NASA Tech Briefs

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August 1993 Vol.17 No. 8

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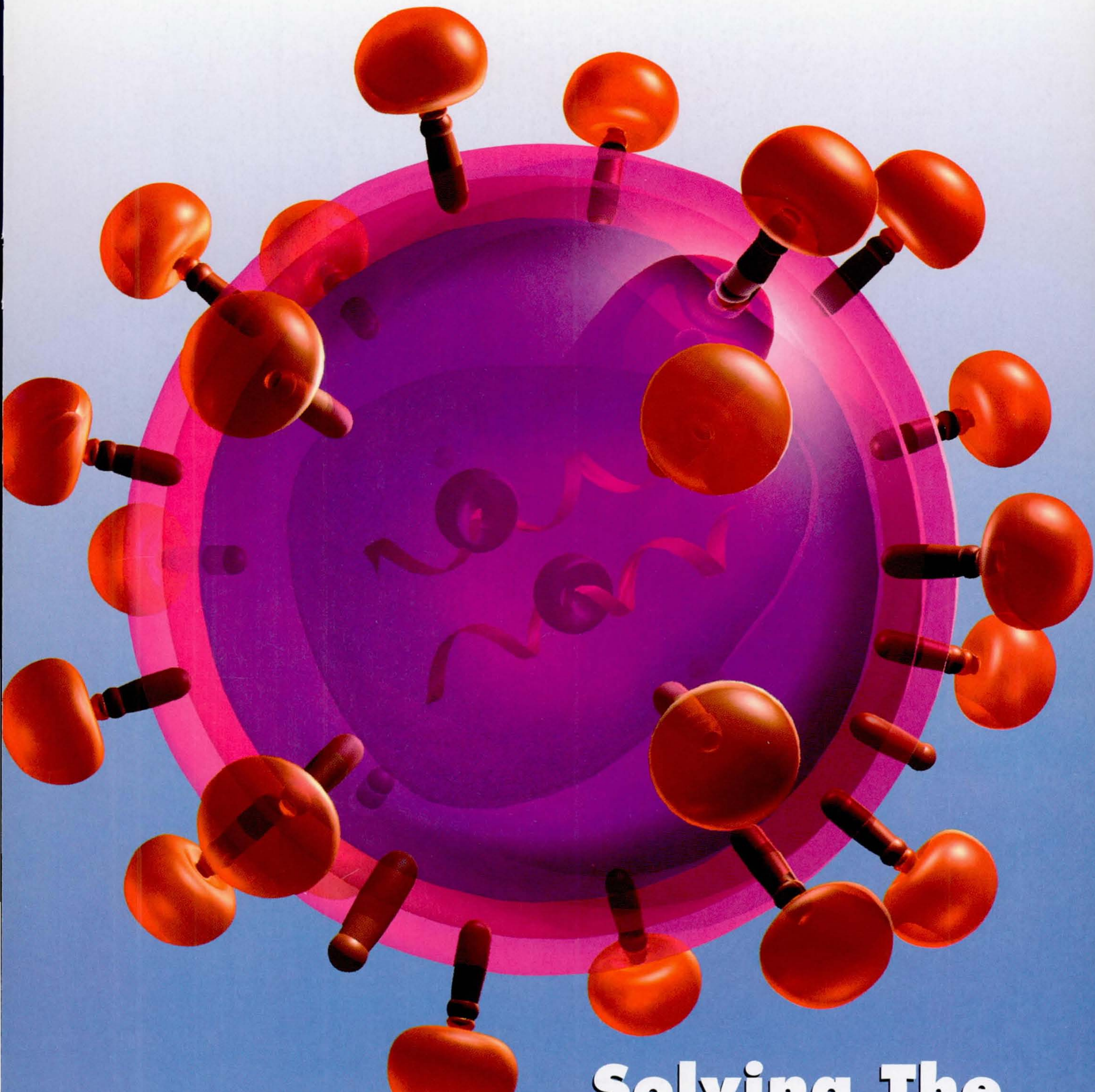

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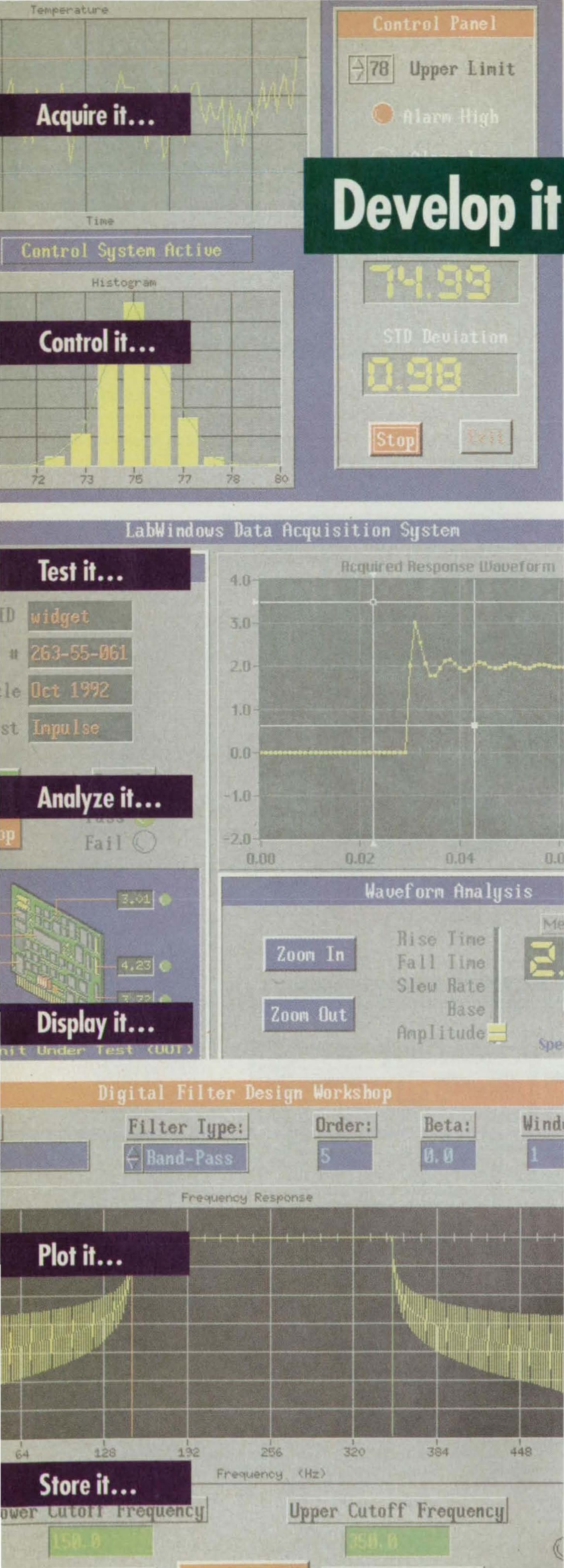

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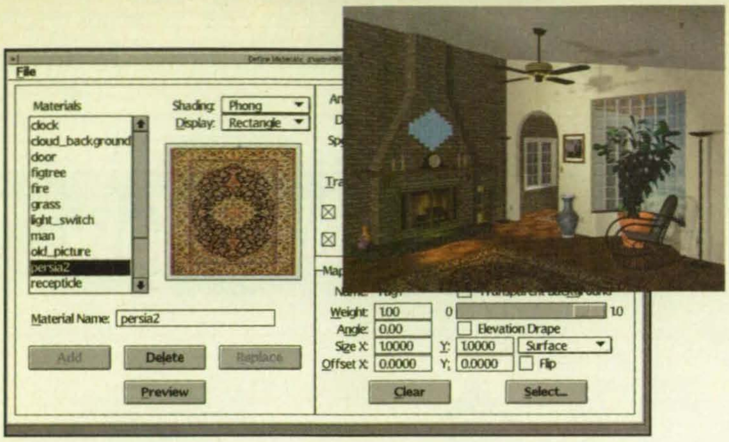

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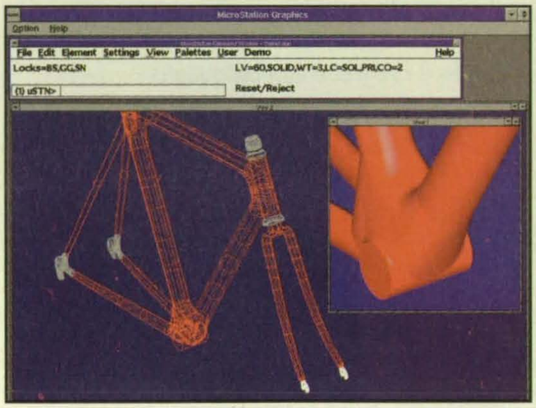

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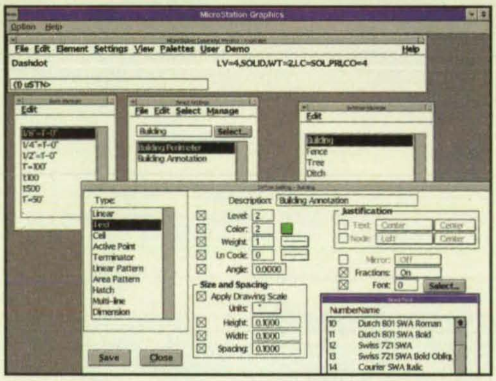

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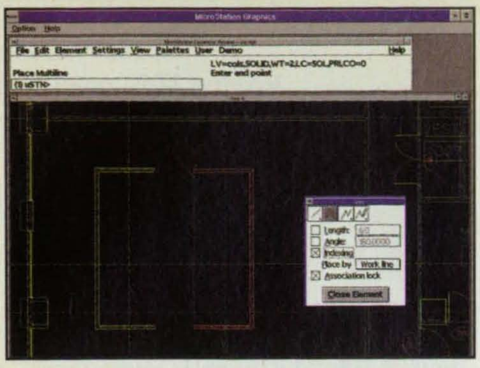

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TECHNICAL SECTION

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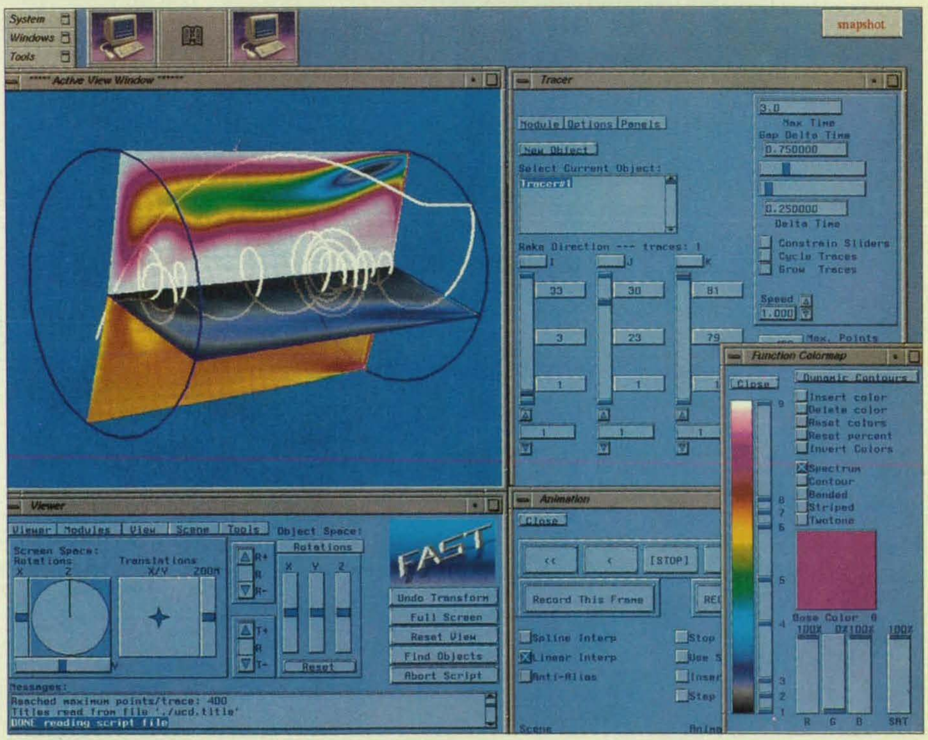

Photo courtesy Ames Research Center

The Flow Analysis Software Toolkit (FAST) is a collection of programs for visualization of numerical and experimental data. Intended primarily to enable graphical depiction of computed flows, FAST also combines the capabilities of and permits data sharing between such programs as PLOT3D, RIP, SURF, and GAS. As illustrated above, all of the modules in FAST feature a highly-interactive graphical user interface. See the tech brief on page 30.

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In response to your suggestions, we have made the subscription/information request form (page 83) easier to use. The questionnaire portion of the form has been simplified (please note that you only need to fill out questions 1-8 if applying for or renewing a subscription) and the long list of circle numbers has been replaced with boxes for you to write in the numbers of Technical Support Packages and/or advertisers from which you would like more information. We welcome your comments about the revised form and any suggestions for additional changes in **NASA Tech Briefs.**

DEPARTMENTS

On the cover:

Uncovering the mysterious makeup of the human immunodeficiency virus (HIV), illustrated in this computer-generated graphic, is the goal of a unique collaboration between NASA's Marshall Space Flight Center and American Bio-Technologies Inc. Using advanced x-ray crystallography to analyze the virus' protein components, the team hopes to construct a 3D model that will aid in the development of therapeutic drugs, vaccines, and diagnostic tools. ***Turn to page 16.*** Illustration courtesy American Bio-Technologies Inc.

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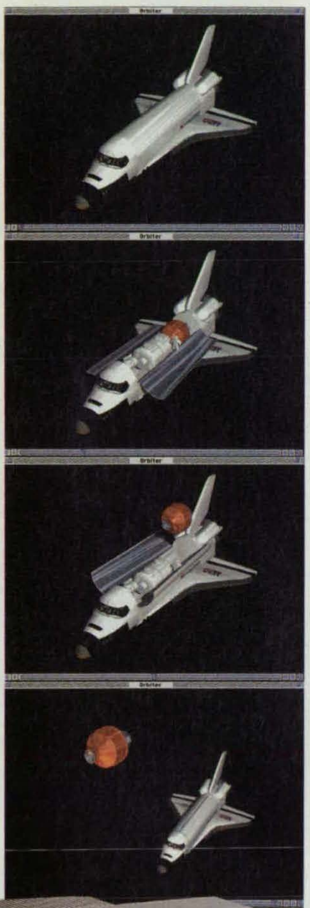

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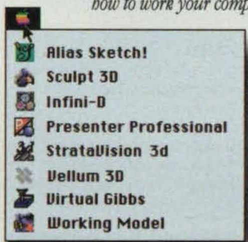

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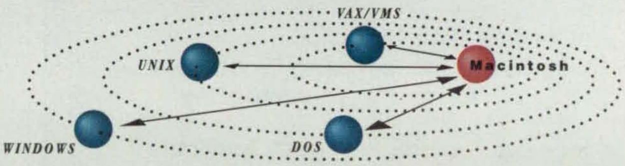

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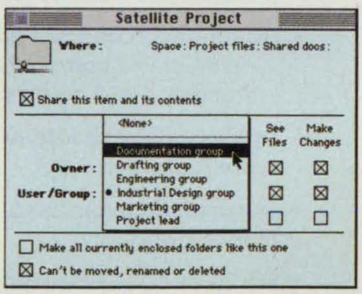

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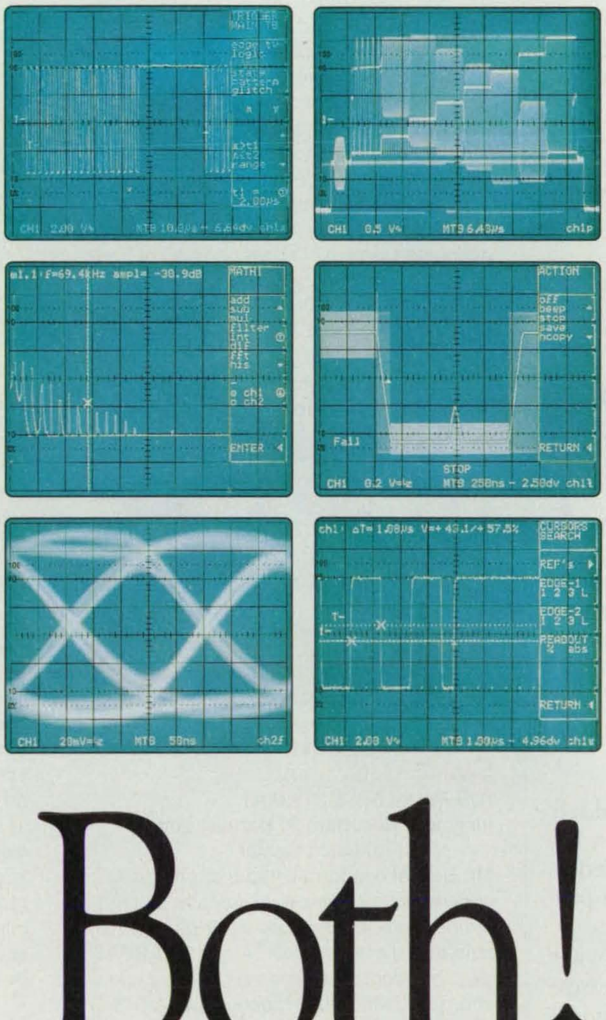

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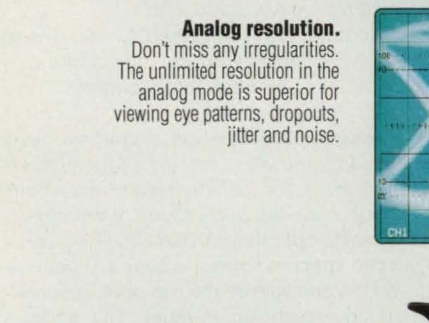

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(US Patent No. 5,193,963)

Inventors: **Douglas A. McAffee**, **Edward R. Snow**, and **William T. Townsend**, Jet Propulsion Laboratory

A six-degree-of-freedom universal force-reflecting hand controller provides an intuitive means for a human operator to interact with and control teleoperated systems. The device features excellent kinesthetic feedback, high-fidelity force/torque feedback, a kinematically simple structure, mechanically decoupled motion in all six degrees of freedom, and zero backlash. It provides a larger work envelope, greater stiffness and responsiveness, a smaller stowage volume, and better overlap of the user's range of motion than previous designs.

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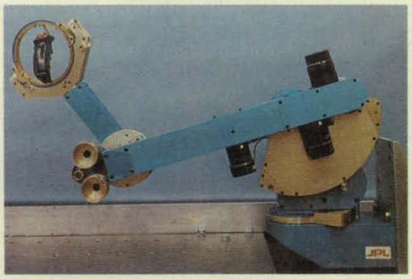

Ceramic Fiber-Reinforced Glass-Ceramic Matrix Composite

(US Patent No. 5,214,004)

Inventor: **Narottam P. Bansal**, Lewis Research Center

Mr. Bansal has formulated a strong, tough, and refractory composite for use in high-temperature applications such as gas turbine and diesel engines. A slurry of BSAS glass powders is cast into tapes, then stacked alternately with mats of continuous CVD-SiC fibers. The tape-mat stack is warm-pressed to produce a "green" composite which is first heated to burn out organic constituents and then hot-pressed to form a machinable BSAS glass-ceramic fiber-reinforced composite.

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Acoustophoresis Separation Method

(US Patent No. 5,192,450)

Inventor: **Joseph S. Heyman**, Langley Research Center

A novel separation technique differentiates chemical species by their acoustic properties—absorption, scattering, and radiation stress. An ultrasonic transducer applies an acoustic wave to one end of a container holding species with differing absorption coefficients. The wave frequency is tuned to the point of resonance of the species to be separated, whereby it is moved toward one end of the container for removal. A second transducer may be used to apply an oppositely directed wave to prevent undesired streaming. In addition, a radio frequency coupled with a magnetic field can help identify a species within a medium comprised of species with similar absorption coefficients.

For More Information Write In No. 553

Alkali Metal Carbon Dioxide Electrochemical System for Energy Storage and/or Conversion of Carbon Dioxide to Oxygen

(US Patent No. 5,213,908)

Inventor: **Norman H. Hagedorn**, Lewis Research Center

An innovative electrochemical cell employs alkali metal anodic reactants such as lithium, potassium, or sodium—which are extremely energetic and lightweight—and cathodic reactants such as carbon dioxide for use in environments where carbon dioxide is abundant and oxygen is absent. At operating temperature, the anode and the electrolyte (the carbonate of the alkali metal) are liquid. Gold is the preferred catalyst for reducing the carbon dioxide at the cathode.

For More Information Write In No. 554

Real-Time Imaging Spectrometer

(US Patent No. 5,216,484)

Inventors: **Tien-Hsin Chao**, **Li-Jen Cheng**, **Jeffrey W. Yu**, and **James L. Lambert**, Jet Propulsion Laboratory

A multispectral imaging instrument developed at JPL offers real-time operation and high resolution for airborne and spaceborne Earth sciences applications. It employs an acousto-optic tunable filter (AOTF)—a solid-state spectral bandpass filter that operates on the principle of acousto-optic interaction in an anisotropic medium. The ability to electronically set the AOTF's bandpass wavelength to any value within its wide tuning range provides observational flexibility, permitting modification of observational parameters in real time during remote operation.

For More Information Write In No. 556

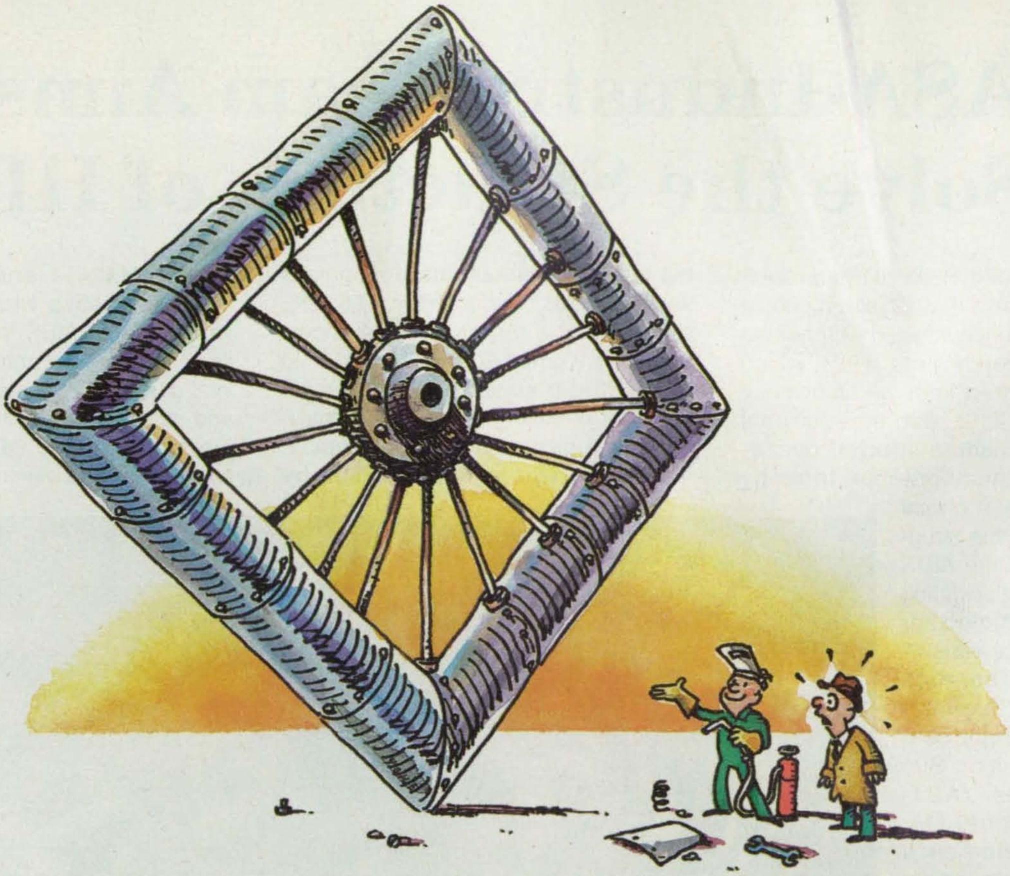
GaAs-Based Optoelectronic Neurons

(US Patent No. 5,204,521)

Inventors: **Steven H. Lin**, **Jae H. Kim**, and **Demetri Psaltis**, Jet Propulsion Laboratory

Two new optoelectronic neurons, designed as building blocks for neural networks, provide adjustable thresholds, high optical gain, and low power consumption. In one, an LED is monolithically-integrated with a double heterojunction bipolar phototransistor (detector) and two metal semiconductor field-effect transistors (MESFETs) on a single GaAs substrate. It exhibits a differential optical gain of 6, an optical switching energy of 10 pJ, and power consumption of 2.4 mW. A second device comprises three MESFETs (one an optical FET detector) on a single GaAs substrate and offers a differential optical gain of 80, an optical switching energy of 38 pJ, and power consumption of 1.8 pW.

For More Information Write In No. 557



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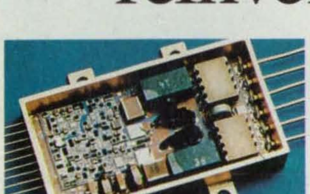

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For More Information Write In No. 672

NASA-Industry Team Aims to Solve the Structure of HIV

The World Health Organization estimates that 13 million people have been infected with human immunodeficiency virus (HIV), which causes Acquired Immune Deficiency Syndrome (AIDS), with an additional one million children infected perinatally. These numbers may triple by the year 2000. A critical component of the struggle to combat the AIDS pandemic is elucidating the precise molecular structure of the virus. A unique collaboration between NASA's Marshall Space Flight Center and American BioTechnologies (ABT) Inc., Cambridge, MA, aims to provide such structural data on an unprecedented scale.

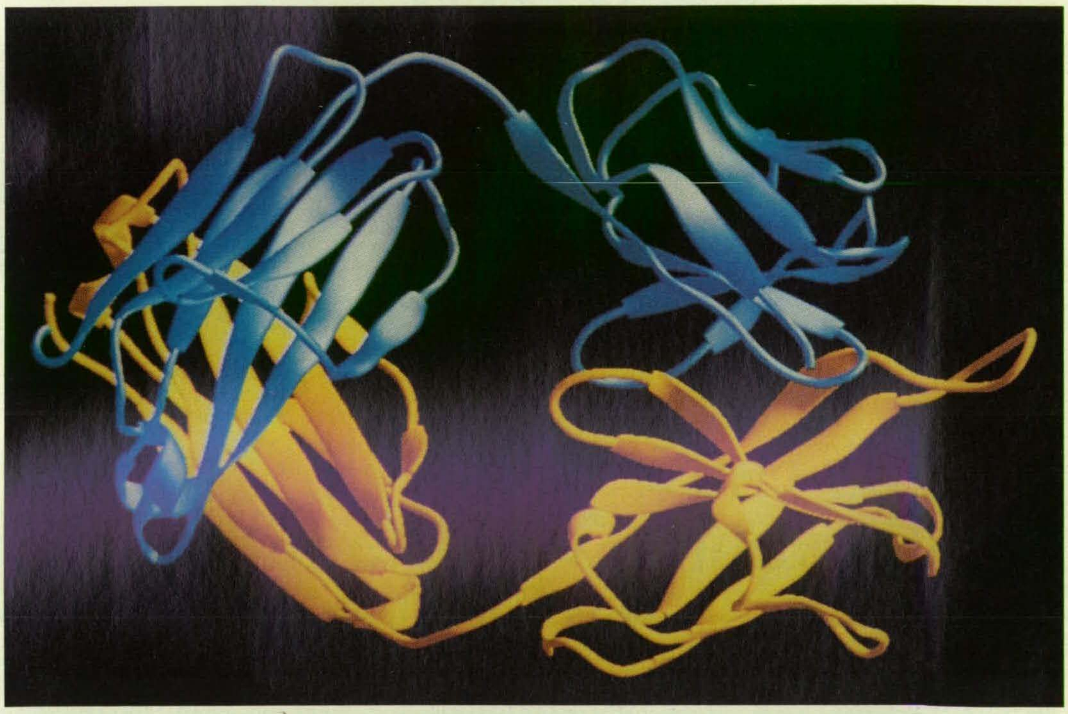
The research project will employ advanced high-resolution x-ray crystallography technology and expertise developed at Marshall to build a three-dimensional atomic model of HIV. "This is crucial for designing inhibitory drugs and other therapies, developing vaccines, and improving diagnostic tools," said ABT president Simon McKenzie.

The resulting data could help provide a more complete understanding of antibody structure and antibody-antigen interaction. "From the perspective of drug design, this is absolutely imperative because the virus has turned out to be much more complicated than was anticipated," said Dr. Daniel Carter, leader of the Marshall research team. "In the end, it's probably going to come down to understanding the detailed interactions of these proteins at a molecular level."

NASA's association with ABT began shortly after Marshall researchers determined the first structure of a human monoclonal antibody that recognizes the AIDS virus. The antibody, Fab 3D6, binds to a coat protein in HIV-1 known as GP41. Carter approached ABT in hopes that it could provide a larger fragment of GP41 to extend the analysis to the protein-antibody complex. McKenzie, who was impressed by Marshall's successes in crystallizing proteins, suggested broadening the project's scope.

"He asked if we would like to have them all—all the proteins of HIV-1, HIV-2, and the related retroviruses—which was just incredible," recalled Carter. "Most crystallographers feel fortunate to have one or two. Altogether, the project will have access to 100 recombinant proteins and antibodies—as far as I know, there's no collaboration like this anywhere else in the world."

Marshall researchers will receive proteins from the two strains of HIV as well as HTLV-1 and HTLV-2, both human leukemia viruses, and SIV-1, which causes AIDS in the green monkey. "It's been eight years since the viral genome was determined for HIV-1 and still only two of the protein structures are known," said Carter. "If we succeed in determining just one there will be 50 percent more information available."



This computer-generated model, acquired through analysis of x-ray crystallography data, represents the first known 3D structure of a human monoclonal antibody that binds to one of the proteins comprising HIV-1.

ABT, a 28-person bioengineering firm founded in 1987, is a worldwide supplier of recombinant HIV proteins but does not conduct structural AIDS research on its own. "It's a very unusual project," said McKenzie. "Most people only contemplate trying to analyze one protein because the process is very difficult, arcane, and fraught with disappointments."

The x-ray crystallography technique involves passing an x-ray beam through

(continued on page 20)

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CONFERENCE PROGRAM

TUESDAY, DEC. 7

8:30 - 11:00 am
Plenary Session—Defense Conversion: New Opportunities For Industry

1:00 - 3:00 pm
Concurrent Symposia— Critical Technologies: Advanced Manufacturing, Computer Hardware, Environmental Technology, Materials Science, Photonics

3:30 - 5:30 pm
Concurrent Symposia—Critical Technologies: Artificial Intelligence, Biotechnology, CAD/CAE, Test & Measurement, Video/Imaging

WEDNESDAY, DEC. 8

8:30 - 10:30 am
Workshop—How To Successfully Tap Into The Government's Multi-Billion Dollar Technology Bank

1:00 - 3:00 pm
Concurrent Symposia—Critical Technologies: Information Management, Materials Science, Power & Energy, Robotics, Virtual Reality

3:30 - 5:30 pm
Concurrent Symposia—Critical Technologies: Advanced Manufacturing, Artificial Intelligence, Computer Software, Environmental Technology, Test & Measurement

7:00 - 9:00 pm
Technology Transfer Awards Dinner (Marriott Hotel)

THURSDAY, DEC. 9

8:30 - 11:00 am
Plenary Session—International Technologies For Transfer

1:00 - 3:00 pm
Concurrent Symposia—Critical Technologies: Advanced Manufacturing, Biotechnology, Environmental Technology, Materials Science, Video/Imaging

EXHIBITION HOURS

Dec. 7	10:00 am - 6:30 pm (open reception 5:00 - 6:30 pm)
Dec. 8	10:00 am - 5:00 pm
Dec. 9	9:00 am - 3:00 pm

Preregister and $ave Complete the preregistration form below and mail with check or money order (if applicable) to the Technology Utilization Foundation, or fax it with credit card data to (212) 986-7864. **Deadline for preregistration is Friday, November 19.**

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Complete Registration (includes symposia and exhibits, a ticket to the Awards Dinner, and a set of Tech 2003 Proceedings)	$250	$295
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Air Travel United Airlines, official airline for Technology 2003, is offering a 10% discount off the unrestricted YUA coach fare or 5% off the lowest applicable fares. Attendees who book their tickets via UA's toll-free # (1-800-521-4041) will be entered into a drawing for two round-trip tickets good in the continental U.S. and Hawaii. Refer to meeting ID# 537CB when reserving tickets.

QUESTIONS? CALL WENDY JANIEL AT (800) 944-NASA.

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USE A SEPARATE FORM OR PHOTOCOPY FOR EACH REGISTRANT. BE SURE TO ANSWER ALL QUESTIONS BELOW.

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- I ☐ Test/Measurement Instruments
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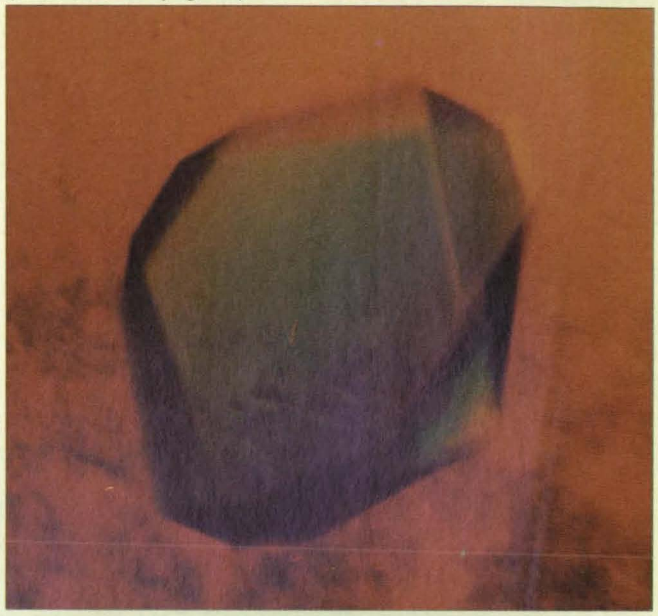
(continued from page 16)



X-ray diffraction of crystals such as this one of a human monoclonal antibody bound to part of the AIDS virus can yield clues to molecular architecture and, in turn, ways to design drugs, vaccines, and diagnostic tools.

single protein crystals repeatedly to obtain hundreds of diffraction patterns. These patterns, created as the atoms within the crystal scatter the x-rays, are compiled and analyzed on a computer to assemble a model of the protein's molecular architecture.

Success depends upon the production of large, high-quality crystals of the proteins. Unfortunately, each protein presents a new challenge and unique solubility characteristics. "We grow them by screening literally thousands of different conditions—changing pH and precipitating agents to reduce solubility, varying temperature, protein concentration, and other variables," explained Carter, who received NASA's 1990 Inventor of the Year award for using x-ray crystallography to solve the 3D structure of human serum albumin, the principal blood protein. "The result is a gigantic matrix and you have no idea if or where the crystals are going to grow."

Marshall's new 7500-square-foot Laboratory for Structural Biology, scheduled to open in November, will provide added work space and computer graphics facilities for the massive undertaking. The new laboratory will support the group's microgravity research on the space shuttle, which also may benefit the AIDS project. "The microgravity experiments assess quality differences between crystals grown at 0g versus 1g," explained Carter. "It's now well established that some crystals grow better at 0g. The likelihood is very high that microgravity will benefit the crystal growth of some of the AIDS-related proteins."

Carter expects the research to have spinoffs in a variety of areas. "These other viruses [HTLV-1 and HTLV-2] cause cancer and I think future researchers will find that many specific types of cancers are caused by retroviruses—understanding how to stop them is extremely important." Concurring is the National Institutes of Health, which has called structural biology a "linchpin in US biotechnology research" providing critical insights into molecular function that can speed the search for means to prevent or cure diseases. ❑

For more information about the technologies described in this article, contact Dr. Daniel Carter, Mail Stop ES-76, Marshall Space Flight Center, AL 35812, Tel: 205-544-5492.

