NASA Tech Briefs

THE DIGEST OF NEW TECHNOLOGY

Official Publication of the National Aeronautics and Space Administration
October 1994 Vol.18 No.10

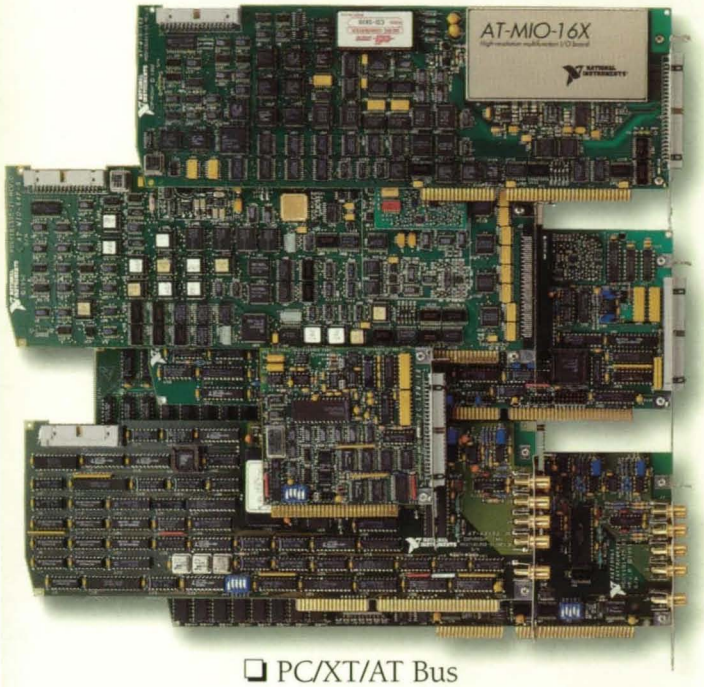
Transferring Engineering Technology to Over 200,000 Qualified Readers Throughout Industry and Government

TECHNOLOGY 2004

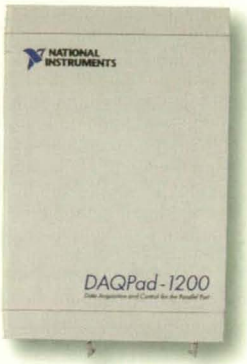
Exhibits Preview

Data Acquisition And Analysis

Multiple Choice.

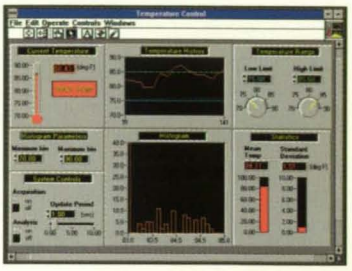


❑ PC/XT/AT Bus

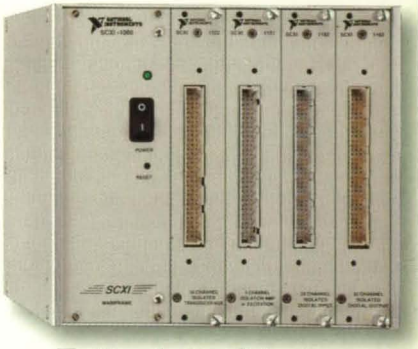


❑ Parallel Port

❑ PCMCIA



❑ Software



❑ Signal Conditioning

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Contents

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FEATURES

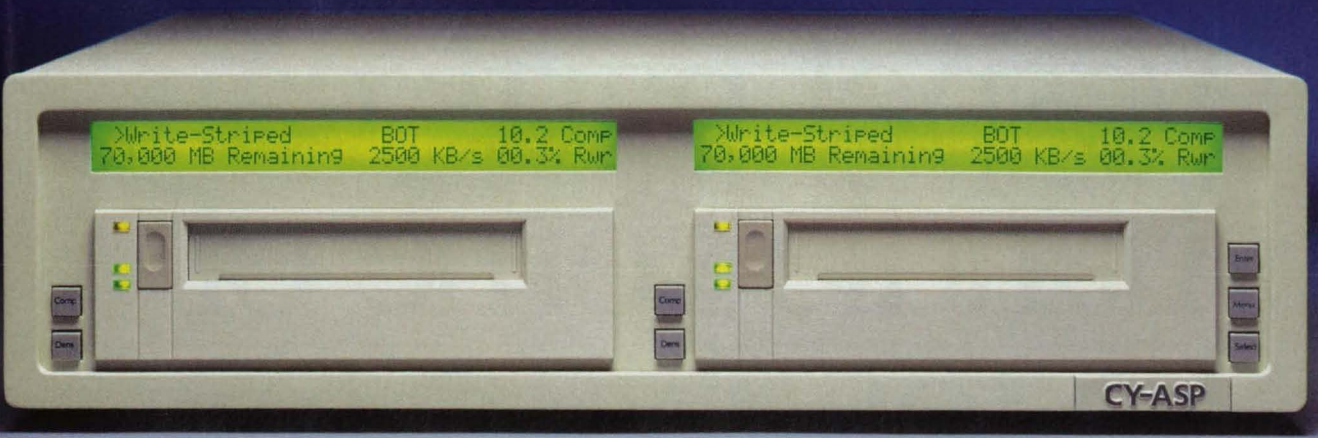
TECHNICAL SECTION

(continued on page 6)

Laser power converters designed by Technology 2004 exhibitor Spire Corporation convert approximately one watt of laser power into electrical power with up to 60 percent efficiency. Similar in operation to high efficiency solar cells, the units are designed for specific wavelengths corresponding to commonly available lasers. For more information on these and other innovative technologies see the Exhibits Preview beginning on page 10.

Photo courtesy Spire Corporation

At 200 MB Per Minute, We're Setting The Pace.



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AT&T	Novell
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Concurrent	PS/2
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Data General	PC 386/ix
DEC SCSI	PC MS-DOS
DEC BI-Bus	PC Xenix/Unix
DEC DSSI	Pertec
DEC HSC	PICK
DEC Q-Bus	Plexus
DEC TU/TA81	Prime
DEC Unibus	Pyramid
Gould/Encore	Sequent
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IBM RT	Texas Instruments
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In ***Striping Mode*** data writes to two or more tapes at once, maximizing throughput.

Consider it a data storage management tool, a solution that will help you solve the problems you encounter every day: the need for higher capacity and speed, the need to make duplicate tapes for off-site storage and data exchange, the need for real-time status information, and the need to save resources and boost productivity on every level.

Of course, we also know that a storage solution is only as good as the data you get back. With a bit error rate of less than 1 in 10^{17} bits read, the CY-ASP gives you the *highest* data integrity.

Based on proven 8mm helical scan technology, each drive supports our switch-selectable *data compression* option. And each drive features a 2-line, 40-column backlit display that gives complete status information.

Backed by a two year warranty that includes expert service and support from our in-house engineering group, the CY-ASP is setting the pace in performance, flexibility and value.

Other configurations are available, ranging from a 2.5 GB subsystem to an intelligent, automated 3 TB tape library. And they're all compatible with the widest range of computer systems and networks.

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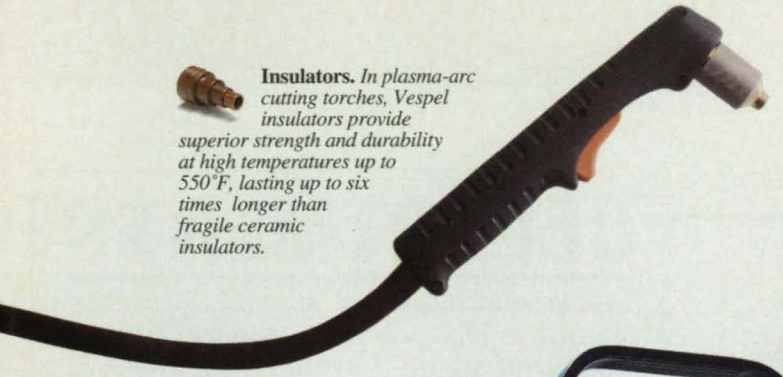


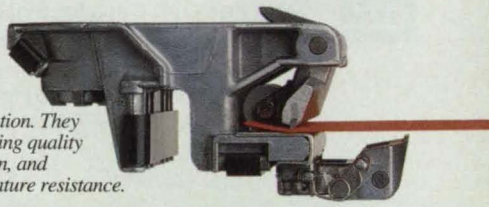
Insulators. *In plasma-arc cutting torches, Vespel insulators provide superior strength and durability at high temperatures up to 550°F, lasting up to six times longer than fragile ceramic insulators.*

Seal Rings. *In the assembly of automobile transmissions, Vespel seal rings reduce costs by replacing expensive metal rings, which can fracture or deform during assembly. They also reduce warranty costs by producing a better seal.*

Thrust Washers. *In farm tractor transmissions, Vespel thrust washers reduce costs and manufacturing time by eliminating the need for secondary machining. Vespel washers also exhibit high performance and low wear with limited or no lubrication.*

Bearings. *In photocopiers, Vespel composite idler gear hub bushings are a cost-effective alternative to metal. The Vespel parts provide ultra-high temperature resistance and dimensional stability while offering a low coefficient of friction, as well as long life without lubrication.*

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



Wear Strips. *In textile equipment, Vespel tenter frame clip wear strips reduce costs by eliminating the need for lubrication. They also improve textile manufacturing quality by eliminating oil contamination, and provide good wear and temperature resistance.*

also be considered if you have parts that rub together, if metal parts are too noisy, or if fluid flow needs to be controlled.

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Contents *(continued)*

DEPARTMENTS

On the cover:

At Technology 2004 the US Army Research Laboratory will highlight electronic analysis technology such as the Thermal Desorption Mass Spectrometer. The device enables researchers to probe compound semiconductor material samples to determine binding energies, surface reaction rates, and desorbed species in rapid succession at concentrated levels of parts per billion. Turn to the Technology 2004 Exhibits Preview on page 10.

Photo courtesy US Army Research Lab

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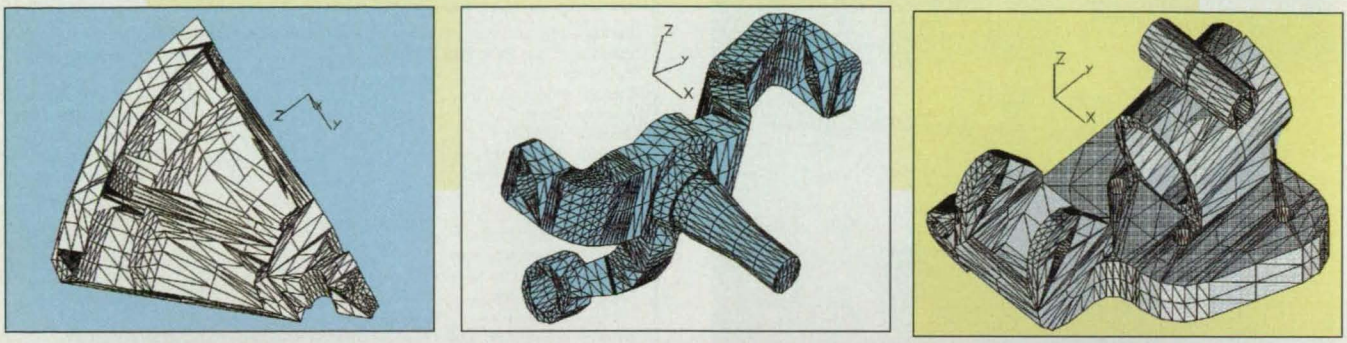
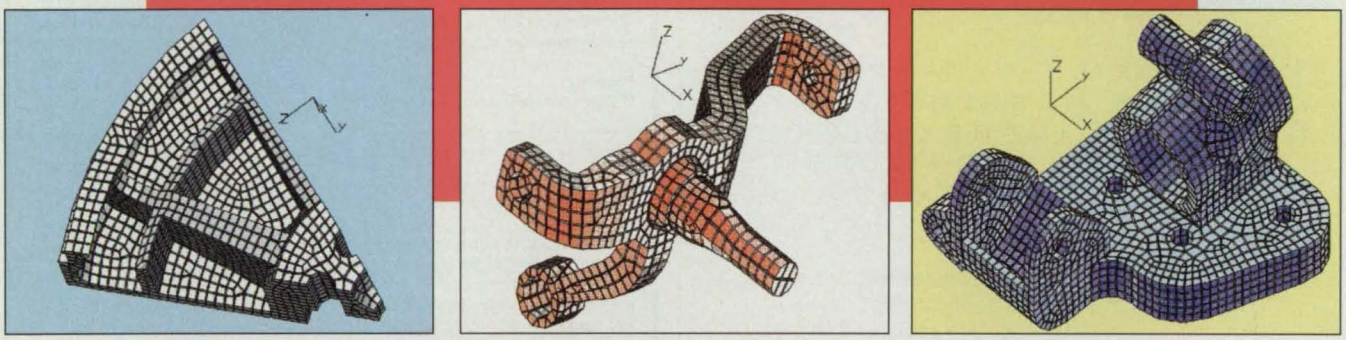
Merlin™ Mesh Enhancement Technology gives you the highest quality finite element mesh available

Typical unconditioned meshes from "competitive" products



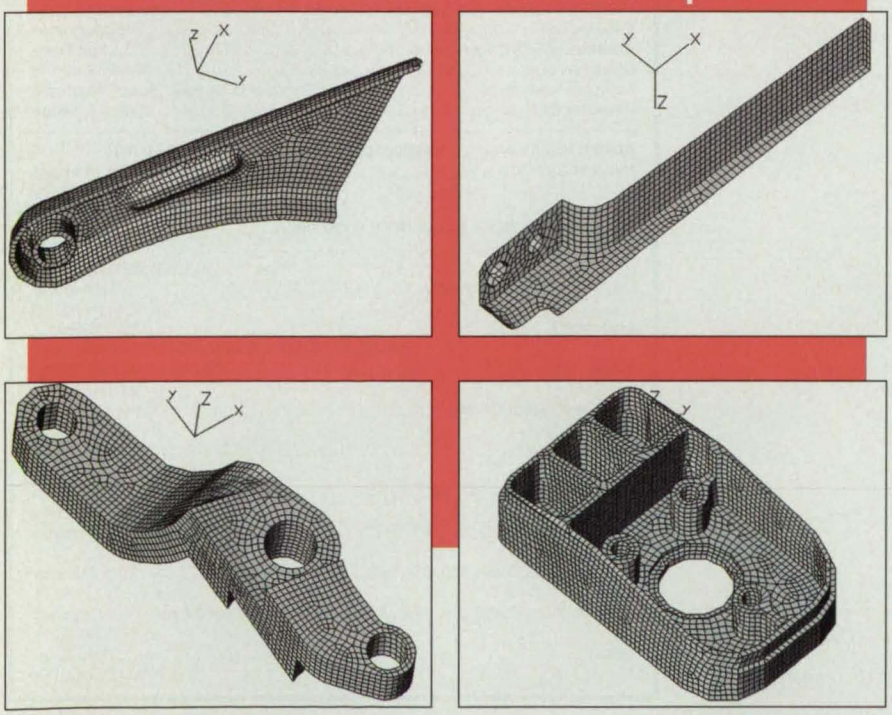
After Merlin™ one-step mesh enhancement technology



(Algor brick element models above shown with an 85% shrink-element factor.)

Merlin produces engineering-quality, quadrilateral surface meshes for high-accuracy plate/shell FEA or 8-node "brick" element generation using Hexagen (fully automatic). Merlin enhances the mesh quality of Algor's modeling and design software. In addition, Merlin is included in Houdini™ which is unique software that takes existing or new CAD solid models and automatically creates high-accuracy, 8-node "brick" finite element models.

Additional "After Merlin" Examples



Merlin technology turns a 3- or 4-node surface mesh or CAD solid model into a high quality 4-node mesh in an easy, one-step process.

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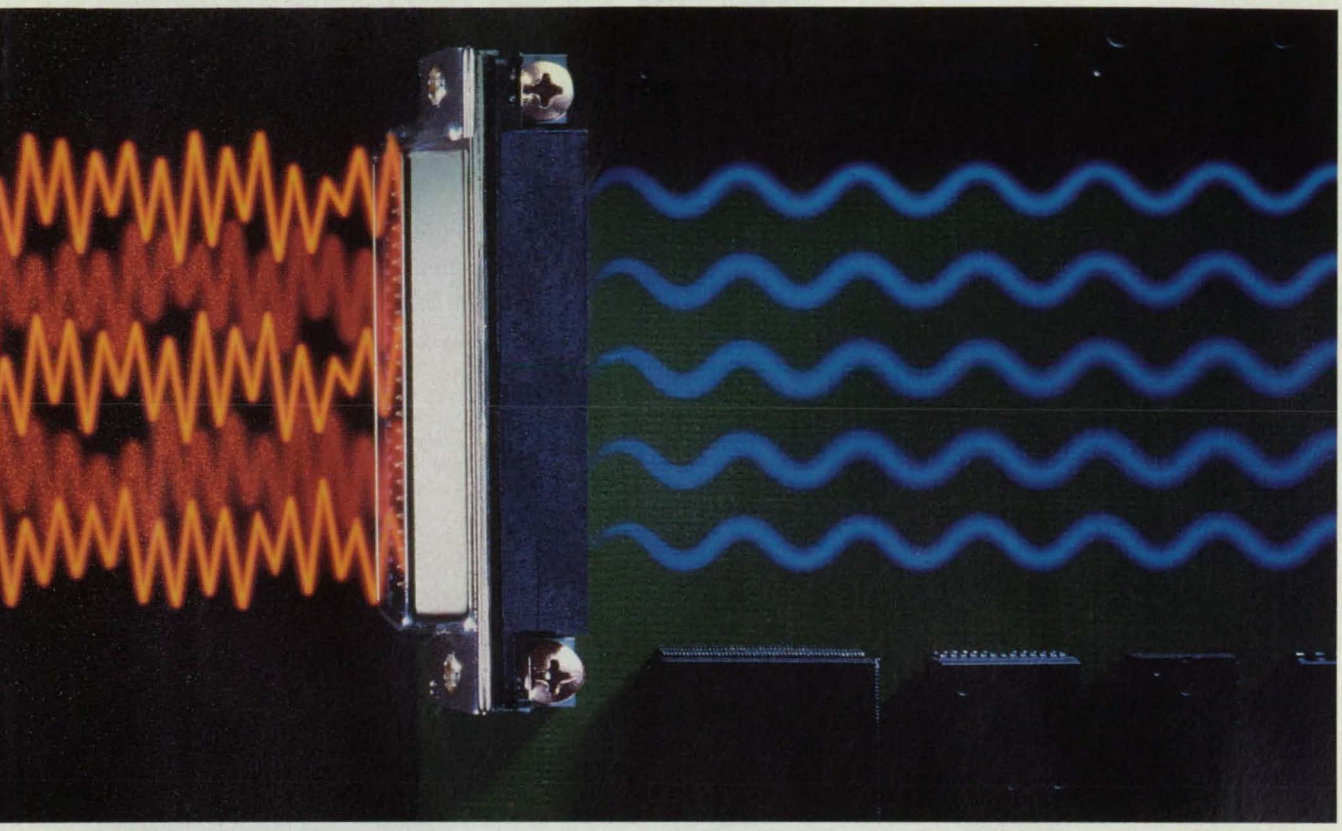
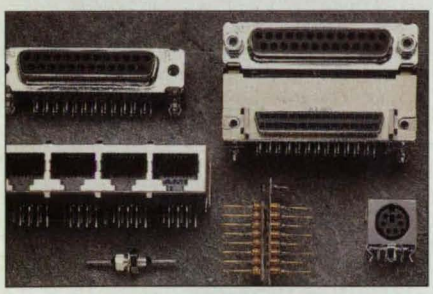
AMP filtered connectors drop in. EMI problems drop out.





FILTER TYPE	INSERTION LOSS*
Ferrite	3-8 dB
Capacitive Film	10-30 dB
Chip Capacitor	10-40 dB
Capacitive Array on Ferrite	15-40 dB
Tubular Capacitor	20-40 dB
Distributed Element	20-90 dB

*typical performance @ 100MHz, 50 Ω system)

If you're tackling EMI noise problems with discrete components on the pcb, we've got a much better idea for you. AMP filtered connectors provide the EMI answer you're looking for – and they do it quicker, and easier, at a lower cost.

These one-piece, fully integrated problem-solvers drop right in to standard footprints – eliminating the hassle and time loss of board redesign when you find yourself facing EMI problems in a finished design, or in an existing product.

And if you need to control costs, just add up the expense of on-board filtering – loose components, inventory cost, extra assembly steps, and lost board real estate – and compare for yourself. Filtered versions of our most popular connector types do a better job, with solid, characterized performance. And they can often do it at a lower final cost.

We offer the broadest range of filtering technologies available, in the world's best connectors (ours) – from sub-Ds to mini-ribbon cable, mini-DINs to mod jacks. We also have loose-piece and cable styles, and provide custom services as well.

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TECHNOLOGY 2004

Exhibits Preview

Technology 2004 (November 8-10, 1994, Washington, DC convention center) will feature 80,000 square feet of exhibits by government, industry, and academia demonstrating new inventions, products, and processes available for license or sale. Special areas of the exhibits hall will highlight companies who have received Small Business Innovation Research (SBIR) grants from federal laboratories; NASA spinoffs; and photonics technology. Following is a list of this year's exhibitors.

Aerospatiale 332
Les Mureaux Center, France,
will highlight its role in various European space projects and exhibit new products and technologies in such areas as thermal protection, magnetic bearings, and HP filament winding.

Ames Laboratory—US Department of Energy 554
Ames, IA,
will highlight advanced materials and coatings technologies, polymer metallurgy, quantitative NDE instrumentation/techniques, environmental characterization systems, and new analytical methods.

Applied Research Laboratory/Pennsylvania 321
State University
State College, PA
This university/Navy laboratory will showcase technologies including acoustics/vibration, guidance and control, simulation and modeling, materials and manufacturing, fluid dynamics, energy sources, and information systems.

Association of American Railroads 250
Pueblo, CO
The Transportation Test Center is a research and test facility with a wide range of capabilities for research, development, and evaluation testing.

Astro-Med Inc. 738
West Warwick, RI,
will exhibit high speed, high performance chart recorders having 2 to 32 channels, real-time sample rates to 250 kHg, digital interface, and data capture.

Austrian Trade Commission 231
New York, NY,
provides business information for investment, international trade, and technology exchange between Austria and the US, while representing Austrian companies.

Automated Precision Inc. 134
Gaithersburg, MD,
will feature instruments and systems for precision dimensional measurement including laser interferometers, 3D digital scanning probes, and complete measuring and analyzing systems for CNC machining centers.

Aviation Week & Space Technology 139
New York, NY
Aviation Week Group/McGraw Hill publications include *Aviation Week & Space Technology, World Aviation Directory, Business & Commercial Aviation, AWG Newsletters* and *Show News.* Electronic print media include Aviation/Aerospace OnLine.

Ballistic Missile Defense Organization 408
Technology Applications Program
Washington, DC
BMDO's Technology Applications program is responsible for transferring BMD-funded technologies to the commercial marketplace and other government agencies. Spinoffs with medical, electronics, optics, computer, energy, materials, environmental, and manufacturing applications will be exhibited.

Barnstead/Thermolyne Corporation 341
Duburque, IA,
manufactures laboratory, liquid handling, and water purification equipment. Products include hotplates, stirrers, mixers, furnaces, shakers, incubators, thermal cyclers, deionization, distillation, and reverse osmosis systems, bottle top dispensers, and pippettors.

Best Manufacturing Practices 406
College Park, MD
An integral part of the Navy's MANTECH program, BMP identifies the best practices in US industry and encourages businesses to share them and work together toward greater efficiency, productivity, and improved product reliability.

BF Goodrich Aerospace/Simmons Precision 521
Vengennes, VT,
develops advanced aerospace systems, including integrated utilities management systems for subsystem integration; Advanced Development Systems—an integration and testing tool; and remotely interrogated sensor electronics, which monitor stress within composite and glass epoxy materials.

BHK Inc. 424
Pomona, CA,
will exhibit UV and IR sources and power supplies, electro-optical and opto-mechanical assemblies, low pressure mercury, zinc, and cadmium lamps, wavelength calibration lamps, and IR filament lamps.

Brookhaven National Laboratory 243
Upton, NY,
will focus on basic and applied research in the physical, biomedical, and environmental sciences and in selected energy technologies.

Canon Communications Inc. 450
Santa Monica, CA,
publishes trade magazines for the medical device and contamination control industries, including *Medical Device & Diagnostic Industry, Medical Product Manufacturing News, Microcontamination, Medical Plastics & Biomaterials Designer's Handbook: Medical Electronics,* and *IVD Technology.*

Catalyst Advertising 143
Fallbrook, CA,
has available 3400 patents for license, as well as world patentbank databases and a PHL-patent hotline BBS.

Centro Estero Camere Commercio Piemontes 447
Torino, Italy
This technology transfer center's main goal is to promote and develop international business relations and high technology transfers.

Cornell Theory Center 130
Ithaca, NY,
one of the four NSF-founded supercomputer centers in the US, offers leading edge computational resources for academic and industrial researchers. The exhibit will feature videos and application demonstrations.

CorpTech 235
Woburn, MA
Bring your technologies to market using CorpTech's detailed product information on 36,000 US technology manufacturers: a great source for finding potential sources of technology or potential sources of funding for your own.

Cybernet Systems Corp. 129
Ann Arbor, MI,
will exhibit the PER-Force hand controller used for telerobotics, virtual reality, and simulation. The device produces force-reflection along six axes to produce "virtual" force feedback.

Defense Technical Information Center 647
Alexandria, VA
The Department of Defense (DOD) sponsors 21 Information Analysis Centers (IACs) that collect, analyze, and disseminate scientific and technical information. Support is provided for acquisition and operational activities of DOD components, contractors, and other qualified users.

Diamonex Inc. 135
Allentown, PA,
is a leading manufacturer of amorphous diamond-coated products for optical, medical, and industrial applications and polycrystalline diamond products for electronics applications.

East/West Technology Partners Ltd. 454
Arlington, VA,
offers US/Russian technology transfer experts specializing in: technology patenting and licensing, technology searches, contract research, and US/Russian business arrangements and negotiations.

Edgewood Research, Development & Engineering Center 548
Aberdeen Proving Ground, MD
provides opportunities in artificial intelligence, biodetection, environmental and ecological restoration/remediation, air purification/ventilation/pollution control, hazardous material detection and cleanup, biomedication, toxicology, animal test alternatives, and chemical/biological mass spectrometry.

EG&G Inc.—Rocky Flats Environmental Technology Site 851
The site's mission is to develop and demonstrate innovative environmental remediation technologies.

Energy Science & Technology Software Center 439
Oak Ridge, TN,
is the Department of Energy's detection and software management facility, authorized to license and distribute software developed under the sponsorship of DOE and the Nuclear Regulatory Commission.

Environmental Protection Agency 847
Washington, DC
An educational display will provide information about on-going partnerships with industry and opportunities to work with the EPA to develop environmental technologies.

Federal Aviation Administration Technical Center 622
Atlantic City, NJ,
will offer information on technologies currently under development/deployment in the FAA, including GPS, aircraft safety, ATC, airport capacity and runways, human factors, surveillance, and radar technology.

Federal Highway Administration 228
Washington, DC,
will present the latest technology transfer projects in pavements, structures, traffic and safety, as well as intelligent vehicle highway systems.

Federal Laboratory Consortium 526
Sequim, WA
The FLC offers access to federal laboratory expertise and capabilities. Seekers of new federal technology, unique facilities, or assistance with technical problems can contact the FLC Regional Coordinator in their area.

FLIR Systems Inc. 426
Portland, OR,
will exhibit an extensive line of infrared imaging products including the Prism thermal imaging cameras and the IQ series of real-time analysis systems.

Force Imaging Technologies 724
Chicago, IL,
will showcase thin (0.003"/0.067mm), flexible force sensors and systems that provide static and dynamic contact pressures over a wide load range—from less than 1 psi to over 20,000 psi (7K Pa-137M Pa).

Gage Applied Sciences Inc. 140
Montreal, Quebec,
will display ultra-fast PC-based and LabVIEW-compatible data acquisition supplies such as A/D cards as fast as 250 MSPS.

Gulf Coast Alliance for Technology Transfer 734
Fort Walton Beach, FL
GCATT's 11 federal laboratories and four research universities offer unique technology and test facility assets in fields including environmental, electronics, optics, magnetics, sensors, materials, and human performance.

Harmonic Drive Technologies 343
Peabody, MA,
manufactures precision transmission products for accurate positioning of robots, machine tools, web processing machinery, test equipment, and tracking devices.

HEMCO Corp. 234
Independence, MO,
will exhibit the Unilab, a preengineered modular room structure that can be designed and built to meet cleanroom, environmental control, and insulated self-contained lab enclosure specifications.

Hewlett-Packard Co. 229
Rockville, MD
The Hewlett-Packard booth will feature industry-leading, high-performance workstations available on the SEWP contract, as well as applicable contract software including imaging technology.

Hickson International P&C 133
Leeds, England,
is a chemical company with a sales turnover of $500M, 3000 employees worldwide, and major interests in fine chemicals, wood preservation, coating technology, surfactants, and sulphur chemicals.

Hughes Space & Communications Company 727
Los Angeles, CA

Idaho National Engineering Laboratory 422
Idaho Falls, ID,
will present a new concept in high-speed mass transit, the CyberTran system, under development at the laboratory. The system represents affordable, high-speed energy-saving mass transit that is an electrically-powered steel-wheel-on-steel-rail.

INCO Specialty Powder Products 511
Saddle Brook, NJ,
sells specialty metal and ceramic powders and fibers. Applications include batteries, conductive polymers, magnetic alloys, catalysts, EMI shielding, and lightning strike protection.

Infolytica Corp. 525
Montreal, Quebec,
will spotlight its new 5.1 version of MagNet electromagnetic simulation software for PCs and workstations. MagNet software helps eliminate time delays and costs of prototyping and testing.

Information Handling Services 121
Englewood, CO,
is the world's largest re-publisher of value-added technical and regulatory information, available in multiformat delivery systems.

Ingenieurschule Biel 350
Biel, Switzerland,
will exhibit the Solar Car "Spirit of Biel-Bienne III", a microspace PC for embedded industrial controlling, fuzzy logic, and microelectronics development tools, applications, and integrated circuits.

INONET, Inc. 748
Ridgefield, CT
This CompuServe Forum is for the thousands of innovators, inventors, patent attorneys, technology transfer agents, engineers, venture capitalists, and corporate decision makers interested in innovations.

Integrated Sensors Inc. 248
Utica, NY,
will demonstrate its first commercial spin-off product from the NASA Relative Attitude and Position Estimation Program (Phase II). The system tracks an object in real-time and provides measurements of its position and angular orientation.

Invention Machine Corp. 721
Cambridge, MA,
will present the Invention Machine™ Software System, which solves complex engineering/invention problems, predicts new engineering solutions, and is the largest and most successful Russian software project.

Knowledge Express Data Systems 615
Wayne, PA
Subsidized access to the Knowledge Express Core Contents online service for technology transfer and business development is now available under the Technology Reinvestment Project (TRP).

Lawrence Berkeley Laboratory 722
Berkeley, CA
LBL is a major national laboratory with 3,000+ employees, an annual budget of $260 million, and expertise in energy, environment, materials, computing, and biotechnology.

Lawrence Livermore National Laboratory 322
Livermore, CA,
specializes in measurement and diagnostics, computations science, lasers and electro-optics, manufacturing engineering, electronic systems, engineered material, applied physics and chemistry, atmos-pheric and geosciences, bioscience, and environmental sciences.

Litton Amecom 750
College Park, MD,
designs, manufactures, and provides life cycle support of sophisticated electronics products in four major areas: space systems, electronic warfare, RF communications, and telecommunications.

Los Alamos National Laboratory 145
Los Alamos, CA,
will present information on energy and environmental technologies, earth science, materials science, advanced manufacturing, computing modeling and simulation, instrumentation, and biotechnology and biomedicine.

Los Alamos National Laboratory, Detonation Systems Group 149
Los Alamos, NM,
will display technology for initiation of high explosives including modeling techniques, slapper detonator initiation, and optical initiation, actuators, and cabling.

Machida Inc. 254
Orangeburg, NY,
will exhibit its complete line of flexible fiber optic borescopes, video systems, and related accessories.

Martin Marietta Specialty Components Inc. 227
Largo, FL,
provides technological assistance to industry, universities, and others. The company will be soliciting proposals and proposal partners for product/technology development and commercialization at the Department of Energy—Pinellas Plant.

The Mathworks Inc. 522
Natick, MA,
will spotlight its MATLAB Technical Computing Environment featuring high-performance math and graphics, a high-level matrix language, SIMULINK, the Real-Time Workshop, and a comprehensive family of MATLAB application toolboxes including neural networks and nonlinear control design.

McGraw-Hill Inc. 351
New York, NY
The *Federal Technology Report* covers the latest developments in US government programs that support civilian and dual-use technology. McGraw-Hill's *Biotechnology Newswatch* and *Cancer & Genetics Report* cover science, business, and politics in those fields.

MEG Array Inc. 733
Lake Park, FL,
offers system and circuit designers a broad selection of 20-80 volt linear bipolar integrated circuit arrays.

Mid-Atlantic Technology Applications Center 544
Pittsburgh, PA
MTAC provides a wide range of technology management services and specializes in technology transfer from NASA and other federal agencies.

NASA 430
Washington, DC
NASA's R&D mission programs will be highlighted together with a "theater island" describing key technologies resulting from the nation's space program. Spinoffs from aeronautics and space research will be displayed along with new technological advances from the National AeroSpace Plane.

NASA Ames Research Center 641
Moffett Field, CA,
will present composite flexible blanket material, a protective coating for ceramic material, toughened uni-piece fibrous insulation, a spatial auditory display, a fiber optic vibration sensor, a wireless dynamic data exchange communication system, an automation and support system for expert telescience, a microwave incineration to process biological waste, and a fault tree diagnosis and optimal test sequence.

NASA Centers for the Commercial Development of Space 433
College Station, TX
The Center for Space Power will provide information on profitable commercial partnerships with industry. The Center for Micromolecular Crystallography will highlight protein engineering/purification, 3D structure determination, and structure-based drug design. The Center for Hybrid Communications Networks will demonstrate object-oriented newtork and management tools. The Center for the Commercial Development of Space Power and Advanced Electronics investigates critical technologies for advanced space power systems.

NASA Dual-Use Telerobotic Technology Display 642
Pasadena, CA,
will feature NASA-funded innovative telerobotic technology being developed at the various NASA Centers, universities, and industry for dual-use will be demonstrated. Applications include flexible manufacturing, telesurgery, virtual environment interface, automated inspection, and remote servicing.

NASA Goddard Space Flight Center 441
Greenbelt, MD,
will exhibit its Earth Alert Systems, a Topographical Study System, and the Parabola, a system for ecological studies.

NASA Jet Propulsion Laboratory 643
Pasadena, CA
JPL has a variety of programs through which technology is successfully developed and exchanged with US industry.

NASA John C. Stennis Space Center 541
Stennis Space Center, MS,
will present technologies available for commercialization including a gamma ray collimator for NDTE of thick-walled pressure vessels, smart sensor technology, and engine plume diagnostic testing.

NASA Johnson Space Center 628
Houston, TX
Johnson's Tech Transfer Commission will feature demonstrations of the commercial application of virtual environments, machine simulation, process management, electronic documentation, pattern recognition, automated diagnosis, shock absorber, and intelligent systems.

NASA Kennedy Space Center 427
Kennedy Space Center, FL,
is the gateway for all East coast space launches. Primary areas of development include advanced software, sensors, instrumentation, robotics, and communications/networks.

NASA Langley Research Center 442
Hampton, VA,
Langley conducts research in a wide range of disciplines to support aeronautics and space programs, and promotes the transfer of technology to US industry.

NASA Lewis Research Center 543
Cleveland, OH,
will feature the successful low-cost fabrication of silicon carbide-based ceramics and fiber-reinforced composites, and an ultra-high resolution miniature color CRT for virtual reality applications.

NASA Marshall Space Flight Center 640
Huntsville, AL,
will feature displays and information about the new lithium-aluminum alloy, industrial computed tomography, robotics simulation software, the Water Window X-Ray Microscope, and a versatile Shuttle-derived foam for industrial use.

NASA STI Program 542
Arlington, VA
Our global reach and full line of products and services help us meet the scientific and technical information needs of researchers worldwide.

NASA Tech Briefs 741
New York, NY
Reaching over 200,000 engineers and executives throughout industry and government, *NASA Tech Briefs* magazine has first publishing rights to the latest technologies developed by NASA and its contractors.

National Technology Transfer Network 634
Washington, DC,
will spotlight the six regional technology transfer centers that work with federal and state technology transfer activities to help US industry gain access to over 700 federal laboratories and other sources of technology for commercial and industrial use.

National Automotive Center 739
Warren, MI,
is a dedicated initiative set up by the US Army Tank-Automotive Research, Development & Engineering Center to foster technology transfer and dual-use tank-automotive R&D between government, industry, and academia.

National Institute of Standards and Technology 547
Gaithersburg, MD
An agency of the US Department of Commerce's Technology Administration, NIST's primary mission is to promote US economic growth by working with industry to develop and apply technology, measurements, and standards.

National Instruments 553
Austin, TX,
will exhibit hardware and software for GPIB and VXI instrument control, hardware and software for data acquisition, and LabView, LabWindows/CVI, and HiQ application software.

National Security Agency 338
Ft. Meade, MD,
will feature microelectronics, computing, communications and networking, signal processing, and advanced mathematics.

National Space Society 233
Washington, DC
NSS is a non-profit membership organization supporting space exploration and development through public education, political activism, local chapters, and publication of *Ad Astra* magazine.

National Technology Transfer Center 306
Wheeling, WV
NTTC services include free access to federally-funded technology (800-678-6882), electronic bulletin board announcing technology transfer opportunities, training on technology transfer issues, and strategic partnering conferences.

Navy Research, Development, Test, and Evaluation Labs 314
Warminster, PA
Eight Navy research, development, test, and evaluation activities are featured at this exhibit, including laboratories from the Naval Air Warfare Center, Naval Civil Engineering Laboratory, Naval Command Control and Ocean Surveillance Center, Naval Medical Research and Development Command, Naval Surface Warfare Center, and Naval Undersea Warfare Center.

Naval Research Laboratory 125
Washington, DC,
will exhibit R&D programs available for licensing in the areas of advanced materials, bio-molecular engineering, chemical processing, electronics, optics, sensors, and information technology.

Novespace 328
Paris, France,
will describe European technology transfer networks established around Novespace and will feature various technology catalogs.

Oak Ridge Centers for Manufacturing Technology 458
Oak Ridge, TN
The ORCMT, a joint Y-12/ORNL effort, is a national industrial resource for applied research, demonstration, fabrication, development, prototyping, and education. The Metals and Ceramics Division will exhibit intermetallic alloys, ceramics and ceramic matrix composites, polymer matrix composites, and various testing devices available for licensing to private industry.

Olympus America—Industrial Fiberoptic Division 342
Lake Success, NY,
will highlight remote visual inspection instruments: fiber optics, rigid borescopes, video image scopes, and video enhancement equipment, as well as high magnification borescopes and fiberscopes for vacuum video inspections and industrial applications.

Optical Society of America 137
Washington, DC
OSA is an engineering and scientific society with over 12,000 members, covering all areas of optics including optical fabrication and testing, imaging, electro-optics, lasers, fiber optics, and photonics.

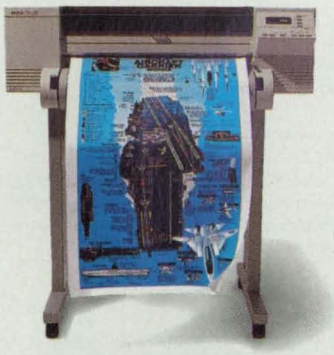
Phillips Business Information Inc. 452
Potomac, MD,
publishes a variety of newsletters and magazines detailing current news and business opportunities in several high-technology markets. Titles include: *Technology Transfer Week, Defense Daily, Space Business News, C4I News,* and *Space Station News.*

Pittsburgh Energy Technology Center 821
Pittsburgh, PA
The PETC is the nation's largest government laboratory devoted to the development of new, environmentally-clean fossil energy technologies including processes that use US coal resources to produce liquid transportation fuels and chemicals.

Powertronic Systems Inc. 552
New Orleans, LA
PSI has been a military/commercial electronics design and manufacturing contractor, as well as a reliability and maintainability software vendor, for over ten years.

Princeton University Plasma Physics Laboratory 241
Princeton, NJ
Funded by the Department of Energy, the laboratory's primary mission is to develop the basis for toroidal magnetic fusion energy. This work has led to advances in physics, engineering, and technological disciplines for non-fusion applications.

The Unplodder.



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Proto Manufacturing 448
Oldcastle, Ontario,
will exhibit the latest developments in non-contract stress measurement.

R. Brooks Associates Inc. 150
Williamson, NY
will feature state-of-the-art video imaging and remote positioning systems currently utilized throughout the US commercial nuclear industry.

Real World Interface Inc. 144
Jaffrey, NH,
will display mobile robots for advanced research in the areas of autonomous systems, machine learning, vision based navigation, sensor fusion, and mobile robot based manipulation.

Research Triangle Institute 136
Research Triangle Park, NC,
will demonstrate its 27 years of success in transferring federal research and technologies into commercial products. RTI will showcase its TechTracS™ technology tracking database system.

Rexham Custom 523
Matthews, NC,
is a leader in custom coating and laminating of high-performance materials. Coating services range from a class 1000 cleanroom pilot coating facility to worldwide production from one of eight ISO 9000 registered plants in the US and Europe.

Rockwell International 122
Canoga Park, CA
Rockwell's Rocketdyne division will be displaying NASA/Space Shuttle Main Engine (SSME)-derived transferrable technologies.

RTC North Ltd. 848
Tyne & Wear, England,
will focus on offers and requests from technology-based organizations in Northern England and provides information on joint venture opportunities.

SAMPE 551
Covina, CA
Founded in 1944, SAMPE is an international educational scientific association dedicated to the exchange of data on new materials and processes.

Sandia National Laboratories 131
Livermore, CA,
offers facilities for manufacturing process development, environmental testing, environmental remediation technology development, combustion research, computing, and microelectronics research.

Sandia National Laboratories 740
Albuquerque, NM
The Remote Sensing and Verification Program develops monitoring/data systems and provides analysis, facilities, and field expertise in support of nonproliferation and other national objectives.

Sel-Tronics, Inc. 141
Landover, MD
Sel-Tronics, a manufacturer's representative, will be displaying fiber products from Math Associates & Recording and Data Acquisition Products from Gould Instrument Systems.

Sky Technology Vehicle Design & 606
Development Company
Hurst, TX,
will feature the Aircar, a "roadable" aircraft narrow enough for road driving in the flight configuration.

Software Consultants International Ltd. 737
Kent, WA,
will demonstrate TemPRO™, a business re-engineering product that runs in the Windows environment providing simulation and analysis capabilities. System customization, training, and support also are available.

Space Age Group 354
Los Angeles, CA,
was established to introduce NASA spin-off products and technology to foreign markets, with particular emphasis on Japan and the Far East.

Space News 349
Springfield, VA
plays an essential role in worldwide space enterprises, providing news, critical insight, and a common communications medium for the world's space leadership.

Spire Corp. 347
Bedford, MA,
will highlight optoelectronic devices including high power diode lasers, solar cells, semiconductor epi-wafers, biomedical lasers, thin film coatings, and custom surface texturing and pv module equipment.

TCAM Technologies 735
Eastlake, OH,
will display a radical new mechanical actuation system that projects many engineering improvements over the state-of-the-art. TCAM is seeking potential licensees for its technology in fields including valve actuators, automotive and appliance actuators, and aerospace actuation products.

Technology Access 132
Novato, CA,
is a concise, independent, practical newsletter of analysis and opportunities in technology transfer, commercialization, defense conversion, and policy. It includes inventions for all industries, contacts, and a free information hotline.

Technology Transfer Business Magazine 336
Vienna, VA,
presents methods of successful transfer for competitive advantage to inform users of technology resources.

Technology Transfer Society 412
Indianapolis, IN,
is a non-profit organization created to promote the growth and enhance the effectiveness of technology transfer. Through timely publications and multi-disciplinary membership, the society is an exceptional networking and collaboration system for the technology transfer professional.

Thiokol 421
Brigham City, UT,
will highlight technologies developed in internal IR&D or DOD/NASA programs that show potential for commercialization, new propulsion concepts, or enhanced environmental processes.

Tiodize Co. 222
Huntington Beach, CA,
will display anti-corrosion coatings, solid film lubricants, Teflon coatings, self-lubricating composites, composite fasteners, degreasers, hard anodize with Teflon, mold releases, water base coatings, and titanium anodize with no dimensional change.

US Air Force, Armstrong Laboratory 128
Brooks AFB, TX,
will present human-centered technologies available for collaborative research and/or licensing opportunities in aerospace, medicine, occupational and environmental health, training, human engineering, and environics.

US Air Force, Manufacturing Technology 505
Directorate
Wright-Patterson AFB, OH
Wright Laboratory's Manufacturing Technology Directorate is tasked to ensure the nation's defense aerospace industrial base is fully capable and responsive in supporting Air Force needs in the development, production, and support of planned and existing weapon systems and components.

US Air Force, Phillips Laboratory 507
Kirtland AFB, NM,
will focus on opportunities available through the Phillips Laboratory for technology transfer and dual-use applications.

US Air Force (Science & Technology) 506
Wright-Patterson AFB, OH,
will display the latest Air Force technologies with application in the medical, environmental, information management, and educational fields; dual-use technologies, and the Air Force tech transfer program.

US Army Armament Research 247
Development and Engineering Center
Picatinny Arsenal, NJ
The US Army ARDEC will present two technologies available for commercialization by the private sector, featuring information on Decision Aids.

US Army Corps of Engineering Laboratories 236
Vicksburg, MS,
will highlight technologies ready for commercialization from the Corps' R&D laboratories. These laboratories conduct research in the areas of facilities and construction, infrastructure remediation, structural engineering, CAD/CIS, railroads, pavements, soils, environmental engineering, waterways and harbors, and cold climate facilities.

US Army Electronics & Power Sources 240
Directorate
Fort Monmouth, NJ
The Electronics and Power Sources Directorate, Army Research Laboratory will feature electronics technology and devices available for commercialization with emphasis on technology transfer through patent licensing and cooperative agreements.

US Army Research Laboratory 242
Adelphi, MD,
will exhibit a broad range of technology areas promoting the military.

US Army Research Laboratory/ 239
Battlefield Directorate
Adelphi, MD,
will provide illustrations of its multifaceted research program as well as specific technologies available for commercial application.

US Department of Agriculture, 148
Office of Technology Transfer
Beltsville, MD
The USDA's Agricultural Research Service, with 124 laboratories nationwide, offers opportunities for small and large corporations. Information on technology transfer programs and research projects will be exhibited by the ARS Office of Technology Transfer.

US Department of Agriculture/Special Programs 747
Washington, DC,
will feature advanced materials ranging from lubricants to polymers to composites, all derived from renewable agricultural products.

US Department of Energy, 621
Kansas City Plant (Allied Signal)
Kansas City, MO,
will spotlight manufacturing process capabilities in electrical, mechanical, materials, and environmental areas that can be used for prototyping, testing, and process prove-in for product development.

US Department of Energy, National 416
Renewable Energy Laboratory
Golden, CO,
will provide a lively visual overview of the organization, objectives, and research and development programs of DOE's Office of Energy Efficiency and Renewable Energy. A pictorial of efforts to advance energy efficiency and renewable energy technology throughout America's building, transportation, industry, and utility sectors also will be on display.

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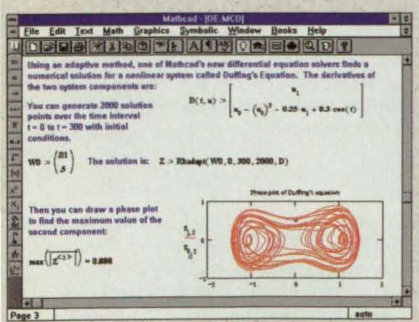

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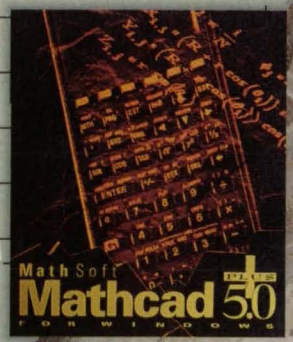

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US Department of Energy/ 214
Technology Utilization Office
Washington, DC
The DOE's technology transfer exhibit can help identify technologies and expertise available for transfer to private industry, or assistance and collaboration at the DOE laboratories across the nation.

US Department of the Interior 728
(US Bureau of Mines)
Washington, DC,
will display results of federally-funded mining, materials, water resources, and other research and information studies.

US Department of Veteran Affairs 237
Washington, DC,
will provide examples of progress in the Department of Veteran Affairs Rehabilitation research and development program for improving the quality of life for the disabled.

United Technologies Corp./USBI Co. 333
Huntsville, AL
USBI is the prime contractor to NASA for the nonmotor segments of the Space Shuttle's Solid Rocket Boosters. Spinoff technologies will be featured.

University of Dayton Research Institute 410
Dayton, OH
UDRI conducts both basic and applied research for government and industrial sponsors. Information will be available on its research capabilities and technologies available for licensing.

Van Nostrand Reinhold 509
New York, NY,
publishes books on the subject of quality and technology management, including such innovative works as Petrozzo/Stepper: *Successful Reengineering;* Smith/Reinerston: *Developing Products in Half the Time*; Goldman/Nagel/Preiss: *Agile Competitors and Virtual Organizations*; Patterson: *Accelerating Innovation*; and Jackson/Frigon: *Management 2000.*

Veritec Inc. 516
Chatsworth, CA,
provides turnkey systems (hardware/software) for marking and reading high data density 2D VERICODE Symbols. Applications include the electronic, automotive, and aerospace industries.

Vortex Unlimited 823
New York, NY
The company reports achieving reduced temperature thermonuclear fusion (neutron capture), providing energy by the release of charged particles. New fusion energy concepts and texts also are available.

Westinghouse—Savannah River Company 138
Aiken, SC
Developing real solutions to real problems is the role of the Savannah River Technology Center, the Savannah River Site's applied research and development laboratory.

Yokogawa Corporation of America 142
Newnan, GA
Since 1957, Yokogawa has provided the North American marketplace with high quality test and measurement instruments. A complete line of chart recorders including new thermal array oscilloscopes and waveform/FFT Analyzers will be displayed.

SBIR PAVILION

Active Technologies Inc.
Alamogordo, NM,
will display the Lightning Charger, the world's lightest production genset, weighing just 16 lbs. It produces 900 W of 115 V power for lights and up to 80 amperes to start 12 and 24 volt vehicles.

Advanced Refractory Technologies Inc.
Buffalo, NY
Diamond-like Nanocomposite Coatings (DYLAN™) technology represents a revolutionary new family of thin film coatings, engineered at the atomic scale, that can be tailored and customized for specific properties.

Alternative Systems Concepts Inc.
Windham, NH
will demonstrate VIOOL (VHDL Interfacting Object Oriented Languages), a tool to facilitate true concurrent engineering including rapid prototyping, virtual prototyping, and hardware/software co-design.

