December 2000

Vol. 24 No. 12

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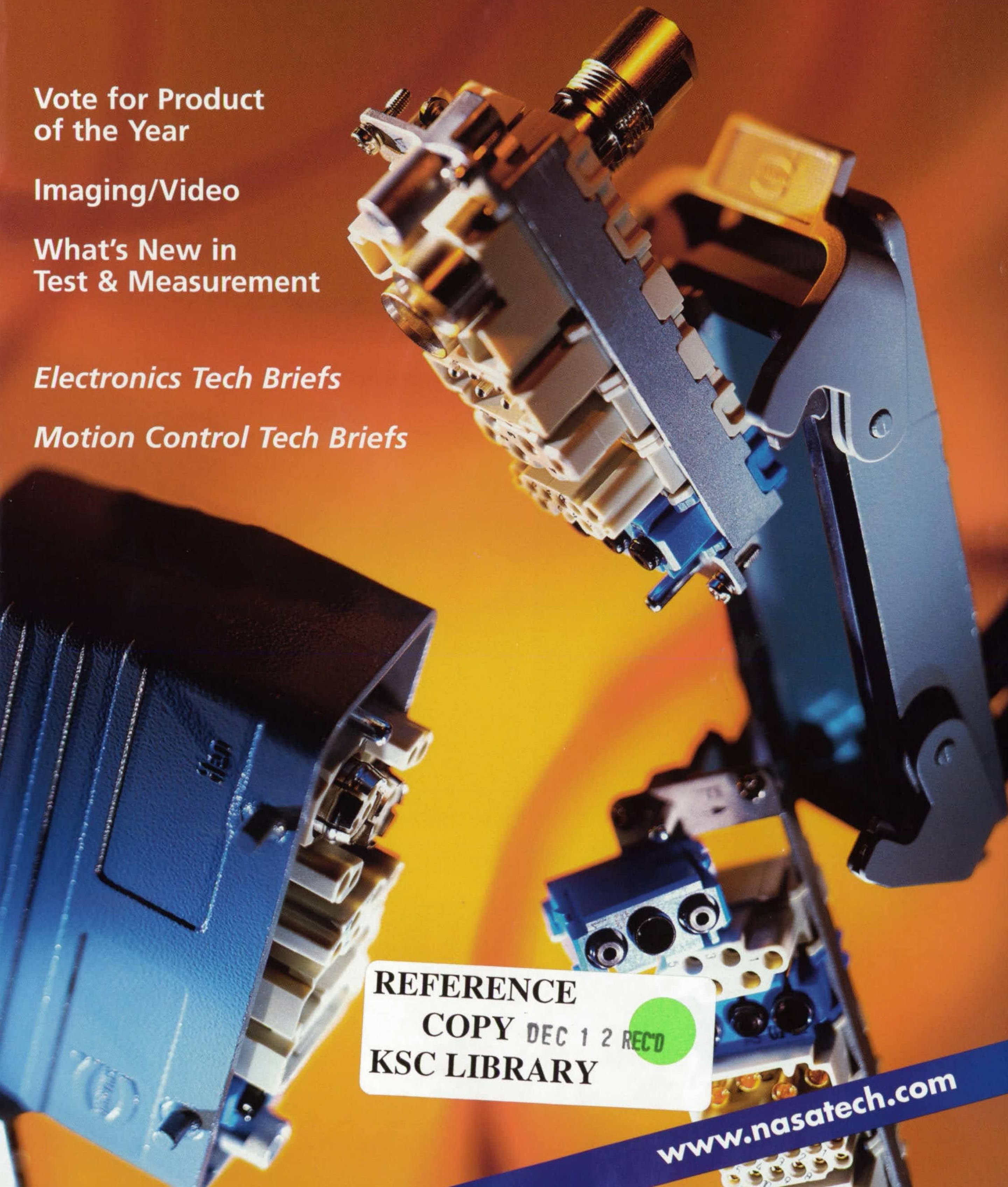

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FEATURES

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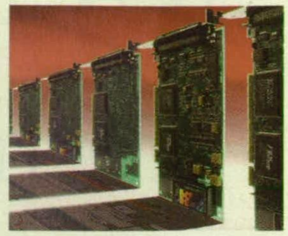
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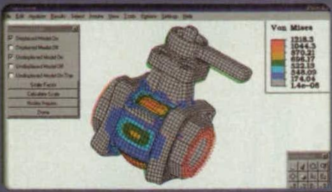
BRIEFS

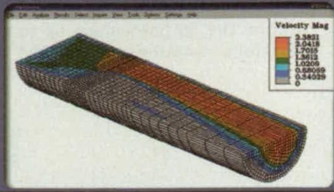
DEPARTMENTS

SPECIAL SUPPLEMENTS

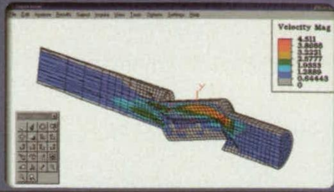
12 Reasons Why Algor Should Be Your FEA Partner



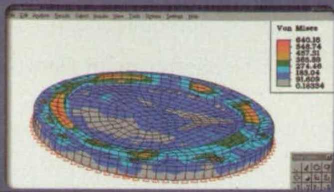
Linear Static Stress - Algor's linear static stress product enables you to capture complex assemblies, such as this valve assembly, from a CAD solid modeler and run a finite element analysis using fast solver technology. Typical loadings are pressure, acceleration, temperature, force and prescribed displacements.



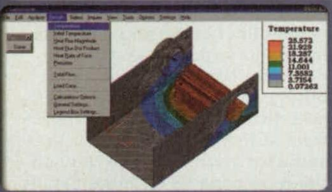
Steady Fluid Flow - Prescribed velocities and pressures provide the loading for this 3-D steady fluid flow analysis of a pipe with a gate valve. Algor's multiple load curves allow for easy data entry for adding loading such as gravity.



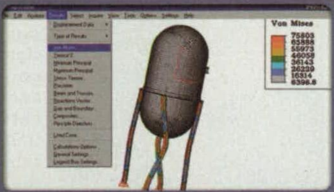
Unsteady Fluid Flow - Unsteady fluid flow of this ball valve system was analyzed using a 3-D CAD solid model. Algor's unique processor solves for velocities and pressures throughout the dynamic event, using a specialized meshing algorithm for high velocity gradients.



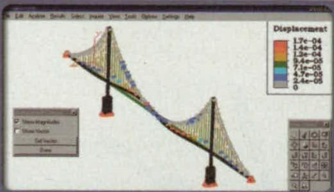
DDAM - Algor's Dynamic Design Analysis Method enables you to analyze the shock response at the mountings of shipboard equipment such as watertight doors, masts, propulsion shafts, rudders, exhaust uptakes and portholes, as shown above.



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



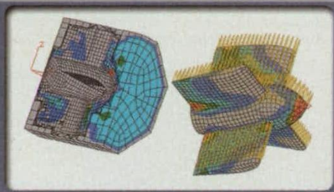
Nonlinear Static Stress - Algor's nonlinear product helps to accurately predict large deformation and large strains caused by static loading. As seen by this water tank, buckling of a structure is one type of failure that can be exposed.



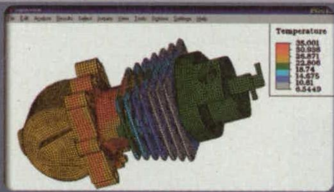
Linear Dynamic Stress- A modal analysis is one of the linear dynamic stress analyses performed on this suspension bridge. Failure can occur when the loading frequency is at the structure's resonant frequency. Algor's linear dynamic analyses accurately predict these frequencies and dynamic effects.

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

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



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



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

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

Algor has been developing FEA software since 1978.
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to offer FEA on PCs, which have evolved into the NT workstations of today.
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PRODUCT OF THE MONTH

Universal Matrix keyboard-video-mouse switches from Network Technologies of Aurora, OH, let users share up to eight different computers without the need for plug-in modules.

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ON THE COVER

Han-Modular® electrical connectors from Harting of North America, Elgin, IL, can be snapped into metallic frames without the need for tools. Designers can combine fiber optics and electrical signaling media with high and low power options. Using standard hoods and housings, the connectors are available in 13 different modules for applications from automation equipment to semiconductor machinery. See New on the Market on page 58 for more details on the Han-Modular connectors.

(Image courtesy of Harting Inc.)

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NASA Commercial Technology Team

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NASA's Technology Sources

If you need further information about new technologies presented in *NASA Tech Briefs,* request the Technical Support Package (TSP) indicated at the end of the brief. If a TSP is not available, the Commercial Technology Office at the NASA field center that sponsored the research can provide you with additional information and, if applicable, refer you to the innovator(s). These centers are the source of all NASA-developed technology.

Ames Research Center
Selected technological strengths: Fluid Dynamics; Life Sciences; Earth and Atmospheric Sciences; Information, Communications, and Intelligent Systems; Human Factors.
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cblake@mail.arc.nasa.gov

Dryden Flight Research Center
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Jet Propulsion Laboratory
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Kennedy Space Center
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Langley Research Center
Selected technological strengths: Aerodynamics; Flight Systems; Materials; Structures; Sensors; Measurements; Information Sciences.
Sam Morello
(757) 864-6005
s.a.morello@larc.nasa.gov

John H. Glenn Research Center at Lewis Field
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Larry Viterna
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cto@grc.nasa.gov

Marshall Space Flight Center
Selected technological strengths: Materials; Manufacturing; Nondestructive Evaluation; Biotechnology; Space Propulsion; Controls and Dynamics; Structures; Microgravity Processing.
Sally Little
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sally.little@msfc.nasa.gov

Stennis Space Center
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kirk.sharp@ssc.nasa.gov

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NASA ON-LINE: Go to NASA's Commercial Technology Network (CTN) on the World Wide Web at **http://nctn.hq.nasa.gov** to search NASA technology resources, find commercialization opportunities, and learn about NASA's national network of programs, organizations, and services dedicated to technology transfer and commercialization.

NASA Program Offices

At NASA Headquarters there are seven major program offices that develop and oversee technology projects of potential interest to industry. The street address for these strategic business units is: NASA Headquarters, 300 E St. SW, Washington, DC 20546.

Carl Ray
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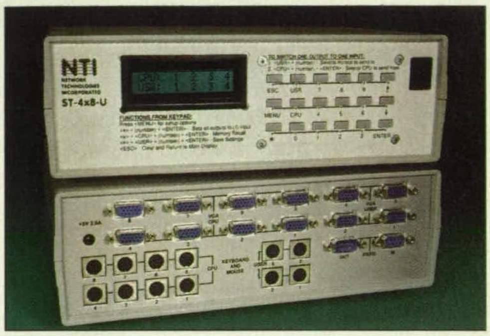
PRODUCT OF THE MONTH



Network Technologies, Aurora, OH, offers two models of its Universal Matrix KVM switches. The ST-2x8-U-DT and ST-4x8-U-DT electronic keyboard-video-mouse switches allow two or four users to individually command or simultaneously share up to eight PC, Sun, and Macintosh computers without the need for plug-in modules. Users can change platforms using adapter cables. Dedicated microprocessors prevent CPUs from locking up, and a keyboard hot-plug feature allows users to change keyboards — even between platforms — with no need to reboot. An LCD display, RS-232 control, and an On Screen Display user interface with password security are included. An optional dual redundant power supply is available, replacing lost power in case of a failure.

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NASA Technology Helps Firefighters

Technologies that protect spacewalking astronauts may soon be available to firefighters through the development of an advanced suit that offers greater protection, endurance, mobility, and better communications. Displayed at NASA Johnson Space Center's Inspection 2000 event last month in Houston, the suit could double the time a firefighter can battle a blaze before having to rest and cool off.

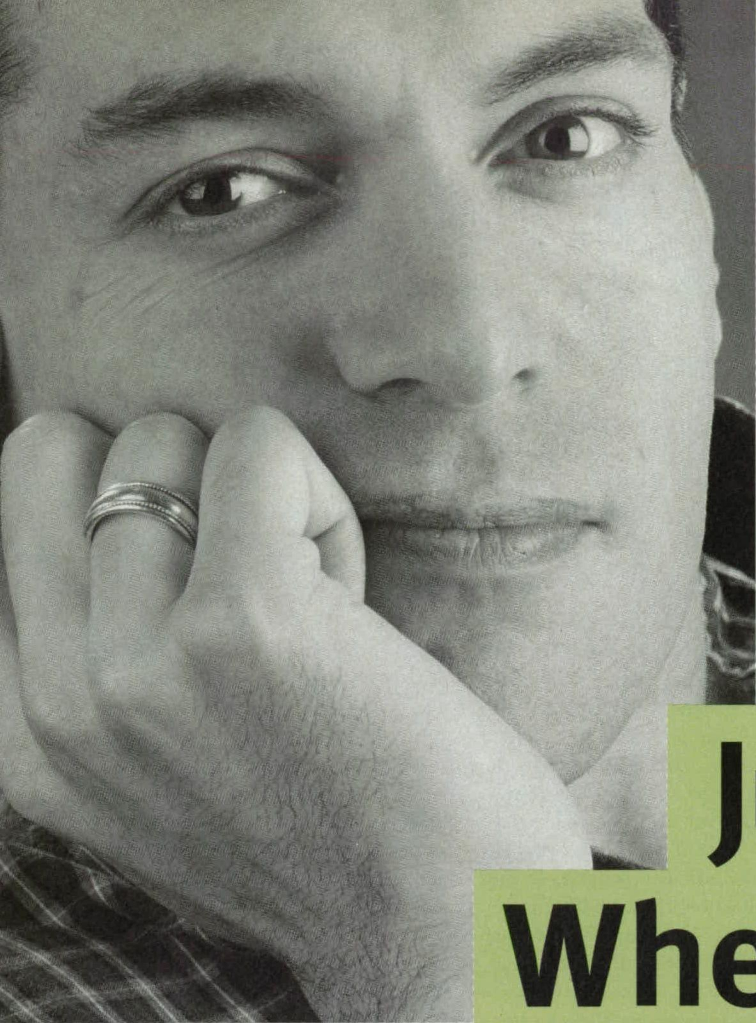
About 100 firefighters are killed and 100,000 injured each year. Johnson Space Center (JSC) — working with the Houston Fire Department, the Department of Defense (DOD), and Lockheed Martin — has incorporated a number of NASA technologies into the advanced suit, including active cooling, which protects the firefighter from metabolic heat trapped in the suit. Combined with new fabrics on the outer garment, the liquid-cooling inner garment can allow more lengthy exposure to temperatures up to 500°F, compared to a maximum of 300°F for current suits. The suit will be double-sealed, exposing no skin areas, and will provide greater impact protection and protection against hazardous materials.