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 24). NASA's patent-licensing program to encourage commercial development is described on page 24.

Reflection-Type Oil-Film Skin-Friction Meter

This self-contained unit can be used in flight or wind-tunnel tests. All components are housed in a palm-sized package that can be attached readily under the aerodynamic surface.
(See page 48.)

Measuring Inhomogeneities in Thermocouple Wires

A new apparatus measures electrically significant inhomogeneities in thermocouple wires. The wires are pulled by spools through liquid nitrogen, while the output voltage of the thermocouple is recorded on a strip chart.
(See page 48.)

Acoustical Detection of Flameout in a Combustor

This flameout detector automatically shuts off the supply of fuel to a combustor in which the flame has been or is about to be lost. The detector contains relatively simple decision circuits.
(See page 46.)

Electrically Conductive Polyimide Films

Polyimide films have been made semiconductive via the incorporation of semiconductive surface layers of SnO_2. The films are flexible and resistant to both weather and high temperature. They can be used, for example, on aircraft to provide resistance to lightning strikes and in microelectronics and flexible circuitry.
(See page 57.)

Moving-Gradient Furnace With Constant-Temperature Cold Zone

A proposed moving-gradient heat-pipe furnace for terrestrial or spaceborne experiments on directional solidification in the growth of crystals would use an outer heat pipe that would help in controlling the temperature of the cold zone of the furnace.
(See page 56.)

Positioning Fixtures for X-Ray Inspection

Flanged fixtures are designed to position an x-ray source at fixed locations within welded parts that are to be inspected radiographically. The fixtures reduce setup time and eliminate the waste of film that occurs when x-radiographs are taken at incorrect positions.
(See page 72.)

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We've outlined below NASA's Technology Transfer Network—named the participants, described their services, and listed the individuals you can contact for more information relating to your specific needs. We encourage you to make use of the information, access, and applications services offered.

How You Can Access Technology Transfer Services At NASA Field Centers:

Technology Utilization Officers & Patent Counsels—Each NASA Field Center has a Technology Utilization Officer (TUO) and a Patent Counsel to facilitate technology transfer between NASA and the private sector.

If you need further information about new technologies presented in *NASA Tech Briefs*, request the Technical Support Package (TSP). If a TSP is not available, you can contact the Technology Utilization Officer at the NASA Field Center that sponsored the research. He can arrange for assistance in applying the technology by putting you in touch with the people who developed it. If you want information about the patent status of a technology or are interested in licensing a NASA invention, contact the Patent Counsel at the NASA Field Center that sponsored the research. Refer to the NASA reference number at the end of the Tech Brief.

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If you represent a public sector organization with a particular need, you can contact NASA's Application Team for technology matching and problem solving assistance. Staffed by professional engineers from a variety of disciplines, the Application Team works with public sector organizations to identify and solve critical problems with existing NASA technology. **Technology Application Team, Research Triangle Institute, P.O. Box 12194, Research Triangle Park, NC 27709; *Dr. Doris Rouse, Director,* (919) 541-6980**

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Program Aids Specification of Multiple-Block Grids

The user is relieved of some of the burden of collecting and formatting data.

Ames Research Center, Moffett Field, California

The 3DPREP computer program aids the specification of multiple-block computational grids (see Figure 1). Such grids are used to compute flows about bodies like airplanes that have complicated shapes. A flow field is divided into topologically simpler blocks to simplify the computations, and a grid fitted to the body is then generated in each block. 3DPREP relieves the user of some of the burden of collecting and formatting the many data that are needed to specify blocks and grids, and prepares input data for NASA's 3DGRAPE grid-generating computer program.

3DPREP is a highly interactive graphical preprocessing program that is designed for use on a powerful graphical scientific computer workstation. It is divided into three main parts, each of which corresponds to a principal graphical-and-alphanumerical

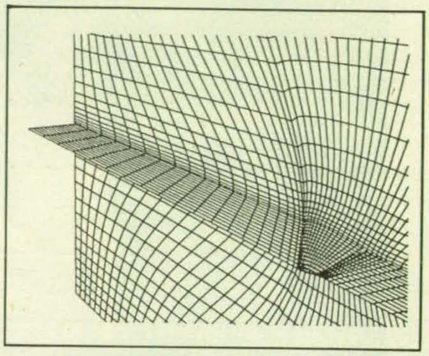

Figure 1. This **Two-Block Grid About an Isolated Wing** was generated with the help of the 3DPREP computer program.

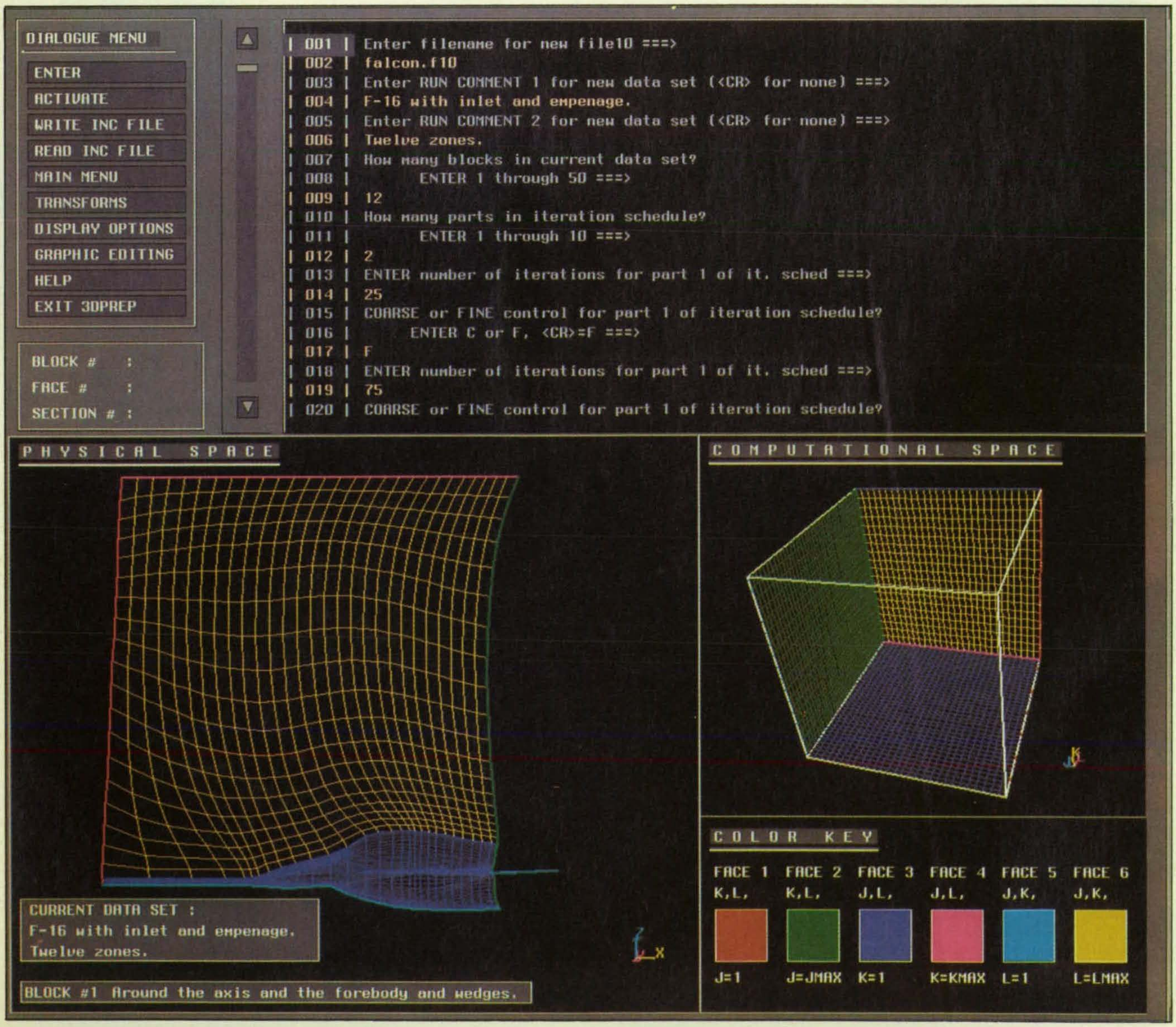

Figure 2. The **Display of the Dialog Entry Facility** asks the user for data pertaining to the grid. The cube at the lower right corner is a computational cube — the topological equivalent of the grid block in question. The faces of the cube are color-coded to show correspondences between physical and computational spaces.

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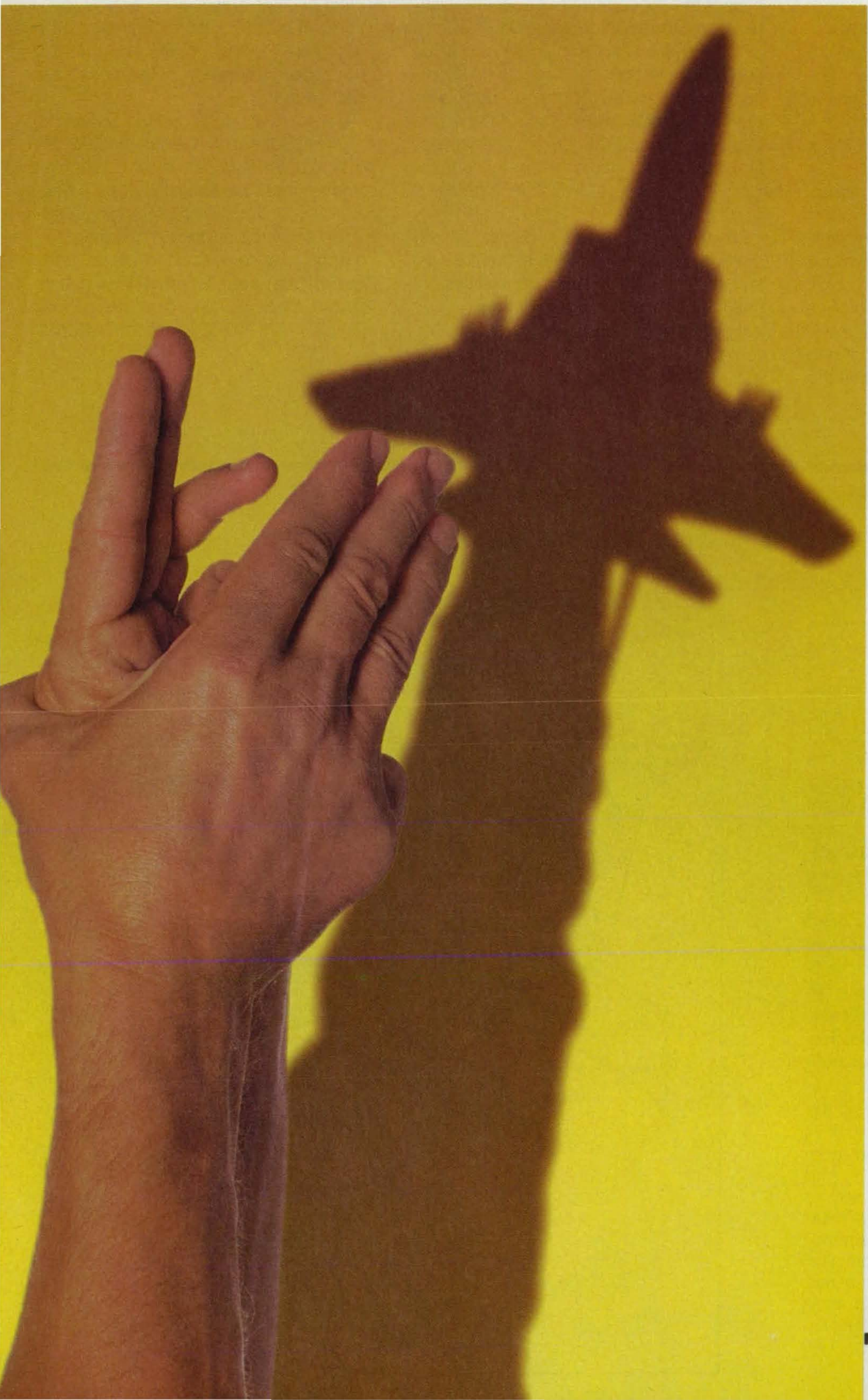

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display. The first part, called the "dialog entry facility," is mainly for the benefit of the novice user. It puts up a display like that in Figure 2, in which the computer asks the user specific questions about the grid to be generated. First, it asks for data pertaining to the entire grid, then for data pertaining to the blocks, then for data pertaining to faces and sections of faces of the blocks. A history of the dialog between the user and the computer is maintained; this history can be scrolled up or down. The user can store or restart the dialog. Errors are trapped in a conversational manner. A context-sensitive "help" display is available.

The second main part of 3DPREP is called the "graphical editing facility." A more-experienced user can take advantage of this facility to enter data more rapidly than through the dialog entry facility, or a less-experienced user could move to this facility from the dialog entry facility to modify previously entered data. In addition to pictures of the grid like those shown in Figure 1, the display generated by this facility includes four panels — the first containing data on the entire grid; the second, third, and fourth containing data on the current block, current face, and current section, respectively. Images of buttons, activated by a mouse, enable the user to advance to "next" and "previous" blocks, faces, and sections. Other images of buttons enable the selection, entry, or modification of a datum in a panel.

Where appropriate, selection of a datum causes the appearance of a subpanel that requests additional information or offers a range of choices. Errors in the data thus entered are trapped, and panels that contain incomplete or erroneous data are marked by small blinking red dots. A list of all such errors can be obtained. Help facilities are available with each panel. Default values are available wherever appropriate.

The third main part of 3DPREP is called the "multiple-block facility." It offers a collection of generally useful capabilities or "utilities," including the following:

- It plots the fixed boundary faces of all the blocks.
- It generates a "pop-up" panel display called "double point readout," wherein one or two points are identified by block number(s), index value(s), Cartesian coordinates, and graphical display. If there are two points, the distance between them is also shown.
- The "generate surface" utility enables the user to specify a grid line and generate a surface from it.
- Data on surfaces can be entered from other sources and in other formats (e.g., from other computer programs). Such data can be used in full and can be transposed (rows and columns can be exchanged).

This work was done by R. L. Sorenson of **Ames Research Center** *and K. M. McCann of Sterling Zero One. Further information may be found in AIAA paper A91-19157, "A Method for Interactive Specification of Multiple-Block Topologies."*

Copies may be purchased [prepayment required] from AIAA Technical Information Service Library, 555 West 57th Street, New York, New York 10019, Telephone No. (212) 247-6500.
ARC-13082

Improved Depiction of Measured Flow Fields

A method developed for simulated flows is modified for use with measured flows.

Lewis Research Center, Cleveland, Ohio

The measurement-monitor-surface (MMS) procedure makes it possible to apply, to measurements of flow fields, the interactive computer-graphical techniques that process simulated flow-field data into mach-number contours and other pictures of selected aspects of the flows. The MMS procedure was developed to satisfy the need for an improved method of analyzing flow data obtained by two-dimensional laser anemometry in a low-aspect-ratio, transonic, axial-flow fan rotor in a turbomachine (see Figure 1).

Previously, two obstacles had impeded the application of the computer-graphical techniques to these data: one was insufficient resolution of the locations of the fan blades; the other was the relatively low density of measurement points in the flow field. The MMS procedure removes both obstacles by enriching the set of measurement data — in effect, interpolating the data to intermediate points to obtain finer resolution. The enriched data then con-

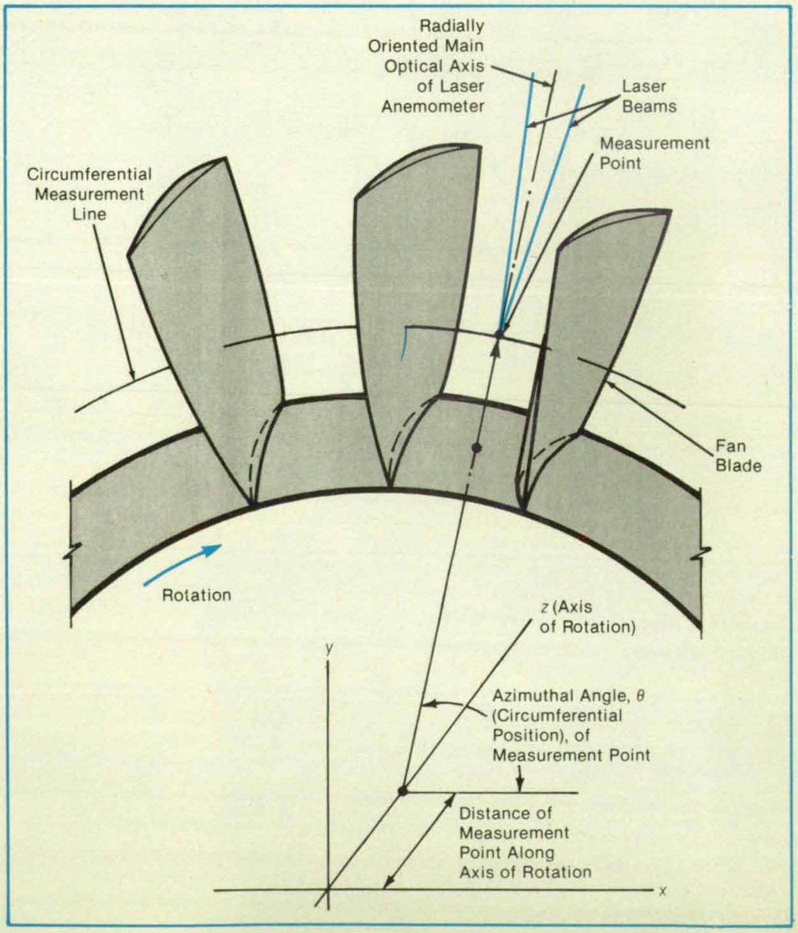

Figure 1. The **Laser Anemometer**, with its main optical axis oriented radially, measured axial and circumferential components of flow velocity at the intersection of the laser beams. As the blades rotated past the measurement position, the measurement point swept out a circumferential measurement line.

stitute the input data for the graphical programs.

The MMS procedure is based on a blend of techniques from four scientific disciplines. In the first step of the MMS procedure, a simple mathematical model of the physics of the flow is used to process the measurement data into data on the mass density, two components of momentum density, and energy density at each point in the measurement grid. This flow-physics model is based partly on the premise that the surfaces along which the measurement data were acquired approximate the locations of the rotor-design streamlines.

In the second step of the procedure, a simple grid-generation scheme is used to derive a grid that includes the shape of the rotor and streamline-type coordinates of all the points in the measurement grid. In the third step, a scattered-data-interpolation scheme known as Shepard's method is used to move information from the measurement grid to the new grid, thereby forming a monitor surface for mass density, two components of momentum density, and energy density. In the fourth and last step, computer-graphical techniques for the depiction of flows are used to make pictures of the monitor surfaces and of the quantities that can be calculated from them (see Figure 2).

This work was done by Jeffrey H. Miles of **Lewis Research Center**. *Further information may be found in NASA TM-103679 [N91-19044], "Improved Visualization of Flow Field Measurements."*

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.
LEW-15492

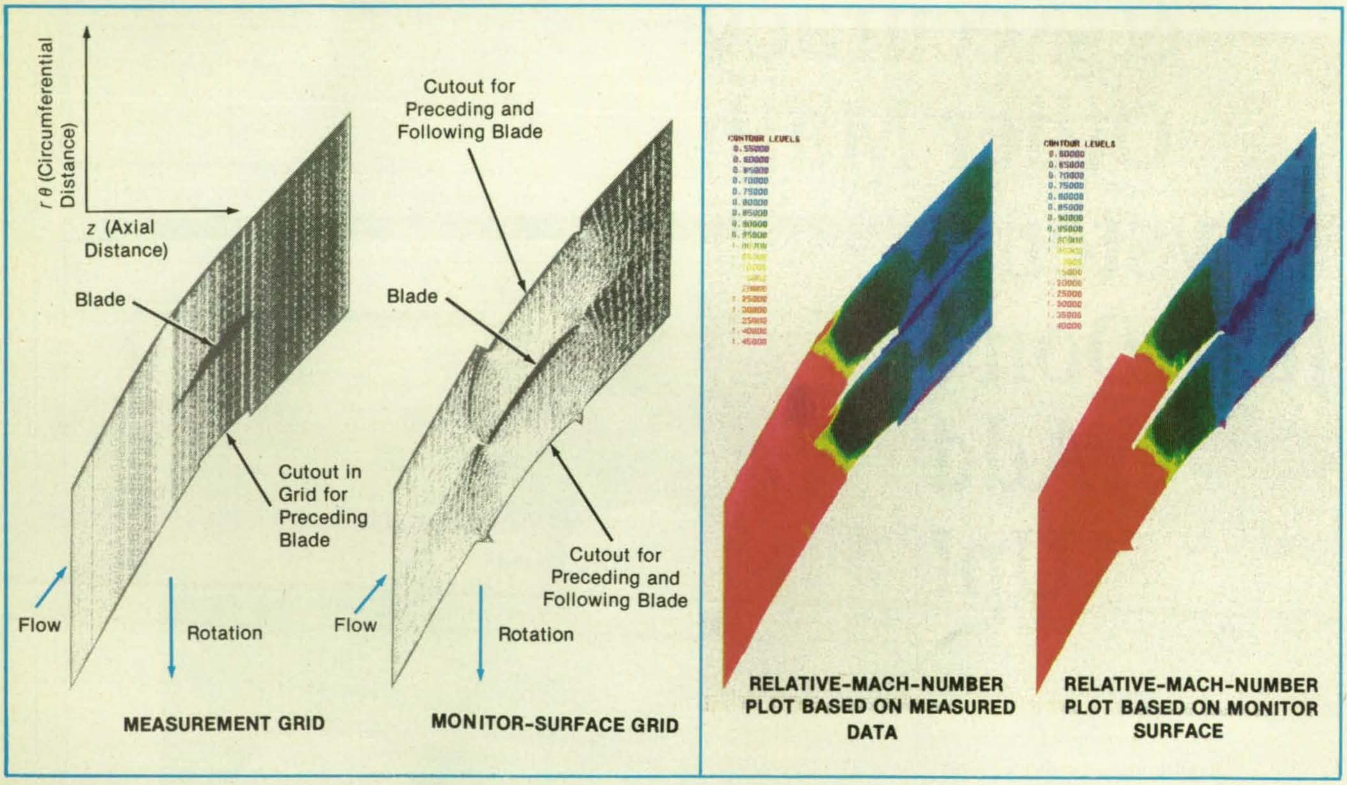

Figure 2. **Mach-Number Data Are Plotted** on the measurement and monitor-surface grids. Each color represents a region of constant mach number. Note the jagged appearance of the blade in the plot on the measurement grid and the smoother appearance on the monitor-surface grid.

Flow Analysis Software Toolkit

FAST helps the user to examine graphical depictions of numerical data.

The Flow Analysis Software Toolkit (FAST) computer program provides a software environment that facilitates visualization of data. FAST is a collection of separate programs (modules) that run simultaneously and help the user to examine the results of numerical and experimental simulations. The user can load data files, perform calculations on the data, view the results of these calculations, construct scenes of three-dimensional-appearing graphical objects, and plot, animate, and record the scenes.

The primary intended use of FAST is graphical depiction of computed flows, but FAST can also assist in the analysis of other types of data. FAST combines the capabilities of such programs as PLOT3D, RIP, SURF, and GAS into one software environment with modules that share data. Sharing data among modules eliminates the drudgery of transferring data between programs. All the modules in FAST have a consistent, highly interactive graphical user interface. Most commands are entered by pointing and clicking. The modular construction of FAST makes it flexible and extensible. The environment can be customconfigured, and new modules can be developed and added as needed.

The following modules have been developed for FAST: VIEWER, FILE IO, CALCULATOR, SURFER, TOPOLOGY, PLOTTER, TITLER, TRACER, ARCGRAPH, GQ, SURFERU, SHOTET, and ISOLEVU. A utility is also included to facilitate the inclusion of modules defined by the user in the FAST environment. The VIEWER module is the central control for the FAST environment. From VIEWER, the user can change attributes of objects, interactively position objects in three-dimensional space, define and save scenes, create animations, spawn new FAST modules, add view windows, and save and execute command scripts.

The FILE IO module loads PLOT3D-type grid, solution, Jacobian solution, and function files into the FAST environment. It consists of several windows for loading files, displaying attributes, and deleting data from shared memory. ARCGRAPH loads and renders ARCGraph metafiles in the FAST environment. This module enables the user to load, view, and set the attributes of an ARCGraph object.

The CALCULATOR module attaches to loaded grid and solution data and enables the user to calculate a variety of scalar and vector functions by use of these data. SURFER operates on the grid data read in by the FILE IO module and the scalar and vector fields generated by the CALCULATOR module. From these data, SURFER can generate a wide variety of grid surfaces. These surfaces can be rendered as points, lines, vectors, and polygons. In addition, each surface can be colored either by some constant color specified by the user, or by scalar field values. Surfaces can also be shaded. GQ is used to compute grid-quality measures on one-, two-, and three-dimensional structured grids. Sixteen base functions are intended to give users flexible means of testing the quality of any grid. These functions include grid-cell volume and two- and three-dimensional measure of skewness, orthogonality, aspect ratio, and stretching.

The TOPOLOGY module takes a grid and a vector field as input and displays the topology of the vector field. Vector-field features displayed by TOPOLOGY include critical points and eigenvector traces. PLOTTER attaches to grid and scalar field data and generates graphical objects, each of which contains a series of two-dimensional line plots.

TRACER is the module used to calculate and display particle paths once the data have been loaded or calculated. Traces can be computed individually, or a range of traces can be predefined and computed all at once.

The SURFERU, SHOTET, and ISOLEVU modules are intended for use with unstructured grids. These are grids with tetrahedral cells. SURFERU is similar to the SURFER module. The SHOTET module is used for looking at particular cells in a tetrahedral mesh. ISOLEVU is used for displaying data off surfaces in such forms as isosurfaces, cutting planes, cylinders, and spheres.

Finally, the TITLER enables creation of titles for inclusion in scenes and animations with FAST. Strings can be handled separately, each having its own font, font size, color, and style.

FAST is written in ANSI compliant FORTRAN 77 and C language for use on SGI IRIS-series workstations running IRIX 3.3 or later. It requires a minimum of 16 Mb of random-access memory for execution, although a capacity of 32 Mb is preferred. A minimum of 75 Mb of hard-disk memory space is required. System privileges are required during the installation. The standard distribution medium for FAST is a 0.25-in. (6.35-mm) streaming magnetic IRIS tape cartridge in UNIX tar format. This program was released in 1992.

IRIS, IRIX, and SGI are trademarks of Silicon Graphics, Inc. UNIX is a registered trademark of UNIX System Laboratories Inc.

This program was written by Velvin Watson and Karen Castagnera of **Ames Research Center**; *Todd Plessel, Fergus Merritt, Paul Kelaita, John West, Tim Sandstrom, Jean Clucas, Al Globus, Gordon Bancroft, and Jason Williams of Sterling Software; Pam Walatka of Computer Sciences Corp.; John Semans; Robert Neeley and Clyde Gumbert of Langley Research Center; and Mark Chaussee of the University of California, San Diego. For further information, Circle 46 on the TSP Request Card.*
ARC-13316

General-Purpose Graphics-Library Program

NASADIG provides flexibility for the creation of graphics with text.

The NASA Device Independent Graphics Library (NASADIG) computer program is a general-purpose graphics-library program for use with many computer-based-engineering and management application programs. NASADIG gives the user the opportunity to translate data into effective graphical displays for presentation. This software offers many features that provide the user with flexibility in creating graphics. These include two- and three-dimensional plotting, splines and polynomial interpolation, area blanking control, multiple log/linear axes, legends and text control, curve-thickness control, and multiple text fonts (18 regular, 4 bold).

NASADIG contains several groups of subroutines. Included are subroutines for definition of axes and areas of plots; setup and display of text; area blanking; setup of style, interpolation, and plotting of lines; control of color shading and patterns; control of legends, blocks of text, and characters; initialization of devices; setting of mixed alphabets; and other useful functions. The usefulness of many routines is dependent on the prior definition of basic parameters. The control structure of the program uses a serial-level construct with each routine restricted for activation at some prescribed level(s) of definition of problems.

NASADIG provides the following output device drivers: Selanar 100XL, VECTOR Move/Draw ASCII, and PostScript files; Tektronix 40xx, 41xx, and 4510 Rasterizer; DEC VT-240 (4014 mode); IBM AT/PC compatible with SmartTerm 240 emulator; HP Laser-grafix Film Recorder; and QMS 800/1200 and DEC LN03+ laser printers.

NASADIG is written in ANSI FORTRAN 77 and is intended to be machine-independent. The source code is currently distributed in formats compatible with DEC VAX-series computers operating VMS 5.0 or higher (MSC-21801), and UNIX computers (MSC-22001). The UNIX version has been successfully implemented on Sun-series computers running SunOS, SGI-series computers running IRIX, DECstation-series computers running ULTRIX, and a Cray X-MP computer running UNICOS. MSC-21801 is available in DEC VAX BACKUP format on either a 9-track, 1,600-bit/in. (630-bit/cm) magnetic tape (standard distribution medium) or a TK50 tape cartridge. MSC-22001 is available on a 0.25-in. (6.35-mm) streaming-magnetic-tape cartridge in UNIX tar format. With minor modification, the UNIX source code can be ported to other computers including IBM PC/AT-series and compatible computers. NASADIG is also available bundled with TRASYS, the Thermal Radiation Analysis System program (COS-10026, DEC VAX version; COS-10040 CRAY version).

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This program was written by Joseph E. Rogers of **Johnson Space Center**. *For further information, Circle 16 on the TSP Request Card.*
MSC-22001

Software for Graphical Representation of a Network

Animated schematic diagrams help engineers analyze designs.

The System Visualization Tool (SVT) computer program was developed to provide systems engineers with a means of graphically representing networks. SVT generates diagrams that illustrate the structures and states of networks defined by the users. The program provides systems engineers with a powerful tool that simplifies analysis of requirements and the testing and maintenance of complex software-controlled systems. SVT employs visual models that support the analysis of chronological sequences of requirements, simulation data, and related software functions. It currently employs these models to support analysis of the OMS and RCS propellant-distribution systems of the Space Shuttle; however, SVT can be applied to other pneumatic, hydraulic, and propellant-distribution networks.

SVT is used to define and view arbitrary configurations of such major hardware components of a system as propellant tanks, valves, propellant lines, and engines. In addition, it graphically displays the status of each component. One of the major advantages of SVT is that it utilizes visual cues to represent the configuration of each component within a network.

In its application to the Space Shuttle program, the SVT visually represents the state of a system by use of a color scheme to indicate the presence or absence of fuel and oxidizer throughout each leg of a network. Systems engineers are able to distinguish the states of mathematical models of the network models by interpreting the colors of the components of the network. Red is used to present information about fuel. Green is used to present information about oxidizer. Blue is used when information about both fuel and oxidizer is to be displayed. A dashed line anywhere within the network indicates that the presence of at least one propellant is unknown.

A unique feature of the SVT is its ability to control and monitor user-defined valves by associating switches and status indicators [known as measurement/stimulus identifiers (MSID's) or discretes] with them. Systems engineers can assign up to 12 discretes to control or monitor each valve. In addition, the rules of the network are determined by logical combinations of up to 4 discrete inputs for each of the valves defined in the network.

The SVT is written in Turbo Pascal, version 5.0, for IBM PC and compatible computers running PC-DOS or MS-DOS. Some files cannot be compiled under version 5.5 of Turbo Pascal; however, a sample executable code is provided. The program requires a mouse and a VGA or EGA graphics display with a minimum of 128K EGA random-access memory. Network images can be plotted on an IBM 7372 color plotter. Sample input files are included. The standard distribution medium for SVT is a set of two 5.25-in. (13.34-cm), 360K MS-DOS format diskettes. The contents of the diskettes are compressed using the PKWARE archiving tools. The utility to unarchive the files, PKUNZIP.EXE, is included. SVT was developed in 1990. Please note that there is no author support available for this program.

Turbo Pascal is a registered trademark of Borland International, Inc. IBM and IBM PC are trademarks of International Business Machines Corp. MS-DOS is a registered trademark of Microsoft Corp. PKWARE and PKUNZIP are registered trademarks of PKWare, Inc.

This program was written by R. William McAllister and James P. McLellan of IBM for **Johnson Space Center**. *For further information, Circle 13 on the TSP Request Card.*
MSC-21791

Graphics-Printing Program for the HP Paintjet Printer

IMPRINT prints color, gray, and black-and-white images from raster files.

The IMPRINT utility computer program has been developed to print graphics specified in raster files by use of the Hewlett-Packard Paintjet color printer. IMPRINT reads bit-mapped images from files on a UNIX-based graphics workstation and prints out three different types of images: wire-frame images, solid-color images, and gray-scale images. The wire-frame images are in continuous tone or, in the case of low resolution, in random gray scale. In the case of color images, IMPRINT also prints by use of a default palette of solid colors.

IMPRINT is written in C language for use on IRIS 4D-series computers running the IRIX operating system with an HP Paintjet printer. This program is written in ANSI C and may not be compilable on some UNIX compilers that do not meet ANSI standards. IMPRINT has been implemented by use of the MIPS C compiler, v3.0 and v3.3. IMPRINT supports raster images only. The standard distribution medium for this program is a 0.25-in. (6.35-mm) streaming-magnetic-tape cartridge in UNIX tar format. The program was developed in 1989.

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This program was written by Victor R. Atkins of Martin Marietta Corp. for **Marshall Space Flight Center**. *For further information, Circle 17 on the TSP Request Card.*
MFS-28526

Program Aids Creation of *X–Y* Plots

VEGAS enables programmers to create plots through high-level subroutine calls.

The VEGAS computer program enables application programmers to create X–Y plots in various modes through high-level subroutine calls. The modes consist of passive, autoupdate, and interactive modes. In the passive mode, VEGAS takes input data, produces a plot, and returns the control to an application program. In the autoupdate mode, VEGAS forms plots and automatically updates them as more information is received. In the interactive mode, VEGAS displays the plot and provides popup menus for the user to alter the appearance of the plot or to modify the data. Among the many functions available in interactive mode are the abilities to zoom in on particular points; to position the plot; to scale the axes; to remove specific points; and to flag points, modify points, and fit curves to points and to other curves. This package of software is built on top of, and is consistent with, the TEMPLATE graphics subroutine package.

VEGAS is written in FORTRAN 77 for DEC VAX-series computers running VMS. It requires TEMPLATE 6.0, a graphics library from the Liant Software Corp. VEGAS requires 350K of random-access memory. The program is available in DEC VAX BACKUP format on a 9-track, 1,600-bit/in. (630-bit/cm) magnetic tape (standard distribution medium) or on a TK50 tape cartridge. VEGAS was developed in 1987

DEC, VAX, and VMS are trademarks of Digital Equipment Corp. TEMPLATE is a registered trademark of Liant Software Corp.

This program was written by James F. Jeletic of **Goddard Space Flight Center**. *For further information, Circle 37 on the TSP Request Card.*
GSC-13470

Displaying Data From Duct/Fluid Calculations

DUCT6D postprocesses data from computations based on line-element models of the dynamics.

DUCT6D is a FORTRAN program for enhancing the postprocessing of data computed by programs based on line-element mathematical models, especially dynamical models of ducts and the fluids contained in them. DUCT6D is based partly on the assumption that a coupled duct/fluid-dynamic system has been analyzed by use of line elements that represent the beam properties of the duct and the one-dimensional acoustical properties of the fluid.

