPlace and Scientific Word **mathematics communication software** for Windows from TCI Software Research, Las Cruces, NM, combines text with a method of writing mathematics in the same document window. WorkPlace provides a link to Mathematica® for manipulating or plotting mathematical expressions. WorkPlace and Word are priced at $595 and $375, respectively.

For More Information Write In No. 747

Logical Vision Ltd., Burnaby, BC, Canada, has announced WiT **visual programming software** for designing image processing and analysis algorithms used in scientific, medical, and industrial problem-solving applications. Features include built-in libraries in data conversion, flow control, filtering, measurement, morphology, and segmentation. The program runs on Windows and Sun platforms.

For More Information Write In No. 748

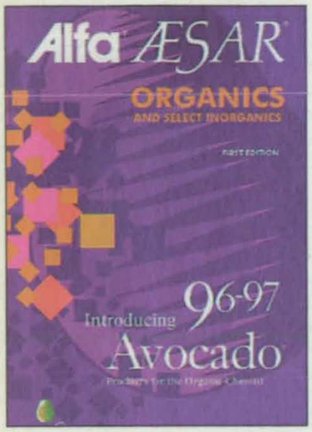
Bridge2000™ **date change software** from LexiBridge Corp., Monroe, CT, is a program for CICS/COBOL computer applications facing problems related to improper handling of the year 2000 date change. The program discovers and corrects two-digit year cases in a system's data structures and implements necessary changes in referencing program logic.

For More Information Write In No. 749

Computer Aided Design Software (CADSI®), Coralville, IA, has released revision 8 of its Dynamic Analysis and Design System (DADS) **3D mechanical system simulation and animation software** for Windows NT and UNIX platforms. It enables mechanical engineers to simulate, animate, and evaluate the performance of 3D mechanical systems and provides texture mapping, parametric modeling, and integrated simulation within CAD programs.

For More Information Write In No. 743

New Literature

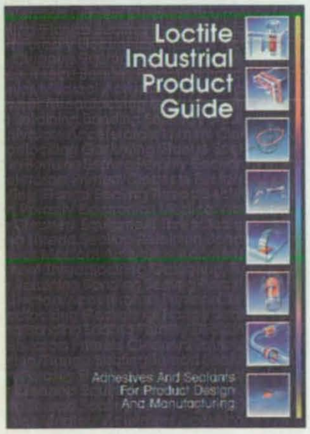


The 1996-97 Avocado Organics Catalog from Alfa Aesar, Ward Hill, MA, features a new line of **organic chemicals** for use by research and development chemists. More than 20,000 related products are described, including inorganic chemicals used in the synthesis of organic materials.

For More Information Write In No. 755

Deltron, North Wales, PA, has released a 40-page brochure describing **linear and switching power supplies**. Switchers are available with one to seven outputs, from 120 to 2000 watts; linears are available in standard sizes with one to three outputs.

For More Information Write In No. 756



An Industrial Product Guide from Loctite Corp., Rocky Hill, CT, describes **adhesives and sealants** for use in electronics, medical equipment, and industrial design. Sections on threadlocking, threadsealing, gasketing/flange sealing, retaining, bonding, and sealing porosity are included.

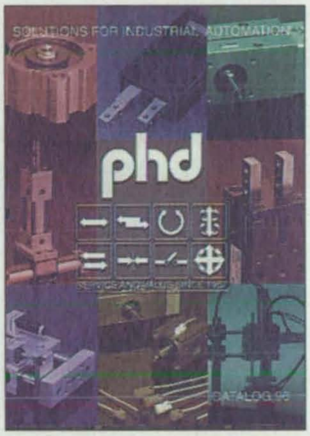
For More Information Write In No. 757

American Linear Manufacturers, Westbury, NY, offers a catalog describing crossed-roller **linear motion products**, including bearings, slides, and motorized stages. Also featured are custom assemblies, product modifications, options, and accessories.

For More Information Write In No. 760

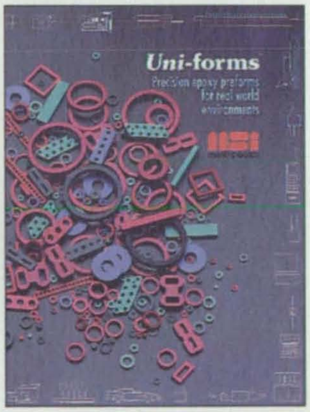
Analogic's Data Conversion Products Group, Peabody, MA, has announced a 192-page catalog of **data conversion components**, which includes hybrid, modular, and board-level products. Featured are A/D converters, DC-to-DC converters, amplifiers, and data acquisition boards for design engineers in medical, CCD imaging, instrumentation, and spectroscopy fields.