Applied BioPhysics Inc.
Troy, NY,
is developing a new instrumental approach that electrically probes the morphology of cells in culture. The method, known as electric cell-substrate impedance sensing (ECIS), non-invasively monitors cells grown upon miniature gold film electrodes.

BSI Corp.
Eden Prarie, MN,
BSI coatings are bonded directly and permanently to surfaces via a photoactivatable spacer group using PhotoLink™ process. Commonly used noncovalent heparin binding techniques show depletion of heparin activity within hours, while BSI's covalently-bonded heparin provides a durable coating that retains high levels of activity for up to several weeks.

Candela Laser Corp.
Wayland, MA,
in collaboration with the University of Chicago, has developed a simple ultracentrifugal technique that can measure LDL, HDL2, HDL3, and Lp(a) cholesterol directly in a single test.

Charles River Analytics Inc.
Cambridge, MA
Open Sesame!, the first intelligent agent for the Macintosh, monitors events, states, and user actions in a computerized environment, learns repetitive tasks, and provides a means to automate on behalf of the user.

ChemTrak™
Sunnyvale, CA,
has developed AccuMeter® technology, a quantitative, disposable personal diagnostic test device that fits into the palm of a hand. The first application is a home cholesterol test marketed by Johnson & Johnson.

Conquest Software Inc.
Columbia, MD,
has commercialized natural language processing, an advanced approach to full-text searching that delivers unprecedented performance in retrieval accuracy, and streamlines the process of finding and working with textual information.

Cybernet Systems Corp.,
Ann Arbor, MI,
develops tools for dynamically registering graphical models to real-world imagery for advanced robot control, including the PER-Force™ six-degree-of-freedom reflection hand controller.

Daniel H. Wagner Associates Inc.
Hampton, VA,
The company's automated container ship loading system is a PC-based control system that eliminates pendulum sway as containers are carried from pier to ship. This system allows full speed moves and will save as much as 30% of the loading cycle time.

Diagnostic Devices Group
Kirkland, WA,
is developing a low-cost, ambulatory instrument to assist patients suffering from urinary incontinence. Using non-ionizing ultrasonic energy, the unit will continuously monitor the patient's bladder and automatically set off an audible alarm whenever a pre-established volume threshhold is exceeded.

Dimension Technologies Inc.
Rochester, NY,
is developing LCD displays producing 3D images viewable without special glasses or user position restrictions. The DTI 1100C Virtual Window™, provides either a 320 x 480 resolution, full color 3D image or a 640 x 480 full color, 2D image on a 10.4" LCD.

Electronic Medical Instruments Inc.,
Bellevue, WA,
markets a neuromuscular stimulator for the treatment of hemiplegia due to stroke and traumatic brain damage. The DSS IV Unit has the potential to allow a significant number of the approximately 10,000,000 hemiplegics in the US to regain control of paralyzed limbs.

Eloquent Technology Inc. (ETI)
Ithaca, NY
Eloquence, ETI's multi-voice, unlimited vocabulary text-to-speech synthesis software, is designed for use in applications such as telephone services, computer e-mail, talking vehicles, screen readers for the visually impaired, and voice output communication aids for the speech impaired.

Epsilon Lambda Electronics Corp.,
Geneva, IL
The Fiber Millimetrics low-cost integrated millimeter wave radar subsystem has been commercialized to produce millimeter wave systems for consumer applications, notably a collision warning system now in use on America's largest interstate public bus fleet.

Essex Corp.
Columbia, MD
Delta-WP is a performance testing system for detecting workplace impairment that can be used as an alternative to intrusive chemical drug and alcohol testing. Delta-WP administers simple tests that measure basic thinking and reaction performance.

Foster-Miller Inc.
Waltham, MA,
The company's display will highlight:
• practical hardware for microclimate cooling systems, which has led to prototype production contracts for two types of cooling systems for military personnel.
• Superex Polymer Inc., a company spun-off from Foster-Miller to commercialize new polymer processing technology that enables the manufacturing of film, sheet, tubing, and molded products from liquid crystal polymers (LCPs) and LCP-thermoplastic blends.

Illinois Superconductor Corp.
Evanston, IL,
is developing fault current limiters based on high-temperature superconductor materials for a variety of military, industrial, and utility applications.

Individual Monitoring Systems Inc.
Baltimore, MD,
has developed a training device for personal exercise and health maintenance. The "BioTrainer" is a miniature monitoring unit that clips to the belt and accurately records the duration and intensity of body movements during exercise.

I.S. Grupe Inc.
Lombard, IL
Using its powerful SearchLITE® software, the company has created OncoDisk, a user-friendly, cost-effective CD-ROM version of the National Cancer Institute's database containing information on standard treatments for nearly all cancers.

Lynntech
College Station, TX,
will exhibit a test system designed for automatic control of a fuel cells and stacks with outputs ranging from a fraction of a watt to more than a kilowatt.

Materials & Electrochemical (MER) Corp.
Tucson, AZ,
will present an array of technologies including:
• Fullerenes—a new form of carbon with unique physical and electrochemical properties—that can be used to produce lightweight and enviromentally safe batteries.
• A metal coating process that produces composites by consolidation through hot diffusion bonding for use in electronic heat sinks, fusion reactor components, and various structure applications.
• A process to produce spheroid-shaped particles using plasma-initiated self-propagating high-temperature synthesis reactions.
• A method of bonding dissimilar materials such as ceramics or carbon-carbon composites to metals using active brazing.

Merritt Systems Inc.
Merritt Island, FL,
has developed a novel collision-avoidance sensing and control system for robotic devices. Obstacles are detected up to one-half meter or more away, and sensor cells can provide full coverage for robotic manipulators or sensitive equipment.

Metabolic Solutions Inc.
Merrimack, NH,
will display a non-invasive, non-radioactive breath test that provides accurate information concerning the degree, progression, and prognosis of hepatic disease.

Natural Fibers Corp.
Ogallala, NE,
manufactures down comforters and pillows containing milkweed floss. Milkweed cultivation conserves natural resources and uses low amounts of chemicals and fertilizer, while processing milkweed pods produces no liquid waste or air pollution.

Ocean Optics Inc.,
Dunedin, FL,
will display a spectrometer system that is 1000 times smaller and 10 times less expensive than conventional spectrometers. The device couples the ver-satility of inexpensive optical fibers with an extremely small 1024-element CCD array spectrometer.

Ocutech Inc.
Chapel Hill, NC
The AutoFocus VES allows hands-free focusing of the innovative and popular manual-focus Vision Enhancing System™. The system features a wide range of focus from 12 inches to infinity and operates continuously without user control.

OPTICS 1
Westlake Village, CA,
will introduce an ultra-lightweight head-mounted display system that provides full-color, high-resolution images while reducing eye strain. The PT-O1™ is targeted for video-assisted surgery and non-destructive testing and inspection.

Physical Optics Corp. (POC)
Torrance, CA,
will display a variety of technologies including:
• A family of multimedia communication systems capable of increasing the capacity of local area networks by 50 times. The HoloLink® system can transmit high density data streams or high-resolution color imagery without any time delay or data reduction.
• Holographic non-lambertian diffuser screens that have unusual beam shaping capabilities to improve the brightness and contrast of any imaging and flat-panel display screen by up to 15 times.
• A novel 3D imaging system based on autostereoscopic techniques and holographic optical elements that does not require polarized glasses or lenses.
• The Automatic Face Recognition System, which performs identification or verification by matching a human face against a large database of known faces.
• A hybrid neural network system for real-time object and spectral signature.
• A universal remote lighting system that efficiently couples energy from a light source into and through an optical fiber and delivers the light to a remote location.

PICS Inc.
Reston, VA,
will present DietMate, a hand-held computer that implements a self-management program for weight loss and cholesterol reduction. It combines nutrition, exercise, and behavior modification to promote gradual, permanent lifetyle changes.

QUEST Integrated Inc.
Kent, WA,
will demonstrate EUCLID™, an advanced laser alignment tool for use in aerospace manufacturing, civil engineering, and large rotating machinery that align equipment to within a few thousandths of an inch over distances from 100 to 1000 ft.

RedZone Robotics Inc
Pittsburgh, PA,
is developing an automated in-situ tank inspection system for underground storage tanks. The system will be deployed through a four-inch pipe to perform ultrasonic inspection, measuring tank wall thickness and detecting corrosion areas and potential leaks.

Research Biochemicals International
Natick, MA,
has developed several unique chemical agents that are useful in the direct and noninvasive study of brain changes that accompany the advance of Parkinson's disease.

Software Consultants Intl. Ltd.
Kent, WA
The company's TemPRO™ technology addresses the problem of Business Process Re-engineering (BPR) by assimilating the latest BPR practices and modeling techniques. TemPRO can automate the actual BPR model rather than just document it.

Stamet Inc.
Gardena, CA,
has created the Stamet Solids Pump, the world's first continuous, precision feeding, metering, and control device for injection of dry solids into substantial fluid pressure up to 100 psig.

TCI Software Research
Las Cruces, NM,
will demonstrate Scientific WorkPlace 2.0 for Windows, a powerful technical word processor seamlessly integrated with a computer algebra system through a unique math interpreter.

Terrapin Technologies
South San Francisco, CA,
has applied its polymer technology to achieve previously impossible separations of a family of closely related proteins called GST (Glutathione S-Transferase), which play a major role in the resistance of tumors to cancer drugs.

Thermacore Inc.
Lancaster, PA,
will showcase two technologies:
• An aluminum liner for composite material tubing that endows the composite tubing with metal-like characteristics without compromising its lightweight and strength advantages.
• The Moving Gradient Heat Pipe Furnace, which simulates a conventional directional solidification furnace without the need for mechanical translation of the furnace or sample material.

Transcience Associates
Evanston, IL,
will highlight the MicroFlow™ rubber-geared pump at the heart of an inexpensive 3-axis robotic system for the loading and dosing of multiwell microplates.

TRI Inc.
Knoxville, TN,
will highlight Omniview, a patented means for removing distortion associated with a wide angle video image that replaces the functions of a pan and tilt mechanism, zoom lens, drive motors, amplifiers, and controls in a single device that has no moving parts.

TRICOR Systems Inc.
Elgin, IL,
will feature a low-cost, long-range EO surveillance imaging system providing scene tracking, stabilization, recording, and image enhancement processing for airborne or surface vehicle installation.

Trident Systems Inc.
Fairfax, VA,
will feature CASCADE (Computer-Aided System and Component Architecture Design Environment), an advanced hierarchical multi-domain computer system design, capture, and analysis environment.

Virtual Computer Corp.
Reseda, CA
The company's Virtual Computer™ is a completely reconfigurable computing device enabling the placement of software directly into the silicon chip.

Vortec Corp.
Collegeville, PA,
will display an advanced melting/forming process for the manufacture of low-cost glass-ceramic tiles from industrial wastes such as coal-fired boiler ash, spent aluminum pot liners, and electric arc furnace dust.

SPINOFF PAVILION

Center for Optics Manufacturing 833
Rochester, NY,
will display information related to its Opticam, Opticim, Manufacturing Science, and Optimod programs.

Innovative Insulation Inc. 833
Ft. Worth, TX,
will exhibit Super R Radiant Barriers that reduce heating and cooling costs by reflecting radiating heat. They may be used independently or to increase the performance of conventional insulations.

LASER PAVILION

Alliance for Photonic Technology 612A
Albuquerque, NM
APT represents the photonics R&D capabilities of the federal laboratories in New Mexico and the University of New Mexico. Information will be available from Sandia National Labs, Los Alamos National Lab, Phillips Lab, and the UNM Center for High Tech Materials.

Big Sky Laser Technologies 711
Bozeman, MT,
specializes in compact, rugged, solid state lasers for real-world applications. On display will be the model CFR 200 Nd: YAG Laser and various specialty laser pump cavities and accessories.

Carl Zeiss Optical 612B
Petersburg, VA,
will exhibit Micron Laser Eyewear, which offers protection against light from 180-2100 zm with optical densities up to 7. Three stylish frames with molded sideshields are available.

CEBAF 718
Newport News, VA,
will present a plan for a superconducting radio frequency driven free-electron laser that has promise as a source of tunable high average power coherent light for military and industrial applications.

IEEE/Lasers & Electro-Optics Society 713B
Piscataway, NJ,
will feature information on membership in IEEE and LEOS. Complimentary copies of LEOS publications and conference promotions will be available.

ILX Lightwave Corp. 716
Bozeman, MT,
manufactures electro-optic instrumentation in the areas of laser diode control, fiber optic test and measurement, and laser measurement. Products include laser diode controllers and parameter analyzers, fiber optic light sources and meters, multimeters and wavelength meters.

IntraAction Corp.—Acousto Optics 614
Bellwood, IL,
will exhibit acousto-optic devices including modulators, deflectors, optical frequency shifters, tunable filters, mode lockers, q-switches, a polychromatic modulator, and associated OEM or laboratory drive electronics such as frequency synthesizers and RF power amplifiers.

Laser Tech Briefs 717
New York, NY,
features reports of new inventions and innovations in the photonics field, encompassing laser components and systems, optics, electro-optics, fiber optics, imaging and detector technology.

Light Brigade Inc. 817
Kent, WA,
conducts training seminars and videotapes for fiber optics covering system design, installation, and maintenance. A catalog listing the various courses and videotapes is available. Supplies and tools for the technician and end user also will be on display.

Moyco Precision Coated Abrasives 713
Montgomeryville, PA,
manufactures an integrated line of precision finishing materials. Products include lapping film, abrasive powder, micro-finishing film, vehicle, coolant, and polishing pads.

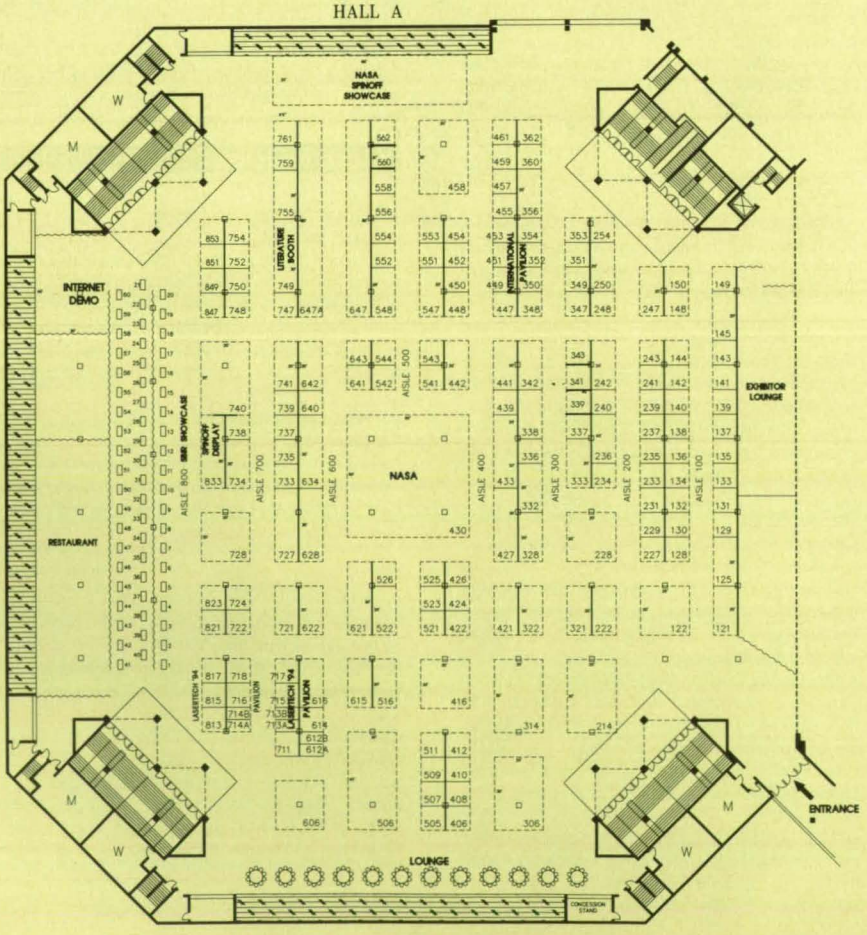
Photonics Spectra 715
Pittsfield, MA
Free copies of *Photonics Spectra* magazine for photonics technology, covering optics, lasers, fiber optics, electro-optics, imaging, and optical computing. Also on display will be the 4-Book Photonics Directory Set.

QUEST Integrated Inc. 813
Kent, WA,
will display EUCLID™, an advanced laser alignment tool for use in aerospace manufacturing, civil engineering, ship construction, and large rotating machinery alignment.

Rocky Mountain Instrument 616
Logmont, CO,
will exhibit precision laser and imaging optics, coatings, assemblies, and instrumentation from UV to far IR, custom, standard and OEM.

Spiricon Inc. 714A
Logan, UT,
will highlight state-of-the-art products for spatial intensity and propagational analysis of all laser sources, UV to far IR, CW and pulsed, from microwatts to megawatts.

Exhibits Hall Floor Plan



LITERATURE EXHIBIT

Anorad Corp. 749
Hauppauge, NY
A positioning equipment technology guide provides an overview of engineered motion control systems. Anorad's products include linear, rotary, and air bearing stages; linear servo motors; and controls.

Automation Gages Inc. 749
Rochester, NY,
manufactures high-precision ball and cross roller linear bearings with travels from ½ inch to 35 inches and available in aluminum, steel, and cast iron.

Balzers 749
Hudson, NH
Literature will describe Balzers Full Range™ vacuum gauge measures from atmosphere to UHV by utilizing two gauges in one. Turbomolecular Drag pumps permit the use of a backing pump 100 times smaller for savings in cost, space, and power.

Detroit Tool Industries 749
Madison Heights, MI
Product information will describe Spiralock International locking thread form cutting tools, fasteners, and thread gages.

EPIX, Inc. 749
Buffalo Grove, IL
A brochure will detail the 4MEG VIDEO Model 12 for image acquisition, processing, and display on PC-compatible interfaces to almost any video source and offering up to 256 MB of image memory.

E-Tek Dynamics Inc. 749
San Jose, CA
The company's catalog features world-renowned fiber optic products including isolators, couplers, WDMs, passive components, electro-optic devices, laser instruments and systems.

Fenix Technology, 749
Yuma, AZ,
manufactures arclamps and flashlamps. Its brochure describes standard lamps suitable for a variety of lasers, CAD technology, and Thorium-free products.

General Magnaplate Corp. 749
Linden, NJ
This technical guide explains how coatings improve the performance of metal parts by increasing hardness, resisting corrosion, and reducing friction and sticking with dry-lubricating synergistic surface enhancements.

Institute of Environmental Sciences (IES) 749
Mt. Prospect, IL
The IES is dedicated to enhancing process and product quality through the advancement of controlled environment technologies. It establishes and maintains standards, recommended practices, educational programs, and communication forums.

ISOMET Corp. 749
Springfield, VA,
manufactures acoustic optic modulators and multichannel modulators with integral beamsplitters, deflectors, frequency shifters, AOTFs and related RF drive electronics. Spectral ranges are UV, visible, and IR to 12 microns.

JML Direct Optics 749
Rochester, NY
The Second Edition of the JML Direct Optics catalog is available with complete design parameters for singlets, doublets, and triplets. Multi-element systems, coatings, cylinders, and prisms also are available from stock.

(continued on page 109)

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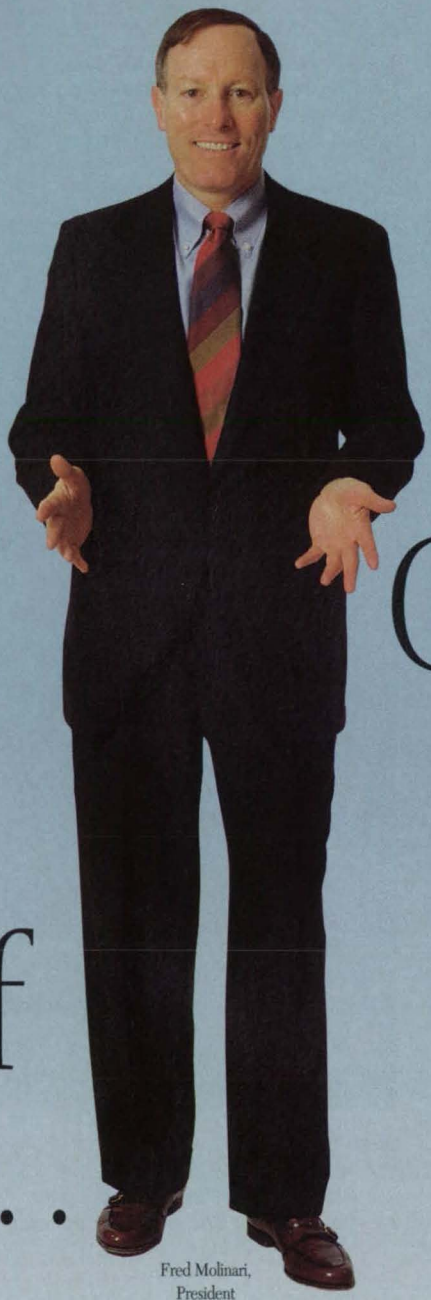
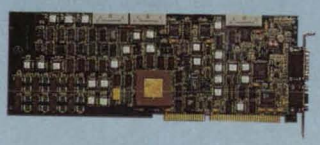


Fred Molinari,
President

You Need One of These.



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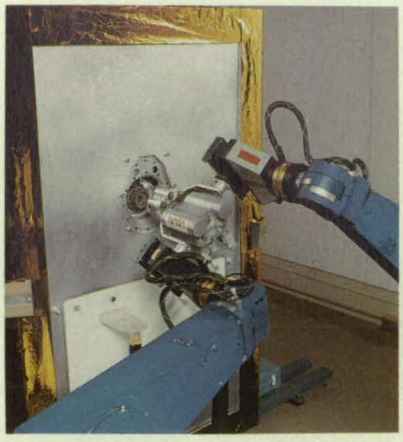
NASA PATENTS

NASA has a portfolio of 3000 patents and pending applications available now for license by businesses and individuals, including these recently patented inventions:

High Density Cell Culture System
(US Patent No. 5,330,908)
Inventor: **Glenn F. Spaulding**, Johnson Space Center

A low-cost culture vessel for growing delicate mammalian cells is simple to construct and can be used in laboratories with conventional roller drive units. The vessel is constructed in a one-piece integral and annular configuration with an open end capped by an endwall. Tapered access ports in the endwall can receive hypodermic syringes for introduction of fresh nutrient and withdrawal of spent nutrients. Subjecting the walls of the vessel to neutron or laser bombardment to form minute gas-permeable perforations increases the surface area available for oxygenation and thus culture productivity.
For More Information Write In No. 731



Dual-Arm Generalized Compliant Motion with Shared Control
(US Patent No. 5,336,982)
Inventor: **Paul G. Backes**, Jet Propulsion Laboratory

Multiple-arm robotic systems provide many valuable capabilities beyond single arm systems, particularly when handling heavy or unwieldy objects. For example, coordinated control of multiple robots allows one robot to act as a flexible fixturing device while the other executes a task. Mr. Backes has developed a novel robot control system for dual multi-joint arms that uses a unified control algorithm to integrate cooperative dual-arm control with multisensor-based task control.
For More Information Write In No. 730

Plasma Arc Welding Weld Imaging
(US Patent No. 5,329,089)
Inventors: **William F. McGee** and **Daniel J. Rybicki**, Marshall Space Flight Center

Clear visual data of plasma arc welds as they are formed is important to optimal control of the process. The new device uses an optically clear shield cup surrounding the welding torch's constricting nozzle and a guide tube outside the torch carrying two assemblies of optical fibers. One assembly transmits light from a source onto the weld pool; the second contains a lens that picks up an image of the pool to be returned to a remote location for real-time process control.
For More Information Write In No. 732

General-Purpose Architecture for Intelligent Computer-Aided Training
(US Patent No. 5,311,422)
Inventors: **R. Bowen Loftin**, **Lui Wang**, **Paul T. Baffes**, and **Grace C. Hua**, Johnson Space Center

A general-purpose artificial intelligence architecture is adapted to train personnel in the performance of complicated tasks and to produce the desired results with minimal expenditure of energy, time, and resources. The training system employs a rule-based language having a control structure that uses a specific message-passing protocol for procedural or step-by-step tasks. The trainee may reach the "solution" by any of number of alternate valid paths.
For More Information Write In No. 733

Prosthetic Elbow Joint
(US Patent No. 5,314,500)
Inventor: **Bruce C. Weddendorf**, Marshall Space Flight Center

Mr. Weddendorf has designed an artificial manually-positionable elbow joint with a locking feature—a pin through a locking wheel loaded in double shear—that can withstand the repeated heavy loading encountered by a wearer working in an industrial, construction, farming, or similar environments. Simpler and possessing fewer parts than conventional devices, the joint is less expensive to manufacture and designed to be easily and quickly disassembled by a wearer having only one hand employing a screwdriver, penknife, or other simple tool.
For More Information Write In No. 734

Adjustable Control Station With Movable Monitors and Cameras for Viewing Systems in Robotics and Teleoperations
(US Patent No. 5,331,413)
Inventor: **Daniel B. Diner**, Jet Propulsion Laboratory

In a teleoperator workstation or operator-supervised robotic automation system, panning, tilting, or rolling of the cameras can cause misalignment between them and the operator viewing the monitor. Mr. Diner's control station mounts each monitor on an automated platform that moves to match the viewing angle of the camera whose image it displays. In addition, the optimal viewing arrangement and system parameter configuration can be determined and stored for each operator's individual characteristics, enabling automation of an optimal series for successive tasks in real time.
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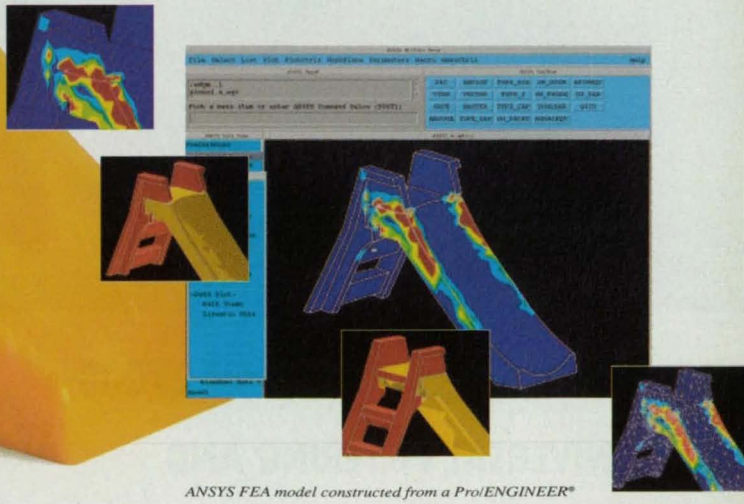

ANSYS FEA model constructed from a Pro/ENGINEER® assembly accurately showed that large, nonlinear deflections tripled the maximum stresses in the slide handrail.

Photograph and FEA model provided courtesy of Today's Kids, Dallas and DRD Corporation, Tulsa.

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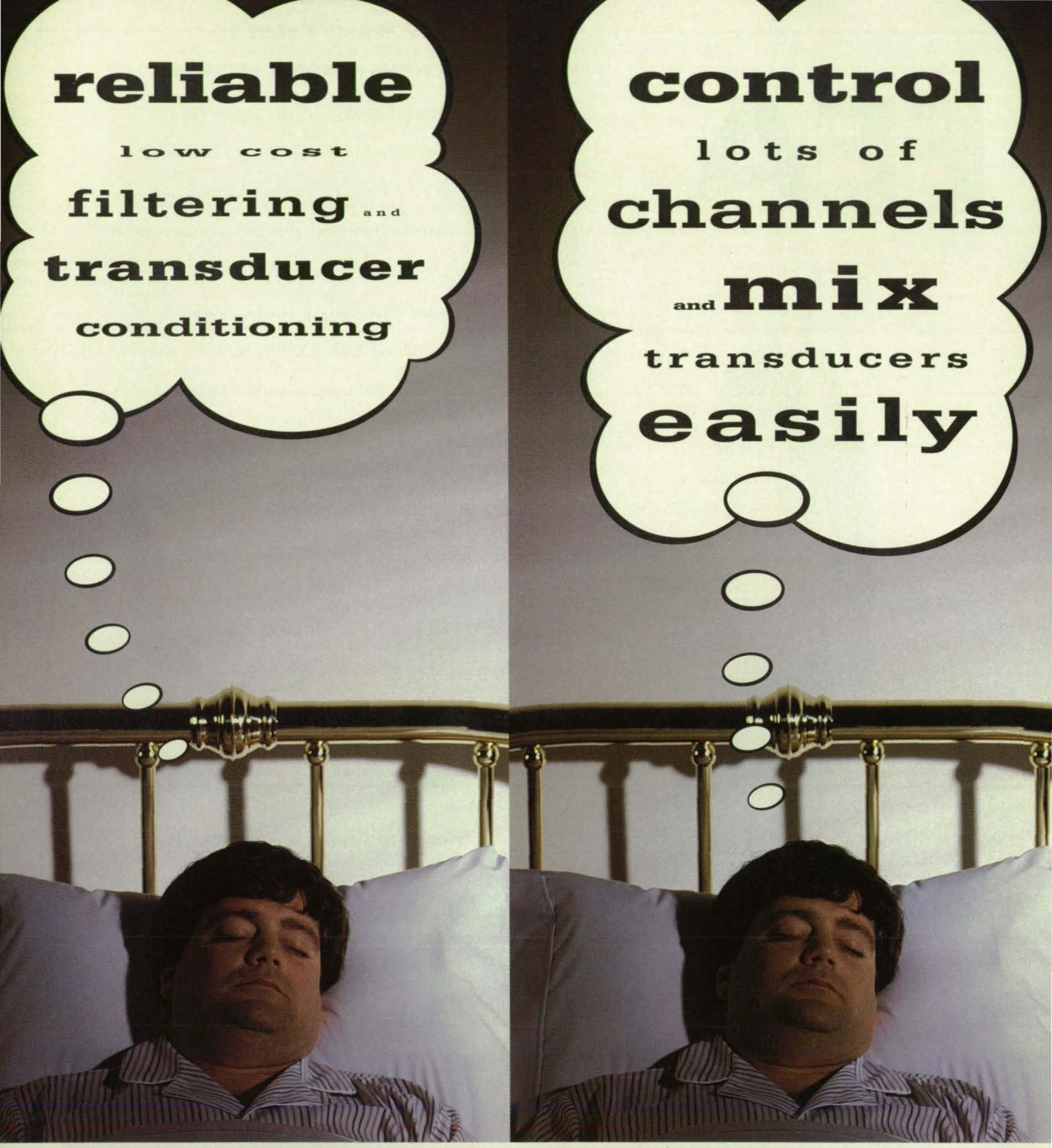

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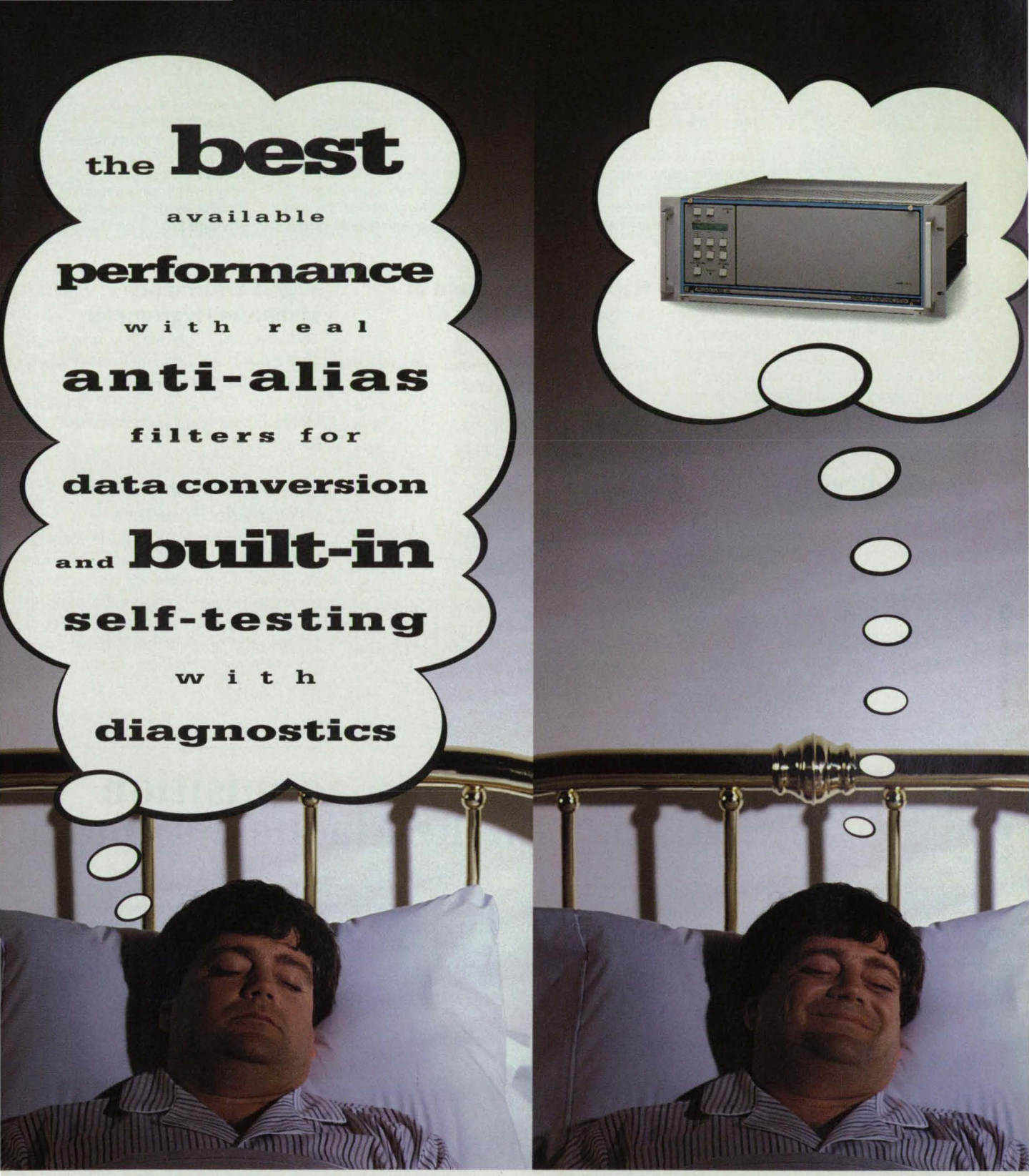

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For More Information Write In No. 517

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 Technology Utilization Office of the sponsoring NASA center (see page 20). NASA's patent-licensing program to encourage commercial development is described on page 20.

Capaciflector Camera

Sensing electrodes arranged in rows and columns can be used to generate capacitive images. Sensors of this type can be used by robot-control circuits to prevent collisions with objects, to identify objects, or to navigate amongst them.
(See page 58.)

High-Hot-Strength Ceramic Fibers

Continuous fibers that consist of lamellae of alumina and yttrium aluminum garnet offer exceptionally high strength, resistance to creep, and chemical stability at high temperatures. These fibers outperform sapphire fibers.
(See page 81.)

Rapid Measurement of Asbestos Content of Building

A small spectrophotometer would give fast, dependable indications onsite. Building renovators would not have to go through elaborate sample-collection and laboratory procedures to determine the need for removal of asbestos.
(See page 77.)

Alarm- and Power-Monitoring System

This system enables monitoring of many remote equipment modules. It monitors data on alarms and power supplies and can cover up to 256 remote terminal units.
(See page 58.)

High-Performance Miniature Hygrometer

This relatively inexpensive unit measures dewpoints as much as 100 °C below ambient temperatures, with an accuracy of 0.1 °C, and 100 times as fast as conventional hygrometers.
(See page 72.)

Making Semicrystalline Polyimide Powders

These powders are formed in reaction vessels, without grinding. They are commercially attractive for fabrication of adhesive bonds, compression molding of shaped parts, and deposition onto reinforcing fibers for hot-pressing into polyimide-matrix/fiber composites.
(See page 80.)

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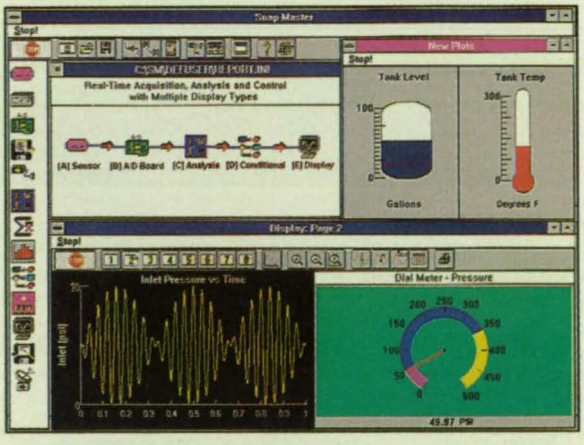

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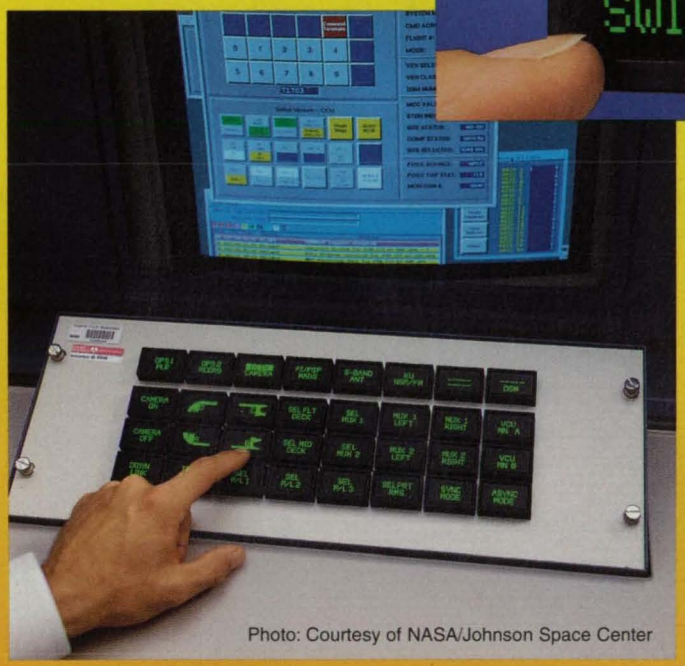

Photo: Courtesy of NASA/Johnson Space Center

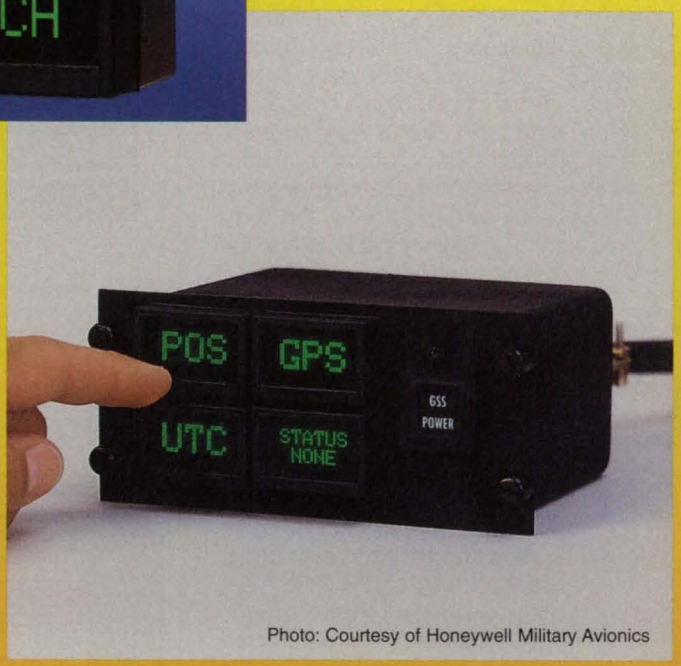

Photo: Courtesy of Honeywell Military Avionics

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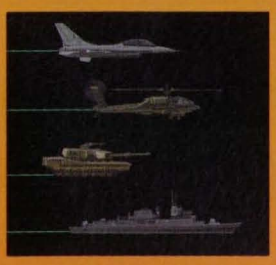

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NASA's Jet Propulsion Laboratory, Pasadena, California

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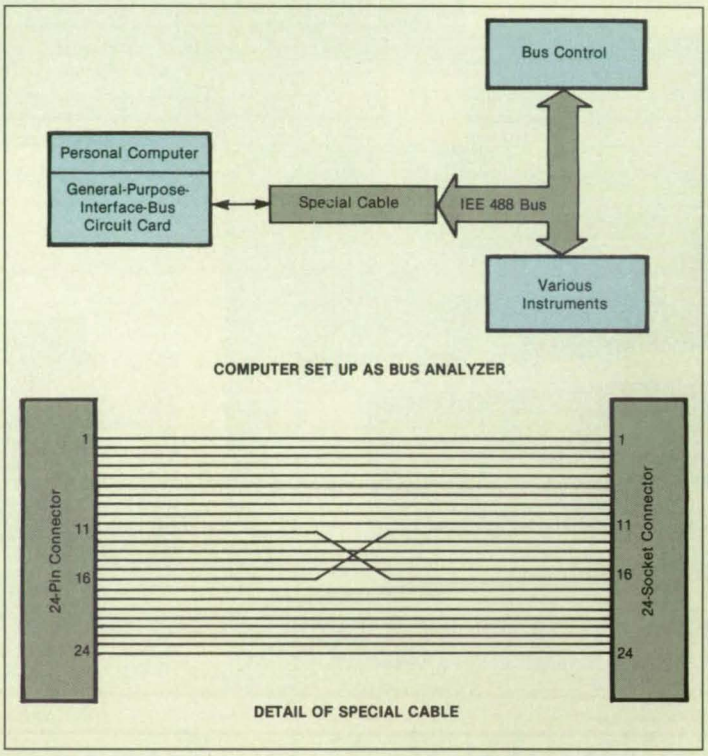
The bus, which conforms to a standard set by the Institute of Electrical and Electronics Engineers, is ordinarily used to connect a host computer (called a bus controller), with voltmeters, power meters, signal generators, power supplies, and other laboratory instruments. Each instrument is given a unique address, and the controller sends commands to the addresses to set scales, interrogate for statuses, and take measurements, for example.

When the computer is programmed with the special software and the adapter cable is installed, the computer functions as a bus analyzer, noting all messages that flow over the bus. The software makes the computer track the addresses that are enabled and reports all messages. The results can be recorded in a data file or simply displayed on the video monitor of the computer. The software is available in either Ada or Quick Basic language.



The **Personal Computer Monitors The Bus** through a special cable in which pin 11 is switched with pin 16.

This work was done by Bruce L. Conroy of Caltech for NASA's **Jet Propulsion Laboratory**. *For further information,* ***write in 14*** *on the TSP Request Card. NPO-18700.*

Optimal Preprocessing of GPS Data

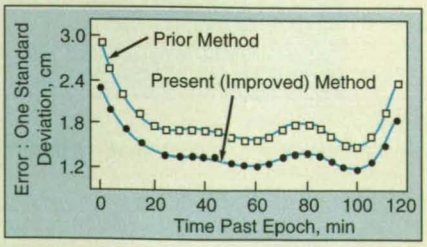
The number of data is reduced without degrading the strength of the data

NASA's Jet Propulsion Laboratory, Pasadena, California

An improved technique for preprocessing data from a Global Positioning System (GPS) receiver reduces the processing time and the number of data that have to be stored. The technique is optimal in the sense that it maintains the strength of the data. It can also sometimes increase the ability to resolve ambiguities in the numbers of cycles of the received GPS carrier signals.

To give meaning to even a brief description of the improved preprocessing technique, it is necessary to describe some aspects of preprocessing and processing of GPS data. Preprocessing of GPS data involves combination of the four streams of GPS data, which are described below, into one stream of data. As used here, "strength" denotes a semiquantitative measure of the validity, utility, and/or precision of the data, and it increases with decreasing standard deviation of the data.

Preprocessing is applicable to data on the signals received from one GPS satellite. Each GPS satellite transmits at two frequencies: f_1 = 1.57542 GHz and f_2 = 1.2276 GHz. By use of (1) satellite-



The **Error in Determination of Position** of a site that carries a GPS receiver is reduced by use of the improved data preprocessing technique.

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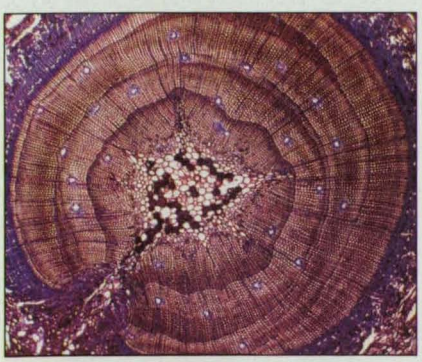

In Living Color!

With 24-bit precision color and 2.6 million pixels, the KODAK MEGAPLUS XRC Camera is ideal for use in film animation, electronic publishing and other color-critical applications. The XRC camera also features four different high-definition display modes, a high-speed SCSI port and RGB connections for analog display.

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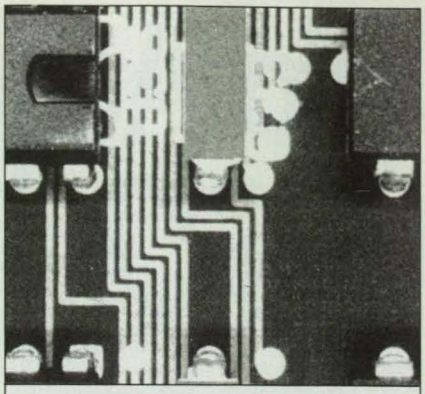

A Resolution Revolution!

With 4.2 million pixels per image, the KODAK MEGAPLUS Camera, Model 4.2 is ideal for use in metrology, microscopy, machine vision, document digitization, semiconductor inspection and other applications requiring the highest resolution. The camera features 8-bit pixel depth, frame rates of 2.1 images/second, analog and digital video outputs.

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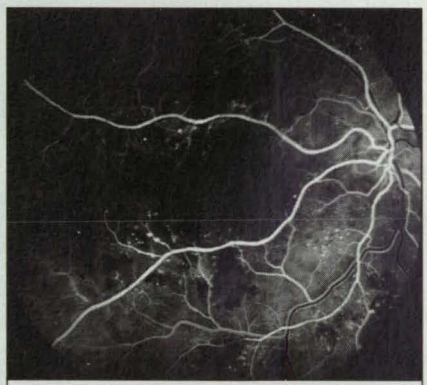

Eye-Catching Images!

The KODAK MEGAPLUS Camera, Model 1.4 is a proven performer in applications such as medical imaging, document digitization and quality assurance inspection. With a 1320 x 1035 pixel array, this camera's resolution is four times better than competitive cameras – at a price that's more affordable than ever.

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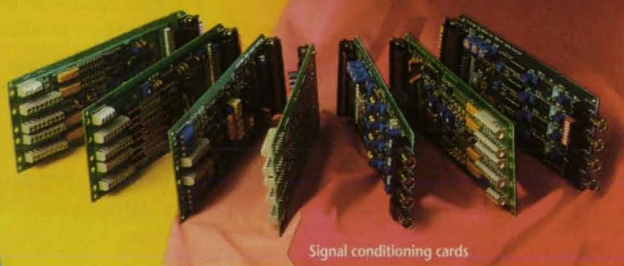
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ephemeris data broadcast via at least four GPS satellites themselves plus (2) measured times of arrival of signals from these GPS satellites, the data-processing subsystem in a GPS receiver can compute the position of the receiver. The range (distance) between the receiver and each satellite transmitter is an essential component of GPS data.

A GPS receiver can acquire two types of precise data from the f_1 and f_2 signals from each satellite: these are the P-code pseudoranges and the phases of the f_1 and f_2 carrier signals. Except for contamination by clock errors, atmospheric delays, and instrumental delays, pseudorange is an absolute measure of the range between the transmitter and the receiver. The phase of a carrier signal is also a measure of range but differs from pseudorange in two respects: it is biased by an unknown integral number of cycles, and it is characterized by a data noise much lower than that of pseudorange. Hence, these two data types complement each other nicely, and together they provide information substantially stronger than does either by itself.

It is common practice to combine measurements at the two frequencies to remove the ionospheric delays. This combination is performed independently, and thus suboptimally for pseudorange and carrier phase, leaving two streams of data to be used in the estimation process that follows. These two streams of data can be combined further to reduce the volume of data, but the preprocessing technique used heretofore for this purpose was again suboptimal in that it diminished that strength of the data.

The four streams of GPS data from one satellite are given by

$\Phi_1(t_i) = \rho(t_i) - \alpha_1\zeta(t_i) + B_1$ with data noise σ_Φ

$\Phi_2(t_i) = \rho(t_i) - \alpha_2\zeta(t_i) + B_2$ with data noise σ_Φ

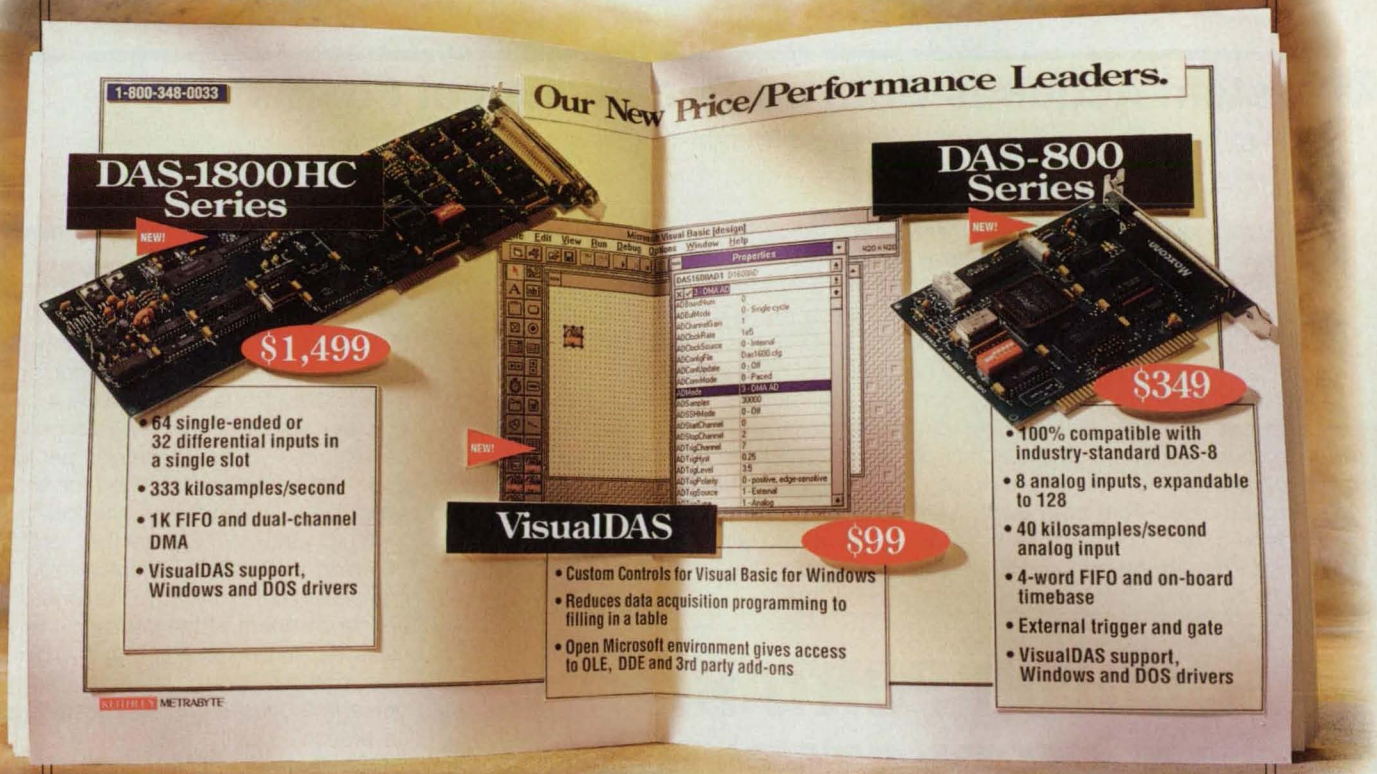
$R_1(t_i) = \rho(t_i) + \alpha_1\zeta(t_i)$ with data noise σ_R

$R_2(t_i) = \rho(t_i) + \alpha_2\zeta(t_i)$ with data noise σ_R for $i = 1,2, \ldots N$, where t_i is the ith observation time, Φ is the measured phase of a carrier signal, R is a measured pseudorange, the subscripts 1 and 2 denote the two frequencies, $\rho(t_i)$ is the ionosphere-free pseudorange, $\zeta(t_i)$ is a quantity proportional to the line-of-sight ionospheric electron content, B_1 and B_2 are carrier-phase biases (ambiguities in the number of cycles), which are unknown and constant over the whole span of the data,

$$\alpha_1 = f_2^2/(f_1^2 - f_2^2)$$

and

The Company that Wrote the Book on PC Data Acquisition Announces a New Chapter.