The inputs to DUCT6D include the geometric data from the model and the static, modal, or transient-displacement data from the solution. The output of DUCT6D represents the geometry of the coupled duct/fluid system and results of the analysis by use of three-dimensional shell elements. The shell-element display facilitates visualization of the cross-sectional dimensions and of the cross-sectional rotations of the duct that are caused by bending or torsion. In addition, acoustic pressures in the duct are represented with color and can be animated simultaneously with the structural displacements, thus conveying the results of the analysis far better than can animations of the original line-element model.

To make use of DUCT6D, the user must have at least a minimal knowledge of PATRAN. The format of the output of DUCT6D is a PATRAN neutral file and PATRAN Command Language (PCL) instructions. The PCL instructions automate the animation process, directing PATRAN how and where to read the animation data. Therefore, the user's skills need include only the ability to specify a neutral-format geometry and execute a PCL.

DUCT6D is written in FORTRAN for use on SGI-series computers. A minimum of 300K of random-access memory is required for execution. The standard distribution medium for DUCT6D is a 0.25-in. (6.35-mm) streaming-magnetic-tape cartridge in UNIX tar format. This program was developed in 1992.

This program was written by Joe B. Saxon and Terry L. Prickett of Rockwell International Corp. for **Marshall Space Flight Center**. *For further information, Circle 53 on the TSP Request Card.*
MFS-28750

Resistively Loaded Microstrip-Patch Antenna

Bandwidth is doubled by a simple modification.

Langley Research Center, Hampton, Virginia

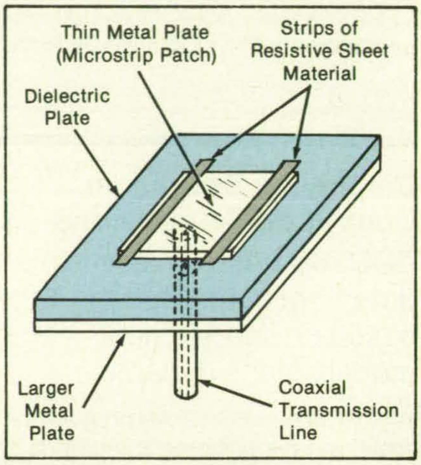
Conventional microstrip-patch antennas are limited to operation in very narrow frequency bands. A simple modification increases the width of the frequency band of such an antenna by a factor of two or more while maintaining nearly the same thickness with only a very slight increase in the width or length of the antenna.

A radiating microstrip-patch antenna consists mostly of a thin rectangular metal patch on one surface of a dielectric plate with a larger metal plate on the opposite surface. Excitation is supplied to the microstrip patch via an electrical connection to the center conductor of a coaxial transmission line, the outer conductor of which is connected to the larger metal plate.

The modification consists in the addition of strips of very thin electrically resistive sheet material (see figure). The resistive material is located along the edges of the patch to attenuate the high currents near the edges and to cause the effects of the edges to be a smoother function of frequency and, thus, to cause the resonance of the patch to be less sensitive to the width of the patch. The result is an increase in the bandwidth of the basic microstrip-patch antenna. Although the example illustrated in the figure shows two resistive strips applied to a simple rectangular microstrip-patch antenna, more-complicated microstrip-patch antennas could also be modified by the addition of various resistive strips to increase the bandwidths of transmission and reception of signals in various polarizations.

The bandwidth of a working model of the modified antenna was found to be more than twice that of a working model of the unmodified antenna. Optimum bandwidth performance can be obtained by adjustment of the shapes, resistances, and locations of the resistive strips.

This work was done by Marion C. Bailey of **Langley Research Center**. *No further documentation is available.*
LAR-13973



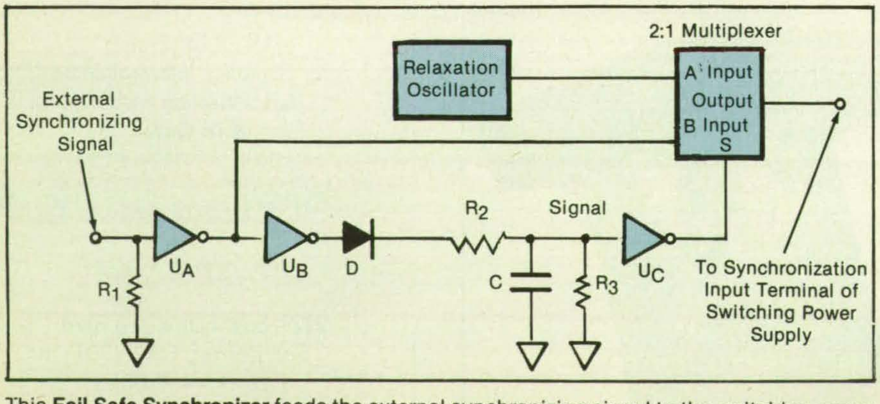
Strips of a Thin Resistive Material are added near two edges of a conventional microstrip-patch antenna.

Fail-Safe Synchronizer for Power Supply

This circuit provides a timing signal when an external synchronizing signal is lost.

Goddard Space Flight Center, Greenbelt, Maryland

The circuit shown in the figure provides synchronizing signals to a switching power supply in which the switching is required to be synchronized with external events. During normal operation, this circuit passes the external synchronizing signal to the power supply. When the external synchronizing signal is lost (e.g., because of a malfunction in external circuitry or because of testing), this circuit provides a substitute timing signal from a free-running internal relaxation oscillator.



This **Fail-Safe Synchronizer** feeds the external synchronizing signal to the switching power supply. When the external synchronizing signal is lost, it feeds the signal from the relaxation oscillator to the power supply.

The heart of this circuit is hex inverter U, three parts of which are denoted on the figure as U_A through U_C. Other parts of U are contained in the relaxation oscillator. During normal operation, the external synchronizing signal is buffered by U_A and fed to the B input of the multiplexer; it is also buffered by U_B and used to charge capacitor C through Schottky diode D and current-limiting resistor R_2. R_3 is chosen large enough that (1) it bleeds the charge off C with an acceptably long time constant and (2) to minimize the voltage drop in the resistive divider of R_2 and R_3, it is large with respect to R_2.

Hex inverter U has hysteresis inputs. During normal operation, C remains charged to a potential above the input high voltage of U_C, which is thereby made to maintain a low-output (logic 0) state at the S input of the multiplexer. In this logic 0 state, the multiplexer passes the signal from input port B (in this case, the buffered external synchronizing signal) to its output port.

When the external synchronizing signal is lost, resistor R_1 brings the input terminal of U_A down to low voltage (logic 0). Therefore, no forward bias is available to charge capacitor C through diode D. When C has been discharged to a sufficiently low voltage, U_C and the S input of the multiplexer switch to the logic 1 state, in which the multiplexer passes the signal from input port A (in this case, the signal from the relaxation oscillator) to its output port.

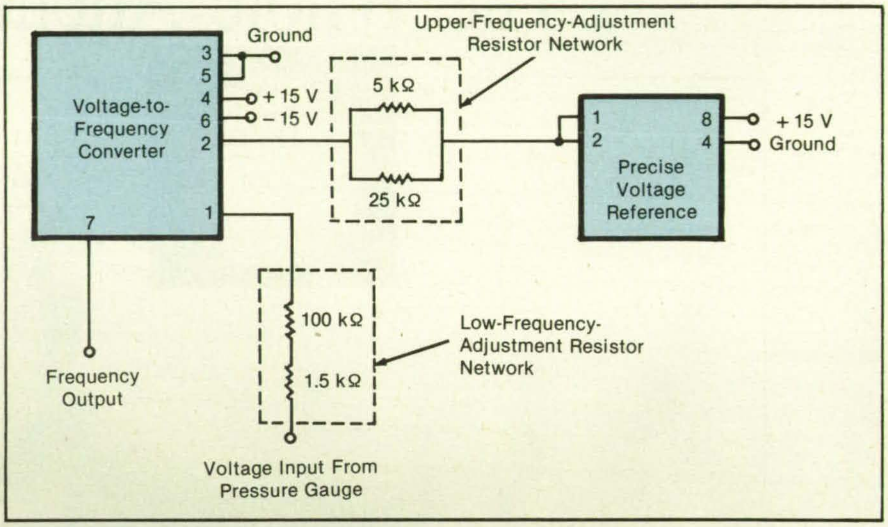
This work was done by Richard B. Katz of **Goddard Space Flight Center**. *For further information, Circle 44 on the TSP Request Card.*
GSC-13544

Voltage-to-Frequency Converter for Pressure Calibration

Accuracy of a pressure standard is increased.

Langley Research Center, Hampton, Virginia

Measurements of pressures on the walls of wind tunnels and on the surfaces of models in the wind tunnels at the National Transonic Facility at NASA's Langley Research Center are now made with the help of an electronically scanned pressure-measurement (ESP) system. For in situ calibration of the ESP system, a pressure standard of 200 psia (1.38 MPa, absolute) was chosen because of the 15- to 135-psia (0.10- to 0.93-MPa, absolute) operating-pressure range and the specific design of the commercial pressure instrumentation. The uncertainty of the standard, ±0.02 percent of full scale, accounts for a limiting pressure error of ±0.04 psi (±0.3 kPa). This significant error can be reduced by using a high-line-pressure, low-differential-pressure standard, the ranges of which match those of the ESP modules, to measure the calibration pressures. Currently available high-accuracy pressure sensors that satisfy this requirement put out voltage indications of pressures instead of the frequency indications of pressures required for use in the ESP system. Therefore, a voltage-to-frequency converter circuit was developed to convert the analog output to frequency output in the range of 32 to 42 kHz that is required for direct connection with the ESP system.



Two Resistance Networks provide upper and lower frequencies that correspond to zero and full-scale pressure outputs, respectively.

The voltage-to-frequency converter circuit, shown in the figure, is designed to convert the 0- to 5-Vdc analog output voltage from a high-line-pressure, low-differential-pressure standard to the required frequency range. The main components of the circuit are the precise voltage reference, the voltage-to-frequency converter, and two frequency-adjustment resistance networks. A precise 5-Vdc level from the voltage reference is coupled to the voltage-to-frequency converter through the upper-frequency-adjustment resistance network. The total resistance of this network is chosen to result in the generation of the desired upper frequency, 42 kHz, which corresponds to the zero-pressure output of the standard.

The analog output of the pressure standard is fed to the voltage-to-frequency converter through the lower-frequency-adjustment resistance network. The resistance of this network is chosen to obtain the lower frequency, 32 kHz, which corresponds to the full-scale output of the pressure standard. These two resistance networks enable the use of any pressure standard that puts out an analog voltage in the range of 0 to 10 Vdc. The output of the circuit is connected directly into the ESP system in the same manner as that of the manufacturer's pressure standard.

Calibration showed that the computed pressure agreed with the known pressure to within 0.05 percent of full scale or 0.015 psi (0.1 kPa) for the range selected, yielding an error reduction of about 60 percent. This development enables the selection of a wider variety of high-accuracy pressure standards to enhance the accuracy of measurement of the ESP instrumentation while requiring little modification of the manufacturer's system and no modification of the operating software of the system. The voltage-to-frequency converter is useful primarily in wind-tunnel instrumentation and is readily adaptable to commercial instruments currently in use.

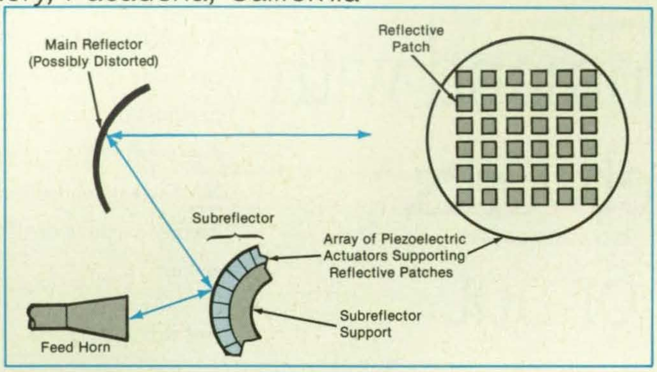
This work was done by Bradley S. Sealey and Michael Mitchell of **Langley Research Center**. *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Langley Research Center [see page 24]. Refer to LAR-14255

Piezoelectrically Adjustable Array of Antenna Reflectors

The array would be adjusted to compensate for distortions.

NASA's Jet Propulsion Laboratory, Pasadena, California



Reflecting Patches on Piezoelectric Actuators would constitute the subreflector. The actuators would be adjusted individually to displace the reflecting patches, thereby compensating for distortion in the main reflector and restoring the desired radiation pattern.

In a proposed method of correcting for distortions in the main reflector of a paraboloidal-dish or similar microwave antenna, compensating distortions to restore the desired radiation pattern would be imposed on the subreflector. Distortions of the main reflector can include manufacturing errors plus gravitational, vibrational, thermal, and wind distortions. Heretofore, in some applications, distortions of main reflectors have been compensated by use of arrays of radiating elements fed through complicated power-dividing and phase-shifting networks. Such networks introduce radio-frequency losses, which increase with operating frequency.

In the proposed method, the radio-frequency wiring would be simplified and radio-frequency losses reduced by elimination of the networks. Instead, the surface of the subreflector would be divided into many reflective patches, each of which would be mounted on a piezoelectric actuator to make it independently adjustable (see figure). An associated very-large-scale integrated circuit would act as a controller. In response to command signals and/or measurements of the radiation pattern, the circuit would control the dc bias to be applied to each piezoelectric actuator, which would respond by displacing its reflective patch to effect the commanded local radio-frequency-path-length compensation.

This work was done by Te-Kao Wu and Christopher S. Ruf of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, Circle 48 on the TSP Request Card.*
NPO-18538

Development of Multilayer Metallic Mesh Low-Pass Infrared Filters

Prototype filters exhibit the desired transmissivity vs. wavelength.

NASA's Jet Propulsion Laboratory, Pasadena, California

Etched-metallic-film low-frequency-pass (long-wavelength-pass) filters with relatively sharp cut-on at wavelengths of 30 to 40 μm have been developed for use in infrared instruments. These filters would be particularly useful in observing astronomical bodies that exhibit wide temperature dynamic range. The reduction in the signal dynamic range (due to the temperature extremes) could be accomplished by blocking the short-wavelength radiance by using low-pass metallic mesh filters.

The concept of etched-metallic-film filters is not new; what is new is the solution of the practical problems of design and fabrication of filters for the particular wavelength range. The most widely used form of metallic mesh filters consists of a regular two-dimensional array of either square holes in a thin metallic film (inductive mesh) or metal squares deposited on a suitable substrate (capacitive mesh) as shown in Figure 1. For transmission, the inductive mesh behaves as a high-pass (low-wavelength) filter, and the capacitive mesh behaves as a low-pass (high-wavelength) filter. The filters that are being developed are of the capacitive form. While a single capacitive mesh structure already constitutes a low-pass filter, the performance can be improved (making the low-pass characteristic more square-like) by stacking two or more such filters.

One of the advantages of etched-metallic-film dichroic filters, whether inductive or capacitive, is design flexibility: whereas the frequency responses of optical-type infrared filters depend primarily on the properties of the filter materials, the frequency responses of the etched-metallic-film filters depend primarily on the dimensions and shapes of the metallic elements and the gaps between them. In the case of multiple-layer filters of this type, the distances between layers are additional design parameters that affect the frequency responses.

Other design parameters that afford less flexibility are the indices of refraction, absorption coefficients, and thicknesses of the dielectric layers that support the multilayer capacitive mesh films. Because these parameters are not easily controllable, the search for the optimum dielectric material is a significant part of the design task. Mylar (or equivalent) polyethylene terephthalate film 6.35 μm thick was selected as the prototype dielectric material because it has suitable electrical and mechanical properties and has been used previously to support capacitive-grid etched-metallic-film filters.

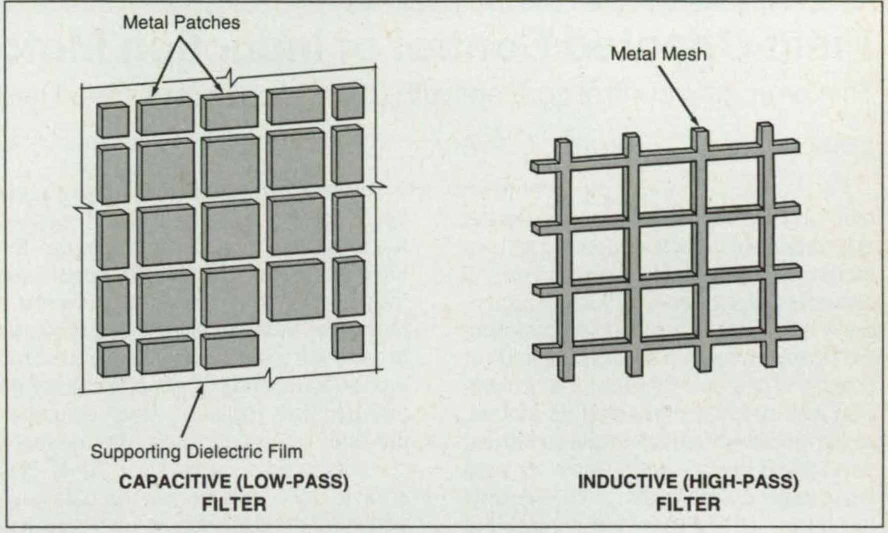


Figure 1. **Capacitive and Inductive Mesh Filter** geometries are shown. The capacitive filter is composed of an array of metal squares on a dielectric substrate, and the inductive filter consists of an array of crossed conductive wires.

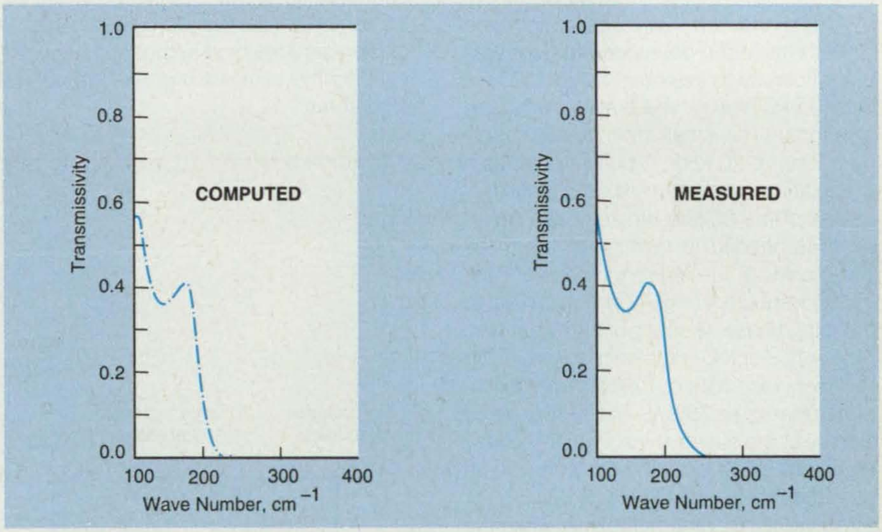


Figure 2. The **Computed and Measured Frequency** responses of the prototype multilayer filter are in substantial agreement.

The onset of transmissivity with increasing wavelength can be made sharper by use of multiple layers with various spatial periodicities and gaps between the metal patches. Various prototype multilayer designs were investigated by computer simulation, leading to a seven-layer design comprising four metallic films deposited on the surfaces of three stacked dielectric substrates. Figure 2 compares the computed and measured frequency response of a prototype fabricated according to this design.

This work was done by Sohrab Mobasser of Caltech and Larry S. Horowitz and O'Dale K. Griffith of Applied Modern Technologies, Inc., for **NASA's Jet Propulsion Laboratory.** *For further information, Circle 51 on the TSP Request Card.*

NPO-18632

Field-Oriented Control of Induction Motors

This emerging control concept will enhance control of speed and torque.

Lewis Research Center, Cleveland, Ohio

Field-oriented control represents an emerging approach to control of the speeds and torques of induction motors intended for use in large variable-speed drives and servocontrol actuators. Induction motors are known for simple, rugged construction; the ability to sustain overloads for short times; and relatively light weight in comparison with permanent-magnet dc motors, which are used in small variable-speed and servodrives but are not suitable for scaling to larger power levels (> 25 kW). Until the advent of field-oriented control, the need for complicated control systems to vary the torques and speeds of induction motors has inhibited the use of them in the intended new applications.

A field-oriented control demonstration system has been developed for use with a commercial three-phase, 400-Hz, 208-V, 5-hp (3.7-kW) motor. These systems include a resonant (for small size) power supply operating at 20 kHz. A pulse-population-modulation subsystem selects individual pulses of the 20-kHz single-phase waveform as needed to synthesize the three waveforms of the appropriate lower (machine) frequency (e.g., 400 Hz) applied to the three phase windings of the motor (see Figure 1). Electric actuation systems using this technology are currently being built to peak powers of 70 kW. The amplitude of voltage of the effective machine-frequency waveform is determined by the momentary frequency (equivalently, population or temporal density) of the pulses, while the machine frequency is determined by the rate of repetition of the overall temporal pattern of pulses. The system enables independent control of both voltage and frequency.

The induction motor can be controlled in either a voltage- or a current-regulation mode. In the voltage-regulation mode, control is imposed directly by an external programmable controller. In the current mode, rotor-speed feedback information is used in a closed-loop control scheme. In this mode, a speed-control circuit adjusts the torque command within microseconds. For example, a maximum-torque-change command can be sent, causing the motor to reverse direction over the full speed range very rapidly.

As shown in more detail in Figure 2, the speed-control circuit board takes the speed feedback information and generates the torque-command current. This current and the manually commanded flux current are processed by the remaining circuit boards to generate the desired phase-current-reference commands. These commands are then sent to a regulator, which compares the reference commands with feedback currents to produce an error signal. This error is used to generate the gate-drive signals for the pulse-population-modulation converter.

Subsequent efforts will be devoted to reduction of the size and complexity of the control system. Of the options considered, the use of a digital signal processor appears to represent the best approach because it enables the evaluation of various control algorithms.

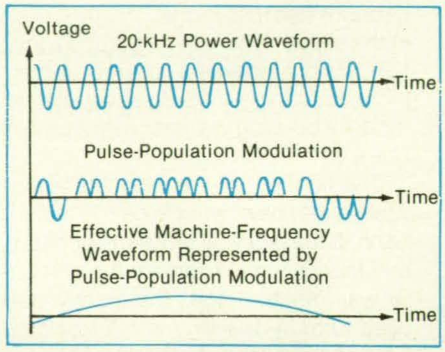


Figure 1. **Pulse-Population Modulation** is used to synthesize a waveform at a lower frequency, approximately equivalent in effect to a sinusoid of that lower frequency applied to a phase of the motor.

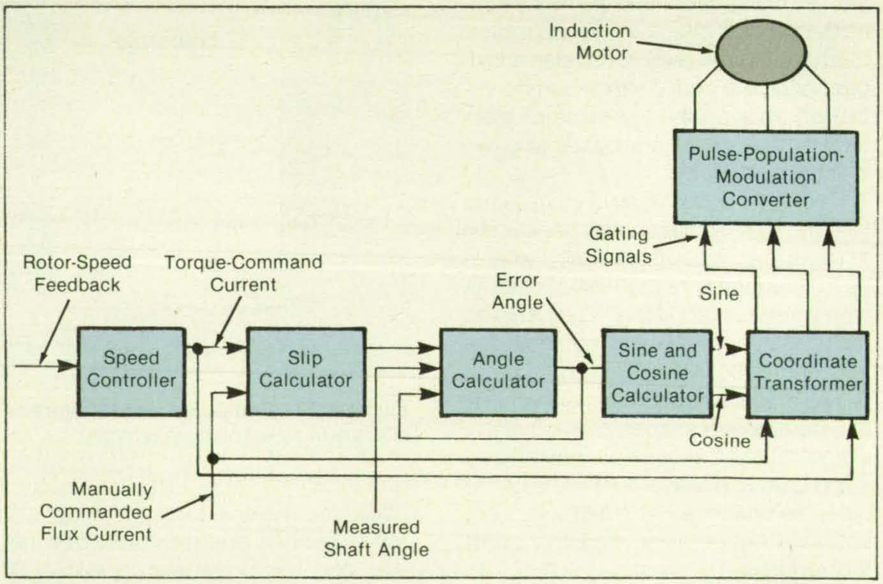


Figure 2. The **Field-Oriented Control System** provides for feedback control of torque or speed or both.

This work was done by Linda M. Burrows and Mary Ellen Roth of ***Lewis Research Center*** *and Don S. Zinger of the University of Akron. Further information may be found in NASA TM-103154 [N90-22731], "Field Oriented Control of Induction Motors."*

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.
LEW-15335

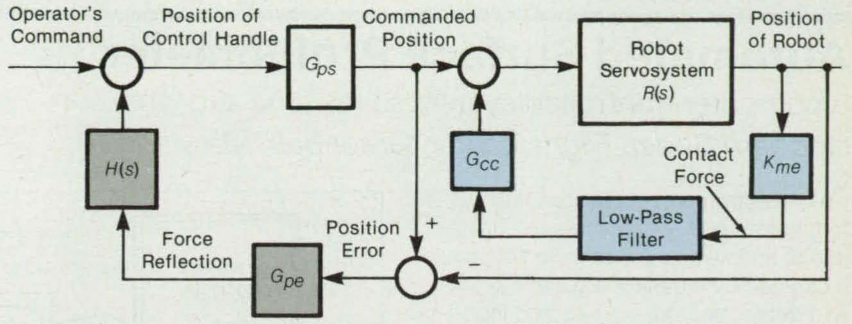
Remote Robot Control With High Force-Feedback Gain

High gain allows more sensitive, faster operation.

NASA's Jet Propulsion Laboratory, Pasadena, California

An improved scheme for force-reflecting hand control of a remote robotic manipulator provides unprecedently high force-reflection gain — as much as 2 or 3, even when dissimilar master and slave arms are used. Until now, a gain of $\frac{1}{10}$ has been the maximum attainable without loss of stability for a very stiff typical industrial robot arm; that is, the maximum force that could be applied to an operator's hand via a control handle was only one-tenth the force of contact (as measured by force and torque sensors on the robot) between the associated remote manipulator and the manipulated object. With such a low gain, small differences between the actual and commanded positions of the manipulator could create undesirably large contact forces. For safety and reliability, larger gains are needed.

Part of the reflected force in the improved scheme is proportional to the position error, which is the difference between the actual position of the robot arm and the position commanded by the operator. This position-error force-reflection concept is combined with compliance control (described below) to enable the required high gain.



Notes: 1. The G's denote gains.
2. $H(s)$ and $R(s)$ denote transfer functions in the Laplace-transform domain.
3. K_{me} denotes effective stiffness of the contact environment.

Three Feedback Loops are contained in a remote robot control system that exerts position-error-based force feedback and compliance control. Outputs of force and torque sensors on the robot are not used directly for force reflection, but for compliance control, while errors in position are used to generate reflected forces.

Compliance control is implemented at the robot (which can be remote from the operator's control station) by low-pass-filtering the outputs of force and/or torque sensors on the robot and using the filtered signals to alter the operator's position and/or orientation command. The filtered force and/or torque feedback makes the robot hand behave as though, in each degree of freedom, a damped spring were in series with the otherwise stiff, controlled-position manipulator.

The improved control scheme was compared with seven other control schemes in experiments in which the operators controlled robots so that they inserted a peg in a hole and inserted and removed a screw in a tapped hole. In both tasks, position-error-based force feedback with compliance control proved to be the best control scheme, yielding the shortest completion times with the smallest contact forces.

This work was done by Won S. Kim of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, Circle 49 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 24]. Refer to NPO-18668

Automated Surface Profilometer

A computer-controlled system saves time and labor.

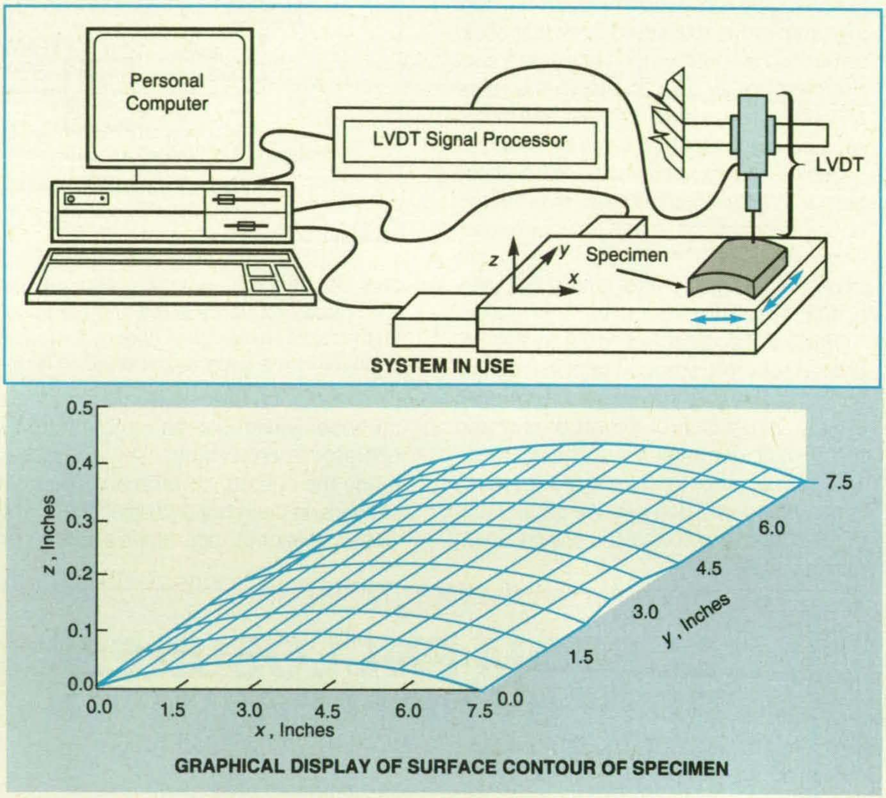
Goddard Space Flight Center, Greenbelt, Maryland

An electromechanical scanning system automatically measures the deviation of sheets and plates from flatness. It can quickly measure a surface profile and detect bumps, bulges, and indentations as small as 0.001 in. (25 mm) in height or depth.

Unlike currently available coordinate-measuring machines, this system is highly automated. The new system thus saves hours of labor in measuring specimens ranging in size from a few centimeters to about a meter.

The system (see figure) includes a personal computer, an *x–y* scanning table, and a digital linear variable differential transformer (LVDT) as the measuring element. Under control by the computer, the *x–y* table drives the specimen plate back and forth under the LVDT, stopping to take LVDT surface-height readings at programmed locations, until the scan has been completed.

The computer repeatedly records the *x–y* coordinates and the LVDT reading (*z*) at each measurement position. From these data, the computer constructs and displays a three-dimensional (*x, y, z*) plot of the surface of the specimen. The *z* dimension (LVDT displacement) is shown on an exaggerated scale to emphasize defects.



The ***x–y* Table Moves the Specimen** to programmed locations under the LVDT while the computer records the surface-height readings of the LVDT. The resulting graphical display shows the surface contour.

This work was done by E. James Chern of **Goddard Space Flight Center**. *For further information, Circle 3 on the TSP Request Card.*
GSC-13513

Acoustical Detection of Leakage in a Combustor

Abnormal combustion excites a characteristic standing wave.

Langley Research Center, Hampton, Virginia

An acoustic transducer and a relatively simple analog electronic circuit quickly and automatically generate an alarm when abnormal combustion occurs upstream of the spray bar (fuel injector) in a combustion chamber. During normal, steady operation, fuel is sprayed downstream, and combustion takes place downstream of the spray bar. Sometimes prolonged thermal stress causes the spray bar to crack, allowing fuel to leak out upstream of the spray bar. The leaked fuel gives rise to abnormal upstream combustion, which can cause serious damage to both the spray bar and the other equipment in the combustion chamber. The acoustical leak-detection system gives an early warning of failure, enabling the operating personnel to stop the combustion process and repair the spray bar before the leak grows large enough to cause damage.

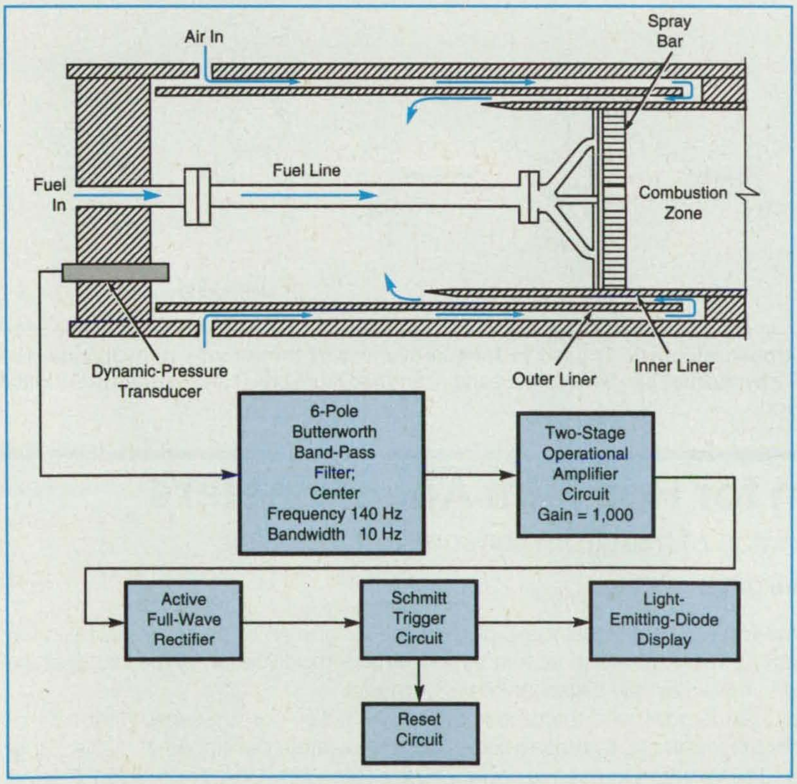
The figure is a simplified illustration of a combustion chamber and the acoustical leak-detection system. Prior experience shows that upstream combustion excites an acoustic standing wave in the fundamental mode of that portion of the chamber that lies between the fuel injector and the exit end of the inner liner. In the original combustion chamber for which this system was designed [an 8-ft (2.4-m) high-temperature test chamber], this mode has a frequency of 140 Hz. In normal operation, the acoustic spectrum includes only a small peak at this frequency — slightly above the background noise with 30Hz being predominant (fundamental mode of entire chamber). When upstream combustion occurs, this spectral peak becomes large.

To detect this characteristic acoustic emission, the acoustic transducer (a simple dynamic-pressure transducer) can be placed in the air-supply duct or in the normally cool portion of the combustion chamber upstream of the spray bar. The output of the transducer is narrow-band-pass-filtered at the characteristic frequency (140 Hz in the original application), amplified, and rectified. The rectified signal is sent to a trigger circuit that activates the alarm when the signal exceeds a level indicative of a potentially damaging fuel leak.

This simple acoustic-signal-detection concept is also applicable to engines, gas turbines, furnaces, and other machines in which acoustic emissions at known frequencies signify the onset of damage. For example, bearings in rotating machines could be monitored for the emergence of characteristic frequencies that have been shown in previous tests to be associated with incipient failure. It is also possible to monitor for signs of trouble at multiple frequencies by feeding the output of the transducer simultaneously to multiple band-pass filters and associated circuitry, including a separate trigger circuit set to the appropriate level for each frequency.

This work was done by Richard L. Puster of **Langley Research Center** *and Jeffrey L. Petty of PRC Kentron, Inc. For further information, Circle 67 on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Langley Research Center [see page 24]. Refer to LAR-14683.



Acoustic Emissions at a Characteristic Frequency (in this case, 140 Hz) are excited by abnormal combustion upstream of the spray bar. These emissions are detected by use of a dynamic-pressure transducer and relatively simple band-pass, alarm-level circuitry. The alarm signal is generated quickly, without the long delay inherent in more-elaborate circuitry that performs spectral analysis.

Physical Sciences

Sensitive, Selective Test for Hydrazines

Derivatives of hydrazines are formed, then subjected to gas chromatography and detected via chemiluminescence.