Firefighters, along with JSC engineers, have identified about 40 potential areas for high-tech improvements. One of those improvements is the cooling capability. "With protection from both internal and external heat sources, the firefighter will be able to extend the time available to perform the tasks of saving lives and property," said Tico Foley, an aerospace engineer in the Crew Station Branch of JSC's Space and Life Sciences Directorate.

The suit design is still evolving and could have an integrated helmet with duplex radio, infrared imaging to search for victims, biodata and temperature sensors, and readouts on the status of its life-support system. The suit's modular design also allows more freedom of movement than present suits, and it is lighter in weight.

The Houston Fire Department set requirements for the suit, and JSC's Technology Transfer and Commercialization Office is coordinating the project. The DOD has developed heat stress models, and tested and evaluated materials.

For more information, visit the Johnson Space Center Public Affairs Office at www.jsc.nasa.gov/pao.



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I have a low-voltage downlight that in normal operation gets quite hot. I am looking for a product that will color glass and operate under this light source. I am trying to filter the light to give a specific light waveform output to light up artwork, bringing out various colors. However, the glass will become quite hot through operation. Thank you for any assistance.

Rod Simpson
rod_simpson@msn.com.au

Does anyone know of any links to work done recently on ice detection using capacitive pressure sensors? I am interested in the simulation of actuations and a readout circuitry.

Saed L.
saedl@yahoo.com

*(**Editor's Note:** Saed, we published a tech brief on page 74 of the October 1999 issue entitled "Frequency-Scanning Capaciflectors" from Goddard Space Flight Center. You can access that brief, and additional Technical Support Package information, on the* NASA Tech Briefs *web site at www.nasatech.com. NASA's Ames Research Center (www.arc.nasa.gov) and John H. Glenn Research Center (www.grc.nasa.gov) also are good sources of information on capacitive pressure sensors.)*

Several years ago, I was introduced to *NASA Tech Briefs* in a research laboratory where I worked. I remember browsing through my first issue thinking, "I cannot believe they are so willing to share all these great ideas...this is an inventor's dream!" Its clear and succinct style kept me coming back over and over for ideas and solutions that I could apply in surgery and biomedical research. If the truth were to be known, many of the devices and solutions that are applied to problems in my field of neurosurgery, as well as in general medicine and other industries, come as a result of technology transfer. I am confident that a pivotal component or idea that will solve another important problem in medicine lies within *NASA Tech Briefs'* covers.

Scott R. Gibbs, M.A., M.D.
Brain & NeuroSpine Clinic
Cape Girardeau, MO
sgibbs@mvp.net

I am designing a helium-cooled (4K) quartz (fused silica) and Invar sample cell — sealed using indium metal — for neutron spectroscopy measurements. I need confirmation on the cryogenic thermal expansion properties of Invar 36 between room-temperature and zero Kelvin. I would appreciate any reliable sources for this information.

Henry Belch
hbelch@anl.gov

Patents

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

Method of Forming Micro-Sensor Thin-Film Anemometer

(U.S. Patent No. 6,018,861)

Inventors: Mark Sheplak, Catherine B. McGinley, Eric F. Spina, Ralph M. Stephens, Purnell Hobson Jr., and Vincent B. Cruz, Langley Research Center

Turbulence measurements in high-speed flows have historically been obtained by hot-wire anemometry. However, high stagnation temperatures, high dynamic pressures, and flow contaminants severely limit the life of hot-wire elements in hypersonic flow. An alternative is hot-film anemometry, with a thin metallic film deposited along the stagnation line of a rigid dielectric substrate, thus increasing mechanical strength. But the frequency response characteristics of the existing hot-film probes are inadequate to resolve the full turbulent spectrum for hypersonic flows. The inventors' device and method has fast response and durability in hypersonic airflows. It provides an anemometer having a microsensor thin-film probe, a half-wedge formed from a single crystal of aluminum oxide (i.e., sapphire) and containing an iridium sensor formed on its rounded tip along the stagnation line. The sensor is formed by first depositing a layer of copper over the sapphire substrate. A layer of photoresist is then deposited over the copper and dried. A contact print of the sensor shape is then made into the photoresist by exposure to UV light. The photoresist is then developed, leaving an opening to the copper layer corresponding to the sensor shape. The copper is etched to produce an opening to the sapphire substrate corresponding to the sensor shape. The photoresist is removed and niobium is deposited on the exposed substrate. Without breaking the vacuum, iridium is deposited onto the niobium layer. The copper is then removed with an etchant and the probe is annealed in a hard vacuum at approximately 1000 degrees C to stabilize the resistance of the sensor. Sensors formed according to this method show a significant improvement in frequency response due to the lower thermal inertia of the sensor compared to conventional 5.0-micrometer hot wire and existing hot films.

Endothelium-Preserving Microwave Treatment for Atherosclerosis

(U.S. Patent No. 6,047,216)

Inventors: James R. Carl, G. Dickey Arndt, Patrick W. Fink, N. Reginald Beer, Philip D. Henry, Antonio Pacifico, and George W. Raffoul, Johnson Space Center

Atherosclerosis is a progressive disease in which fatty, fibrous, calcific, or thrombotic deposits produce lesions consisting of plaque or scar tissue within the arterial walls. As the lesions grow in size, the passageway through the coronary artery may be corresponding reduced in effective cross-sectional diameter (stenosis), restricting the nutrient blood flow to muscles of the heart. Techniques such as balloon angioplasty and UV laser angioplasty have been developed to mechanically increase the luminal opening, but they tend to traumatize the artery's endothelium, a very fragile layer of cells that limits thrombotic processes, and often result in reclosing of the passageway. The invention provides methods and apparatus for thermally necrosing (ablating) connective tissue and softening fatty and waxy plaque in lesions by use of microwaves while controlling the temperature rise in other arterial tissues and in the endothelial layer. The lesion is heated while limiting damage to other tissues. The microwave power level of operation and its frequency, from 30 GHz to 300 GHz, are chosen so that a temperature increase from absorption of microwave energy in the endothelium is limited by the blood exchange rate to a desired safe range. The heating period for raising the temperature a potentially desired amount, about 20° C, within the atherosclerotic lesion may be less than about one second.

For more information on the inventions described here, contact the appropriate NASA Field Center's Commercial Technology Office. See page 12 for a list of office contacts.

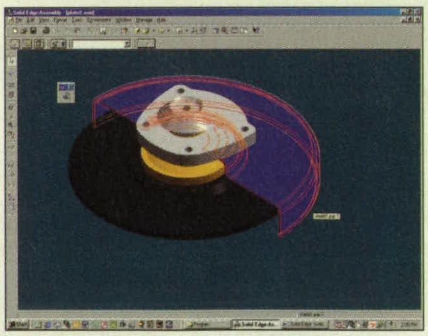
Solid Edge Version 9: A Drafter's Friend

Steven S. Ross

Since 1996, Unigraphics Solutions (St. Louis, MO) has issued about one major release of its Solid Edge CAD/CAE software every six months. It's always been one of the easiest mechanical design packages to draw with, and it's always been one of the packages of choice for machine design and for really large assemblies — especially when sheet metal is involved. We looked at Version 9 in beta in late October, just as the final version was being readied for distribution. We found some nice new features in the core product, but the real news is in the new extra-price add-ons.

The biggest improvement is in weldment design. The process now is more logical. After you design the parts to be welded, you can specify material-removal and other surface preparation, weld beads, and post-weld machining. You get all the documentation — pre-weld and post-weld. There's even a "label weld" command that lets you document changes in part edges and weld beads.

You can toggle between fully detailed parts and simplified parts as needed. Display of simplified parts calculates much faster, helping you work with large assemblies. Users can specify how to simplify a part for display, and toggle between simple and detailed parts as needed. Users can also set the display to not calculate hidden edges.

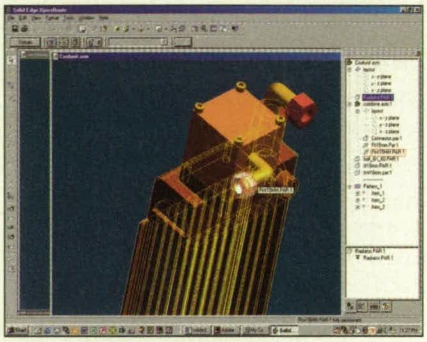


Rendered 3D view. Passing the mouse over a part shows its edges in outline as well.

Several new "sensors" have been added. In Solid Edge, sensors continually monitor some parameter that you set — minimum distances between parts, or sheet metal manufacturability. New sensors include surface area of a part, and a custom meter for (as an example) manufacturing cost.

A bunch of little improvements help the drafter. The Move Part command, for instance, now supports collision detection. Control of text in drawings is much improved, and hole tables are easier to preserve.

Translators — including STEP, IGES, DGN, DWG, and DXF — have been improved, but many designers will find the add-ons more exciting. One is an "engineering handbook" by MechSoft.com that allows you to design parts using known or calculable properties. There's a Web publisher from Immersive Design that lets you turn Solid Edge files into Web content. It includes 3D models that can be viewed and manipulated inside Internet Explorer. The Xpand3D module creates solid models out of 2D CAD drawings in DXF, DWG, DGN, and IGES. It doesn't always work because designs can be ambiguous, even when you have multiple views. But it is a powerful tool.



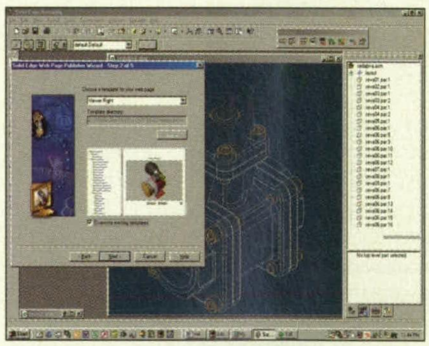
Note that passing the mouse over a part in this radiator assembly produces its label on the drawing and highlights it in the edge bar at right.

Unigraphics is hardly the only vendor selling to mechanical designers. Some other products are awesome with large assemblies, but Solid Edge is no slouch. One recent entrant in Unigraphics' annual design contest actually designed an entire plant in Solid Edge as one large, 65,000-part "assembly." Solid Edge is particularly strong in sheet metal design. It uses the Parasolid kernel (Unigraphics owns it and licenses it to competitors), which may be a selling point to those who are worried about the chief competitor, ACIS, which was recently sold. In theory, Solid Edge parts can be more truthfully translated to other Parasolid-based design products' file formats.

But, frankly, the biggest advantage Solid Edge may have is among casual users — designers who spend less than 20 percent of their time drafting. Solid Edge is remarkably intuitive to use and responsive on the screen, and it has a good Web-based publishing system for collaboration. Some will find it similar to what they are used to in the 2D CAD world.

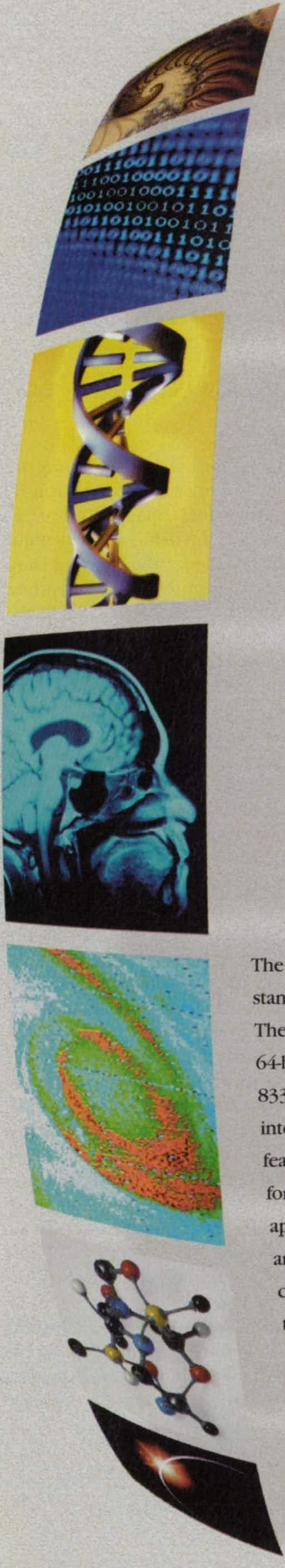
Version 9 is supported on Windows 98, 2000, and NT 4.0 with Intel or AMD Athelon CPUs. It is not supported on Windows 95, but generally runs fine. We reviewed mainly in Windows 98 and Millennium Edition with 256 MB of RAM and a 733-MHz Intel Pentium III. The recommended minimum configuration is 128 MB of RAM and an OpenGL graphics card. We had it running, slowly, in 64 MB of RAM on a Windows NT 4.0 machine with a 200-MHz Pentium Pro CPU.

The core product sells for $4,995. Existing Solid Edge customers get the new version as part of their annual $1,296 maintenance contract, along with unlimited technical support. The new add-ons range from $495 (Web publisher, Xpand3D, feature recognizer) to $1,495 (engineering handbook, XpresRoute tub path drafting), with annual maintenance about 20% of the purchase price. The add-ons can be bought as floating licenses for a premium of roughly 80%. This allows multiple workstations on a network to share (typically) one license. For purchasing information, visit UGS at http://www.solid-edge.com.



The web publishing wizard, getting set to publish the drawing on screen to the Web. Notice the parts listing as well as the drawing itself.

Steve Ross is an Associate Professor at Columbia University's Graduate School of Journalism. He has been reviewing CAD software for 15 years.



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For More Information Circle No. 563

Who's Who at NASA

Kenneth Wagner, Aerospace Technologist, Goddard Space Flight Center

Kenneth Wagner is an Aerospace Technologist at NASA's Goddard Space Flight Center in Greenbelt, MD. He was the lead software engineer and lead electrical engineer for the Pistol Grip Tool, a computer-controlled power tool that is used on both shuttle and space station repair missions. (A tech brief on the Pistol Grip Tool was featured on page 62 of the November issue.)