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$$\alpha_2 = f_1^2/(f_1^2 - f_2^2).$$

The data noise is assumed to be white and of the same level in the f_1 and f_2 signals. This completes the necessary description of GPS data to be preprocessed and processed.

The improved preprocessing technique is based partly on elimination of B_1 and B_2 in the data-stream equations and introduction of a correlation between the Φ_1 and Φ_2. It is feasible to base the technique partly on these concepts because a common bias with a given uncertainty is equivalent to a fully correlated data noise of the same uncertainty. The resulting modified data-stream equations are written in a matrix-vector form that facilitates simplification, leading to a complicated but nevertheless closed-form equation that combines the four streams of data into an optimal, weighted-least-squares estimate of $\rho(t_i)$, plus an associated equation for the covariance of ρ; the form of the latter equation is identical to that of a stream of carrier-phase measurements with constrained bias. The figure illustrates an example of the increase in precision afforded by use of the improved processing technique.

This work was done by Sien-Chong Wu and William G. Melbourne of Caltech for NASA's **Jet Propulsion Laboratory**. *For further information,* ***write in 6*** *on the TSP Request Card. NPO-18767.*

System Acquires Data on Reactivities of Foams

High rates of acquisition enable analysis of fast-reacting sprays.

Marshall Space Flight Center, Alabama

A data-acquisition and -plotting system, called the DAPS™, has been developed to enable accurate and objective determination of physical properties related to the reactivities of polyurethane and polyisocyanurate foams. The DAPS™ is an automated, computer-controlled test apparatus that acquires data on rates of rise, rise profiles, exothermic temperatures, and internal pressures of foams prepared from both manual and machine-mixed batches. The data are used to determine minute differences between the reaction kinetics and exothermic profiles of foam formulations, the properties of the end products of which are statistically undifferentiated. The DAPS was developed because the results of measurements performed by older manual techniques depended on the training and experience of test technicians. The automated apparatus yields repeatable results and provides many more data in nearly continuous data plots (as compared with relatively few data points recorded manually). The DAPS™ thus provides a significant improvement in determination of reactivity.

Several improvements have been made since the original version of the DAPS was built. The DAPS software was changed to give users control of the data-acquisition rates: initially, the rate was fixed at 4 samples per second; now, the rate can be set at 1, 2, 4, 8, or 16 samples per second. Fast sampling is needed for analysis of fast-reacting foams, the low-temperature [35°F (17°C)] reactivity profiles of which are typically characterized by completion times of 6 to 10 seconds. To enable sampling at the greater rates, an ultrasonic sensor assembly in the DAPS was replaced by a newer assembly that offers improved focusing and internal calibration.

New read-only memory chips containing a firmware image program were installed in a microprocessor in the ultrasonic-sensor assembly to establish the faster sampling. Other firmware on the added chips corrected minor problems associated with the transfer and manipulation of data. Thermocouples of different sizes were tested to select one that gives the best compromise between rapid response to exothermic changes of fast-reacting foam sprays and long operational lifetimes. The selected thermocouple lasted for 80 pours.

A number of other significant changes were made in software. A user-selectable delay before acquisition of data begins was added to allow for the various times required for mixing of the ingredients of various foams. The rate of acquisition of temperature and pressure data was made selectable at either one or two samples per second. The number of pours to be displayed was increased from the original two to five. Pour-setup information, including durations of tests, repeat series for autotermination, and holdoff times to allow for calculation of rates, was added to the data file. User-selectable pour data, in-

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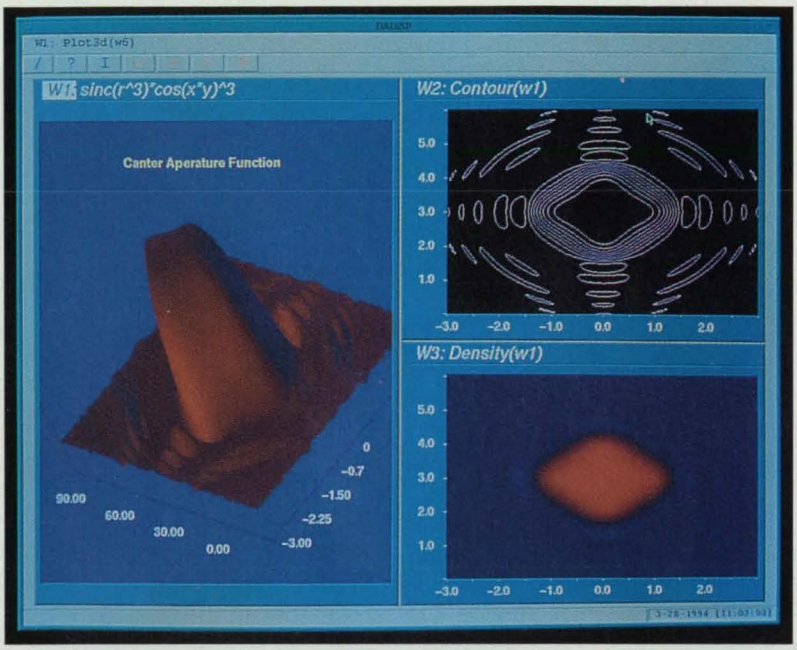

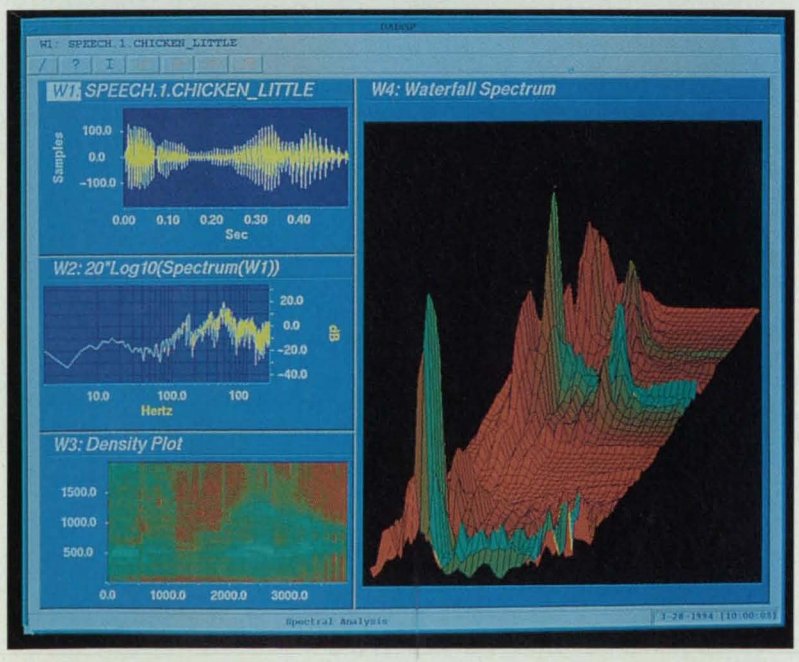

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cluding the weights of cups that contain components, mixing times, bung weights, and the initials of test technicians were added to system menus. Selectability of the degree of smoothing of data was added, as was the ability to accept gel and marker data, pending the incorporation of algorithms that will produce such data. An option to plot the data automatically after each pour was added.

This work was done by Joe T. Walls of Martin Marietta Corp. for **Marshall Space Flight Center**. *For further information,* ***write in 66*** *on the TSP Request Card. MFS-28804*

High-Storage-Capacity Accelerometer System

Small, low-frequency accelerations are recorded for subsequent analysis.

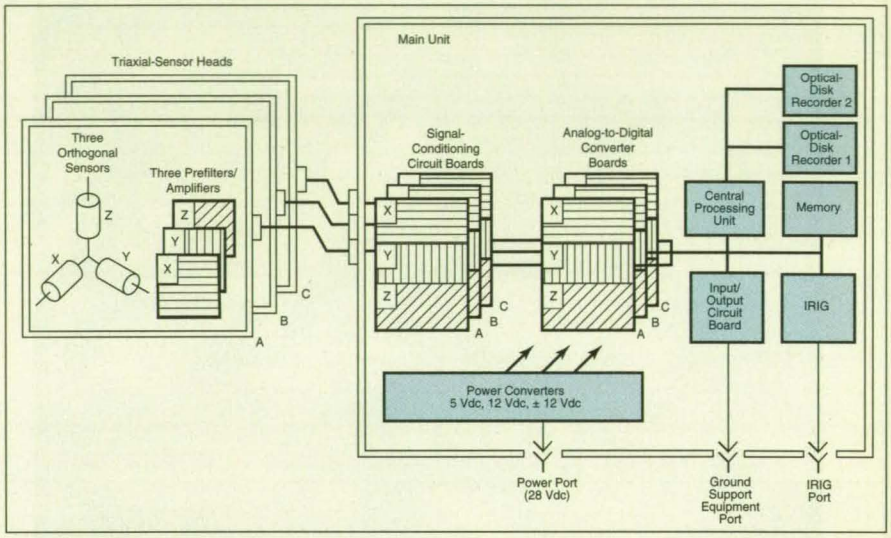
Lewis Research Center, Cleveland, Ohio

An instrumentation system measures and records accelerations at frequencies from 0 to 100 Hz and magnitudes from 10^{-5} to 0.5 g (where g = 9.8 m/s^2, approximately the gravitational acceleration at the surface of the Earth). The system can store gigabytes of acceleration-versus time data on optical disks for later analysis. The system was developed to aid research on small accelerations in a spacecraft in orbit. It can also be used on Earth; for example, with modified acceleration sensors to monitor the acceleration environments of sensitive products transported by airplanes, railroad trains, trucks, or ships.

The system (see figure) includes a main unit for electronic control unit and three sensor heads. The main unit contains a microprocessor, analog-to-digital converters, two to six optical-disk recorders, electronic signal filters, a control panel, and power converters. Each sensor head contains three orthogonal sensors, an electronic signal filter, and an amplifier capable of gain settings of 1, 10, 100, and 1,000, providing a dynamic range from 10^1 to 10^4 V/g. The analog signals generated by the sensors are amplified and filtered in the sensor heads before transmission to the main unit.

The signals are filtered further in the main unit, then converted from analog to 16-bit digital format by a phase-coherent process. The microprocessor in the main unit controls the data-sampling rate, which can range from 12.5 to 500 samples per second, for each of the 9 acceleration sensors. The microprocessor also sets the gains of the variable-gain analog amplifiers in the heads according to the magnitudes of the signals.

The digital data are fed to the optical-disk recorders; one side of each disk can hold 200 megabytes of data. If the disks can be changed manually or automatically, the number of data that can be recorded is nearly unlimited.



Triaxial Sensor Heads can be located as far as 20 ft (6 m) from the main unit. The inter-range instrument group (IRIG) decoder board obtains mission elapsed-time data, which are then interleaved with acceleration data before recording on optical disks.

This work was done by Theodore L. Chase, Neil D. Rowe, Richard DeLombard, John M. Koudelka, William M. Foster II, and John E. Thomas of **Lewis Research Center** *and Donald H. Priebe, John A. Heese, and Brian Finley of Sverdrup Technology, Inc. For further information,* ***write in 53*** *on the TSP Request Card. LEW-15529*

SAR Processing Based on Two-Dimensional Transfer Function

An algorithm based on the ETF outperforms others.

NASA's Jet Propulsion Laboratory, Pasadena, California

The exact transfer function (ETF) is a two-dimensional transfer function that constitutes the basis of an improved frequency-domain-convolution algorithm for processing synthetic-aperture-radar (SAR) data. The ETF incorporates terms that account for the Doppler effect of the motion of the radar relative to the scanned ground area and for the antenna squint angle.

The ETF algorithm was derived in an effort to overcome the disadvantages of a prior frequency-domain-convolution algorithm called the "range-Doppler" (RD) algorithm. The RD algorithm is based partly on the assumption that a two-dimensional transfer function that represents the phase history of a point target can be derived from a product of two one-dimensional functions in the time domain.

One of the disadvantages of the RD algorithm is that it requires extra interpolation of data to compensate for the variation in the distance between the radar and the target ("range migration" for short). Another disadvantage is that the predicted range-migration curve in the range-time-vs.-azimuth-frequency domain may not be accurate, leading to degradation of the impulse response function. A related algorithm called the secondary-range-compression (SRC)

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algorithm compensates for this degradation at small squint angles; another related algorithm called the squint-imaging-mode (SIM) algorithm compensates for this degradation at large squint angles, but is also disadvantageous in that it entails additional vector multiplications in the frequency domain.

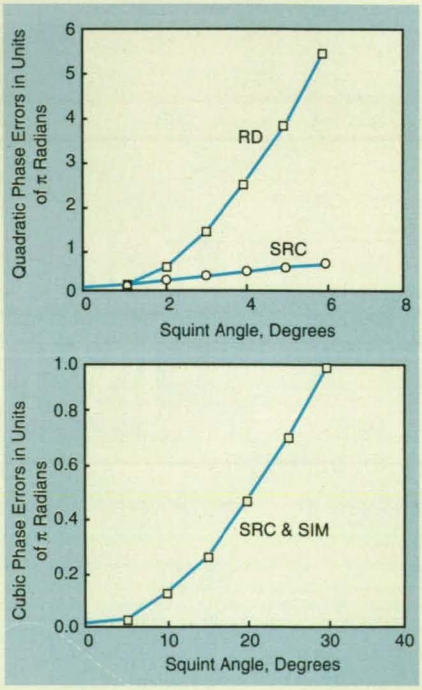
In deriving the ETF algorithm, it is assumed that the phase history of a point target is a two-dimensional function in the time domain. Despite its name, the exact transfer function is not exact: It is based partly on the assumption that after the range-compression stage of SAR processing, the response function of a point target in the range or range-time dimension can be approximated by a delta function. It is also assumed that the phase history of a point target within the width of the radar beam can be well approximated by a quadratic function of time. Taking the two-dimensional Fourier transform of the resulting time-domain point-target response function and assuming a large time•bandwidth product, one obtains the frequency-domain point-target response function (H_{ETF}), which is the desired ETF:

$$H_{ETF}(f_1, f_2) = A \exp\left\{j\pi\left[-\frac{f_c}{(f_1 + f_c)f_r} f_2^2 + \frac{2f_d}{f_r} f_2 - \frac{(f_1 + f_c)f_d^2}{f_c f_r}\right]\right\}$$

where A is a factor of proportionality, f_c is the carrier frequency, f_1 is the range frequency, f_2 is the azimuth frequency, f_d is the Doppler centroid frequency, and f_r is the rate of change of Doppler frequency. The second and third terms disappear when the radar beam is aimed broadside to the ground track.

One of the advantages of H_{ETF} is that it is explicit in terms of f_d and f_r, both of which can be estimated conveniently and accurately from SAR data. The ETF algorithm was analyzed, in comparison with the RD, SRC, and SIM algorithms, both algebraically with respect to phase errors (see figure) and by computer simulation using synthetic radar echoes from point targets and parameters of the SEASAT SAR system. The results show that the ETF offers superior performance at large squint angles.

This work was done by Chi-Yung Chang, Michael Y. Jin, and John C. Curlander of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 96*** *on the TSP Request Card.*
NPO-18895



The **Residual Phase Errors** of the transfer functions of the RD, SRC, and SIM algorithms (that is, the phase errors of these algorithms beyond that of the ETF) increase with the squint angle. The phase error is an important measure of performance because it affects the system impulse response function.

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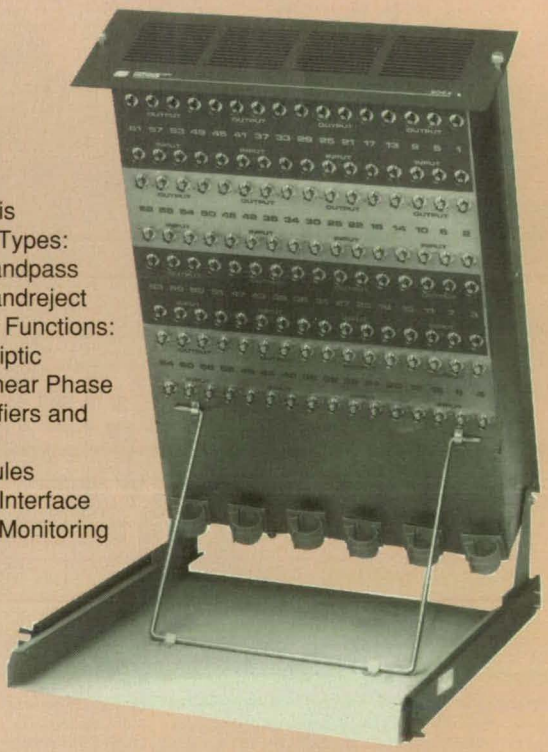

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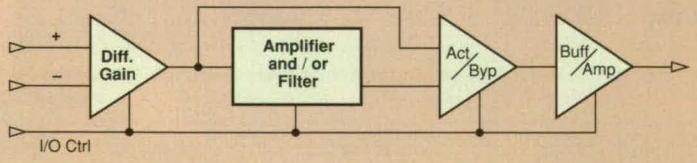

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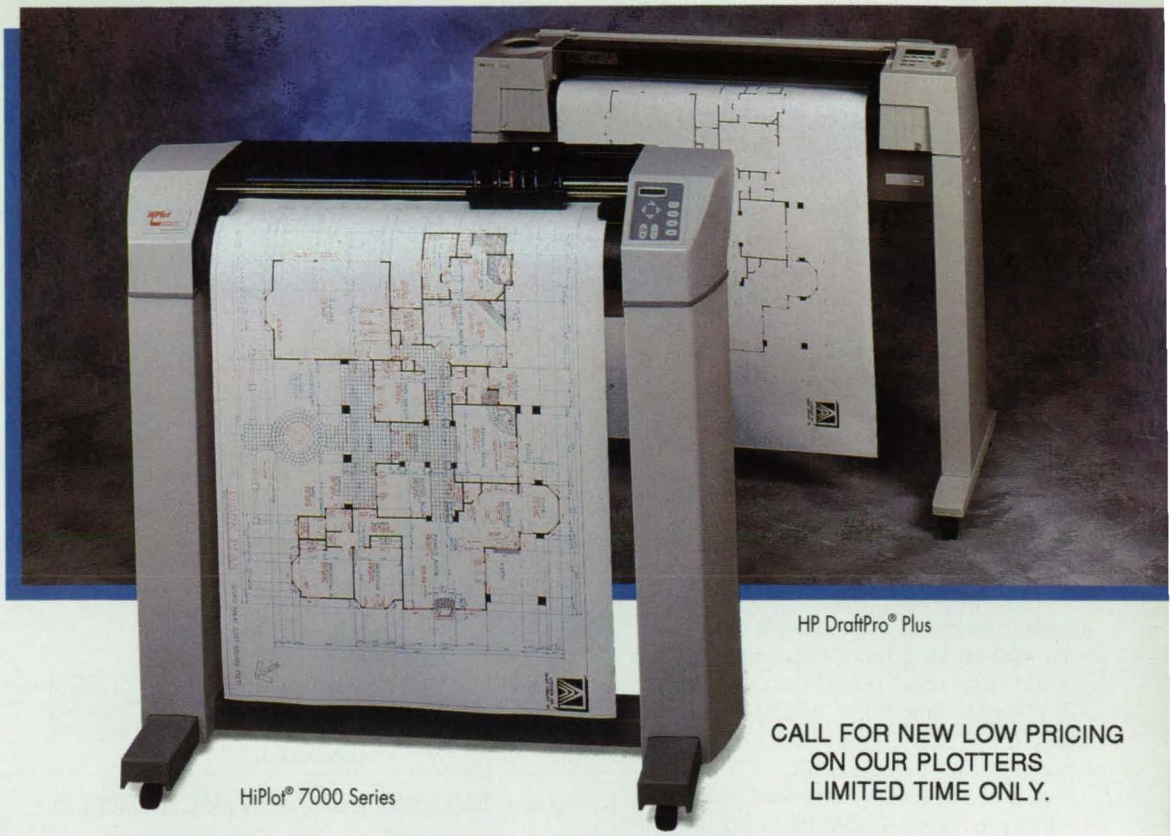

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Precise-Test-Pulse Generator

This circuit produces single test pulses of stable duration and amplitude.

Lewis Research Center, Cleveland, Ohio

A precise test pulse with a stable duration and amplitude is often needed for calibration of test equipment. The figures illustrate a precise-test-pulse generator that provides such a waveform and has many additional desirable features.

One of the requirements for the design of this pulse generator is that it be capable of driving four 50-Ω loads with a single 100-μs-long output pulse when triggered. The output pulse is required to have a stable amplitude selectable at either 0.5 or 0.25 V. The polarity of the output must also be selectable.

U1 is a quartz-crystal-controlled oscillator that provides a 1-MHz clock signal. Pullup resistor R_1 provides a 15-V clock pulse to divider U2. The output of U2 is a 100-kHz square wave, which is connected to clock 2 of the dual D flip-flop U4. U4 is configured as a digital one-shot.

The trigger contact is connected to the input of Schmitt trigger U3. The output of U3 is connected to clock 1 of U4. D1 of U4 is pulled high. Reset 1 of U4 is connected to output 2 of U4. Output 1

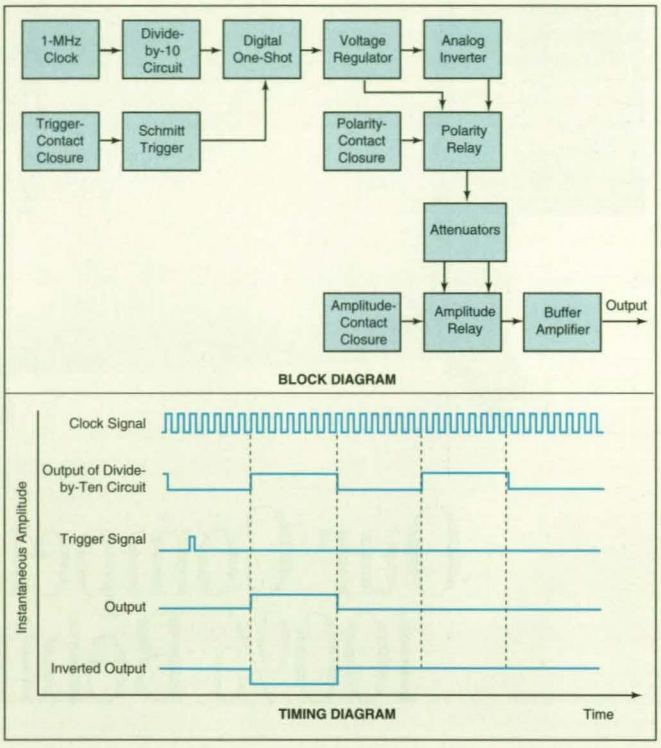

Figure 1. These **Block and Timing Diagrams** illustrate the essential functions of the precise-test-pulse generator.

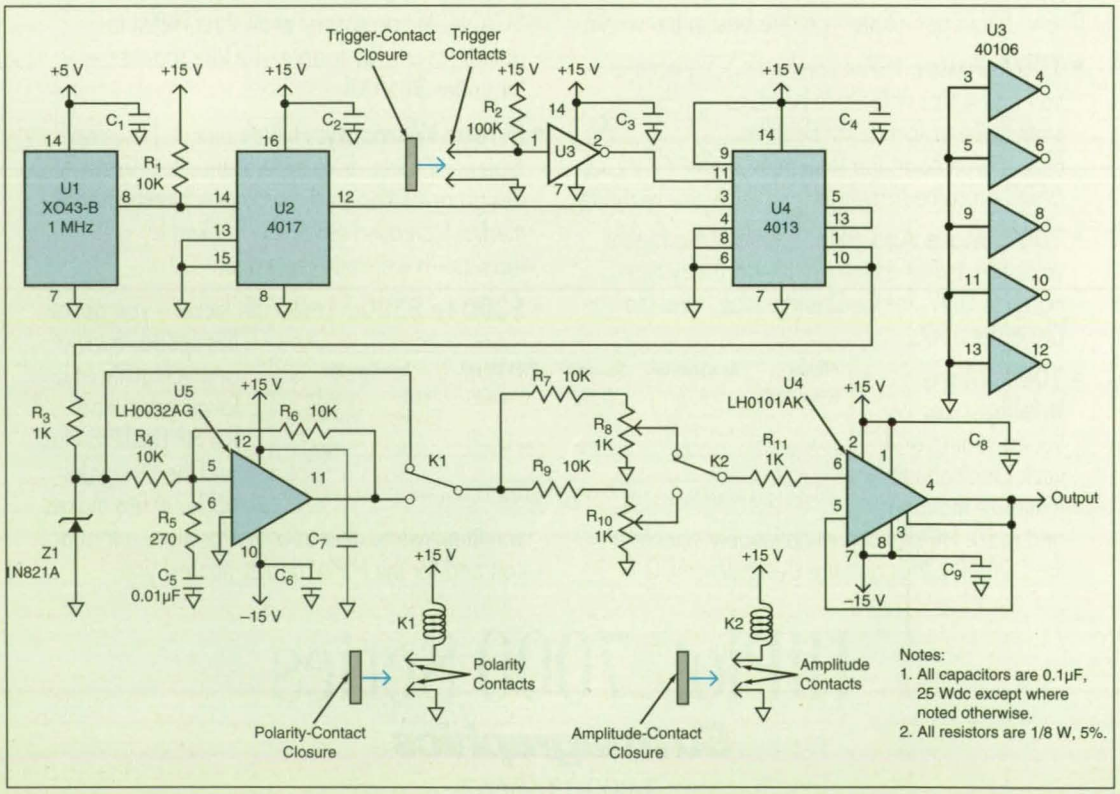

Figure 2. The **Precise-Test-Pulse Generator** is made of commercially available integrated circuits and discrete components.

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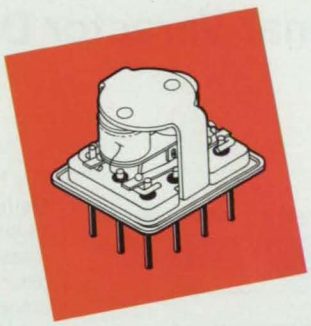

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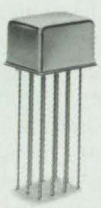

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of U4 is connected to D2 of U4.

Triggering the pulse generator provides a pulse to the second flip-flop. The second flip-flop then produces a single pulse with a duration equal to that of the clock input and resets the first flip-flop. Thus, a single 100-μs pulse with a stability equal to that of the clock is provided.

The amplitude of the output of U4 is regulated by resistor R_3 and the temperature-compensated zener diode Z1. The 6.2-V pulse is fed to the normally closed contact of the polarity-switching relay K1. The pulse is also fed to the input of the high-speed operational amplifier U5, which is configured as a unity-gain inverter. The output of U5 is a negative pulse, which is fed to the normally open contact of K1. Thus, K1 can be used to select either a positive or negative pulse by activating or not activating via the polarity-contact closure.

The common contact of K1 is connected to two adjustable voltage dividers that comprise resistors R_7 and R_9 and potentiometers R_8 and R_{10}. Each potentiometer provides a pulse amplitude adjustable from 0 to 0.5 V. The wiper of one potentiometer is connected to the normally open contact of amplitude-switching relay K2. The wiper of the other potentiometer is connected to the normally closed contact of K2. The common contact of K2 is connected to the input of the wideband high-power operational amplifier U4, which is configured as a unity-gain buffer amplifier. The output of U4 is capable of providing 2 A continuously and thus can easily drive four 50-Ω loads in parallel.

The circuit can be readily modified to accommodate other test requirements. The duration of the pulse can be modified by a clock U1 of different frequency or by changing the frequency divider U2. The amplitude of the pulse can be increased to as much as 15 V, the exact value depending upon the value of the zener diode Z1 and the values of the voltage-divider resistances R_7, R_8, R_9, and R_{10}.

This work was done by Dennis Eichenberg of **Lewis Research Center**. *No further documentation is available.*
LEW-15727

Improved Fabrication of Back-to-Back Planar Varactor Diodes

Processing is simpler, and the processed devices are more robust.

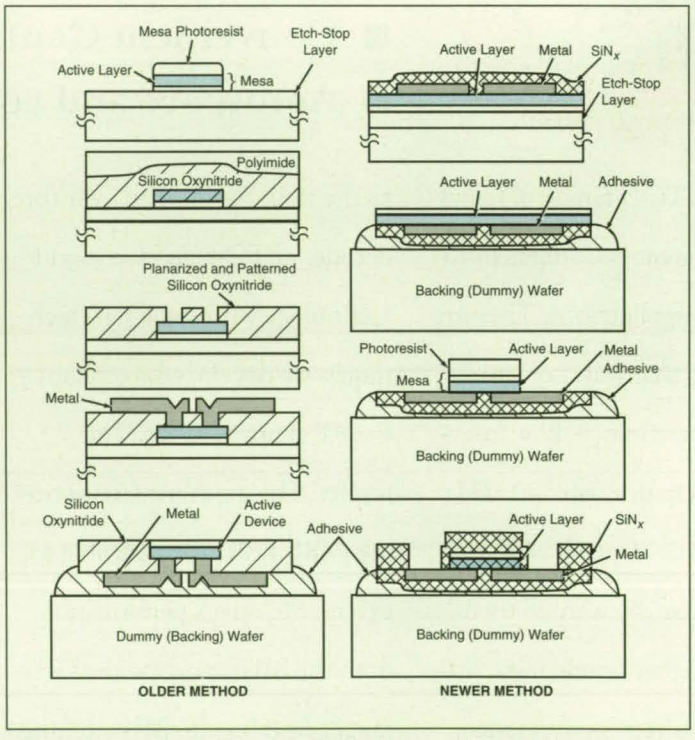
NASA's Jet Propulsion Laboratory, Pasadena, California

An improved method for the fabrication of GaAs-based back-to-back planar varactor diodes simplifies processing and makes the fabricated devices less vulnerable to damage at various intermediate process steps. In so doing, the method is expected to increase device yields.

Planar varactor diodes are being developed to replace whisker-contact varactor devices in submillimeter-wave heterodyne receivers. The planar devices are more rugged than whisker-contact devices are; the planar devices are also amenable to integration into relatively large planar arrays that could be useful in communication systems.

Two essential parts of the fabrication of individual devices or an array of such devices are (1) the deposition of metal contact pads that make contact only at desired isolated locations on each device and (2) the isolation of each device from other devices fabricated on the same wafer. In fabrication by older methods, such isolation has been effected by use of isolation implants and/or by etching away material from the front sides of the wafers to form mesas that constitute the individual devices. Both of these techniques are problematic and, in some applications, involve the difficulty of handling of extremely small and/or thin parts that are easily damaged.

The left side of the figure illustrates a device at several principal steps of a typical older fabrication process, in which the front-side mesa etch is performed first. The right side of the figure illustrates principal steps in fabrication according to the improved method, in which process steps are juggled into a different order and modified. One net effect of the juggling and modification is to keep the various layers and the patterns formed therein essentially planar (therefore rugged) during the intermediate process steps and to eliminate the need to handle the thinned structures. Another net effect is to defer the mesa isolation and associated metallization steps until near the end of the process, in such a way as to eliminate the difficulties involved in mesa isolation and metallization at the beginning as in older methods.



The **Newer Method** offers several improvements over the older method: the process steps are modified and juggled to provide simplified processing of devices that are more rugged.

In the improved method, the deposition of metal contact pads on the top and any other top-side processing are performed first; there is no preceding mesa step. A passivating layer (e.g., SiN_x) is deposited over the metal, then the wafer is turned upside down and bonded to a backing or dummy wafer by use of wax, epoxy, glue, or other suitable adhesive. The wafer thus mounted is etched down to the required small thickness (typically 1 to 3 μm). Then the mesa etch is performed, leaving the metal contact pads, passivating layer, and mesas adhering to the dummy wafer.

Processing after this step depends on the application: Typically, it involves deposition of a passivating or dielectric layer and patterning of this layer for access to

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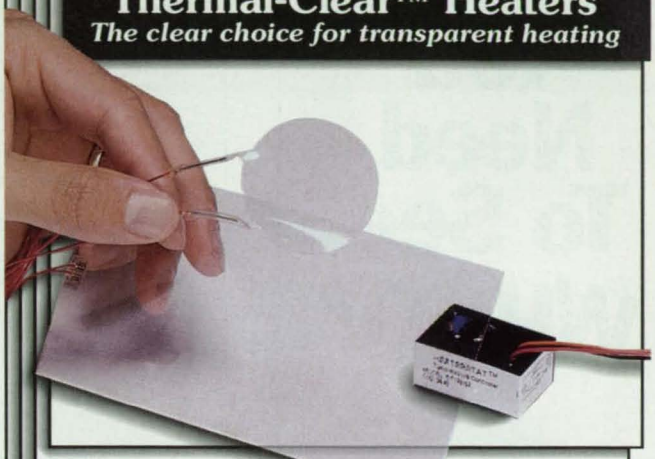

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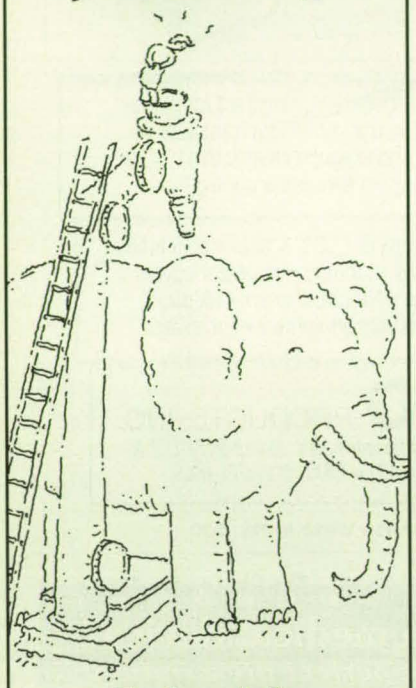

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the metal contact pads. Optionally, the devices can be left arrayed on the backing wafer or removed by melting or dissolution of the adhesive.

This work was done by Richard P. Smith, Debabani Choudhury, Suzanne C. Martin, and Margaret A. Frerking of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 97*** *on the TSP Request Card.*
NPO-18800

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Goddard Space Flight Center, Greenbelt, Maryland

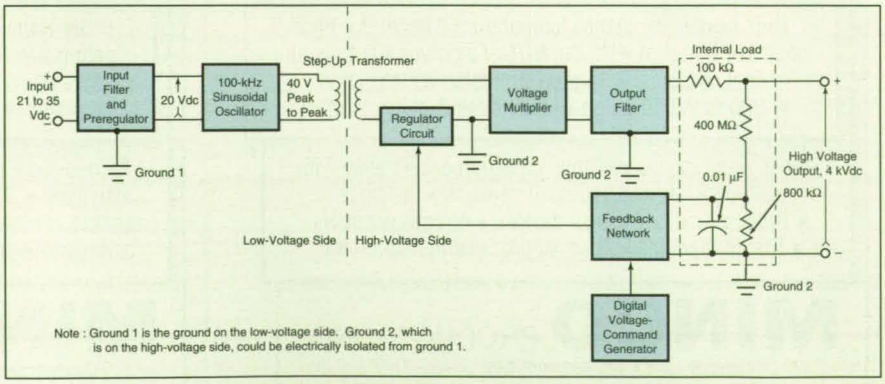
An improved dc-to-dc converter functions as a programmable high-voltage power supply with a low-power-dissipation voltage regulator on the high-voltage side. The design of this power supply overcomes the deficiencies of some older designs in which voltage regulation takes place on the low-voltage side and problems arise in connection with the competing requirements to both (a) sense the high voltage to provide feedback to the voltage-regulator circuitry and (b) isolate the high voltage from the circuitry on the low-voltage side. The design of this power supply also overcomes the major deficiency of other older designs in which the voltage-regulator circuitry lies on the high-voltage side and dissipates more power than is desirable.

This power supply can operate from a poorly regulated input dc supply that can range from 21 to 35 Vdc and delivers a regulated high voltage that can be set at any of a number of commanded levels up to about 4 kVdc. The input power is first processed through an input filter and preregulator, which supplies 20 Vdc to a 100-kHz sinusoidal oscillator. The output of the oscillator, at 40 V peak to peak, is fed to a step-up transformer, which isolates the low-voltage side from the high-voltage side.

The output of the transformer, at 500 V peak to peak, is fed to the series combination of a regulator circuit and a conventional Cockcraft–Walton voltage multiplier, which can deliver a maximum of 4 kVdc. The output of the voltage multiplier is filtered, yielding a high voltage of up to 4 kVdc with a ripple of about 10 mV peak to peak.

The output of the filter is connected to an internal load in the form of a network of resistors. A 100-kΩ resistor in the internal load protects against overcurrent in the event that the high-voltage output terminals are short-circuited. The series combination of a 400-MW and an 800-kW resistor acts as a low-power-dissipation voltage divider that provides a small feedback voltage to a feedback network. A 0.01-μF capacitor suppresses high-frequency transients so that the feedback network and regulator respond to only the relatively slowly varying output dc high voltage.

The feedback network provides for variations in gains and shifting of levels in passing the feedback voltage to the regulator circuit. The overall function of the feedback network and regulator circuit is to increase or decrease the conductance of that part of the regulator circuit that is electrically in series with the transformer and voltage multiplier, when the output voltage decreases or increases, respectively. Thus, the circuits strive to limit the excursion of the output voltage from a nominal level. The power supply is programmable in the sense that this level



The **Internal Load** provides both a low feedback voltage and protection against overcurrent, yet it dissipates little power during normal operation.

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can be selected, from among a number of discrete values, by sending a digital command to the feedback network.

This work was done by Karen Castell and Arthur Rutberg of **Goddard Space Flight Center**. *For further information,* ***write in 62*** *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, Goddard Space Center [see page 20]. Refer to GSC-13289

Cellulose Triacetate Dielectric Films for Capacitors

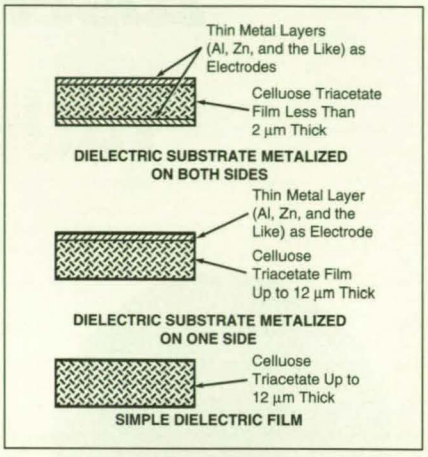
Advantages include high breakdown strength and a self-healing capability.

NASA's Jet Propulsion Laboratory, Pasadena, California

Cellulose triacetate is being investigated for use as a dielectric material (see figure) in high-energy-density capacitors for pulsed-electrical-power systems. Cellulose triacetate, which was first prepared in the year 1865, is a soluble derivative of cellulose and is used extensively as a substrate material for photographic film.

Cellulose triacetate is a good candidate for use as a capacitor dielectric material because it has a high oxygen-to-carbon ratio, which promotes self-healing during and after dielectric breakdown as follows: When a dielectric breakdown occurs in a capacitor, the resulting short-circuit current causes the cellulose triacetate to decompose into hydrogen, carbon dioxide, water, and other reaction products. These products passivate the metal electrode(s) (by vaporization or oxidation of the metal) in the vicinity of the breakdown before any significant electric charge can flow through the breakdown region. This causes the capacitor to return to its operating condition almost instantaneously.

Cellulose triacetate films with thicknesses ranging from 2 to 30 mm were fabricated for use in preliminary experiments by the following procedure: Various casting solutions were prepared by dissolving 5 to 10 weight percent of cellulose triacetate in a mixture of chloroform, dichloromethane, and 2-methoxyethanol. (The chloroform and dichloromethane were used as solvents; the 2-methoxyethanol served as a release agent to facilitate lift-off from the casting surface.) Each solution was cast on a 5-in. (12.7-cm) laboratory casting drum heated to a temperature of 30 °C and was dried somewhat on the drum to form a film. The film was peeled off the drum and dried in an electric oven at a temperature of 160 °C. The dried film was wound under tension to orient its molecular structure.



Films of Cellulose Triacetate can be metalized on one or both sides for use as substrates for electrodes and/or as dielectrics between electrodes in capacitors. Alternatively, they can be used without metalization as simple dielectric films.

The films thus fabricated were subjected to x-ray-diffraction, thermomechanical, ac-impedance, and dielectric-breakdown tests. In particular, one film 13 μm thick exhibited a dielectric constant of 3.6 and a dissipation factor of 0.016 at a frequency of 1 kHz and a breakdown strength of 12.15 kV/mil (4.783×10^8 V/m). The combined test data suggest that the oriented, primarily amorphous crystalline structure of the film could be further biaxially oriented and the degree of its crystallinity could be increased by stretching at a temperature of 250 °C, with a consequent reduction of thickness to <2 μm and increase in dielectric breakdown strength to more than 15 kV/mil (5.9×10^8 V/m).

This work was done by Shiao-Ping S. Yen of Caltech and T. Richard Jow of the U.S. Army for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 24*** *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 [see page 20]. Refer to NPO-18935.

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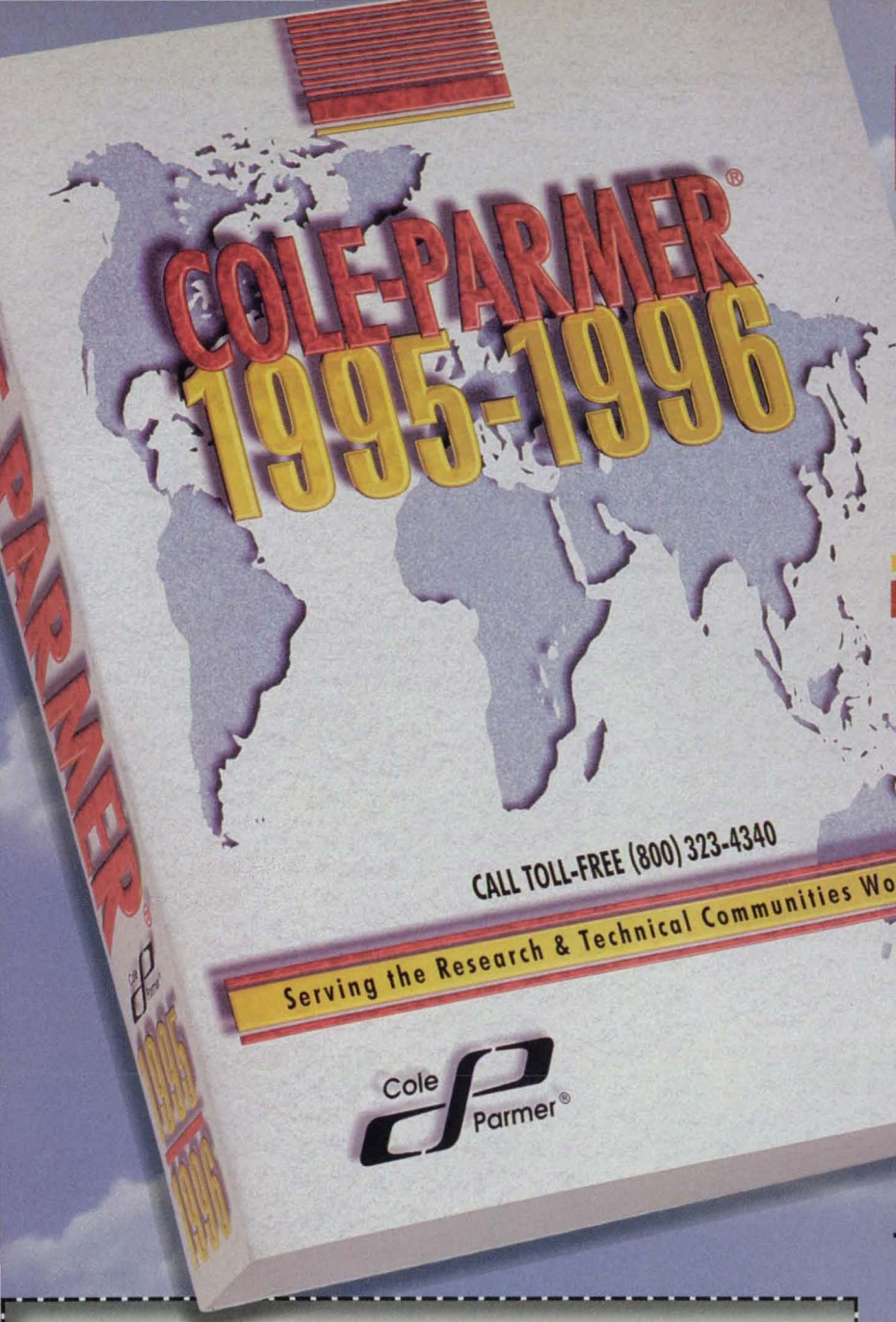

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Electromagnetic-Repulsion Systems for Deicing Aircraft

These systems can be fit to many exterior surfaces, as retrofits or original equipment.

Lewis Research Center, Cleveland, Ohio

Improved eddy-current electromagnetic-repulsion deicing systems have been developed for use on a variety of exterior aircraft surfaces like the leading edges of wings, engine inlets, propellers, and helicopter rotors. These systems are light in weight, consume little average power, and are capable of protecting against severe icing conditions.

Older eddy-current electromagnetic-repulsion deicing systems include thick electromagnet coils that must be mounted inside the wings or other surfaces from which ice is to be removed, and cannot be easily retrofit to preexisting aircraft. Moreover, the older eddy-current systems cannot remove as thin a layer of ice as the improved system. In contrast, the improved systems include electromagnet-coil/eddy-current repulsion units no more than 0.10 in. (2.5 mm) thick. These improved eddy-current systems are suitable for retrofitting by conforming to and mounting on the exterior of aircraft surfaces. In tests, a prototype improved eddy-current system removed ice as thin as 0.010 in. (0.25 mm), and removed all ice over 0.065 in. (1.65 mm) thick.

The basic principle of operation is the same as in the older systems: electrical charge on a capacitor is discharged through an electromagnet coil, generating a pulsed magnetic field that induces eddy currents in an adjacent conductive surface. A typical discharge reaches a peak current of about 4,000 A in a rise time of about 70 μs. The magnetic repulsion between the current in the coil and the eddy current generates a mechanical impulse that moves the outer surface rapidly away from the coil layer. This movement breaks the ice adhesion bonds to the outer surface and expels the ice outward.

Figure 1 shows part of a typical system that includes a number of electromagnet coils mounted on the leading edge of a swept wing. The coils are covered by an outer sheet, which is anchored to the wings along its edges. When a coil is energized, the resulting impulse momentarily pushes the outer sheet a short distance [0.01 to 0.15 in. (0.025 to 3.8 mm) during less than 0.1 s] outward from the fixed wing surface. The outer sheet can cover an area larger than that covered by the coils themselves, so that ice can be removed from the larger area without having to cover it entirely with coils.

The top part of Figure 2 illustrates schematically a typical coil, which comprises two flat spirals of copper strip conductor about 0.02 in. (0.5 mm) thick, separated by a layer of insulating material about 0.01 in. (0.25 mm) thick. A typical coil is 5 in. (12.7 cm) in diameter and has eight turns in each spiral. The self-inductance and resistance of a typical coil are 20 μH and 50 mΩ, respectively. Coils of this type can be designed and manufactured by established techniques for computer-aided design and for mass production of circuit boards. Pulse-generating circuitry under the pilot's control can be placed at any convenient location in the

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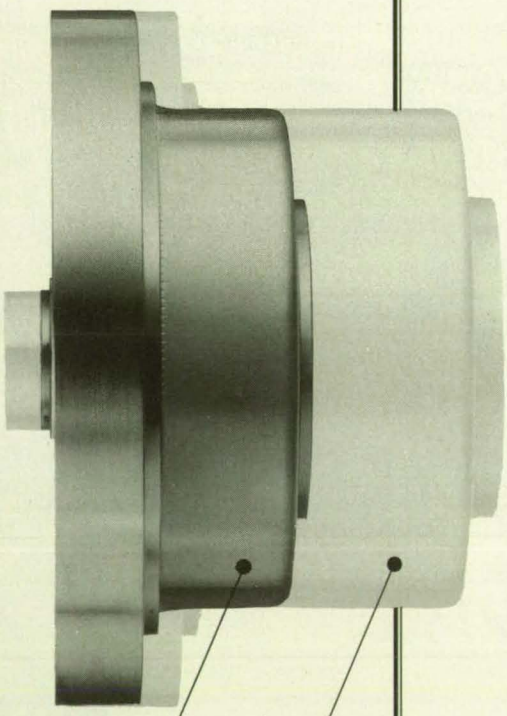

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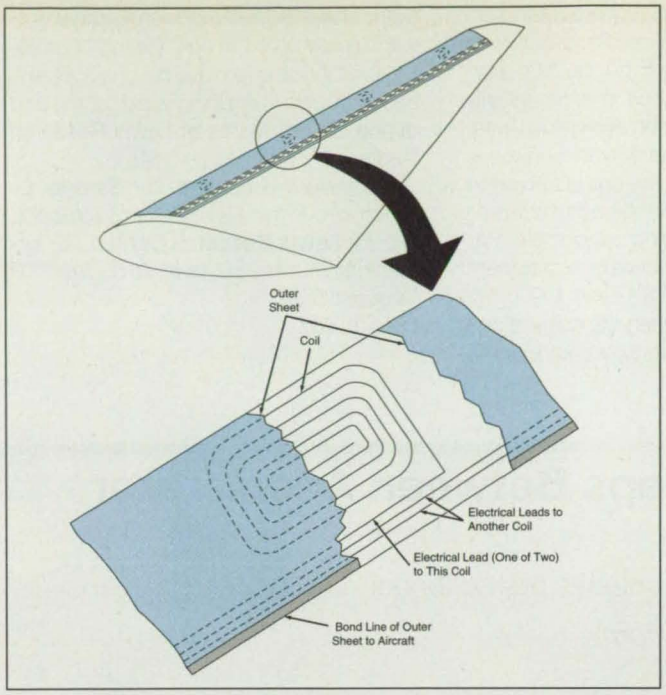

Figure 1. **Eddy-Current-Generating Electromagnet Coils** are mounted at various locations on the leading edge of a swept wing and covered by an outer sheet. Pulsed electrical currents are applied to the coils as needed, and the resulting mechanical impulses in the outer sheet knock off accumulated ice.