For More Information Write In No. 758



Catalog 96 from PHD Inc., Fort Wayne, IN, features **automation components** such as linear actuators, grippers, powered slides, rotary actuators, switches, sensors, cylinders, and accessories. Also included are product sizing software, videotapes, and CD-ROMs.

For More Information Write In No. 761



Multi-Seals, Manchester, CT, has introduced a four-page brochure on Uni-Forms® **epoxy preforms** for aerospace, computer, electronics, fiber-optic, medical, and military applications. Included are standard and custom epoxy preforms.

For More Information Write In No. 765

A catalog of **data acquisition products for PCs** from United Electronic Industries, Watertown, MA, describes hardware, software, third-party drivers, and OEM support programs. The line of high-speed, high-channel-count products includes 1 MHz, 12-bit and 200 kHz, 16-bit boards.

For More Information Write In No. 762

StacoSwitch, Costa Mesa, CA, has released a 24-page Lighted Pushbutton Switch designer's guide, which covers the Series 80 Sunlight Readable **lighted switches and indicators**. The catalog provides electrical and mechanical designers with MIL QPL listings, electrical switching characteristics, and accessories.

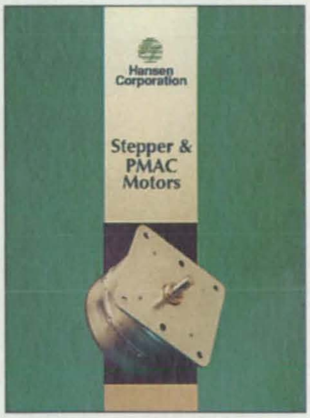
For More Information Write In No. 763

Actuators are described in an eight-page brochure from Bimba Manufacturing Co., Monee, IL. Featured are Double-Wall® cylinders, stainless steel and position feedback cylinders, Ultran® rodless cylinders, Pneu-Turn® rotary actuators, flow controls, quick connect switches, and custom actuators.

For More Information Write In No. 764

Exergen Corp., Watertown, MA, offers the IRt/c™ Handbook of **non-contact temperature sensors**, which includes more than 300 sensor models and accessories, thermal switch models for adhesive detection, and handheld scanners. A selection/installation guide, application notes, and case histories also are featured.

For More Information Write In No. 767

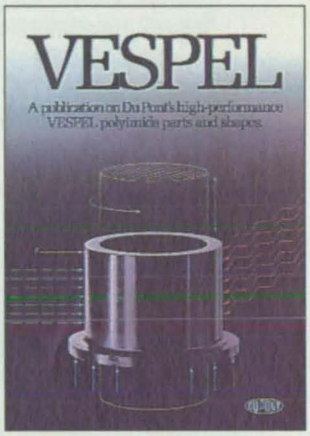


Hansen Corp., Princeton, IN, offers a 16-page brochure describing **stepper and PMAC motors** with various torque ranges and step angles. Included are standard features and specifications, dimensional diagrams, and available options for each model.

For More Information Write In No. 769

A 28-page **switching systems** catalog from Keithley Instruments, Cleveland, OH, describes four mainframes handling from 80 to 576 channels and 54 different switching cards that plug into mainframe slots. The systems connect multiple test points and instruments in R&D systems, engineering work stations, and automatic test equipment. Also included are memory, programming, and connection options.

For More Information Write In No. 759



Vespel **polyimide parts and shapes** from DuPont Engineering Polymers, Newark, DE, are described in a 12-page brochure. Technical data on Vespel SP includes dimensional stability; wear, temperature, and radiation resistance; machining and fabricating capabilities; and sealing compliance. Also featured are applications and benefits.

For More Information Write In No. 766

A 32-page catalog describing **board-level computers for industrial automation** is available from American ELTEC, Princeton, NJ. Products include basic automation boards, scalable VMEbus processors, carrier boards, interfaces, analog I/O boards, programmable logic controllers, and related software.

For More Information Write In No. 768

New on the Market

Product of the Month

Nomadics, Stillwater, OK, offers **modular instruments,** which use desktop, laptop, and handheld computers in conjunction with credit-card-sized plug-in devices, allowing engineers to carry lightweight instruments or free up bench space. The instruments work with any computer equipped with a PCMCIA slot, and consist of a sensor interfaced to the PCMCIA card. Data does not need to be transferred from an instrument to a computer for processing, display, or storage; it can be viewed in multiple real-time formats. Instrument functions can be integrated with other capabilities resident on the computer, such as communication via modem. Available instrument cards include a basic pH card kit; a pH logging system; a conductivity meter; a thermocouple datalogger; and a six-channel thermistor datalogger card with Windows-based software.

For More Information Write In No. 700

Polaroid Corp. Electronic Imaging Systems, Cambridge, MA, has introduced the PDC-2000 **digital camera,** which captures 24-bit color digital images that can be transferred to any computer or printed at a resolution level as high as 1600 x 1200 pixels. It can be used for image archiving, multimedia programs, surveillance and security, and other industrial applications. The camera features automatic exposure control, auto-focus, and automatic flash. Images are date- and time-stamped when transferred to any Macintosh or Windows-compatible computer.