John F. Kennedy Space Center, Florida

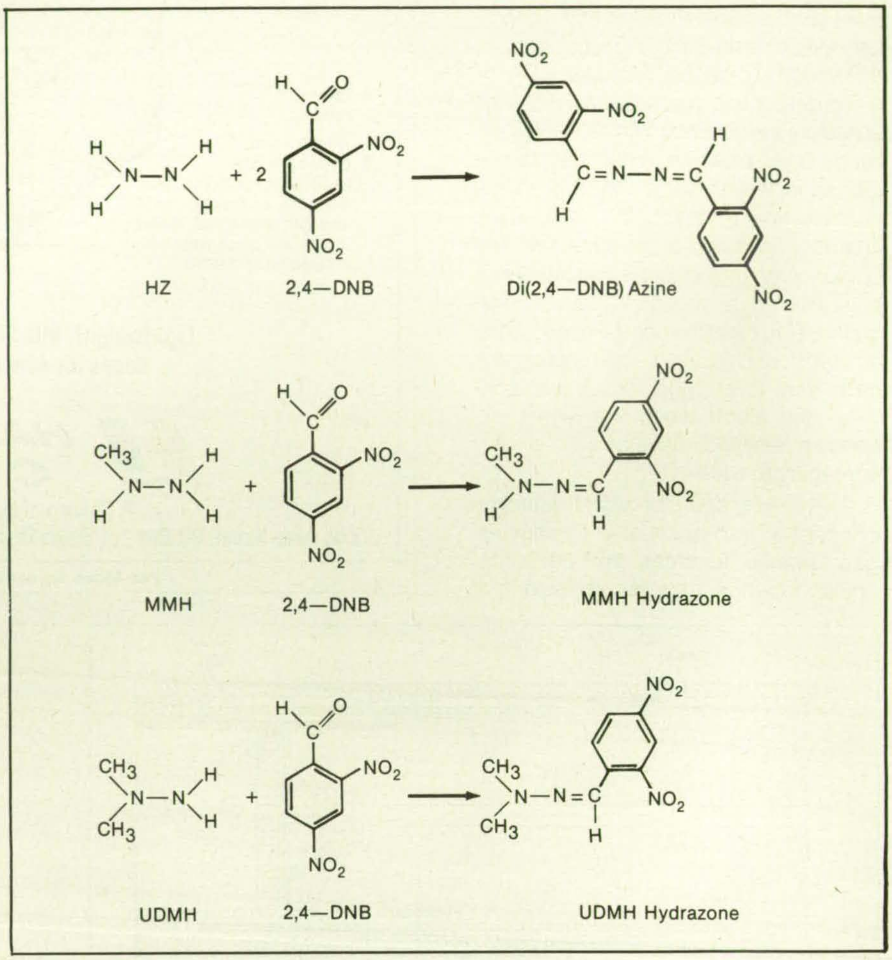
In a method of detecting and quantifying hydrazine vapors, the vapors are reacted with a dinitro compound to enhance sensitivity and selectivity. Hydrazine (HZ), monomethyl hydrazine (MMH), and unsymmetrical dimethylhydrazine (UDMH) can be analyzed quantitatively and qualitatively, either alone or in mixtures.

The vapors are collected and reacted with 2,4-dinitrobenzaldehyde (DNB). This step makes it possible to concentrate the hydrazine in derivative form, thereby increasing sensitivity to low initial concentrations. The step also increases selectivity because only those constituents of the sample that react with DNB are concentrated for analysis.

The three derivatives of the three hydrazines are separated by capillary gas chromatography and each is then detected individually by chemiluminescence. The use of DNB as the derivatizing agent increases the selectivity of the chemiluminescence-detection step by enabling the pyrolysis of the analytes in the absence of oxygen. It also provides two NO molecules per DNB molecule, further increasing sensitivity.

This work was done by David Roundbehler and Stephen MacDonald of Thermedics Inc. for **Kennedy Space Center**. *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Kennedy Space Center [see page 24]. Refer to KSC-11561



2,4-Dinitrobenzaldehyde is used to form derivatives of three forms of hydrazine. The derivative hydrazines can be identified and quantified more precisely than can the original compound.

Active Thermal Isolation for Hot-Film Anemometers

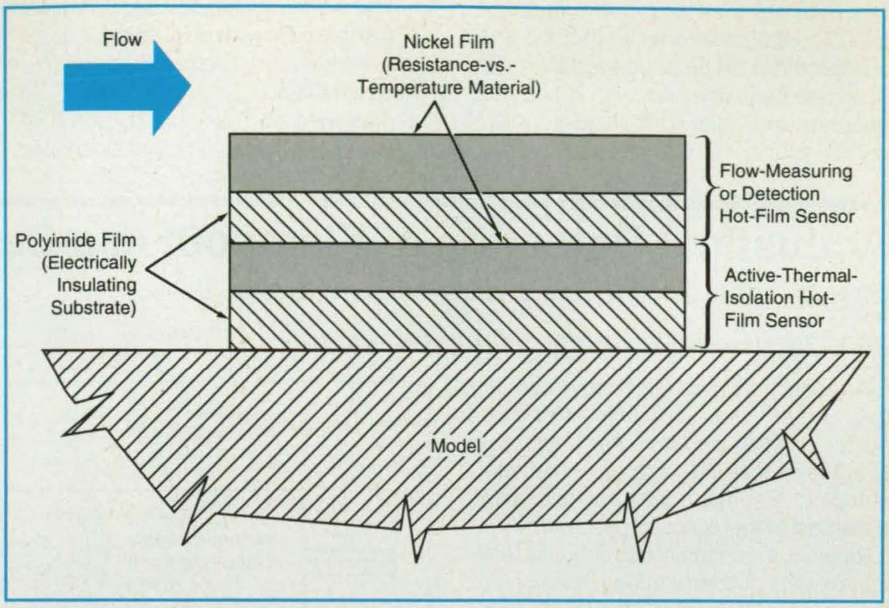
Local heating compensates for conduction of heat from sensors into modules.

Langley Research Center, Hampton, Virginia

Transitions in flows on wind-tunnel models can be detected by use of hot-nickel-film sensors deposited on substrates of polyimide and bonded to the surfaces of the models. A substrate layer, in this case, Kapton® (or equivalent) polyimide provides electrical isolation but very low thermal isolation. Substantial heat is lost to the model by conduction, affecting the frequency response and resolution of the sensor. A thicker substrate would reduce thermal loss, but the substrate must be made as thin as possible to minimize flow disturbances. In one technique now used to compensate for this thermal loss, the entire model is heated by internal sources. However, the temperature of the model changes much more slowly than do the temperatures of the hot-film sensors. Furthermore, the internal sources of heat consume a substantial amount of power, and the installation of them necessitates extensive modification of the inside of the model.

An active hot-film-sensor/thermal-isolation system developed at NASA Langley Research Center provides thermal isolation from the model and retains the advantage of low substrate thickness, so that the sensor does not disturb the boundary layer significantly. The system, shown in the figure, consists of two hot-film sensors, one mounted directly on the other with sensing areas vertically aligned. This two-sensor assembly is mounted on the surface of the model. Each hot film consists of metal with a high temperature coefficient of electrical resistance; in this case nickel, which is deposited or glued on a highly electrically insulating substrate material like polyimide.

The outer (top in the figure) sensor detects changes in boundary-layer flow phenomena, and the inner (bottom in the figure) sensor actively thermally isolates the top sensor from the model. The inner sensor is the active thermal-isolation sensor, which provides dynamic localized heating of the model and is operated with the same response time as that of the detection (outer or top) sensor. The inner hot-film sensor compensates for thermal properties of the model by providing heat at the rate needed to sustain the thermal conduction, leaving the outer hot-film sensor free to respond to changes in flow, independently of thermal properties of the model.



Two Hot-Film Sensors are stacked on a wind-tunnel model. The outer (top) sensor detects changes in the boundary-layer flow. The inner (bottom) sensor provides active thermal isolation between the outer sensor and the model.

One of the major benefits of this system is that the conductive transfer of heat can be controlled with the same response time as that of the hot-film sensor. Stated somewhat differently, the thermal boundary condition can be controlled at the response time of the detection hot-film sensor, which is significantly less than the response time of an internally heated model.

In comparison with an internally heated model, this system requires less power to maintain the outer hot-film sensor at a given temperature, thus enabling the system to respond over a greater dynamic range before the power limits of the instrument are reached. This reduction in power has enabled the use of much higher operating temperatures on thermally conductive models. The increased operating temperatures directly correspond to the ability to detect boundary-layer turbulence phenomena at higher frequencies. Also, this system does not require any modifications of the model. The stacked sensors can be bonded to the surface of most wind-tunnel models, even to curved surfaces, and then removed after completion of the experiments.

This work was done by Scott D. Martinson, David L. Gray, and Debra L. Carraway of **Langley Research Center**. *For further information, Circle 84 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, Langley Research Center [see page 24]. Refer to LAR-14612.

Probing Composites With Integrated Polar Backscatter

Unwanted signals caused by reflections from surface textures are removed in postprocessing.

Langley Research Center, Hampton, Virginia

Integrated polar backscatter (IPB) is a technique wherein an ultrasonic probe signal is incident upon a part at a non-normal angle of incidence and the resulting scattered ultrasonic signal is measured and integrated to produce a single NDE quantity. The method is used to detect and evaluate quantitatively the internal conditions of composite materials. By use of IPB, one can evaluate the internal structure of a fiber composite and detect such structural defects as those caused by broken fibers, porosity, and inclusions. A serious problem, however, occurs in practice because the surface texture of a typical composite produces reflected waves that cause incorrect, excessive values of IPB.

A method of removing or avoiding this signal aberration should make IPB a practical technique for nondestructive evaluation (NDE) of composite-material parts that have cloth surface impressions. The method involves the recognition that the cloth impression on the surface of the composite causes a reflection that is analogous to that from a diffraction grating in optics. Depending upon the nature and thickness of a composite part, the polar backscattered signal may contain the sum of several signals emanating from reflection- and refraction-type gratings caused by the surface. Empirically, in samples without surface impressions, the internal scattering components of the polar backscatter signals appear to behave approximately linearly. Conversely, there are periodic peaks in the frequency domain if there is a surface impression on either or both sides of a part.

The IPB data are recorded digitally and stored for off-line computer processing. Fourier analysis of the total signal can be used to extract the periodicity constants required to quantify the unwanted reflected components. In this way, IPB, as applied to composites with surface texture, can be accurately computed by applying an appropriate filter function. In an alternate method, IPB would be computed with frequency components that do not include the periodic peaks in the frequency domain.

This method requires no preparation of the sample. It requires only a technique of acquisition of digital radio-frequency data, which method is rapidly becoming the standard means of acquisition of ultrasonic data in field installations.

The data are recorded in the time domain and stored off-line, so that the IPB computation can be performed after the scan has been finished, with little or no effect on the initial scan (data-acquisition) time or on the sample.

This work was done by Eric I. Madaras of **Langley Research Center**. *For further information, Circle 96 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, Langley Research Center [see page 24]. Refer to LAR-14535.

Acoustical Detection of Flameout in a Combustor

Loss of a standing wave signifies incipient loss of flame.

Langley Research Center, Hampton, Virginia

An acoustic flameout detector automatically shuts off the supply of fuel to a combustor in which the flame has been or is about to be lost. This and other flameout detectors are important safety systems: If the flow of fuel is not stopped quickly in a flameout, the accumulated unburned fuel can reignite suddenly in an explosion. In the combustor for an 8-ft (2.4-m) high-temperature tunnel for which the acoustic flameout detector was first designed, the explosion could be large enough to cause death and injury as well as destruction of the combustor and nearby equipment.

Prior flameout detectors have based on optical and thermal detection principles. The transducers in some of these detectors cannot give reliable indications of flameout until the flame has traveled completely out of the combustor. The transducers in others respond more rapidly, but they also respond to phenomena that are not unique to flameouts. All depend on electronic logic circuitry to decide whether the detected phenomenon is a flameout. The delay in the logic circuitry adds significantly to the overall response time, which can be of the order of 1 second in a typical case. In comparison, the acoustic flameout detector includes relatively simple, fast decision circuits and responds much more rapidly to an easily detectable acoustic phenomenon that gives an unambiguous indication of incipient flameout.

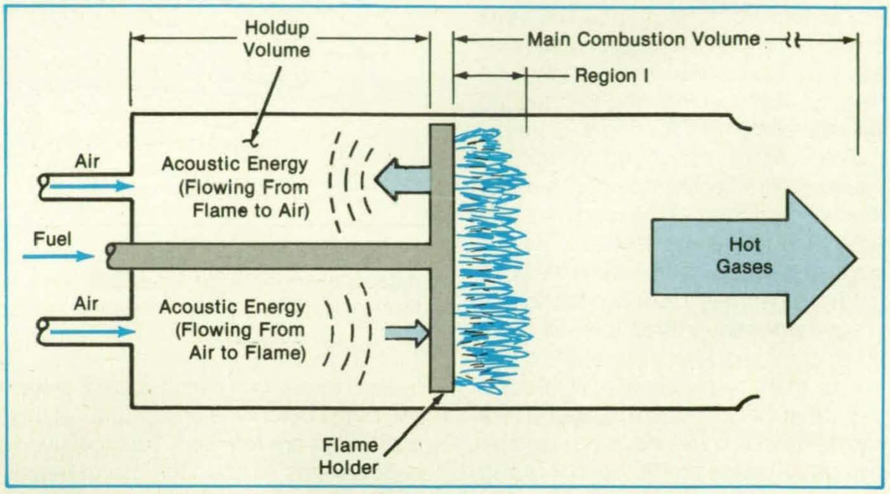


Figure 1. **Acoustic Waves Are Generated** in the holdup volume during combustion. The absence of one of these waves can be detected as an indication of flameout.

A typical combustor (see Figure 1) includes a flameholder, which injects fuel into the combustion volume. Air or other gaseous oxidant is delivered through the volume behind the flameholder, which is known in the industry as the holdup or delivery volume. The combustion process generates acoustic waves in the holdup volume; typically, the most pronounced of these is the fundamental-mode standing wave of the holdup volume. This wave is always excited during combustion, and the excitation ceases the instant the flame moves away from the region (region I in the figure) close to the flameholder.

The acoustic flameout detector (see Figure 2) can be designed with simple, fast decision circuits because the only decision that must be made is whether the amplitude of the acoustic wave in question is above or below a preset threshold level. Acoustic signals are sensed by a dynamic-pressure transducer mounted on a spray bar of the flameholder. The output of the transducer is processed through a signal conditioner and a buffer amplifier, then

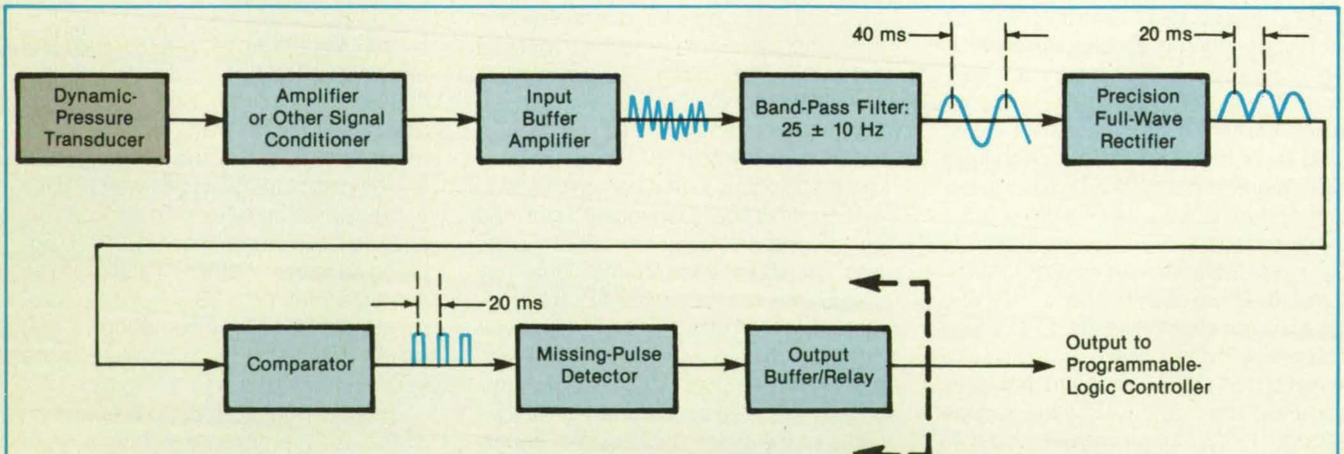


Figure 2. The **Acoustic Flameout Detector** contains relatively simple decision circuits, because the only decision it has to make is whether an acoustic wave in a specific frequency band is strong enough. If not, then flameout is about to occur, and the acoustic flameout detector sends a signal to turn off the supply of fuel.

band-pass filtered at the frequency of the acoustic wave to be detected (25 ± 10 Hz in the original application). The output of the band-pass filter is full-wave rectified, then processed through a comparator, which puts out a pulse for each rectified peak above the preset threshold voltage. During normal combustion, there is one pulse for each half period of the acoustic wave in question.

The pulses from the comparator are fed to a missing-pulse detector, which contains an internal timer that is reset by each pulse. If, after the most recent pulse, no further pulses are received within three half periods (60 ms in the original application) plus a small additional delay of 3 ms, then the missing-pulse detector sends a signal to an output buffer/relay. If the missing-pulse detector sends this signal a second time, then the output buffer/relay sends a signal to a programmable-logic controller, which initiates closure of the fuel valve. The overall response time from the start of flameout to the generation of the valve-closure signal in the original application is about 120 ms. It takes about 300 ms for all combustion products to leave the combustor. Thus, the acoustic flameout detector initiates a response to flameout about 180 ms before flameout is complete.

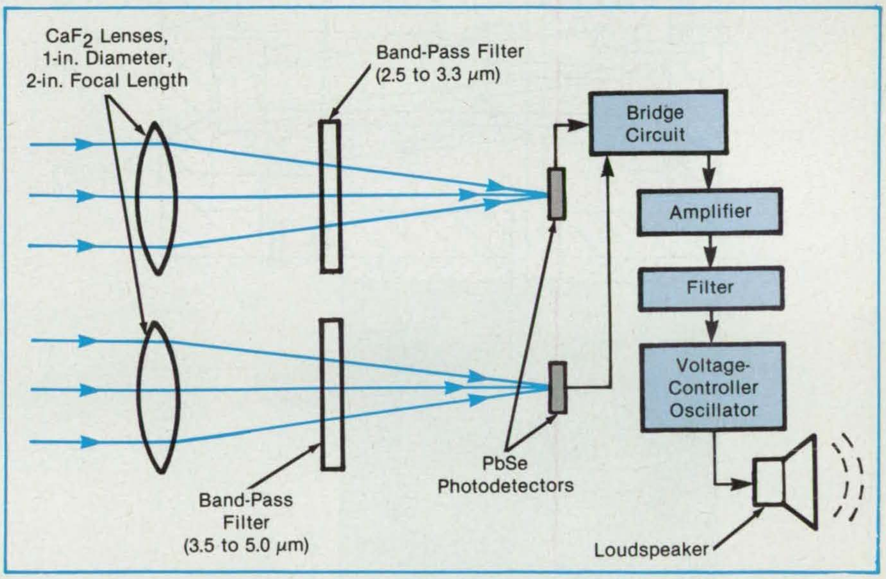
This work was done by Richard L. Puster, John M. Franke, James W. West, Edward E. Adcock, John J. Chapman, and B. Scott Sealey of **Langley Research Center** *and Jeffrey L. Petty and Subbiah Venkateswaran of Lockheed Engineering & Sciences Co. For further information, Circle 5 on the TSP Request Card.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Langley Research Center [see page 24]. Refer to LAR-14900

Two-Band Pyrometers Detect Hydrogen Fires

Working distances of as much as 100 m should be possible.

John F. Kennedy Space Center, Florida



A Portable, Battery-Powered Unit would give an audible alarm, in the form of an increase in the frequency of a tone, when aimed at a hydrogen fire.

Two-band infrared pyrometers that detect small hydrogen fires at greater distances in full daylight are being developed. Pyrometers are needed for this purpose because hydrogen fires in daylight are invisible to human eyes and to standard charge-coupled-device video cameras. The hydrogen-fire-detecting pyrometers in current use operate at ultraviolet wavelengths, where the signals from hydrogen fires are so weak that the ranges of these detectors are limited to about 50 ft (about 15 m).

The developmental detectors utilize a part of the infrared spectrum in which the signals from hydrogen flames are 10^3 to 10^4 times as intense as they are in the ultraviolet region of current detectors. Also, one can utilize low-loss infrared lenses for focusing and for limiting fields of view to screen out spurious signals from nearby sources. As a result of this combination of signal-strengthening features, the new detectors can operate at greater ranges; in principle, they should be able to detect hydrogen fires at distances of as much as 100 m when fully developed.

The basic principle of detection is to exploit the unique infrared-emission spectrum of a hydrogen fire. This spectrum differs sharply from the infrared-emission spectra of sunlight (both direct and reflected), carbon-based flames, incandescent lamps, and other natural and artificial phenomena likely to be found in the vicinity of a hydrogen fire. Of these infrared sources, the hydrogen fire is the only one that emits more power in the wavelength band from 2.8 to 3.2 μm than in the wavelength band from 3.3 to 5.0 μm. Thus, one can use the ratio between measured powers in the two wavelength bands to distinguish between hydrogen fires and other sources.

A portable hydrogen-fire detector according to this concept (see figure) would include CaF_2 lenses, each of which would focus infrared radiation from the source(s) in the field of view through a band-pass filter onto a PbSe photodetector. One of the filters would transmit at wavelengths of 2.5 to 3.3 μm; the other, at 3.5 μm and longer (PbSe does not sense photons with wavelength greater than 5.0 μm). The photodetectors would be connected in a bridge circuit, the imbalance of which would be amplified, filtered, and used to drive an audio-frequency voltage-controlled oscillator.

In the absence of an infrared source, the bridge would remain balanced and the unit would emit an audible tone at a middle frequency. When the detected radiation in the shorter-wavelength band exceeded that in the longer-wavelength band, the bridge would become unbalanced in one direction, causing the frequency to increase and thereby alerting the user to the presence of a hydrogen fire in the field of view of the unit.

Incidentally, a carbon-based flame emits more power in the longer-wavelength band and could, therefore, be detected via a bridge imbalance in the other direction and the consequent decrease in the audio frequency. A battery-powered prototype was constructed and tested on a number of indoor and outdoor targets, including hydrogen and propane flames. As expected, the audio frequency increased for the hydrogen flame and decreased for the propane flame.

This work was done by J. David Collins of **Kennedy Space Center**, *Robert C. Youngquist and Stephen M. Simmons of Boeing Aerospace Operations, Inc. For further information, Circle 7 on the TSP Request Card.* *KSC-11576*

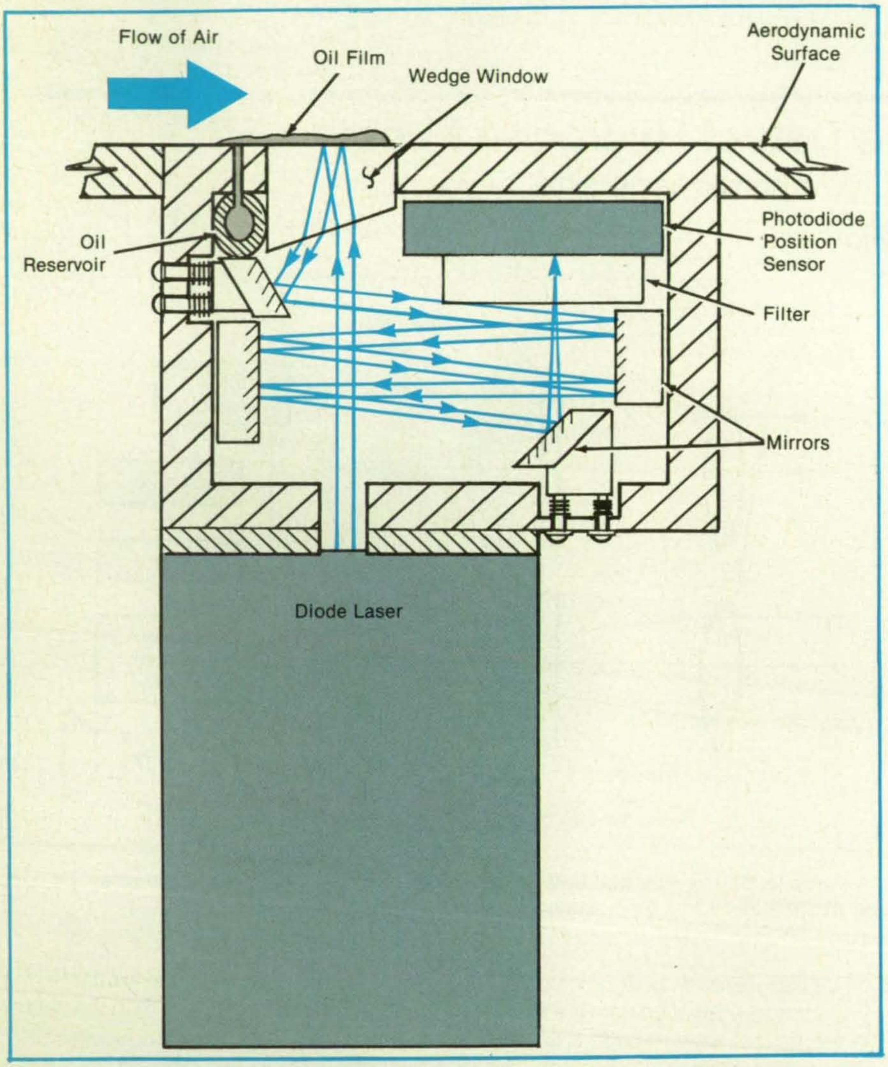
Reflection-Type Oil-Film Skin-Friction Meter

A self-contained unit can be used in flight or wind-tunnel tests.

Langley Research Center, Hampton, Virginia

An oil-film skin-friction meter for both flight and wind-tunnel applications uses internal reflection and is a self-contained, compact unit. Like other oil-film skin-friction meters, it is based on the following principle of operation: if an oil of known viscosity is injected onto a surface on which an aerodynamic boundary layer is developing, then the measurement of the change of its slope with time enables the calculation of the wall shear stress or skin friction at the site of the oil.

The oil-injection apparatus associated with the internal-reflection oil-film skin-friction meter includes an oil reservoir, a small on-demand pump, and a tube that leads to the surface over which the aerodynamic boundary layer is developing (see figure). The oil-injection port is located about 1 cm upstream of the site where the skin friction is to be measured. The skin-friction meter includes a solid-state laser or other small source of light, a transparent window (about 10 mm in diameter) flush with the surface, and a photodiode position sensor. The beam of light from the source is reflected internally from the inside of the top of the oil film and falls onto the sensor. Multiple reflection with a cascade of mirrors can be used to augment the light arm and improve sensitivity. As the slope of the oil film changes with time, the location of the returned beam on the sensor also changes. The output voltage of the sensor is recorded by an analog-to-digital converter and stored for processing and display of the value of the skin friction.



The **Laser, Mirrors, and Photodiode Position Sensor** are housed in a palm-sized unit that can be attached readily under the aerodynamic surface.

The skin-friction meter is contained in a small, palm-sized housing, in which the source of light, mirrors, and sensor are mounted rigidly in alignment. The entire unit can be mounted rigidly under the skin of an aircraft or wind tunnel, eliminating any relative vibration between the optical elements and the skin of the aircraft or wind tunnel. The meter is primarily applicable to flight and wind-tunnel tests, but it could also be used in chemical-processing plants.

This work was done by Promode R. Bandyopadhyay of Analytical Services & Materials, Inc., and Leonard M. Weinstein of **Langley Research Center**. *For further information, Circle 39 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, Langley Research Center [see page 24]. Refer to LAR-14520

Measuring Inhomogeneities in Thermocouple Wires

Output voltage is measured as a temperature-gradient pattern moves along the wires.

Langley Research Center, Hampton, Virginia

The figure illustrates an apparatus for the measurement of electrically significant inhomogeneities in thermocouple wires. Inhomogeneities can include spatially varying impurities and other manufacturing deviations from the nominal alloy composition, splices, butt welds, portions that have become oxidized from long-term heating in use, and spatially varying deviations from the nominal alloy compositions (caused by impurities and/or irregular alloy melts). The offset in the Seebeck coefficient at an inhomogeneity can give rise to an offset in the Seebeck electromotive force if the inhomogeneity is exposed to a gradient of temperature. The resulting offset in the output electromotive force of the thermocouple can exceed the specified tolerance,

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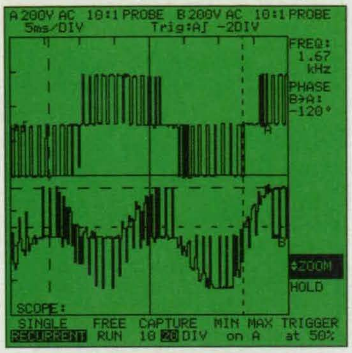
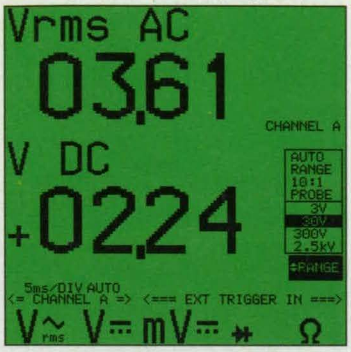
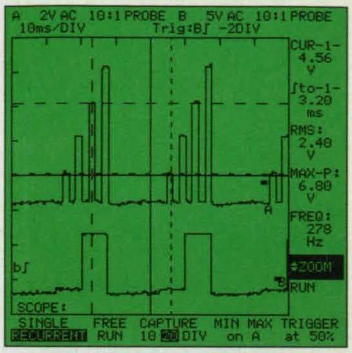
6:42 AM, Motor in #2 shaft overheating.
Dual channel shows incorrect drive signal.



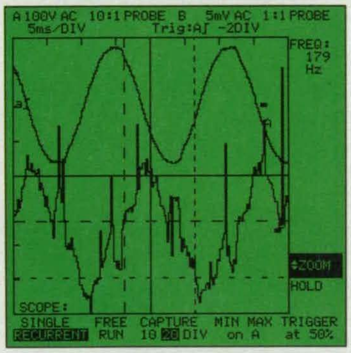
8:23 AM, Security Monitor not working.
3-1/2-digit DMM indicates bad ground.



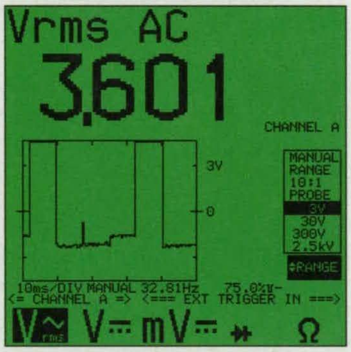
9:25 AM, Conveyor Stepper Control fails.
Cursors help find broken sync connection.



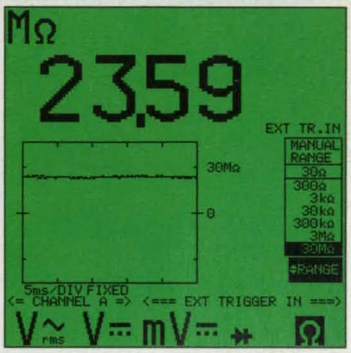
10:57 AM, Intermittent Auditorium lighting.
Waveform shows too much noise.



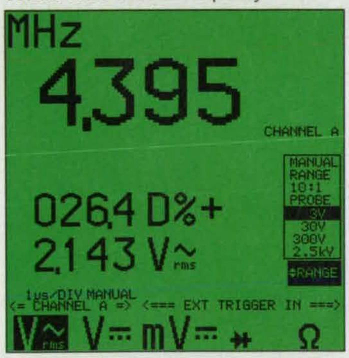
11:17 AM, 5V Control Signal is bad.
Scope display reveals -DC offset.



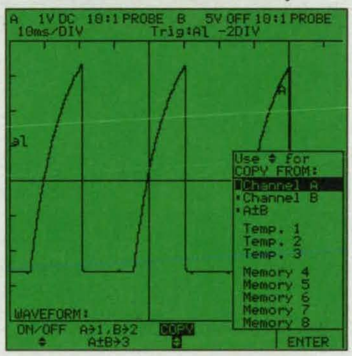
12:58 PM, Air Conditioner overheating.
Resistance shows corroded connection.



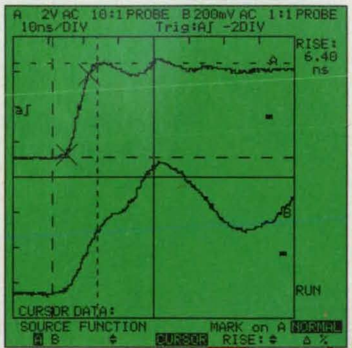
1:22 PM, Copier toning uneven.
Counter finds clock off frequency.



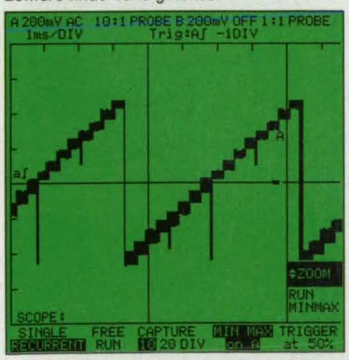
2:14 PM, Testing Power Inverter loads.
Save reference waveform to memory.



3:12 PM, Copier fails, again!
The ns rise time helps find broken shield.



4:05 PM, Salesman presents demo board.
25MS/s finds 40ns glitches.



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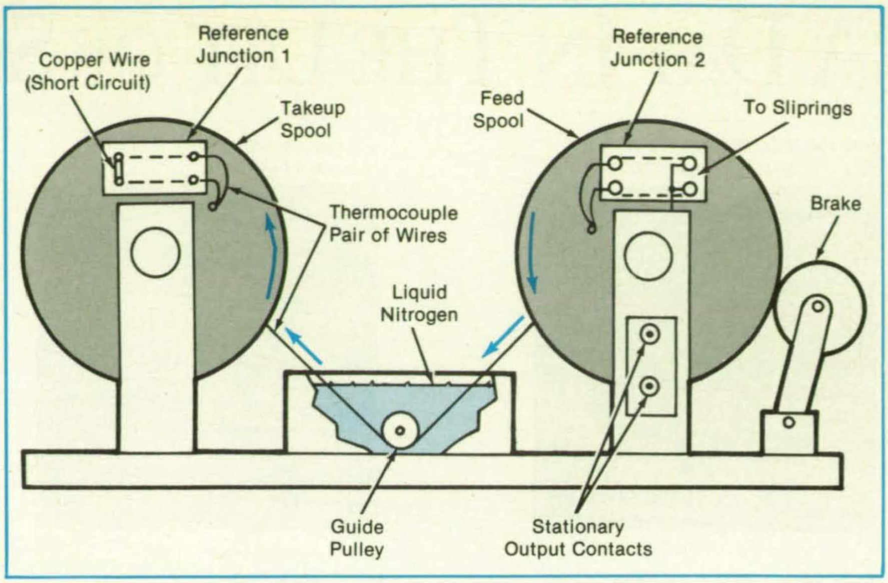
which is typically 0.4 percent for premium-grade thermocouple wire. Thus, to eliminate this hidden source of error, it is necessary to detect and locate inhomogeneities.

The pair of thermocouple wires to be tested is connected to the input terminals of the feed-reel reference junction 2. The output of this reference junction is connected via low-noise sliprings to stationary output terminals. The thermocouple under test is then wound onto the feed reel. The free end of the thermocouple under test is then fed under a guide pulley in the liquid nitrogen bath, through the take-up reel-wire guidance system, and onto the take-up reel. The thermocouple under test is then connected to the input of reference junction 1, which is mounted on the take-up reel. The output of reference junction 1 is shorted with copper wire, effectively referencing the thermocouple under test to 0.0°C and compensating for temperature changes of the take-up and feed reels.