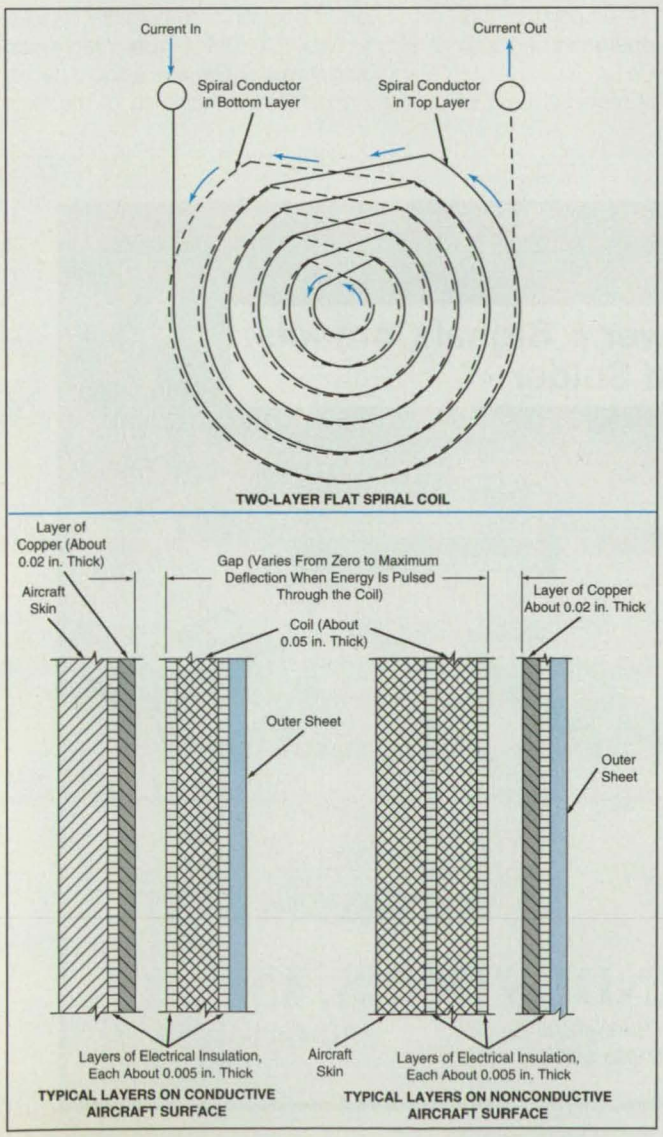

Figure 2. **Configurations of Coils and Associated Components** can be tailored to the specific aircraft surfaces to be protected. The flat, counterrotating-spiral coil configuration shown here is typical.

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aircraft and connected to the coils via low-inductance transmission lines.

As shown at the bottom of Figure 2, the relative arrangement of each coil, the outer sheet, and the associated components depends on whether the aircraft surface is electrically conductive (e.g., an aluminum wing of a conventional passenger airplane) or nonconductive (e.g., fiber/matrix composite material in a lightweight advanced aircraft). If the aircraft surface is conductive, then the eddy currents are generated in either the aircraft surface or a copper layer affixed to the aircraft surface; the repulsion takes place between the coil and the fixed conductive surface(s), so that the coil is momentarily pressed outward against, and moves with, the outer sheet. If the aircraft surface is nonconductive, then the coil is affixed to the aircraft surface and the eddy currents are generated in either a conductive outer sheet or in a conductive layer adjacent to the outer sheet; in this case, the repulsion takes place between the coil and one of the outer conductive layers, so that the outer sheet is pressed momentarily outward, away from the coil. Testing of prototypes of these improved deicing systems has occurred in an icing wind tunnel and during aircraft flights at Lewis Research Center.

This work was done by Samuel O. Smith and Peter Zieve of Electroimpact, Inc., for **Lewis Research Center**. *For further information,* ***write in 46*** *on the TSP Request Card.*
LEW-15487

Capacitive Measurement of Gaps Between Accelerator Grids

Tedious mechanical and optical measurement techniques are no longer needed.

NASA's Jet Propulsion Laboratory, Pasadena, California

Two techniques that involve simple measurements of capacitance provide straightforward indications of the distance between two closely spaced perforated electrodes (also called "grids") in an ion-accelerator apparatus. The measurements are needed for adjustment and diagnosis because the performance of the accelerator depends strongly on the distance between grids. Both normal and abnormal handling of the accelerator can alter this distance at room temperature; the heating and resulting gradients of temperature that occur during normal operation can also alter the intergrid distance.

Older techniques for measurement of the gap at room temperature include refocusing microscopes and the use of feeler gauges. Other optical and mechanical techniques have been used to measure the gap at operating temperature (typically 300 to 500 °C). These older mechanical and optical techniques are tedious, necessitate considerable handling of the elec-

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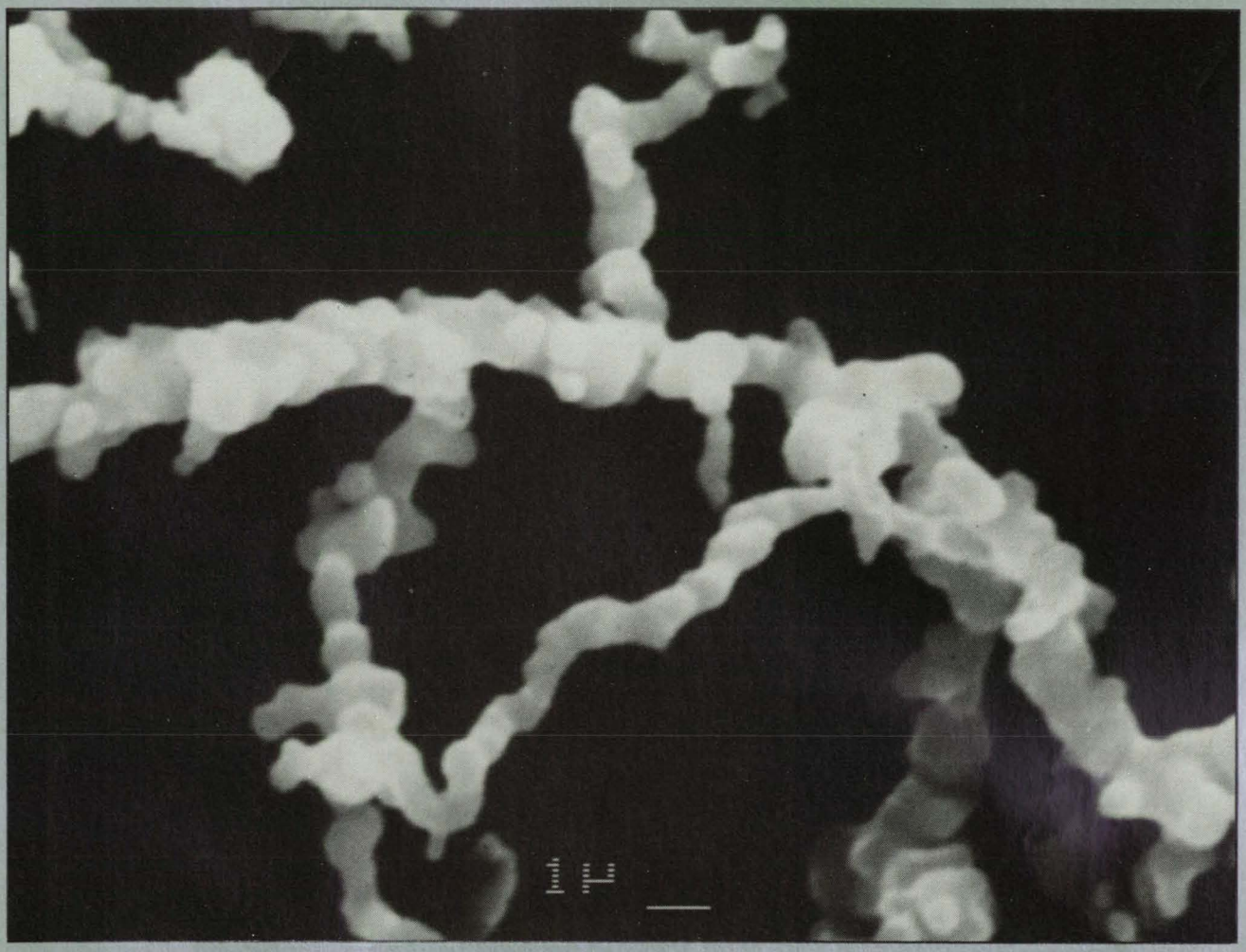

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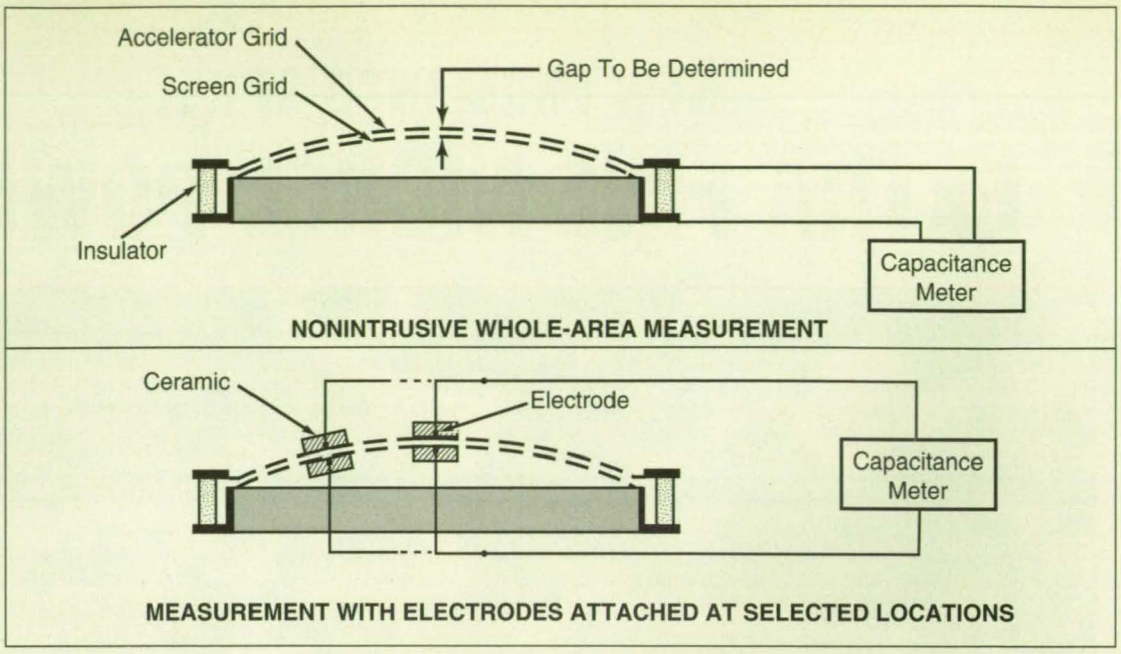


Capacitive Measurements of the distance between the grids are relatively easy and can be performed at both ambient and operating temperatures.

trodes, and yield measurements on the gap between only two points at any given time.

The capacitive measurement techniques can be implemented easily at both ambient and operating temperatures, and they involve much less handling of the grids. Indeed, the first technique (see top part of figure) can be implemented without touching the grids at all, and it yields a measurement representative of the entire intergrid gap instead of the gap at one location only. Very simply, one attaches a capacitance meter to the external grid contacts to measure the capacitance between the grids. This measurement is easily converted to an intergrid distance by use of the well-known approximate proportionality between the capacitance and the reciprocal of the distance averaged over the area of the grids.

The second capacitive measurement involves some initial handling of the grid, but no handling thereafter, and it yields more-detailed information. In this technique, very small pairs of electrodes are attached to, but electrically insulated from, the grids at several locations of interest. The capacitance between the electrodes in each such pair is measured, and the interelectrode gap at the location of each pair is then computed from the proportionality between the capacitance and a function that decreases with distance [the function is typically intermediate between $(\text{distance})^{-1}$ and $(\text{distance})^{-2}$, the exact form depending on the electrode geometry].

This work was done by John R. Brophy and Charles E. Garner of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 28*** *on the TSP Request Card.*
NPO-19132

Compact Electric- and Magnetic-Field Sensor

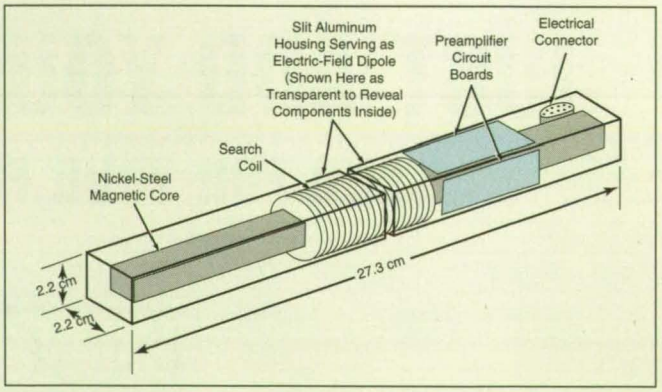
A search coil and an electric-field dipole are collocated.

NASA's Jet Propulsion Laboratory, Pasadena, California

A compact sensor measures both electric and magnetic fields. The sensor includes both a short electric-field dipole and a search-coil magnetometer. Three such sensors can be mounted orthogonally to provide triaxial measurements of an electromagnetic field at frequencies ranging from near 0 to about 10 kHz.

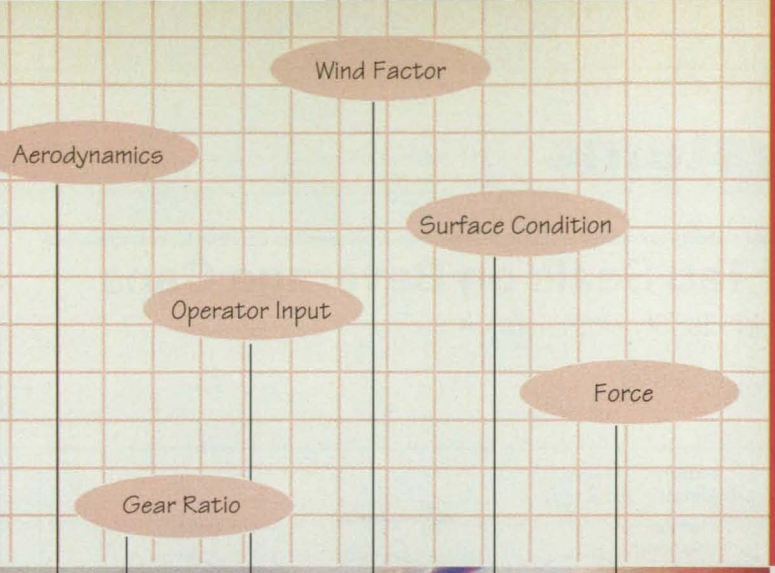
The search coil typically consists of 30,000 turns of fine wire wound on a segmented bobbin at the midlength of a laminated nickel-steel core of 1 cm^2 cross-sectional area. A preamplifier composed of three operational amplifiers on a circuit board is mounted near the bobbin (see figure).

An aluminum housing that surrounds the search-coil magnetometer is slit at its midlength into two pieces that constitute the elements of the electric-field dipole. The output of the dipole is fed to another preamplifier, which is also composed of three operational amplifiers on a circuit board.



The **Electric-Field Dipole** sensor houses the magnetic-field core and winding as well as preamplifiers on circuit boards.

This work was done by Daniel Winterhalter and Edward Smith of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 124*** *on the TSP Request Card.*
NPO-19034



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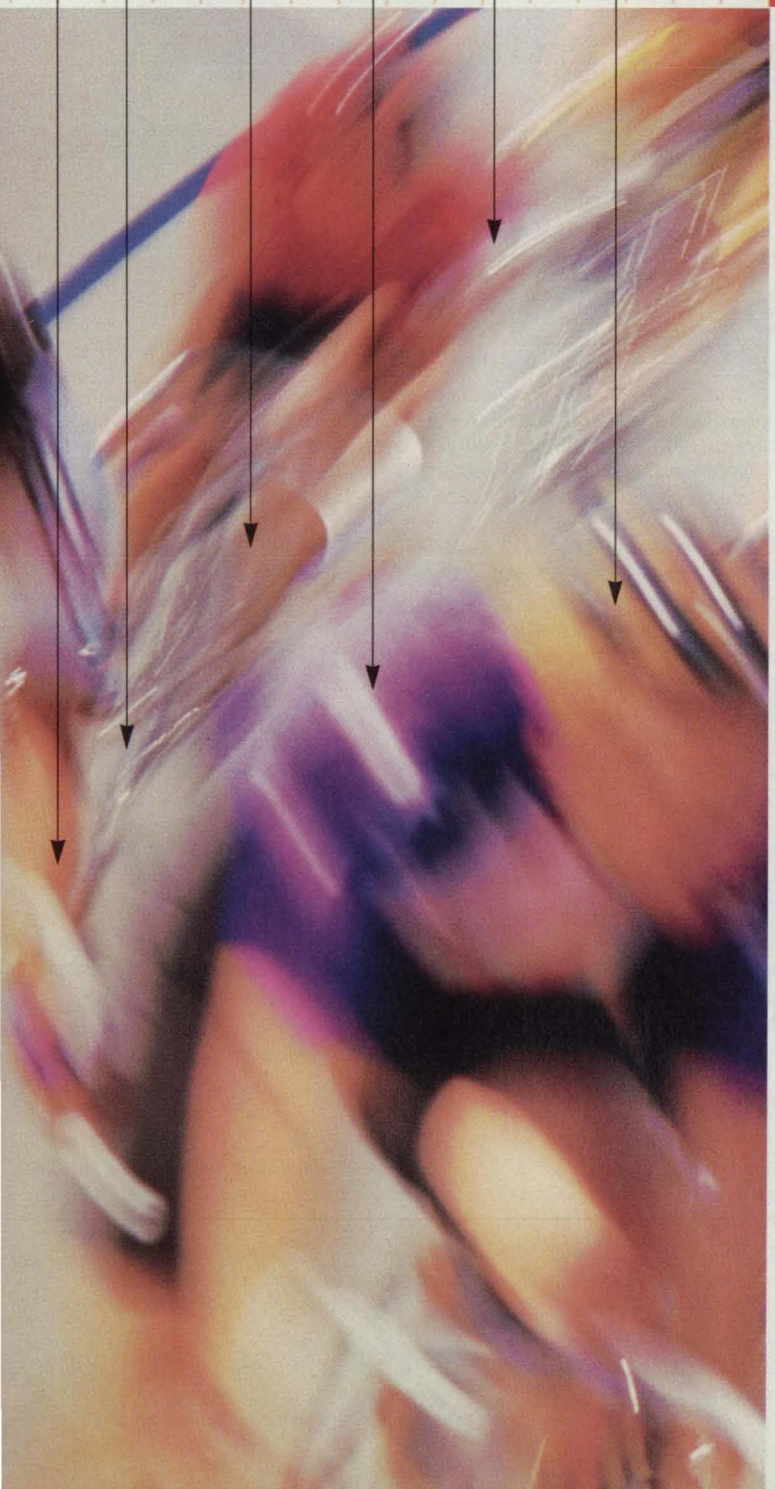

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Eddy-Current Inspection of Tab Seals on Beverage Cans

An automated quality-assurance system would identify defective cans.

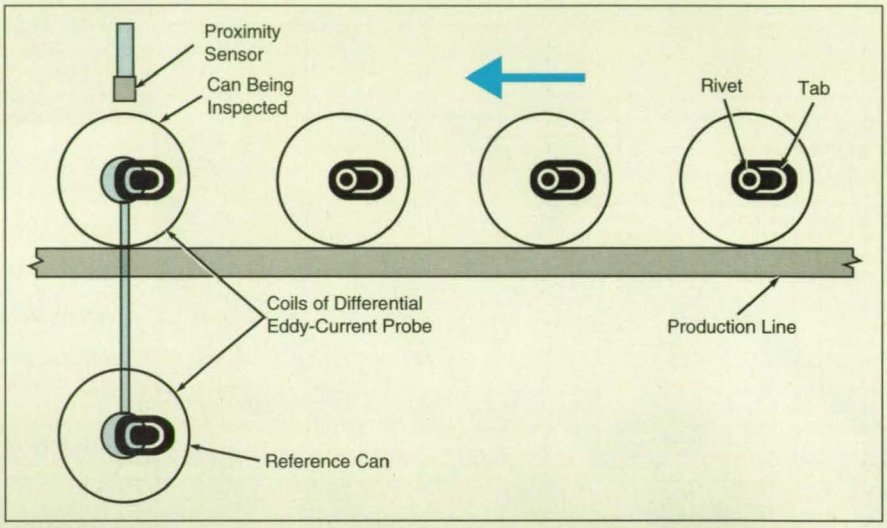
NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed eddy-current inspection system would monitor tab seals on beverage cans. The device would inspect all cans at the usual production rate of 1,500 to 2,000 cans per minute. Thus, automated inspection of all units would replace the current method of visual inspection by microscope aided by mass spectrometry, which is a slow method that can be used only for spot checking one out of thousands of cans.

Although the technique of tab sealing is well established and reliable, failures still occur, and even if only few cans out of a million are defective, they must be identified and removed: When a seal fails and leaks, it causes corrosion and leakage of adjacent cans in storage, creating a messy cleanup problem, a tarnished manufacturer's reputation, and a costly monetary settlement. Thus an inexpensive, 100-percent inspection method is highly desirable.

The built-in opener on the cover of a beverage can consists of a lever in the form of a tab fastened to the cover by a rivet head that is formed integrally from the cover itself. In the process of forming the rivet and squeezing its head, several defects can occur; these include cracks, fractures, and variations in the diameter of the rivet head.

The proposed eddy-current inspection system would detect these defects in real time. Sealed cans on a conveyor would pass near one of two coils in a differential eddy-current probe (see figure). The other coil in the differential eddy-current probe would be positioned near a stationary reference can on which the tab seal is known to be of acceptable quality. A signal of a certain magnitude (predetermined by experiment) at the output of the probe would indicate a defective can, which would then be automatically ejected from the conveyor.



Cans on a Production Line would pass by one of two coils of a differential eddy-current probe. Eddy currents induced in the production-line can being inspected should match those induced in the reference can. If the mismatch exceeded a predetermined value, the inspected can would be considered defective, and an actuator would eject the can from the

For accurate readings, it is essential that the test and reference cans be in the same position relative to their respective probe coils. To ensure this, a proximity sensor would measure the distance of an approaching can and trigger an eddy-current measurement at the instant the can reaches the proper position.

A counter would track numbers of defective cans. Statistical criteria would then be applied to the numbers of defective and nondefective cans to determine whether the manufacturing process is becoming defective and correction is needed.

This work was done by Yoseph Bar-Cohen of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 23*** *on the TSP Request Card.*

NPO-18758

Digitally Controlled Acoustic-Testing System

More-precise, real-time computer control replaces approximate, non-real-time manual control.

Goddard Space Flight Center, Greenbelt, Maryland

A digital electronic control system has been developed for use in effecting accurate, real-time, closed-loop control of a large acoustic test facility. The installation of the digital control system incorporates state-of-the-art technology to optimize shaping of the acoustic spectrum and controlling the operation of equipment in a large reverberant chamber to a degree not possible with open-loop manual control.

The chamber has a volume of 40,000 ft^3 (about 1,100 m^3). Most controllers for acoustic-testing chambers like this one are open-loop manual subsystems in which technicians adjust one-third-octave sliders of a spectrum shaper to adjust acoustic spectra. During a test, a technician moves the sliders while observing the real spectrum and the desired reference spectrum on a cathode-ray tube display. Unfortunately, a typical manual controller contains 27 sliders, and it is nearly impossible for a technician to control the sound levels in all 27 one-third-octave bands during a 1- to 2-minute test. In most cases, the technician can correct only the major differential sound pressure levels by moving some of the sliders and hoping

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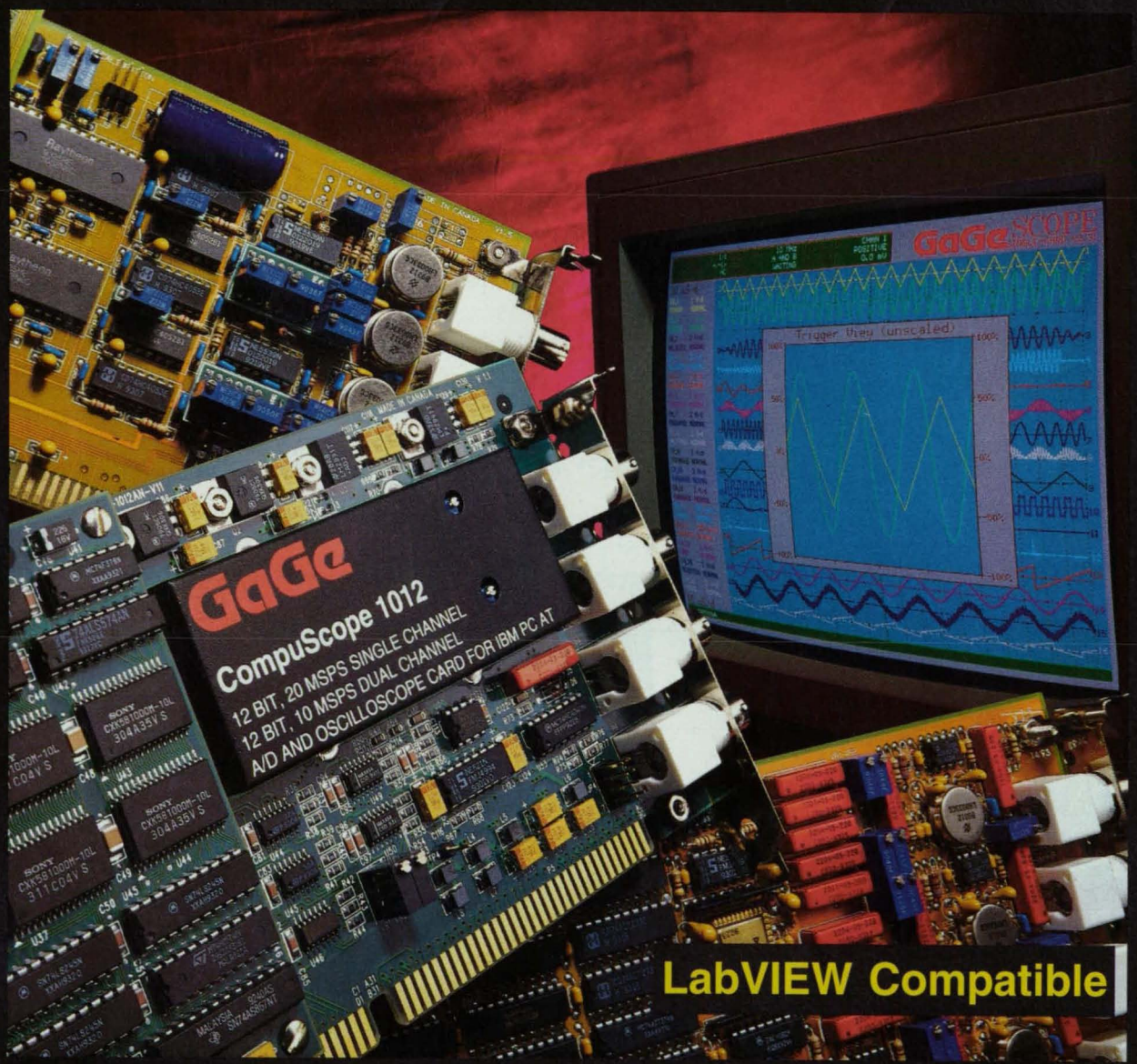

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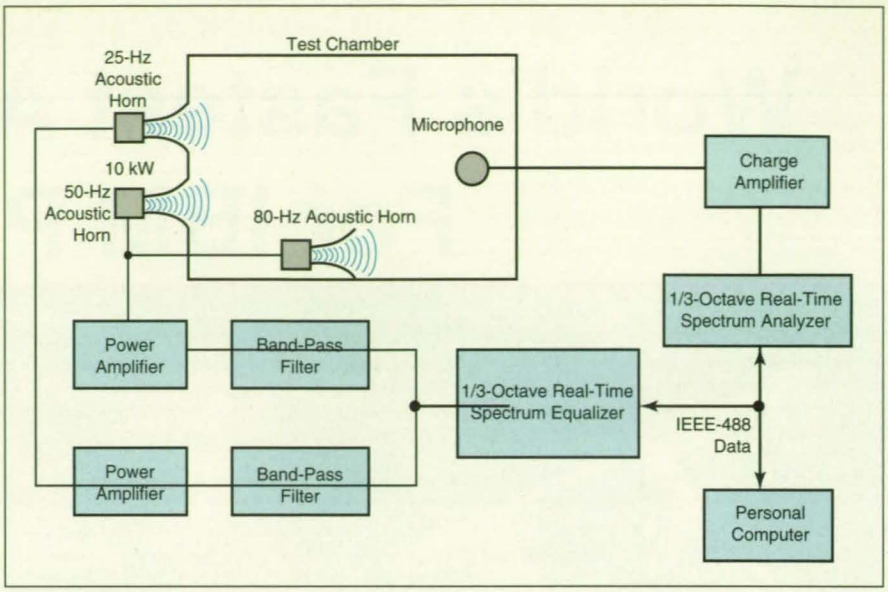
that the overall spectrum will fall within tolerance.

The digital control system, in contrast, very nearly matches the actual spectrum to the reference spectrum. The digital control system communicates with such equipment as control microphones, signal conditioners, a real-time acoustic-signal analyzer, the spectrum shaper, power amplifiers, acoustic horns, and signal generators. The overall system operates in real time in a closed loop (see figure), updating and correcting the sound pressure levels in the one-third-octave bands to obtain the acoustic spectrum specified for each test.

During a test, the digital control system also provides a graphical display of the actual spectrum superimposed on the reference spectrum. It turns a random-noise generator on at the beginning of a test and turns it off as soon as the test is complete. It completes a closed-loop spectrum measurement and adjustment every 3 to 4 seconds. It stores the following information and prints it out at the end of the test:

- Overall history of sound pressure level versus time;
- Differential correction signal from the reference and actual sound pressure levels for each one-third-octave band;
- Attenuation settings of each one-third-octave filter;
- The identity of the tested item, details of the test project, duration and level of the test, settings of band-pass filters, and other relevant information; and
- Parameters of the acoustic-testing system.



The **Personal Computer Controls** the equipment that generates and measures sound. The acoustic-testing system exposes test items to high noise levels (139 to 150 dB) with spectra adjustable in one-third-octave bands at frequencies from 25 to 10,000 Hz.

This work was done by K. C. Shah and R. Burkhardt of **Goddard Space Flight Center**. *For further information,* ***write in 30*** *on the TSP Request Card.*
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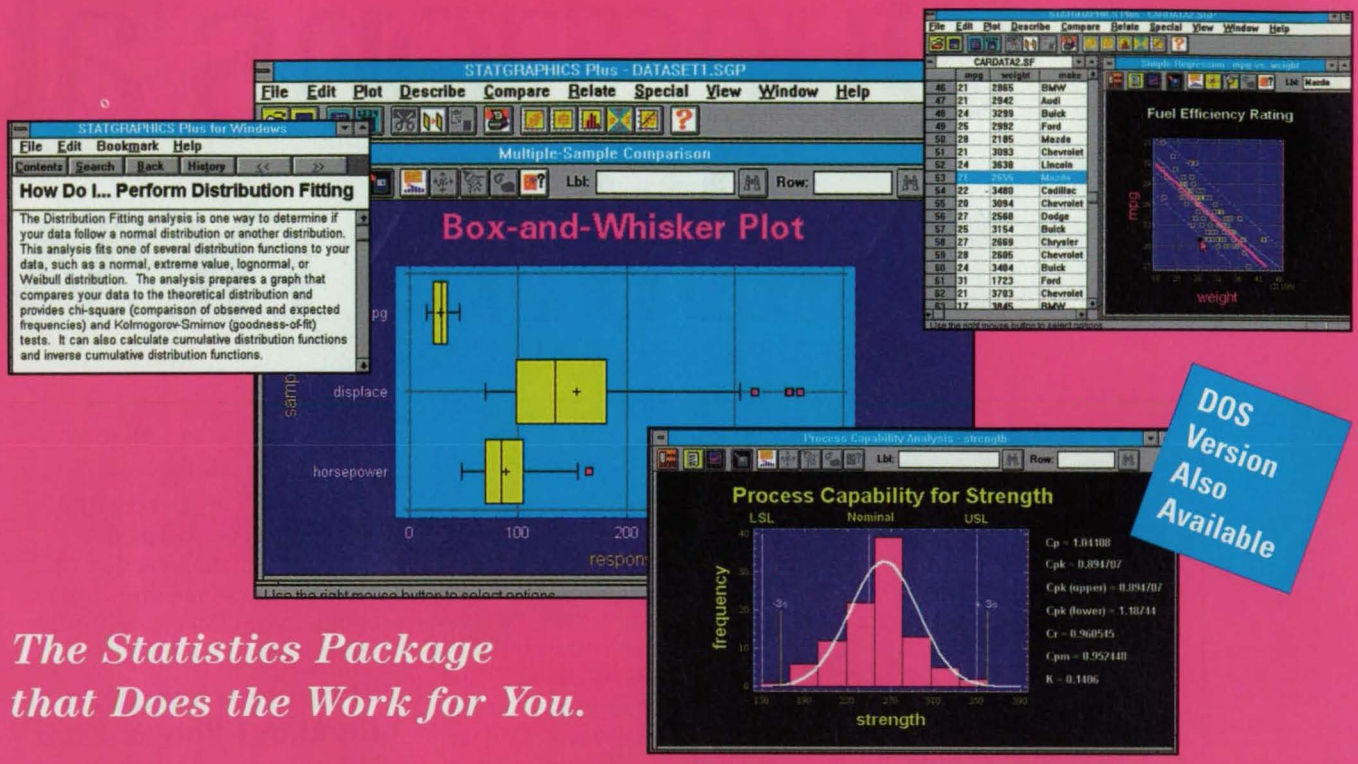

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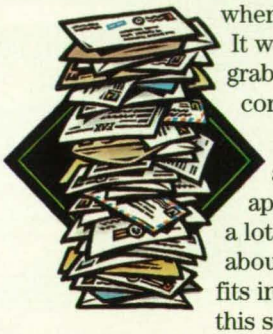
For More Information Write In No. 506

Questions ab
nothing new.



Remember the good old days when VXI was first introduced? It was supposed to replace a grab bag of technologies, conventions, and standards.

Well, judging by the amount of letters we get, it appears that people still have a lot of questions about it, and about where Hewlett-Packard fits in. So we thought we'd use this space to deliver what may turn out to be the most useful VXI product of all: answers.

"I don't want to paint myself into a corner with a proprietary vendor. Just where does HP stand on open VXI systems?"

VXI is, by definition, a totally open technology. And everything we've done — or will ever do — supports that philosophy.

Together with our competitors, we pioneered the development of the IEEE VXI standard. Then we supported it by offering more VXI products than anyone else. In addition to an array of hardware products, we developed the kind of software (like HP VEE, our graphical programming language) that helps engineers realize new levels of productivity — all with total openness as our focus.

We guarantee that every HP VXI product will be designed to work in open multivendor VXI systems. So where do we stand on the issue of openness? Right at the front of the line.

"I've been hearing a lot about Plug & Play. Where do you guys come in?"

Once the VXI*plug&play* Alliance Systems modified its charter to address the entire installed base of VXI users, HP joined immediately and enthusiastically.

VXI plug&play member

Why? Because we believe this alliance can bring another breakthrough in multivendor interoperability and ease of use. In the spirit of cooperation, we'll be working with the other alliance members to develop software standards and resolve system issues.

"I understand individual boxes. But VXI is another story entirely. Is there any way to make system development easier?"

It's one of our industry's little ironies that a technology developed to bring order out of chaos

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out VXI are
But answers are.

has itself spawned so many questions. Knowing that, we resolved to make system installation incomparably easy.

We start with our VXI Installation Consultant (VIC) software that takes you step-by-step through the installation and configuration process. It'll help you get your multivendor system up and running quickly and correctly. And our worldwide consulting and repair service will help you keep it that way.

Of course, one of the most critical aspects in assuring ease of system development is the software you choose. That's why we've worked hard to provide BASIC and C programmers with the tools they need to simplify test development.

Software can have a major impact on the ease of *system* development, too. So we'll continue to enhance our products so that your test code is portable across standard platforms, giving you the choices you want and the migration path you require. For example, HP VEE will soon run VX*Iplug&play* instrument drivers.

"I can set up test instruments in my sleep. But VXI...I just may need some help. Are you going to be there for me?"

Every step of the way.

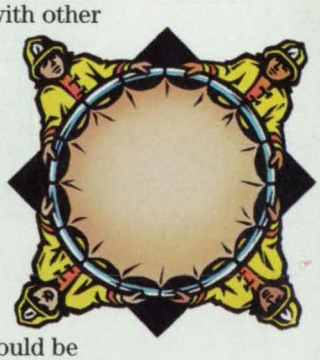
If you need help with system integration, count on our Custom Systems Integration Team to work with you on everything from software development, racking and cabling to complete multivendor system development.

For turnkey applications, our Channel Partners program links us with companies that have expertise in your industry. Together we'll deliver test systems that meet your requirements.

"Reassure me that I won't be sinking a lot of money into a test architecture without a future."

On the contrary, VXI just may be the one architecture with the future built in. The reason: it's based on industry standards that continue to provide users with cost-effective, automated measurements using compatible instruments, computers, and software. In other words, open.

Are we committed to making VXI work? Yes. We've contributed to the industry's most widely used technology, developing software such as SICL (Standard Instrument Control Library) and SCPI (Standard Commands for Programmable Instruments). And, with other alliance members, we're looking forward to taking VXI a lot further.



What it all amounts to is this: openness, performance, cost, application knowledge, experience, and support are critical issues you should be thinking about. But they're just components of a larger issue — the ability to easily develop multivendor VXI test systems. And nobody's got a better answer than HP.

Any questions?

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Alarm- and Power-Monitoring System

This system enables central monitoring of many remote equipment modules.

John F. Kennedy Space Center, Florida

An electronic central monitoring system, called the Remote Monitor Alarm System (RMAS), is being used to monitor malfunction alarms and power supplies of remotely located equipment modules of transmitting and receiving equipment in the fiber-optic communication network at Kennedy Space Center. The RMAS (see figure) includes a central monitoring unit (CMU) at a location convenient for technicians, plus a remote terminal unit (RTU) at each remote site that contains equipment to be monitored.

Each RTU is connected to the power supplies and alarm outputs of the equipment at its remote site. Each remote unit can monitor 120 alarm points, 8 dry-relay points, and 48 analog-voltage alarm points.

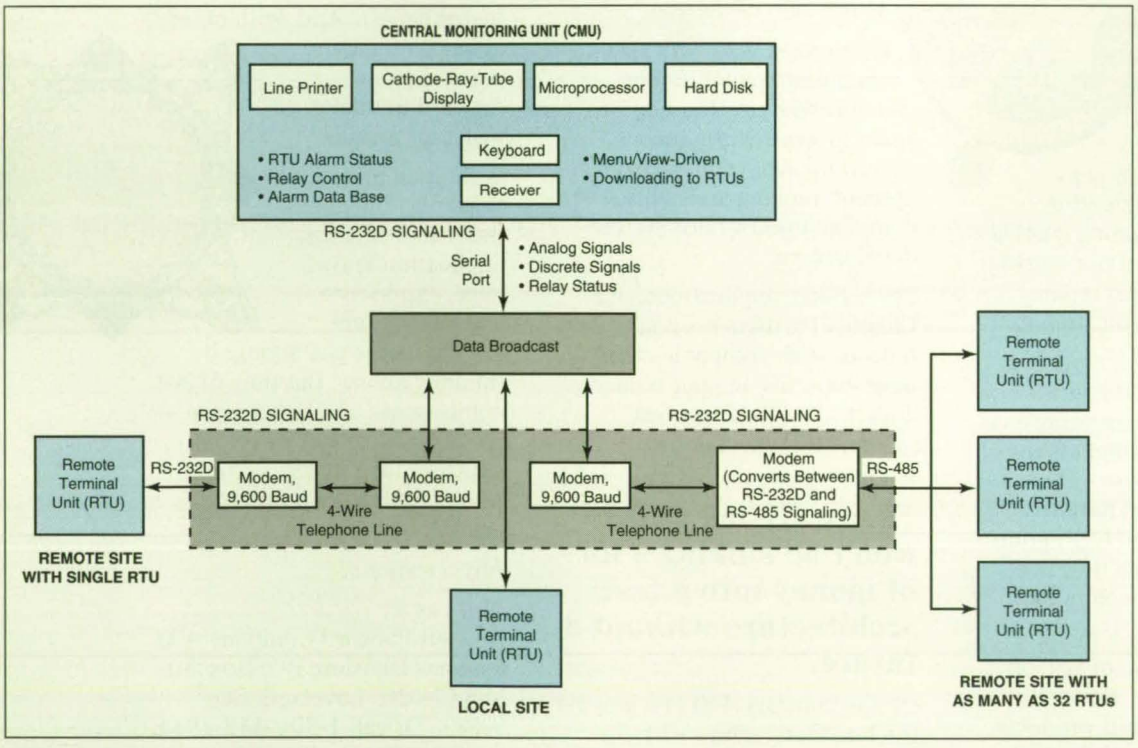
The CMU can monitor as many as 256 remote units: it polls each of the RTU's in turn and receives status information from them. Current alarms information can also be retrieved from the remote units, and relays at the remote units can be reset from the central unit. Status and alarm information is displayed at the central unit, and stored on hard disk. Paper records of alarms with time-stamp information are printed, and an audible alarm is available.

Remote sites are connected to the central site via telephone lines, rather than through the fiber-optic network. The monitor data are sent at 9,600 baud, using half-duplex transmission. As many as 32 remote units can be connected to a single telephone line.

The configuration of each remote unit can be reprogrammed from the central unit and stored in nonvolatile memory at the remote site, except that the digital address of a remote unit can be changed only by manual intervention at the remote site.

This work was done by Rob Stute of **Kennedy Space Center** *and F. Houston Galloway, Bob Swindle, Tracy Alan Bierman, and Pedro Medelius of I-NET. For further information,* ***write in 91*** *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, Kennedy Space Center [see page 20]. Refer to KSC-11655.



Remote Terminal Units collect data on alarms and power supplies of monitored equipment and send these data to the central monitoring unit. They also provide relays that can be controlled from the central monitoring unit.

Capaciflector Camera

Sensing electrodes arranged in rows and columns can be used to generate capacitive images.

Goddard Space Flight Center, Greenbelt, Maryland

Figure 1 shows a multiple-element capacitive proximity sensor of the "capaciflector" type, with sensing electrodes formed as thin strips and arranged in rows and columns. Each row or column sensing electrode provides a measurement of the capacitance between itself and a proximate object. From the measurements provided by all the row and column electrodes, the known dependence of each capacitance on the positions and orientations of the electrodes and the object, and the known positions of the electrodes, associated processing circuitry can construct a three-dimensional capacitance image of the object. Because of this imaging capability, the sensor is called a "capaci-

flector camera." Sensors of this type could be installed on robot arms, and the three-dimensional capacitance images that they generate could be used by robot-control circuits to prevent collisions with the capacitively sensed objects, to image and identify these objects, and to navigate amongst them.

Each electrode is covered by a thin layer of electrically insulating material. The sensing electrodes are driven by a fixed-frequency source (e.g., a crystal-controlled oscillator), all at the same voltage, through current-measuring voltage followers. Like the capaciflectors described in several recent articles in *NASA Tech Briefs*, this sensor also includes a shielding electrode driven through a voltage follower from the same source. The driven shielding electrode in a capaciflector minimizes the capacitance between the sensing electrodes and electrical ground (electrical ground being the surface of the robot arm on which the sensor is mounted) and concentrates more of the sensing electric field outward from the sensing electrodes, increasing the sensitivity and range of the sensor. An optional floating shield can be driven in a similar way to serve as an additional sensing electrode that provides a single capacitance reading that serves as a nonimaging, gross indication of proximity. Because all of the electrodes are driven at the same voltage, the sensing electrodes do not sense the driven shielding electrode, and they do not sense each other. That is to say, there is no crosstalk between a sensing electrode and any of the other electrodes: each sensing electrode gives an independent measurement of the capacitance between itself and the sensed object.

The capacitance between each sensing electrode and the sensed object gives rise to a current in the sensing electrode. The current-measuring voltage follower that drives the sensing electrode puts out a voltage that varies with this current by virtue of the voltage drop of this current across the voltage-follower resistor R, as indicated in simplified form in Figure 2. Each such output voltage (one for each row and column sensing electrode and one for the floating shield if used) is fed to external processing circuitry, where it is compared with a reference voltage derived from the source voltage to obtain a signal proportional to the sensed capacitance. The sensed-capacitance signals from all the rows and columns are then processed further to obtain the three-dimensional image of the sensed object.

This work was done by John M. Vranish of **Goddard Space Flight Center**. *For further information,* ***write in 32*** *on the TSP Request Card.*

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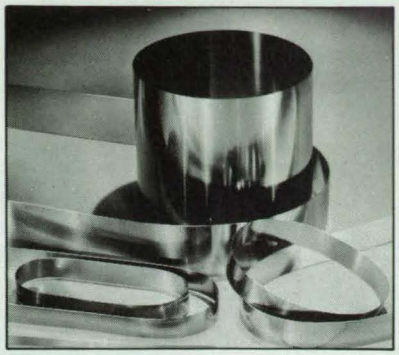

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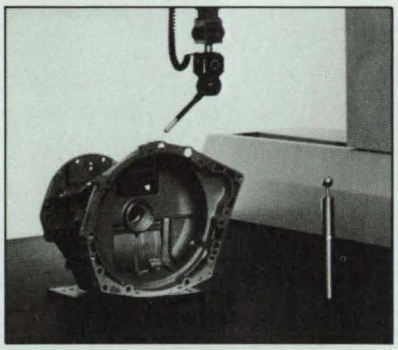

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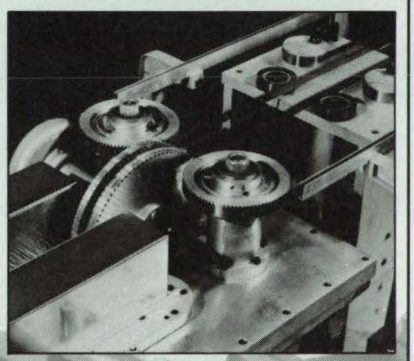

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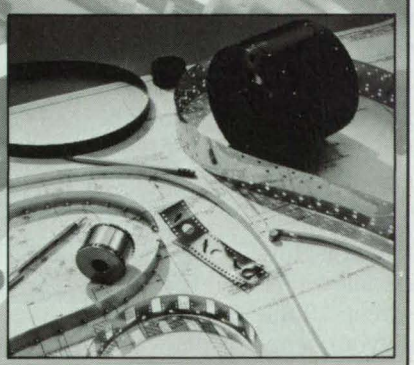

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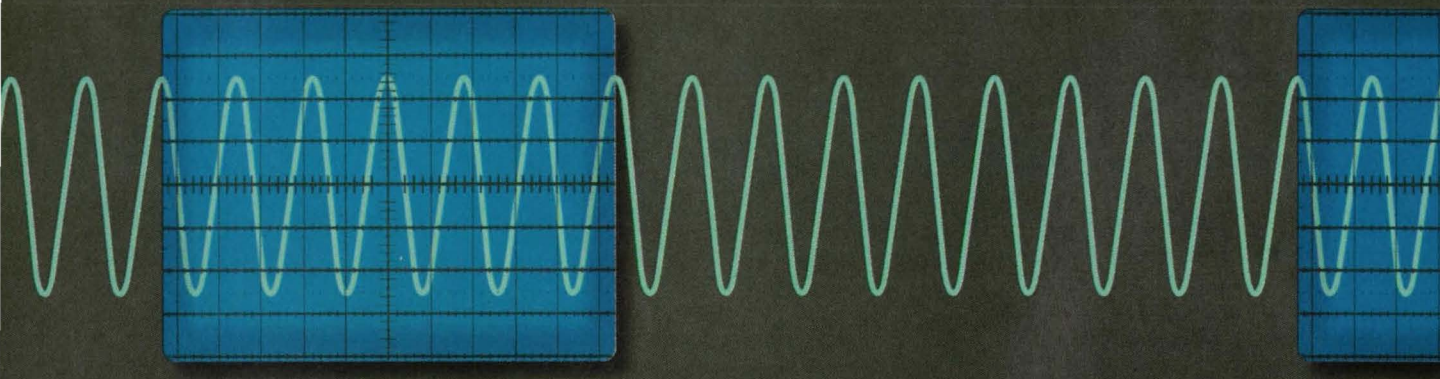
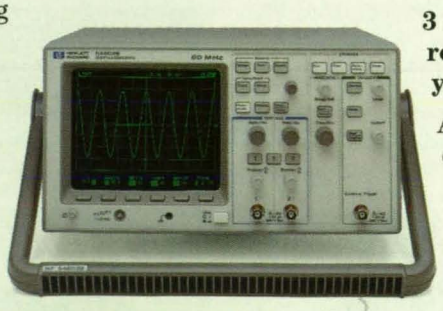


Imagine driving in rush-hour traffic. And every so often, you close your eyes for a few seconds. You'd better pray nothing critical happens while you're not collecting visual information.

Scary, right? Yet that's exactly what it's like to use most digital troubleshooting scopes.

The fact is, lurking somewhere between all the data your scope displays is some data your scope misses. And if the cause of your problem is in that missing data, it could be a real headache.



So how can you be sure you're getting the information you need to be more confident in your troubleshooting? The HP 54600-series scopes.

3 processors: the real key to seeing your signal.

A high sample rate doesn't mean much if your scope isn't gathering data frequently enough. And that's a problem with most low-cost scopes. They have only a single processor that's required to do everything from gathering to tabulating to displaying an incoming signal. And because it gets overwhelmed, it simply ignores new data while it displays old data.

The HP 54600-series, on the other hand, has three processors, deftly acquiring, processing, and displaying data blocks in parallel — delivering a maximum refresh rate of 1.5 million points/sec. Giving you consistently dependable answers.