For More Information Write In No. 720

The Turcon® Roto Glyd Ring® double-acting **rod and piston seal** for rotary or oscillating applications is available from Busak+Shamban Seals Division, Fort Wayne, IN. The low-friction seal provides abrasion resistance and is designed for use under high pressure and at low sliding speeds. It can be used for internal and external sealing applications.

For More Informaton Write In No. 723

Series 1005 **AC current transducers** from American Aerospace Controls, Farmingdale, NY, are available in 15 current ranges from 0 to 2Aac through 0 to 300Aac. The non-intrusive, self-excited current sensing devices require no auxiliary power and feature output of 0 to 5Vdc. Internal components are protected by a plastic case that withstands storage temperatures from -55°C to 85°C.

For More Information Write In No. 721

The RTU-1 microPower **data logger/programmable controller** from Synetcom Digital, Redondo Beach, CA, records and reports data from standard analog and digital remote site sensors, via radio link or local RS232, to a PC. Features include an internal radio-compatible modem, RS232 serial port, four analog and four digital inputs, two contact closure output lines, and an internal solar panel regulator/battery charger.

For More Information Write In No. 733

Communications Specialties, Hauppauge, NY, has announced the Scan Do Ultra **video scan converter,** which supports high-resolution PC and Macintosh computer workstations. Features include composite, S-Video, RGB, and YUV outputs; genlock support; multiscanning; dual computer inputs; and variable sizing and positioning. It provides VGA, SVGA, and Macintosh compatible down converted outputs.

For More Information Write In No. 725

New on the Market

Oce-Engineering Systems, Chicago, IL, has introduced the 9400 mid-volume **large-format plotter**, which uses electrophotography and radiant fusing imaging technology to produce two "E"-sized plots per minute. The system incorporates one or two 500-foot rolls of plain paper, film, or vellum. It can be controlled through Oce Plot Director software, which supports a variety of CAD formats and includes AutoCAD and Windows drivers.

For More Information Write In No. 724

The ECCM3 and ECCM4 **microprocessor crystals** from Ecliptek Corp., Costa Mesa, CA, are glass surface mount devices that offer frequency stability with minimal board space requirements. They are available in nominal frequency ranges of 11 MHz to 120 MHz and can sustain ±5 ppm stability over a temperature range of -20°C to +80°C.

For More Information Write In No. 726

EME Fan & Motor, Irvine, CA, has introduced Sunon **mini-fans** for air movement in small, confined areas. The fans provide low power consumption and feature an 8-pole design. Available sizes include diameters of 20mm, 25mm, 30mm, and 35mm. The 5-volt and 12-volt fans are offered in ball bearing models.

For More Information Write In No. 727

Nicolet Instrument Technologies, Madison, WI, offers the 2580-P **waveform analyzer**, which collects multiple channels of analog data via data acquisition hardware. The hardware is linked internally via a parallel bus to a Pentium® 120 MHz computer with a color TFT display and Windows software for analysis and control. More than 80 analysis functions can be performed on data sets of any length. A built-in report generator creates color documents.

For More Information Write In No. 730

Stock Drive Products, New Hyde Park, NY, has introduced the D34D62-22 Series of 1.8° full-step angle **hybrid stepping motors**, which operate at 200 steps per revolution and provide holding torques from 26 to 142 oz. in. They operate in ambient temperatures from -20°C to +50°C and run either clockwise or counterclockwise. The motors can be specified with single- or double-ended 0.25" diameter hardened steel shafts.

For More Information Write In No. 732

Total Temperature Instrumentation, Williston, VT, offers the SMPS DIN **rail-mounted power supply**, which converts an input voltage of 85 to 264 VAC 50/60 Hz to 24 VDC. The device is used to provide power to field transmitters and other instruments that run on 24 VDC. It features built-in short circuit protection for overload and a high wattage output.

For More Information Write In No. 734

Stratasys, Eden Prairie, MN, has introduced the Genisys™ **rapid prototyping system**, which acts as a 3D printer, allowing the user to print concept design iterations at a desk from a workstation. AutoGen™ software orients and scales the part, slices the data, and automatically builds the part. Three-dimensional prints up to 8" x 8" x 8" can be produced in a plastic polymer material. The system operates on Sun, Hewlett-Packard, and Silicon Graphics workstations, as well as Windows NT.

For More Information Write In No. 735

Infinity Photo-Optical, Boulder, CO, has introduced the InFocus™ **internal focusing system for microscopes**, which fits atop the stand of most microscopes. The system optically sections through cell structures in 3D and confocal microscopy, and corrects aberration and contrast losses. It is available for infinity-corrected or fixed-tubelength DIN-standard objectives. Binocular/trinocular interfaces are available.