***NASA Tech Briefs:* What is the Pistol Grip Tool and how does it differ from other power tools?**

Kenneth Wagner: The Pistol Grip Tool (PGT) is a rotary power tool that can be used to turn a drill bit, wrench socket, screwdriver, or other power tool bit. The major difference is the level of control the PGT offers in terms of the power and the torque applied.

NTB: How long did it take to develop this tool?

Wagner: We worked on it for about three years. Paul W. Richards, who was working in the Hubble Servicing Office at Goddard, saw a need for a handheld power ratchet tool that was self-contained. Goddard had already built a larger ratchet tool, but it was in two pieces and was a little bit larger and harder to use. What Paul did was assemble a team from Goddard, Orbital Sciences Corp., and Swales and Associates (which is now Swales Aerospace), and we got together and built this handheld tool. And I think it supplements the other one nicely.

NTB: The PGT features built-in sensors. What functions do they perform?

Wagner: There is an external port that allows you to program what the settings of the tool are going to be — it is not a fixed torque that it can generate. It can generate up to 14 different torque settings and six different speed settings through the programming port.

NTB: How is NASA currently using the PGT?

Wagner: The tool is now flying on the Hubble servicing missions, and it will fly on all International Space Station assembly missions. In orbit, an astronaut programs the tool with the Payload General Support Computer, or PGSC, while he or she is in the crew cabin. The PGSC is an IBM ThinkPad laptop. The astronaut then detaches the cable and goes out with the tool. It allows a lot of flexibility on a mission. We also use the tool for easy and accurate screw loosening and to engage and disengage latches.

NTB: What are some possible commercial applications for the tool?

Wagner: The tool could be used in any application where a precise amount of torque or turns is required. In something like auto repair, where under-torquing or overtorquing could have dangerous consequences, I could see the PGT being used. The tool also could be useful in a manufacturing facility where workers would be able to apply precise torque and turn counts to delicate fasteners in an assembly line; for instance, in the assembly of eyeglasses or plastic-cased computers. It could be useful in biomedical applications, where a doctor would apply precise torque to an orthopedic screw or to a brace. When used on screws, the PGT accurately tightens them to keep from stripping their threads and makes sure enough torque has been applied to keep the screw tight.

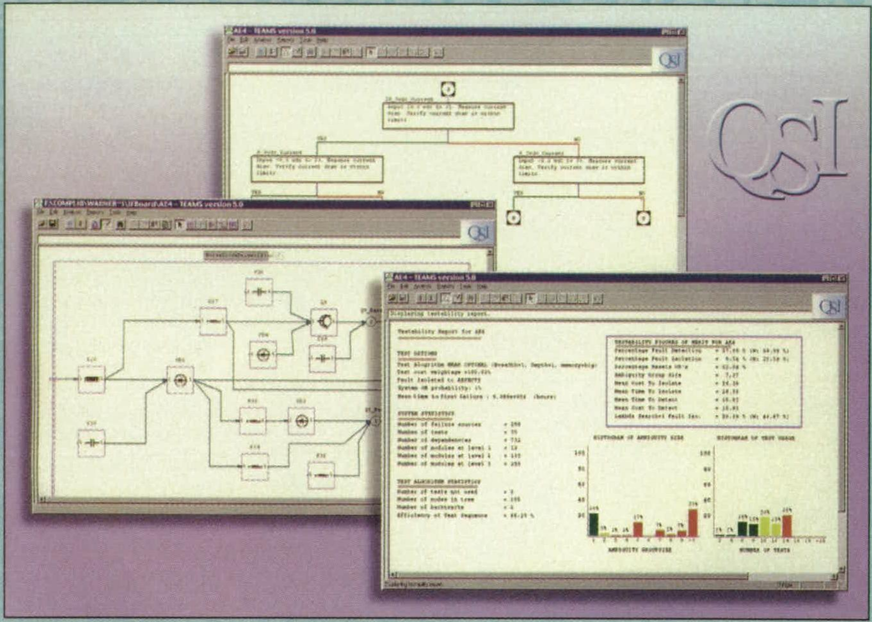
A full transcript of this interview appears online at www.nasatech.com. Mr. Wagner can be reached at kenneth.w.wagner.1@gsfc.nasa.gov.


IF YOU CAN THINK IT, WE CAN DO IT.

Application Briefs

Failure Modeling Tool Used for Shuttle Wiring Diagnostics

TEAMS failure modeling software
Qualtech Systems
Wethersfield, CT
860-257-8014
www.teamqsi.com



The Wiring Integrated Research (WIRe) team at NASA's Ames Research Center in Moffett Field, CA, utilized TEAMS (Testability Engineering and Maintenance System) failure modeling software to explore means of automatically extracting high-fidelity failure models from the Space Shuttle's wiring database.

Qualtech Systems developed an open interface to the SCAN (Shuttle Connector Analysis Network) database to import the necessary information about modules, connectors, wiring harnesses, and jumpers, and automatically generated TEAMS models of all of the wire harnesses of a shuttle subsystem. Failure modes modeled include pushed pins and bent pins of connectors, opens and shorts of conductors, high-voltage dielectric breakdown and impedance mismatch, and noise pickup due to cable degradation.

To perform the tests, one or more connectors had to be de-mated, and the test equipment was connected to the open connectors. The mating and de-mating of connectors was modeled using switches and nodes. TEAMS assessed the test coverage and fault isolation of the wiring system, given the mate/de-mate status of the connectors as indicated by the SCAN database.

For More Information Circle No. 740

CCDs Will Help NASA Map 40 Million Stars

Charge-coupled devices (CCDs)
Scientific Imaging Technologies
Tigard, OR
503-431-7100
www.site-inc.com

Scientific Imaging Technologies will supply 56 charge-coupled devices (CCDs) for a space telescope that will map 40 million stars and search for new planets outside our solar system. The Full-sky Astrometric Mapping Explorer (FAME) project, part of NASA's medium-class Explorer (MIDEX) program, is a five-year mission to be launched in 2004. Observations made during the mission could help resolve questions about the size and age of the universe.

The CCDs are 4096 x 2048, 15-μm pixel devices that will be thinned and configured with an anti-reflective coating. CCDs are the key components in digital imaging systems. These highly sensitive, silicon-based microchips produce high-resolution images by turning light into a stream of electronic signals, which can be recorded, analyzed, and displayed. The CCD technology incorporates a patented process for thinning and strengthening the silicon substrate to accommodate the back-illumination of the CCD pixels, a process that yields devices with very high quantum efficiency (QE) at wavelengths from near infrared to ultraviolet.

This technology will be utilized on the FAME satellite, a low-cost survey instrument designed to accurately determine the positions, distances, and motions of 40 million stars within our galaxy. The telescope will measure stellar positions to less than 50 microarcseconds. To put this in perspective, the width of a typical strand of human hair would subtend 50 microarcseconds viewed from a distance of 130 to 190 miles.

For More Information Circle No. 741

Commercialization Opportunities

Improved Infrared Imaging of Bulk Defects in CdZnTe Wafers

The improved method would guide the "mining" of large wafers. The method is to be used in fabricating focal-plane arrays of photodetectors for x-ray and gamma-ray astronomy.
(See page 32.)

Improvements in Computed-Tomography Imaging Spectrometry

Improvements have resulted in unprecedented capabilities for imaging with spatial, spectral, and temporal resolution. The equipment in its present form could be used in medical and pharmaceutical applications.
(See page 36.)

GA Synthesis of Circuits Using Linear Representation

This method of automated synthesis differs from other GA-based circuit synthesis methods in that the topology of a circuit, the number of its components, and the types and values of the components are all made to evolve by use of the GA.
(See page 40.)

Silicon Carbide npnp Thyristors

Fabricated and tested as prototype power-switching devices, these thyristors can operate at temperatures up to 350 °C. These thyristors feature epitaxial n- and p-doped layers of 4H SiC in the sequence npnp, starting on the substrate, as opposed to the more conventional pnpn structure.
(See page 42.)

Small Lidar Altimeter Would Operate at Low Light Levels

Relatively high resolution would be achieved without resorting to high power. The unit is proposed for use aboard spacecraft for mapping land and sea surfaces.
(See page 43.)

Improved Methods of Testing Cryogenic Insulation Materials

Two methods and their corresponding apparatuses are based on the cryogen-boiloff calorimeter method wherein the amount of heat that passes through an insulation specimen to a cryogenic fluid in a vessel is proportional to the rate of boiloff from that vessel.
(See page 46.)

Real-Time Optoelectronic Particle-Fallout Monitors

Settings in which these instruments could prove useful include clean rooms for assembly of optical and electronic equipment, food-packaging facilities, and other areas where one seeks to prevent product contamination by airborne dust and fibers.
(See page 49.)

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FREE NEWSLETTER

Cast Your Vote for

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Sixth Annual Readers' Choice Awards

Each month, you can find the Product of the Month on the UpFront editor's page of *NASA Tech Briefs*. The Product of the Month is a new product with exceptional technical merit and practical value to our more than 200,000 engineering and management readers.

This month, we ask you to vote for the one product among those highlighted throughout the year that you feel was the most significant new product introduced for the engineering community this year. The product receiving the most votes will be named *NASA Tech Briefs* 2000 Readers' Choice Gold Winner for Product of the Year. The products with the second and third highest number of votes will be awarded the Silver and Bronze awards, respectively.

Last year's winner of the Gold Award for Product of the Year was CoBrain knowledge processing software from Invention Machine Corp. of Boston, MA.

On the facing page are descriptions of each of the Products of the Month chosen in 2000. Choose the one product you feel should receive Product of the Year honors, and cast your vote in one of the following ways:

- Visit the *NASA Tech Briefs* web site at **www.nasatech.com** and indicate your choice on the Product of the Year ballot;
- Complete the ballot below and fax it to the Editor at 212-986-7864; or
- Mail the ballot to: Product of the Year, *NASA Tech Briefs*, 317 Madison Ave., New York, NY 10017.

Only one vote per person will be counted. Your completed ballot must be received by January 26, 2001. All eligible voters will be entered in a random drawing to win valuable prizes contributed by past winners of Readers' Choice Awards.

The 2000 Readers' Choice Awards will be announced on March 5, 2001, during National Manufacturing Week in Chicago. We'll also list the winners in the April issue of *NASA Tech Briefs*, and on our web site at **www.nasatech.com**.

2000 *NASA Tech Briefs* Readers' Choice Product of the Year Ballot

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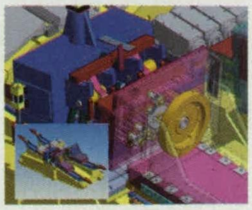
Check only one box

- ❑ **January:** Labtec - Spaceball 4000 FLX 3D motion controller/ input device
- ❑ **February:** Autodesk - Autodesk Inventor Release 2 3D solid modeling software
- ❑ **March:** Intergraph Computer Systems (SGI) - Zx10 ViZual Workstation
- ❑ **April:** Computer Dynamics - Century-C/M series flat-panel computers/monitors
- ❑ **May:** COMSOL - FEMLAB multiphysics modeling and analysis software
- ❑ **June:** Xerox Engineering Systems - MAX 200 wide-format digital document system
- ❑ **July:** Capital Equipment Corp. - webDAQ/100 web-based data acquisition device
- ❑ **August:** Agilent Technologies - 54600 series oscilloscopes
- ❑ **September:** IBM Engineering Solutions - CATIA Version 5 Release 4 CAD/CAE software
- ❑ **October:** CUI Stack - IESP/IESF miniature pressure sensors
- ❑ **November:** The MathWorks - MATLAB version 6 technical computing software
- ❑ **December:** Network Technologies - Universal Matrix KVM keyboard-video-mouse switches

Product of the Year Nominees

Labtec, Vancouver, WA, introduced the Spaceball 4000 FLX 3D motion controller/input device that minimizes arm and wrist stress, and features an adjustable wrist pad for right- or left-hand use. It allows users to simultaneously pan, zoom, and rotate 3D models. With six-degrees-of-freedom motion control, users push, pull, or twist the PowerSensor ball for X, Y, and Z axis translations and rotations. Twelve buttons offer access to 22 customized functions.



Autodesk Inventor Release 2 3D solid modeling software from Autodesk, San Rafael, CA, is based on Adaptive Design, a new process that enables users to design the way they think, and collaborate with teams. It allows intelligent 2D layouts to become the foundation for 3D assemblies, and lets designers relate parts and assemblies by specifying shape and position instead of parameters and equations.

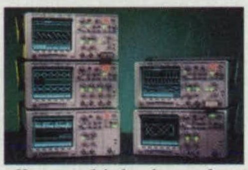
Intergraph Computer Systems, Huntsville, AL, offered the Zx10 ViZual Workstation. (The product line is now owned by SGI, Mountain View, CA.) The computer features Wahoo Technology with Streaming Multiport Architecture that improves system throughput and performance of the 2D/3D graphics pipeline. The workstations feature 64-bit PCI buses, single or dual Pentium III 733-MHz processors, and up to 8 GB of PCI33 ECC SDRAM.

The Century-C/M Series of enclosed flat-panel computers and monitors from Computer Dynamics, Greenville, SC, is available in four display sizes. The units offer an analog resistive touchscreen and are available with or without a membrane keypad. They feature Celeron CPUs to 500 MHz, and have standard PC functionality with two RS-232 ports, two RS-232/422 ports, parallel port, mouse, and a 1.44-M front-accessible floppy drive.

COMSOL, Burlington, MA, introduced FEMLAB multiphysics modeling and analysis software that automates methods of parametric analysis and design optimization. The software runs on top of MATLAB technical computing software, and can model virtually any physical phenomena with partial differential equations including heat transfer, fluid flow, electromagnetics, and structural mechanics. It can import DXF drawing files from CAD software, and includes a model library of more than 80 models.

The MAX 200 wide-format digital document system from Xerox Engineering Systems, Stamford, CT, operates at 7.9" per second, delivering more than 1,020 D-sized prints and 540 E-sized prints per hour. It features a highlight red option that allows users to communicate critical changes and hard-to-see details with red ink. The system features dual 400-DPI LEDs for image quality, 256 levels of gray, and the ability to print in red, black, or both.

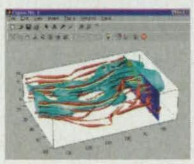
Capital Equipment Corp., Billerica, MA, offers webDAQ/100, a Web-based data acquisition device that combines A/D and D/A hardware with Web technology. With a built-in Web server, the system contains its own user interface. The user plugs the system into a network connection, starts up their Web browser, and configures acquisition parameters, start and stop operations, and data reports. It features up to 32 MB of RAM, 500-KHz throughput at 12-bit accuracy on 32 input channels, and eight D/A output channels.