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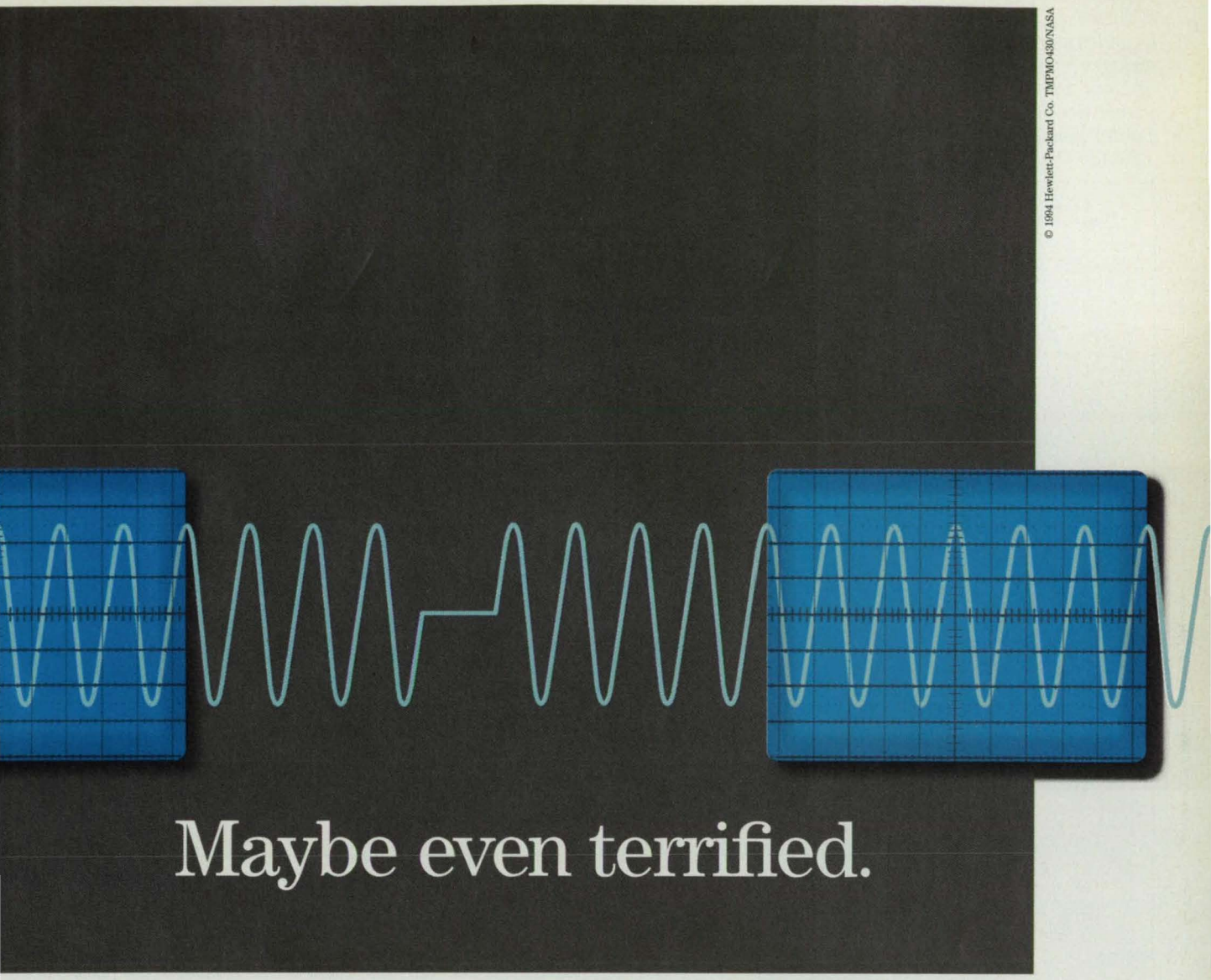

Maybe even terrified.

vector display mode produces bright, continuous waveforms that deliver the detailed information you need for your digital troubleshooting.

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With five models to choose from, each affordably priced from $1,995* to $4,995*, with 2 or 4 channels, and bandwidths from 60 to 500 MHz, the HP 54600-series has the right scope for you.

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This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center [see page 20]. Refer to GSC-13564.

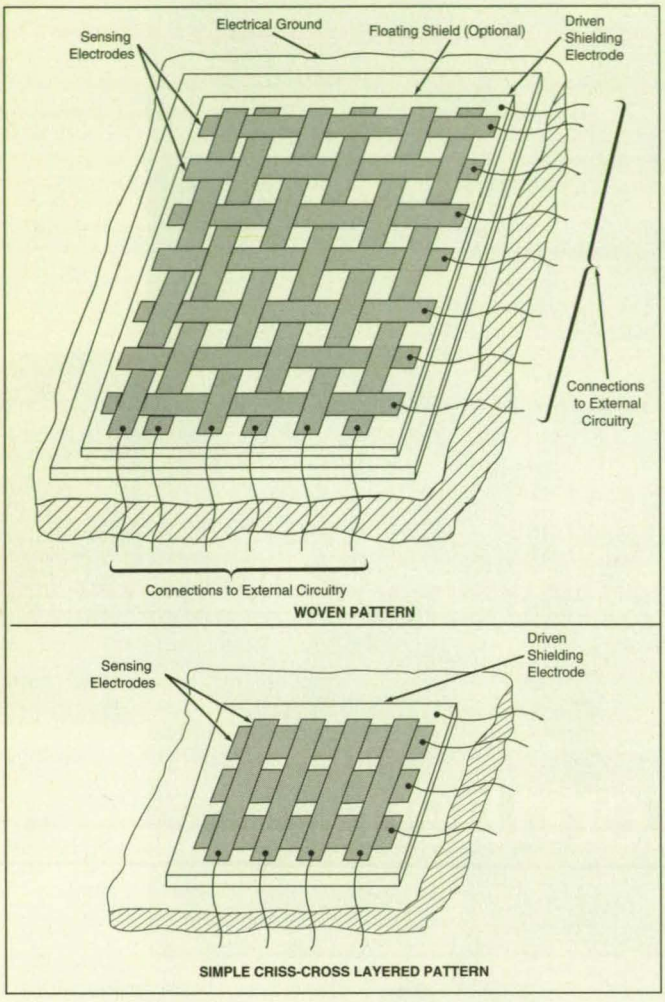


Figure 1 (left). **Sensing Electrodes in a Pattern of Rows and Columns** can be woven tightly or arranged simply in two layers at right angles to each other. If the second arrangement is used, then there must be gaps between the sensing electrodes in the outer layer so that the electric fields from the sensing electrodes in the layer underneath can reach out to the sensed object. The number of rows and columns can be many more than shown here.

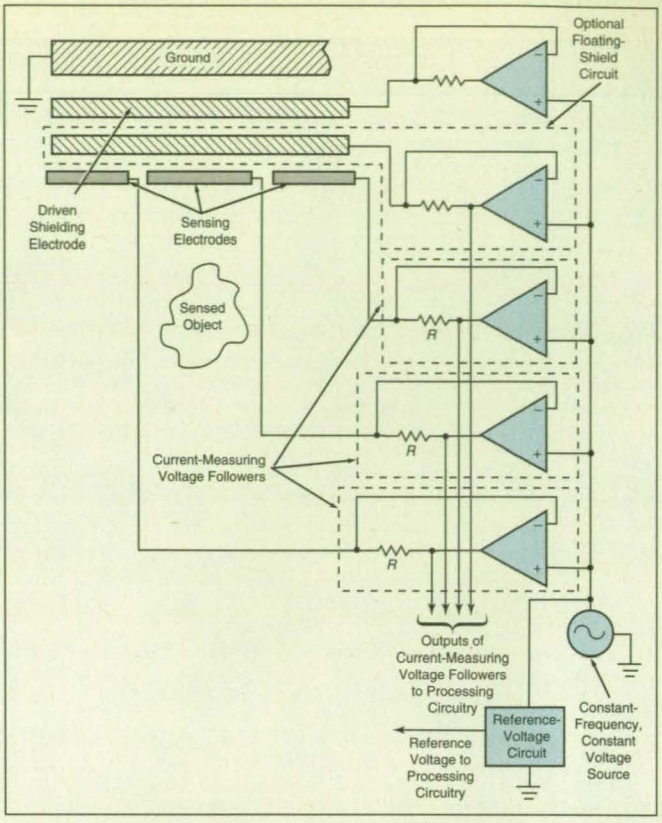


Figure 2 (above). **Current-Measuring Voltage Followers** put out voltages indicative of the capacitances between the sensing electrodes and the sensed object. Only three sensing electrodes are shown here, but more can be used — one for each row and column of the sensor array.

Monitoring Integrity of Composite Aircraft Components

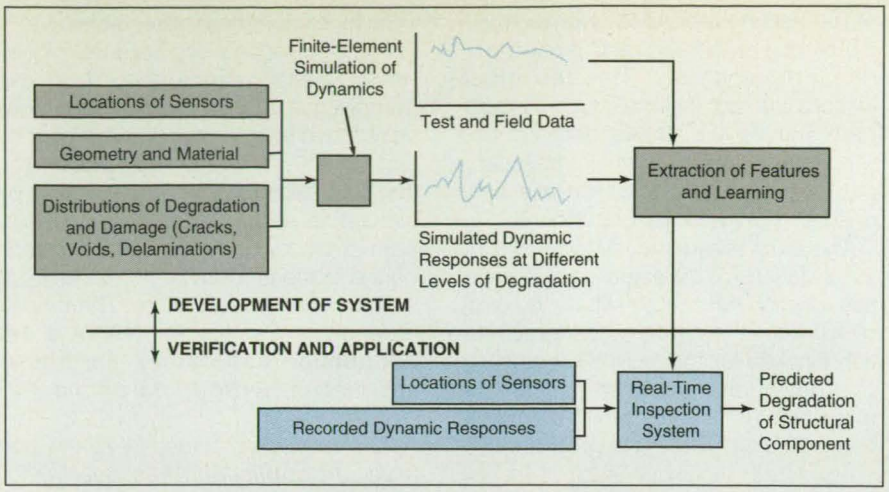
A computer-based system detects flaws in aerospace structural materials.

Lewis Research Center, Cleveland, Ohio

A system to monitor the integrity of composite-material structural components of aircraft in service has been developed. The system includes strain gauges and accelerometers installed permanently in the components to monitor vibrations, a microprocessor-based data-acquisition system to process the outputs of these vibration sensors, and a desktop computer to analyze the acquired data. By automating a significant part of the inspection process, this system will reduce the amount of time needed for inspection and reduce the cost of inspection equipment. It will also contribute to safety by giving timely warning of hidden flaws that necessitate early, detailed inspection of critical components to determine whether the components should be replaced immediately.

The system is representative of an emerging structural-health-monitoring or "smart structures" technology, which combines the disciplines of artificial intelligence, dynamics of structures, mechanics of composite materials, and signal processing. The system is based on a commercial structural-monitoring system that is used worldwide to monitor the integrity of a variety of structures, including pressure vessels and critical high pressure components in nuclear powerplants. The point of departure for the development of the present system is a recent version of the commercial system that is designed specifically for use on composite-material structures, with all their complex dynamics.

The structural health monitoring system records vibration data and processes the data from composite structural components in an automated way so that an inspector can interpret the results immediately in terms of the amount, location, and type of damage in the structure. These measurements can be taken either by monitoring vibrations in flight, or by using more sophisticated controlled vibration actuators.



The **Methodology of the Pattern-Recognition Approach** to structural-health monitoring provides for training and upgrading of the pattern-recognition algorithm as additional data on vibrational responses in the presence of known failures are acquired.

Recently developed pattern-recognition software (see figure) then correlates the recorded vibration measurements with previously recorded data known to be characteristic of flawed structural components. Progressive damage (e.g., the extent of delamination in a composite panel) could also be estimated by correlation of data with simulated vibrational responses in the presence of various degrees of damage.

This work was done by Shu Shing Tang, Kuan-Luen Chen, An-Yu Kuo, and Peter C. Riccardella of Structural Integrity Associates, Inc., Anthony N. Mucciardi of Infometrics, Robert J. Andrews of the University of Dayton Research Institute and Joseph Grady of **Lewis Research Center.** *For further information,* ***write in 72*** *on the TSP Request Card. LEW-15778.*

Processing in a GPS Receiver to Reduce Multipath Errors

Multipath range errors could be halved.

NASA's Jet Propulsion Laboratory, Pasadena, California

Four techniques of ancillary real-time digital processing of signals in a Global Positioning System (GPS) receiver have been introduced to reduce the effects of multipath propagation of the signals on the position estimates produced by the receiver. These techniques could be applied in addition to other signal-processing techniques and to such other techniques as designing the receiving antenna to make it insensitive to reflections of GPS signals from nearby objects (see Figure 1).

The techniques have been implemented by modifying the TurboRogue GPS receiver, which digitally processes all baseband tracking data. The receiver can simultaneously measure (1) the phases of the coarse-acquisition (C/A) and precision (P) codes modulated onto the L1 (1,575.92-MHz) GPS carrier signal and the phase of the P code modulated onto the L2 (1,227.6-MHz) GPS carrier signal, plus (2) the pseudorange from each of eight GPS satellites. All tracking loops in the receiver are controlled via software, and high-speed (20.456-MHz) signal-processing operations (see Figure 2) are performed in a very-large-scale integrated-circuit chip. The following three features of TurboRogue signal processing are significant with regard to the reduction of multipath errors.

- Independent correlator/accumulators compute early, late, and prompt (P) in-phase and quadrature (I and Q) correlation sums. Delay processing of correlation sums is under full software control, enabling the use of a variety of techniques.
- Complete initialization of carrier and code parameters (phase and rate) can be performed by the software at the nominal phase-feedback rate (50 Hz). This feature is especially useful for accurately "mapping" the receiver cross-correlation function after satel-

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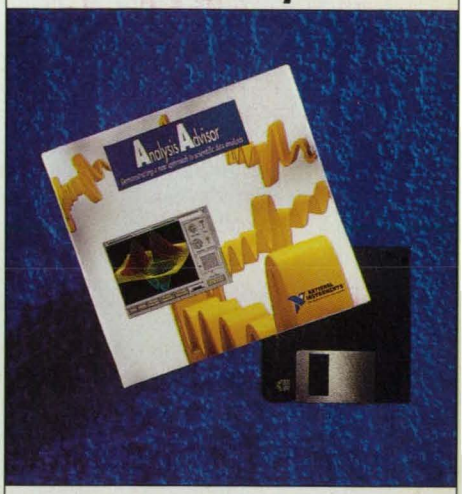

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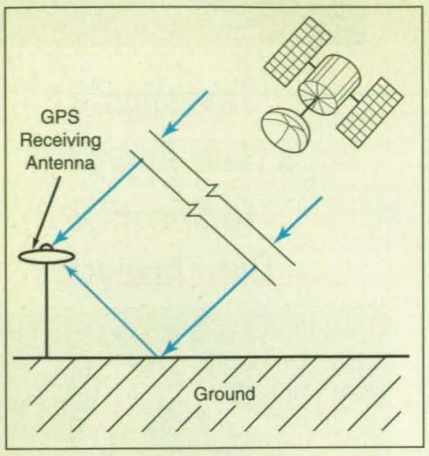

Figure 1. In **Multipath Propagation**, the signal arrives at the receiving antenna both along a direct path and after reflection (usually from the ground and other nearby objects).

lite and receiver filtering has been applied by sweeping the delay in the model code by changing it in very small (<< 1 code chip) increments. This enables the more-accurate simulation of multipath effects and provides an accurate correlation shape that can be used to correct for them.

- All data (C/A, P1, and P2) are processed at the 20-MHz rate. The C/A correlators are set for a 500-ns (2-MHz) increment of delay for acquisition of the signal. Following acquisition, the software adjusts the increment of delay of the C/A correlator to 50 ns (20 MHz).

One of the proposed ancillary processing techniques for the reduction of multipath errors is based on the observation that for some ranges of multipath delay, the amount of pseudorange multipath error depends on the increment of delay in the receiver between early and late correlation channels. When this is the case, smaller increments of delay result in smaller multipath errors. The use of smaller increments of delay is particularly effective in reducing multipath errors for the C/A code.

The second technique involves tracking by use of the early and prompt correlation sums only. This technique exploits the fact that inasmuch as multipath signals are always delayed with respect to direct signals, phase and pseudorange observables are best derived from the earlier correlations.

The third technique involves looking for deviations of the actual code correlation function (relative amplitude vs. delay offset) from the predicted code correlation function for the multipath-free case. The deviations are used to infer the magnitude of the multipath errors and to correct the pseudoranges accordingly.

The fourth technique involves looking for variations of phase among the early, prompt, and late correlations. These variations are used, along with the general principle that multipath errors are larger for later correlations, to infer the presence of multipath errors and generate corrections for carrier-phase observables.

The first, second, and third techniques have been employed by the TurboRogue GPS receiver, in which they were found to reduce multipath errors by factors of 3, 1.5, and 1.5, respectively. The third technique was also tested by simulation and found to reduce multipath errors by an amount that depends on the multipath delay.

This work was done by Thomas K. Meehan of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 85*** *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 [see page 20]. Refer to NPO-18970.

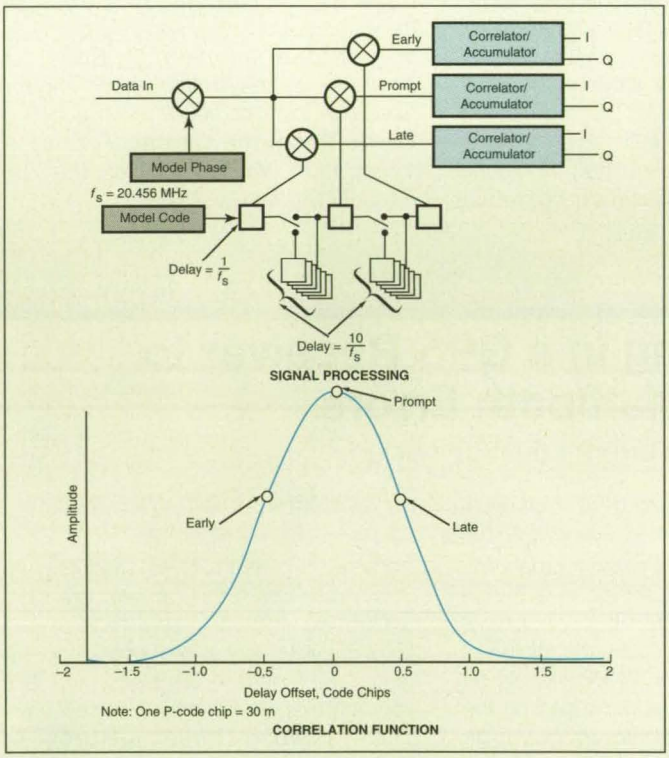

Figure 2. The **Major Signal-Processing Functions** are implemented digitally in the TurboRogue receiver.

Real-Time, Polyphase-FFT, 640-MHz Spectrum Analyzer

Much of the processing loss of windowed FFTs would be eliminated.

NASA's Jet Propulsion Laboratory, Pasadena, California

A real-time polyphase-fast-Fourier-transform (polyphase-FFT) spectrum analyzer is being designed to aid in the detection of multigigahertz radio signals in two 320-MHz-wide polarization channels. The spectrum analyzer will divide the total 640-MHz spectrum into 33,554,432 (2^{25}) frequency, channels, each about 19 Hz wide. This will be achieved by use of eight identical 80-MHz, 4,194,304-channel, real-input polyphase-FFT filter banks, each bank implemented in hardware as a pipelined special-purpose, digital signal processor (see figure on page 67).

The use of polyphase filter preprocessing is intended to eliminate much of the processing loss associated with windowed FFTs. The architecture of the polyphase-FFT filter bank increases sensitivity to narrow-band signals. Consideration of finite-word-length effects (quantization, roundoff, and truncation errors) led to a proposed filter design featuring 8-bit inputs, 16-bit fixed-point polyphase arithmetic, and 24-bit fixed-point FFT arithmetic with

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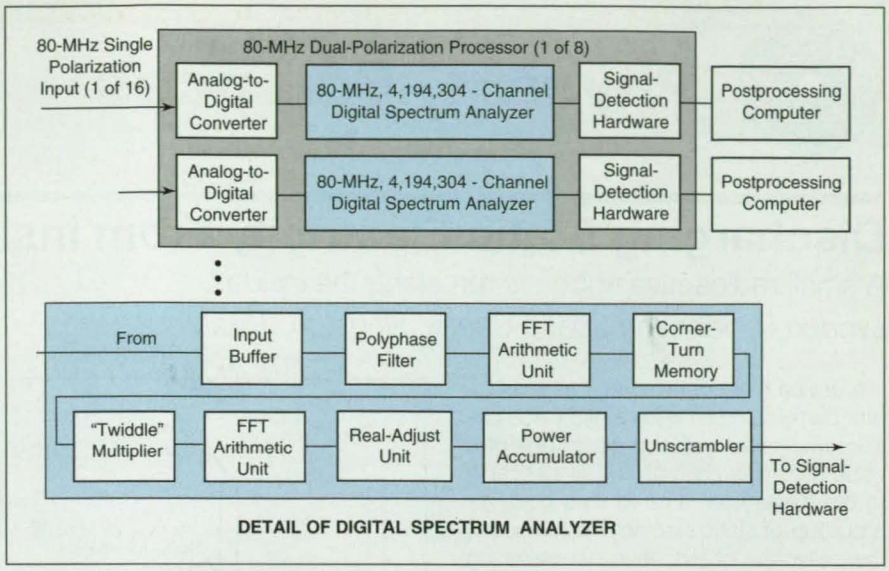
mid-computation renormalization for increased dynamic range. This design is expected to provide balanced system performance with input (analog-to-digital) quantization dominating as the internal source of noise.

The size and thus the cost of the polyphase-coefficient memory is substantially reduced by use of run-length compression of the polyphase filter coefficients. A further improvement, in comparison with an older prototype, consists of the replacement of two spectrum-length (4,194,304-complex-point) double buffers with single buffers and the removal of a third spectrum-length double buffer, for pipeline reordering of data.

The design was tested by computer simulations. The results of the simulations show that the processors could operate at the limits of the 8-bit analog-to-digital converters, providing input signal-to-noise ratios up to 41 dB, with less than 1-dB loss in sensitivity. The results also demonstrated 90 dB two-tone dynamic range by detecting a weak signal 90 dB below a strong signal 10 FFT channels away.

This work was done by George A. Zimmerman, Michael F. Garyantes, Michael J. Grimm, Bentsian Charny, Randy D. Brown, and Helmut C. Wilck of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 79*** *on the TSP Request Card. NPO-18776.*



The **Real-Time Polyphase-FFT Spectrum Analyzer** would divide a total spectrum of 640 MHz into 33,554,432 frequency channels of about 20 Hz each.

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Discharging Static Electricity From Inside a Glass Tube

A small radioactive ribbon is run along the inside.

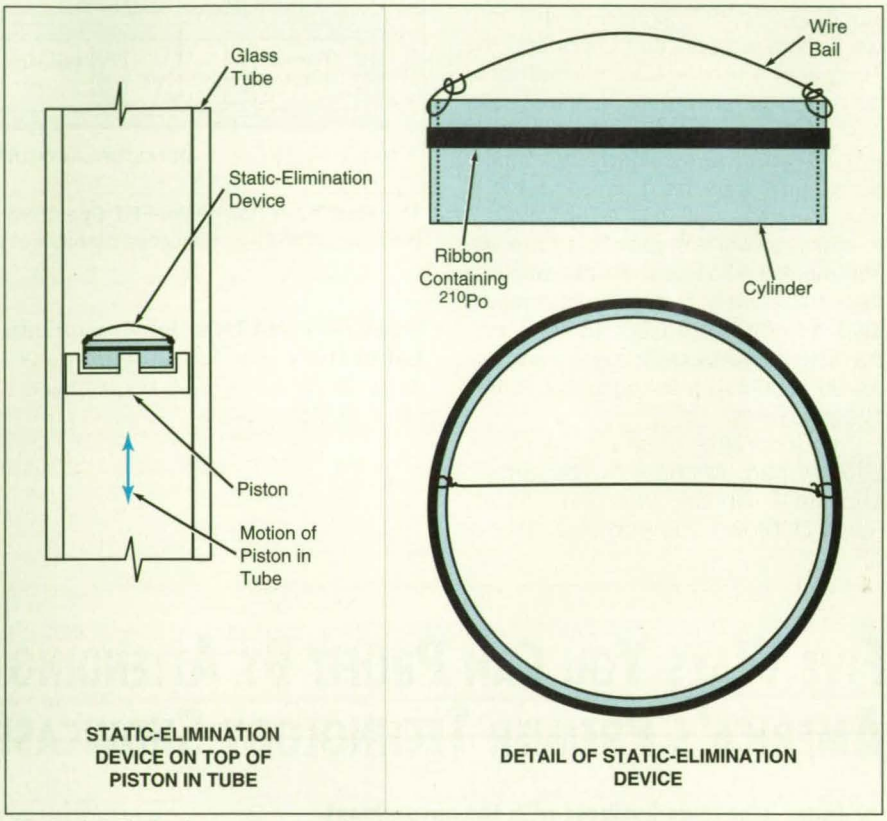
Lyndon B. Johnson Space Center, Houston, Texas

A device that contains an emitter of alpha particles discharges static electricity from the inside wall of a glass tube of a volumetric-flow calibrator. It is desirable to discharge from time to time because a buildup of static electricity can result in the collection of dirt, thus necessitating more-frequent maintenance of the tube.

One technique used heretofore to prevent the buildup of static electricity has been to run equipment in a room with humidity ≥50 percent; this technique is expensive and only partially effective. Another technique used heretofore has been to coat the inside of the tube with antistatic solution, which causes sticking and collects dirt, resulting in the need for more-frequent cleaning.

The present device (see figure) includes a cylinder that has a wall thickness of 1/16 in. (about 1.6 mm), a diameter about 1/2 in. (1.27 cm) smaller than the inside diameter of the tube, and a height such that it extends about 1/2 in. (1.27 cm) above a piston that moves along the tube and that is part of the calibrator. These dimensions are determined by the size of the volumetric tube and are not critical.

Attached to the top of the cylinder in this device is a ribbon that contains ^{210}Po, which emits α particles. The amount of polonium needed depends on the diameter of the cylinder: typical amounts are 1,000, 500, or 100 μCi for diameters of 5.5 in. (about 14 cm), 1.75 in. (about 4.4 cm), or 0.75 in. (about 1.9 cm), respectively. The ribbon consists of a bottom layer of silver, a middle layer of ^{210}Po, and a top layer of gold, all pressed together. The ribbon is attached by epoxy to the cylinder, which could be made of polyvinyl chloride, another plastic, or another suitable lightweight material.



The **Antistatic Device** emits α particles to discharge static electricity from the inside wall of the glass tube.

The device sits on the calibrator piston and rides up and down with the piston, discharging the inside wall of the glass tube. For convenience of removal of the device, it could include a lightweight wire bail joined to the cylinder.

This work was done by Walter L. Ellsbury of Lockheed Engineering & Sciences Co. for **Johnson Space Center**. *No further documentation is available.*
MSC-21973

Thin-Film Resistive Heater

High, localized flux can be applied to a complex surface.

Langley Research Center, Hampton, Virginia

A thin-film electrically resistive heater applies a high, controlled flux of heat to the surface of an object. The heater is mounted directly on the surface of the object. The heater is small, simple to operate, and considerably less expensive than are laser and arc heating facilities, which can cost several million dollars.

Whereas conventional electrical resistance heaters are formed as separate units and then bonded onto the objects to be heated, a thin-film heater is formed during a bonding process in the sense that it is vapor-deposited onto the object being heated. Any of such vapor-deposition techniques as electron-beam vapor deposition, ion-assisted electron-beam vapor deposition, or sputtering can be used to deposit a thin film of a metal or metal alloy onto an object.

The adhesion of the film is typically very

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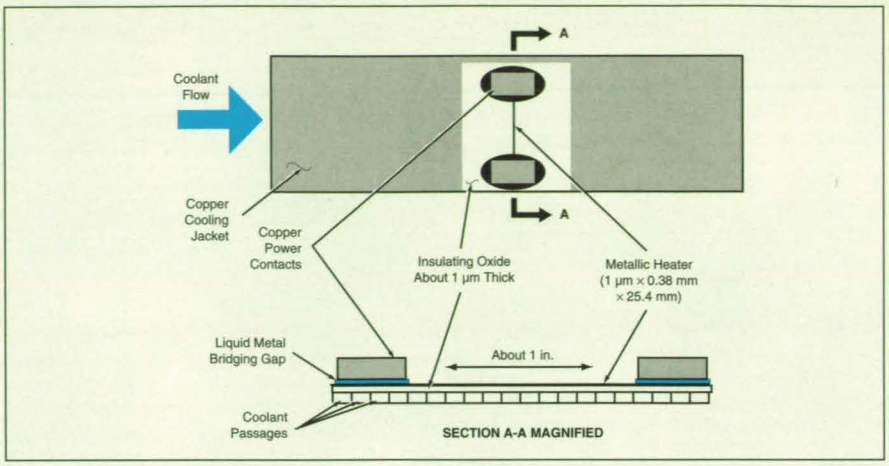
good, and little additional bonding material (which would interfere with the transfer of heat to the object) is needed. Thus, an excellent thermal connection is obtained with the thin-film heater. The thickness of the film can be accurately controlled in the deposition process. In addition, the resistance of the heater and the shape of the heat source can be tailored by masking the object before depositing the heater. Thus, by controlling the material, thickness, and shape of the deposited heater, the conduction path and heating profile can be tailored. The shape of the object to be heated is limited only to shapes that can be easily coated by vapor deposition.



Thin-Film Conductive Heater is shown installed on an actively cooled panel. An insulating oxide is used in this case to isolate the electrically conductive panel from the heater.

Electrical current can be fed to the heater via flexible electrical contacts (for example, flexible copper strips) or via liquid metal contacts. If the thin-film heater is to be applied to an electrically conductive object, then before the thin-film heater is deposited, a layer of electrically insulating material must be applied to isolate the heater electrically from the object and to channel the applied electrical current through the heater only.

The motivation for the development of the thin-film resistive heater was the need to generate a very high, localized heat flux to test a leading edge for the National AeroSpace Plane. This heater concept enables the efficient application of extremely high heat fluxes to the surfaces of objects without need for expensive or specialized facilities. In fact, because the only other equipment needed is an appropriate power supply, the thin-film heater is essentially a portable device that may prove useful in a wide range of eventual applications in research and in the field.

This work was done by Stephen J. Scotti of **Langley Research Center**. *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 [see page 20]. Refer to LAR-14592.

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Heat Pipe With Interrupted Slot

Part of the slot is kept dry to prevent blockage of priming flow.

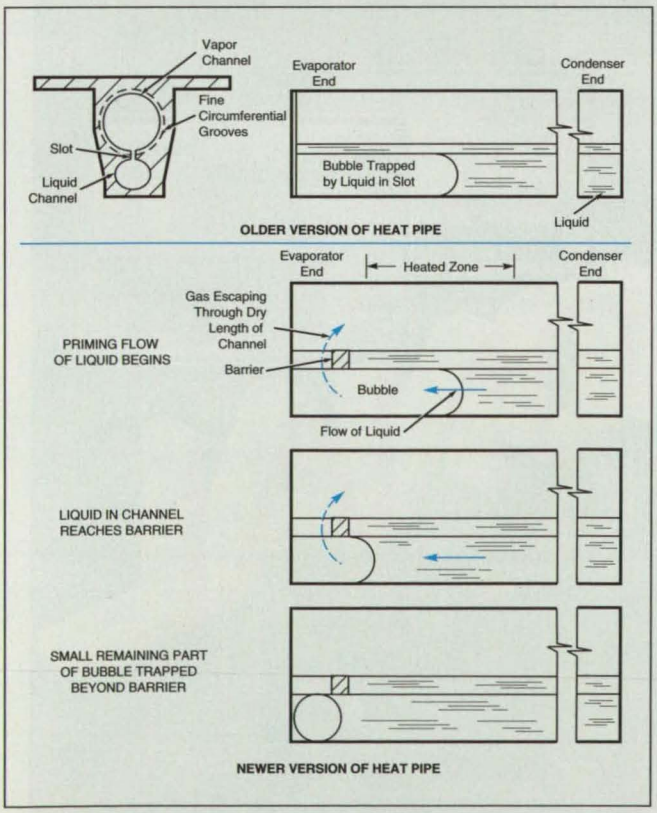
Lyndon B. Johnson Space Center, Houston, Texas

The figure illustrates older and newer versions of a heat pipe that contains parallel liquid and vapor channels connected by a narrow slot. The channels and the slot extend the full length of the heat pipe. The only difference between the two versions is that near the evaporator end in the newer version, the slot is interrupted by a plug or, if the heat pipe is cast, by a bridge of heat-pipe material cast integrally across the groove. This small barrier assists in priming the heat pipe.

In normal operation of either version of the heat pipe, liquid fills the liquid channel, the slot, and the fine circumferential grooves that line the wall of the vapor channel. At the evaporator (heated) end of the heat pipe, the liquid is vaporized from the circumferential grooves. The vapor travels along the vapor channel to the condenser (cooled) end of the heat pipe, where it condenses. With the help of capillary forces, the condensed liquid returns through the liquid channel to the evaporator end.

The heat pipe must be primed in the sense that there must be sufficient liquid at the evaporator end during initial heating, or else normal operation will not be established. If normal operation is not established, the heat pipe will not transfer heat at an adequate rate, and the temperature of the evaporator end could rise unacceptably. If the heat pipe is laid out horizontally or with the evaporator end lower than the condenser end, then the weight of the liquid suffices to prime the heat pipe.

However, in the absence of gravitation (and perhaps in some



The **Barrier in the Slot** near the evaporator end of the newer version keeps liquid out of a small part of the slot at the evaporator end until the heated zone becomes primed.

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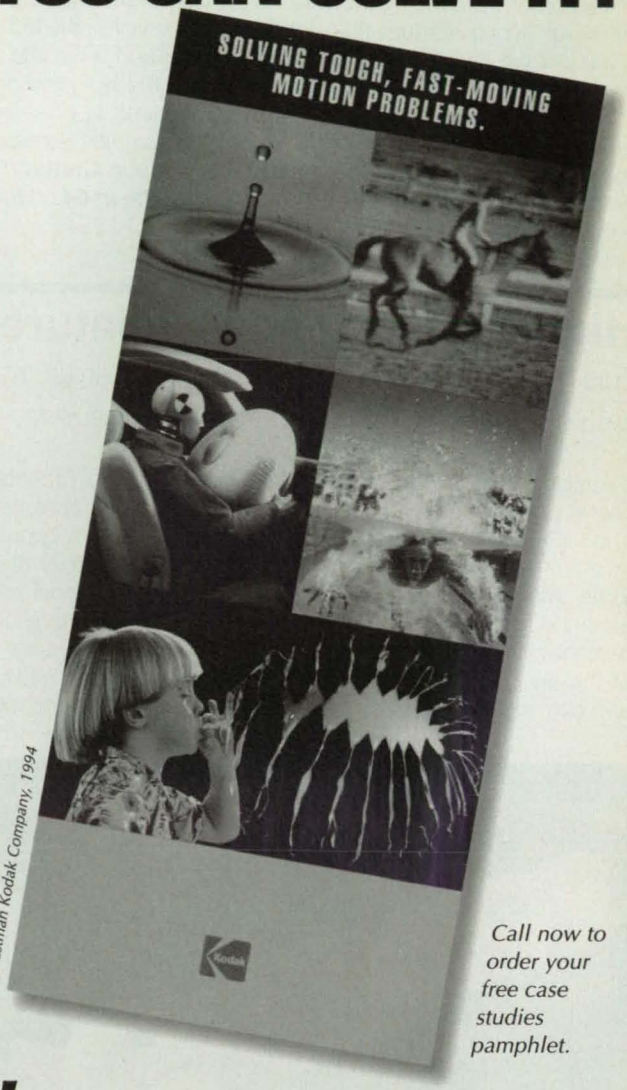

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unusual circumstances in the presence of gravitation), capillary forces tend to cause the liquid to fill the slot preferentially before it fills the liquid channel. If, under these circumstances, a bubble of vapor and noncondensible gas accumulates in the liquid channel at the evaporator end of the older version of the heat pipe before or during startup, then the liquid in the slot will trap the bubble, which will impede priming.

In the newer version of the heat pipe, vapor and noncondensible gas can still accumulate in the liquid channel at the evaporator before or during startup, but in this case, the barrier keeps the liquid out of a small part of the slot at the bubble. This dry part of the slot allows the bubble to escape into the vapor channel, thereby making room for liquid to move in during startup. Once the bubble shrinks past the barrier, the liquid fills the remaining small part of the slot by capillary action, thereby trapping the bubble; however, the bubble is now much smaller and is outside the heated zone.

This work was done by Richard F. Brown, Robert L. Kosson, and Fred Edelstein of Grumman Aerospace Corp. for **Johnson Space Center**. *For further information,* ***write in 64*** *on the TSP Request Card.*
MSC-22245

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C 2457(f)], to the Grumman Corp. Inquiries concerning licenses for its commercial development should be addressed to
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Mail Station A19B-GHQ
1111 Stewart Avenue
Bethpage, NY 11714
Refer to MSC-22245, volume and number of this NASA Tech Briefs *issue, and the page number.*

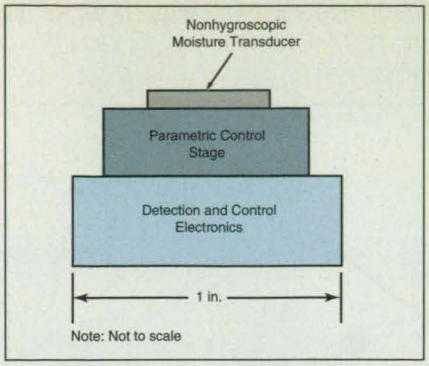
High-Performance Miniature Hygrometer

This hygrometer offers the accuracy of larger, more complicated, more expensive instruments.

NASA's Jet Propulsion Laboratory, Pasadena, California

A relatively inexpensive hygrometer (see figure) that occupies a volume less than 4 $in.^3$ (66 cm^3) measures dewpoints as much as 100°C below ambient temperatures, with an accuracy of 0.1°C. Field tests indicate that its accuracy and repeatability are identical to those of state-of-the-art larger dewpoint hygrometers traceable to the National Institute of Standards and Technology. This dewpoint hygrometer operates up to 100 times as fast as older hygrometers do, and it offers the simplicity and small size needed to meet the cost and performance requirements of many applications.

This dewpoint hygrometer differs from older dewpoint hygrometers based on the "chilled-mirror" concept in two major respects: it senses water vapor by use of a resonant mechanical device, and it implements a parametric approach of dewpoint detection, in which a change in the output of the transducer is measured as a function of a specific thermodynamic quantity. The sensitivity of the resonant mechanical moisture transducer in this hygrometer is of the order of 10^5 times



This **High-Performance Miniature Hygrometer** operates on a mechanical-resonance principle but offers the inherent accuracy and reproducibility of a "chilled-mirror" dewpoint hygrometer in a small, simple, relatively inexpensive structure.

that of an optical reflection transducer in a chilled-mirror dewpoint hygrometer. Also in contrast to some other hygrometers, the moisture transducer in this hygrometer does not contain hygroscopic materials, which are subject to hysteresis and aging effects that cause errors. The moisture transducer is a simple two-terminal device that is commercially available at low cost.

In addition to the moisture transducer, this hygrometer contains a parametric control stage and detection and control electronics. The parametric control stage, which is made of commercially available components, varies the appropriate thermodynamic quantities for detection of the dewpoint. These quantities are controlled and measured in conjunction with the output of the moisture transducer. As a result of the parametric approach, the moisture transducer is required to measure only relative quantities.

The detection and control circuitry is made of simple off-the-shelf components. It calculates the parametric dependence between the output of the transducer and the state of the control stage. From this dependence, the dewpoint can be calculated directly.

This work was done by Thomas R. Van Zandt, William J. Kaiser, Thomas W. Kenny, and David Crisp of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 31*** *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

William T. Callaghan, Manager
Technology Commercialization
Jet Propulsion Laboratory
4800 Oak Grove Drive
Pasadena, CA 91109

Refer to NPO-19028 volume and number of this NASA Tech Briefs *issue, and the page number.*

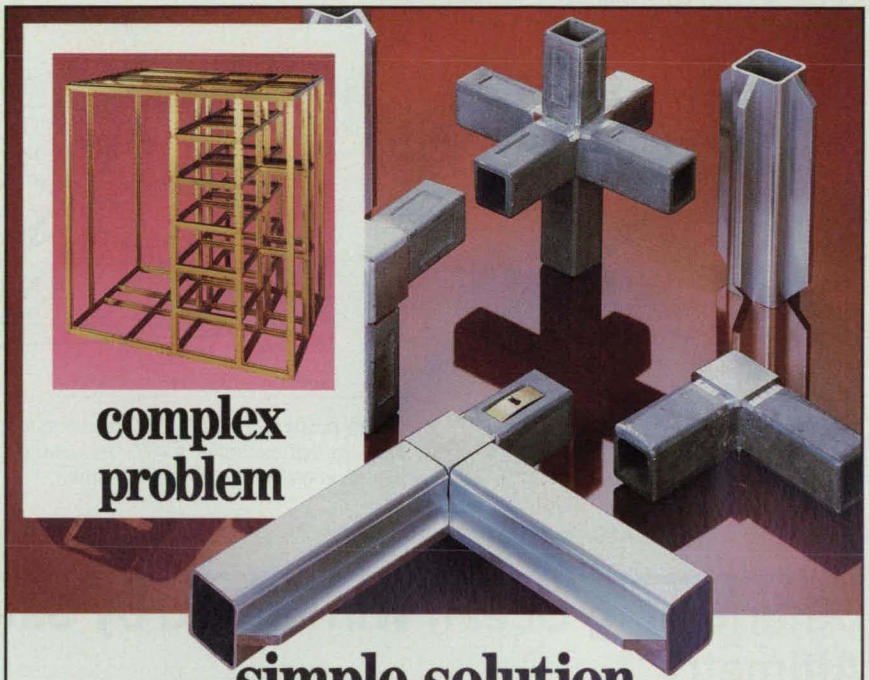
Global Geodesy Using GPS Without Fiducial Sites

Fiducial coordinates are not necessary for global geodetic measurements.

NASA's Jet Propulsion Laboratory, Pasadena, California

The Global Positioning System (GPS) can be used to make global geodetic measurements without the use of fiducial site coordinates. A fiducial site is one with coordinates that are held fixed during analysis and treated as known parameters. Traditionally, fiducial coordinates used for GPS analysis have come from Very Long Baseline Interferometry (VLBI) or Satellite Laser Ranging (SLR).

Baseline lengths and geocentric radii for each site are well determined without



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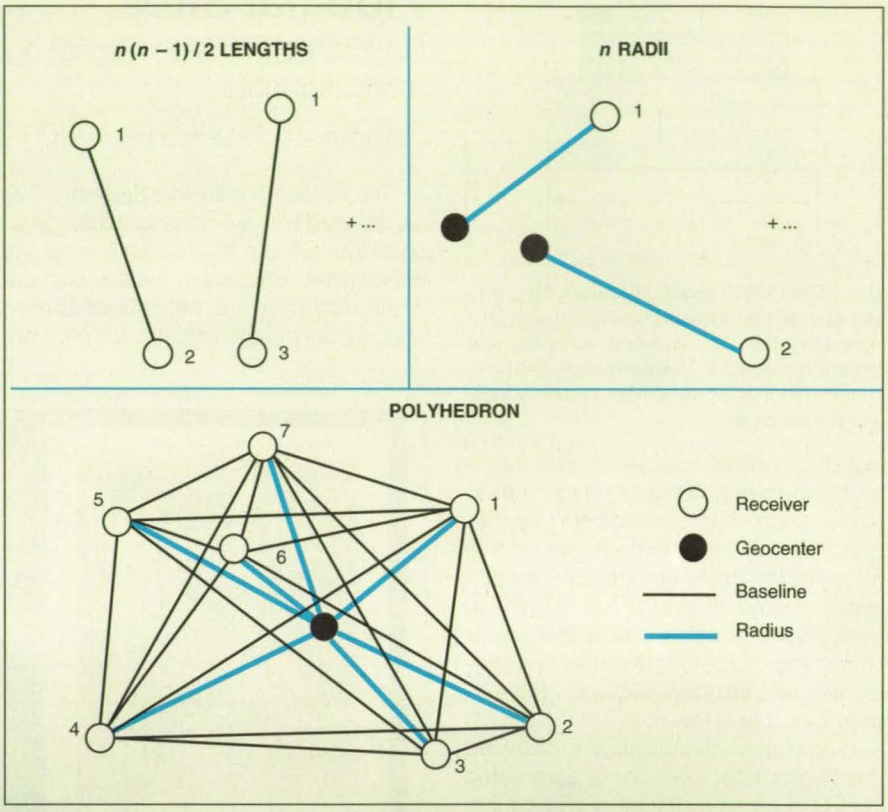
having to fix any site coordinates. Given n globally distributed sites, the n (n – 1)/2 baseline lengths and n geocentric radii form a polyhedron with each site at a vertex and with the geocenter, or center of mass, at the intersection of all the radii. Geodetic information can be derived from the structure of the polyhedron and its change with time.

The no-fiducial approach was tested with data from a global GPS experiment in 1991 involving 21 sites. Baseline length precision, as determined from daily repeatability, was 2 mm + 4 parts per billion for the 17 sites in the Northern Hemisphere. Baseline length accuracy, determined by comparison with VLBI, showed an rms agreement of 2.1 parts per billion. The precision of geocentric radii indicated by daily repeatability was 15 cm. The accuracy of geocentric radii derived from comparison with VLBI yielded an rms agreement of 3.8 cm. Measurements of baseline lengths and geocentric radii determined with the no-fiducial approach are both precise and accurate.

The no-fiducial approach can be applied to any global geodetic technique. Regional experiments can make use of it by including data from global tracking sites. Fiducial coordinates are not necessary for global geodesy, and, if they are not accurate, holding them fixed can lead to systematic errors.

This work was done by Michael B. Heflin and Geoffrey Blewitt of Caltech for **NASA's Jet Propulsion Laboratory**.

For further information, ***write in 88*** *on the TSP Request Card.*
NPO-18783



Given *n* Sites, the $n(n-1)/2$ baseline lengths and n geocentric radii define a closed polyhedron. In this example, $n = 7$. Geodetic information can be derived from the structure of the polyhedron and its change with time.

Determining Ocean Windspeed by Satellite Radar Altimetry

An improved algorithm accounts better for the degree of development of waves.

NASA's Jet Propulsion Laboratory, Pasadena, California

Measurements of the ocean surface by satellite radar altimetry can be converted to more-accurate estimates of surface windspeed by use of an improved algorithm that contains an empirical mathematical model. The mathematical model used previously yielded windspeed estimates that contained systematic errors because it failed to account for the effect of the degree of development (in effect, the history) of waves on the radar cross section and on the travel time and waveform of the return radar pulse.

The improved algorithm and model were derived from studies of empirical radar-altimetric and buoy wind and wave measurements. These studies focused on the relationships among the heights, speeds, and shapes of waves, the degrees of development or histories of the waves, and the radar-altimetric measurements. These studies revealed that the systematic errors in the estimates by the previous model were correlated with the degree of development of waves as expressed in terms of a quantity called the "wave age."

The concept of "wave age" was introduced in a previous article in *NASA Tech Briefs* on the related problem of accounting for systematic errors in the radar-altimetric measurement of sea level; namely, "Degree of Development of Waves and Bias in Radar Altimetry" (NPO-18392), *NASA Tech Briefs*, Vol. 17, No. 1 (January 1993), page 60. There remains some controversy regarding the validity of the wave age as a single parameter that summarizes complex interrelated effects; the justification for using it is that it yields useful estimates when tested with empirical data. There are several alternative formulas for the wave age; the relevant one in this case is $\xi = A\,(gH/U^2)^a$ where A and a are empirical parameters, g is the gravitational acceleration at the surface of the ocean, U is the windspeed, and H is the significant wave height, which is one of the principal data outputs of the radar altimeter.

j	S_{j0}	S_{j1}	S_{j2}	S_{j3}
1	–0.200	10.689	–1.544	0.0576
2	159.381	–31.428	2.106	–0.0471

The **Coefficients of the Polynomial Fit** were derived for two ranges of ξ, as identified here by their j values.

One of the two input data for the improved algorithm and mathematical model is H. The other is σ_0, which is the radar cross section and is another principal output datum of the radar altimeter. Although ξ does not appear explicitly in the improved model and algorithm, it nevertheless plays an important indirect role in

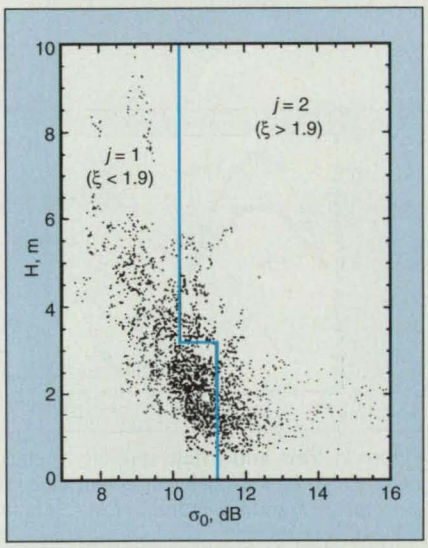
that the model was derived as a separate polynomial fit to empirical data in each of two slightly overlapping subsets of empirical data, each datum being assigned to one subset or the other depending on whether its ξ was greater or less than 1.9. This assignment manifests itself in the model as a division of the σ–H plane into two regions: each σ_0, H pair is assigned a parameter $j = 1$ or 2, according to whether it lies in one region or the other (see figure).

The algorithm and model can now be described as follows:

1. Given a specific σ_0, H pair, determine whether this point lies within the cluster of points shown in the figure. If so, this point should be considered "normal" and treated according to the model in step 2. If the σ_0, H pair appears as a statistical outlier in that it is far from the cluster of points in the figure, then it is considered "abnormal" and should be treated according to step 3.
2. For a normal point, determine j according to the figure, then compute the windspeed according to

$$U = \sum_{n=0}^{3} s_{jn} \sigma_0^n$$

where n is an integer, each s_{jn} is a coefficient defined in the table, the units of σ_0 are decibels, and the units of U are meters per second.
3. For an abnormal point, compute the windspeed from an empirical function of the form $U = f(\sigma_0)$, which depends in part on the type of abnormality.



The **Principal Radar-Altimeter Data Outputs** H and σ_0 are assigned to either of two regions according to their x values. Each dot represents an empirical H, σ_0 pair.

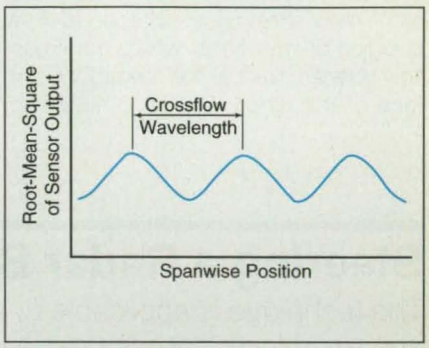
This work was done by Roman E. Glazman of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 100*** *on the TSP Request Card.*
NPO-18884

Measurement of Crossflow Vortex Structure

Microthin multiple hot-film sensors yield data on crossflow wavelength.

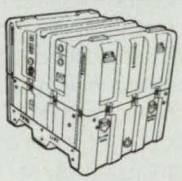
Langley Research Center, Hampton, Virginia

The attainment of laminar airflow on aircraft wings has significant potential for reducing drag and increasing fuel efficiency. On a swept wing, the airflow is highly three-dimensional, and several fundamental instability modes, including crossflow disturbances, strongly influence the transition of the flow in the boundary layer from laminar to turbulent. Detailed measurements of the crossflow vortices would facilitate an understanding of the crossflow disturbances. A method has been developed for measuring the wavelengths of crossflow vortices by using surface-mounted, microthin, multielement hot-film sensors.



Processed Outputs of Hot-Film Sensors as a function of spanwise position indicate a series of corotating crossflow vortices.