During a test, the spools are rotated by use of motors, gear drives, and an electronic controller (not shown in the figure) to pull the wires through the liquid-nitrogen bath. Meanwhile, the thermocouple voltage at the stationary output contacts is fed to a strip-chart recorder.

The wires are exposed to severe temperature gradients, amounting to an overall change of 200 °C, where they enter and leave the liquid nitrogen. If the wires are homogeneous, the net output voltage is zero. If an inhomogeneity passes through the liquid-nitrogen/air interface, the resulting deviation of the output voltage from zero can be seen immediately on the strip chart. If the inhomogeneity is greater than allowable, the reels can be stopped temporarily so that the inhomogeneity can be tagged before it is wound onto the takeup reel.



The **Spools Are Rotated** to pull the thermocouple wires through the liquid nitrogen, while the output voltage of the thermocouple is recorded on a strip chart.

This work was done by Cecil G. Burkett, Jr., James W. West, and James R. Crum of Wyle Laboratories for **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 24]. Refer to LAR-14669

Corona and Ultraviolet Equipment for Testing Materials

Specimens can be exposed to a simulated hostile environment.

NASA's Jet Propulsion Laboratory, Pasadena, California

Two assemblies of laboratory equipment are being developed for use in testing the abilities of polymers, paints, and other materials to withstand ultraviolet radiation and charged particles. When fully developed, either or both assemblies might be used separately or together to simulate approximately the combination of solar radiation and charged particles that would be encountered by the materials aboard spacecraft in orbit around the Earth. Presumably these assemblies could also be used to provide rigorous environmental tests of materials that would normally be exposed to artificial ultraviolet radiation and charged particles in industrial and scientific settings or to natural ultraviolet radiation and charged particles aboard aircraft at high altitudes.

One of the assemblies is a vacuum ultraviolet source built around a commercial deuterium lamp (see Figure 1). The output spectrum of the lamp includes a peak at a wavelength of 124 nm, which simulates the solar Lyman α line. A temperature sensor and water jacket help to control the temperature of the lamp.

The other assembly (see Figure 2) ex-

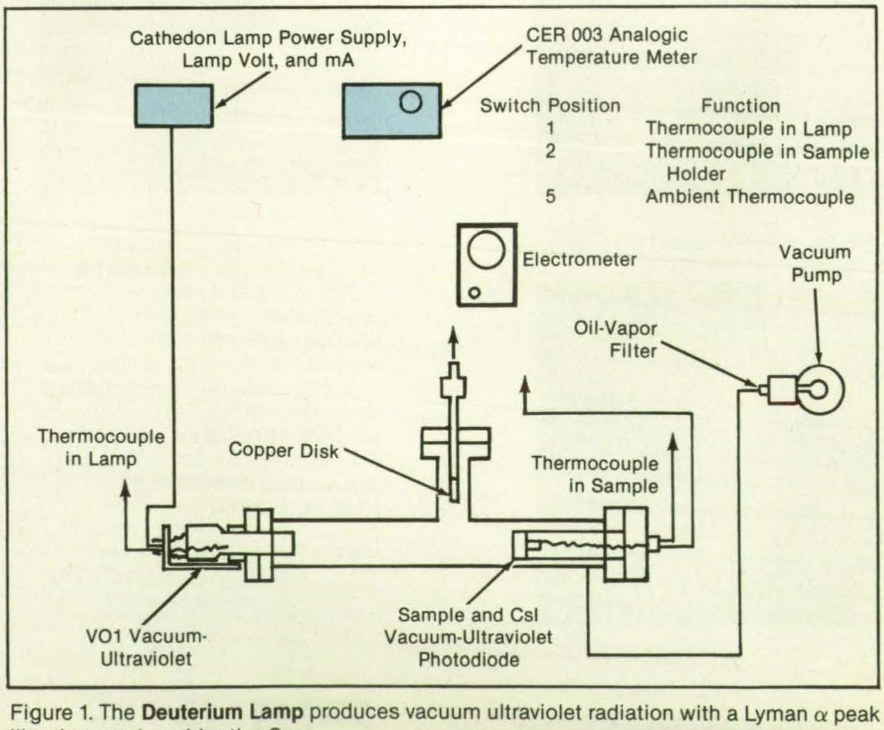


Figure 1. The **Deuterium Lamp** produces vacuum ultraviolet radiation with a Lyman α peak like that produced by the Sun.

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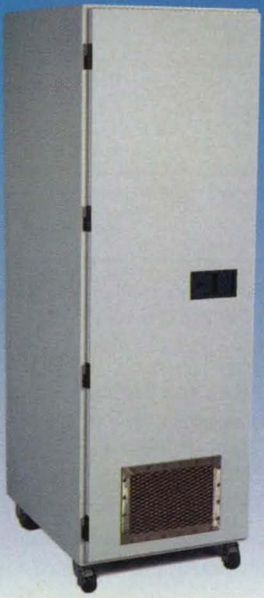

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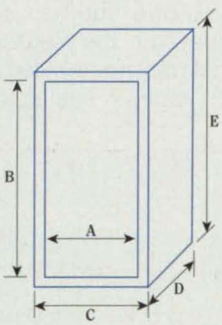

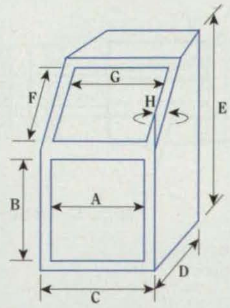

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poses a specimen in a partial vacuum to both ultraviolet radiation and a brush corona discharge. The assembly includes a vacuum chamber that contains the specimen holder, a mercury lamp of a type that would ordinarily be used to produce ozone and that generates ultraviolet radiation at a wavelength of 254 nm, and an electrode connected through a current-limiting resistor to a high-voltage power supply. By the combination of vacuum pumping and a small leak of dry air, the pressure in the chamber is maintained during operation at about 30 μm (about 0.4 Pa). When the power supply is set at +13.5 kV, a brush corona discharge of about 2.2 kV and 0.75 mA is generated at the electrode.

The corona discharge bombards the specimen with charged particles. The ultraviolet radiation is essential to this bombardment because it prevents the accumulation of charge on a specimen of electrically insulating material: if the charge is not removed by exposure to ultraviolet radiation, then eventually the charge builds up sufficiently to repel subsequent bombarding charged particles.

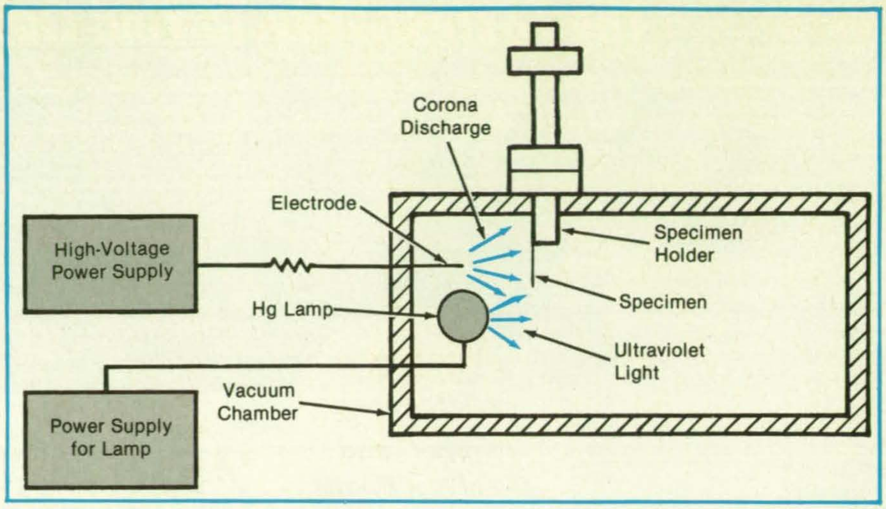


Figure 2. The **Corona-Discharge Chamber** includes an ultraviolet lamp, which prevents the specimen from accumulating charge, thereby preventing it from repelling bombarding charged particles from the corona.

This work was done by Eric G. Laue of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, Circle 80 on the TSP Request Card.* *NPO-18554*

Hyperthermal-Atomic-Oxygen Generator

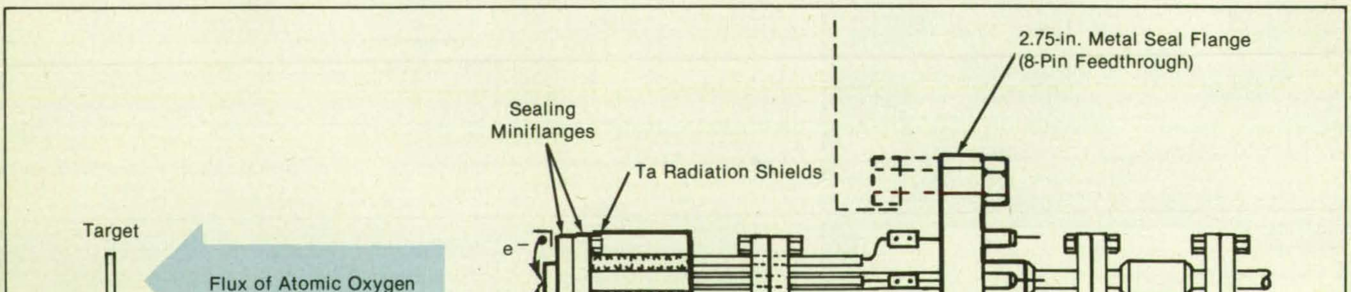
This small instrument simulates conditions of low orbit around the Earth.

Langley Research Center, Hampton, Virginia

A small hyperthermal-atomic-oxygen generator (HAOG) compatible with an ultrahigh vacuum (UHV) has been developed at the NASA Langley Research Center. The HAOG can provide a pure flux of ground-state oxygen atoms with a mean kinetic energy of approximately 5 eV, accurately simulating conditions in low orbit around the Earth, and can be mounted on any existing UHV processing or analysis system. Other competitive systems are large, expensive, and immobile and are not compatible with UHV.

As shown in the figure, a multipin, 2.75-in. (69.85-mm) metal seal flange contains a centered tube through which molecular oxygen is supplied. The oxygen permeates a 150-µm-thick membrane of Ag/0.05 Zr. The membrane is in the shape of a "top hat" so that it projects beyond the sealing miniflanges that are spotwelded at four points 90° apart. A heater assembly heats the membrane to the desired temperature for sufficient permeation flux.

Tantalum radiation shields prevent excessive heating of the surrounding chamber. The membrane is electrically isolated so that it can be biased. Oxygen at a pressure of approximately 200 torr (13 kPa) is provided on the upstream side of the membrane as a source. The molecules dissociatively absorb on the surface, dissolve into the lattice of the membrane, and diffuse



Atomic Oxygen Is Desorbed from the surface of the membrane by electron-beam bombardment.

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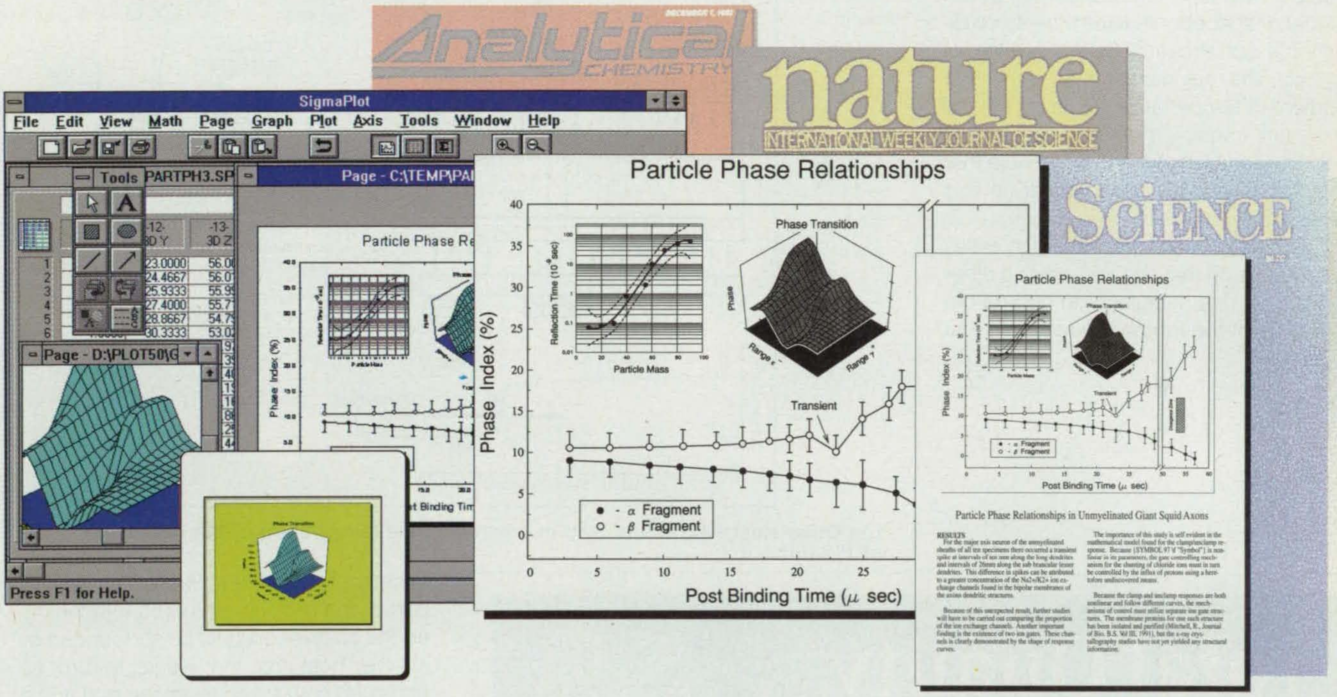

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ic oxygen have been achieved.

The HAOG is clean and compatible with other UHV processing or diagnostic systems and is relatively inexpensive and simple to operate. It is expected to prove extremely valuable in studies involving atomic oxygen because it can be added easily to existing systems.

This work was done by R. A. Outlaw 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 24]. Refer to LAR-14674.

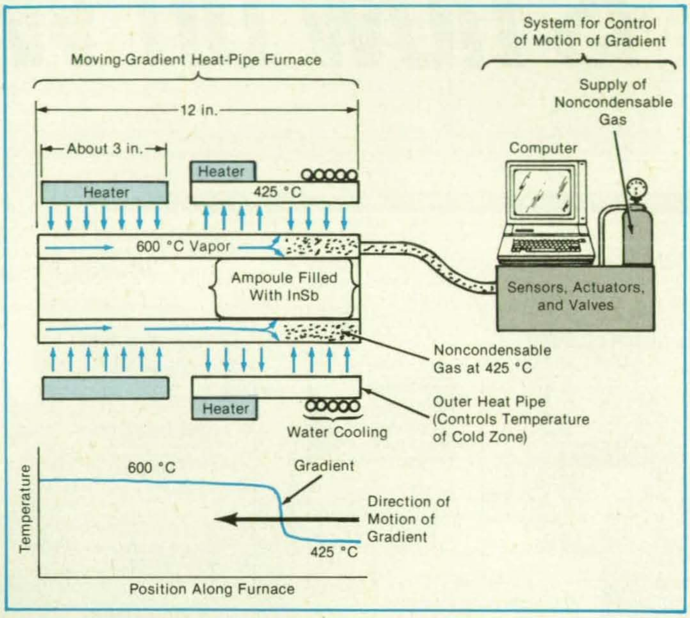
Moving-Gradient Furnace With Constant-Temperature Cold Zone

A heat pipe around the cold zone would be kept at a constant temperature.

Marshall Space Flight Center, Alabama

The figure illustrates a proposed moving-gradient heat-pipe furnace for use in terrestrial or spaceborne experiments on directional solidification in the growth of crystals. The region that contains the high gradient of temperature would be moved to the left, causing the solidification front to move to the left along the ampoule that contains the specimen material (in this case, InSb).

This particular conceptual design arises out of research that showed, among other things, that it is necessary to control the cold zone of the furnace to maintain it at constant temperature. For this purpose, a part of the heat-pipe furnace that included the cold zone would be surrounded by another heat pipe that would, in turn, be equipped with a heater at one end and a water cooling coil at the other end. The temperature of this heat pipe would be maintained at the desired constant value (in this case, 425 °C) by controlling the water cooling. This heat pipe would be serve as a constant-temperature heat source or heat sink, as needed, for the gradient of temperature as the gradient region moved along the furnace.



The **Outer Heat Pipe** would help in controlling the temperature of the cold zone of the furnace.

This work was done by Nelson J. Gernert and Robert M. Shaubach of Thermacore, Inc., for **Marshall Space Flight Center**. *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 24]. Refer to MFS-26201.

Materials

Electrically Conductive Polyimide Films

Semiconducting surfaces of SnO_2 are formed by curing polyamic acids that contain tin complexes.

Langley Research Center, Hampton, Virginia

Polyimide films have been made semiconductive (the conductivities have ranged from $3.0\times10^{-3}\ \Omega^{-1}$ to $1.0\times10^{-2}\ \Omega^{-1}$) via the incorporation of semiconductive surface layers of SnO_2. If an SnO_2-surfaced polyimide film is to be used as a free-standing film (i.e., released from the glass plate or other rigid substrate on which it is formed), then the semiconductive layer should be protected by a top coat of polyimide, deposited as a film from solution directly onto the SnO_2. The resultant films are flexible and resistant to both weather and high temperature. They can be used, for example, on aircraft to provide resistance to lightning strikes. They could also be used in microelectronics and flexible circuitry.

The production of a polyimide film with a semiconductive SnO_2 surface layer involves the following steps: (1) selection of a tin complex soluble in the solvent of choice for the polyamic acid to be processed into the polyimide film; (2) preparation of the polyamic acid solution; (3) addition of the soluble tin complex with mixing until the solution is homogeneous; (4) spreading of the solution as a film; (5) thermal treatment to imidize the polymer, to induce migration of tin complex to the surface of the film, and to convert the tin complex to inert, semiconductive SnO_2. Steps 2 and 3 can be interchanged: the tin complex can be first dissolved, and polymerization conducted in the presence of the complex.

As indicated schematically in the first reaction of Figure 1, the polyamic acid resin designated as PMDA/4,4′-ODA was prepared by adding a solution of 14.08 g (0.0645 moles) of pyromellitic dianhydride (PMDA) in dimethyl acetamide (DMAc) to a solution of 12.92 g (0.0645 moles) 4,4′-oxydianiline (ODA) in DMAc. A solution of 5.04 g (0.0121 mole) of $SnCl_4(\text{dimethylsulfoxide})_2$ in DMAc was added to the polyamic acid resin solution, and the resulting mixture was stirred for a total of 16 h. The resulting polyamic acid resin solution contained 10.9 percent solids.

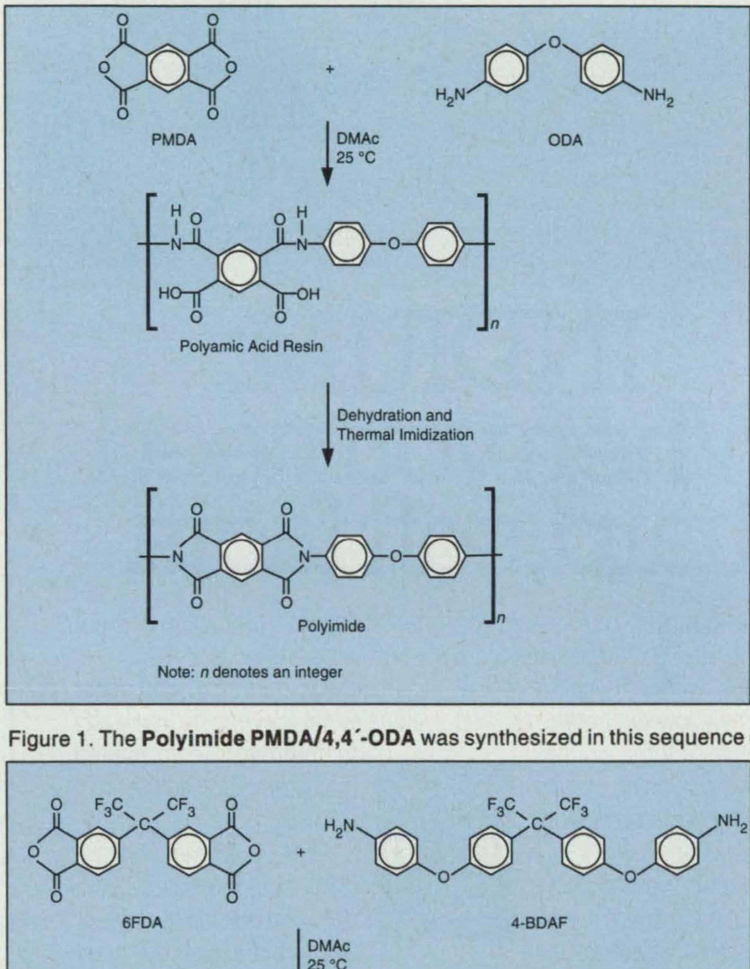


Figure 1. The **Polyimide PMDA/4,4′-ODA** was synthesized in this sequence of reactions.

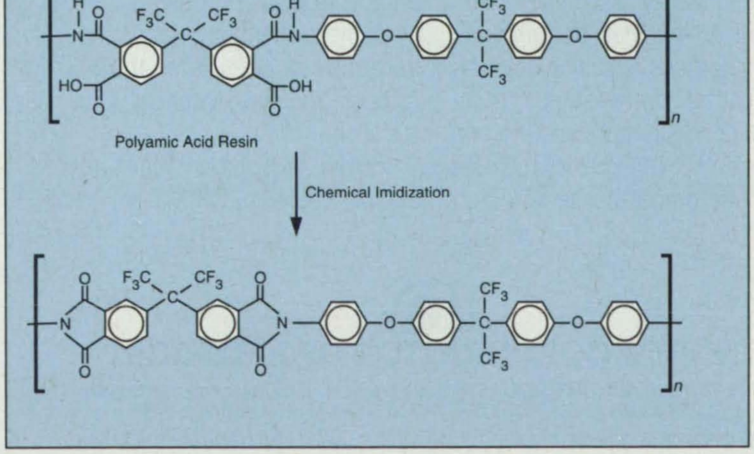


Figure 2. The **Polyimide 6FDA/4-BDAF**, synthesized in this sequence of reactions, can be used to cover a semiconductive surface layer of tin oxide on PMDA/4,4′-ODA.

A sample of resin solution that had an inherent viscosity of 1.75 dL/g was poured onto a cleaned glass plate and spread as a film by pulling the plate under a doctor blade that was set at a gap of 28 mil (0.71 mm). The polyamic acid film was then cured to the polyimide (the second reaction in the figure) in a forced air oven by heating for 20 min at a temperature of 60 °C, 10 min at 80 °C, 60 min at 100 °C, 60 min at 200 °C, and finally 60 min at 300 °C. The resulting material was a clear brownish film with a thickness of 1.4 mil (0.04 mm).

The surface of the film was semiconductive, with a measured conductivity of $1.07 \times 10^{-2}\ \Omega^{-2}$; the underside of the film was nonconductive, as was the bulk of the film. This material contained 5.20 percent tin. Its softening temperature (T_g) was found to be 321 °C. Its polymer decomposition temperature was determined to be 534 °C (2.5 °C/min, heating in air), indicating excellent thermal stability. The surface conductivity of the semiconductive surface was unaffected by either the tape test (attaching and removing a piece of tape) or mild abrasion. This indicated good adhesion of the surface conductive material to the polyimide substrate.

Figure 2 schematically illustrates the reaction route for forming the protective polyimide coat over the semiconducting surface layer of SnO_2. When an experimental coated film was removed from the glass plate on which it was formed, its conductivity was unaffected, as was its conductivity after it had been flexed several times at 180 °C in an effort to disrupt the continuity of the SnO_2 layer. In contrast, when a semiconducting film without the protective coat was removed from the glass plate on which it was formed, its surface conductivity was reduced to less than $8.19 \times 10^{-3}\ \Omega^{-1}$.

This work was done by Anne K. StClair for **Langley Research Center**, *Stephen A. Ezzel and Larry T. Taylor of Virginia Polytechnic Institute and State University, and Harold G. Boston of Lockheed Engineering & Science 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 24]. Refer to LAR-14936.

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COSMIC, NASA'S Computer Software Management and Information Center, distributes software developed with NASA funding to industry, other government agencies and academia.

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Computer Programs

These programs may be obtained at a very reasonable cost from COSMIC, a facility sponsored by NASA to make computer programs available to the public. For information on program price, size, and availability, circle the reference number on the TSP and COSMIC Request Card in this issue.

Mathematics and Information Sciences

TOAD Editor

This program facilitates manipulations of contents of files in TOAD format.

The Transferable Output ASCII Data (TOAD) computer program (LAR-13755), implements a format that is designed to facilitate the transfer of data across communication networks and dissimilar host computer systems. Any data file that conforms to the TOAD format standard is called a TOAD file. The TOAD Editor is an interactive software tool for manipulating the contents of TOAD files. The TOAD Editor creates a spreadsheet for TOAD files. Selected subsets of data can be tabulated, sorted, exchanged, duplicated, filtered, removed, replaced, inserted, and transferred to and from other TOAD files. The TOAD editor is commonly used to extract filtered subsets of data for visualization of the results of computation.

The TOAD Editor also offers such user-oriented features as on-line help, clear English error messages, a startup file, macroinstructions defined by the user, a command history, user variables, UNDO features, and a full complement of mathematical, statistical, and conversion functions. A companion program, the TOAD Gateway (LAR-14484), converts data files from a variety of other file formats to that of TOAD.

The TOAD Editor is written in FORTRAN 77 for interactive execution on computer workstations of the CONVEX C, Sun3 and Sun4, Silicon Graphics 4D and Personal IRIS, and DEC ULTRIX and VAX/VMS series, all with little or no modification. The TOAD Editor requires 2.5Mb of random-access memory for execution, though increasing the capacity of the Editor will require additional memory. The standard distribution medium for the TOAD Editor is a 0.25-in. (6.35-mm) streaming-magnetic-tape cartridge in UNIX tar format. It is also available in DEC VAX BACKUP format on either a 9-track, 1,600-bit/in. (630-bit/cm) magnetic tape or a TK50 tape cartridge. The TOAD Editor was developed in 1990.

CONVEX is a trademark of CONVEX Computer Corp. Sun3 and Sun4 are trademarks of Sun Microsystems, Inc. DEC, VAX, VMS, and ULTRIX are trademarks of Digital Equipment Corp. IRIS 4D and Personal IRIS are trademarks of Silicon Graphics, Inc. UNIX is a registered trademark of AT&T Bell Laboratories.

This program was written by Bradford D. Bingle, Anne L. Shea, and Alicia S. Hofler of Computer Sciences Corp. for **Langley Research Center**. *For further information, Circle 19 on the TSP Request Card.* LAR-14423

Interface to the SURE Program

ASSIST automatically generates a semi-Markov model of a fault-tolerant computer system.

The Abstract Semi-Markov Specification Interface to the SURE Tool (ASSIST) computer program is an interface program that will enable reliability engineers to design large semi-Markov mathematical models accurately. The user describes the failure behavior of a fault-tolerant computer system in an abstract, high-level language. The ASSIST program then automatically generates a corresponding semi-Markov model. The abstract language enables efficient description of large, complicated systems; a one-page ASSIST-language description can result in a semi-Markov model with thousands of states and transitions. The ASSIST program also implements model-reduction techniques to facilitate efficient modeling of large systems.

Instead of listing the individual states of the Markov model, reliability engineers can specify the rules that govern the behavior of a system, and these are used to generate the model automatically. ASSIST reads an input file that describes the failure behavior of a system in an abstract language and generates a Markov model in the format needed for input to SURE (the semi-Markov Unreliability Range Evaluator program) and PAWS/STEM (the Pade Approximation With Scaling and Scaled Taylor Exponential Matrix programs).

A Markov model consists of a number of system states and transitions between them. Each state in the model represents a possible state of the system in terms of which components have failed, which ones have been removed, and the like. Within ASSIST, each state is defined by a state vector, where each element of the vector takes on an integer value within a defined range. An element can represent any meaningful characteristic, such as the number of working components of one type in the system, or the number of faulty components of another type in use. Each statement that represents a transition between states in the model comprises three parts: a condition expression, a destination expression, and a rate expression. The condition expression is a Boolean expression that describes the values of the state-space variables of those states for which the transition is valid. The destination expression defines the destination state of the transition in terms of the values of state-space variables. The rate expression defines the distribution of elapsed time for the transition.

The mathematical approach chosen to solve a reliability problem can vary with the size and nature of the problem. Although different solution techniques are utilized on different programs, it is possible to have a common input language. The Systems Validation Methods group at NASA Langley Research Center has created a set of programs that form the basis for a reliability-analysis workstation. The set of programs are the SURE reliability-analysis program (COSMIC program LAR-13789, LAR-14921); the ASSIST specification interface program (LAR-14193, LAR-14923); the PAWS/STEM reliability-analysis programs (LAR-14165, LAR-14920); and the FTC fault-tree tool (LAR-14586, LAR-14922). FTC is used to calculate the probability of the top event in a fault tree. PAWS/ STEM and SURE are programs that interpret the same SURE language but utilize different methods of solution. ASSIST is a preprocessor that generates SURE language from a more abstract definition.

SURE, ASSIST, and PAWS/STEM are also offered as a bundle. Please see the abstract for COS-10039/COS-10041, SARA — SURE/ASSIST Reliability Analysis Workstation, for pricing details.

ASSIST was originally developed for DEC VAX-series computers running VMS and was later ported for use on Sun computers running SunOS. The VMS version (LAR-14193) is written in C language and can be compiled with the VAX C compiler. The standard distribution medium for the VMS version of ASSIST is a 9-track, 1,600-bit/in. (630-bit/cm) magnetic tape in VMSINSTAL format. It is also available on a TK50 tape cartridge in VMSINSTAL format. Executable codes are included. The Sun version (LAR-14923) is written in ANSI C language. An ANSI-compliant C compiler is required to compile this package. The standard distribution medium for the Sun version of ASSIST is a 0.25-in. (6.35-mm) streaming-magnetic-tape cartridge in UNIX tar format. Both Sun3 and Sun4 executable codes are included. Electronic copies of the documentation in PostScript, TeX, and DVI formats are provided on the distribution medium. (The VMS distribution lacks the .DVI format files, however.) ASSIST was developed in 1986 and last updated in 1992.

DEC, VAX, VMS, and TK50 are trademarks of Digital Equipment Corp. SunOS, Sun3, and Sun4 are trademarks of Sun Microsystems, Inc. UNIX is a registered trademark of AT&T Bell Laboratories.

This program was written by Sally C. Johnson of **Langley Research Center** *and David P. Boerschlein of Lockheed Engineering & Sciences Co. For further information, Circle 98 on the TSP Request Card.*
LAR-14923

Interactive Image-Registration Program

REGISTERTOOL assists the user in joining images via tie points.

In processing images, mathematical and logical functions are often applied to spatially similar digital images. However, these functions cannot be carried out if the images are not spatially aligned with respect to one another. The REGISTERTOOL computer program provides for interactive registration of images, yielding results that can be used for further processing.

With REGISTERTOOL, the user marks two sets of corresponding points (tie points) on the original and the reference images to determine the rotation, translation, and scaling of the original image with respect to the reference image. Because the choice of tie points requires pixel accuracy, a zoomed area of both images is displayed for greater precision. The resulting registered images can be saved to disk in Sun rasterfile format.

REGISTERTOOL is written in C Language for Sun-series computers that have color-display capabilities and that run Sunview or OpenWindows under SunOS. No binaries are included with this distribution. REGISTERTOOL requires 222K of random-access memory for execution. The standard distribution medium for REGISTERTOOL is a 0.25-in. (6.35-mm) streaming-magnetic-tape cartridge in UNIX tar format. REGISTERTOOL was developed in 1991.

Sun, Sunview, OpenWindows, and SunOS are trademarks of Sun Microsystems, Inc. UNIX is a registered trademark of AT&T Bell Laboratories.

This program was written by Elizabeth L. Avis of Computer Sciences Corp. and Mary-Anne K. Posenau of **Langley Research Center**. *For further information, Circle 95 on the TSP Request Card.*
LAR-14746

Managing Information on Technical Requirements

This program serves multiple users on a project, supporting efficient and consistent operations.

It is often necessary for individuals working on a project to share and to control information on a project-wide basis. The Technical Requirements Analysis and Control Systems/Initial Operating Capability (TRACS/IOC) computer program provides supplemental software tools for the analysis, control, and interchange of project requirements so that qualified project members might have access to pertinent project information, even if they are in different locations. This package of software enables the users to analyze and control requirements, serves as a focal point for project requirements, and integrates a system that supports efficient and consistent operations.

TRACS/IOC uses relational-data-base technology to manage and query all data on requirements. The Oracle DBMS software was chosen for its data-base-management constructs, its ease of use in the Macintosh computer programming environment, and its availability for use on other computers. The features of the data base include a data-definition language for describing the data to be stored, a data-manipulation language for efficient data operations, and methods of data-base support features. Oracle can be used in either a stand-alone- or a distributed-computer environment to coordinate the activities required to support a project through its entire life cycle.

TRACS/IOC offers interactive capability to interrogate the data base and to display information on project requirements. It provides a limited report capability but can be extended to generate reports interactively from the data base or to save reports to a file for later printing. This report capability is facilitated by PostScript — an interpreted language.

TRACS/IOC is a HyperCard stack for use on Macintosh computers running HyperCard 1.2 or later and Oracle 1.2 or later. This package of software also requires System version 6.0 or later and Finder or MultiFinder 6.1. The package requires 6Mb of disk memory space and a minimum of 2Mb of random-access memory. Note that later versions of HyperCard 1.2 and Oracle 1.2 may have their own minimal system requirements that exceed those mentioned here. A PostScript-compatible output device or emulation/conversion software is required to print reports by use of TRACS/IOC. The standard distribution medium for this package is one 3.5-in. (8.89-cm), 800K Macintosh-format diskette. TRACS/IOC was developed in 1991.

Macintosh, Finder, MultiFinder, and HyperCard are trademarks of Apple Computer, Inc. Oracle is a registered trademark of Oracle Corp. PostScript is a registered trademark of Adobe Systems Inc.

This program was written by Lemuel E. Mauldin III of **Langley Research Center** *and Dana P. Hammond of Computer Sciences Corp. For further information, Circle 68 on the TSP Request Card.*
LAR-14844

TECHNOLOGY 2003 UPDATE

The Latest News About America's Premier Technology Showcase

Tech Transfer Week: Four Events, One Goal—To Aid U.S. Business

Over 8000 technology managers and engineers throughout U.S. industry, government, and universities are expected to attend **Technology 2003**, the fourth national technology transfer conference and exposition, December 7-9, 1993 in the Anaheim, CA convention center. In just three years, this NASA-sponsored event has more than doubled in size, making it the world's largest tech transfer conference. The goal of **Technology 2003** is to "improve the U.S. economy and industrial competitiveness by transferring leading-edge technologies to new commercial markets," according to James R. Thompson, general conference chairman and executive vice president of Orbital Sciences Corp.

This year, three other events have joined forces with **Technology 2003** in Anaheim for National Technology Transfer Week (Dec. 5-11): the Test Technology Transfer Symposium (Dec. 6-9), sponsored by the International Test Evaluation Association and the American Society of Test Engineers, which will bring together the commercial, government, and academic communities to share ideas, methods, and technologies related to test engineering challenges of the 21st century; the Technology Transfer Society Annual Meeting (Dec. 6-7), which will offer a dynamic forum dedicated to the pragmatic issues of making money in technology transfer; and "Capitalizing Spatial Information Technology" (Dec. 6), a one-day symposium covering business and finance opportunities in GIS and remote sensing, sponsored by the American Society for Photogrammetry & Remote Sensing.

Technology 2003 symposia registrants can attend the sessions of any of these other conferences without additional charge. More information about each event will appear in the September issue of *NASA Tech Briefs*. If you have immediate questions, please call Wendy Janiel at (800) 944-NASA.