For More Information Write In No. 729

Marketplace

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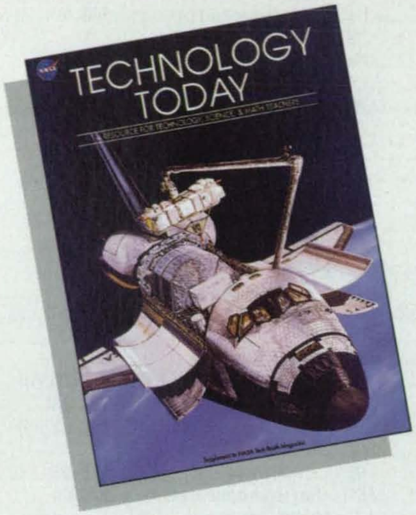

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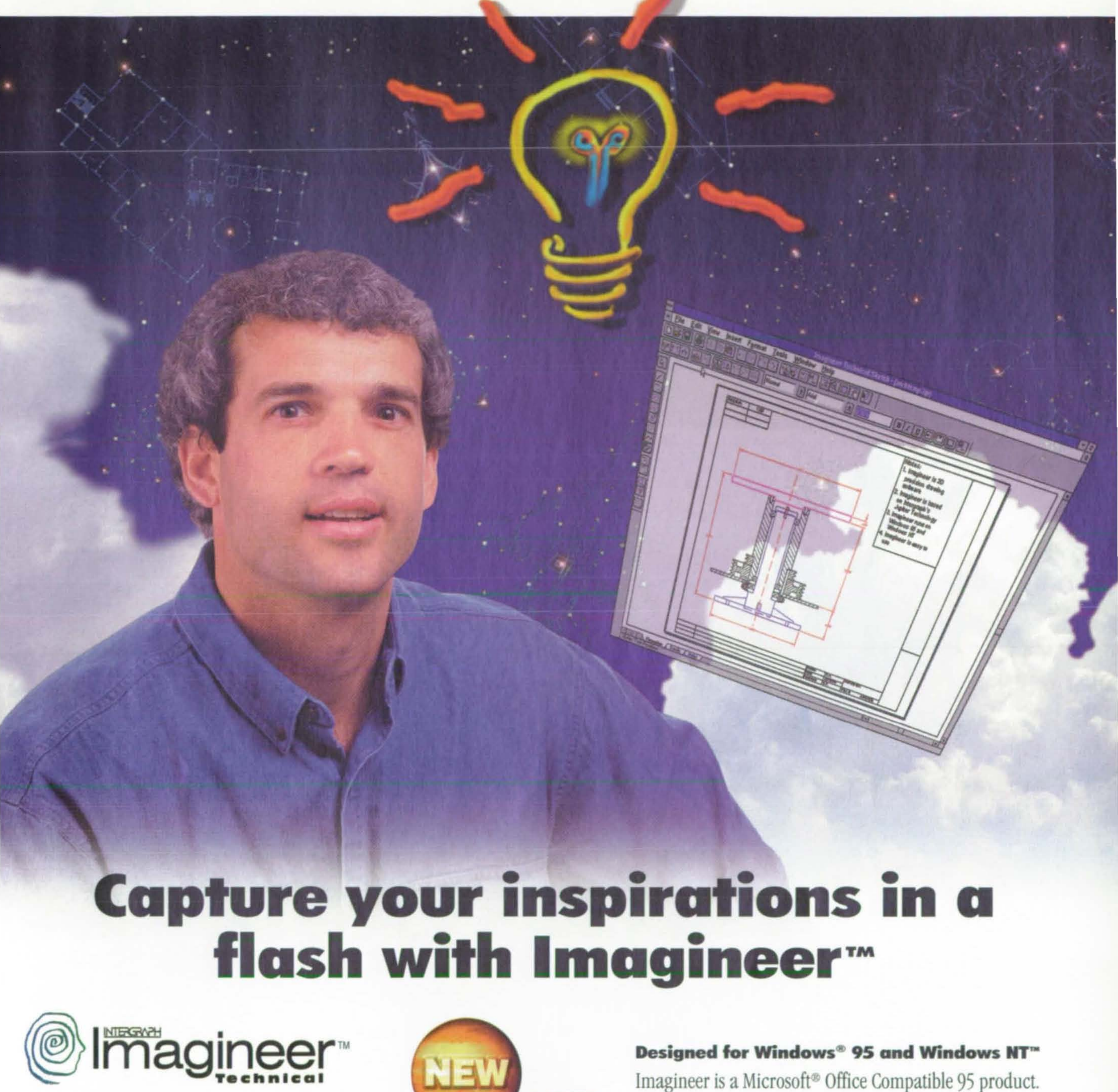

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