Each hot-film sensor provides a signal related to flow conditions on the surface of the airfoil. The sensors are formed by vapor deposition of layers of nickel and copper on a Kapton® (or equivalent) polyimide sheet 2 mils (0.05 mm) in thickness. Copper leads are connected at the ends of each hot-film sensor to connect it to a constant-temperature anemometer circuit. The hot-film sensors are spaced in a straight-line array so that about 10 sensors are included within the distance of 1 crossflow wavelength (0.3 in.). The sensor array covered a spanwise distance of 1 in. (2.54 cm), and the sensors were aligned to the crossflow vortex pattern as obtained by the flow visualization. The root-mean- square



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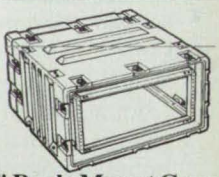

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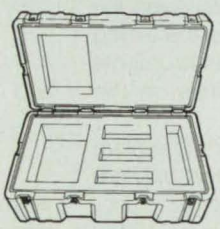

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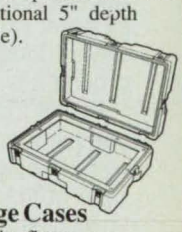

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signal from each sensor is plotted as a function of its spanwise location, and the wavelength of the crossflow vortices is determined by noting the distance between two maximums or two minimums of root-mean-square values.

The figure shows a root-mean-square signal from a series of corotating crossflow vortices measured on a swept-wing wind-tunnel model. Surface measurements of the shear stress on an airfoil should show a region of high shear where the crossflow vortices direct airflow toward the surface of the airfoil. On the other hand, there should also be a region of low shear where the crossflow vortices direct airflow away from the surface of an airfoil. The distance between two successive peaks or valleys corresponds to the wavelength between two crossflow vortices.

This method provides a direct and true value of the wavelength of crossflow vortices at various spanwise locations without any localized flow disturbances. A better understanding of this phenomenon will aid in control of the crossflow disturbances in the laminar boundary layer, leading to reduced drag and increased fuel efficiency of aircraft.

This work was done by Dal V. Maddalon of **Langley Research Center**. *For further information,* ***write in 60*** *on the TSP Request Card.*

This invention has been patented by NASA (U.S. Patent No. 5,209,111). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Langley Research Center [see page 20]. Refer to LAR-14824.

Steering a Radar Beam Toward the Zero-Doppler Line

The technique is applicable to a variety of radio and optical instruments.

NASA's Jet Propulsion Laboratory, Pasadena, California

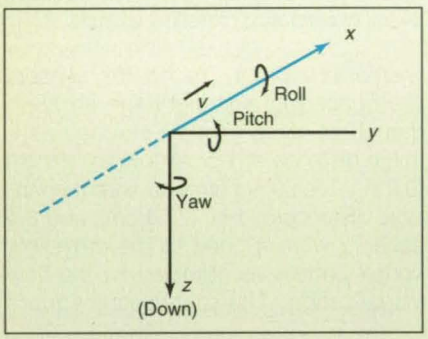


Figure 1. This **Coordinate System** moving with the radar platform is used to compute pitch and yaw adjustments to aim toward the zero-Doppler line.

An algorithm computes the angles needed to aim a radar beam from an airborne or spaceborne platform toward the Doppler line projected on the ground for which the Doppler shift of the radar return is zero. The algorithm was devised to reduce Doppler errors and thereby simplify processing of data from a synthetic-aperture-radar system, in particular an imaging radar system operating aboard the Space Shuttle. However, the algorithm is also applicable to the aiming of other radio or optical instruments toward their zero-Doppler lines on the ground.

Figure 1 shows the coordinate system used in the original spacecraft application and helps to illustrate the basic principle of the algorithm. The orbit of the spacecraft around the Earth is assumed to be nearly circular, and the local instantaneous horizontal velocity of the spacecraft defines the x axis in the coordinate system, which moves with the spacecraft. The z axis is defined as the nadir axis. The y axis points rightward from the spacecraft trajectory, perpendicular to the x and z axes. Roll, pitch, and yaw are defined as rotations about the x, y, and z axes, respectively. During SAR operation, the coordinate axes of the spacecraft body are kept approximately aligned with the corresponding axes of this coordinate system, except as described below.

The antenna boresight is pointed to an off-nadir look angle by a combination of a fixed roll angle of the spacecraft along with mechanical steering or electronic beam steering. The foregoing look-angle adjustments in roll are prescribed, and it is required to compute small yaw and pitch adjustments of the spacecraft attitude to point the boresight toward the zero-Doppler line on the ground. It is also required to orient the spacecraft so that the antenna boresight will scan along the zero-Doppler line when the beam is steered mechanically or electronically in roll.

These requirements are expressed by the equations

$$\mathbf{p} \cdot \mathbf{V}_{st} = 0$$

and

$$\frac{d\mathbf{p}}{d\theta_L} \cdot \mathbf{V}_{st} = 0$$

where $\mathbf{p}$ is the unit vector along the antenna boresight, $\mathbf{V}_{st}$ is the relative velocity of the sensor (spacecraft) and target (surface of the Earth at the point of intersection with the antenna boresight), $\mathbf{p}$ and $\mathbf{V}_{st}$ are given in the previously described coordinate system moving with the spacecraft, and θ_L is the off-nadir look angle in roll. The solution of these two equations gives the required yaw and pitch steering angles.

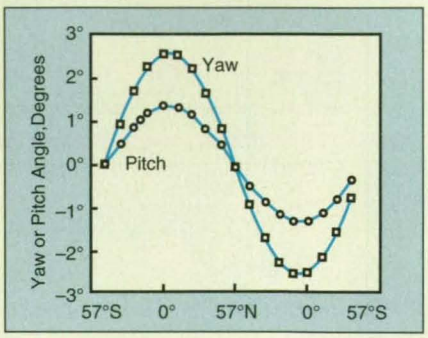


Figure 2. **Yaw and Pitch** steering angles were computed for a spacecraft that ranges between 57° south latitude and 57° north latitude along its orbit.

The algorithm computes, in advance, the yaw and pitch steering angles for an entire orbit (see Figure 2) by implementing the following procedure:

a. Use an orbit-propagator to generate the spacecraft position and velocity vectors along the entire orbit.
b. Given the look angle, derive the target velocity vectors along the entire orbit.
c. Convert the spacecraft and target velocity vectors to the coordinate system moving with the spacecraft; that is, use them to compute $\mathbf{V}_{st}$.
d. Solve the two equations for the yaw and pitch angles.

This work was done by Chi-Yung Chang and John C. Curlander of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 47*** *on the TSP Request Card.*

NPO-18896

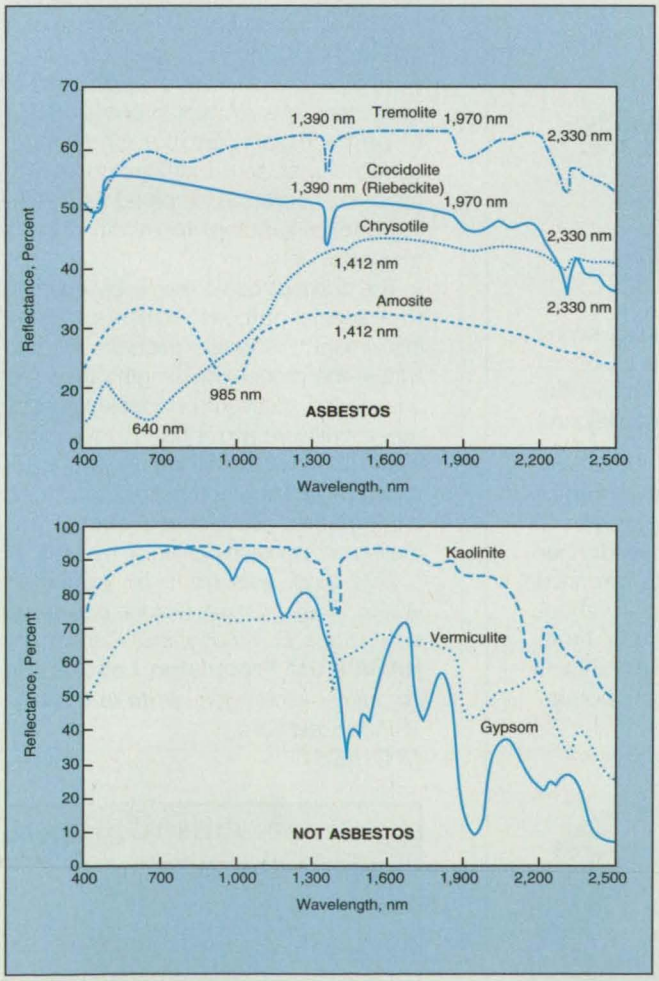
Rapid Measurement of Asbestos Content of Building Materials

A small spectrophotometer would give fast, dependable indications onsite.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed portable instrument would measure asbestos content of construction materials in place, usually without need to remove specimens of the materials for analysis in a laboratory. The instrument would help building renovators determine, quickly and accurately, whether asbestos is present in thermal and acoustic insulation, electrical wiring, roofing shingles, floor tiles, and other common building materials, and whether costly procedures for removal of asbestos were necessary.

The current method of detecting as-bestos involves examination of specimens under microscopes: Specially trained technicians try to recognize and count the numbers of asbestos fibers in the specimens. Such examinations are laborious, time consuming, and expensive and sometimes yield erroneous results. The proposed instrument would provide a cheaper, more accurate alternative.



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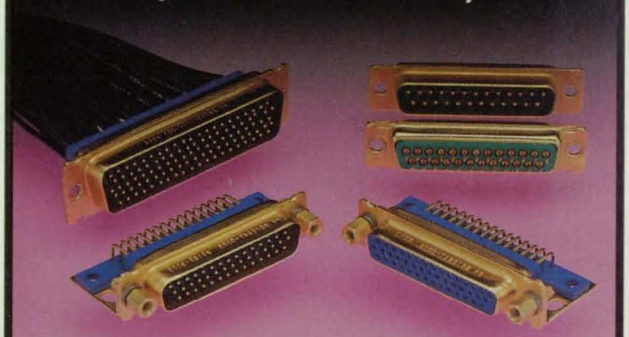

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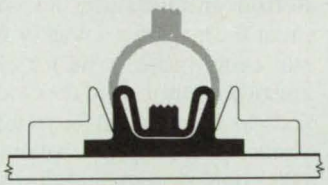

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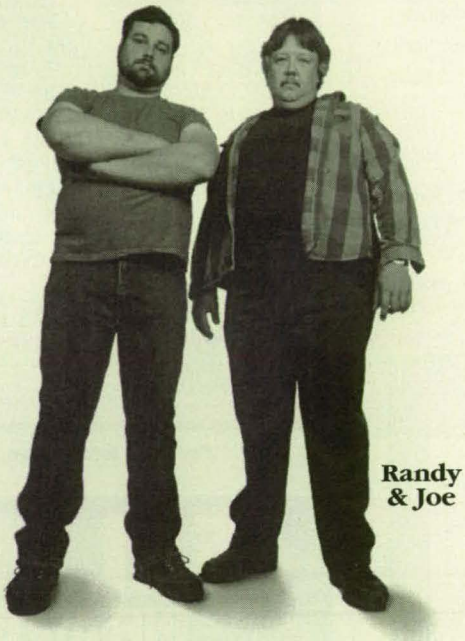

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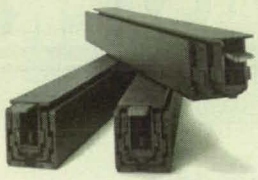

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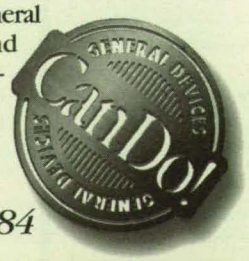

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The proposed instrument — a spectrophotometer — would be brought to a building site to be examined. It would beam near-infrared light at each specimen (which would remain in situ), analyze the spectrum of the infrared light reflected from the specimen, and compute asbestos content (if any) of the specimen from the magnitudes of spectral features known to be characteristic of asbestos.

In an experiment to demonstrate the concept, a commercial spectrophotometer was used to measure the spectral reflectances of specimens in the near-infrared wavelength region of 0.4 to 2.5 μm. Asbestos in various forms, such as amosite, crocidolite, tremolite, chrysotile, and anthophyllite, has unique narrow absorption bands in this wavelength range (see figure). The experimenters found that they could consistently detect asbestos in concentrations as low as 0.5 percent by weight. They found it possible to distinguish between asbestos and spectrally similar minerals, kaolinite and vermiculite, that are often found mixed with asbestos. The experimental spectrophotometric technique was found to be best suited to detection of asbestos in light-colored matrices like floor tiles and spray-on insulation, and no special preparation of specimens of such materials was found to be necessary. On the other hand, specimens of dark matrices containing asbestos had to be prepared (by washing and/or sanding) to obtain reliable measurements.

The concept could readily be adapted to a special-purpose, battery-powered instrument that would generate infrared light in the proper wavelength range and analyze the spectrum of reflected light by use of software and a built-in microprocessor designed specifically for this application. A building contractor using such an instrument could obtain reliable information on asbestos content in minutes.

This work was done by James R. Weiss, Cindy I. Grove, Gordon L. Hoover, and James B. Stephens of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 8*** *on the TSP Request Card.*
NPO-18981

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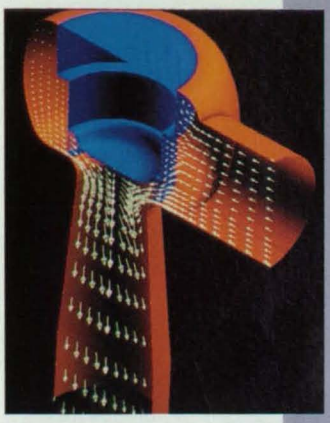

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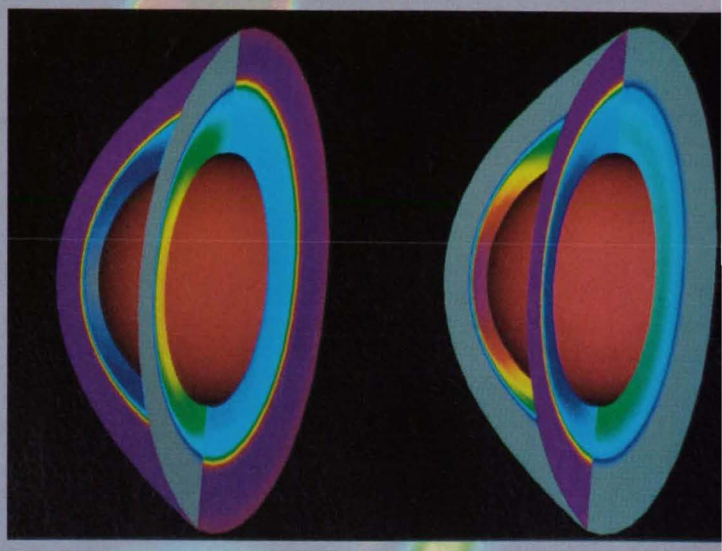

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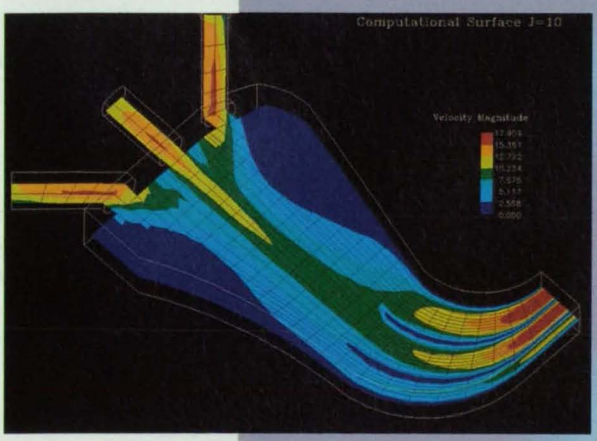

Velocity magnitude on center plane through a multi-port transition duct.

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Making Semicrystalline Polyimide Powders

Powders with desirable melt-flow properties are formed in reaction vessels, without grinding.

Langley Research Center, Hampton, Virginia

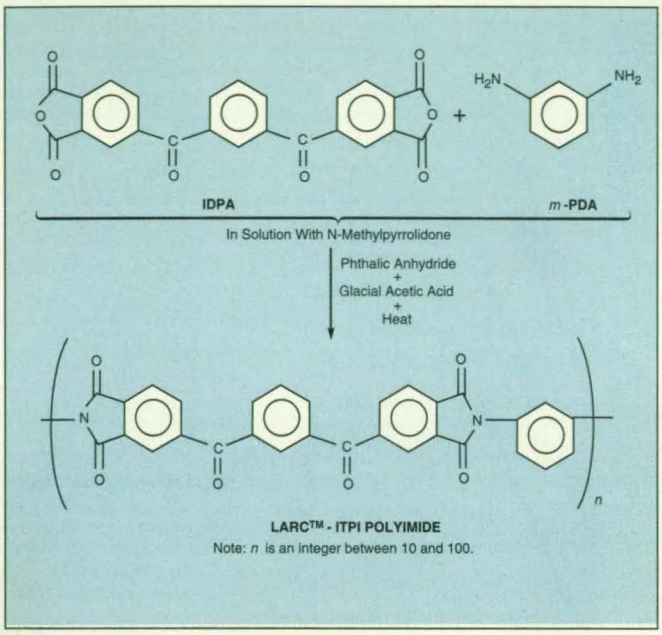
Semicrystalline polyimides that have controlled molecular weights can be synthesized in a process that yields the polyimides in powder form. These polyimides exhibit transient crystallinity that gives rise to melt flow of a high degree at processing temperatures of about 300 to 350°C, which are slightly above their melting temperatures. Consequently, these polyimide powders are commercially attractive for fabrication of adhesive bonds, compression molding of shaped parts, and deposition onto reinforcing fibers for subsequent hot pressing into polyimide-matrix/fiber composites.

A polyimide powder of this type is formed directly by precipitation from the reaction mixture in the reaction vessel in which it is polymerized; that is, it is not necessary to grind a polymerized mass to form the powder. In the process, the monomeric constituents are allowed to react in a solvent such as N-methylpyrrolidone. Next, the polymer precursor is dehydrated with glacial acetic acid, which is also a nonsolvent for the resulting polymer.

The molecular weight(s) of the polyimide formed in this process depend(s) primarily on the stoichiometric offset between the monomeric constituents and on the amount of the end-capping agent. Moreover, it is necessary to add an excess of end-capping agent about 1 hour after the beginning of the reaction to afford desirable melt stability in the powder end product.

For example (see figure), the monomeric constituents used in one experiment were 12.7767 g (0.0233 mole) of IDPA and 2.5955 g (0.024 mole) of m-PDA. The IDPA was added to a stirred solution of the *m*-PDA in 53 mL of N-methylpyrrolidone under a nitrogen atmosphere. After stirring the mixture for 1 h, 0.2559 g (0.00173 mole) of phthalic anhydride was added as an end capper, and stirring then continued for 2 more hours.

Next, 17 mL of glacial acetic acid was added as the dehydrating agent. Then the mixture was heated to 120°C and held at that temperature for 10 hours, resulting in precipitation of a polyimide powder. The powder was isolated by filtration. Differential scanning calorimetry showed that the powder had a glass-transition temperature of 248.5°C, a melting temperature of 299.9 °C, and a specific heat of fusion of 28.9 J/g. An x-ray diffraction test indicated that the polymer was crystalline, while the infrared spectrum of the polymer indicated that imidization was complete.



The **Polyimide Precipitates as a Powder** from the reaction mixture in this reaction sequence, which is typical of the process described in the text.

This work was done by Terry L. St. Clair of **Langley Research Center** *and Alice Chang of Lockheed Engineering & Sciences Co. No further information is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Langley Research Center [see page 20]. Refer to LAR-15020.

Metal-Filled Adhesives Amenable to X-Ray Inspection

Adhesive joints between metal parts are rendered radiopaque.

Goddard Space Flight Center, Greenbelt, Maryland

Adhesive joints between metal parts can be made amenable to nondestructive radiographic inspection by incorporating radiopaque fillers that increase the x-ray contrasts of the joints. The adhesives can be, for example, epoxies, urethanes, acrylics, phenolics, or silicones, with the appropriate curing agents and with such modifiers as polysulfides, polyamides, or butadiene rubbers. Typically, an adhesive is mixed with 5 to 50 volume percent powdered radiopaque filler. A typical filler of this type contains mica for adhesive strength, and a high-atomic-number metal (or a compound that contains such a metal) for radiopacity.

The choice of radiopaque filler metal is not critical, provided that the filler makes the adhesive more opaque than are the metal parts that the filled adhesive bonds together. Tungsten, which has an atomic number of 74, is a good choice, although

other metals in the range 72 to 84 can be used. The metal can be in elemental form or in a compound such as an oxide, silicate, or carbonate. One important advantage of compounds is that they are often inexpensive, naturally occurring materials. In addition, because compounds are less dense than the corresponding elemental metals are, it is easier to keep them dispersed in the adhesives.

Whether the metal is used in elemental or compound form in a given case, the mixture must be stirred thoroughly to ensure a homogeneous distribution, and the mixture should be applied promptly to the joint before the filler settles in the adhesive. It may be necessary to add a thixotropic agent such as fumed silica powder to retard settling.

The amount of filler needed in the mixture depends on the filler metal and the metals being bonded. To obtain adequate radiopacity in a bond between steel parts, for example, more metal filler is needed than in a bond between aluminum parts. The amount of filler for a specific application can be determined easily by preparing adhesives with different concentrations of filler and testing them for opacity with conventional x-ray equipment.

In an experiment, pairs of sheets of aluminum 0.16 cm thick were bonded with layers of filled adhesive 0.4 cm thick. The filled adhesives consisted of 25 parts by weight epoxy, 3 parts polysulfide modifier, 10 parts various proportions of tungsten and mica filler, and 4 parts polyamine curing agent. It was found that at least 15 volume percent of tungsten in the filler was necessary to enable the detection of voids by use of 0.5-Å x rays. To detect voids with 0.15-Å x rays, it was necessary to incorporate at least 40 volume percent of tungsten into the filler. In neither case did the increase in tungsten reduce the lap shear strength of the adhesive bond.

This work was done by Ralph D. Hermansen, Thomas H. Sutherland, and Roamer Predmore of Hughes Aircraft Co. for **Goddard Space Flight Center**. *For further information,* ***write in 99*** *on the TSP Request Card. GSC-13195*

High-Hot-Strength Ceramic Fibers

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Lewis Research Center, Cleveland, Ohio

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The principal application for the $Al_2O_3/ Y_3Al_5O_{12}$ fibers is reinforcement of ceramic- or metal-matrix composite parts that operate at extremely high temperatures in air. These fibers are leading candidates for reinforcement of intermetallic-matrix composites in the exhaust nozzles of developmental high-speed civil transport aircraft engines. Other potential applications are in the aerospace, automotive, chemical-process, and power-generation industries, where they can increase operating temperatures and minimize oxidation.

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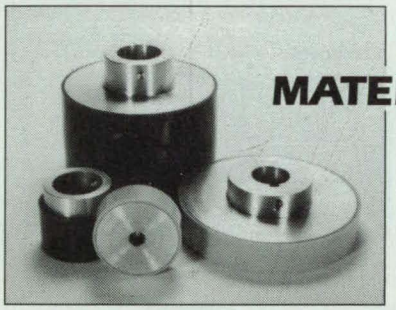

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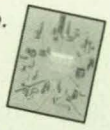

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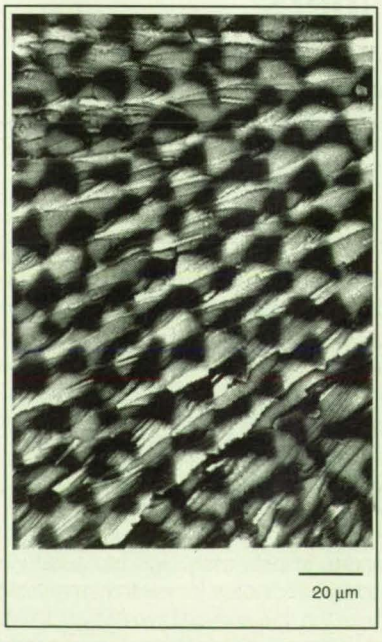
The $Al_2O_3/Y_3Al_5O_{12}$ fiber material is a directionally solidified eutectic made by the laser-heated floating-zone method. In an experiment to demonstrate the fabrication process, powders of polycrystalline alumina and yttria were mixed in eutectic proportions (18.5 mole percent yttria, 81.5 alumina) in water, along with small amounts of a methyl cellulose binder and glycerine as a plasticizer. The resulting slurry was dried to a paste, which, in turn, was extruded to form a polycrystalline fiber. Further processing converts the extruded fiber into a rod, which was used as the feedstock for the laser-heated floating-zone process. In this process a pair of beams from a CO_2 laser was focused on the fiber as the fiber was drawn, thus heating a small spot on the fiber and creating a melt zone that moved along the fiber. The resolidified fiber left behind by the passage of the melt zone consisted of alternating lamellae of alumina and YAG (see figure).

The thinner the lamellae, the stronger the fiber. The lamellae can be kept thin by suitably controlling the rate of solidification, the thermal gradient in the melt zone, and the diameter of the fiber. The presence of YAG in the nontwinable phase helps the fiber maintain strength at high temperature. The resistance of the fiber to off-axis creep is attributable to the large ratio of width to thickness in the eutectic microstructure.

This work was done by Ali Sayir of Case Western Reserve University for **Lewis Research Center** *and Lawrence E. Matson of Wright Patterson Air Force Base. For further information,* ***write in 67*** *on the TSP Request Card. LEW-15769*



The **Microstructure of Directionally Solidified Eutectic** $Al_2O_3/Y_3Al_5O_{12}$ is a composite of $Y_3Al_5O_{12}$ lamellae (light phase) and Al_2O_3 lamellae (dark phase).

Hydrogen-Resistant Fe/Ni/Cr-Base Superalloy

This is the strongest Fe/Ni/Cr-base hydrogen- and corrosion-resistant alloy yet developed.

Marshall Space Flight Center, Alabama

An experimental Fe/Ni/Cr-base superalloy exhibits high strength and exceptional resistance to embrittlement by hydrogen. Similar to other commercial Fe/Ni-base superalloys, this alloy contains a two-phase microstructure consisting of a γ' precipitated phase in a γ matrix phase. Expected to be produced in wrought, weldable form and as castings, the alloy maintains high ductility and strength in air and hydrogen. Its strength exceeds that of any previously known Fe/Cr/Ni hydrogen-, oxidation-, and corrosion-resistant alloys. Thus, it provides higher strength-to-weight ratios for lower weight in such applications as storage vessels and pipes that must contain hydrogen.

After a review of the literature indicated that such hydrogen-resistant Fe-base superalloys as A-286 and JBK-75 have matrix compositions that have evolved from those of hydrogen-resistant stainless steels (single-γ-phase materials), the development of the experimental alloy has been based on the strategy of (1) formulating compositions that form hydrogen-resistant matrix (γ), (2) increasing the volume fraction of precipitate (γ') and adding γ-matrix strengthening elements to obtain higher strength, and (3) processing the alloy in such a way that its microstructural characteristics resemble those of JBK-75. In brief, the experimental alloy satisfies the following criteria.

- The Fe/Ni/Cr ratio in γ is maintained the same as in JBK-75.
- The composition of γ' is maintained close to that in JBK-75.
- There is an increased volume fraction of γ' for strengthening.
- W and Mo have been added to strengthen the γ matrix.

The experimental alloy is one of several that were formulated and processed according to these criteria and compared with JBK-75, which was previously the best hydrogen-resistant alloy. The comparison led to the identification of the present experimental alloy, which has hydrogen resistance equivalent to that of JBK-75. The composition of this alloy in weight percentages is 40.2 Fe/34 Ni/4 Co/15.5 Cr/ 2.0 Mo/1.0 W/0.5 V/2.5 Ti/0.3 Al. The table lists the tensile properties of JBK-75 with those of the experimental alloy, showing that the strength of this alloy is approximately 10 to 15 percent higher than that of JBK-75 while the ductility of the alloy is comparable to that of JBK-75.

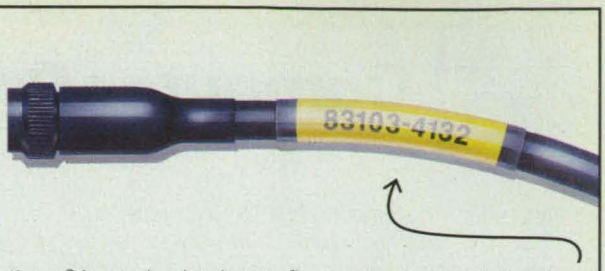
The experimental alloy displays a very clean microstructure without deleterious precipitates at grain boundaries. Transmission electron microscopy indicates a two-phase microstructure consisting of a γ' precipitated phase in a γ matrix phase. The overall microstructure is comparable to that of alloy JBK-75.

This work was done by Biliyar N. Bhat of **Marshall Space Flight Center** *and Po-Shou Chen and Binayak Panda of IIT Research Institute. 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, Marshall Space Flight Center [see page 20]. Refer to MFS-26250.

Material	Atmosphere	Yield Strength, kpsi	Ultimate Tensile Strength, kpsi	Elongation to Break, Percent	Reduction Area at Break, Percent
JBK-75	Air	106.3	162.9	26.7	40.2
	H_2	108.6	162.2	23.5	41.7
Experimental Alloy	Air	121.3	177.1	23.8	40.2
	H_2	122.5	178.2	23.5	37.8

Tensile Properties of the experimental alloy are compared with those of JBK-75.



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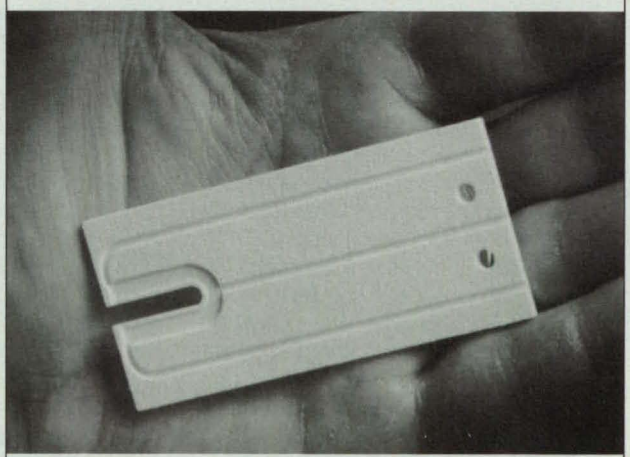

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Fabrication Technology

Program Helps Standardize Documentation of Software

IDMS helps a program manager in tailoring a documentation standard to a project.

The Intelligent Documentation Management System (IDMS) computer program was developed to assist project managers in implementing the information system documentation standard known as NASA-STD-2100-91 (NASA STD, COS-10300) of NASA's Software Management and Assurance Program. The standard consists of data-item descriptions (DID's), or templates, each of which governs a particular component of software documentation. For example, one DID governs the user's guide, another the quality-assurance requirements, and so on. The DID's are hierarchically interrelated to one another, forming a DID hierarchy, or inverted tree structure.

It is up to the project manager (PM) of a given project to determine which of the DID's apply to a particular project and which are not applicable. Also, if any one of the DID's grows too large to be comfortably embedded as an in-line section of a parent document, the PM may roll it out as a separate volume, but must maintain traceability between this volume and its parent document.

IDMS functions as a decision-support system that automates the process of tailoring the DID hierarchy. IDMS uses an embedded expert-system program called the Project Manager Advisor (PMA) to advise the PM on how the standard should be tailored on the basis of such qualitative project criteria as level of risk, security and/or privacy aspects, and the like. IDMS then provides the PM with the capability to custom-tailor the DID hierarchy for a particular project, to assign and manage writing responsibility for individual DID's to members of the project team, to maintain configuration management of the pieces of documentation in process, and to compile these pieces of documentation periodically into draft and/or final versions of a complete set of documentation. IDMS has been designed to be data-independent, such that it can be adapted easily to virtually any documentation standard that involves hierarchically related DID templates.

IDMS is written in C language for IBM PC-series and compatible computers running MS-DOS. The program requires at least 5 Mb of disk space and a VGA or EGA graphics display. The source code can be compiled properly only with the inclusion of files from the Vermont Views software package (available from Vermont Creative Software, Richford, VT, 802/848-7731); however, an executable code is provided on the distribution medium. The executable code requires at least 640K of random-access memory and MS-DOS v3.1 or higher. Printing of IDMS-produced documents requires WordPerfect v5.0, or higher. The standard distribution medium for this program is a set of four 5.25-in. (13.34-cm), 1.2-Mb diskettes in MS-DOS format. The program price includes a copy of the NASA STD package (COS-10300) diskette as well as the IDMS documentation. IDMS was developed in 1992.

This program was written by G. Howe of Systems Research and Applications Corp. for **Lewis Research Center**. *For further information,* ***write in 7*** *on the TSP Request Card. LEW-15589*

Mathematics and Information Sciences

Portable Software for Numerically Controlled Machining

A revised version of APT conforms to the FORTRAN 77 standard.

The APT computer code is one of the most widely used software tools for complex numerically controlled (N/C) machining. "APT" is an abbreviation for "Automatically Programmed Tool" and is used to denote the programming language. Development of the APT language and software system was begun in the late 1950's as an industry and university research effort sponsored by the U.S. Government.

APT is a "problem-oriented" language that was developed for the explicit purpose of aiding N/C machine tools. The original APT program contained undocumented, nonstandard FORTRAN, which made it difficult to port the program to different operating systems. P-APT (Portable APT) is a revised version of APT that was written to conform to the FORTRAN 77 standard. All machine-dependent code has either been replaced or isolated and documented.

Machine-tool instructions and geometry definitions are written in the APT

language to constitute a "part program." The APT part program is processed by the P-APT software to produce a cutter-location (CL) file. This CL file can then be processed by postprocessors supplied by the user to convert the CL data into a form suitable for a particular N/C machine tool. This current offering of the P-APT system represents an adaptation, with enhancements, of the public-domain version of APT IV/SSX8. Enhancements include a "super pocket" feature, which provides for concave pockets with curved sides and islands.

The P-APT system software is organized into two separate programs: the load complex and the APT processor. The load complex handles the table-initiation phase and is usually run only when changes to the P-APT processor capabilities are made. This phase initializes character-recognition and syntax tables for the P-APT processor by creating FORTRAN block data programs. The P-APT processor consists of four components: the translator, the execution complex, the subroutine library, and the CL editor. The translator examines each APT statement in the part program for recognizable structure and generates a new statement, or series of statements, in an intermediate language. The execution complex processes all of the definition, motion, and related statements to generate cutter-location coordinates.

The subroutine library contains routines that define the algorithms required to process the sequenced list of intermediate-language commands generated by the translator. The CL editor reprocesses the cutter-location coordinates, according to commands supplied by the user, to generate a final CL file.

The APT language is a statement-oriented, sequence-dependent language. With the exception of such programming techniques as looping and macros, statements in an APT program are executed in a strict first-to-last sequence. To provide programming capability for the broadest possible range of parts and machine tools, APT input (and output) is generalized, as represented by 3-dimensional geometry and tools, and is arbitrarily uniform, as represented by the moving-tool concept and output data in absolute coordinates.

P-APT is written in FORTRAN 77 for execution on Sun4-series computers running SunOS. Although P-APT is written in standard FORTRAN 77 and was designed to be readily portable code, it has been fully tested on only a Sun4-series computer running SunOS. By making documented modifications to the source code, one can also port the code to a DEC VAX-series computer running VMS. P-APT required 3.1 Mb of random-access memory (RAM) for execution. A minimum of 16 Mb of RAM and 32 Mb of disk space used for swap space is recommended. The standard distribution medium for this program is a 0.25-in. (6.35-mm) streaming-magnetic-tape cartridge in UNIX tar format. P-APT is available by license for a period of 10 years to approved licensees. The licensed program product includes the P-APT source code, makefiles, examples, and one set of supporting documentation. Additional copies of the documentation may be purchased. P-APT was developed in 1992.

This program was written by J. Poland and T. Premack of **Goddard Space Flight Center**. *For further information,* ***write in 65*** *on the TSP Request Card.*
GSC-13558

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System Measures Loads in Bolts

An improved system based on the P^2L^2 interferometer measures absolute loads.

Langley Research Center, Hampton, Virginia

An improved technique for ultrasonic nondestructive measurement of the loads in bolts involves the use of a pulsed phase-locked loop (P^2L^2) interferometer. The technique provides for correction of errors and for automatic readout of the loads in bolts.

Previously, the P^2L^2 was used to measure only changes in the loads in bolts, and ultrasonic transducers were left on the bolts during tightening. The load in a bolt already tightened could not be measured because variations in the temperature, transducer, cable, ultrasonic couplant bonding material, and other components affected the reading. Like the previous P^2L^2-based system, other bolt-load-measuring systems that use times of flight of ultrasonic waves to measure bolt loads are also affected by changes in temperatures, transducers, cables, and bonding materials. In addition, they are more difficult to use and generally less accurate than is the P^2L^2 system.

The previous version of the P^2L^2 system (see Figure 1) measures changes in the phases of acoustic waves and reads out corresponding changes in frequency. The system is locked to a given frequency, and the frequency of its output signal changes as a load is applied to the bolt. The change in the bolt load is computed from the frequency shift (referenced back to the initial lock-point frequency) by use of a factor derived from previous calibration measurements in a load cell.

Unfortunately, changes in temperature shift the lock-point frequency, as does use of a different transducer, cable, couplant, P^2L^2, and other components. The improved technique compensates for these changes in the lock-point frequency, so that actual bolt load can be measured, by use of transducers that are rebonded after bolts have been tightened. Figure 2 shows the improved version of the system, in which a calibration block and thermometer have been added.

This improved technique and system enable the use of the same or a different transducer that has been rebonded to a bolt at a different temperature and with the same or a different cable, P^2L^2, and/or couplant. The improved technique provides the ability to measure absolute loads rather than merely changes in loads. This technique may be applicable to critical fasteners in aerospace applications, nuclear reactors, petroleum and other chemical processing plants, steel bridges, and other structures.

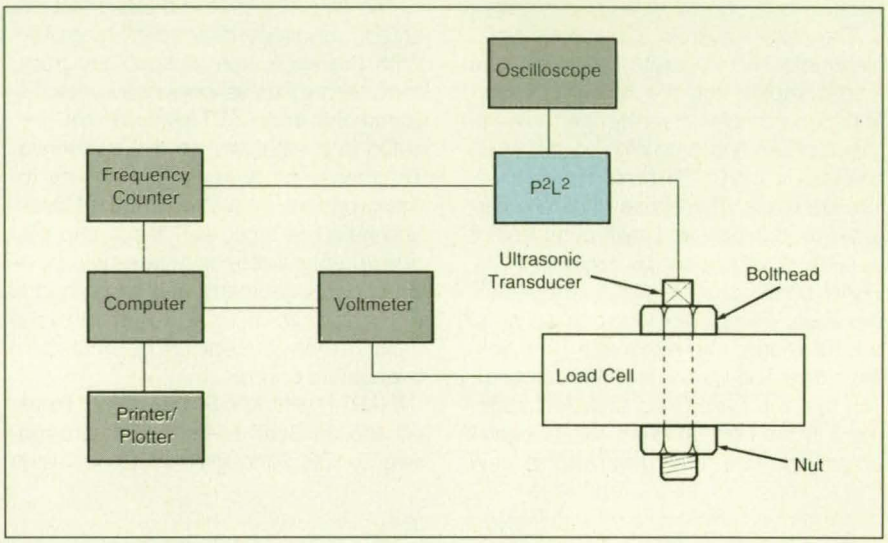

Figure 1. The **Previous P^2L^2 System** for measuring changes in bolt loads is shown here configured for calibration.

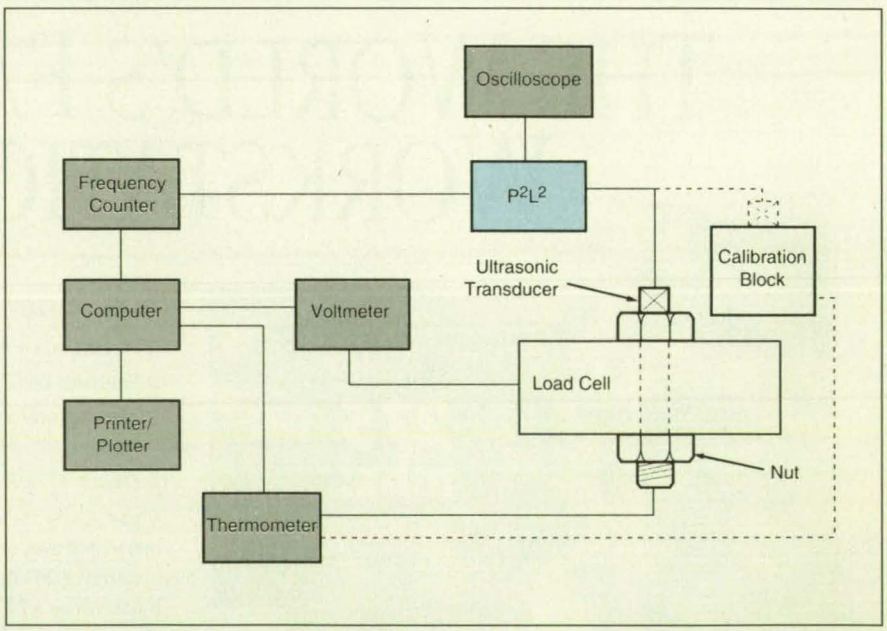

Figure 2. The **Improved P^2L^2 System**, also shown configured for calibration, includes an added thermometer and calibration block.

This work was done by Sidney G. Allison of **Langley Research Center**. *For further information,* ***write in 78*** *on the TSP Request Card.*

This invention has been patented by NASA (U.S. Patent No. 5,150,620). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Langley Research Center [see page 20]. Refer to LAR-14168.

Self-Aligning Truss-Joint Mechanism

Features include automatic latching and redundant manual drive.

Lyndon B. Johnson Space Center, Houston, Texas

Figure 1 shows details of a self-aligning mechanism for use at a joint in a truss, scaffold, tower, or other structure. This mechanism provides a secure joint and facilitates quick assembly and disassembly of the structure. During initial approach and latching prior to hard docking and self-alignment, the mechanism tolerates lateral misalignment of as much as 1-⅞ in. (±47.6 mm) and angular misalignment of as much as 6°.

Figure 2 shows an operating sequence. The two subassemblies are brought into proximity and pushed together so that the spherical tip of the plunger on the upper subassembly makes contact with the conical guide in the lower subassembly. The two subassemblies are then pushed together further until the spherical tip slips below six spring-loaded fingers in the base, causing the fingers to latch on top of the spherical tip. At this stage, the upper subassembly is captured but can still be angularly misaligned.

Next, the main drive shaft in the upper subassembly is rotated to turn the lead screw clockwise, thereby drawing the hous-

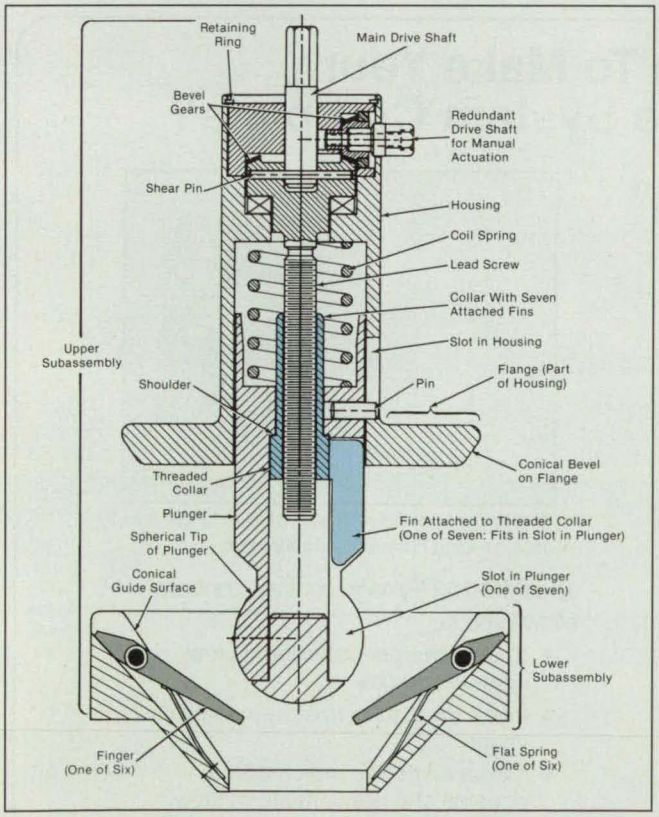

Figure 1. The **Self-Aligning Truss-Joint Mechanism** can be actuated by a single motor or manual rotary drive. Each subassembly is connected permanently to one of two structural components to be joined. This mechanism facilitates quick assembly and disassembly and may be suitable for robotic operation.

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ing of the upper subassembly downward on the plunger, toward the lower subassembly. Eventually, the conical bevel on the flange of the upper subassembly makes contact with some point on the conical guide surface of the lower subassembly. Further rotation of the lead screw draws the two conical surfaces into hard contact all around, thereby enforcing alignment.

Torque is coupled between the main drive shaft and the lead screw via the shearpin, which is made of a soft metal. In the event of a freezeup or failure of the main drive, the shearpin can be broken, and the lead screw can then be actuated manually via a redundant drive shaft.

The lower right part of Figure 2 illustrates decoupling from the latched, aligned condition. The lead screw is rotated counterclockwise, moving the threaded collar and the fins attached to it downward. The coil spring also pushes the spherical tip downward a short distance. As the fins continue downward, they push the fingers outward, so that the fingers no longer grasp the spherical tip. The upper subassembly can then be pulled away from the lower subassembly.

This work was done by Clarence Wesselski of Lockheed Engineering & Sciences Co. for **Johnson Space Center**. *For further information,* ***write in 9*** *on the TSP Request Card.*
MSC-22025

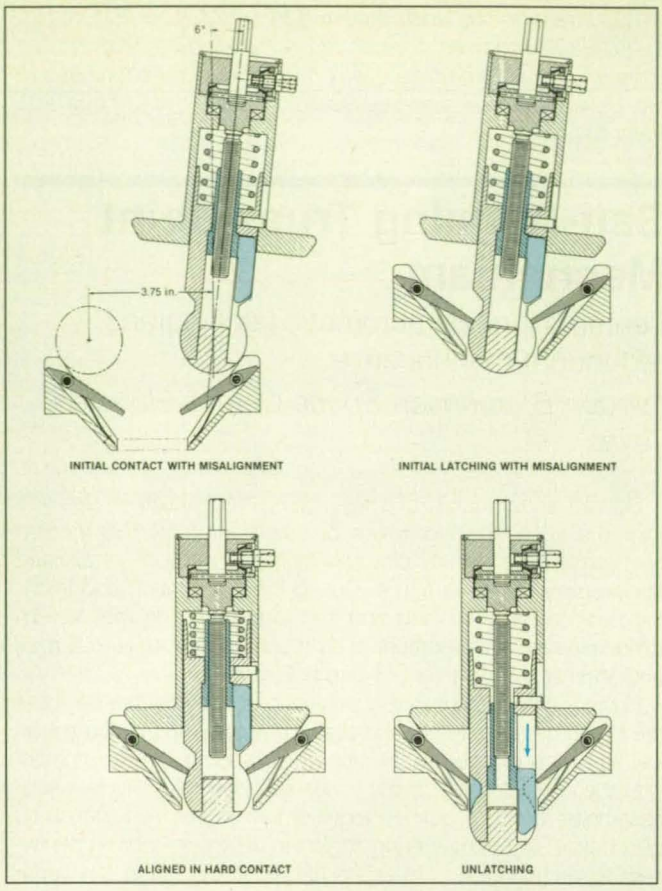

Figure 2. The **Operation of the Mechanism** is illustrated at representative stages of a fastening and unfastening sequence.

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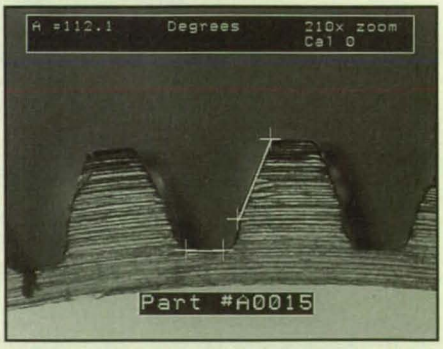

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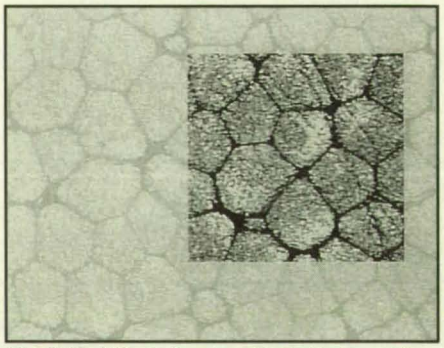

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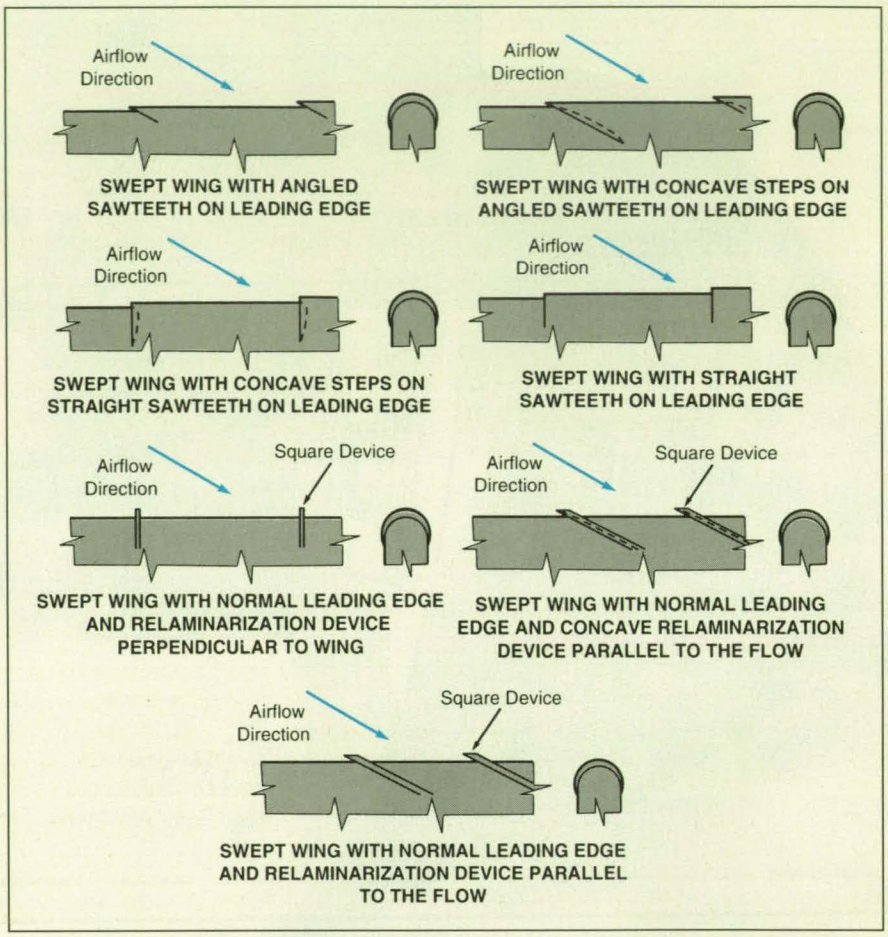
Drag is reduced economically.