The 54600 series of oscilloscopes from Agilent Technologies, Colorado Springs, CO, offers multiple-channel configurations: 2- and 4-channel or the mixed-signal oscilloscope with 2 + 16 channels. The scopes include 2 MB of MegaZoom deep memory behind each channel, and a high-definition display system that maps deep memory into 32 levels of gray scale. Users can view two analog and up to 16 digital signals simultaneously.

IBM Engineering Solutions, Dallas, TX, released CATIA Version 5 Release 4 CAD/CAM/CAE software for both 2D and 3D design that incorporates 12 new products and 39 enhancements, including improvements in mechanical CAD, shape design and styling, manufacturing, analysis, cabling, and process coverage. It also features standard parts catalogs, sheet metal design integration, structure design, large assembly management, generative and interactive drafting, and a 2.5-axis machining product.

CUI Stack, Beaverton, OR, offers the IESP Series Resin Molded Cover and IESF Series Flexible Board miniature pressure sensors that use a proprietary material called Inastomer. The material provides both elasticity and conductivity, allowing the sensors to continuously react to the degree of pressure applied. IESP sensors feature fixed pin mounting terminals; IESF sensors are fastened with a pressure-sensitive tape and can mount to curved surfaces.



The MathWorks, Natick, MA, released version 6 of MATLAB technical computing software as part of Release 12 of its product family. MATLAB 6 includes a new desktop front-end and integrated tools that provide access to the software's math, analysis, visualization, and programming capabilities. New tools simplify common tasks such as importing data, performing analyses, and creating informative graphics. Also featured are optimizations to the product's core matrix computing and signal processing engines.

Universal Matrix KVM keyboard-video-mouse switches from Network Technologies, Aurora, OH, are electronic switches that allow two to four users to individually command or simultaneously share up to eight PC, Sun, and Macintosh computers without the need for plug-in modules. Users can change platforms using adapter cables. The keyboard hot-plug feature allows users to change keyboards on the fly — even to a different platform — without rebooting.

Electronics Manufacturers Use X-Ray Imaging Systems for Yield Improvement

The higher yield due to x-ray imaging inspection means fewer PCBs to diagnose, repair, and re-test.

Contract electronics manufacturers have become one of the largest markets for x-ray imaging systems, both in dollar volume and unit sales. These systems typically are off-line, positioned at the end of the assembly line of the surface mount technology (SMT) process, and employed for inspection after value has been added and just prior to the plated through-hole process. On-line systems, however, are becoming increasingly popular, as are combination x-ray and automated optical inspection (AOI) systems.

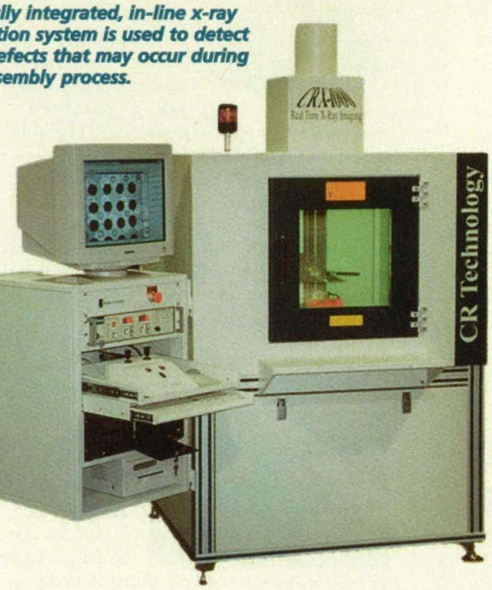
The driver behind this comparatively new machine-vision market is the increased use of ball grid arrays (BGAs) and other area array devices, as well as the desire for yield improvement and rapid rework that have emerged as concerns of overriding interest for printed circuit board (PCB) manufacturers.

This interest in yield improvement is largely motivated by the fact that an immense volume of process and test data is generated by a typical PCB manufacturer during test operations. The volume of data continues to grow as automated inspection instrumentation improves. As a result, manufacturing engineers and quality control personnel are constantly challenged by the need to rapidly collect and analyze any new data, and use it to improve manufacturing yield rates.

BGAs and X-ray Inspection

X-ray inspection quickly is becoming one of the primary tools used by PCB and electronics contract manufacturers where BGAs, micro-BGAs, Chip Scale Packages (CSPs), flip chips, and other hidden connection devices have become standard elements in PCB design. Traditional verification methods are no longer sufficient to analyze these devices. By using x-ray inspection, the characteristics of hidden solder joints can be checked in a simple, reliable, and cost-effective manner. The higher yield due to x-ray inspection means fewer PCBs to diagnose, repair, and re-test. In some manufacturing operations, this improvement in yield has been so dramatic that the manufacturer has been able to eliminate in-circuit testing (ICT) altogether with consequent savings in labor, capital, and floor space.

This fully integrated, in-line x-ray inspection system is used to detect BGA defects that may occur during the assembly process.



In the case of functional board tests (FBTs), the savings can be even more dramatic. These savings can be brought about by shortening test times, reducing the number of failed PCBs requiring diagnosis, cutting down on the use and cost of skilled technicians, and virtually eliminating "fatal" defects that lead to scrapping of boards.

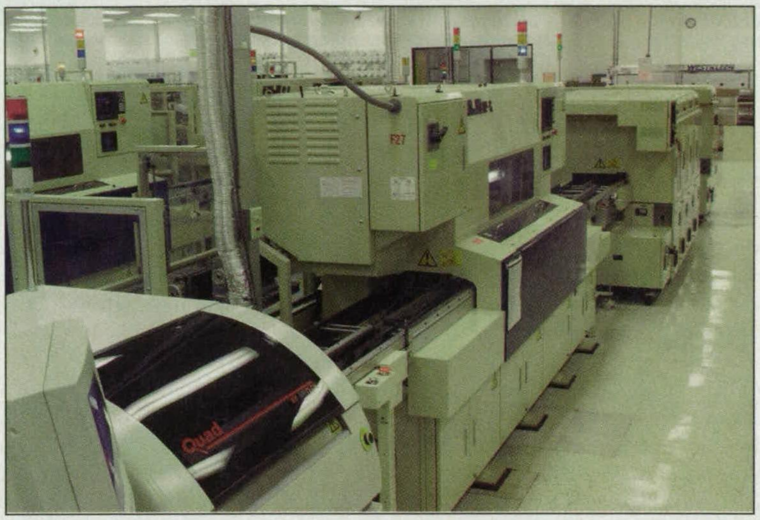
Until BGAs were incorporated into product design, most PCB and electronics contract manufacturers found little need to incorporate x-ray inspection into their production process. Traditional methods such as human visual inspection, electrical tests (including manufacturing defect analysis or MDA), in-circuit, and functional tests were sufficient. These methods, however, did not provide adequate detection of hidden solder problems such as voids, cold solder joints, and poor solder adhesion. Only x-ray inspection was able to detect these problems effectively, in addition to monitoring the process quality and providing immediate feedback required for proactive process control.

Let's take a quick look at x-ray imaging and typical BGA problems. First is missing or misplaced solder and balls on BGAs once the devices have been mounted to the PCB. Second is solder bridging, which often occurs — especially with reworked BGAs — when an excess amount of solder has been put on the contacts, or the solder was applied improperly. Third is misregistration — when the BGA balls do not align properly with the pads on the PCB. The fourth problem is solder voids, which are the result of the expansion of trapped compounds in the solder during heating.

Choosing the Right System

Choosing the right x-ray system can be a challenging task, given the choices in capabilities and price ranges for systems available today. Before making a decision, it is important to consider all of the requirements to be placed on the system and the estimated savings derived from incorporating the system into the manufacturing process. Important factors to consider include the initial cost, resolution, magnification, image-processing features, and the degree of automation desired. There is also another important consideration: competitive advantage. On large contracts wherein PCB assembly is vitally important, the use of an x-ray system can be the deciding factor in being rewarded a contract.

An important consideration is price. Systems can range from basic manual units starting at about $50,000, to fully au-



Turnkey manufacturing lines include in-line and off-line inspection systems to detect voids and defects that occur during assembly.

tomated in-line systems costing over $500,000. An off-line, high-resolution x-ray inspection system with X-Y-Z indexing and joystick control may be the right call for even the largest PCB applications.

Manual systems generally provide the most flexible and economical solution for x-ray inspection where thorough examination is not required. These systems typically are used in various stages in the manufacturing process, including the inspection of incoming components, process monitoring, quality control, and failure analysis. With manual systems, an operator visually analyzes an x-ray image and determines what represents a defect. However, as with any decision based solely on operator judgement, results will vary with operator skill, time of day, and throughput requirements. Results also can be affected by personal factors such as the relatively uneven performance of human inspectors, the attention span of the particular operator, even the specific day (inspection may be less effective on Friday afternoon than Monday morning). Nevertheless, these systems offer the greatest inspection flexibility and the quickest implementation time without in-depth operator training or system programming.

Semi-automated x-ray systems offer a higher level of inspection sophistication by using machine vision and programmable device-positioning tables. These systems analyze device placement and solder integrity based on preset gray-level parameters. Although an operator is still required for subjective decisions, the machine vision-based x-ray inspection is inherently more reliable and offers greater throughputs than possible with manual inspection.

Fully automated x-ray systems are most commonly used in high-volume/low-mix manufacturing applications or instances where product liability issues dictate 100% solder-joint inspection. These systems feature pass-through conveyors and are designed to operate at line speed. Fully automated systems generally offer statistical process control (SPC) information as an option. Some automated systems also offer the additional ability to perform cross-sectional or three-dimensional inspection of solder joints on double-sided boards. These systems require significant amounts of programming and operational support, and usually are best suited for high-volume/low-mix applications.

X-ray inspection systems are a proven tool to detect hidden solder joints, help establish and control the manufacturing process, analyze prototypes, and identify process faults.

Long-term process improvement is a concept that requires input from as many sources as possible. X-ray inspection, where defect data is automatically collected, maintained, and monitored is an ideal starting point for improving both product quality and yield.

For more information, contact the author of this article, Luke C. Kensen, Director of Business Development, at Express Manufacturing, Santa Ana, CA; Tel: 714-979-2228; e-mail: LKensen@eminc.com; or visit www.eminc.com.

Finding Known Shapes in an Image by Pruning Parameter Space

This method is both efficient and robust.

NASA's Jet Propulsion Laboratory, Pasadena, California

An improved method of processing two- and three-dimensional image data to locate known shapes called "geometric primitives" involves (1) extraction of edges and other relevant image features and (2) performing a hierarchical search, in a space of parameters of equations that describe the shapes of the features, for those parameters that represent the geometric primitives. This method is inspired by prior object-recognition methods in which parameter spaces are recursively divided and pruned. The most closely related prior methods of this type are based on variations of the Hough transform. Whereas the prior methods have generally offered robustness or computational efficiency but not both, this method offers both, along with other advantages: It enables the efficient and robust extraction of geometric primitives from noisy and incomplete data that include many distracting data, without need for initial estimates of the locations of the geometric primitives.

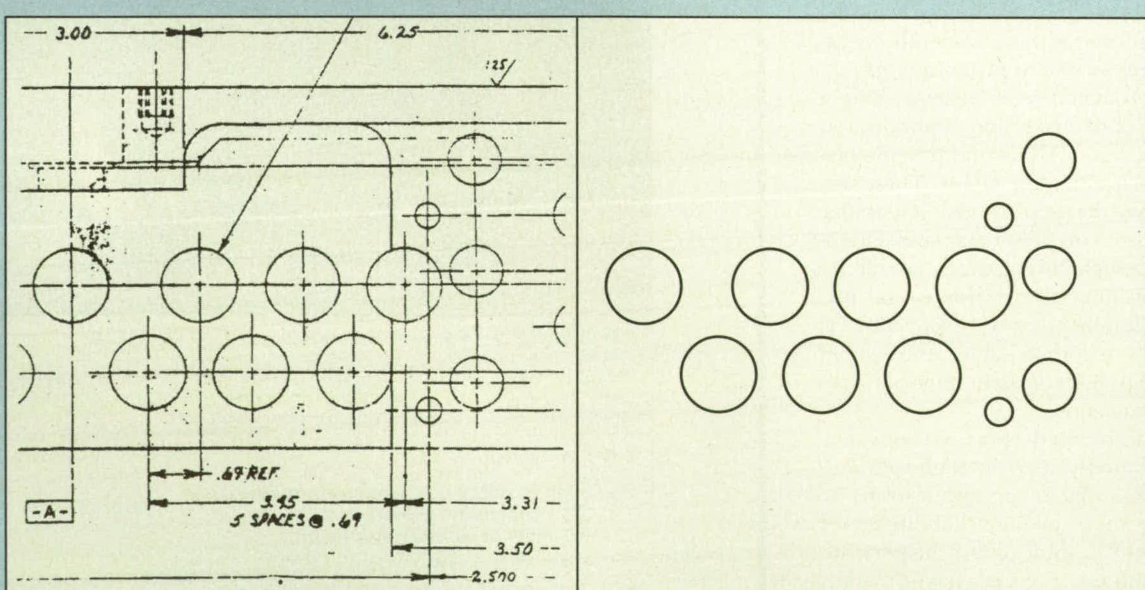
In this method, one extracts geometric primitives from image data in the following way: One searches for parameters that satisfy a quantitative acceptance criterion based on the number of data features that approximate geometric primitives within a specified error measure. The search involves the subdivision of the parameter space into rectilinear cells, possibly starting from one or a few large cell(s). Each point in the parameter space represents a candidate position of a geometric primitive in the data. The cells are volumes of the parameter space and thus represent continuous ranges of locations of geometric primitives in the parameter space.

Each cell in the parameter space is tested to determine whether it can contain the parameters of a primitive that satisfies the acceptance criterion. If the acceptance criterion is not satisfied, the cell is pruned. If the acceptance criterion is satisfied, then the cell is split into two subcells and the subcells are examined recursively. When the smallest specified cell size is reached, the primitive at the center of the cell is tested to determine whether it meets the acceptance criterion.