Technology 2003 Symposia To Spotlight Dual-Use Technologies

In addition to 80,000 square feet of exhibits showcasing licensable inventions and new products, **Technology 2003** will feature some 100 symposia presentations by top technologists focusing on government-developed innovations with strong commercial promise in manufacturing, computing, electronics, biotechnology, environmental technology, and other critical areas. Some highlights:

Researchers at the Department of Energy's Idaho National Engineering Laboratory (INEL) have developed spray forming technology for producing near-net-shape solids and coatings of a variety of metals, polymers, and composite materials. The INEL technique, which combines novel spray nozzle design with advanced process control and on-line diagnostics of spray plume, offers unique opportunities for simplifying materials processing while improving product quality.

Anatomy meets virtual reality: NASA's Johnson Space Center teamed up with the University of Texas to create a Virtual Visual Environment Display (VIVED) that provides a unique educational experience. VIVED may one day enable surgical students to learn how to perform high-risk procedures on virtual patients, and students of all ages to better understand anatomy by walking through a simulated human body.

The Air Force's Phillips Laboratory has produced microscopic tubes that are orders of magnitude smaller than existing tubing. The microtubes can be fabricated from any material, including high-temperature materials such as quartz or ceramics, and have nearly universal application in areas as diverse as optics, medicine, and microelectromechanical devices. They offer the opportunity to miniaturize (even to the nanoscale) existing products and devices and to fabricate products that previously were impossible to produce.

HAZBOT III, a teleoperated mobile robot designed at the Jet Propulsion Laboratory, will enable HAZMAT teams to locate, identify, and mitigate hazardous material incidences without risking personnel. The robot also could aid in law enforcement and mining operations.

A state-of-the-art Universal Signal Conditioning Amplifier (USCA) developed at NASA's Kennedy Space Center automatically configures itself for maximum accuracy (12 bits) and resolution (16 bits), using the information stored in its nonvolatile memory. Designed for use with most types of transducers and data acquisition systems, the invention can minimize setup times while improving system reliability and providing more accurate results.

A space spinoff could help the environment: NASA's Lewis Research Center has developed a high-capacity ion exchange material (IEM) that removes toxic metals from contaminated water. The IEM can be made into many forms, such as thin films, coatings, pellets, and fibers, and therefore can be adapted to purify contaminated water wherever it is found — wastewater treatment systems, lakes, ponds, industrial plants, or homes.

To reserve your place at Technology 2003, fill out and mail (or fax) the registration form on page 19 of this issue.

Mechanics

Finite-Difference Algorithms for Computing Sound Waves

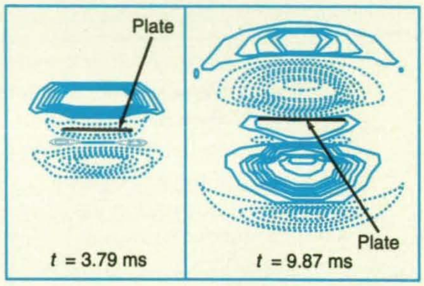
Governing equations are considered as a matrix system.

Ames Research Center, Moffett Field, California

A method of computing the evolution of an acoustic field in multidimensional space and in time involves any of a number of algorithms that can be derived from finite-difference approximations of the fundamental differential equations of acoustics. This method is a variant of the method described in "Scheme for Finite-Difference Computations of Waves" (ARC-12970), *NASA Tech Briefs*, Vol. 16, No 10, 1992, page 105. To recapitulate: The noted article discussed the derivation of a series of compact, high-fidelity algorithms, based on the concept of a discrete dispersion relation, to solve the first-order scalar convective wave equation.

The development of the present method begins with the matrix-vector formulation of the fundamental equations, which involve first-order partial derivatives of the primitive variables (pressure and velocity) with respect to space and time. The particular matrix formulation places time and the spatial coordinates on an equal footing, so that governing equations can be considered as a matrix system and treated as a unit. The spatial and temporal discretizations are not treated separately as in other finite-difference methods but instead are treated together by linking the spatial-grid interval and the time step via a common scale factor that is related to the speed of sound.

The discretization is performed by use of matrix exponential functions in a manner that is already well established in methods for the solution of systems of linear, constant-coefficient, ordinary differential equations. This approach to discretization is reminiscent of asymptotic expansions in which the effect of a rapidly varying quantity (the phase) pre-



The **Diffraction of a Sound Wave by a Plate** is illustrated by contours of constant interference pressure computed for two different times, t, after the time of incidence of the wave at the plate. The plate is 3.26 m wide; the wave is incident from the top, with a wavelength of 4.32 m.

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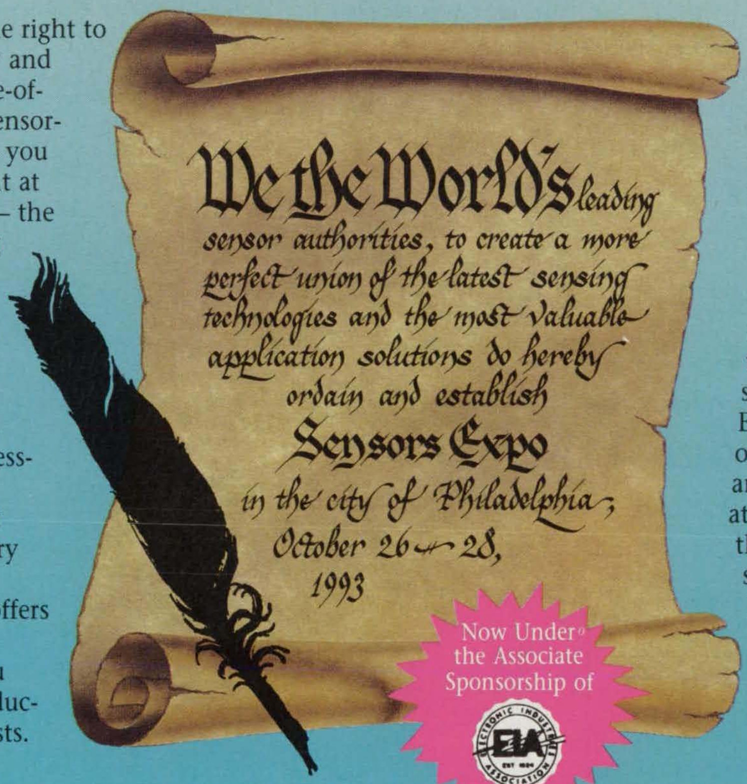

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dominates over that of a slowly varying quantity (the amplitude).

In the special case of classical acoustics, the truncation error is proportional to the fifth power of the size of the spatial-grid interval or time step, so that the resulting algorithms are accurate to fourth order in both space and time. These algorithms are as computationally efficient as older second-order algorithms. Assuming that the matrix exponentials commute, very efficient splitting methods can be used to track two-dimensional waves.

The method has been demonstrated by using it to compute one- and two-dimensional waves propagating and reflecting back and forth between simple boundaries. The ability of the method to simulate more-complicated situations was demonstrated by using it to simulate the short-term diffraction of an incident, initially harmonic wave by a plate (see figure).

This work was done by Sanford Davis of **Ames Research Center**. *Further information may be found in AIAA paper A91-12458, "Matrix-Based, Finite-Difference Algorithms for Computational Acoustics."*

Copies may be purchased [prepayment required] from AIAA Technical Information Service Library, 555 West 57th Street, New York, New York 10019, Telephone No. (212) 247-6500.

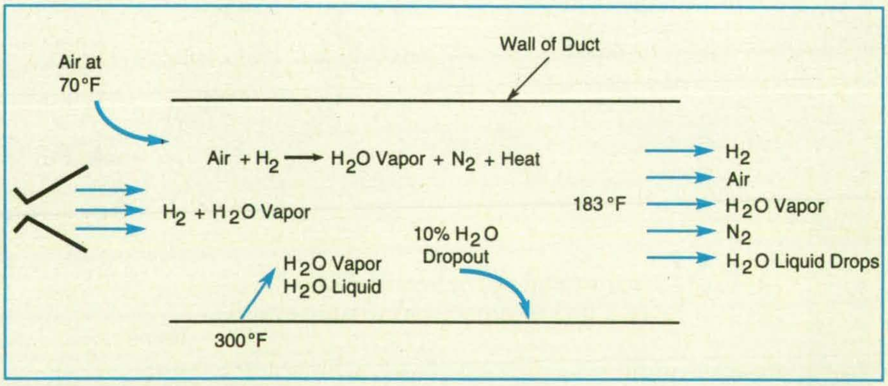
ARC-13098

Simplified Model of Duct Flow

Inputs and outputs can be estimated with relatively little computation.

John F. Kennedy Space Center, Florida

A simplified, lumped-parameter mathematical model of flow in a duct has proved useful in estimating quasi-steady inlet and outlet flows. The model is adequate to simulate important features of compressible or incompressible flows that include aspiration, shock losses (if compressible), combustion, transfers of heat, and changes in phase (see figure). Furthermore, it can simulate flows in straight or twisted ducts with constant or varying cross sections. In comparison with a full three-dimensional, finite-difference model, this model requires much less computation and can be matched with experimental data more easily.



In this **Example of Duct Flow** with complicated thermal and chemical effects, unburned hydrogen from the exhaust of a rocket motor is mixed with aspirated air, water vapor, and very small water drops to make the resulting gas mixture nonexplosive. Once the total flow is estimated by the method described in the text, local conditions for combustion or explosion can be evaluated in more detail.

In this lumped-parameter representation, the flow is characterized by the exit velocity, V; and by an experimentally determined pressure-loss coefficient, K, that summarizes the effects of all frictional losses as though they caused a change in the cross-sectional area presented to an inviscid flow. Values of K are determined from measurements of pressures and velocities in quasi-steady flow. Once values of K are known from flows of test gases in a small-scale model duct, they can be used to compute flow in the corresponding full-scale duct because they are substantially independent of size and of variations in the gas mixture. This formulation provides a simple equality between the entrance momentum and a fictitious inviscid version of the exhaust momentum. This simple equality can, in turn, be used to simplify the iterative computation of flow conditions.

The total pressure loss (entrance loss + friction loss + exit dynamic pressure) is given by $(1 + K)\rho V^2/2$, where ρ is the average or effective mass density of the fluid in the duct. Then if the duct has length L, it can be shown that the acceleration of the flow is given by

$$\frac{dV}{dt} = \left(\frac{1+K}{2L}\right)\left(V_{eq}^2 - V^2\right)$$

where t = time and V_{eq} is the equilibrium velocity at which the exit dynamic pressure, $\rho V^2/2$, of quasi-steady flow equals the static ambient atmospheric pressure. In effect, this differential equation states that the transient velocity can be obtained as a perturbation of the quasi-steady equilibrium velocity, which, in turn, has been computed by iteration. The separation of the computation of transient and quasi-steady velocities simplifies enormously the problem of making the iterative solution converge.

This work was done by Wayne E. Simon of Martin Marietta Corp. for **Kennedy Space Center**. *For further information, Circle 104 on the TSP Request Card.*
KSC-11495

Machinery

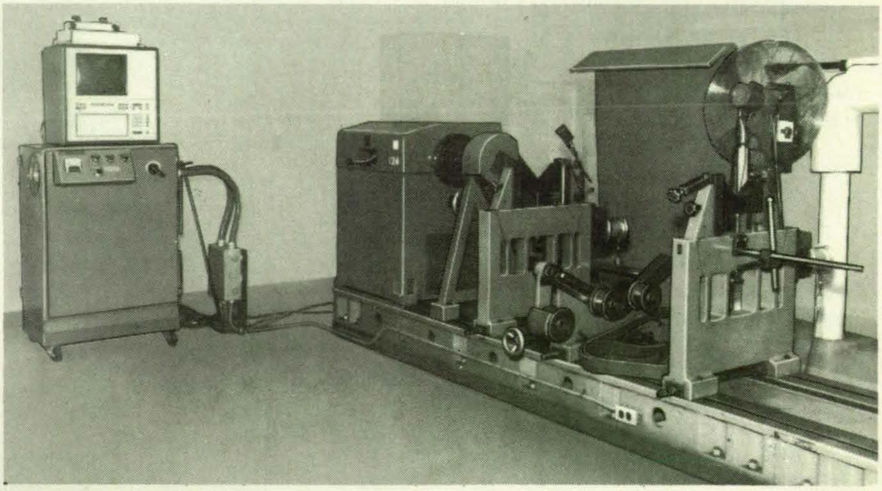
Dynamic Balancing of Turbomachinery Shafts and Rotors

A time-efficient method involves the use of balancing arbors.

Lewis Research Center, Cleveland, Ohio

A method for the dynamic balancing of turbomachinery shafts and rotors has been developed with a view toward reducing the time spent in the balancing process. The need for a shortened dynamic-balancing process arises from the emerging interest in increasing the test productivity of turbines and compressors; in the worst case, the conventional dynamic-balancing process can consume much time because it can include the disassembly of the machinery, the tedious iterative process of balance measurements and balancing alternations, and reassembly of the machinery.

The improved method is based on existing dynamic-balancing techniques and equipment, but differs from the prior method by incorporating the use of a balancing arbor, which is a mandrel that duplicates the mounting geometry and the



This **Balancing Machine** — one of several in use at NASA Lewis Research Center can handle shafts that weigh between 20 and 5,000 lb (between 9 and 2,300 kg) rotating at 600 to 1,400 rpm.

dynamic-balance properties of a shaft that has been balanced. The idea that underlies the improved method is that once a shaft has been balanced, it should not be necessary to disassemble the machinery and/or shaft completely and rebalance the shaft when replacing a rotor on the shaft. Instead, one balances the replacement rotor on the balancing arbor, then installs the balanced rotor on the shaft.

The improved method prescribes the following balancing process:

1. Assemble the shaft to be balanced without the rotor, but with all of the associated rotational hardware and precise bearing spacers in place of bearings.
2. Match-mark the assembled parts of the shaft and rotational hardware with respect to each other and to an analogous 0° rotational location.
3. Mount the assembled parts on the balancing machine, and balance them to the limit of accuracy of the balancing machine, removing or adding material as necessary.
4. Obtain an extra rotor (called the "checkout rotor"), which is to be used in balancing operations but not placed in service. Mount the checkout rotor on the balanced, assembled shaft.
5. Match-mark the checkout rotor with respect to the balanced, assembled shaft and the analogous 0° location.
6. Mount the checkout-rotor-and-shaft assembly on the balancing machine, and balance it to the limit of accuracy of the machine, removing or adding material as necessary from the checkout-rotor.
7. Remove the checkout rotor from the shaft.
8. Remove the precise bearing spacers from the shaft.
9. Install the precise bearing spacers onto the balancing arbor.
10. Mount the checkout rotor onto the arbor.
11. Match-mark the arbor with respect to the checkout rotor and an analogous 0° location.
12. Mount the arbor-and-rotor assembly on the balancing machine, and balance to the limit of accuracy, removing or adding material from the arbor. The balancing arbor is now calibrated to the shaft. This procedure compensates for the machining tolerances of the shaft and the balancing arbor.
13. To prepare to balance a new rotor (to be placed in service), mount this rotor on the balanced arbor.
14. Match-mark this rotor with respect to the arbor and an analogous 0° location.
15. Balance the rotor as part of the rotor-and-arbor assembly to the limit of accuracy.
16. Remove the balanced rotor from the arbor.
17. Install and align (according to the match-marked analogous 0° location) the balanced rotor onto the shaft.

If a balancing arbor is not to be used, then the balancing process can consist of steps 1 through 8 only, and the rotor to be placed in service is used instead of the checkout rotor. Whatever variant of the procedure is employed, it is important to note that some unbalance may remain and cause trouble in service. In that case, it is necessary to resort to field balancing.

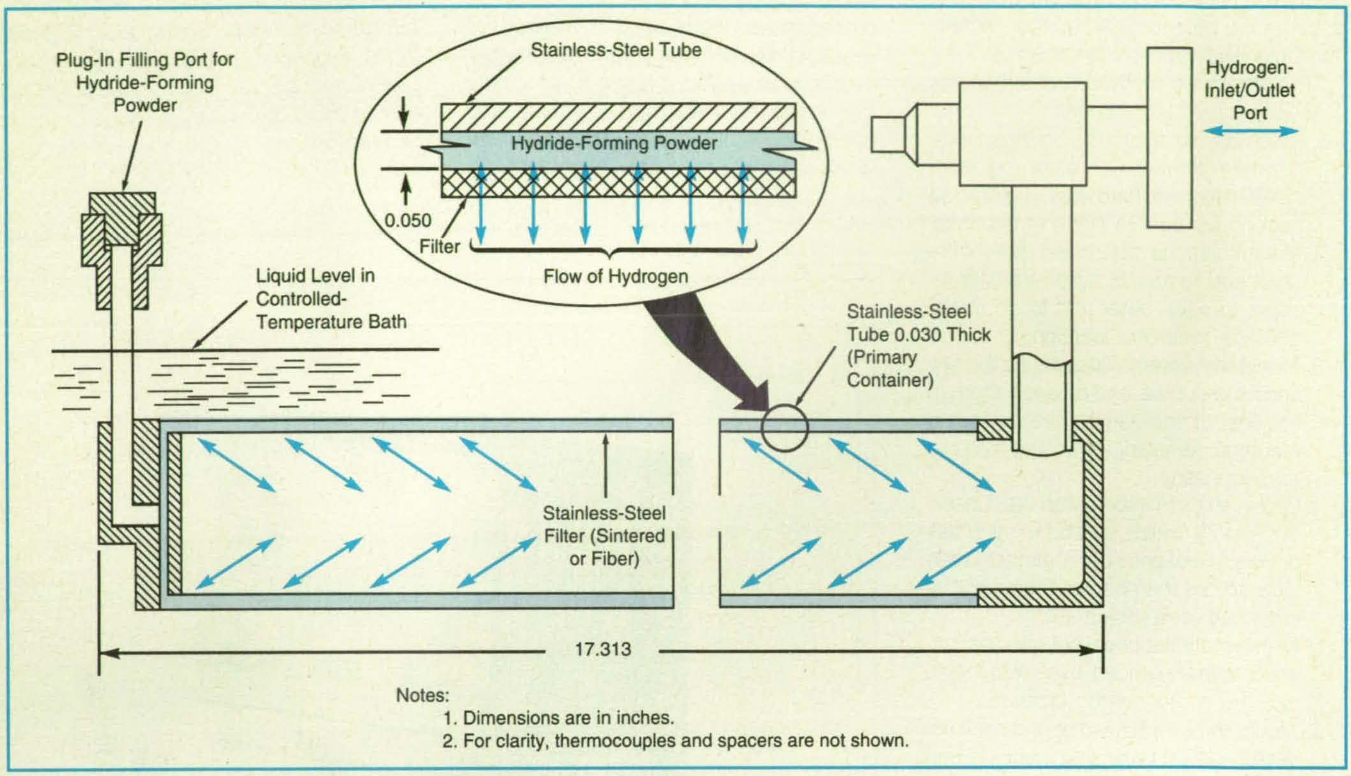
This work was done by Vincent G. Verhoff of **Lewis Research Center**. *Further information may be found in NASA TM-102537 [N90-20392], "An Applicational Process for Dynamic Balancing of Turbomachinery Shafting."*

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.
LEW-15186

High-Suction Hydride Sorption Pump

Improved design provides high pumping speed at low pressure.

NASA's Jet Propulsion Laboratory, Pasadena, California



Hydride-Forming Powder Is Retained in a thin layer in contact with the inner surface of the stainless-steel tube. This configuration provides a large surface area and short path for efficient transfer of heat and small resistance to flow.

The figure illustrates a hydride sorption unit that serves as a suction pump in a cryogenic system. The purpose of this unit is to draw a vacuum on a reservoir of liquid hydrogen that has been produced initially, by other associated equipment, at a temperature of 20 to 30 K. The evaporation of hydrogen from the reservoir cools the hydrogen remaining in the reservoir, and the continued sublimation after freezing cools the reservoir further, down to 10 K. To obtain the quick cooldown required in many applications, the sorption unit must be capable of reducing the pressure of hydrogen from 8 atmospheres (0.81 MPa) (for liquid hydrogen at 30 K) to 1.9 torr (0.25 kPa); thereafter, the sorption unit must be capable of absorbing the hydrogen that sublimes from the hydrogen ice as this ice absorbs heat from the device being cooled to 10 K, while maintaining the pressure below 1.9 torr.

In designing a hydride sorption unit for this purpose, it is necessary to overcome two major obstacles to rapid pumping at low pressure. The first obstacle is that the absorption of hydrogen in the hydride-forming metal powder is exothermic. If the heat of absorption is not removed quickly, the temperature of the hydride bed increases, with a concomitant increase in the sorption pressure. The other obstacle is the pressure drop (resistance to flow) through the hydride bed and through its filter. (The filter is necessary to prevent the hydride-forming powder from migrating out of the sorption unit through the associated plumbing. Migration is caused partly by the cyclic expansion and contraction of the hydride-forming powder during absorption and desorption, respectively.)

The present hydride sorption unit features a large surface area and short conduction path for the rapid and efficient transfer of heat from the hydride powder to the surroundings. The primary container of the sorption unit is a stainless-steel tube that can be immersed in a water bath or otherwise heat-sunk to dissipate the heat of absorption at room temperature. The hydride-forming powder is ZrNi, and is retained in a gap only about 0.050 in. (about 1.3 mm) thick between a stainless-steel filter and the inner surface of the stainless-steel tube. This configuration also provides a short flow path and thus minimizes resistance to flow. Spacers (not shown in the figure) in the gap suppress the migration of the powder by keeping the powder in separate compartments.

This work was done by Steven Bard and Jack A. Jones of Caltech and Robert C. Bowman, Jr., and Robert S. Dowling of Aerojet General Corp. for **NASA's Jet Propulsion Laboratory**. *For further information, Circle 83 on the TSP Request Card. NPO-18604*

Fabrication Technology

Dummy End Points Maintain Orientation in Welding

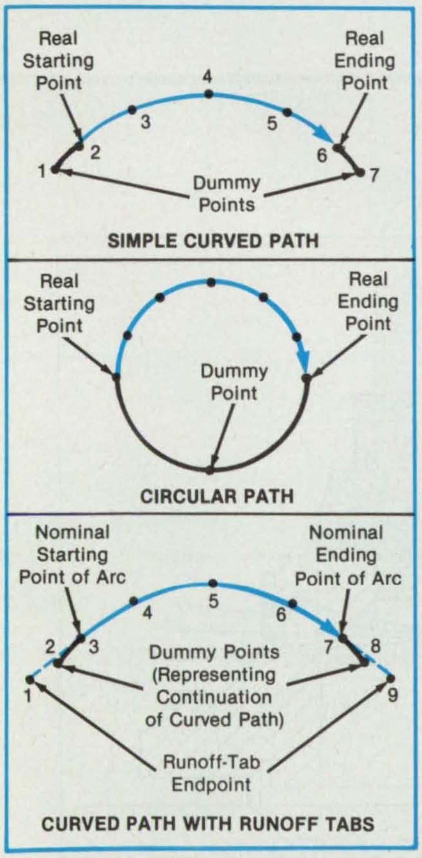
A programming artifice keeps the weld puddle from running off.

Marshall Space Flight Center, Alabama

Dummy points can be added during off-line programming of a circular, noncontiguous computer-controlled weld path to keep the weld puddle in the proper orientation at the ends of the path. Heretofore, when such a path has been generated by the Unigraphics (or equivalent) computer-aided design/computer-aided manufacturing (CAD/CAM) system, the orientation of the weld puddle at the first and last points has sometimes been incorrect, with the result that the weld puddle can run off the workpiece.

The misorientation occurs because of the way in which the particular CAD/CAM system makes the welding robot move in coordination with the workpiece-positioning table to enable the welding torch to reach the end points. In this particular system, to keep the weld puddle oriented so that molten metal does not run out, one should make the table (only) move while holding the torch still. In practice, one does this by use of the dummy points. The incorporation of the dummy points is simple and requires only a few extra minutes of programming effort.

Two extra points are generated in the design — one before the real starting point and one after the real ending point (see figure). Each dummy point must be located at least 0.1 in. (2.54 mm) away from its real end point. After the off-line-programming file (the ".CLS" file in Unigraphics) is converted to a manufacturing file (a ".PAR" file in Unigraphics), the extra points are deleted. However, for the purpose of orientation, the welding control system treats



Dummy Points Are Added to the ends of three example weld paths to maintain the correct orientation of the weld puddle. The dummy points are removed from the program before welding begins.

the extra points as though they still existed, and treats the actual starting and ending points as though they were intermediate. The correct orientation of the puddle is thus maintained at all positions.

If the path is circular and lies in a single plane perpendicular to the axis of the welding torch, then only one extra point is needed. This point should be midway between the real starting and ending points. Again, the point is deleted after conversion of the files.

If the workpiece includes runoff tabs, the extra points should lie between the runoff-tab end points and the starting and ending points of the welding arc. The dummy points should be deleted after conversion of the files.

This work was done by Karen E. Sliwinski and Maureen L. Levitt of Rockwell International Corp. for **Marshall Space Flight Center**. *No further documentation is available.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Marshall Space Flight Center [see page 24]. Refer to MFS-29859

Positioning Fixtures for X-Ray Inspection

Fixtures reduce setup time and eliminate waste of film.

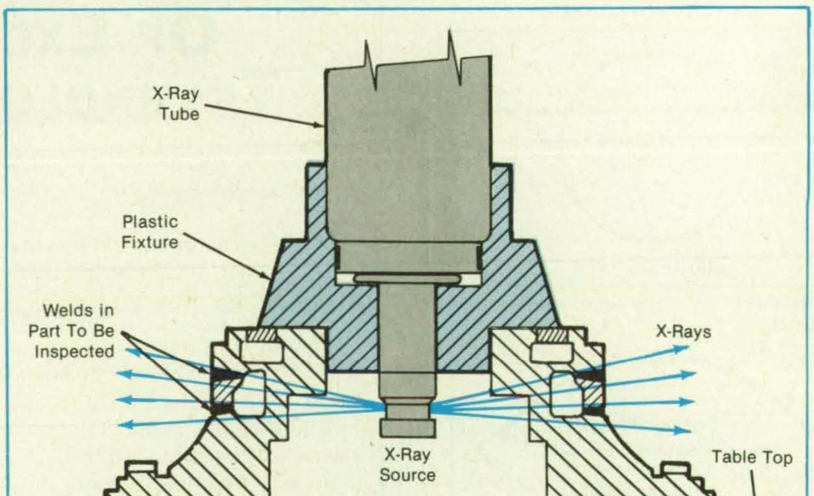
Marshall Space Flight Center, Alabama

Flanged fixtures are designed to position an x-ray source at fixed locations within welded parts that are to be inspected radiographically. The fixtures eliminate the need for tedious measurements to find the proper locations and alignments of the x-ray source. The fixtures thus reduce setup time and eliminate the waste of film that occurs when x-radiographs are taken at incorrect positions. Furthermore, variability among parts, inspectors, and shifts is eliminated.

Each fixture is essentially a flanged plastic cylinder that holds an x-ray tube on its axis (see figure). The fixture is designed to fit a specific part so that it holds the x-ray source at the internal position from which x rays are required to emanate so as to illuminate the region of interest (usually a weld joint).

This work was done by Jerry W. Lee and Don B. Romo of Rockwell International Corp. for **Marshall Space Flight Center**. *For further information, Circle 47 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 24]. Refer to MFS-29862.



The **Flanged Fixture** rests on the upper machined surface of a part to be inspected. The position of the x-ray source is determined by the fit of the x-ray tube in the fixture and the depth of a shoulder within the fixture, which is therefore designed for the specific part to be inspected.

Cleaning by Blasting With Pellets of Dry Ice

Parts can be cleaned rapidly, without toxic chemicals.

Marshall Space Flight Center, Alabama

A dry process strips protective surface coats from parts to be cleaned, without manual scrubbing. The process does not involve the use of flammable or toxic solvents. The process can be used to remove coats from a variety of materials, including plastics, ceramics, ferrous and nonferrous metals, and composites. It adds no chemical-pollution problem to the problem of disposal of the residue of coating material.

The process consists of blasting solid carbon dioxide (dry ice) pellets at the surface to be cleaned. The pellets sublime on impact and pass into the atmosphere as carbon dioxide gas. The size, hardness, velocity, and quantity of the pellets are adjusted to suit the coating material and the substrate.

The heart of the equipment needed to effect the process is a pelletizer, which converts refrigerated liquid CO_2 into the pellets. Air-delivery equipment moves a stream of the pellets to a blasting gun, where compressed air fires them at the surface to be cleaned.

When small parts are cleaned in humid air, the dry ice can chill them enough that moisture condenses on them. They can simply be wiped dry. Complexly shaped parts can be placed in a drying oven to prevent corrosion by condensed moisture.

The time saved by blast cleaning with CO_2 pellets is substantial: Where solvent cleaning requires 8 worker-hours, blast cleaning with CO_2 pellets can do the job in 1 hour or less.

This work was done by Jody Fody of The Boeing Co. for **Marshall Space Flight Center**. *For further information, Circle 22 on the TSP Request Card. MFS-28702*

Mathematics and Information Sciences

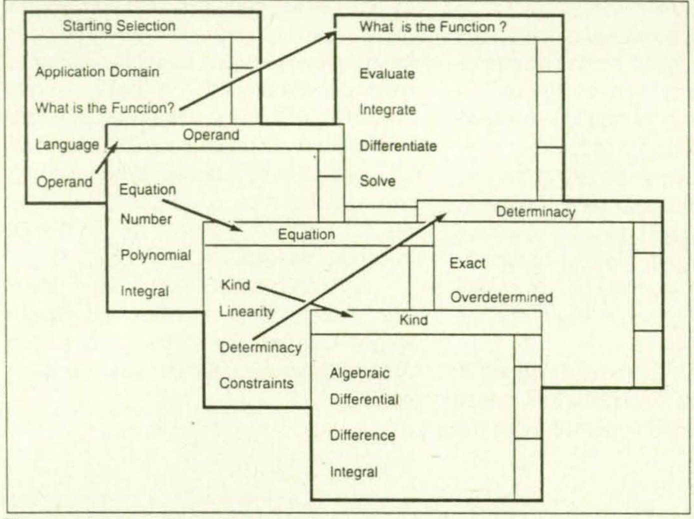
Classifying Software for Reuse

Both beginners and experts can retrieve software components for use in new programs.

NASA's Jet Propulsion Laboratory, Pasadena, California

A scheme for classifying software facilitates and accelerates retrieval of software components. The method thus aids the reuse of software and thereby increases software developers' productivity. The scheme is used to discover software components that meet a specified need in a large collection of useful, reliable components. The classification and retrieval methodology of this scheme applies equally to things unrelated to software — for example, hardware, patents, legal cases, and books.

To make the general practice of reuse of software successful, it is necessary to make the discovery of a preexisting software component to fill a specific need cost less than developing the component anew would cost. The classification scheme was developed with this in mind,



These **Lists of Questions and Answers** are typical of those that are presented to the user by the classification software. The user interacts with the classification software by choosing among the displayed questions and answers. The user thus proceeds through the classification space of facets that describe the desired software component.

and with a view toward meeting the needs usually expressed by software developers.

The classification scheme is based partly on the use of facets; that is, independent views of the properties of software components. Facets can also be regarded as dimensions in a Cartesian classification space. The scheme involves (1) specification of a set of properties of each component to be classified and (2) refinement of properties by specification of additional properties, by use of binary relations of the form *entity* **relation** *value*. In such a relation, *entity* denotes either a component or a property. *Value* can denote a component, a property, or an atom (a name for which no further description is provided). A **relation** is equivalent to a facet, and the value of the relation is equivalent to the position along that axis of the classification space that is represented by the facet.

The scheme is implemented in software that includes two major parts: (1) a searcher, which is a software system that is used to discover software that meets a given need; and (2) a retriever, which is a software component that retrieves all the files necessary to use a selected software component.

The searcher enables the user to find the desired software without being required to answer an excessive number of questions and without presenting the user with too many possible answers to any one question. Although it guides an inexperienced user through the system, it lets an expert user forge ahead without artificial restriction.

The searcher displays appropriate questions and, when the user has selected a question, displays possible answers. Questions correspond to relations, and the set of answers to a given question corresponds to the set of values of the relation represented by that question. The user thus proceeds through a series of displays of questions and answers (see figure).

Components and properties can be arranged into hierarchies. Properties can also possess other properties specified by relations; that is, a relation of the form *property* **relation** *property* is permitted. This allows the *value* parts of relations to be classified, so that one may use the full power of the retrieval system to select the appropriate value for a relation. The ability to classify values enables a human classifier to balance the number of answers against the number of questions. That is, the classifier may decrease the number of possible answers presented, but doing so increases the number of questions presented when the user selects an answer that is a classification for a set of values.

The retriever goes to work when the user has identified the desired software component. In the simplest case, the data base of software components and the retriever reside in the same computer. All the retriever has to do then is produce a list of the names of the files necessary to use the selected component. In the more-general case, the data base of software components is distributed across several computers that are not necessarily near each other. In that case, the retriever might use a file-transfer protocol to fetch the various files from computers in a network or connected by modems and telephone lines.

This work was done by William V. Snyder of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, Circle 27 on the TSP Request Card.* *NPO-18530*

Optimization of a Computational Grid

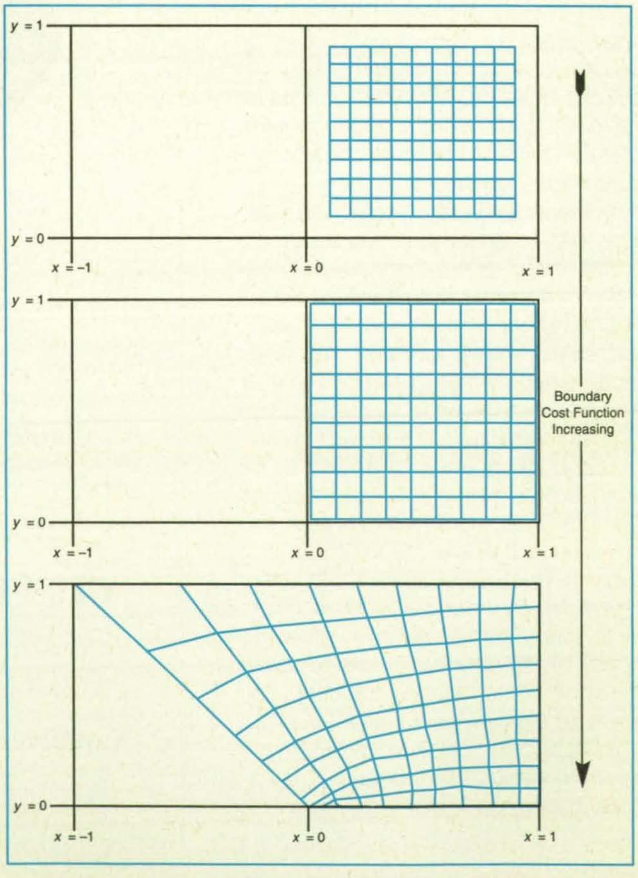
Generation of the grid is decoupled from definition of the geometry.

Lyndon B. Johnson Space Center, Houston, Texas

In an improved method of generation of a computational grid, the grid-generation process is decoupled from the definition of the geometry; that is, it is decoupled from the geometric specification of the boundary to which the grid must conform. The computational grid could be, for example, one that is to be used to obtain numerical solutions of the differential equations of a flow in a region bounded by a surface or surfaces.

Heretofore, grids for use in such flow-field computations have been specified and/or generated concomitantly with the boundaries, so that it has been necessary to redefine boundary surfaces when refining grids to resolve finer details of flow fields. In the improved method, it is not necessary to redefine the boundary. Instead, continuous boundaries in the physical domain are specified (often by specifying lines and surfaces algebraically), and then grid points in the computational domain are mapped onto the continuous boundaries.