Langley Research Center, Hampton, Virginia

Significant difficulties have been encountered in the effort to manipulate flows on swept wings at supersonic speeds to obtain low drag. Several studies have been performed showing that, by use of suction, the flow over a wing could be relaminarized and maintained laminar over 75 to 80 percent of chord length. To produce the necessary suction, it is necessary to use vacuum pumps, tubes, switches, and valves. These add weight to an airplane and use up some of its power. Also, it can be difficult to fit such active suction devices into the small spaces inside the leading edges of most present supersonic aircraft.

Passive devices that can significantly reduce wing drag have been designed at NASA Langley Research Center. These are relaminarization devices that are simple and easy to use. The devices are small discontinuities (i.e., square devices or saw-toothed edges) built into the surfaces of wings. As shown in the figure, the devices range from angled to straight, saw-toothed to square, and with and without concave steps. The saw-toothed configuration could be built into the wings of future airplanes. The square devices could be machined separately and retrofitted to any existing supersonic airplane.



The **Drag-Reducing Devices** can be made in a variety of designs; all can be incorporated into future airplanes, and some can be retrofitted to existing airplanes.

These devices are designed to reduce total airplane drag by changing the high-drag turbulent wing-leading-edge flow to low-drag laminar wing-leading-edge flow. The devices will be used primarily on high-speed (particularly supersonic) airplanes, but may also be useful in reducing drag in other applications.

This work was done by Theodore R. Creel of **Langley Research Center**. *For further information,* ***write in 98*** *on the TSP Request Card.*

This invention has been patented by NASA (U.S. Patent No. 5,205,519). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Langley Research Center [see page 20]. Refer to LAR-14470.

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Low-Pressure-Drop Shutoff Valve

Under normal flow conditions, a flapper would present minimal cross section to flow.

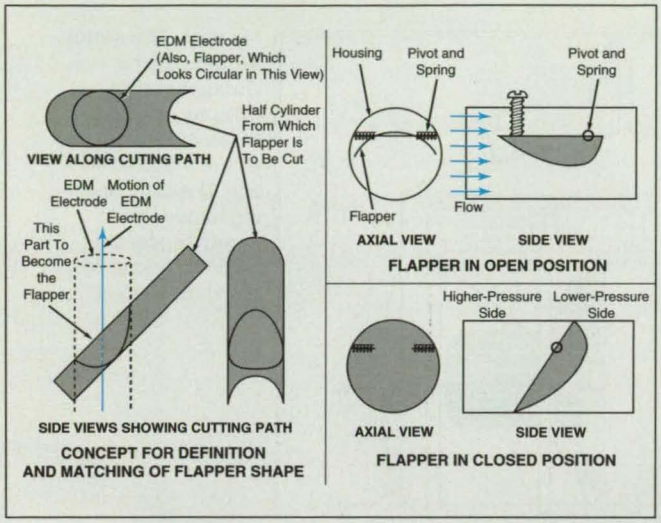
Lyndon B. Johnson Space Center, Houston, Texas

A proposed flapper valve would remain open under normal flow conditions but would close upon a sudden increase to a high rate of flow and would thereafter remain closed until reset. Thus, the valve would be a fluid/mechanical analog of an electrical fuse or circuit breaker. The valve would be useful, for example, in stop-

ping the loss of fluid through a leak in a cooling system.

The proposed valve would replace a commercially available valve that also performs this shutoff function but contains a different mechanism of the spring-and-poppet type. The principal disadvantage of the commercial valve is that the spring-and-poppet mechanism introduces a significant cross section into the flow path and thus introduces a significant head loss under normal flow conditions.

The proposed valve would include a round cylindrical housing (possibly made from a piece of pipe) oriented along the flow. The flapper would be machined from a half cylinder of the same



The **Low-Pressure-Drop Shutoff Valve** would contain a flapper machined from a cylindrical surface like that of the valve housing. During normal flow conditions, the flapper would present a small cross section to the flow.

inner and outer radii as that of the housing. The edge of the flapper would be defined, theoretically, by orienting the centerline of the half cylinder to intersect the centerline of the housing at 45° (see figure). One practical way to fabricate the flapper might be to orient the half cylinder at 45° with respect to a cylindrical electrical-discharge-machining (EDM) electrode, then perform EDM while moving the electrode along its cylindrical axis while holding the half cylinder fixed.

The flapper would be mounted on a pivot in the housing. Springs on the pivot would bias the flapper toward the open position, in which the flapper would be tilted, with respect to the centerline, by a small angle that could be adjusted by use of a setscrew. This adjustment, along with the stiffness of the springs, would determine the rate of flow that would trip the valve closed.

Once the valve was closed, the torque caused by the static pressure of the fluid on the flapper would overcome the spring bias, keeping the valve closed. Thus, the valve would remain closed until the upstream-to-downstream differential static pressure was somehow relieved or until the flapper was forcibly reset to the open position.

This work was done by John Thornborrow of **Johnson Space Center**. *For further information,* ***write in 35*** *on the TSP Request Card.*
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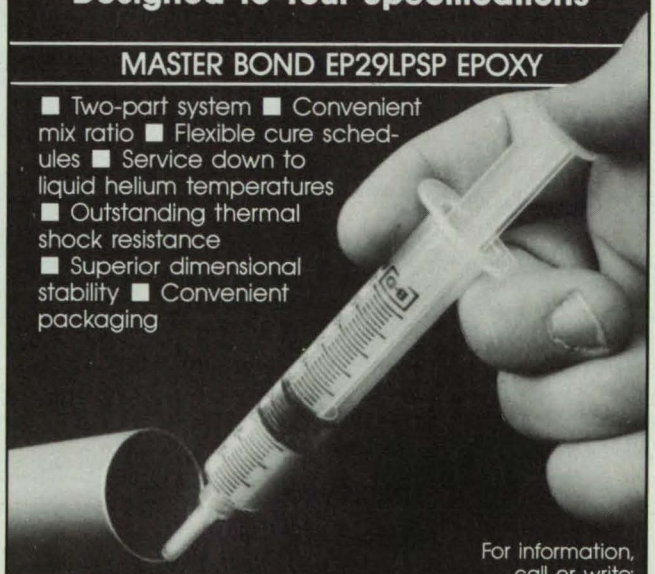

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Pulley With Active Antifriction Actuator and Control

Effective bearing friction would be minimized.

NASA's Jet Propulsion Laboratory, Pasadena, California

A proposed torque actuator and an associated control system would minimize the effective friction of a rotary bearing. In the original intended application, the rotary bearing is that of a pulley in a pulley-and-counterweight suspension in a laboratory apparatus used in experiments on structural vibrations. In this application, it is desirable to minimize the bearing friction of the pulley since it causes undesirable levels of structural damping, which, to some extent, masks the performance of the closed-loop control systems in the experiment. Torque actuators and control systems based on the same concept might also be useful in reducing bearing friction in gyroscopes, galvanometers, torquemeters, accelerometers, earth-motion detectors, and balances.

The pulley would be affixed to the shaft of a dc torque motor, which would be mounted in a housing (see Figure 1). The housing would be supported by flexural pivots in a stationary yoke. An optical encoder would measure the rotation of the pulley with respect to the housing. An external optical sensor would measure the rotation of the housing with respect to the stationary yoke.

The suspended object would be connected to the counterweight via a wire, which would pass over the pulley. The vertical motion of the suspended object would cause the pulley to turn; the resultant frictional torque of the pulley bearing would cause the housing to turn in the flexural pivots. The output of the external optical sensor — a measure of the angle of rotation of the housing — would be processed, and the processed output would be fed back to the motor to produce a compensating torque. The feedback control system would strive to minimize the rotation of the housing, thereby minimizing the effective bearing friction by applying just enough motor torque to counteract it.

Figure 2 is a block diagram that illustrates the mathematical models used to analyze the suspension, actuator, and control system. The bearing friction is modeled as the sum of a Coulomb-friction component (with a constant static value and a lower dynamic value) plus a viscous-friction component proportional to the speed of rotation of the pulley in the housing. The controller consists of a seventh-order compensator preceded by a constant-gain amplifier. The conceptual system comprising the mathematical models was subjected to Bode frequency-response analysis (which does not account for Coulomb friction), describing-function frequency-response a-

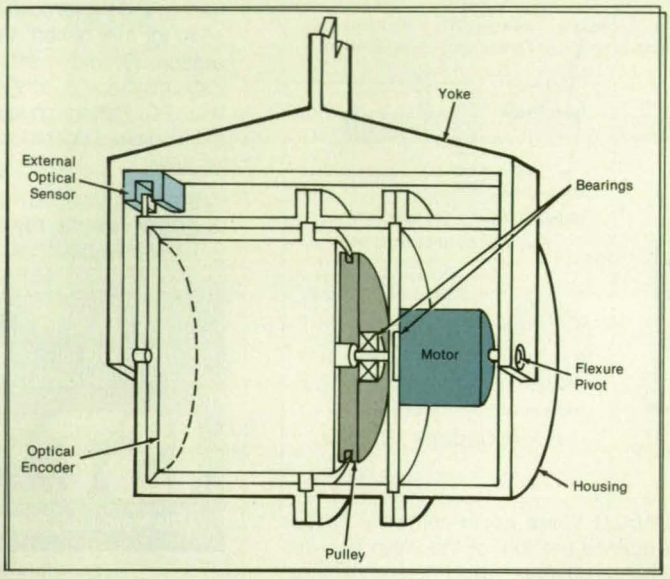

Figure 1. The **Motor Would Exert a Compensating Torque** in response to feedback from the external optical sensor. The compensating torque would nearly cancel the frictional torque of the shaft bearings.

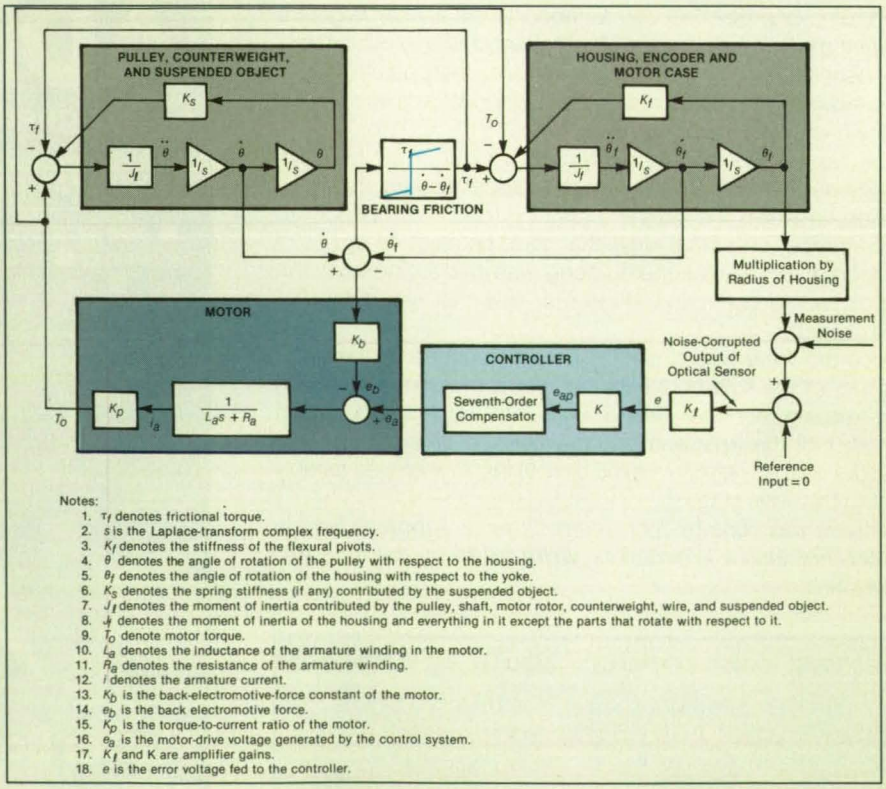

Figure 2. This **Block Diagram** shows the relationships between the subsystems and the mathematical models used to analyze them.

nalysis (which does account for Coulomb friction), and computer simulations of behavior in the time domain. The results of the analyses and simulations showed that the overall system should be stable and perform well, even in the presence of significant measurement noise, Coulomb friction, and deliberate limiting of the torque applied by the motor.

This work was done by Che-Hang C. Ih and Howard C. Vivian of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information,* ***write in 105*** *on the TSP Request Card.*
NPO-18653

Active Vibration Dampers for Rotating Machinery

Piezoelectric actuators and control circuits offer potential advantages over older, purely mechanical dampers.

Lewis Research Center, Cleveland, Ohio

Active dampers are being developed to suppress vibrations in rotating machinery like power-transmission equipment, electric motors, jet engines, and stationary turbines. These dampers are essentially feedback control systems that include motion sensors, electronic control circuits that process the outputs of the sensors into actuator-drive signals, and reciprocating piezoelectric actuators that apply vibration-counteracting forces and displacements to the machinery. A similar active damper that contained different actuators was described in "Active Suppression of Rotor Vibrations" (LEW-14488), *NASA Tech Briefs*, Vol. 11, No. 6 (June 1987), page 64. The general concept is also applicable to the suppression of vibrations in stationary structures subject to winds and earthquakes, for example.

The active damper shown schematically in the figure is one of many versions that are possible under the general concept. This damper suppresses horizontal vibrations in a rotating shaft; an identical or similar damper could be placed at 90° to this one to suppress vertical vibrations. The motion sensor could be a displacement, velocity, or acceleration transducer; in this version, it is a displacement transducer that is fixed to the machinery casing in such a position and orientation that it senses horizontal translation of the housing of a bearing in which the shaft turns. The bearing housing is mounted on cantilever beams, which serve as springs that accommodate a limited amount of vibrational displacement but do not allow the bearing housing to rotate.

The piezoelectric actuator is connected between the bearing housing and the machinery casing at a point diametrically opposite the displacement transducer. The mounting hardware includes elastomeric pads that passively damp vibrations at frequencies above the high-frequency performance limit of the active components; it is necessary to suppress these high-frequency vibrations because their feedback could cause the system to become unstable.

The output of the displacement transducer is passed through a dc-offset circuit to correct for any dc bias, and through a differentiator to obtain a velocity signal. The dc-corrected displacement signal and the velocity signal are filtered, amplified, and summed to obtain a composite actuator-control sig-

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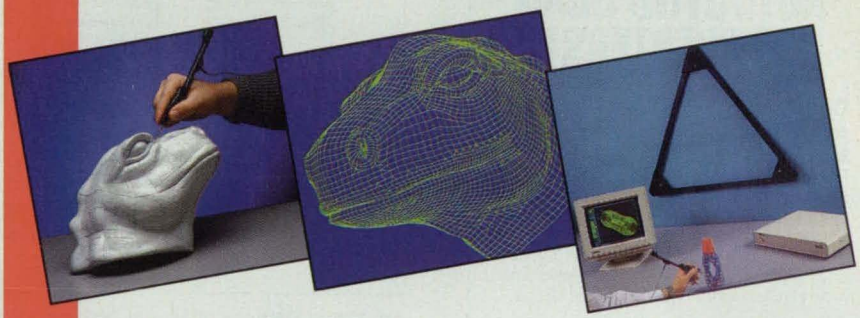

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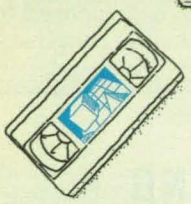

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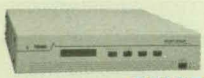

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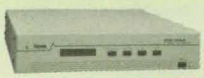

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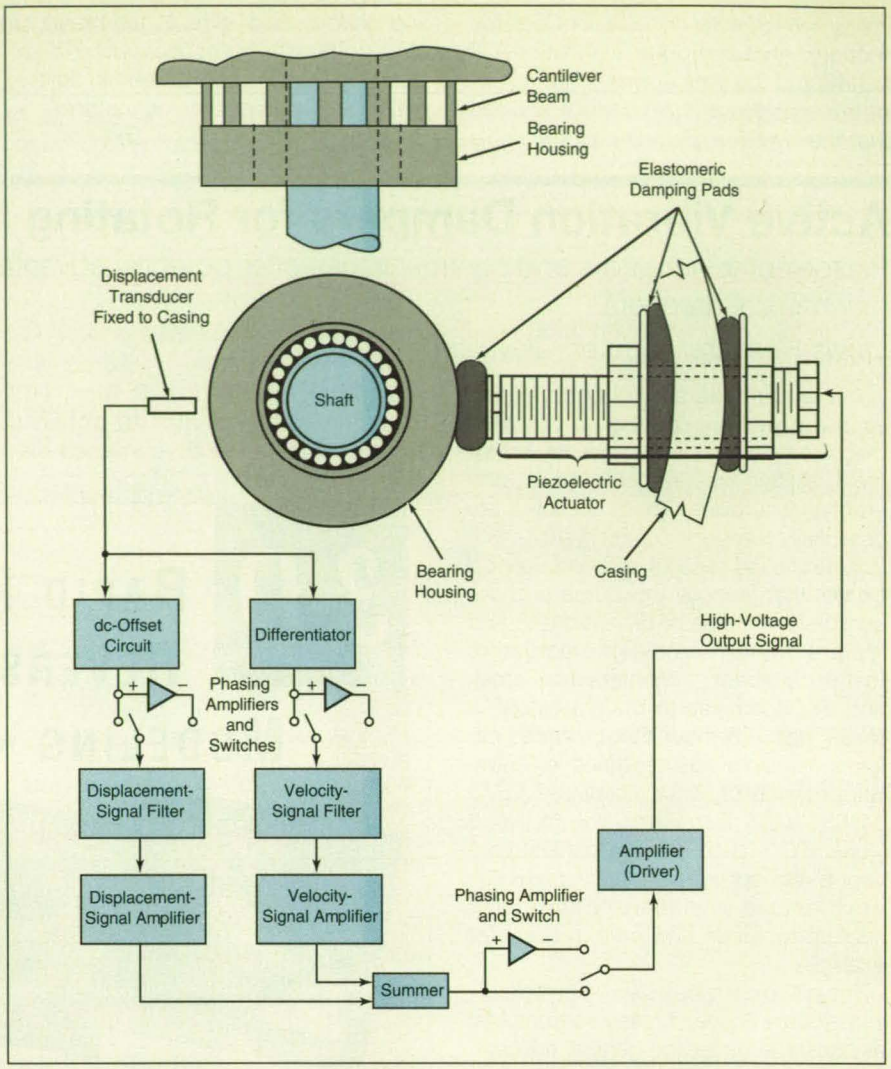


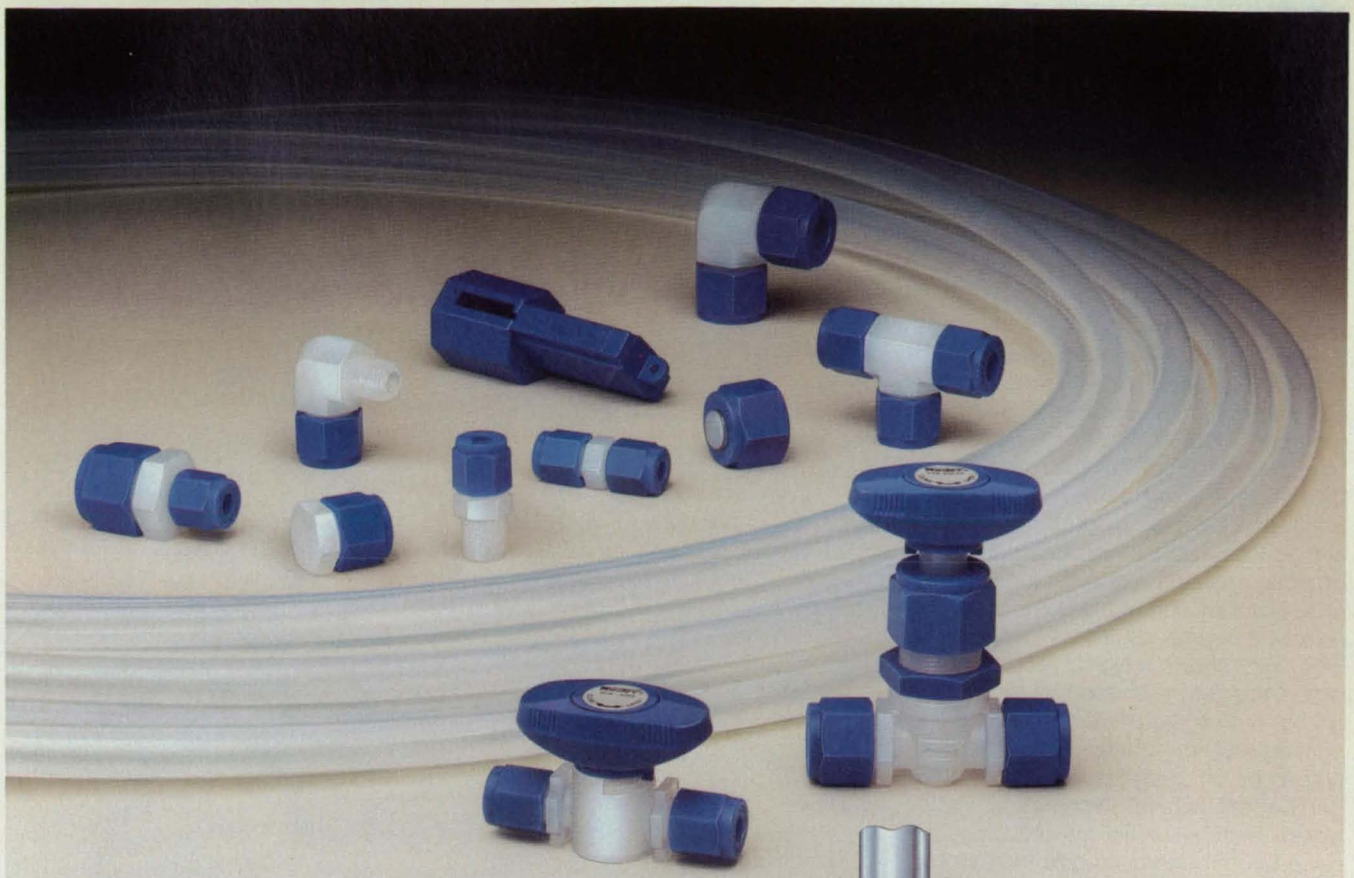
An **Active Damper** offers adjustable suppression of vibrations. In comparison with a conventional mechanical damper, it can be small and lightweight. It can also respond faster to transients.

nal. Switches and inverting amplifiers provide for proper phasing of signals. The gain or attenuation in the displacement-signal amplifier determines the amount of active stiffness produced by the feedback loop. Similarly, the gain or attenuation in the velocity-signal amplifier determines the amount of active damping produced by the feedback loop. The composite actuator-control signal is amplified in a driver circuit, which generates the high-voltage signal that is applied to the piezoelectric actuator. The stack of piezoelectric elements in the actuator expands and contracts in response to this signal, thus applying the compensatory vibrations that constitute active damping.

The developmental active piezoelectric dampers offer potential advantages over older, purely mechanical dampers based on elastomeric devices, friction, and/or fluid films (in some cases, requiring pumped-fluid lubrication systems). These advantages include smaller size and weight. Also, whereas cavitation can occur in fluid-film dampers and thereby cause the amount of damping to vary unpredictably, the active piezoelectric dampers offer more-predictable amounts of damping. Yet another advantage of the active dampers is the capability to vary active stiffnesses (without altering machinery structures) to change frequencies of vibration to avoid structural resonances. Further developmental work will be needed to overcome the limitations of the piezoelectric actuators; these limitations include short strokes, phase lags, and electromechanical instabilities.

This work was done by Albert F. Kascack, John J. Ropchock, and Tomas F. Lakatos of **Lewis Research Center**, *Gerald T. Montague of Sverdrup Technology, Inc., and Alan Palazzolo and Reng Rong Lin of Texas A&M University. For further information,* ***write in 5*** *on the TSP Request Card.*

LEW-15427



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Blind-Anchor-Nut-Installation Fixture (BANIF)

The fixture enables placement of anchor nuts in otherwise inaccessible places.

Langley Research Center, Hampton, Virginia

The blind-anchor-nut-installation fixture (BANIF)(see Figure 1) was developed specifically for the purpose of replacing or installing anchor nuts in blind holes or other inaccessible places. Attachment of an anchor nut to the BANIF enables placement of the anchor nut on the blind side of a component. Previous methods required disassembly or remanufacturing of the component to achieve the same results.

Figure 2 shows a typical procedure in which the fixture is used to install an anchor nut on the blind side of a component. First, the clearance hole for the bolt to be anchored is drilled into the component (which, in this case, is a block). Then an anchor-nut drill fixture is placed in the clearance hole with alignment pins upright, and one of two rivet holes (to be located on opposite sides of the clearance hole) is drilled.

The anchor-nut drill fixture is rotated 180° in the hole, and the second rivet hole is drilled. The anchor-nut insert on the BANIF is threaded into the anchor nut by use of the insert driver allowing the driver to clear the insert.

Then an anchor-nut ear is fed into the clearance hole, by use of the BANIF, and the entire anchor-nut assembly is passed through to the blind side of the block. The BANIF is then put in tension until the anchor nut makes contact with the blind surface of the component, with the ears of the anchor nut in alignment with the rivet holes.

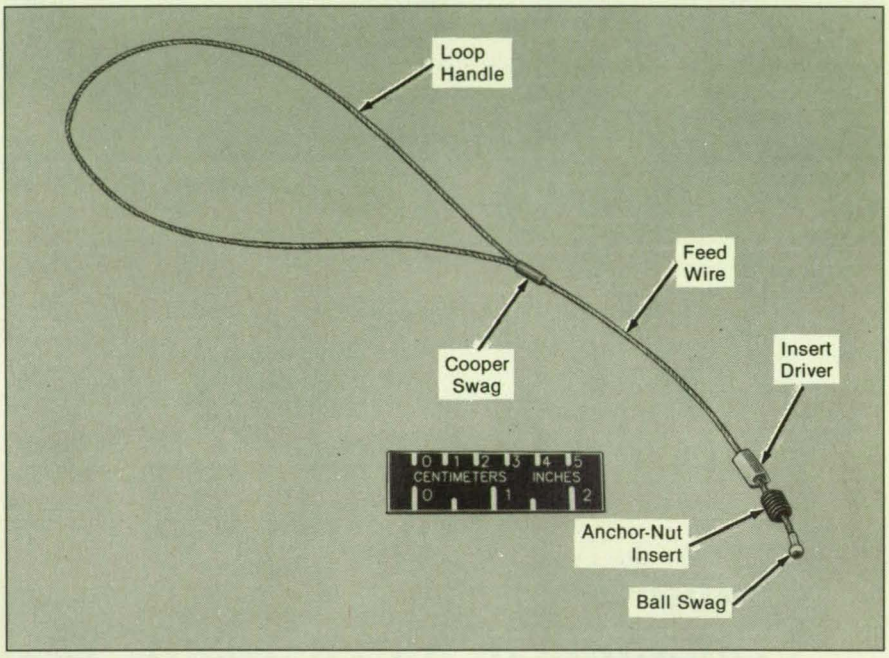

Figure 1. The **Blind-Anchor-Nut-Installation Fixture** eliminates the need to disassemble a component to install an anchor nut in a blind hole in the component.

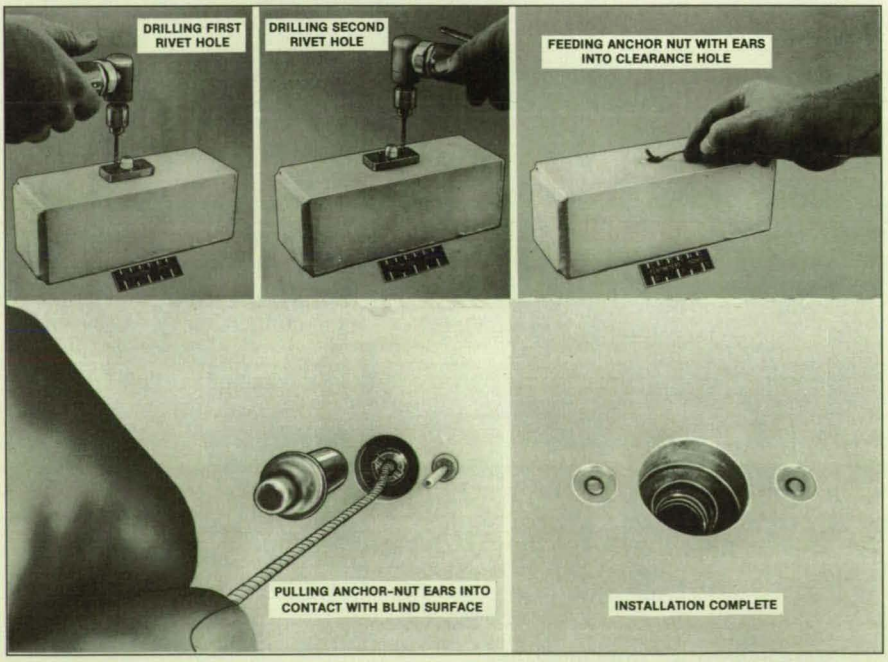

Figure 2. These are Some of the Steps of a simple installation procedure that is performed with the help of the fixture shown in Figure 1.

A Kleco® (or equivalent) clamp is installed in one rivet hole, through one of the ears of the anchor nut, to hold the anchor-nut assembly in place. A rivet is placed in the other rivet hole. The clamp is then removed and replaced with the second rivet. Then the BANIF is unscrewed and removed. When installation in complete, the anchor nut is held firmly in place on the blind side of the component with two flush rivets on the accessible side.

The BANIF was used during refurbishment of the Long-Duration-Exposure Facility (LDEF) Assembly and Transportation system (LATS) at NASA Kennedy Space Center. Is currently being used at NASA Langley Research Center when application is required in blind places.

This work was done by Norman F. Willey, Jr., and James F. Linker of **Langley Research Center**. *No further documentation is available.*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or

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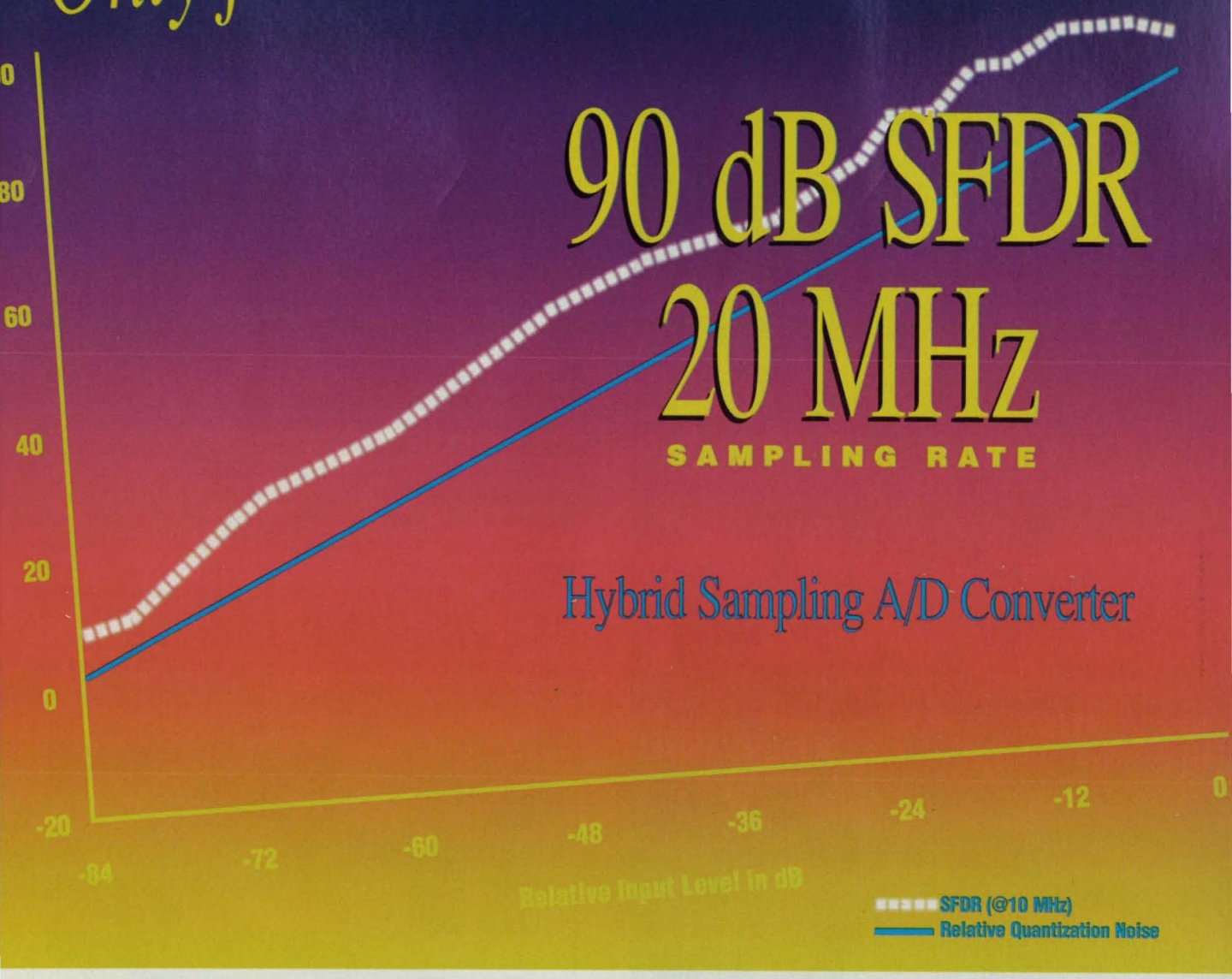

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exclusive license for its commercial development should be addressed to the Patent Counsel, Langley Research Center [see page 20]. Refer to LAR-14542.

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John F. Kennedy Space Center, Florida

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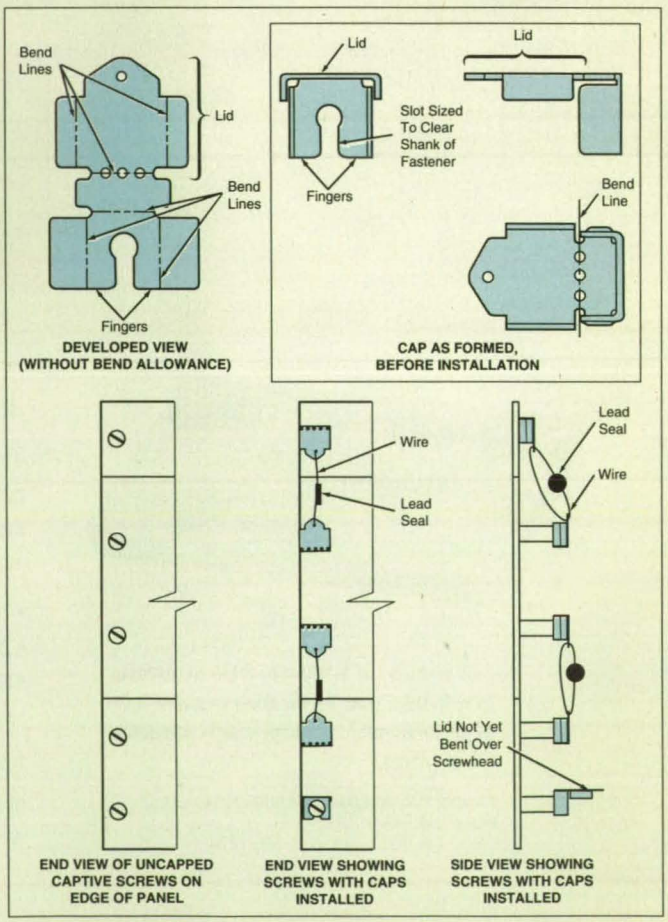

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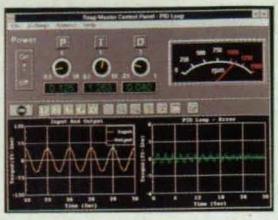

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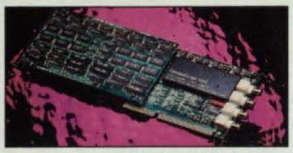

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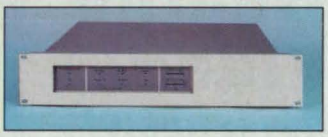

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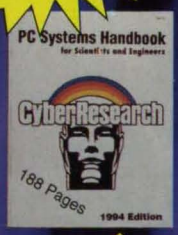

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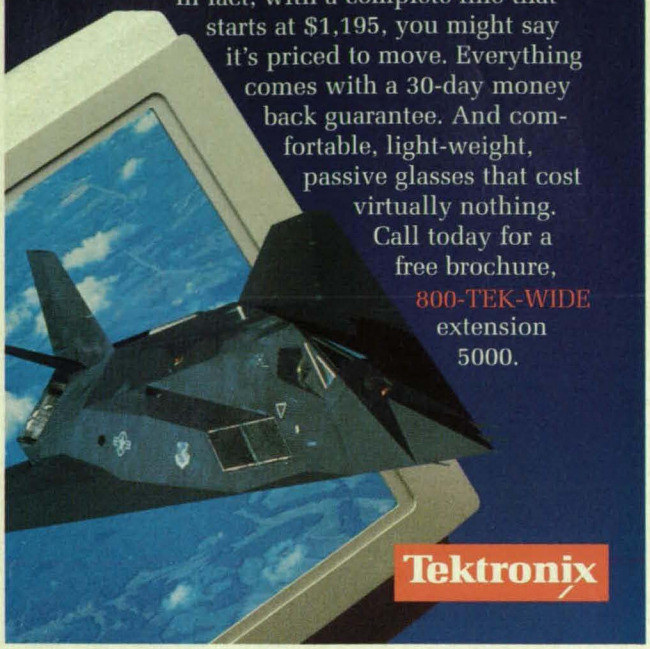

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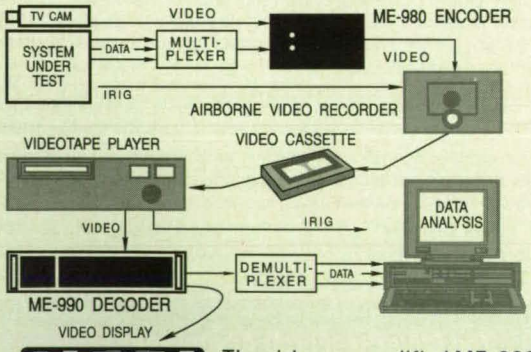

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Base station ME-990 recovers data to original format and timing for analysis. The system is particularly useful with low data rates and where visual images in sync with data are more revealing than data or video alone.

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fastener on the same panel.

This work was done by Kenneth D. Peters of Harris Space Systems Corp. for **Kennedy Space Center**. *For further information,* ***write in 95*** *on the TSP Request Card.*

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C 2457(f)], to the Harris Corp. Inquiries concerning licenses for its commercial development should be addressed to

John DeAngelis
Harris Corp.
P.O. Box 37, Mail Stop 2-1110
Melbourne, FL 32902

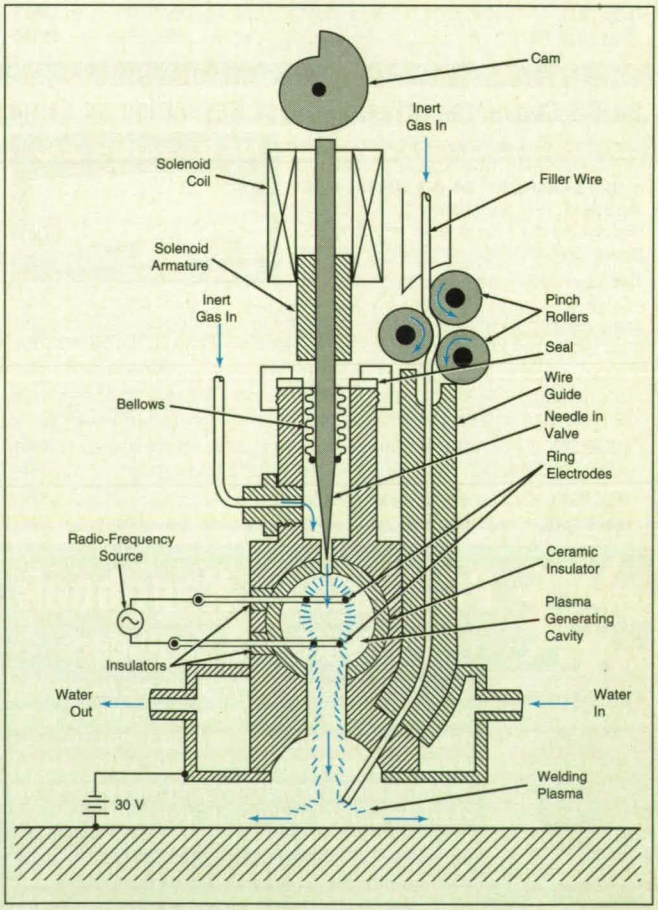
Refer to KSC-11564, volume and number of this NASA Tech Briefs *issue, and the page number.*

Apparatus for Metal/Inert-Gas Welding in Vacuum

Controlled flow of plasma would reduce dispersal in vacuum, thereby preventing extinction.

Marshall Space Flight Center, Alabama

The figure illustrates a proposed metal/ inert-gas welding-torch assembly that would operate in a vacuum. Currently available metal/inert-gas welding torches operate only momentarily (if at all) in a vacuum: the vacuum removes the atmospheric barrier to rapid dispersal of the inert gas from the region between a torch and a workpiece, causing extinction of the welding plasma.



Plasma Would Be Generated in an interior chamber and focused onto the workpiece in a vacuum. Pinch rollers would feed wire to the weld puddle.

In the proposed welding-torch assembly, the plasma would be generated in an interior chamber, where the gas could be maintained sufficiently dense. Electromagnetic and electrostatic fields would focus the plasma onto the workpiece with sufficient density to prevent extinction and with sufficient intensity to produce a weld puddle in the workpiece.

The flow of gas into the plasma-generating chamber would be turned on or off by a solenoid-actuated, bellows-sealed needle valve. A repeatable rate of flow would be established by a cam, which would limit the opening travel of the needle solenoid. Inasmuch as the cam would be located outside the vacuum, it could be used to adjust the plasma somewhat, without breaking vacuum.

Two ring electrodes in the plasma-generating chamber would be excited at one or more radio frequencies to ionize the gas, creating the plasma. The plasma would flow from the chamber along a cylindrical passage in a metal body cooled by water. The body would be maintained at an electrostatic potential of –30 V with respect to the workpiece; the combination of a domed opening at the end of the passage and a flat plate on the bottom of the body would configure the electrostatic field to help in focusing the plasma onto the desired spot on the workpiece. The plasma flowing from the bottom of the welding-torch assembly onto the workpiece would be sustained by the 30-V potential.

This work was done by C. O. Stocks of **Marshall Space Flight Center**. *For further information,* ***write in 25*** *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, Marshall Space Flight Center [see page 20]. Refer to MFS-28808.

More About Stitching for Monitoring Composite Parts

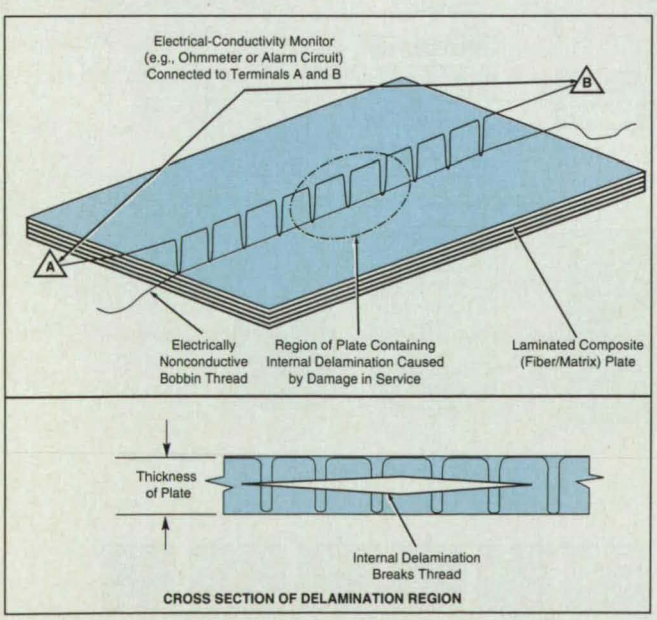
An alternative configuration is illustrated.

Lyndon B. Johnson Space Center, Houston, Texas

A slight modification has been proposed for a method of remote electrical-continuity monitoring to detect internal delaminations, cracks, and other flaws in composite materials.

The figure illustrates an application of the method to a composite plate.In this case, an electrically nonconductive bobbin thread is included.

This work was done by Howard S. Travis of Lockheed Engineering & Sciences Co. for **Johnson Space Center**. *No further documentation is available.*
MSC-22113



The **Conductive Thread Stitched on a Composite Plate** would remain continuous until a delamination, crack, or surface damage occurred, stretching or breaking the thread. The resulting increase in electrical resistance of the thread would be easily measurable.

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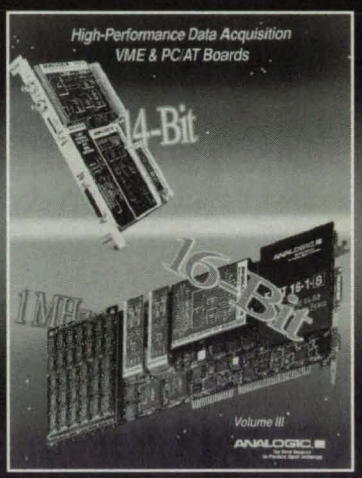

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Automated Help System for a Supercomputer

The system will supplement human experts in advising users.

Ames Research Center, Moffett Field, California

Expert-system software is being developed to provide an automated system of user-helping displays in a supercomputer system at the Ames Research Center Advanced Computer Facility. Users are located at remote computer terminals that are connected to the supercomputer (in this case, a Cray Y-MP1832) and to each other via gateway computers, local-area networks, telephone lines, and satellite links. The automated help system is intended to answer routine user inquiries about how to use the services of the computer system. It would be available 24 hours per day and would reduce the burden on human experts at the Advanced Computing Facility, thereby freeing them to concentrate on helping users with complicated problems.

The automated help system is designed especially for novice and intermediate users, on the basis of statistical analysis of users' questions during 1 year of operation of the facility. The prototype help-system computer program resides on one of the computers on the network at the facility. The program includes an expert-system software shell, called "Guru," which is a suite of integrated software that includes a natural-language interface, an expert-system shell, a manager with a multiple-index processor, and application software. Guru also accommodates the incorporation of other programs, procedures, or subroutines.

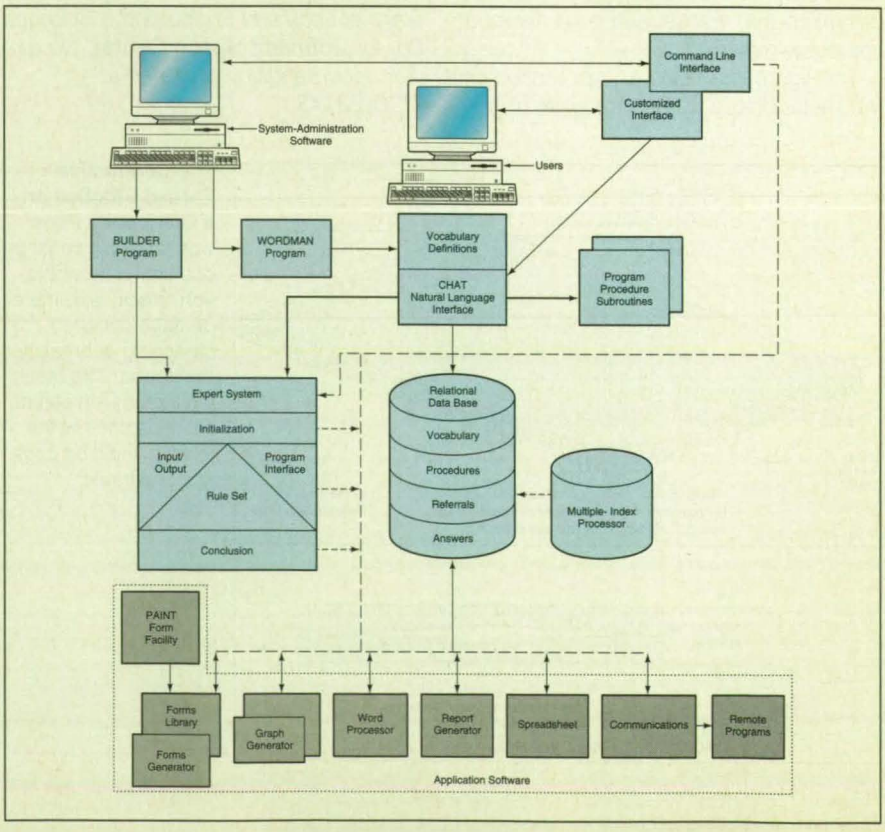
The figure is a schematic diagram of the relationship between the user and the software and the relationships among the various parts of the software. The dashed lines and arrows indicate bidirectional flows, thereby illustrating the extent of the integration of the software. For example, either a procedure or a spreadsheet entry can call the expert system. Moreover, the expert system can call a procedure, execute a spreadsheet, add to or extract from a data base, or consult another expert system.

System-administration software is used to address and upgrade the system through the terminal shown at the upper left of the figure. The system-administration software accumulates data that guide the upgrading of the system; it records each user's inquiry and identity, the answer, the source of the answer, and the response time (defined here as the time between the user's inquiry and the user's response to the options presented in response).

Users on the network communicate with the expert help system through their terminals by making inquiries in natural language. A user's query is processed through one of three possible paths, depending on its nature. For example, a question regarding a complex action (such as locating a lost job) is handled by the expert system. A special request that requires the execution of a program (for example, checking the status of the supercomputer), a procedure (how to make a job for the supercomputer), or the display of a form (how to change one's password) is routed through the path shown on the right side of the figure. A simple request for information (such as how to obtain an account) is processed by use of the relational data base, via the middle path in the figure.

This work was done by George P. Callas and Catherine H. Schulbach of **Ames Research Center** *and Michael Younkin of Control Data Corp. Further information may be found in NASA TM-102837 [N93-72466/TB], "Investigation of an Automated Cray User Services System (Cray User Services 'Expert System')."*

Copies may be purchased [prepayment required] from the NASA Center for AeroSpace Information, User Services Division, Linthicum Heights, Maryland, Telephone No. (301) 621-0394. Rush orders may be placed for an extra fee by calling the same number. ARC-13094.



The Prototype Automated Help System includes expert-system software that answers users' questions, system-administration software that measures performance and provides for upgrading, and special-purpose application software.

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For More Information Write In No. 551

Microcoupon Assay of Adhesion and Growth of Bacterial Films

In comparison with older assay techniques, this one is faster and more convenient.

Lyndon B. Johnson Space Center, Houston, Texas

A microbiological assay technique facilitates the determination of some of the characteristics of sessile bacteria like those that attach to and coat the interior walls of water-purification systems. These biofilms can cause sickness and interfere with the purification process. The assay technique enables direct measurement of the rate of attachment of bacterial cells, their metabolism, and the effects of chemicals on them. The technique can thus be used to quantify the effects of both bactericides and growth-stimulating agents.