At each state in this recursive process of division and pruning, the test is performed by an efficient algorithm that is conservative in that it never rules out a cell that contains a good primitive. Although this test can sometimes fail to rule out a cell that does not contain any good primitive, this failure does not result in false positives in the end because false positives are ruled out in the subsequent tests performed at subsequent finer subdivisions.

An interesting facet of this method is that a hierarchy is constructed not only in the parameter space, but also in the image feature space. This makes it possible for many image features to be pruned at each step with little computation, in addition to the pruning in the parameter space. Empirical evidence suggests that this hierarchical pruning reduces the complexity of the extraction process. In cases in which the number of data greatly exceed that needed for extraction of geometric primitives, robust random sampling can also be used to increase speed.

In some initial test cases, the geometric primitives were relatively simple shapes



ORIGINAL IMAGE

DETECTED CIRCLES

Circles in a Noisy Scanned Engineering Drawing were detected by processing the digitized scanned image according to the method described in the text.

(circles and cylinders). The test cases were representative of three different image-recognition problems: identifying craters in digital images of planetary bodies, detecting the predominantly cylindrical bodies of unexploded bombs in images of a military test range, and detecting circles in an engineering drawing (see figure). Examples of other potential applications include locating parts for robotic assembly and detecting symbols in engineering drawings for transcription by computer.

This work was done by Clark F. Olson of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Information Sciences category. NPO-20941*

Improved Infrared Imaging of Bulk Defects in CdZnTe Wafers

Images would guide the "mining" of large wafers for fabricating x-ray detectors.

Goddard Space Flight Center, Greenbelt, Maryland

An improved method of infrared imaging of bulk defects in cadmium zinc telluride (CdZnTe) wafers has been developed. The method is intended primarily to be a means of identifying those portions of large CdZnTe wafers that are suitable to be "mined" for use in fabricating focal-plane arrays of photodetectors for x-ray and γ-ray astronomy. Suitable portions are those that exhibit acceptably high degrees of uniformity of x-ray spectral response. The present method of infrared imaging is useful for identifying the suitable portions because, as described below, there is a correlation between (1) x-ray spectral responses and (2) infrared images of bulk defects that affect those responses.

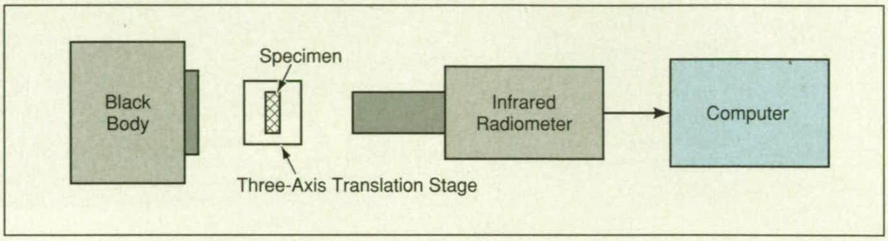


Figure 1. **Black-Body Infrared Radiation** passes through a specimen and is detected by a radiometer to form an image of bulk defects in the specimen.

Prior to the development of the present method, numerous investigators had used infrared-transmission imaging to document the distribution of bulk defects in CdZnTe. Incandescent lamps were used as the sources of radiation, and the infrared images were detected by silicon charge-coupled-device cameras operating at wavelengths just beyond the visible range. The present method is also one of infrared transmission imaging, but the wavelength range and the means of implementation are different.

Figure 1 schematically depicts the apparatus used in the present method. The source of radiation is a large-area black body at a temperature of 70 °C. The radiation detector is an infrared radiometer that operates in the wavelength range of 8 to 12 μm; it includes an HgCdTe photodetector cooled to 77 K by liquid nitrogen. A three-axis translation stage is used to manipulate a CdZnTe specimen wafer. Various lenses, including a microscope objective, are used to optimize images of defects.

During the development of the present method, experiments were performed to determine whether the infrared images produced by the apparatus described above could be used to identify the desired portions of CdZnTe wafers. In these experiments, CdZnTe specimen wafers of two different sizes (15 by 15 by 2 and 26.9 by 26.9 by 2 mm) were set up as planar photodetectors and exposed to a collimated beam of x rays from a 160-kV microfocus x-ray tube. The collimated beam was either 100, 250, or 500 μm wide. Each specimen was mounted on a computer-controlled, motorized translation stage and was translated in 100, 250, or 500 μm increments across the detector plane. At each increment of position, the CdZnTe detector output was processed into an x-ray-spectral response by a simple pulse-height-analysis system.

The bulk defects that can be seen in the infrared images include grain boundaries and twin boundaries decorated with tellurium inclusions, and pipelike voids. The results of the experiments show that there is a correlation between poor x-ray-spectral response and grain boundaries decorated with tellurium inclusions (see Figure 2).

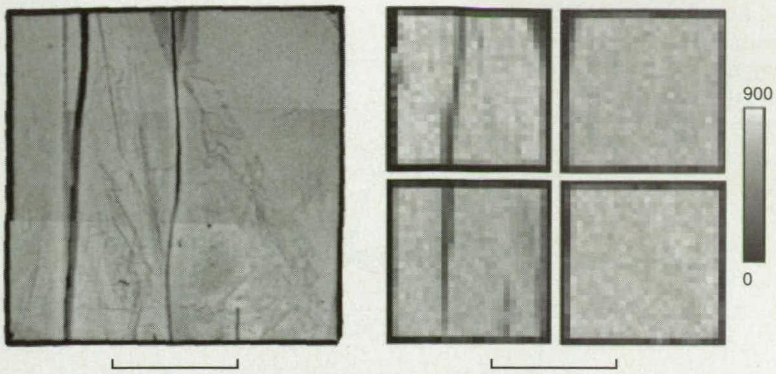


Figure 2. **Infrared-Transmission and X-Ray Spectral Images** of the same CdZnTe specimen exhibit correlations that can be useful in selecting relatively-defect-free areas for fabrication into focal-plane arrays of x-ray detectors. The x-ray spectral image comprises four subimages because for operation of the CdZnTe specimen as an x-ray detector, it was necessary to subdivide its anode contact into four areas to reduce leakage noise.

It would be natural to ask why the infrared imaging method is preferable to generation of x-ray spectral images of wafers. The answer is simply that it would take a long time to scan a wafer [about 80 hours at 500-μm resolution for a 5-in. (127-mm)-diameter wafer] and most of that time would be wasted because of large defect densities encountered in practice. Instead, one could use the present infrared-imaging method to screen an entire wafer quickly to identify areas with acceptably low defect densities and dimensions large enough for fabricating photodetector arrays.

This work was done by Bradford Parker, J. Timothy Van Sant, Richard Mullinix, C. M. Stahle, A. M. Parsons, and J. Tueller of **Goddard Space Flight Center**, *Bruno Munoz of Unisys Corp., S. D. Barthelmy of Universities Space Research Associates, and S. J. Snodgrass of Raytheon STX. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*
GSC-14255

Image Generators With Compact Optics

These devices can be used for head-mounted, helmet-mounted, and eyeglass-mounted displays.

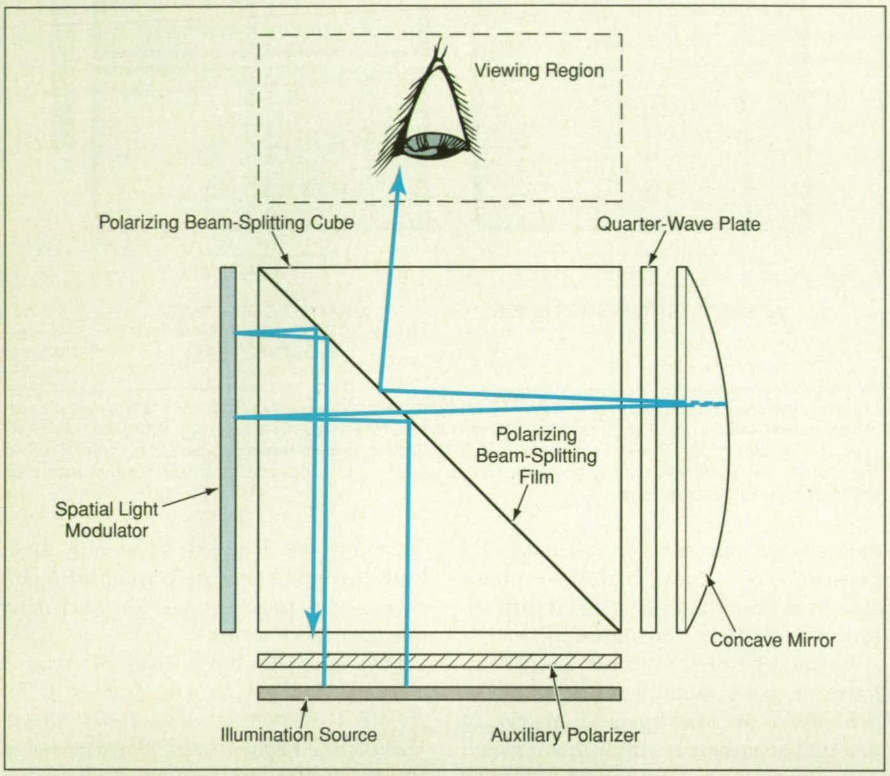
Lyndon B. Johnson Space Center, Houston, Texas

Compact image generators that contain illumination sources and electronically controlled spatial light modulators have been invented. Compactness is achieved by folding of the optical paths that link the illumination sources, the spatial light modulators, and the viewing regions into which images are projected. The optical configuration of a device of this type ensures that a large proportion of the light from the illumination source is directed into the viewing region; consequently, the device is unusually energy-efficient for a display device and can, therefore, be operated at a relatively low power (possibly even battery power) for a given display brightness. By virtue of their compactness and low power consumption, these image generators are suitable for head-mounted, helmet-mounted, and eyeglass-mounted displays.

These image generators can be designed in a number of alternative optical configurations, of which one is depicted in the figure. The precise nature of the illumination source is not critical; the source can consist, for example, of one or more light-emitting diodes, laser diodes, cold-cathode or field-emitter cathodoluminescent sources, or incandescent or fluorescent lamps together with a switchable color filter. The spatial light modulator is of a reflective (as distinguished from transmissive) type that effects modulation by either changing or not changing the polarization of light upon reflection, depending on the electronically controlled ON/OFF status of each pixel. The modulating medium in the spatial light modulator is typically a ferroelectric liquid crystal layer.

Light from the illumination source is directed through an auxiliary polarizer into a polarizing beam-splitting cube. The auxiliary polarizer passes only light that is s-polarized with respect to incidence on the polarizing beam-splitting film in the cube. The film reflects most of this s-polarized light toward the spatial light modulator. The light reflected from the spatial light modulator contains the desired image in the form of pixel-by-pixel variations in the proportions of s-polarized and p-polarized light.

The modulated light goes back into the cube, where it is analyzed by the polarizing beam-splitting film: The s-polarized (unchanged) portion of the modulated light is reflected back toward the illumination source. The p-polarized image-bearing light passes through the film, then out of the cube, then through a quarter-wave plate, until it strikes a concave mirror. After reflection from the concave mirror, this light passes back through the quarter-wave plate.



Compactness and Efficient Utilization of Light are achieved by a combination of folding the optical path, polarization, and focusing of light from the modulator and the illumination source.

The double pass through the quarter-wave plate converts the polarization from p to s; consequently, upon striking the polarizing beam-splitting film, this image-bearing light is reflected out of the cube toward a viewing region. The curvature (and thus the focal length) of the mirror is chosen, in conjunction with the other dimensions of the optics, so that (1) to ensure efficient utilization of light, a real image of the illumination source is formed within the viewing region and (2) a magnified virtual image of the pattern of modulated light can be viewed by an eye placed within the viewing region, facing toward the cube.

In some applications, it is desirable to provide for adjustment of the gap between the cube and the spatial light modulator and the gap between the cube and the concave mirror, in order to enable focusing of the viewable image. Optionally, once these adjustments have been completed, the various optical components, including the cube, can be cemented together to produce a rugged assembly that resists misalignment.

This work was done by Mark A. Handschy, Michael R. Meadows, Martin Shenker, and Paul E. Weissman of Displaytech, Inc., for **Johnson Space Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*

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

Mark Handschy
Displaytech, Inc.
2602 Clover Basin Drive
Longmont, CO 80503

Refer to MSC-22992, volume and number of this NASA Tech Briefs *issue, and the page number.*

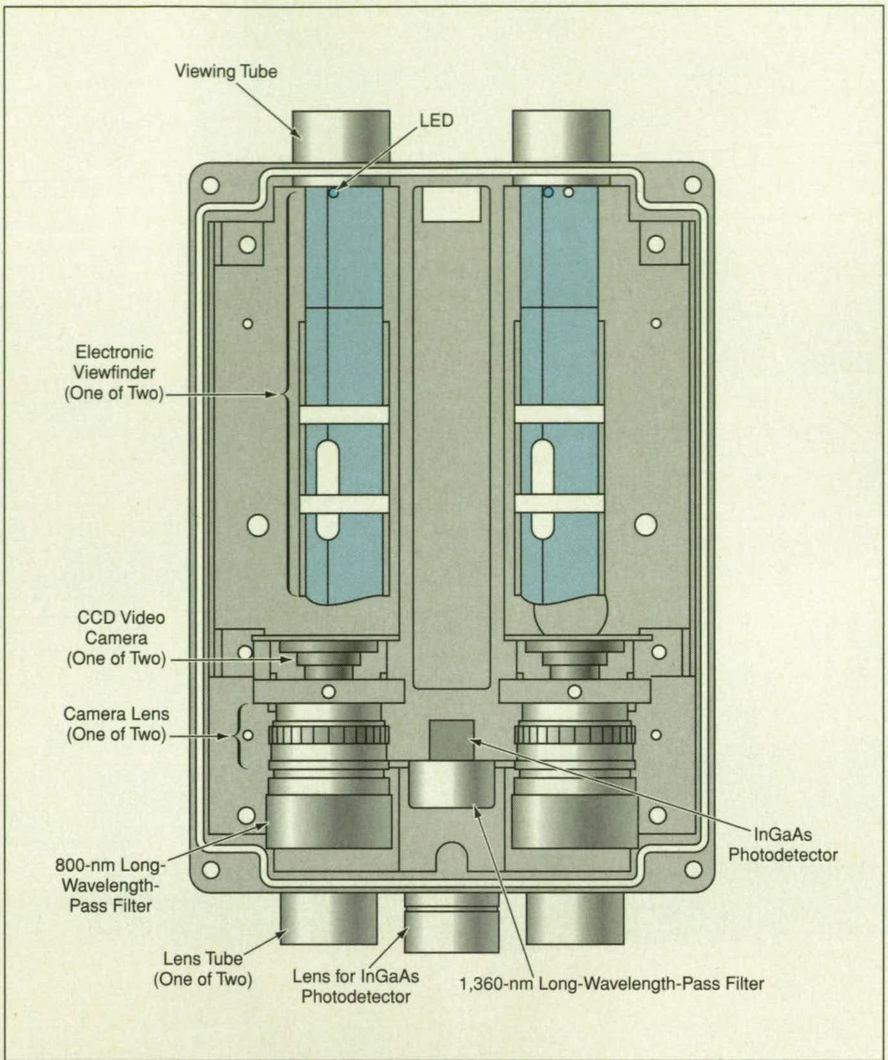
Hand-Held Instrument for Imaging Hydrogen Fires

Hydrogen fires can be seen even in full daylight.