The grid is optimized by use of a conjugate-gradient method: Each grid point is treated as an independent variable in a global cost function that is the weighted sum of (1) a cost function that quantifies the unevenness of the distribution of grid points, (2) a cost function that quantifies the nonorthogonality of the grid, and (3) a cost function that quantifies nonconformity to



In this **Test Case**, the problem is to fit an H-grid to a trapezoid. As the weighting of the boundary cost function increases by a factor of 1,000, the grid conforms more closely to the trapezoidal boundary.

the boundaries in terms of a weighted sum of distances between boundary surfaces and nearby grid points that are supposed to lie on the boundary surfaces. The optimum grid is found by a conjugate-gradient procedure in which the grid points are adjusted iteratively to minimize the penalty function.

Not all penalty functions go to zero, even in ideal cases. In practice some measures could be satisfied more easily or deemed more important, in which case those measures can be weighted more heavily. For example, it is often necessary to weight the boundary cost function more heavily than the unevenness-of-distribution cost function to assure a high degree of conformity of the grid to the physical boundary.

The method has been tested by applying it in some two- and three-dimensional boundaries, including a square, a trapezoid, a nonconvex quadrilateral, a circle, an airfoil, a cube, and a cylinder. The figure shows some of the results from the trapezoid case, illustrating the tendency of the unevenness-of-distribution cost function to contract the grid away from the boundary and the consequent need to weight the boundary cost function more heavily.

This work was done by Daniel G. Pearce of Lockheed Engineering & Sciences Co. for **Johnson Space Center**. *For further information, Circle 90 on the TSP Request Card.* *MSC-22114*

Life Sciences

Electromechanical Nerve Stimulator

A force-and-position transducer aids in research and surgery.

Langley Research Center, Hampton, Virginia

A nerve stimulator applies and/or measures precisely controlled force and/or displacement to a nerve so that the response of the nerve can be measured. The stimulator can be used in research to characterize the behavior of a nerve under various conditions of temperature, anesthesia, ventilation, and prior damage to the nerve. It can also be used clinically to assess damage to a nerve from disease or accident and to monitor the response of the nerve during surgery.

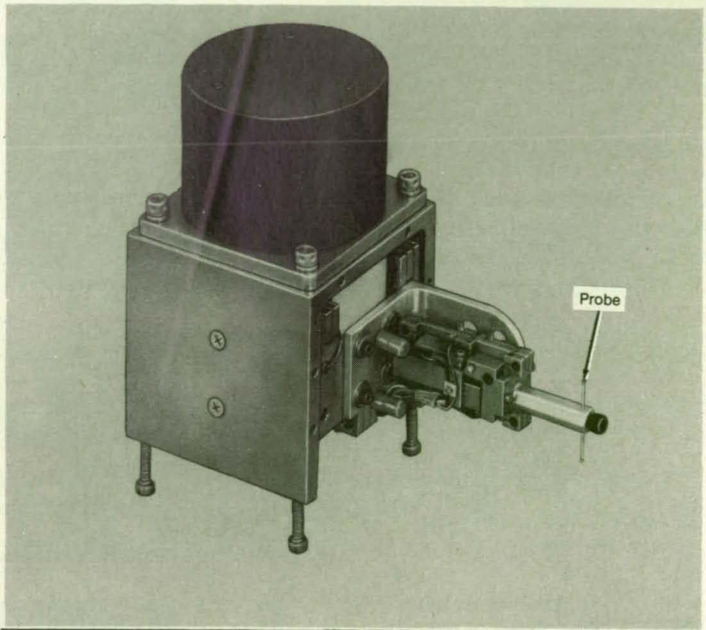
The stimulator consists of three major components connected in tandem: a miniature probe with a spherical tip, a transducer, and an actuator (see figure). The probe applies force to a nerve, the transducer measures the force and sends a feedback signal to control circuitry, and the actuator positions the force transducer and the probe. A separate box houses the control circuits and panel. An operator uses the panel to select the operating mode and parameters from among the following options:

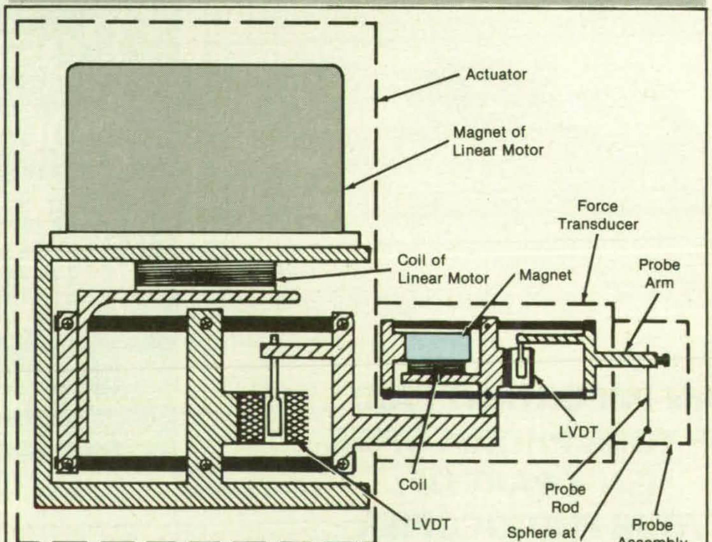
- The unit can be set to apply a constant force adjustable between 0 and 10 g weight (0 and 0.098 N) with a precision of ± 0.05 g (4.9×10^{-4} N). The force can be of indefinite duration or applied as a pulse lasting 1, 10, 30, or 60 s.
- The unit can be set to apply constant displacement adjustable from 0 to 0.25 mm while the applied force is measured. As in the constant-force mode, the displacement can be applied indefinitely or as a pulse.

The actuator contains a parallel-linkage mechanism with two movable platforms. The probe of a displacement-measuring transducer [a linear variable-differential transformer (LVDT)] is mounted on one platform. The coil of a linear motor is mounted on the other platform. The motor moves the platform and the linkage, thereby moving the probe. The LVDT provides a feedback signal to the control circuitry, which maintains the probe in a fixed position, if that mode has been selected by the operator.

The force transducer is a smaller version of the actuator parallel-linkage mechanism. Its body is attached to one of the movable platforms of the actuator. The probe is attached to one of the movable platforms of the force transducer. Because it always operates in the self-nulling or "locked" mode, the force transducer puts out a signal indicative of the force that the probe exerts against the nerve. The control circuitry uses this signal to maintain a constant force between the probe and the nerve if that mode has been selected.

The probe is a spherical epoxy bead on the pointed end of a rod of 0.0625-mm diameter. The rod is mounted vertically in an arm of the force transducer.





The **Force Transducer** protrudes from side of the actuator of the nerve stimulator. The magnet of the linear motor is at the top of the enclosure. The diagram shows details of the actuator and force-transducer linkages. The unit measures approximately 15 by 7 by 14 cm and weighs less than 2 kg.

This work was done by Ping Tcheng and Frank H. Supplee, Jr., of **Langley Research Center** *and Richard L. Prass of Eastern Virginia Medical School. For further information, Circle 147 on the TSP Request Card.*
LAR-14009

Books & Reports

These reports, studies and handbooks are available from NASA as Technical Support Packages (TSP's) when a Request Card number is cited; otherwise they are available from the National Technical Information Service.

Electronic Components and Circuits

Predicting Lifetimes of CMOS ASIC's From Test Data

A concise report discusses recent developments in the use of semiempirical mathematical models to predict rates of failure and operating lifetimes of complementary metal oxide/semiconductor (CMOS) application-specific integrated circuits (ASIC's). Each model represents a specific mechanism of failure. Once the failure mechanisms and models relevant to a given ASIC are chosen, the adjustable parameters in the models are fitted to life-test data acquired from representative integrated-circuit structures on test coupons that are fabricated along with the ASIC's. Then the design parameters of the ASIC's are incorporated into the models, and the models yield the lifetimes.

This work was done by Martin G. Buehler, Nasser Zamani, and John A. Zoutendyk of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "CMOS-ASIC Life Predictions From Test-Coupon Data," Circle 55 on the TSP Request Card.*
NPO-18698

Postirradiation Effects in Integrated Circuits

Two reports discuss postirradiation effects in integrated circuits. The need to investigate post-irradiation effects has become apparent during the past several years in that many such effects have been observed after total-ionizing-dose tests in which circuits have been irradiated with γ rays from ^{60}Co.

To illustrate the importance of determining postirradiation effects, the reports present examples of postirradiation measurements of the performances of integrated circuits of five different types: a dual complementary metal oxide/semiconductor (CMOS) flip-flop, a CMOS analog multiplier, two CMOS multiplying digital-to-analog converters, an electrically erasable programmable read-only memory, and a semiconductor/oxide/semiconductor octal buffer driver. Postirradiation effects in these devices range from recovery of normal operation to catastrophic failure ocurring one week after the end of irradiation, each device exhibiting a different combination of effects. Temperature is shown to play an important role in the annealing of trapped holes and interface states in these integrated circuits.

This work was done by David C. Shaw and Charles E. Barnes of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain copies of the reports, "Post Irradiation Effects (PIE) in Integrated Circuits," Circle 30 on the TSP Request Card.*
NPO-18590

Electronic Systems

Model of Neural Network With Creative Dynamics

A paper presents an analysis of a mathematical model of a one-neuron/one-synapse neural network that features coupled activation and learning dynamics and a parametrical periodic excitation. The analysis is performed to demonstrate the self-programming, partly random behavior of a suitably designed neural network; such behavior is believed to be related to the spontaneity and creativity of biological neural networks.

This work was done by Michail Zak and Jacob Barhen of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Neural Networks With Creative Dynamics," Circle 63 on the TSP Request Card.*
NPO-18125

More About the PHIMAP

A report discusses some engineering problems that arise in implementing the system described in "Programmable Hyperspectral Imaging Mapper" (NPO-17794), *NASA Tech Briefs*, Vol. 16, No. 10 (1992), page 36. The programmable hyperspectral imaging mapper (PHIMAP) is a conceptual generic advanced spectral imaging system that would scan in "pushbroom" fashion along the ground track of an airplane or an orbiting spacecraft. The PHIMAP is based partly on prior spectral imagers and partly on advanced concepts, not yet fully developed, of spectrally agile filters and processing of images on focal-plane arrays. The PHIMAP would provide both high spatial resolution and a large number (typically > 100) of spectral channels. It could be programmed to trade spectral resolution and spectral coverage against signal-to-noise ratio to optimize the utility of image data from scenes of spectrally and spatially varying brightness.

This work was done by James A. Cutts of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Programmable Hyperspectral Imaging Mapper With On Array Processing: A New Approach to Land Remote Sensing," Circle 99 on the TSP Request Card.*
NPO-18482

Physical Sciences

Curvature-Squared Cosmology in the First-Order Formalism

A paper presents a theoretical study of some of the general-relativistic ramifications of a gravitational-field energy density proportional to $R - \alpha R^2$ (where R is the local scalar curvature of space–time and α is a constant). At present in our part of the universe, the quadratic term (αR^2) represents a negligible effect, but its effect can be significant in regions of large curvature; for example, near the postulated "big-bang" origin of the universe.

This work was done by Bahman Shahid-Saless of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Curvature-Squared Cosmology in the First-Order Formalism," Circle 72 on the TSP Request Card. NPO-18332*

Evaporation of Clusters of Drops in a Jet

A report presents a theoretical study of the evaporation of clusters of liquid drops injected with a gas jet that flows into a hot ambient gas. This is one in a series of studies, by the same authors, of various aspects of the behavior of sprays — especially sprays of liquid fuels in combustion chambers.

This study is not a detailed quantitative analysis of the dynamics and thermodynamics of the interacting liquids and gases. Instead, simplified mathematical models are used to extract qualitative information on trends in the interactions.

This work was done by Josette Bellan and Kenneth G. Harstad of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "A Model for the Evaporation of Clusters of Drops Embedded in Jet Vortices: I. Steady Injection of Identical Clusters," Circle 2 on the TSP Request Card. NPO-18610*

Voyager 2 Test of the Radar Time-Delay Effect

A report presents an analysis of radio range measurements generated during the superior solar conjunction of the Voyager 2 spacecraft in December 1985. This is one in a continuing series of studies directed toward verifying the prediction, according to the theory of general relativity, that an electromagnetic signal propagating near the Sun will be delayed by the solar gravitational field.

This work was done by Timothy P. Krisher, John D. Anderson, and Anthony H. Taylor of Caltech for **NASA's Jet Propulsion Laboratory.** *To obtain a copy of the report, "Voyager 2 Test of the Time-Delay Effect," Circle 8 on the TSP Request Card.*
NPO-18420

Materials

Behavior of Aircraft Components Under Crash-Type Loads

A report presents an overview of research that involved the use of concepts of aircraft elements and substructures that have not necessarily been designed or optimized with respect to energy-absorption or crash-loading considerations. Experimental and analytical data that are presented in the report indicate some general trends in the failure behaviors of a class of composite-material structures that include (1) individual fuselage frames, (2) skeleton subfloors with stringers and floor beams but without skin covering, and (3) subfloors with skin added to the frame/stringer arrangement. Although the behaviors of these structures are complicated, a strong similarity in the static and dynamic failure behaviors of these structures is illustrated through photographs of the experimental results and through data obtained from mathematical models of generic composite-material structures. The similarity in behavior can give designers and dynamicists much information about what to expect in the crash behaviors of these structures and can guide designers in improving the energy-absorption and crash behaviors of such structures.

This work was done by Huey D. Carden of **Langley Research Center**, *Richard L. Boitnott of U. S. Army Aerostructures Directorate, and Edwin L. Fasanella of Lockheed Engineering & Sciences Co. Further information may be found in NASA TM-102681 [N90-25368], "Behavior of Composite/Metal Aircraft Structural Elements and Components Under Crash Type Loads — What Are They Telling Us?"*

Copies may be purchased (prepayment required) from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.
LAR-14623

Failure of Aircraft Components Under Crash-Type Loads

A report presents information that was generated and published during the transport- and composite-aircraft-components phases of the impact-dynamics research programs at NASA Langley Research Center. The research was conducted by personnel at the Langley Impact Dynamics Research Facility. The facility is the former Lunar Landing Facility used to train astronauts for landings on the Moon.

This work was done by Huey D. Carden of **Langley Research Center**. *Further information may be found in NASA TM-102679 [N90-24660], "Unique Failure Behavior of Metal/Composite Aircraft Structural Components Under Crash Type Loads."*

Copies may be purchased [prepayment required] from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.
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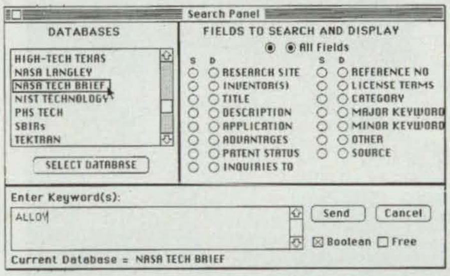

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Mechanics

Balloonlike Shields Against Fast Projectiles

A report proposes the use of flexible gas-filled or liquid-filled pouches to shield spacecraft against impacts by small meteoroids and orbiting debris traveling at speeds $\geq$ 2 km/s. These shields could be made in various forms reminiscent of balloons, pillows, air mattresses, or sealed-air-bubble packing material, for example. They would serve as lightweight, easily installed alternatives to heavier, rigid shields made of spaced aluminum sheets that must be custom-designed and that can be attached to spacecraft only with great difficulty and expense.

This work was done by Michelle A. Rucker of **Johnson Space Center**. *To obtain a copy of the report, "Ablative Shielding From Hypervelocity Particles," Circle 1 on the TSP Request Card.*

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center [see page 24]. Refer to MSC-21884.

Performances of Airplanes on Slippery Runways

A NASA technical paper reports on a 5-year study, conducted jointly by the Federal Aviation Administration (FAA) and NASA, of runway friction under a wide variety of conditions. The study was conducted to satisfy a need for information on runways that may become slippery because of various forms and types of contaminants. Since the beginning of "all-weather" aircraft operations, landing and aborted-takeoff incidents (including accidents) have occurred each year. In these incidents, airplanes have either run off the ends or veered off the shoulders of low-friction runways. These incidents have provided the motivation for various government agencies and aviation industries to conduct extensive research to examine the factors involved in the problem of inadequate runway friction.

This work was done by Thomas J. Yager and Paul Baldasare of **Langley Research Center** *and William A. Vogler of PRC Kentron, Inc. Further information may be found in NASA TP-2917 [N90-15902], "Evaluation of Two Transport Aircraft and Several Ground Test Vehicle Friction Measurements Obtained for Various Runway Surface Types and Conditions."*

Copies may be purchased (prepayment required) from the National Technical Information Service, Springfield, Virginia 22161, Telephone No. (703) 487-4650. Rush orders may be placed for an extra fee by calling (800) 336-4700.
LAR-14570

Vibration Test With Extremal Dual Control

A report discusses the use of extremal dual control to prevent overtesting. In extremal dual control, an electronic test-control subsystem automatically reduces the excitation supplied to a shaker subsystem to keep the force applied by the shaker below a preset force limit and to keep the acceleration of the shaker below a preset acceleration limit. Extremal dual control helps to prevent overtesting when the shaker operates at a resonant frequency of the article under test, of the shaker, and/or of the shaker-and-article assembly. For this purpose, it is necessary to choose the acceleration and force limits so that at the resonances, the various internal forces and accelerations of the coupled shaker and test-article structures remain below the desired limits.

This work was done by Terry D. Scharton of Caltech for **NASA's Jet Propulsion Laboratory**. *To obtain a copy of the report, "Dual Control Vibration Tests of Flight Hardware," Circle 23 on the TSP Request Card.*
NPO-18600

NASA Tech Briefs LITERATURE SPOTLIGHT

Free catalogs and literature for NASA Tech Briefs' readers. To order, circle the corresponding number on the Readers Information Request Form (page 83).

SPECIALIZED TECHNICAL TRAINING

A newsletter of technical articles, training opportunities, publications and Environmental Engineering Specialist Certificate Programs. Open enrollment and short courses include: environmental testing, vibration and shock, climatics, instrumentation, data acquisition, understanding specifications, environmental stress screening (ESS), computer software and systems engineering.

Tustin Technical Institute, Inc.

For More Information Write In No. 300

PRECISION GEAR COMPONENTS

Featuring a wide range of gear components in a variety of materials, this 151 page slim-line brochure is the latest from Berg. Designed to complement the Inch and Metric catalogs, it contains Precision Gears & Racks, Gear Assemblies (Inch & Metric), and an extensive technical section. Products include Spur, Helical, Bevel & Worm Gears in various styles and are available in quantities of 1 to 50,000 directly off the shelf or custom made. Tel: 516-599-1700. Fax: 516-599-3274.

For More Information Write In No. 301

FREE DESIGN AID

Save layout time and eliminate detailing with this 16-page template catalog. This catalog shows full-size drawings of many tooling components used in designing jigs and fixtures. It includes spring & ball plungers, nuts, bolts, washers, knobs, and many other items all with sizes and part numbers. Also included will be a copy of the current catalog listing prices of all items.

Northwestern Tools, Inc.

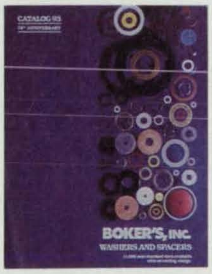
For More Information Write In No. 302

RIGHT ANGLE PLANETARY GEARHEAD CATALOG

A new line of high efficiency right angle gearheads is featured in a six-page color catalog. The gearheads feature precision bevel gears, for over 85% efficiency, and a planetary output section for high torque and low backlash. Bayside's exclusive Clamp-On Pinion™ allows fast and easy attachment of the gearheads to the face of servo and stepper motors. Tel: 516-484-5353. Fax: 516-484-5496.

Bayside Controls Inc.

For More Information Write In No. 303

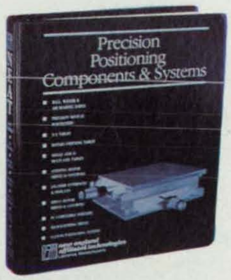


WASHERS AND SPACERS

New for '93! Boker's new 32-page Catalog '93 offers 11,000 non-standard sizes with no tooling charges. Outside diameters of 0.080" to 2.631", a wide variety of inside diameters and thicknesses, and 2,000 material variations create millions of possibilities. Materials include low-carbon, cold-rolled strip and sheet steel; five types of spring steel; stainless steel; aluminum; brass; copper; nickel silver; and such non-metallic materials as Delrin®, Teflon®, Mylar®, and nylon. Metric sizes also. Tel: 1-800-927-4377; Fax: 612-729-8910.

Boker's, Inc.

For More Information Write In No. 304



PRECISION POSITIONING & MOTION CONTROL

NEAT's 1993 catalog, includes the latest additions to our family of *precision positioning components and systems.* We have expanded our entire product line, which includes: single-axis, multi-axis, rotary, high-vacuum, and air-bearing stages; plus a complementary line of stepping, servo, and linear motor drives and controls. Our fully automated CAD/CAM machining facility enables us to provide custom turnkey solutions. Tel: 1-800-227-1066.

New England Affiliated Technologies

For More Information Write In No. 305

NEW FEA DESIGN AND ANALYSIS SOFTWARE

WeCan 5.0 is an integrated engineering design analysis package running on PCs and workstations. It is a full-featured, 3-D package developed by Westinghouse Electric Corporation over a 20 year period and used to simulate and visualize a wide range of static, dynamic and thermal design problems. FREE INFORMATION KIT; FULL WORKING DEMO AVAILABLE. CALL 412-826-3470.

Aegis Software Corporation

For More Information Write In No. 306

COATINGS PROTECT TITANIUM PARTS

CANADIZE® hydrogen-free super-hard surface-enhancement coatings significantly increase the abrasion resistance and wear life of titanium and produce permanently dry-lubricated surfaces that eliminate galling, binding, and seizing. Protect against corrosion and chemical attack. Unusually wide operating temperature ranging from -200 °F to +1200 °F. Call 908-862-6200. Fax: 908-862-6110. Address is 1331 Route 1, Linden, NJ 07036

General Magnaplate Corp.

For More Information Write In No. 307

ANALYTICAL SERVICES—FAST TURN-AROUND

Brochure describes the wide range of materials characterization services that are provided by the firm's Analytical Services Division. Among those described in the brochure are surface area, pore and particle size distribution, density, permeability, chemisorption and pressure testing. Also available are instruments for sale or lease. Tel: 607-257-5544. Toll Free in USA and Canada 1-800-825-5764. Fax: 607-257-5639.

Porous Materials, Inc.

For More Information Write In No. 308

O-RING-SEALED FITTINGS AND VALVES

A full line of flat-faced, O-ring-sealed fittings and valves offering the leak-proof integrity of heat-sealed connections plus slip-in/slip-out accessibility is described. The O-SEAL SYSTEM fittings and valves, in tube and pipe sizes from 1/8" to 2 1/2", are for liquid and gas service from vacuum to 6,000 psi, from -20 °F to +225 °F. Valves have some of the highest flow characteristics of any hand-operated valves. CPV Mfg., Inc., Tel: 215-386-6508; Fax: 215-397-9043.

For More Information Write In No. 310

LAB/TEST FURNACES

A 36-page catalog (Bulletin 3110) describes lab/test furnaces manufactured by Applied Test Systems. Furnaces available in tubes, splits, or boxes in configurations and sizes designed to specific customer requirements. Features include: low power consumption, fast heat-up, long element life, low shell temperature, stainless steel shell. Temperature to 3100 °F.

Applied Test Systems, Inc.

For More Information Write In No. 311

ANVIL'S PC TRAVELER

The ANVIL PC TRAVELER is engineered for transportable PC systems. With over 40 years experience in designing and manufacturing, ANVIL builds cases that add value and functionality to the systems they house. The ANVIL PC TRAVELER provides protection from the hazards of the road, reduced shipping costs and extended system life through protection. The cases are designed for most PCs available today.

Anvil Cases,
A Subsidiary of Zero Corporation

For More Information Write In No. 312

ADVANCED COMPOSITE WORKSHOPS

The brochure describes nine "hands-on" workshops in advanced composite materials technology. They cover fabrication, repair, tooling, blueprint reading, adhesive bonding, engineering design for specialized repairs, and ultrasonic inspection of composites. Emphasis is on prepreg carbon and aramid fiber material and processes, utilizing vacuum bagging and high-temperature curing methods. Tel: 800-638-8441; Fax: 702-827-6599.

Abaris Training Resources

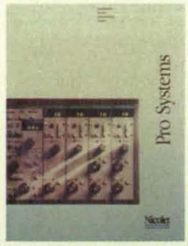
For More Information Write In No. 313

OPTO-MECHANICAL PRODUCT GUIDE

Daedal's new Opto-Mechanical catalog contains hundreds of laboratory bench optical mounts, positioning devices and optical hardware. Complete specifications, dimensions and pricing are included. All products listed can be ordered by phone or fax, can be charged to Visa or MasterCard, and are shipped free to anywhere in the continental US. Tel: 800-245-6903; Fax: 412-744-7626.

Daedal Division,
Parker Hannifin Corporation

For More Information Write In No. 314



NICOLET PRO DIGITAL STORAGE OSCILLOSCOPES

The Nicolet Pro Oscilloscopes offer two or four channels, with 256K per channel, in both eight- and twelve-bit versions, at sampling speeds from 1 MS/s to 200 MS/s. Users can examine the key events in their waveforms without paging or scrolling, by a unique display that shows the max-min boundaries of up to four 256K records.

Nicolet Measurement Instruments

For More Information Write In No. 315

A NEW APPROACH TO SCIENTIFIC DATA ANALYSIS

Analysis Advisor is a free interactive analysis software tutorial that includes demonstrations of graphical and traditional programming methodologies for analysis. You can investigate Digital signal processing, Digital filtering, Windowing, Curve fitting, Signal averaging, Simulation, Interpolation, and Descriptive statistics. Requires Windows 3.1 and 8 MB of memory. Tel: 512-794-0100, 800-433-3488 (US and Canada); Fax: 512-794-8411.

National Instruments

For More Information Write In No. 316

HYSTERESIS BRAKES FOR THE OEM

Magtrol Hysteresis Brakes provide precise torque control without physical contact of parts. Magtrol's new Matched Torque Hysteresis Brakes allow matched selected torque versus current point on any number of brakes, with ±1% tolerance. The Magtrol Hysteresis Brake line offers a broad speed range of more than 30,000 RPM and will remain stable even at extreme operational temperatures. Ratings range from 2.5 oz. in. up to 250 lb. in.

Magtrol, Inc.

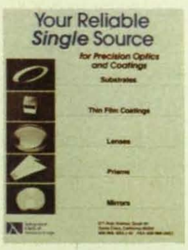
For More Information Write In No. 317

PEN PROBE GUIDE

International Light Inc. is offering a two-page data sheet on its SPL (SPD) family of pen probes, designed for the accurate measurement of luminance, radiance, reflectance and total lumens or watts. The data sheet features descriptions of the SPD (SPL) 024 and 025 series of probes with specifications and features of each model. Photos and diagrams are also included on the SP-1 Data Sheet.

International Light Inc.

For More Information Write In No. 318



Manufacturer of precision optical components including lenses, windows, prisms, filters, beamsplitters and wedges; thin-film coatings in UV, visible and near-IR. Supplier of fabrication services: cutting, shaping and polishing of windows, lenses, mirrors, prisms, and filters to commercial or laser quality. Integrated Optical Services Corp., 671 Aldo Avenue #1, Santa Clara, CA 95054. Tel: 408-988-1653; Fax: 408-988-0623.

Integrated Optical Services Corp.

For More Information Write In No. 319

ULTRA-HARD MATERIALS FABRICATION

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.

For More Information Write In No. 320

CLAMPS

The World of Clamping Catalog 492 describes and illustrates toggle and special clamps with vertical and horizontal hold-down, straight-line, latch, and squeeze action. Spacing products, hydraulic devices, and CAD database are covered along with applications. De-Sta-Co, Troy, MI. Tel: 313-589-2008.

De-Sta-Co

For More Information Write In No. 321

The Capattery 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 Permselective valve, patented by Evans, 33 Eastern Ave., East Providence, RI 02914-2107. Tel: 401-434-5600; Fax: 401-434-6908.

Evans

For More Information Write In No. 322

HIGH POWER "SMART" ELECTRIC ACTUATORS

New linear actuators are driven by TERFENOL-D magnetic shape change metal. Low voltage controls linear or oscillatory motion. "Smart" actuators can simultaneously drive and sense with high accuracy and broad bandwidth. OEM and standard systems are available. ETREMA Products, Inc., 306 South 16th Street, Ames, IA 50010-8102. Tel: 515-232-0820 or 800-327-7291; Fax: 515-232-1177.

ETREMA Products, Inc.

For More Information Write In No. 323

AIRCRAFT BATTERY CHARGER-ANALYZER

Model RF80-K handles vented nickel-cadmium, and sealed or vented lead acid batteries. Automated operation, digital timing and display, constant-current and constant potential charging, plus DigiFLEX® battery and cell analysis. ReFLEX® method charges nickel-cadmium batteries in one hour while reconditioning degraded cells. Christie Electric Corp., 18120 S. Broadway, Gardena, CA 90248. Tel: 310-715-1402; Fax 310-618-8368.

Christie Electric Corp.

For More Information Write In No. 324

CATALOG DESCRIBES DATA ACQUISITION SYSTEMS

General and specialized data acquisition systems are described in this new catalog from Hi-Techniques. Modular in design, these products contain all the software for acquisition of signal data, calculation of data parameters, and output of finished documentation for research and routine test applications. Tel: 608-221-7500.

Hi-Techniques, Inc.

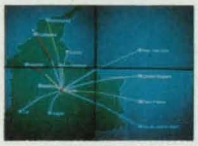
For More Information Write In No. 325

NEW! OPTICAL REFERENCE CATALOG

Edmund Scientific's free 220-page, full-color annual reference catalog features one of the largest selections of precision optics and optical instruments, plus a complete line of components and accessories for both large volume OEM users as well as smaller research facilities and optical laboratories. It contains over 8,000 hard-to-find items, including a large selection of magnifiers, magnets, microscopes, telescopes, and accessories. Tel: 609-573-6280.

Edmund Scientific

For More Information Write In No. 326



WALL-SIZED DISPLAY FOR COMMAND & CONTROL

MediaWall® transforms an array of up to 144 monitors or projectors into a giant computer screen. Display computer data including text, maps, diagrams, animation, photographs, and X-Windows. Digital interface and processing produces images of startling clarity. Resolutions from 640 x 480 to 8K x 6K pixels. Systems start at $24,985.00 plus monitors. Tel: 510-814-7000; Fax: 510-814-7026.

RGB Spectrum®

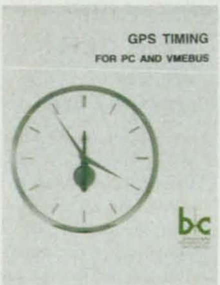
For More Information Write In No. 327

DISPLAY & RECORD UP TO FIFTEEN VIDEO SIGNALS

Watchdog® displays up to 15 video signals on a high resolution monitor (up to 1280 x 1024 pixels) and, optionally, records them on a single VCR. Watchdog accepts infrared, radar, and other non-standard formats. Each signal is displayed in a scaleable video window and can be integrated with computer-generated images. Applications include security, training, robotics, and process control. Tel: 510-814-7000; Fax: 510-814-7026.

RGB Spectrum®

For More Information Write In No. 328

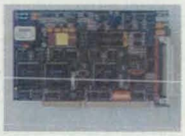


GPS TIMING FOR PC AND VMEbus

This information folder from Bancomm describes new PCbus and VMEbus board-level Global Positioning System (GPS) Satellite Receivers. These products provide worldwide precision time (100 nanosecond) and frequency (1 Part in 10E7) references inside the host computer.

Bancomm

For More Information Write In No. 329



HIGH SPEED DATA ACQUISITION CARD

TransEra announces its powerful 430 data acquisition card. The 430 card boasts a 125K sampling rate, 14 bit resolution, programmable gains and analog triggering.

TransEra Corporation

For More Information Write In No. 330

ZIRCAR PRODUCTS INC.

Manufacturers and fabricators of high performance, high temperature fibrous ceramic thermal, electrical and structural insulation products. Fiber types include: Zirconia, Alumina Silica and other Refractory Oxide compositions. Product forms include: Bulk, Fiber, Powders, Cements, Hardeners, Felts, Cloths, Papers, Boards, Cylinders, Ceramic Composite Shapes and Engineered Insulation Assemblies in standard and custom shapes.

Zircar Products Inc.

For More Information Write In No. 331

ZERO GUARDIAN EXTRA DUTY CABINET BROCHURE

Here is the only custom electronic cabinet without custom fees and no extra tooling charges. Tell us what size and features you need. We'll design and ship within 6 weeks! There are no fixed width, base or vertical wall dimensions if you stay in our min-max guidelines! Need EMI shielding or ruggedized capability? or protection from shock, vibration, water, fungus, and temperature extremes? Brochure highlights design features and suggested applications.

Zero Corporation

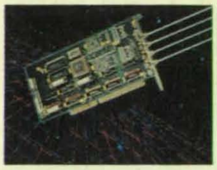
For More Information Write In No. 332

NEW CASES CATALOG

Zero Plastics' new catalog features their complete offering of standard and custom plastic thermoformed and rotationally molded cases for commercial and military applications. Full illustrations and color photographs highlight design features, benefits, suggested applications, and available accessories and options as well as technical data specifications, and ordering information. Zero Plastics, A Unit of Zero Corp., 288 Main St., Monson, MA 01057.

Zero Plastics

For More Information Write In No. 333



MIL-STD-1553/1773 PC INTERFACE

Ponsor Corporation's FIBER OPTIC interface board is used for testing and development terminals for the MIL-STD-1553/1773 data bus. The boards are capable of simulating any one of the three modes of operation and offering complete data recording capability. Extended temperature operation is standard (-40 °C to +85 °C). Menu software and a "C" driver library package are included. Tel: 619-597-0095.

Ponsor Corporation

For More Information Write In No. 334

FREE CATALOG! LINEAR MOTION COMPONENTS

All products ship within 24 hours.

- Ball Slides
- Crossed Roller Slides
- Positioning Slides
- Recirculating Bearings
- Shafts & Supports.

Call TOLL FREE: 1-800-447-2042, In CT: 203-790-4611, or Fax: 203-748-5147. TUSK Direct, Inc., Clarke Industrial Park, PO Box 326, Bethel, CT 06801.

TUSK Direct, Inc.

For More Information Write In No. 335

NEW LOW LEVEL MEASUREMENTS HANDBOOK

Keithley has published a new 220-page handbook with specific techniques for making very accurate, low level measurements. This valuable reference guide is the company's 4th edition and includes sections on making low voltage, low current and resistance measurements, plus typical applications, schematics, and error sources. Tel: 800-552-1115; Fax: 216-248-6168.

Keithley Instruments, Inc.

For More Information Write In No. 336

AUTOMATED PRESSURE CONTROL SYSTEM

Fully Programmable Pressure Generation System, available in pressure ranges from vacuum up to 60,000 psi, interfaces to virtually any computer system. Software provided for IBM-PC Compatible Systems. Both electronic and mechanical over-pressure fail-safe systems with automatic pressurizing fluid refill system. For details call 607-257-5544 in USA and Canada 1-800-APP-VALVE. Fax: 607-257-5639.

Advanced Pressure Products

For More Information Write In No. 337

FREE SAMPLES/ CATALOG ON PLASTIC CAPS & PLUGS

New 1993 Caplugs Catalog lists specs, prices from America's leading manufacturer of protective closures. Includes handy postcards for ordering free samples of 800 stock caps, plugs, edgeliners, grommets, finishing parts, nettings, load-bearing furniture glides and ESD protectors. Caplugs Division, Protective Closures Co., Inc. Tel: 716-876-9855; Fax: 716-874-1680.

Protective Closures Co., Inc.