This assay technique can be used in place of the older standard plate-count and tube-dilution techniques. Assays conducted by both of these older techniques are cumbersome, requiring repeated dilutions and many plates and tubes. They are also time-consuming, taking several days to produce results. Moreover, the results are usually not statistically valid because they involve large errors in comparisons of different experimental lots. In contrast, an assay by the present technique takes only a few hours and produces statistically valid results because it actually comprises 96 component assays performed simultaneously under identical conditions.

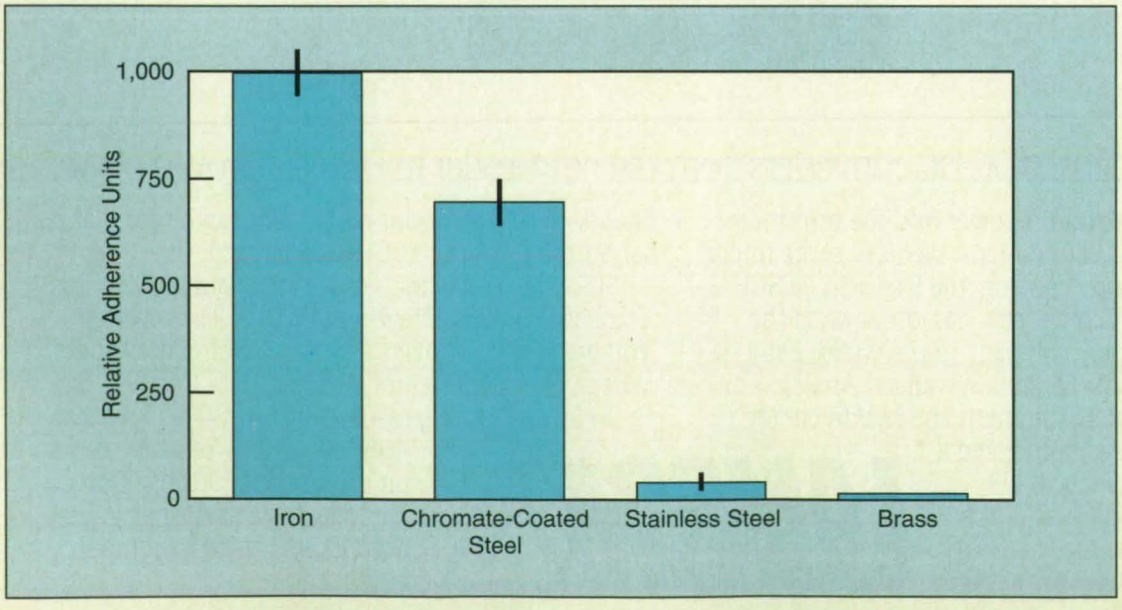
An assay by the present technique is carried out in a receptacle, called a "microplate," that contains 96 wells, each filled with an equal amount of the same bacterial suspension. The microplate is covered with a lid that holds 96 microcoupons, each of which is thereby immersed in one of the wells. Bacteria attach to the microcoupons, which can be made of various materials (see figure).

The assay procedure is as follows:

1. Each well in the microplate is filled with 250 μL of bacterial suspension.
2. The lid is placed on the microplate so that the microcoupons are immersed in the suspension.
3. The covered microplate is placed on a shaker and incubated.
4. After the requisite incubation time, the lid is removed from the microplate and rinsed with sterile water.
5. The lid is placed over another microplate in which each well contains a solution of 24 μL of Alamar Blue (a redox indicator), 10 μL phenazine methosulfate at a concentration of 0.01 mg/mL, 62.5 μL of bacterial nutrient solution, and 152.5 μL of sterile distilled water. Optionally, 3-(4,5-dimethyl-thiazol-2-yl)-2,5-diphenyl-tetrazolium bromide (MTT) can be substituted for Alamar Blue.
6. The lid and its microcoupons are incubated in the new microplate. During an appropriate growth time (typically, 1 to 6 hours), the microplate is scanned by a computer-controlled fluorescence spectrophotometer to measure the reduction of the Alamar Blue. If the MTT is used instead of Alamar Blue, then the microplate can be scanned with a dual-wavelength spectrophotometer to measure the metabolism of the cells.

The effect of a disinfectant or other chemical can be determined by incorporating a contact/neutralization step before incubation and measurement. In the contact/neutralization step, the lid with microcoupons attached is immersed in a solution of the chosen chemical, then in a neutralizing solution, just before step 3.

This work was done by Duane L. Pierson of **Johnson Space Center** *and David W. Koenig of Krug Life Sciences. For further information,* ***write in 176*** *on the TSP Request Card.*
MSC-22365



The **Growth of a Film** of bacteria is influenced by the coupon material. This plot compares the adherence of *Pseudomonas cepacia* bacteria on various metals.

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Books & Reports

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Mechanics

Shear-Joint Capability Versus Bolt Clearance

A NASA Technical Memorandum presents a theoretical study of the relationships between (1) the load-bearing capabilities of shear joints that comprise plates clamped together by multiple bolts and (2) the clearances between the bolts and the boltholes in those joints. In the best case, all n bolts in a joint fit snugly in their holes, and each bolt bears an equal share of the shear load, so that the strength of the joint is n times that of the shear strength of one bolt. In the worst case, only one bolt carries the entire shear load, and the strength of the joint is limited accordingly. In the standard conservative design analysis, one assumes the worst case. The subject of the study is a more realistic intermediate case in which only one bolt (the key bolt) is initially at the limit of its clearance (and thus can carry a shear load) while the remaining $n-1$ bolts are initially centered at full design clearance. As the shear load increases, the shear load on the key bolt deforms its hole, and eventually the other bolts reach the limits of their clearances and begin to bear shares of the load. The study addresses these phenomena via a Hertzian stress analysis.

This work was done by H. M. Lee of **Marshall Space Flight Center**. *Further information may be found in NASA TM-108378 [N93-12419/TB], "Shear Joint Capability Versus Bolt Clearance."*

Copies may be purchased [prepayment required] from the NASA Center for AeroSpace Information, Linthicum Heights, Maryland, Telephone No. (301) 621-0394. Rush orders may be placed for an extra fee by calling the same number. MFS-27313

Analysis of Bolt Loads in Simple Joints

A NASA technical memorandum presents a theoretical analysis of tensile loads on preloaded and nonpreloaded bolts in simple symmetric and asymmetric joints. As in prior *NASA Tech Briefs* articles on this topic, the analysis involves schematic and mathematical models of the joints, wherein the elasticities of the bolts and the bolted hardware and the couplings between them are summarized by representing them as simple springs connected variously in series and parallel. The utility of this analysis lies in the demonstration of how the tensile and compressive loads under various combinations of externally applied tensile load and bolt preload are distributed in a bolt and the abutting bolted flanges of a joint.

This work was done by H. M. Lee of **Marshall Space Flight Center**. *Further information may be found in NASA TM-108377 [N93-12412/TB], "The Mechanism of Bolt Loading."*

Copies may be purchased [prepayment required] from the NASA Center for AeroSpace Information, Linthicum Heights, Maryland, Telephone No. (301) 621-0394. Rush orders may be placed for an extra fee by calling the same number. MFS-27314

Hidden Impact Damage in Composite Structural Members

A report describes experiments in which ultrasonic inspection revealed hidden impact damage in graphite/epoxy composite struts 1 in. (2.54 cm) in diameter. The struts were subject to impacts by dropped weights at kinetic energies of 3.0 in.-lb (0.34 J), 4.83 in.-lb (0.55 J), and 6.74 in.-lb (0.76 J). The impacts at 3.0 in.-lb caused no visible surface damage, while those at 4.83 in.-lb caused very little or no visible surface damage, depending on the specimen. Nevertheless, in ultrasonic C-scan images, roughly elliptical regions of internal damage were clearly evident under the surfaces at the impact sites. When the struts were subjected to compressive stress, all failed by local buckling at the impact sites. The reduction in compressive strength was typically 60 to 65 percent for struts on which the damage was barely visible.

This work was done by Gun-Shing Chen, George M. Bidinger, Suyon Cho, and Michael C. Lou of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Impact Damage in Small Diameter Graphite/Epoxy Composite Struts," **write in 4** on the TSP Request Card.*
NPO-18797

Analysis of Vibrations of a Reed

A report presents a theoretical study of vibrations of plug caps that are placed over the outer ends of some hollow turbine blades to prevent circulation through the hollow cores of the blades. Because each plug cap is held from one side of the hole at the end of the blade, it can act as a cantilever spring, and it can interact with the flow in a manner similar to that of a clarinet reed: that is, the flow around the plug cap can become unstable, causing the plug cap to vibrate. In the report, the issue of stability and instability is addressed by a theoretical analysis of the interactions among (1) the spring-and-mass dynamics of the plug cap, (2) the modulation of flow caused by variation of the gap between the cap and its seat, and (3) the acoustic impedance of the hollow cone of the blade (which is, in effect, an acoustic resonator).

This work was done by Yi M. Chang and James R. Fenwick of Rockwell International Corp. for **Marshall Space Flight Center**. *To obtain a copy of the report, "Reed Stability," **write in 101** on the TSP Request Card.*
MFS-29954

Physical Sciences

Segmentation of Polarimetric SAR Data

A report presents one in a continuing series of studies of the segmentation of polarimetric synthetic-aperture-radar (SAR) image data into regions. These studies are directed toward refinement of a method of automated analysis of SAR data, based on the concept that regions within which SAR backscattering characteristics are homogeneous or at least sufficiently similar, can be identified with a particular kind of terrain (e.g., farmland, forest, urban area, mountains, or sea ice).

This work was done by Eric J. M. Rignot of Caltech and Rama Chellappa of USC for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Segmentation of Polarimetric Synthetic Aperture Radar Data," **write in 136** on the TSP Request Card.*
NPO-18728

Multiple Pages Intentionally Left Blank

(continued from page 18)

MicroPatent 749
East Haven, CT
MicroPatent, a supplier of US and European patent information, is offering free trial subscriptions to monthly patent bulletins in biotechnology, pharmaceuticals, and medical devices from 50 countries.

Molecu Wire Corp. 749
Farmingdale, NJ
A catalog will describe Molecu's unique capabilities to produce precision fine wire and ribbon products including in-house enamelling and gold plating.

National Coalition for Advanced Manufacturing 749
Washington, DC,
is an industry-led coalition advocating industrial modernization. Currently, members include 300 manufacturing companies, 250 industrial trade and technical education associations, and 25 manufacturing extension.

New Technology Week 749
Washington, DC
provides coverage of advanced and energies technologies reporting on business opportunities and strategies, federal policy, technology transfer, and competitiveness issues.

Optigain Inc. 749
Peace Dale, RI
Literature will describe rare-earth doped fiber amplifiers for 1550 nm, 1300 nm, and 800 nm bands and other custom-built active fiber devices including lasers and filters. Computer models for fiber amplifiers, lasers, and single-mode fibers also will be highlighted.

Panasonic Broadcast & Television Systems 749
Rockville, MD,
manufactures a full line of professional/industrial video recorders, monitors, cameras, and production equipment.

Precision Metalsmiths Inc. 749
Cleveland, OH,
offers ferrous and nonferrous investment castings at total lower cost to OEM manufacturers who use precise metal parts under 10 lbs. PMI also does preproduction prototyping.

Presay Corp. 749
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Literature will describe rubber seals and gaskets including inflatable seals for use in environmental chambers, electronic processing and test equipment, and aerospace and defense applications.

Research Support Instruments 749
Hunt Valley, MD,
manufactures precision instrumentation for space flight and other demanding environments. Specializations include remote sensing instrumentation, systems engineering, and special applications.

Rotor Bearing Technology & Software Inc. 749
Conshohocken, PA
This brochure focuses on Advance Rotating Machinery Dynamics, the most advanced and complete software package for rotor dynamics, torsional vibration, fluid-film bearings, rolling element bearing, and lubricant analysis.

Scientific Measurement Systems Inc. 749
Grand Junction, CO,
manufactures the Jarrel-Ash line of gratings, monochromators, and spectrographs. The company's engineers can provide customized instruments to meet customer needs.

Seal Master Corp. 749
Kent, OH
The company's brochure shows inflatable seal construction, configurations, retaining systems, and air connections. Inflatable seals are used where a positive seal is needed between two opposing surfaces.

SEMicro Division of M.E. Taylor Engr. Inc. 749
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Literature will detail the PATTI line of coatings and adhesion testing instruments. Also available are unbiased true tensile tests as per ASTM D4541, as well as test, paint, adhesive, inks, paper, and more.

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SIR Sanford Fleming College 749
Peterborough, Ontario
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Synthetic Technologies Inc., 749
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provides connections to research professionals in key technology areas with its profile directories and databases. These provide detailed information on research efforts, resources, and technology developments throughout industry, government, and academia.

Texnology Inc. 749
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Sarnoff is also commercializing some of its own technologies through new spin-out companies. SENSAR, the first spin-out, was introduced in 1992 to commercialize computer vision hardware and software, and now has three products on the market. A second company, to be announced later this year, will target the video server and video production markets.

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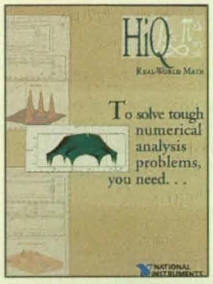
For more information, please contact Cynthia S. Gray, Manager, Media Relations, David Sarnoff Research Center, CN 5300, Princeton, NJ 08543-5300. Tel: 609-734-3038; Fax: 609-734-2870.

LITERATURE SPOTLIGHT

Free catalogs a literature for NASA Tech Briefs readers. To order, write in the corresponding number on the Reader information Request Form (page 107).



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API's 132 page motor systems catalog is a complete source for motion control technical, application, and product data. Definitions, market applications, comparison charts, specifications and diagrams simplify the selection/application process. API products range from full/half step driver modules to high performance microstep systems. Contact American Precision Industries, Controls Division. Tel: 716-631-9800; Fax 716-631-0152.

American Precision Industries

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DCC Corporation

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Envoy Data Corporation

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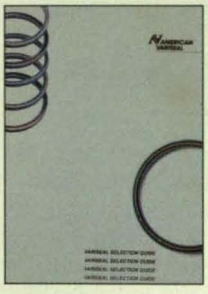

NEW SEAL SELECTION GUIDE

American Variseal announces their new Seal Selection Guide for high performance spring-energized seals. This unique eight-page color manual describes Variseal's wide range of products for static, reciprocating and rotary service. Engineering charts include seal performance ratings at various pressures, temperatures and speeds. Also included are data on seal materials, gland design, surface finish, standard sizes, custom designs, and technical support. Call 1-800-466-1727.

American Variseal

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Lucas Control Systems Products
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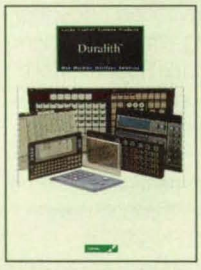

BROCHURE FEATURES DURALITH PRODUCTS

A new capabilities brochure from Lucas Control Systems Products focuses on the application solutions provided by Duralith™ Man-Machine Interface products. The brochure includes sections on custom membrane switch panels, molded rubber actuators and arrays, resistive touch screen panel assemblies, and specialty products. Tel: 804-766-4250; Fax: 804-766-4258.

Lucas Control Systems Products
Duralith™ Man-Machine Interfaces

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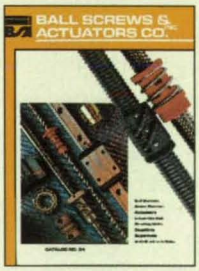

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Ball Screws & Actuators Co.
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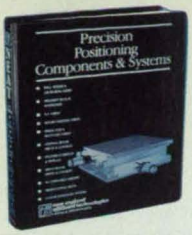

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155 page catalog covers NEAT's expanding line of Precision Positioning Components and Systems. Featured are single-axis, X-Y, multi-axis, rotary, high vacuum, and air bearing stages. NEAT provides complementary stepping and servo motor drives and controls, as well as turnkey solutions to automation, inspection, and production requirements. Stage travels range from 2-30+ in. with a repeatability of 1 μm, speeds to 80"/sec. and resolutions to 5 nm.

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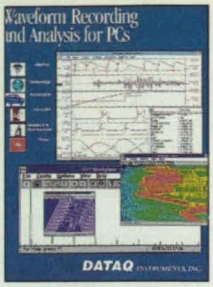

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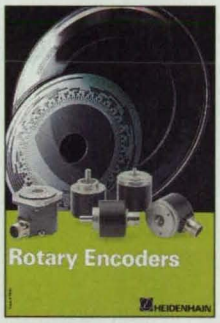

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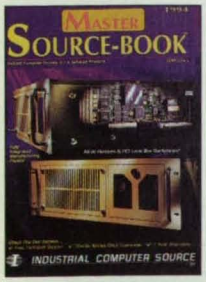

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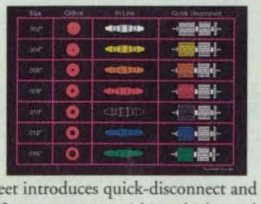

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AME Corporation

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Anorad Corporation

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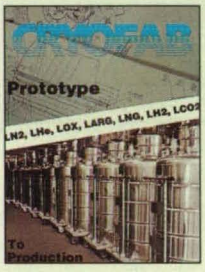

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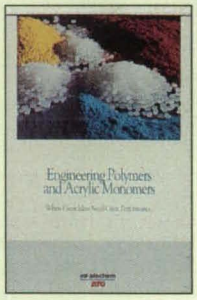

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Empire Magnetics Inc.

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The MacNeal-Schwendler Corporation

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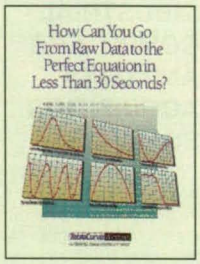

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Reid Tool Supply Company

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ULTRASONIC TESTING EQUIPMENT

The T-Mike E, everything you could want in an ultrasonic thickness gauge, incorporating ten years of customer suggestions into one very compact, easy-to-use unit. Designed to fit comfortably in your hand, the T-Mike E is built to last with an environmentally sealed, water resistant case and keypad. Unit size is 2.5 in. wide, 4.5 in. long, 1.25 in. deep and weighs only 11 oz. Tel: 408-438-6300; Fax: 408-436-7917.

StressTel Corporation

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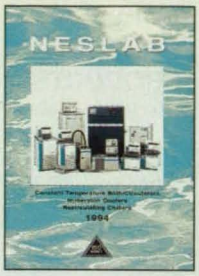

RECIRCULATING CHILLERS

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, 4) and easy access to internal components. Also available is CFC-free Constant Temperature Equipment. Call toll-free at 1-800-258-0830.

NESLAB Instruments, Inc.

For More Information Write In No. 336

TOOLS, TOOL KITS, CASES & TEST EQUIPMENT

Installation/repair tools, tool kits, test equipment, telecom equipment, LAN testers & instrument/shipping cases are detailed in this 300+ page full-color catalog. Includes products for field service & depot repair. Indexed catalog features over 100 standard tool kits & complete information on "customizing" to meet specific customer requirements. Complete specs & prices are provided for all products. Tel: 800-866-5353; Fax: 800-234-8286.

Specialized Products Co.

For More Information Write In No. 337

REAL-TIME NETWORK

The SCRAMNet™ Network combines the real-time speed of replicated shared memory with the flexibility of a fiber optic LAN to get microsecond response from multi-vendor computers. It offers distinct advantages in critical simulations. Brochure highlights system's features.

Systran Corp.

For More Information Write In No. 338

The 1994 REMCOR® Catalog describes the new line of water Chillers and Recirculators. The easy to read tables and graphs make applications and Chiller identification simple and convenient. Send for the complete Chiller Catalog today. Remcor Products Company, 500 Regency Drive, Glendale Heights, IL 60139. Tel: 708-980-6900; Fax: 708-980-8511.

Remcor Products Company

For More Information Write In No. 339

SPRING DESIGN

Mid-West Spring's new **Guide to Spring Design** helps engineers/designers plan, design and specify springs. Brochure includes design formulae, materials property and Wahl curvature stress correction data. Compression, torsion and extension springs are discussed, along with materials data on high carbon spring steel, steel alloys, stainless steel, non-ferrous, and high temperature alloy wire and flat high-carbon spring steels. For more information contact Mid-West Spring Manufacturing Company, 8 Greenwood Ave., Romeoville, IL 60441. Tel: 815-838-7812; Fax: 815-886-1510.

For More Information Write In No. 340

HUNTER MINI-PLATING PENS

Low-cost disposable applicators permit instantaneous selection from a variety of plating possibilities without preparation of solutions. Specially formulated plating compounds can be used anywhere: prototype development work, electronic instrument repair, contact repair, etc. Pens available: copper, tin, zinc, nickel, black nickel, silver, chrome-color, rhodium, palladium and gold (24, 18, and 14K). Tel: 908-526-8440; Fax: 908-526-8348.

Hunter Products, Inc.

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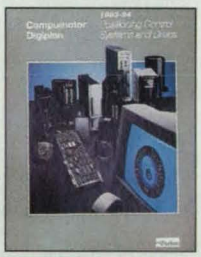

NEW COMPUMOTOR CATALOG! POSITIONING CONTROL SYSTEMS & DRIVES

Compumotor's complete 360 page engineer's guide with specifications, dimensions and performance data presents brushless servos, microstepping motor systems, indexers, linear motors and absolute encoders. Tel: 800-358-9070; Fax: 707-584-8015.

Parker Hannifin Corporation, Computer Motor Division

For More Information Write In No. 342

SEALING ASSEMBLIES

Conax Buffalo offers a 28-page catalog on Conax Buffalo Pressure and Vacuum Sealing Assemblies with comprehensive information on soft sealed technology for wires and probes. Complete technical data and ratings for each product type, from standard sealing glands to complete assemblies, are included, as well as information on custom engineering and applications. Catalog includes a postpaid reply card for technical assistance.

Conax Buffalo

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Ironwood Electronics

Tel: 612-431-7025

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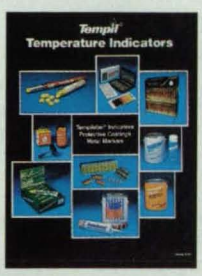

TEMPERATURE INDICATORS AND MONITORS

This most extensive line of temperature indicating products includes sticks, label monitors, indicating liquids and pellets for pre-heat/post-heat welding. The 8-page catalog discusses hand test kits, metal markers and protective coatings. Applications cover welding, metal-working, electronics, nuclear and machinery. Tempil Division, Tel: 908-757-8300; Fax: 908-757-9273.

Air Liquide America Corp.

For More Information Write In No. 345

NOISE CONTROL PRODUCTS

New full-line color brochure describes world-leading SONEX and SONEX 1 acoustical treatments. Anechoic shapes provide 400% greater surface area, absorbing sound and eliminating excess noise better than other materials. The brochure highlights new products added to the SONEX line, basic applications, forms, and specifications of SONEX products for effective noise control and acoustic improvement. Tel: 800-662-0032 or 612-520-3620.

illbruck, inc.

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Jun-Air USA Inc.

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Increase throughput and quality levels for both color and B&W film imagery with gordon's free-standing, digitizing work console. Gordon's exclusive PLANNAR light source features: 3200 K quartz halogen lighting, ±5% flatness of field (no hot spots) and a dc power supply.

gordon instruments

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GEARHEADS GALORE

22-page catalog has complete technical information on full line of precision gearheads for servo and stepper motors. Low backlash, high torque planetary and right-angle designs are available in rations from 3:1 to 100:1, with torques up to 15,000 in-lbs. The catalog features drawings, cutaway views, and application notes. Mounting kits are available for any motor.

Bayside Controls Inc.

Tel: 516-484-5353; Fax: 516-484-5496.

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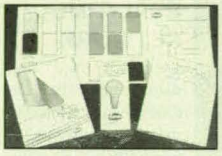

FREE FOAM SAMPLE MATERIALS

Included are separate specification sheets, as well as a standard-grade property comparison chart listing sizes, densities, strengths, and other properties for the usage and selection of foams. Sample pieces feature: Volara—irradiation crosslinked polyolefin: Volara S-types—second-generation cross-linked foams, Volextra—a composite that has been enhanced, and Minacel. 100 Shepard St., Lawrence, MA 01843. Tel: 508-685-2557. Fax: 508-685-9861.

Voltek, Div. of Sekisui America Co.

For More Information Write In No. 350

FREE ENCLOSURES CATALOG

More EMI/RFI shielded cabinets are offered. Shielding effectiveness test data have been revised. Earthquake reinforced enclosures have been added. New dual dimensioned technical drawings in this 300+ page catalog on modular cabinets, sloped front consoles, electronic desks, computer furniture and instrument cabinets. Selections for express shipping in five days. Catalog #500-5 is available in the print version or as an IBM-compatible software program.

Equipto Electronics Corporation

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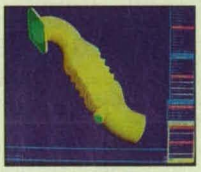

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Abaris Training Resources, Inc.

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Find out why Algor is the choice of more than 10,000 engineers in 50 states and over 60 countries. Product Guide Part 1 has details on Algor's latest design and modeling products, including exclusive Merlin mesh enhancement technology and Hexagen fully-automatic, 8-node solid "brick" mesh generator. Part 2 offers a complete technical overview of Algor's analysis capabilities.

Algor

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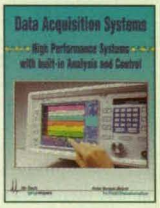

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The HT600 combines internal math algorithms with high speed, high resolution digitizing of analog signals. A built-in VGA color graphics interface with touch panel, mouse or keyboard entry increases ease of use. It boasts sampling rates from 1 sample/sec. to 200 Megasamples/sec. with memory sizes 2k to 32 Meg and digitizers from 8 bits to 16 bits. From $15,500, depending on digitizers & memory length. Delivery: 30-45 days ARO. Contact: Garry Williams, 1-800-248-1633.

Hi-Techniques, Inc.

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OXYGEN ANALYZERS

A full-color brochure introduces a complete line of oxygen analyzers for the laboratory or process line. They are ideally suited for monitoring the oxygen levels in all types of gas streams. Trace oxygen levels from ppb to 100% are accurately determined by these ruggedly constructed instruments. No periodic maintenance or special operator skills are required. Intrinsically-safe and battery-operated models are also available.

Illinois Instruments Inc.

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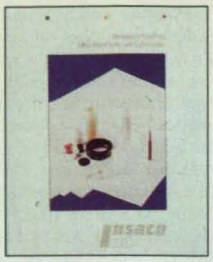

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Insaco's brochure describes the custom manufacture of components in sapphire, ruby, quartz, ceramics of all types including glass-ceramics, alumina, zirconia, carbides, and nitrides. The company routinely fabricates these materials for applications in optics, chemistry, vacuum, bearings, electronics, nuclear, space and medicine. Tolerances are measured in millionths of an inch with surface finishes in angstroms and flatness to fractions of a wavelength. Tel: 800-959-0264; Fax: 800-959-0267.

Insaco, Inc.

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PC-CAM ACCURATELY READS CAD FILES

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Stanford Research Systems

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NEW MOTION CONTROL PRODUCT GUIDE

Aerotech's new 248-page Motion Control Product Guide provides in-depth technical data and design information for our linear and rotary positioning stages; microstepping motors and translators, servo motors and drivers (both DC and brushless); position transducers; and motion controllers (from one to 16 axes). Aerotech, Inc. 101 Zeta Drive, Pittsburgh, PA 15328. Tel: 412-963-7470; Fax: 412-963-7459.

Aerotech

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FREE LAMP CATALOG

This catalog features replacement lamps at discount prices for all types of audio visual, photographic, micrographic and graphic arts equipment. 100% guaranteed brand names - toll free ordering - no minimum order - ALL deliveries via UPS Second-Day Air at no extra cost. Also, lamps for medical and electronic instruments, microscopes and video use. Tel: 800-772-5267, Fax: 1-800-257-0760. PSC Lamps, Inc. 435 W. Commercial St., E. Rochester, NY 14445.

PSC Lamps, Inc.

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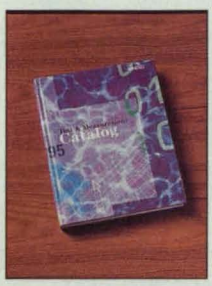

FREE 1995 HP TEST & MEASUREMENT CATALOG

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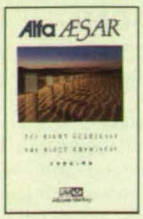

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The Cappatery is a high-reliability double layer capacitor used as a standby power source in memory back-up and bridge-power applications. It has virtually unlimited cycle life and over 20x the capacitance density of conventional capacitors. With a Perm-selective valve, patented by Evans, 33 Eastern Ave., East Providence, RI 02914-2107, Tel: 401-434-5600; Fax: 401-434-6908.

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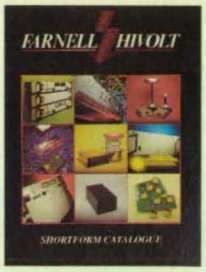

HIGH VOLTAGE CATALOG

New 16-pg. catalog features Farnell Hivolt's standard product range of high voltage power supplies and test equipment. These units address such diverse applications as ion implantation, x-ray equipment, CRT displays and analytical instrumentation. Tel: 216-349-0755; Fax: 216-349-0142. Farnell Advance Power, 32111 Aurora Rd., Solon, OH 44139.

Farnell Advance Power

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NEW BAL SEAL DESIGN MANUAL

The 36-page design manual includes design information and a selection guide for the principal Bal Seal spring-loaded PTFE seal designs for reciprocating, rotating and static application applications. Typical sizes, seal material, spring forces, groove designs, and installation methods for seals ranging in 0.015 to 75 inch diameter and 0.015 to 0.500 inch cross sections. Tel: 800-366-1006 or 714-557-5192; Fax: 714-241-0185.

Bal Seal Engineering Company, Inc.

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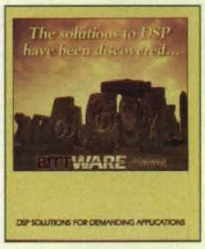

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Knowledge Express Data Systems, L.C.

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For More Information Write In No. 375

Metrum's new 60-page product catalog highlights features and specifications of its entire family of instrumentation recording products, including reel-to-reel analog recorders, laboratory recorders, and portable digital cassette-based tape recorders. The catalog also contains Metrum's peripheral and imaging products, plus highlights of the company's 35-year instrumentation history.

METRUM

For More Information Write In No. 376

TECLAB ESD WORKSTATION CATALOG

Kalamazoo Technical Furniture's 8-page 4/color brochure details the Teclab line of static protective workbenches, workstation systems, and ESD controlled workstation accessories. Included are color options, product specifications, and various levels of ESD protection available. Teclab also offers a Free Planning and Design Service. Teclab, the "professional's bench." Tel: 1-800-832-5227. Fax: 616-372-6116.

Kalamazoo Technical Furniture

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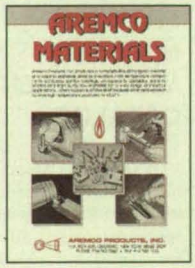

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Aremco Products, Inc.

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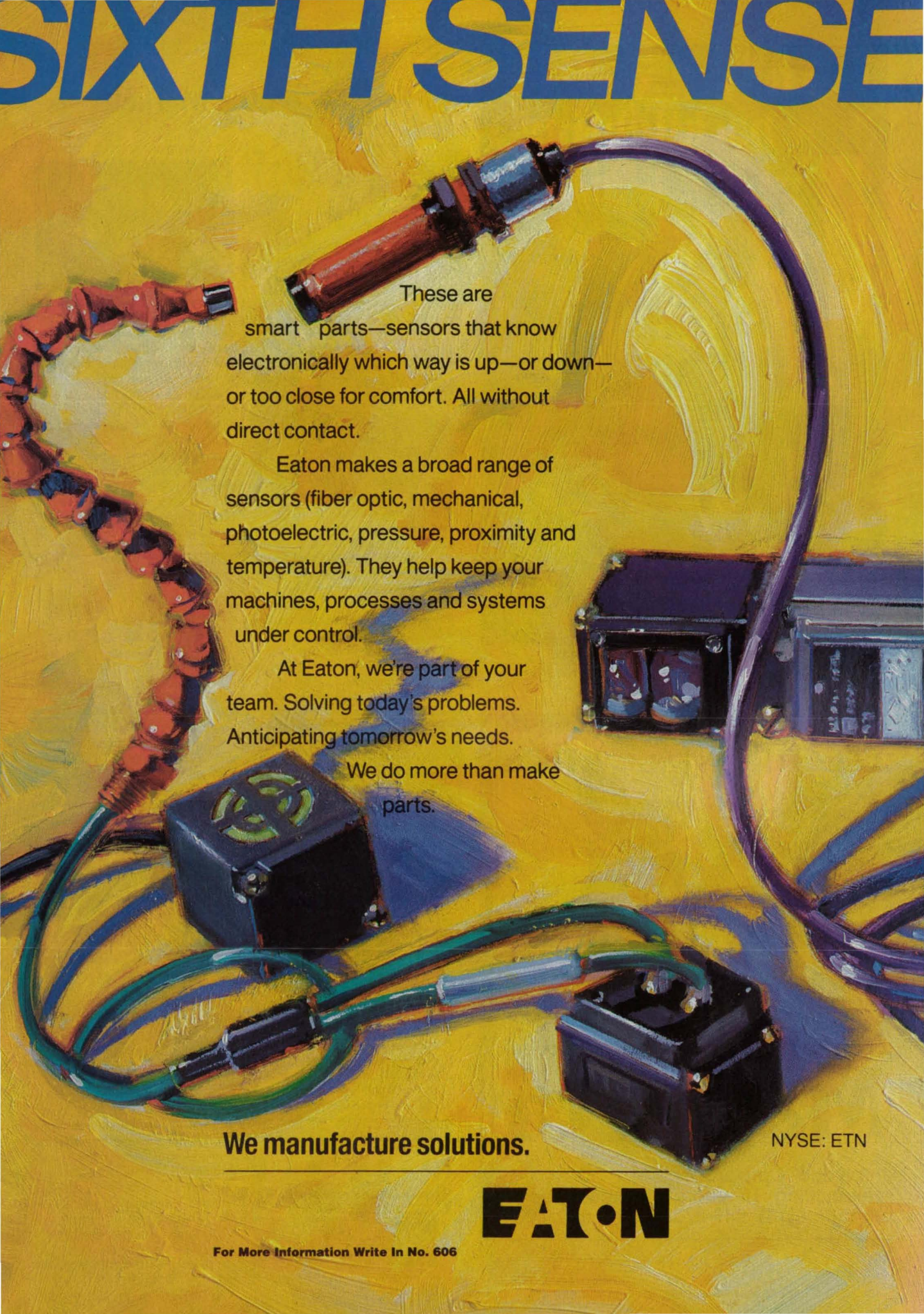

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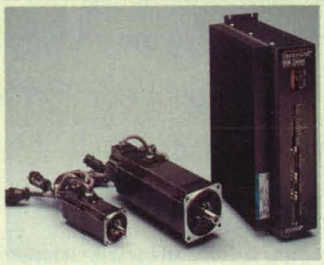
New on the Market

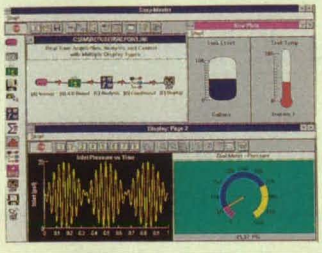
Advanced Computing Labs, West Chester, OH, has released Neural++, a collection of **neural networks** packaged as an easy-to-use C++ library. Neural++ permits the user to explore the adaptive capabilities of neural networks including BP, CPN, Kohonen, and Outstar. Scaling and Z-score data preprocessing are transparently automated.
For More Information Write In No. 706

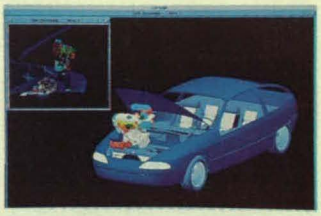


The ElectroCraft® LD-Series **brushless motors** from Reliance Motion Control, Minneapolis, MN, are designed to provide lower-cost solutions to light industrial automation applications. An improved magnetic circuit design dramatically increases the servo motors' torque density while the motors' small size and high torque combine with flying lead construction to permit easy integration into tight locations.
For More Information Write In No. 710

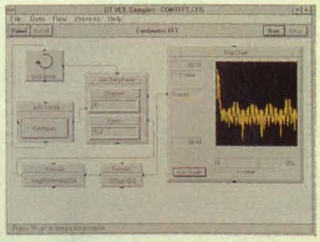
The GP 400 series of PC-programmable **encoders** has been announced by IVO Industries Inc., Eatontown, NJ. The encoders' operating functions and parameters can be programmed before or after installation, and offer the versatility of selecting multiturn absolute and incremental outputs, as well as resolution, output code, and zero points.
For More Information Write In No. 705

The latest update of Snap-Master™ for Windows™ released by HEM Data Corporation, Southfield, MI, is the first **data acquisition, analysis, and control software** for Windows to break the 100 K samples/sec plotting barrier. While offering real-time plotting up to 110,000 samples/second with its "Intelligent Plotting" capability, the program retains its flow chart approach and refined user interface to insure that applications are up and running in minutes.
For More Information Write In No. 713

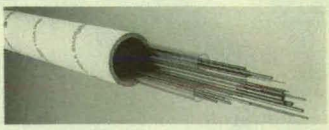




Soft Assembly software from SILMA Inc., Cupertino, CA, enables design engineers to **visualize, test, and verify the manufacturability and maintainability of parts and subassemblies** without producing full-scale physical mockups. *Soft* Assembly automatically generates realistic software prototypes from parts designed on multiple CAD systems. Designers can dynamically manipulate individual parts in real time to verify the feasibility of proposed product assemblies within existing production constraints.
For More Information Write In No. 701



Data Translation, Marlboro, MA, announced DT VEE Sampler™ **visual programming software** based on DT VEE™ for Windows. Shipped free with each of the company's forty DT-Open Layers-compliant data acquisition boards, the sampler provides immediate access to a board's analog inputs without any programming. Users can configure the inputs, select up to four channels from which to sample data, choose continuous or single sample acquisition, perform an FFT on a single channel, display up to four channels on a strip chart, and save the data to memory or disk.
For More Information Write In No. 712



The Eagle Lab Sample Inventory Kit from Eagle Stainless Tube Corp., Franklin, MA, features 57 pieces of 40"-long 300 series **stainless steel hypodermic tubing** in sizes ranging from 6 to 30 gauge and various wall thicknesses. Suitable for evaluation and use by designers and laboratory personnel, the samples were created to let designers experiment with a full range of tubing sizes before placing an order.
For More Information Write In No. 704

New on the Market

An affordable, **dual-user 3D visualization station** offering ultra-fast performance has been unveiled by Megatek Corp., San Diego, CA, and Sea Corp, Newport, RI. Priced at $125,000, the MEGATEK Dual User 3D ViewStation features advanced rendering capabilities such as 24-bit true color, multi-object transparency, texturing, surface anti-aliasing, and 1280 x 1024 resolution.
For More Information Write In No. 709

UniSlide® **assemblies with dual sliders** from Velmex Inc., East Bloomfield, NY, can serve in applications where two objects must share an axis of motion. In addition, when a left and right hand thread lead screw is specified, the reciprocating action moves the objects together or apart. Such motion is used in centering or mating operations for manufacturing or testing.
For More Information Write In No. 703

Numera Software Corp., Seattle, WA, has unveiled Visual CADD™, a professional-quality **2D drafting and design program** created to take full advantage of the Windows™ environment. Developed by the creators of Generic CADD®, the package eliminates extra steps in the input and editing process with shortcut commands and features a large drawing area, customized ribologs, context sensitive pop-up menus, and associative dimensioning.
For More Information Write In No. 708

ThermaCal Inc., Solon, OH, has introduced the first instrument to both **source and measure temperature**. The Model 32's source unit heats or cools the temperature sensor while the sensor output is read by a measure unit. Features include a cool source with a range down to -30 °C; a heat source ranging up to 650 °C, measure units for thermocouples, RTDs, and thermistors, and a measure for 4-20 mA and 20 Vdc from temperature transmitters.
For More Information Write In No. 702

The Power Cube™ **OEM stepping motor drive package** introduced by Whedco Inc., Ann Arbor, MI, converts pulse and direction inputs from an external pulse source into the corresponding current phase sequence necessary to drive the stepping motor. The integrated, easy-to-install package features a high-performance bipolar chopper translator rated at 3 A continuous and optically isolated inputs, accepts power supply input voltages from 12-48 Vdc, and is user configurable in full or half-step sizes.
For More Information Write In No. 711

InData Systems, Skaneateles, NY, has announced the industry's smallest **palmtop full-screen computer terminal**. The RF-100 wireless terminal weighs two pounds, has a removable rechargeable battery, and can be worn on the belts of mobile operators who can use existing mainframe computer applications to send and receive full screens without software changes. These PC terminal/radio-modem systems are designed to communicate in real time from up to two miles or cover up to a million square feet of building space.
For More Information Write In No. 700

General Imaging Corp., Billerica, MA, has introduced ProtoPIPE™, a suite of drag and drop **signal/image processing application development tools**, which enables rapid prototyping of complex imaging applications. Using stand-alone systems, networked systems, or a client/server architecture and an object-oriented interface, users can graphically design, develop, test, simulate, and execute data imaging applications in a fraction of the time required by conventional programming techniques.
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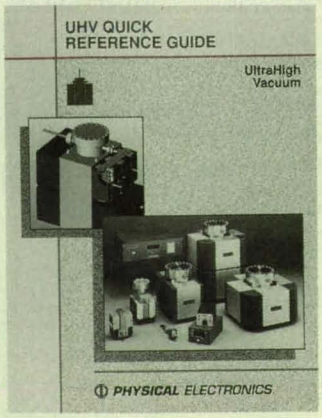
New Literature

Galil Motion Control Inc., Sunnyvale, CA, has published a textbook by Dr. Jacob Tal entitled *Step-by-Step Design of Motion Control Systems.* The tutorial's first part addresses the selection and operation of system elements; the second covers motion programming. Design examples include linear and circular interpolation, electronic gearing, tension control, and dual loop systems for backlash compensation.
For More Information Write In No. 720

A guide to **process system components** from Watlow Electric Manufacturing Co., St. Louis, MO, reviews tubular heating elements; heat exchangers; and immersion, enclosure, radiant, process air, and drum heaters. Also described are process alarms and limits, control panels, process controllers (SCRs, SSRs, and MDRs), infrared and contact temperature sensors, wire and cable, and laboratory services such as calibration and testing.
For More Information Write In No. 716

Physical Electronics, Eden Prairie, MN, has published a *UHV Quick Reference Guide* featuring its line of **ion pumps and controls**. The 48-page guide offers solutions to hydrogen pumping, inert gas pumping, and high gas loads. New products include four new "Tall" ion pumps and eight Non-Evaporable Getter (NEG) options for ion pumps.
For More Information Write In No. 714



A new monthly newsletter entitled *MicroMarkets and Technologies*, published by Vital Information Publications, Mill Valley, CA, addresses issues and trends in **micromachining**—the use of semiconductor manufacturing techniques to create tiny electromechanical components such as sensors, actuators, valves, pumps, and motors. Predicting a world market over $2.5 billion by the year 2000, the newsletter describes the technology's potential for automotive and consumer electronics, medical and process equipment, and mechanical engineering.
For More Information Write In No. 717

More than 30 **digital signal processing (DSP) boards** are described in a catalog from Ariel Corp., Highland Park, NJ. Based on DSP chips from AT&T, Motorola, and Texas Instruments, the boards are available for a range of platforms, including VMEbus, ISA Bus, and SBus. New additions to Ariel's TMS320C40 line include the VMEbus-based quad-C40 Hydra-II and CommIO Industry-Pack I/O subsystem.
For More Information Write In No. 715

Computer Review, Gloucester, MA, has released an updated directory to the "electronic information superhighway." The guide profiles 500 **computer, telecommunications, and electronic information companies** worldwide, including reports on their competitive position and recent joint ventures. Also included are reviews of thousands of computer and communications products.
For More Information Write In No. 718

Thirteen user case histories of **linear motion** problems are detailed in an eight-page publication from Thomson Industries Inc., Port Washington, NY. Operations discussed include robotic insertion of electronic components, automatic transport of silicon wafers into a diffusion processing furnace, a focusing mechanism for an X-ray inspection system, and a parts-handling robot with a 60" reach.
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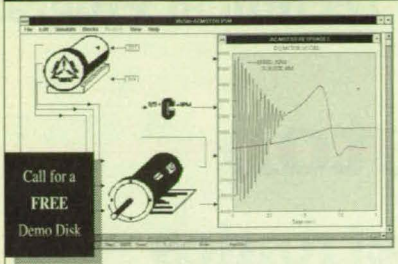

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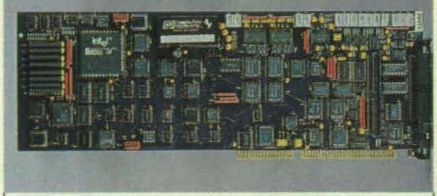

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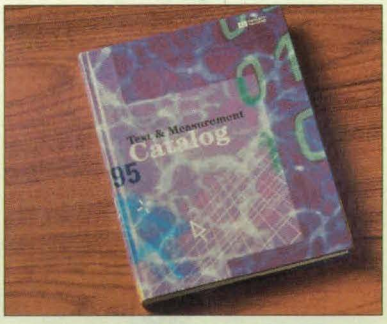

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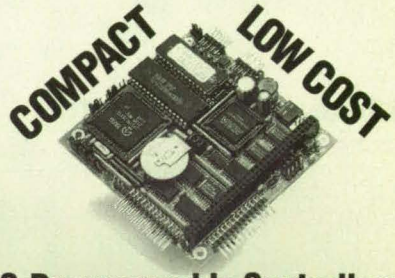

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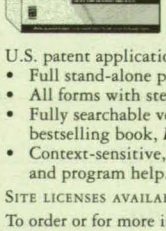

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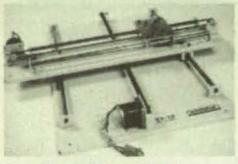

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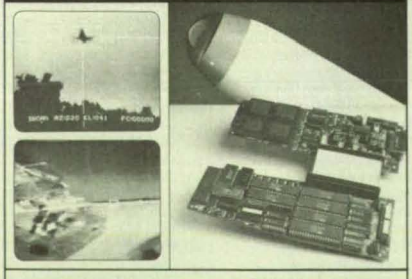

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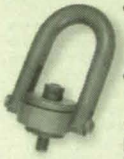

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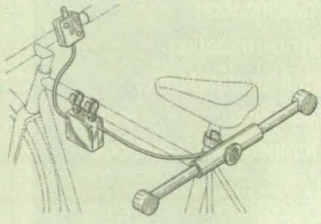

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Call For Nominations

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The first annual Small Business Innovation Research (SBIR) Technology of the Year Awards will be presented this November in Washington, DC in conjunction with the Technology 2004 national technology transfer conference & exposition. Phase II and III SBIR companies that have developed novel, commercially-important technologies and products through SBIR funding are invited to submit nominations and exhibit at Technology 2004. For a complete nomination package, write in no. 424 or call Wayne Pierce at (212) 490-3999.

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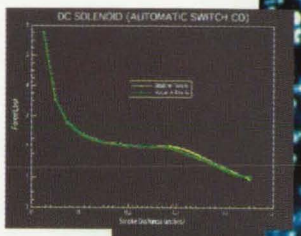

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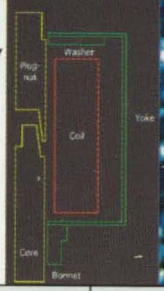

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gap	Energy (J)	Error (%)	Force (N)
0.228	0.107072	0.629551	25.7765
0.253	0.09080784	0.630972	15.8301
0.278	0.0917353	0.551074	12.4962
0.303	0.0869854	0.566156	10.9343
0.328	0.0833859	0.704584	10.1044
0.353	0.0801771	0.594178	9.54882
0.378	0.0774072	0.675732	9.21645
0.403	0.0748866	0.586839	9.00972
0.428	0.0726882	0.626687	8.92038
0.453	0.0706936	0.544622	8.92778

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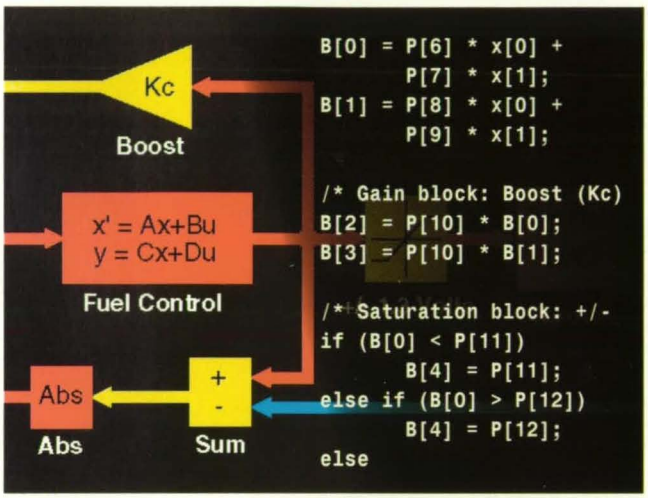
For More Information Write In No. 542

When you need real-time code, a picture is worth a thousand lines.



The Real-Time Workshop lets you create designs with SIMULINK blocks and move directly to hardware-in-the-loop testing — within minutes.

With the SIMULINK Real-Time Workshop, you can automatically generate many thousands of lines of C code from your block diagrams with the push of a button.

Real-Time Workshop's open architecture provides a development environment that enables you to rapidly implement and test your designs on your real-time hardware.

From block diagram to C code

You start by creating a continuous, discrete-time or hybrid model of your system in SIMULINK. Then you generate highly optimized, target independent C code that runs on virtually any floating point hardware.

Turnkey support

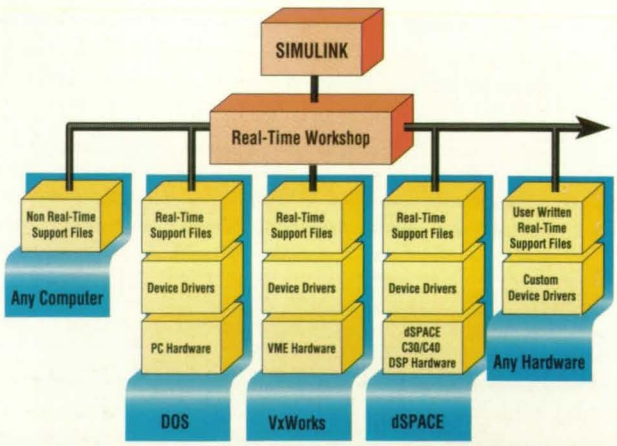
Device drivers provide out-of-the-box operation on supported hardware as well as all the information you need to run on hardware you select. Documented examples and device driver source code are included for:

- dSPACE DSP boards
- VxWorks real-time operating system with VME hardware
- PCs using commercially available I/O boards

Additional dSPACE software products provide complete rapid prototyping, including data monitoring and acquisition. With VxWorks, StethoScope provides data monitoring and acquisition.

Target your hardware

Real-Time Workshop goes beyond generating C code. Its real-time framework API provides an extensible build environment based on customizable makefiles. This enables you to use custom device drivers and to specify compiler and linker options.



When combined with support files and device drivers, the generated code can run on a wide range of target hardware.

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