Stennis Space Center, Mississippi

A hand-held instrument that contains two silicon-based charge-coupled-device (CCD) video cameras (see figure) has been developed for imaging hydrogen fires. This or a similar instrument is needed because the visible light emitted


Sun?
Cray?
IBM?
Talk to the hand.
It's Atipa.



The **Major Components of the Hydrogen-Fire Imager** can be seen in this top view of the instrument with its cover removed.

by a hydrogen fire is so dim that the fire cannot be seen by the unaided human eye — at least, not in bright daylight. Like some other CCD-camera-based instruments developed previously for the same purpose, this instrument is designed to operate at infrared wavelengths where hydrogen fires appear bright, relative to solar background light. One CCD camera is called the "cloudy" camera, while the other is called the "sunny" camera, to indicate the different lighting conditions under which the cameras are designed to operate. In front of the "cloudy" camera is a long-wavelength-pass filter with a cutoff wavelength of 800 nm; during overcast, this filter blocks enough background light to make a hydrogen flame appear bright against the background. In front of the "sunny" camera there is a long-wavelength-pass filter with a cutoff wavelength of 1,100 nm; this filter blocks the solar background in the presence of full sunshine, such that a hydrogen flame is brighter than the solar background. The infrared images in the cameras are converted electronically and displayed to the instrument operator as visible images on miniature cathode-ray tubes in electronic viewfinders. A switch enables the operator to select the camera depending on the current light conditions. Optionally, both cameras and their viewfinders can be used simultaneously for binocular viewing.

The instrument includes a nonimaging, InGaAs-based photodetector that has a field of view 40° wide. This photodetector is preceded by a band-pass filter with a nominal pass wavelength of 1,360 nm, which is the wavelength of a peak in the emission spectrum of a hydrogen flame. This photodetector provides additional spectral discrimination of a hydrogen flame; it can also be used to trigger an audible alarm and a visible flash by light-emitting diodes (LEDs) inside the viewfinders, thereby helping to prevent the operator from overlooking a small hydrogen flame.

This instrument can be used to view a hydrogen flame only 8 in. (20 cm) long from a distance of 50 ft (15 m) in full sunlight. It can also be used to image alcohol fires, typical hydrocarbon fires, and embers, which emit in the same spectral regions as do hydrogen fires. Because a hydrogen fire, an alcohol fire, a hydrocarbon fire, or an ember can be seen readily only through the instrument, the operator can readily distinguish between these phenomena and a bright artificial light or a solar reflection, which can be seen without the instrument.

This work was done by Heidi L. Barnes of **Stennis Space Center** *and Harvey S. Smith of Lockheed Martin. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*

This invention has been patented by NASA (U.S. Patent No. 5,726,632). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Stennis Space Center; (228) 688-1929. Refer to SSC-00040.

Improvements in Computed-Tomography Imaging Spectrometry

CGHs are used for dispersion, and a modified calibration procedure saves time.

NASA's Jet Propulsion Laboratory, Pasadena, California

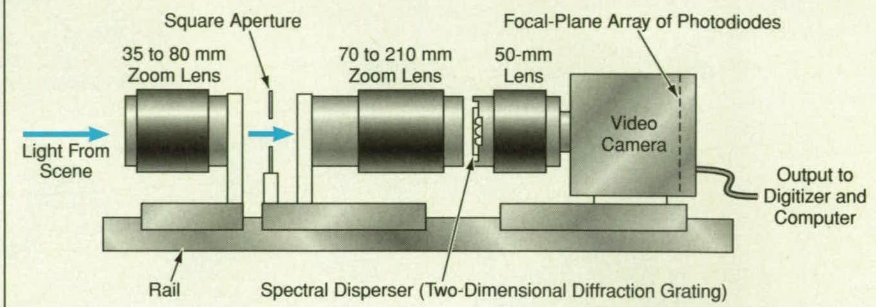
Two major improvements, described below, have been made in the construction and operation of a computed-tomography imaging spectrometer (CTIS). These plus future improvements can be expected to enhance the practicality and commercial viability of CTISs, which, in principle, offer unprecedented capabilities for imaging with spatial, spectral, and temporal resolution. For example, the CTIS in its present form could be used in medical and pharmaceutical applications to perform spectral imaging of transient scenes that contain fluorescent dyes. With increases in spectral accuracy and spatial resolution, it could be used for remote sensing.

A CTIS includes a spectral disperser in the form of a two-dimensional diffraction grating positioned between two relay lenses in a video imaging system (see figure). If the disperser were removed, the system would produce ordinary images of the scene in the field of view of the system. In the presence of the grating, the image on the focal plane of the system contains both spectral and spatial information because the multiple diffraction orders of the grating give rise to multiple, spectrally dispersed images of the scene. By use of algorithms adapted from computed tomography, the image on the focal plane can be processed into an "image cube" — a three-dimensional collection of data on the image intensity as a function of the two spatial dimensions (x and y) in the scene and of wavelength (λ). Thus, both spectrally and spatially resolved information on the scene at a given instant of time can be obtained, without scanning, from a single snapshot; this is what makes the CTIS such a potentially powerful tool for spatially, spectrally, and temporally resolved imaging.

Prior to the improvements reported here, the two-dimensional gratings for CTISs were constructed by stacking and crossing one-dimensional gratings. The disadvantages of this approach are that (1) total throughput efficiency is low, (2) diffraction-order efficiencies cannot be tailored to prevent saturation of focal-plane-array (FPA) photodetectors by weakly dispersed orders, and (3) the pattern of dispered images does not fill the FPA area efficiently. This leads to the first of the two improvements, which is the use of computer-generated holograms (CGHs) as the two-dimensional dispersers. The CGHs offer high total efficiencies and can be designed to generate arbitrary patterns of diffraction-order efficiencies. The CGHs are made from poly(methly methacrylate) by analog direct-write electron-beam lithography followed by development in pure acetone.

To be able to use the computed-tomography algorithms to reconstruct a scene from an image on the focal plane, one must first determine connection weights from positions and wavelengths in the scene to detector pixels. One can determine the connection weights fairly directly by measuring pixel detector outputs while scanning a monochromator-illuminated optical fiber across the scene. Such a complete calibration procedure is hardware-intensive and is time-consuming because the entire scene must be scanned anew for each resolution element in the image cube. This leads to the second improvement, which is a modification of the calibration procedure.

In the modified procedure, one does not scan the entire scene; instead, one uses measurements taken while the single point in the center of the scene is illuminated at each wavelength of interest in the pass band of the CTIS. There are two steps in the modified calibration procedure. In the first step, the pixel outputs are measured at each wavelength. From the measurements, the corresponding system efficiencies (throughput fractions) are calculated for all diffraction orders at all the wavelengths. In the second step, the system efficiencies are used in a ray-tracing computer program that calculates the connection weights from all scene positions to all pixels on the focal plane. The calculation accounts for transmissivities of lenses and other optical elements, plus spectral responsivities of the photodetectors.



This is an **Experimental CTIS**. The heart of this instrument is the two-dimensional diffraction grating, which spectrally disperses an image of the scene in two spatial dimensions. Superior two-dimensional gratings with tailorable properties can be in the form of PMMA computer-generated holograms fabricated by electron-beam lithography and etching.

This work was done by Daniel Wilson, Paul D. Maker, and Richard Muller of Caltech and Michael Descour and Eustace Dereniak of the University of Arizona for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Physical Sciences category.*

NPO-20561

Program for Displaying Large, Coregistered Images

NASA's Jet Propulsion Laboratory, Pasadena, California

DataSlate is an easy-to-use Java-language computer program for displaying coregistered raster images representing large sets of data. The program includes a main viewing module that can display image data that have been converted into a special DataSlate format called "SimpleStruct" by use of an Interactive Data Language program called "SimpleGen." The conversion into SimpleStruct optimizes the organization of the data in the sense that it simplifies any computations that must be done subsequently during perusal of the data. DataSlate enables the user to navigate very large sets of scientific data visually: DataSlate presents a slatelike user interface with simple buttons to select sets of data or to zoom in or out. The user can scroll through a set of data by simply dragging a cursor on a screen. DataSlate can also dynamically load plug-in software tools (e.g., for measuring lengths, angles, areas, or geographic coordinates) at run time. DataSlate can also traverse coregistered collections of data and can present a second data channel in a window on the screen to facilitate correlation or comparison of two sets of data (e.g., from two sensors and/or taken at different times).

This program was written by Akos Czikmantory, Michael Martin, Adrian Godoy, David Hecox, Jose Pena, and Jason LaPointe of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Information Sciences category.*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20691.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GA Synthesis of Circuits Using a Linear Representation

The procedure for designing many practical circuits can be partly automated.

Ames Research Center, Moffett Field, California

A method of automated synthesis of electronic circuits involves the use of a linear (as defined below) genome representation of circuit elements and of connections among them, plus a relatively simple unfolding technique, in conjunction with a genetic algorithm (GA). The method differs from most other GA-based circuit-synthesis methods in that the topology of a circuit, the number of its components, and the types and values of its components (e.g., inductances, capacitances, and resistances) are all made to evolve by use of the GA.

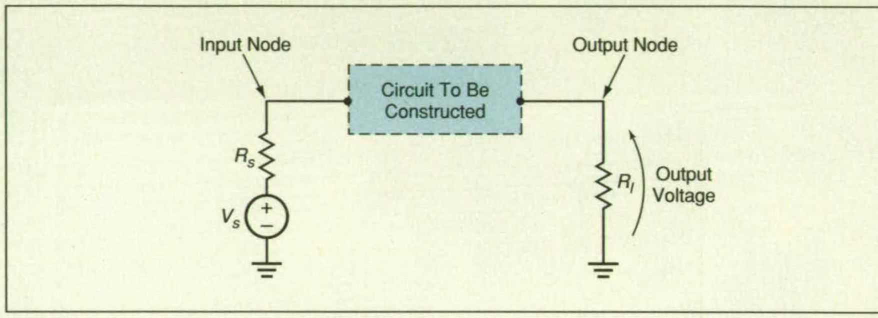


Figure 1. A **Circuit Is Constructed** between fixed input and output terminals. The input source voltage V_s, source resistance R_s, and load resistance R_l are specified in advance.

The linear genome representation is a list of byte codes. The unfolding process is essentially an algorithm in which the byte codes are interpreted to construct a mathematical model of a circuit. In each step of the process, the algorithm starts at one node of the circuit (called the "active node"), proceeds to another node, and connects the two nodes with a component, as instructed by a byte code. The byte code for each component includes (1) an opcode, which specifies the type of component and the identity of the node to which the far end of the component is to be connected, and (2) bytes that specify the value of the component.

The unfolding process begins at a fixed input node and ends at a fixed output node (see Figure 1). In a given step of the process, the far end of a component can be connected to a node that was created previously (e.g., to input, output, or ground), or to a newly created node. When a new node is created, the new node becomes the starting point for the next step. An exception to the unfolding process as described thus far is made for the last component in the list: The last node to be created is connected to the output terminal by a wire. This exception prevents the construction of circuit branches with unconnected ends.

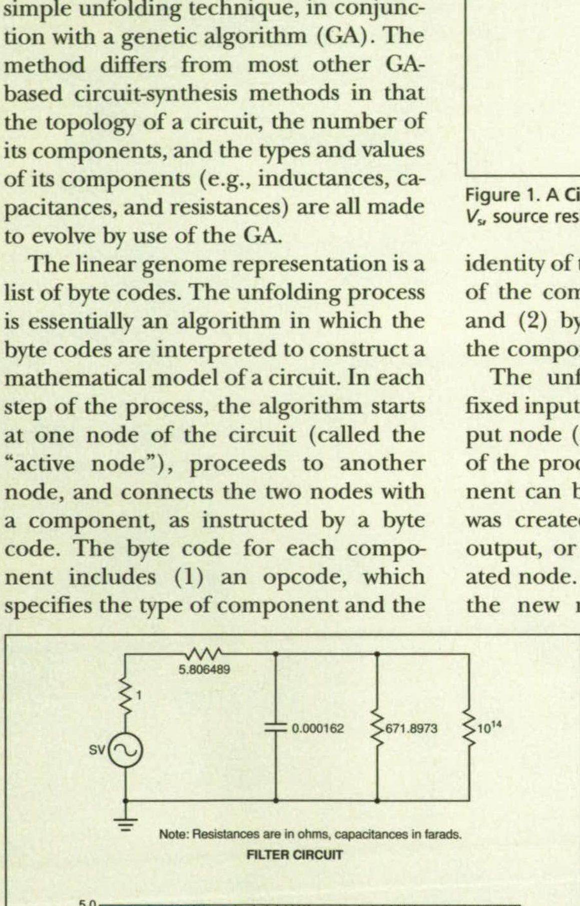


Figure 2. This **Low-Pass Filter** for an electronic stethoscope was synthesized by the method described in the text. The simulated frequency response of the circuit is nearly identical to the target frequency response.

The role of the GA in the synthesis of a circuit is to govern the evolution of both number of byte codes in the list and the specific bytes in each byte code. The GA operates on a population of lists of byte codes, introducing the byte equivalent of mutations. For each member of the population, the unfolding process is carried out, and the electrical performance of the circuit thus synthesized is simulated numerically by the SPICE circuit simulation computer program. The fitness of that member of the population is quantified by a measure of the difference between the desired circuit output and the actual output according to the simulation. For the sake of speed, the GA is implemented in a master/slave parallel-processing scheme in which a controlling computer generates the members of the population and assigns each member to one of a number of other computers that perform the unfolding process, the simulation, and the evaluation of fitness.