For More Information Write In No. 338

VME FOR EVERYONE

PEP's free 44-page four color catalog delivers razor-sharp graphics illustrating our comprehensive line of 3U VMEbus and busless CPU, I/O, mezzanine and piggyback boards, and systems. Also included are PEP's Profibus offerings and a section describing Autobahn and 3U/32 VME. Tel: 412-921-3322; Fax: 412-921-3356.

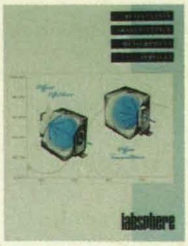
PEP Modular Computers®, Inc.

For More Information Write In No. 339

DESIGN OPTIMIZATION SOFTWARE WITH FEA ENGINEERING BUILT-IN

Free catalog. See why Algor is a world leader in engineering design optimization in which FEA analysis is tightly integrated. Includes solid and surface modeling. Enables engineers to finalize designs before the CAD documentation phase. All popular FEA analyses, including nonlinear. For DOS and UNIX. Adds value to all CAD, CAM, and CAE setups. Tel: 412-967-2700; Fax: 412-967-2781.

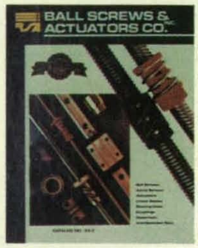
For More Information Write In No. 340



MEASUREMENT SERVICES BROCHURE

UV-VIS-NIR and NIR-MIR Reflectance and Transmittance Measurement Services. A new 4-page brochure describes Labsphere's service capabilities for NIST traceable measurements of reflectance and transmittance in the UV-VIS-NIR and NIR-MIR wavelength ranges. Three standard data format options are offered as well as custom calibrations. The brochure describes the spectroscopic instruments and accessories used in Labsphere's Reflectance Spectroscopy Laboratory.

For More Information Write In No. 341

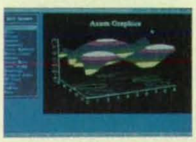


BALL SCREWS, ACME SCREWS, SUPERNUTS & MORE

Expanded & revised 48 page catalog/design guide features rolled, precision rolled & ground thread ball screws, acme screws & self-lube Supernuts in plain anti-backlash & preload styles. Included are thrust bearing units for leadscrews, linear guide bearings & much more. Tel: 408-629-1132 or 1-800-882-8857; Fax: 408-629-2620.

Ball Screws & Actuators Co.

For More Information Write In No. 342



NEW TECHNICAL GRAPHICS SOFTWARE

FREE brochure on new Axum 3.0 technical graphics and data analysis software for PCs. Create publication-quality 2D, contour, and 3D technical graphs. Interactively edit and customize. Export graphs to WordPerfect/Word. Import Lotus, dBase, or ASCII. Do statistics, curve fitting, and data smoothing. Call 1-800-548-5653 ext. 253.

TriMetrix, Inc.

For More Information Write In No. 343

MANUFACTURING SOLUTIONS THROUGH ELASTOMERIC PROCESSING TECHNOLOGY

An introduction to the capabilities and corporate philosophy of Ames Rubber Corporation. Consider the endless possibilities when Ames, a world leader in elastomeric technology, puts its resources to work for you.

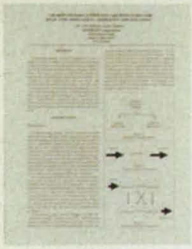
Ames Rubber Corporation

For More Information Write In No. 344

EMI/RFI SHIELDING CAPABILITIES BROCHURE FROM INSTRUMENT SPECIALTIES

Instrument Specialties has issued a new brochure that covers its design, manufacturing, total quality management, and EMC testing capabilities. Titled "All the shielding solutions you need," the piece also provides detailed information, including shielding effectiveness, key features and available options, for selected products. For copies, call 717-424-8510; Fax: 717-424-6213.

For More Information Write In No. 345



REAL-TIME SIMULATION

The SCRAMNet™ Network combines the real-time speed of replicated shared-memory with the flexibility of a fiber optic LAN to get microsecond response. This FREE tech paper compares SCRAMNet's shared-memory networking to the more traditional approaches. Tel: 800-252-5601; Fax: 513-258-2729.

SYSTRAN Corp.

For More Information Write In No. 346

VERSATILE CAM RUNS WITH ANY CAD

Guaranteed CAD/CAM data translators, including IGES Version 5.1 with trimmed NURBS surfaces. Fast and accurate 3D surface design, model, NC programming and machining. Powerful DOS and 32-bit Windows versions. Call 800-488-3615 or 818-361-5605; Fax: 818-361-1919.

Surfware, Inc.

For More Information Write In No. 347

ASSEMBLY TECHNOLOGY EXPO '93

See latest product assembly tools, equipment and services from 300 major vendors. Get updates on automation, electronics, systems integration, and ergonomic issues. September 28-30, Rosemont Convention Center, Rosemont, IL. Call 1-800-323-5155 for FREE Exhibits Badge.

ASSEMBLY Technology Expo '93

For More Information Write In No. 348

HIGH-PERFORMANCE ALLOY

Elgiloy® is a high-performance nickel-cobalt alloy. This brochure describes its characteristics and properties as well as processing information. Elgiloy is offered in strip and wire and is used in a variety of specialized applications.

Elgiloy® Limited Partnership

For More Information Write In No. 349

RP 609Z

The RP 609Z is a plain-paper reader-printer specifically designed for all engineering applications including manufacturing, public utilities and government as both a reference and production printer that will meet the variety of microform printing requirements typical to both operating environments, including: fiche, jackets, 16/35mm roll film and aperture cards. Call 1-800-9-MINOLTA or fax 1-201-818-3240.

Minolta Corporation

For More Information Write In No. 350

OPTICS FOR METROLOGY

This 106-page catalog gives information, including prices, on X-Y tables, microfinishing equipment, toolmakers' microscopes, alignment and monocular zoom microscopes, borescopes and miniborescopes, and fiber optic and miniature illumination systems. Also described are centering microscopes, optical cutting tool geometry analyzers, and more.

Titan Tool

For More Information Write In No. 351

SERVO CONTROL VALVES

Single and Dual Servo Valves from Advanced Pressure Products provide unmatched control of process parameters such as pressure, flow, temperature, fluid ratios and other process parameters. These are available for pressures ranging from high vacuum to 60,000 psi and flows from microliter to gallons per minute. Tel: 607-257-5544. From USA and Canada 1-800-APP-VALVE. Fax: 607-257-2639. Cornell Industry Research Park, 83 Brown Road, Ithaca, NY 14850.

Advanced Pressure Products

For More Information Write In No. 352

DESK, BENCH & PORTABLE CABINETS

AMCO Engineering Co. presents its 20 page, 4/C Desk Top Cabinet Catalog 900. Featured is a complete line of standard instrumentation cabinets in all conventional sizes. The unique, designed-in adaptability accommodates special sizes and applications. Accessories are also offered to complete the systems mounting options. Address: 3801 North Rose Street, Schiller Park, IL 60176. For your free copy call 800-833-3156 or in Illinois 708-671-6670.

AMCO Engineering Co.

For More Information Write In No. 353

MERLIN PRECISION MEDICAL IMAGING

Merlin Engineering brings its vast experience in professional broadcast video processing, from the first video tape recorder to HDTV, to the critical method and industrial imaging fields with a family of digital image processors and scan converters. 36 individual units provide image enhancement, solid state video storage, or conversion from/to non-standard video in both laboratory and airborne environments.

For More Information Write In No. 354

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.

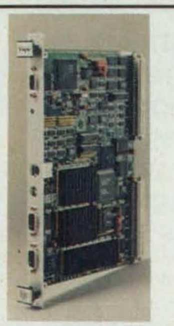
For More Information Write In No. 355

MONITOR, PRINT, AND CAPTURE DATA TO DISK

4-52 channel data management system provides simultaneous waveform monitoring on color VGA display, user programmable 15" wide chart paper, and a variety of SCSI hard, floppy, and DAT drives. Includes control and analysis software. Contact: Grant M. Smith, 1-800-854-8385. Western Graphtec, Inc., 11 Vanderbilt, Irvine, CA 92718.

Western Graphtec, Inc.

For More Information Write In No. 356



Vigra Vgs VME GRAPHICS SERVER

Processor: 33 MHz MIPS R3000 compatible w/FP coprocessor. *Resolution*: Programmable up to 1380x1024. *Memory*: 8 Mbyte DRAM, 2 Mbyte VRAM, 0.6 Mbyte overlay RAM. *Graphics Interface*: X11R5 standard, others available. *I/O*: Keyboard, dual serial, sound generator. Tel: 619-597-7080.

Vigra, Inc.

For More Information Write In No. 357

ENGINEERING ANALYSIS SOFTWARE

Xmath is a mathematical analysis and graphics environment for X Window workstations. Engineering applications include control systems design, test data analysis, and signal processing. Xmath combines numerical algorithms, interactive 2-D & 3-D graphics, and a programmable Graphical User Interface (GUI) designed by Prof. Stephen Boyd and Dr. Craig Barratt. Tel: 800-932-MATH; Fax: 408-980-0400, or demo Xmath on SunSoft's CDWare Vol. 4.

For More Information Write In No. 358

LIGHT SOURCES FOR MODERN DIGITAL TECHNIQUES

is a complete guide to understanding the complex lighting issues posed by the current generation of digital cameras. Matching your lighting to a CID or CCD sensor is as critical as selecting your camera.

Kontron Electronics, Inc.
Image Analysis

For More Information Write In No. 359

NEW EDITION JANE'S SPACE DIRECTORY 1993-94

Comprehensive coverage of the world's space programs and organizations. Designed for the space professional to monitor space developments worldwide, evaluate national and international programs, identify commercial opportunities in the industry and more. Detailed photographs and diagrams and launchers, communications equipment, navigation and the latest developments in space. Featuring names, addresses, phone and fax numbers of top aerospace contractors.

For More Information Write In No. 360

ELECTRONIC HARDWARE CATALOG

Broadest selection of hardware for electronic assemblies. 350-page free catalog includes a full range of standoffs, captive screws and nuts, chassis fasteners, handles, ferrules, spacers and washers. Special sections—new, unusual products, metric information and Mil-plating specifications. Full inventory, fast turnaround, samples. Tel: 1-800-237-0013; Fax: 201-661-3408.

Accurate Screw Machine Co.

For More Information Write In No. 381

INVESTMENT CASTINGS

8-page application brochure covers eight case histories that illustrate the potential and highlight the advantages of investment casting. Selection includes links for endless track, electrical cable connectors, machine guide shoe, and other components, most cast ready to use and some requiring only simple secondary machining. Guide outlines applications and shows parts, and has helpful tips for specifying investment castings. Address: 952 Palmer Ave., Middletown, NJ 07748.

Engineered Precision Casting

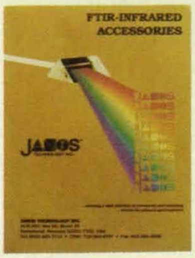
For More Information Write In No. 361

APPLICATION OPTIMIZED SILICON PHOTODIODES

A new free catalog of very high performance silicon photodiodes is available from Janos Technology. Quality and performance equivalent or superior to all competitors. Ion implantation technique employed in manufacture of Avalanche, UV/Blue, Wavelength Selective, Position Sensing, and high speed PIN Diodes. Adaptive manufacturing capability allows for optimization to customer-specific applications. Comprehensive variety of formats—wafers, chips, cans, arrays and integrated subassemblies. Tel: 802-365-7714; Fax: 802-365-4596.

Silicon Photonics
Detector Division of Janos Technology Inc.

For More Information Write In No. 362



FTIR-IR ACCESSORIES CATALOG

Janos Technology FTIR-IR Accessories Catalog covers a wide selection of accessories, sampling devices and high quality crystals and cells for infrared spectrometers. Order the catalog and get the New Products Supple-ment featuring the 5D™ Positioner, a new XYZ stage for quick ATR sampling without MIRRORS. Call 802-365-7714 for a FREE VIDEO on the 5D positioner or fax request 800-338-9764. Address: HCR #33, Box 25, Route 35, Townshend, VT 05353.

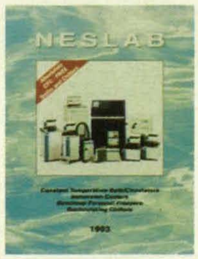
For More Information Write In No. 363

ADHESIVES/ SEALANTS/ COATINGS

Master Bond, Inc. manufactures over 3000 grades of adhesives, sealants, and coatings. Line consists of epoxies, anaerobics, cyanoacrylates, silicons, and acrylics. Both one- and two-part systems. Systems are designed to meet specific requirements. One-on-one assistance available with our highly knowledgeable technical staff. Tel: 201-343-8983; Fax: 201-343-2132.

Master Bond, Inc.

For More Information Write In No. 364



RECIRCULATING CHILLERS

68-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 +30 °C. Chillers feature LED display, operating status gauges, 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. 365

BREAKTHROUGH PORTABLE INSTRUMENTATION RECORDER

The Storeplex Portable Instrumentation Recorder is designed for highly efficient and accurate data acquisition in both laboratory and field use in the automotive, marine, medical, power and energy, defense and aerospace industries. Address: 15375 Barranca Parkway, Suite H-101, Irvine, CA 92718. Tel: 800-847-1226; Fax: 714-727-1774.

Racal Recorders, Inc.

For More Information Write In No. 366

COOLING DEVICES FOR ENCLOSURES

AMCO's 26 page 4/C Cooling Device Catalog 850 features a New Motorized Impeller Blower. This new technology in cooling moves a larger volume of air at a lower cost. This extensive line includes centrifugal blowers and tube axial fans. Complete accessories included. AMCO Engineering Co., 3801 North Rose Street, Schiller Park, IL 60176. For your free copy call 800-833-3156 or in Illinois 708-671-6670.

AMCO Engineering Co.

For More Information Write In No. 367

AUTOMATED PRESSURE GAGE CALIBRATION SYSTEM

Fully Programmable Automated Pressure Gage Calibration System, available in pressure ranges from vacuum up to 60,000 psi, interfaces to virtually any computer system. Windows and DOS version Software provided for IBM-PC Compatible Systems. Both electronic and mechanical over-pressure fail-safe systems with automatic pressurizing fluid refill system. Advanced Pressure Products. Tel: 607-257-5544. From USA and Canada 1-800-APP-VALVE. Fax: 607-257-5639.

For More Information Write In No. 368

PRECISION LINEAR MOTION PRODUCTS

32 page catalog features MADE IN USA Crossed Roller Linear Bearings, NEW Miniature Series, Recirculating Bearings, Slides, X-Y/Multi-axis/ Motorized Stages. Includes detailed product characteristics, design specifications, technical data & complete pricing. Special attention to custom solutions for automation, inspection and production requirements, detailing cost and design considerations. Tel: 800-892-3991; Fax: 516-333-1729.

American Linear Manufacturers

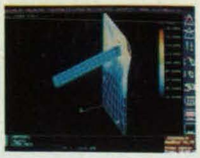
For More Information Write In No. 369

MOTION CONTROL HANDBOOK

Four-color 44-page book sets forth the basic DSP fundamentals; motion controller, servo filters, background PLC, circular interpolation moves, blended moves, cubic spline moves. Includes: 10 programming examples, summarizes PMAC commands and variables with G-code section. Details PMAC's options and accessories, as well as hardware and software.

Delta Tau Data Systems, Inc.

For More Information Write In No. 370



BREAK DOWN COST BARRIERS TO FEA

If a limited budget has locked you out of the power of finite element analysis, then open the door with COSMOS/M EXPLORER. Features a state of the art geometric modeler, graphic pre- and postprocessor, linear and nonlinear statics and dynamics, advanced dynamics, heat transfer and fluid flow analysis for only **$4995**. Basic statics configuration available for as little as $1995. Call 310-452-2158 in the west or 412-967-0958 in the east.

Structural Research and Analysis Corp.

For More Information Write In No. 371

VIDEO, AUDIO, TIME CODE ROUTING SWITCHER

Brochures detail high performance, modular routing switchers for NTSC, PAL, RGB, component, HDTV video, audio. From 30-120 MHz bandwidth. Fiber I/O available. For C[4]I, information management and display, simulation, multimedia integration, surveillance, video conferencing. Call 1-800-854-2831 or 619-263-7711.

DYNAIR Electronics, Inc.

For More Information Write In No. 372

PALM-SIZE FFT ANALYZER

The remarkably small RION SA-77 FFT Analyzer weighs less than 24 ounces and performs like many lab types: 0-50 kHz, up to 800 lines, storage, order analysis, RS-232C, integration, etc. Analysis functions include FFT, phase, and amplitude distribution. The SA-77 complements Scantek's full line of sound and vibration instrumentation. Tel: 301-495-7738; Fax: 301-495-7739. Address is 916 Gist Ave., Silver Spring, MD 20910.

Scantek, Inc.

For More Information Write In No. 373

15 MHz FUNCTION AND ARBITRARY WAVEFORM GENERATOR

The DS340 is a synthesized function generator that outputs sine, triangle, ramp or square waves with 1 μHz resolution. Features include Gaussian white noise, arbitrary waveforms up to 16,300 points (12 bit), phase continuous linear and algorithmic sweeps, and Frequency Shift Keying (FSK). Optional GPIB (IEEE-488) and RS-232 interfaces provide computer control. Software for creating arbitrary waveforms is provided at no charge. Tel: 408-744-9040.

For More Information Write In No. 374

ENGINEERING SERVICES

Optical Research Associates, the industry leading optical design firm, provides world-class engineering solutions across the entire spectrum of optical design. From X-ray wavelengths to the far infrared, from optical systems for consumer and industrial products to highly complex government and military applications, ORA leads the way. In CA, call 818-795-9101; Fax: 818-795-9102. In MA, call 508-872-6001; Fax: 508-879-0698.

Optical Research Associates

For More Information Write In No. 375

PROCESS CONTROLLER IS COMPLETE SYSTEM

New 12LS Complete Control System from ANAFAZE is a rugged 12-loop P.I.D. controller completely wired for sensors, control outputs and power terminations—ready to plug in and use immediately! The 3.5" high, 19" rack-mount unit includes internal SSR relays to drive loads of up to 15 Amps-per-loop for each of its 12 independent control loops. Features include AutoTune, Alarms, Digital I/O, PC-communications, and much more! Tel: 408-479-0415. Fax: 408-479-0526.

For More Information Write In No. 376

NEW CATALOG DETAILS GROOVED PIN FASTENING

Groov-Pin Corporation, a well known manufacturer of pin and insert fasteners, now offers a new 14 page catalog detailing the company's full line of pins, grooved pins and drive studs. In addition to the standard dimension and weight specifications, shear strength and torque data are included, as well as horsepower transmission test results. The catalog also describes a variety of the company's Groov-Pin® brand grooved pins and of its knurled pins and drive studs. Tel: 201-945-6780.

For More Information Write In No. 377

WORKSTATIONS, LAB FURNITURE

20-page illustrated guide covers the Teclab line of technical workstations and laboratory systems furniture. Included are stations of different lengths, combined with a choice of cabinets, shelves, parts drawers, partitions, and other accessories. Catalog has dimensions, shows arrangements, describes work surfaces, and has color selection guide. Tel: 800-832-5227; Fax: 616-372-6116. Teclab, 6450 Valley Industrial Drive, Kalamazoo, MI 49009.

Teclab

For More Information Write In No. 378

COMPUTER CONTROLLED VALVES

Brochure describes company's line of remote and computer controlled on-off, metering and servo valves, pressure generators, automated pressure and flow control systems, pressure gauge calibration systems and capability for custom configurations. Pressure range from high vacuum to 60,000 PSI. Tel: 607-257-5544. Toll Free in USA and Canada 1-800-825-5764. Fax: 607-257-5639. Address: 83 Brown Road, Bldg. 4, Ithaca, NY 14850.

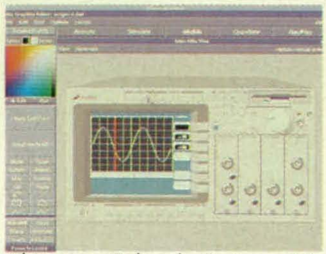
Advanced Pressure Products

For More Information Write In No. 379

201,000 Reasons Why Your Ad Belongs Here

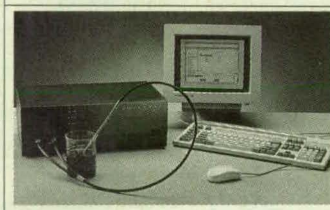
NASA Tech Briefs' Literature Spotlight section offers a low-cost way to reach over 201,000 industry and government LEADERS with your advertising message. These are technology managers, design engineers, and scientists with tremendous buying power. The October 1993 issue is your next opportunity to use this high-impact sales tool. For more information or to reserve space in Literature Spotlight, contact your NASA Tech Briefs sales representative (listed on page 12) or call Joseph Pramberger at (800) 944-NASA.

New on the Market



Altia Inc., Colorado Springs, CO, has released version 1.2 of its **human interface design software** used by instrument developers to create graphical prototypes of front panels without writing graphics code or requiring a software specialist. Unlike GUI builders or graphics toolkits, which use a limited set of standard user interface components, Altia Design enables designers to create fully-customized dynamic user interfaces that accurately simulate their physical counterparts and display real-time graphical data.

For More Information Write In No. 574



Brimrose Corp. of America, Baltimore, MD, has unveiled the Luminar 2000, a **near infrared spectrometer** based on an innovative acousto-optic tunable filter (AOTF) wavelength tuning element. AOTF technology offers improved durability compared to conventional grating technology, high-speed scanning or random wavelength access, and automatic calibration.

For More Information Write In No. 579

Multi-LED **panel mount indicators** from Dialight Corp., Manasquan, NJ, offer the brightness of an incandescent bulb with the reliability and long life (100,000 hours) of a solid-state device. Viewable from 180 degrees, the 556 series lamps operate in direct sunlight as well as wet environments and feature rugged one-inch metal housings and multi-LED light sources with integral circuit protection. Red, yellow, and green indicators are available in 12, 28, and 120 volt versions.

For More Information Circle No. 580

M-series mini-magnetic **circuit breakers** from Carlingswitch Inc., Plainville, CT, provide a 25 ampere rating, four-bar linkage and double-actuation wiping contacts for high reliability, and an oversized contact gap with an arc plate chamber for more dependable arc extinction. Additional features include a heavy-duty enclosure and welded current-carrying junctions.

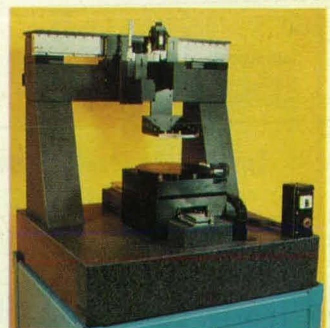
For More Information Write In No. 577

A portable 24-bit **data acquisition system** introduced by Phoenix Scientific Inc., Denver, CO, measures ten channels at up to 4000 samples/sec. Each channel has its own differential preamp and A/D with input noise levels as low as 7.5 nV/root Hz. Digital opto-isolators provide 1500v rms of isolation between channels and to the system ground. Oversampling and onboard digital signal processing permit extremely sharp anti-alias filter corners with no phase shift.

For More Information Write In No. 575

New England Affiliated Technologies, Lawrence, MA, is offering **air bearing inspection systems** for fast, precise, and fully-automatic positioning. Featured products include a five-axis positioning system that performs dual-camera machine vision inspection of printed circuit boards. The system's X and Y axes, which consist of frictionless air-bearing moving elements traveling on precision-lapped granite ways, are directly driven at up to 0.5 meters/sec. by noncontacting linear brushless servo motors.

For More Information Write In No. 576



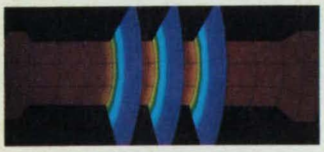
Timberline, Meridian, ID, has released four **computer-aided design and graphics platforms** featuring an exclusive three 32-bit microprocessor design. The host CPU is an Intel 486DX2 66, accompanied by a Weitek P9000 graphics accelerator and an Intel 80376 that controls Timberline's EISA SCSI caching controller. The new platforms can be configured with up to 1 MB of external CPU cache and up to 256 MB of system RAM.

For More Information Write In No. 578

New on the Market

Land Infrared, Bristol, PA, has introduced the Cyclops TI35sm **thermal imaging system** with integral RAM memory for instant storage and recall of thermal images without data storage disks. Stored images can be replayed through the image viewfinder or downloaded directly into a PC for further processing. A unique "Super Memory" facility permits users to freeze-frame and store a rapid sequence of images.

For More Information Write In No. 570



COMET/BEA, **software for calculation of solid model stresses, displacements, and temperatures**, has been released by Automated Analysis Corp., Ann Arbor, MI. It employs the boundary element analysis (BEA) method, which places a surface mesh over the geometry of a part to complete engineering studies 10 to 20 times faster than with finite element analysis, which utilizes a complex volumetric mesh.

For More Information Write In No. 565

The first 1/16 DIN, **fuzzy logic temperature/process controller** is available from Total Temperature Instrumentation Inc., Williston, VT. Dubbed the PYX-4, the 48-mm-square controller utilizes fuzzy logic for start-up and in-process situations. It features PID Autotune, auto/manual operation, universal input (thermocouple, RTD, current voltage, millivolt), loop and heater break alarm, eight-segment ramp/soak function, analog retransmission, cooling output, and RS-485 communications.

For More Information Write In No. 566

The Xpress single-axis, fully-integrated **motion controller** from Teletrac Inc., Santa Barbara, CA, simplifies servo system design by accepting position feedback and delivering motor power from a single card directly mounted in a PC. The ISA-bus integrated board combines a high-speed counter, DSP servo motion controller, and a 20w DC power amplifier.

For More Information Write In No. 562

Interlink Electronics, Camarillo, CA, has introduced two space-saving **cursor control devices** for OEM integrators. The VersaPoint™ Micro-Module is the world's thinnest computer cursor control device—a drop-in module requiring less than 0.25" depth beneath the mounting panel. The VersaPoint Micro Joystick, a fingertip joystick measuring less than 0.35", can fit between the keys of a keyboard for integration into a control panel or handheld controller.

For More Information Write In No. 561

The Consultant, a **notebook computer** from MachineView Inc., Knoxville, TN, can take two-channel vibration measurements, analyze the data, create drawings, prepare reports, and export to any compatible printer. The Consultant contains a removable, MS-DOS-compatible 486DX, 120 MB hard disk capacity, 4 MB of RAM, and eight electronically-switched input channels.

For More Information Write In No. 573

EG&G Reticon, Sunnyvale, CA, has introduced two families of **photodiode arrays** designed for imaging in high ultraviolet fields. The SC series is offered in lengths from 128 to 1024 pixels with a pixel size of 25 x 2500 microns while the TC series is available in lengths from 128 to 512 pixels in a 50 x 2500 micron pixel size. The arrays feature simplified clocking requirements, antiblooming and line reset control, and a differential video output to cancel clock switching noise.

For More Information Write In No. 568

New Literature

II-VI Inc., Saxonburg, PA, is offering a 48-page **optics** catalog designed to assist laser manufacturers and users with selection and specification. It provides information on infrared optics and the role of absorption in laser optics, a comprehensive optics tutorial, and specifications on optics, coatings, and optical components.

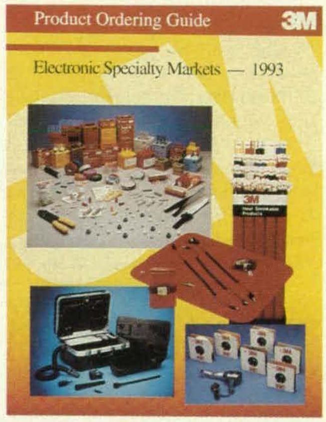
For More Information Write In No. 593

Microetch™ **ion beam etch systems** are showcased in literature from Veeco Instruments Inc., Plainview, NY. The systems feature a new inductively-coupled RF ion source, enhanced computer control, automatic Loadlock substrate handling, and patented wafer-cooling techniques. They are suitable for anisotropic ion beam etching and thin-film deposition.

For More Information Write In No. 592

A product ordering guide for electronic specialty markets is available from 3M's Electronic Products Division, Austin, TX. It is designed for users requiring a wide variety of **electronic and electrical parts**, as well as static control products, in small quantities. Product categories include adhesives, cleaners, breadboards, test clips, connectors, IC sockets, IDC cables, terminals, heat sinks, and diagnostic equipment.

For More Information Write In No. 594



A 160-page reference catalog released by Lectronic Research Labs Inc., Camden, NJ, features more than 7000 **microwave components**. The company, which has been purchasing surplus microwave components since 1946, offers a large supply of pre-owned components at savings of up to 80%.

For More Information Write In No. 591

California Eastern Laboratories, Santa Clara, CA, has published an eight-page **silicon MMICs** product selection guide. Featured products include wideband amplifiers up to 3 GHz, prescalers up to 2.8 GHz, transistor arrays that can be user-configured as double-balance mixers or OR/NOR gates, frequency converters, LED drivers, and high-isolation and video amplifiers.

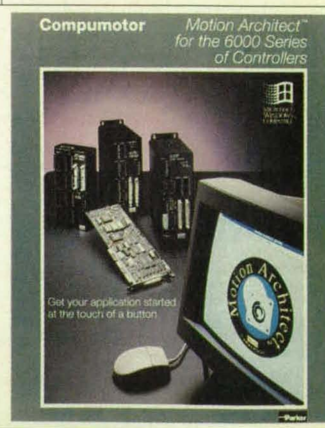
For More Information Write In No. 590

Electrovert Metal Dispensing Division, Providence, RI, has released a brochure illustrating how one-piece, hollow, internally-complex **plastic components** can be molded using metal cores made on its LMS 2000™ equipment. Metal Core Technology™, which can replace metal castings in many applications, provides control of internal surface finish and wall thickness, with core accuracy to 0.0015" per dimension.

For More Information Write In No. 588

A full-color brochure from the Compumotor Division of Parker Hannifin Corp., Rohnert Park, CA, showcases its 6000 series **motion controllers** and Motion Architect™ software for generating motion control programs. The 6000 series comprises the AT6400, a PC/AT®-based indexer capable of synchronizing up to four axes of motion; the 6200 two-axis stand-alone indexer for step and direction motor drives; and the 6250, a two-axis stand-alone servo controller. Each model has incremental encoder feedback on all axes and 48 programmable I/O points.

For More Information Write In No. 589



POSITIONS WANTED

Registered engineer with ten years of experience in the petroleum industry with an emphasis on environmental aspects. Seeking position as an environmental engineer. Will relocate and travel.
Box number 73A

MS in communication theory and research. Consulting/training and management experience. Thesis: Artificial Intelligence and Multimedia. Graduate research experience in design/development of multimedia technologies, artificial intelligence, media consumer behavior and markets. Seeking position in project management/applications development (full-time or consultant). Can learn/apply new areas of expertise.
Box number 74A

Marketing and programs manager with 18 years experience in space systems and advanced technology products. Successfully executed defense, civil, and commercial programs; managed R&D programs; and developed international contracts. Currently working to commercialize government-developed technologies. Possess "Q" and secret clearances. Experienced in Congressional relations. Active leader in AIAA and corporate management society. Executive marketing/programs leadership position desired.
Box number 75A

MS, ceramic engineer, eight years experience in R&D, production, and product development of sensors, thermoelectric, ceramic, metal, and semiconductor systems. Innovative, hands-on, excellent troubleshooting skills. Seeking position in an innovative, materials-based group, preferably in biomaterials, electronic, or optical devices, composites.
Box number 76A

BSEE, BS in economics, MBA in operations management sciences. Seeking QA/QC position, preferably in manufacturing environment. Experience in installation/troubleshooting, performing manufacturing quality audits, and system evaluation on mainframe computer systems. Experience with SPC, trained on ISO-9000 internal auditing procedures. Permanent US resident, willing to travel.
Box number 77A

Aerospace/mechanical engineer with Ph.D in aerospace engineering seeks research/engineer position in computational fluid dynamics/aerodynamics. Post-doctoral experience. Eight years experience in CFD of compressible flow, heat transfer, and material processing (phase change). FORTRAN, UNIX, supercomputer proficient. Excellent publication record. Willing to relocate. Available immediately.
Box number 78A

Seeking chemical industry position in development, manufacturing or business. Ph.D chemist and manager with commercially valuable accomplishments in R&D, manufacturing, business, and management. A record of technical and business success. Astute analyst. Contemporary industrial scientist. Business savvy. Generally achieves objectives.
Box number 79A

Engineering/operations manager seeking opportunity to help a small company grow in excellence and profitability. Successful in assembling, motivating, and organizing rapid product development teams. Full-time or consulting. Don Thornburg, Tel: 206-337-1406.
Box number 80A

Available immediately. 25 years experience in electrical and electronic applications; potting, encapsulation, embedding, conformal coatings, paints, marking inks, thermosets and thermoplastics; ESD, RFI/EMI shielding, conductive and thermally conductive materials. All phases of plastics and polymer processing. Excellent writing and customer/vendor interface skills; supervisory experience; MS in polymer engineering.
Box number 81A

Twenty years experience in plasma systems and processes. Managed semiconductor engineering department. Equipment and process engineer, experienced in wafer fabrication-RIE, PECVD, RF induction, and other vacuum systems. Thin films, multilevel personalization, submicron lithography. 1991 & 1992 awards for cost effectiveness. Computer literate. BA in physics. Excellent writing skills. Tel: 914-226-7750.
Box number 82A

BSME with experience in automotive engine management systems development, testing, test development. Excellent hands-on skills and computer application (CAD, programming, spreadsheets, word processing) education and experience. Seeking challenging position in any area of mechanical engineering that utilizes technical skills and that provides new learning opportunities. Will relocate, prefer Texas.
Box number 83A

Energetic, dedicated military R&D officer with hands-on experience in all phases of the DOD Acquisition Life Cycle. Expert in communications, negotiations, logistics, and management. Background in military intelligence systems. Possess Top Secret clearance with special background investigation. Reply: 870A Cedar St., Ft. Devens, MA 01433. Tel: 508-772-7659.
Box number 84A

Technical documentation specialist with background in software applications, medical research and diagnostics, corporate practices, PC and mainframe environments. Experienced in total documentation tasks. Available for short-term or long-term assignments to provide online text, manuals, and other documentation for instructional, reporting, and marketing purposes. Equipped to handle assignments off-site via telecomputing. Internet: bfreed@nss.org.
Box number 85A

Technical specialist with 19 years of industrial work experience is looking for a position in employee involvement or cost control programs. I hold a BS degree in business administration, and three AAS degrees (mid-management, industrial supervision, and electronics technology). Letters of references from businesses I have helped are available.
Box number 86A

Ph.D in electrical engineering; MS in mathematics; BS in physics/physical engineering seeking contract or captive position in controls, robotics, AI, neural networks, math modeling, E&M, expert systems, simulation. Have US secret clearance and TEMPEST background; industry, government, and research; patent pending; many publications; contract management experience. LISP, CLIPS, Prolog, FORTH, FORTRAN, BASIC.
Box number 87A

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Ph.D in biomechanical engineering. Several years experience in orthopedic and spine biomechanics, human gait analysis, biomaterials, biotribology, soft tissue characterization, and biomechanics modeling. Developed medical devices and orthopedic implants. Laser applications in orthopedics and rehabilitation engineering, including development of assistive devices. Engineering design, applied mechanics, materials science. P.O. Box 199, Greenvale, NY 11548-0199.
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Aerospace/mechanical engineer and scientist, 15 years of extensive Soviet experience on all phases of projects. Firms: Antonov, Korolev, and others. Areas: R&D, aerodynamics, flight mechanics, design of aircraft, spaceships, propulsion systems, engines, rockets. FORTRAN, C. More than four years experience in USA. Will relocate immediately.
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BSEET seeks position of responsibility. Disabled veteran with experience in aerial radar repair and as supervisor. Held top secret special background investigation clearance with NATO. Experience with wire-harness testing systems. Presently instructing at the post-secondary school level. Courses include: electronics, architectural drafting, and AutoCAD.
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