At its present state of development, the method excludes some circuit topologies. Nevertheless, it does enable automated synthesis of many practical circuits that have been designed in the traditional way. For example, one practical circuit synthesized by this method is a low-pass filter for an electronic stethoscope (see Figure 2). Further development of the method can be expected to remove some of the topological restrictions. The incorporation of three-terminal devices (e.g., transistors) has produced amplifier circuits recently.

This work was done by Jason D. Lohn and Silvano P. Colombano of **Ames Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

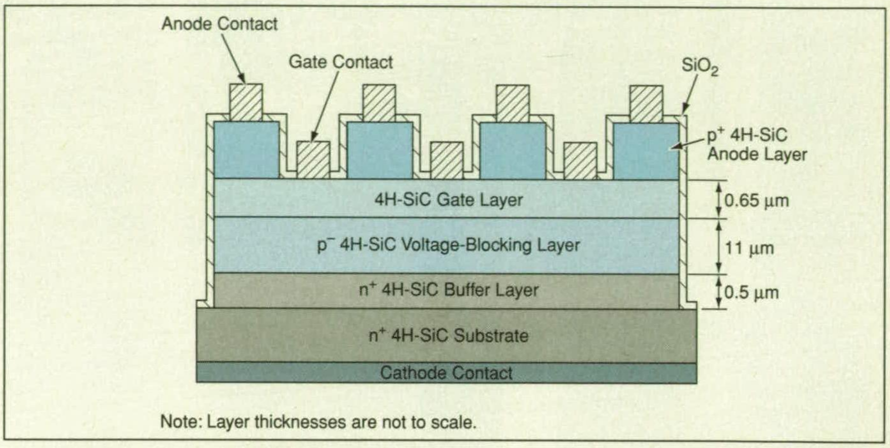
Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Ames Research Center, (650) 604-5104. Refer to ARC-14302.

Silicon Carbide npnp Thyristors

These devices can be operated at temperatures up to 350 °C.

John H. Glenn Research Center, Cleveland, Ohio

Thyristors (semiconductor controlled rectifiers) made from silicon carbide have been fabricated and tested as prototypes of power-switching devices capable of operating at temperatures up to 350 °C. The highest-voltage-rated of these thyristors are capable of blocking current at forward or reverse bias as large as 900 V, and can sustain forward current as large as 2 A with a forward potential drop of –3.9 V. The highest-power-rated of these thyristors (which are also the highest-power-rated SiC thyristors reported thus far) can block current at a forward or reverse bias of 700 V and can sustain an "on" current of 6 A at a forward potential drop of –3.67 V. The highest-current-rated of these thyristors can block current at a forward or reverse bias of 400 V and can sustain an "on" current of 10 A.



This **Cross Section** (not to scale) shows the npnp-layer structure of a representative thyristor of the present type. The n^+-, p^--, n-, and p^+-doped 4H-SiC layers are formed by epitaxy on the n^+ 4H-SiC substrate, which is cut at an angle of 8° off axis.

These thyristors feature epitaxial n- and p-doped layers of 4H SiC in the sequence npnp starting on the substrate; this structure (see figure) stands in contrast to the pnpn structure of common silicon thyristors. The fabrication of the high-quality crystalline structures needed in these layers has been made possible by advances in growth of crystals, epitaxial growth of thin films, doping by both in situ and ion-implantation techniques, oxidation, formation of electrical contacts, and other techniques involved in the fabrication of electronic devices.

The reasons for choosing the npnp structure and for choosing the 4H polytype of SiC (instead of choosing the more common 6H polytype) are the following:

- The npnp structure was adopted to avoid the very high resistances of typical p-doped SiC substrates. In the research that led to the development of the present thyristors, the resistances of p-doped substrates were found to dominate the characteristics of pnpn SiC thyristors.
- It was found in this research that the electron mobilities along the electrical-current paths in 4H-SiC thyristors of the present 4-layer configuration are about 10× those of similar thyristors made from 6H-SiC. Thus, 4H-SiC offers the potential to achieve greater current densities.

It was also found in this research that the defect densities of the 4H-SiC layers (which are formed by epitaxy) are much smaller when substrates cut at large off-axis angles are used. 6H-SiC substrates are typically cut at 3.5° off axis. However, it was found that when 4H-SiC substrates are cut at 3.5° off axis, large numbers of 3C-SiC inclusions are observed in the epilayers. It was found that the 3C-SiC inclusions can be eliminated by growing on 4H-SiC substrates cut at 8° off axis. The highest-power-rated thyristors were found to be achievable only by use of 8°-off-axis-cut 4H-SiC substrates.

Some of these thyristors rated at voltages >400 V and currents >5 A have been characterized at temperatures up to 350 °C. The forward voltage drop at a current of 5 A was found to decrease monotonically from 3.91 V at 27 °C to 3.18 V at 350 °C. The leakage current density at a reverse bias of 400 V was found to increase from about 10^{-6} A/cm^2 at room temperature to 9×10^{-3} A/cm^2 at 350 °C. Even at

350 °C, the ratio between the "on" current and the leakage ("off") current was found to be about 10^5, which should be an acceptable ratio for a power device.

Some of the thyristors were packaged, then stored for 1,000 hours at 350 °C. While many of these thyristors failed, about 25 percent survived the 1,000 hours without significant degradation.

The npnp 4H-SiC thyristors were found be capable of switching at very high speeds. For example, a 600-V, 2-A device was tested to determine its maximum repetition rate for a peak current of 7 A pulsed at a 20-percent duty cycle. It was found that the gate pulse could be repeated after a period of only 4 μs, corresponding to a maximum pulse-repetition frequency of 250 kHz. This speed exceeds the speed of the fastest inverter-grade silicon thyristors.

Two other important parameters for a thyristor are (1) the maximum rate of increase of forward applied voltage that can be applied before the thyristor latches on and (2) the time taken to achieve a high forward current density. The 4H-SiC thyristors tested showed no turn-on even when forward bias was ramped up at a rate of 900 V/μs. Measurements in pulsed operation showed that it took between 3 and 5 nanoseconds for these devices to start carrying currents at densities of 2,800 A/cm^2.

This work was done by John Palmour of Cree Research, Inc., for **Glenn Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Electronic Components and Systems category.*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-16750.

Small Lidar Altimeter Would Operate at Low Light Levels

Relatively high resolution would be achieved without resorting to high power.

Goddard Space Flight Center, Greenbelt, Maryland

A lidar apparatus called a microaltimeter has been proposed for use aboard a spacecraft in orbit around the Earth for mapping land and sea surfaces, including such features of special interest as ice, tree canopies, and flood plains. The microaltimeter is short for "microlaser altimeter" and is so named because it uses a very compact, low-energy, subnanosecond pulse, solid-state microlaser as its source and relatively small (typically 10 to 20 cm in diameter) telescopes, resulting in a factor of 100 reduction in telescope weight and volume, as compared to conventional spaceborne laser altimeters. Operating at thousands of pulses per second, the surface sampling rate is approximately 100 times higher than that of prior spaceborne laser altimeters having the same transmitter power-aperture product.

Many of the design concepts to be embodied in the microaltimeter, and the components to be used to implement the concepts, were derived from an eye-safe satellite laser ranging station called SLR2000. The laser in the microaltimeter would operate at a wavelength of 532 nm, a pulse energy of the order of a millijoule or less, and a pulse-repetition frequency of the order of several kilohertz. The receiver in the microaltimeter would operate in a photon-counting mode, with a mean signal level on the order of one photoelectron per laser pulse. With an ability to measure the times of flight of individual photons and to determine their origin within the receiver field of view through the use of pixellated or imaging detectors, the receiver can provide ranging unambiguous registration of range (and thus height) data with surface locations.

The theoretically predicted performance of the microaltimeter has been tentatively verified in simulations of the operation of the microaltimeter from Earth orbit, performed by use of software developed previously for simulating the operation of the Mars Orbiter Laser Altimeter (MOLA) and the Geoscience Laser Altimeter System (GLAS). In addition to its potential utility for Earth science, the microaltimeter could likely be used to rapidly generate nearly contiguous maps of other planets, moons, comets, and asteroids.

This work was done by John Degnan of **Goddard Space Flight Center**.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Goddard Space Flight Center; (301) 286-7351. Refer to GSC-14098.

Network Wireless Systems Require New Test Equipment Architecture

The latest designs being proposed in the network wireless communications industry are making use of digital IF-based architectures. Modern test equipment must also migrate to this architecture to maintain correlation in simulation testing.

As the designers and builders of network wireless communications systems look to cover the demand for enhanced performance of the base station, a myriad of innovative techniques are being implemented. One hybrid solution is through software-defined code formats that optimize bandwidth utilization in the allocated frequency that is resident in the base station radio. This move toward the software-defined radio for third-generation (3G) wireless products has taxed the capabilities of today's test methods.

New radio designs are implementing digital intermediate frequency (IF) versus the traditional analog complex modulation (IQ) based architectures. These changes force designers to test software-defined radio modules using both digital pattern generation and radio frequency (RF) modulation analysis. The traditional model of injecting base band analog IQ into the module and measuring the RF performance isn't valid anymore. The software-defined radio modules require the multi-carrier, multi-standard signal to be injected into the radio as a digital IF rather than analog IQ.

The advent of highly linear analog-to-digital (A/D) and digital-to-analog (D/A) converters has enabled a new architecture for modern test equipment that matches the software radio evolution. The concept behind the test platform is to provide a mirror image signal scenario for the radio designer that provides for a "real-time" digital baseline to enhance the test process. This is possible due to the highly linear converters that enable the consolidation of numerous functions into one instrument. Using the software-defined radio or digital radio concept as the "baseline" or standard that must be met, the test equipment designer can now build modular, virtual instruments with test equipment grade specifications. Using this concept, a full transmit/receive path for testing the latest wireless standards can be implemented.

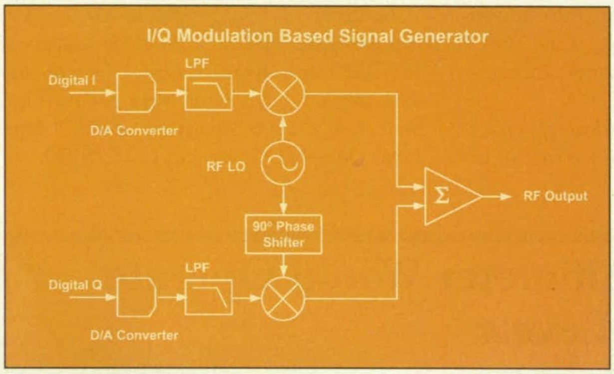


Figure 1

Test System Components

The latest designs being proposed in the network wireless communications industry are making use of digital IF-based architectures. Modern test equipment also must migrate to this architecture to maintain correlation in simulation testing. The legacy test equipment available today typically is implemented using analog modulation techniques, employing IQ modulators. This architecture was sufficient to test the older generation of communication devices.

To implement the software-defined radio as the solution for next-generation deployments, all major components of the base station must be thoroughly characterized in the designer's test lab. To fully meet the designer's expectations at the platform level, these converters are coupled with gigabytes of solid-state memory and broadband RF up-and-down conversion. This provides for real world conditions in the lab and ultimately at production test for both the digital-based radio and major sub-assemblies such as the amplifier, offering true base station simulation.

To further exploit the design options offered by the latest generation converters, the test instrument incorporates a different architecture configured on the "digital radio" test concept. The digital radio concept emulates the process of quadrature modulation with the repeatability, accuracy, and control that only discrete systems can offer. After processing, the digital data stream consists of a real signal at a specified IF center frequency: digital IF. This digital data stream is converted to an analog IF signal by the D/A converter. The resultant signal is a real waveform at the specified IF frequency.

The analog IF signal can be translated to any required frequency through a highly linear, low-distortion up-converter. To implement the receive portion of the digital radio, a similar approach is used. This process would consist of RF down-conversion to a suitable IF frequency, A/D conversion to a digital IF, and signal processing to produce the IQ vectors. The immediate benefit of the digital IF signal generation approach allows for extremely low distortion and nearly immeasurable IQ impairments.

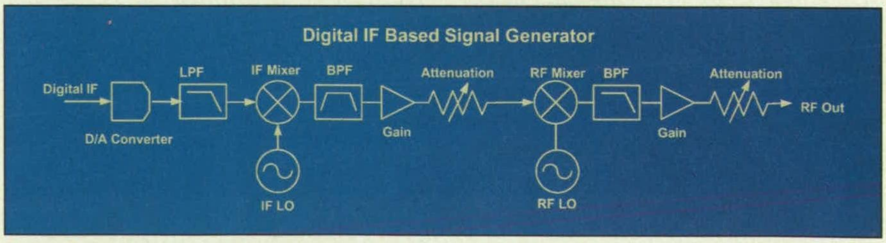


Figure 2

Why Software-Based Parameters Work

The advantage of a modular, digitally based test system that parallels the software-based radio is that it can be applied across the various sub-assemblies or components of the base station, providing complete design continuity. In testing power amplifier linearization, new digital linearization techniques can be tested to prove the latest algorithms.

The advantages and options that begin to emerge from the modular test platform are numerous and quite effective. Using the software-defined radio approach, the equipment can be configured to generate any number of multi-carrier, multi-standard signal scenarios using the vector simulation software. The output of the vector signal generator is used to apply the stimulus to the amplifier. The vector signal analyzer portion of the instrument can acquire, analyze, and automate the performance measurements used to qualify the amplifier. Since all the stimulus/response and analysis occurs within one instrument, there is immediate simplification for the user. Reconfiguring the functionality of this hardware allows receiver tests, interference tests, and additional system-level qualification tests to occur.

Typical testing for power amplifiers utilizes a signal generator based upon an IQ modulator. While this was reasonably efficient for single-carrier generation, addressing the multi-carrier requirements that exist today is much less effective than the modular test system with real-time digital and RF up and down conversion capability. The non-digital, analog-based test sets feature dual D/A converters and analog IQ modulation circuits, waveform memory, and adequate capability for single standard test scenarios. These generators (Figure 1) inherently have the same limitations that have forced base station designers to migrate toward the digital radio concept and, in turn, the digital-based test set.

Using the software-defined radio concept as the architectural basis of a vector signal generator, one can eliminate many shortcomings of today's IQ-based generators. This concept makes use of a single D/A converter and an IF- to-RF up-conversion chain (Figure 2). This mimics the latest base station architectures. The addition of gigabytes of solid-state memory behind the D/A converters permits nearly unlimited flexibility in generating test scenarios. This provides for multi-carrier, multi-standard signal generation and the ability to record and play actual field spectral measurements.

This hardware, coupled with intuitive vector signal simulation software (VSS), gives the test engineer an endless array of multi-carrier, multi-standard spectrums for evaluation. The VSS software suite allows the designer to develop proprietary algorithms and custom modulation schemes independent of the equipment vendor.

The software-defined radio concept allows test equipment designers to use a modular architecture. The modular and software-defined test set, gives the design team key design and test advantages. It offers the option to simulate both transmit and receive paths in a single test instrument, and enables the designers of the radio, digital signal processor, and amplifier to work in parallel rather than in sequence. Finally, the modular test set offers the promise of reducing the capital equipment costs required for communication product design by replacing a number of stand-alone instruments.

For more information, contact the authors of this article, John DeMott, director of wireless products, and Jim Reeves, executive vice president and general manager, at Celerity Systems/L-3 Communications, Cupertino, CA; Tel: 408-873-1001; or visit Celerity Systems at www.csidaq.com.

Test and Measurement

Improved Methods of Testing Cryogenic Insulation Materials

Specimens are easy to fabricate, and thermal performance measurements are repeatable.

John F. Kennedy Space Center, Florida

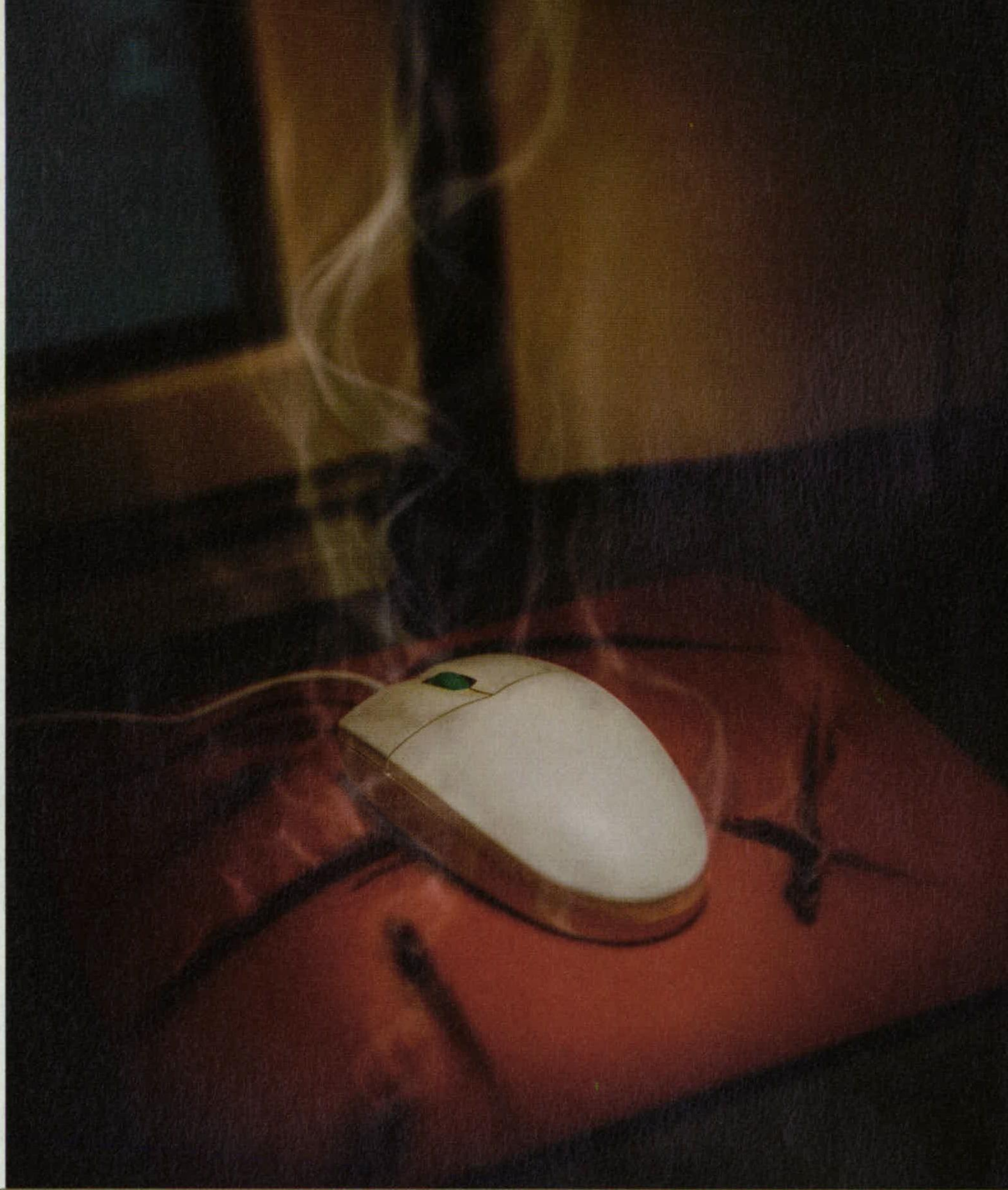
Two improved methods have been developed for testing continuously rolled blankets and blanketlike thermal-insulation materials typically used in cryogenic vacuum systems. Both methods, and their corresponding apparatuses, are based on the cryogen boiloff calorimeter method according to which the amount of heat that passes through an insulation specimen to a cryogenic fluid in a vessel is proportional to the rate of boiloff from that vessel. The boiloff rate is then directly related to the insulating performance of the specimen. The main challenges in the execution of this technique are to (1) eliminate (or minimize) heat leak from the ends by use of thermal guards and (2) obtain stability of the cryogen inside the measurement vessel coincident with stability of the boundary conditions in the vacuum space.

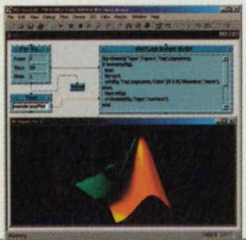
The main problem in testing high-performance materials such as multilayer insulation is the extreme care that must be exercised in their fabrication and installation. Inconsistency in wrapping techniques is the dominant source of error and poses a basic problem in the comparison of such materials. Improper treatment of the ends or seams can render a measurement several times worse than predicted. Localized compression effects, sensor installation, and outgassing are further complications. To eliminate the seam and minimize these other problems, two new methods of fabricating and testing cryogenic insulation systems have been developed.

The first method includes a cryostat test apparatus (Cryostat-1, see Figure 1), which is a liquid nitrogen boiloff calorimeter system for direct measurement of the apparent thermal conductivity at a fixed vacuum level. The cold mass is a 167-mm-diameter, 900-mm-long, vertical stainless-steel cylindrical vessel subdivided into a 10-liter measurement vessel and 2.5-liter thermal-guard vessels at both ends. Continuously rolled materials are installed around a cylindrical copper sleeve using a 1-m-wide wrapping machine. Sensors are placed between layers of the insulation to obtain temperature-thickness profiles. The sleeve is then simply slid onto the vertical cold mass of the cryostat.

Figure 1. **Cryostat-1** for testing thermal-insulation materials is shown with a specimen in place. An extra copper sleeve has been stood alongside for reference.

During operation, all three vessels are kept filled with liquid nitrogen at near saturated condition at ambient pressure (temperature ≈77.8 K). Vacuum levels may be set at any desired pressure from 10^{-5} torr to 760 torr. The temperatures of the cold mass, the sleeve (cold boundary temperature), the insulation outer surface (warm boundary temperature), and the vacuum can (heated by a thermal shroud) are measured. The steady-state measurement of insulation performance is made when all temperatures and the boiloff flow rate are stable. The apparent thermal conductivity value of





the insulation is directly determined from the measured boiloff rate, boundary temperature difference, latent heat of vaporization, and geometry of the test specimen. The measurable heat gain rate for Cryostat-1 is from 0.2 to 20 W.

This method offers the following advantages: (1) enables testing of continuously rolled samples for better accuracy, (2) specimens are representative of most industrial applications, (3) specimens can be easily produced to the desired specifications with an absolute minimum of handing, and (4) specimens can be fabricated off-site.

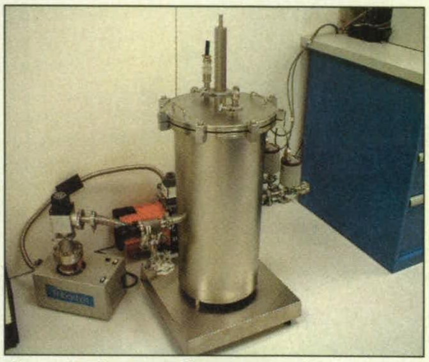


Figure 2. The **Overall Test Setup for Cryostat-2** is shown.

The second method includes a cryostat test apparatus (Cryostat-2, see Figure 2), which is a liquid nitrogen boiloff calorimeter system for calibrated measurement of the apparent thermal conductivity at a fixed vacuum level. The cold mass is a 132-mm-diameter, 267-mm-long stainless-steel vessel thermally guarded by a 132-mm-diameter, 127-mm-long stack of aerogel composite disks at each end. The system features a fully removable cold mass which quickly and easily mounts onto a 0.5-m-wide wrapping machine for installation of insulation material and sensors.

Cooldown and filling of the system are conveniently accomplished through a single port, using a custom ambient-pressure-regulated liquid nitrogen transfer device. Sensors and measurements are similar to those of Cryostat-1. The measurable heat gain rate for Cryostat-2 is from 0.7 to 40 W. The key benefit of this method is that it allows a high rate of testing many different samples with highly repeatable results between runs.

This work was done by James E. Fesmire, Robert A. Breakfield, Dale J. Ceballos, Philip D. Stroda, and James P. Niehoff, Jr., of **Kennedy Space Center** *and Stan D. Augustynowicz of Dynacs Engineering Co. For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Test and Measurement category. KSC-12107/08*

Real-Time Optoelectronic Particle-Fallout Monitors

These instruments would extract quantitative data from images of particles.

John F. Kennedy Space Center, Florida

Optoelectronic instruments for real-time, in situ monitoring of particle fallout are undergoing development. Settings in which these instruments could prove useful include clean rooms for assembly of optical and electronic equipment, food-packaging facilities, and other industrial facilities in which one seeks to prevent contamination of products by airborne dust and fibers.

Heretofore, it has been common practice in particle-fallout monitoring to place initially clean witness plates in the affected work areas, expose them for suitable amounts of time, then take them to laboratories for analysis. Among the disadvantages of this practice are that it does not provide data in real time, and handling of the witness plates can alter the particle samples prior to analysis. Some optoelectronic instruments for real-time and post-exposure analysis of particle fallout have been developed previously, but none has offered the combination of features afforded by the present developmental instruments; namely, real-time operation, imaging of individual particles, and quantitative information on numbers and dimensions of particles.

A typical instrument of this type includes a witness plate mounted above a charge-coupled-device (CCD) or other video camera. The witness plate is illuminated to provide uniform omnidirectional lighting. The camera optics are adjusted to focus on the exposed surface of the witness plate, so that particles that have fallen onto the surface are imaged by the camera. The video output is digitized.

The resulting digital image data is processed by image-analysis software that detects particle edges, maps the particles, counts the particles, and determines principal dimensions and aspect ratios of the particles. The software uses aspect ratios to indicate distinctions between fibers (typical aspect ratios >10:1) and other particles. Instruments of this type can detect and measure particles with dimensions down to somewhat less than 10 μm.

This work was done by Paul A. Mogan of **Kennedy Space Center** *and Christian J. Schwindt and Timothy R. Hodge of I-NET.*

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KSC-11809

Program for Controlling Digital Instrumentation Recorders

John F. Kennedy Space Center, Florida

A computer program enables the simultaneous monitoring and control of two commercial digital instrumentation recorders, each comprising a variable-rate buffer and a data tape recorder. The program can issue all standard tape-motion-related commands (fast forward, rewind, record, forward, reverse, and eject) plus commands for tape search, time code, and buffer settings. The program provides a graphical user interface that facilitates control by the user and displays the operational statuses of the buffers and tape recorders. The program generates a log file that includes a time and date stamp for each control command sent to, and response received from, each buffer and recorder. An option exists in the program to produce tape copies by dubbing from one recorder to the other. The program can also be used to effect a procedure in which data are recorded first on one tape recorder, then the other tape recorder is brought into operation shortly before the end of first tape, so that there is some overlap to ensure continuous recording during a long recording session.

This work was done by Danny B. Sylvester and David M. Welke of The Boeing Company for **Kennedy Space Center**. *KSC-12005*

Program Computes Tone Fan Noise From a Turbofan Engine

TFaNS is a computer program that predicts the tone noise that emanates from the fan stage of a turbofan engine. With the help of this program, engineers working to reduce fan tone noise can study the effects of proposed design changes and are thus more likely to be successful in their efforts.

The interaction of the fan wake with the downstream stator vanes is a significant source of fan noise in a modern turbofan engine. Other fan-noise computer codes predict the rotor/stator tone noise and the noise radiated from the inlet and exhaust sections of fan stage separately. Unlike those codes, TFaNS predicts entire noise field, both inside and outside an engine duct. TFaNS takes account of the effects of reflection and transmission by the rotor and stator and by the duct inlet and nozzle; this is done in addition to the conventional mathematical modeling based on a concept of an annular duct and an isolated stator. In other words, TFaNS couples the results from all such computations that, heretofore, were performed separately, in order to generate a complete fan-stage noise prediction.

TFaNS includes the following modules:

- SOURCE3D estimates the strength of the rotor/stator-interaction tone-noise source.
- INLRAD3D and AFTRAD3D predict the propagation of the tone noise from the source, through the fan-duct termination, to the far field.
- CUP3D couples the results from the aforementioned modules to provide a complete fan-stage noise prediction.
- AWAKEN mediates the input, into the SOURCE3D module, of rotor-wake data that have been obtained through either measurement or else simulation by a computational fluid dynamics (CFD) code.

At present, the range of applicability of TFaNS is limited to subsonic fan-tip speeds.

This program was written by David Topol of United Technologies Corp. and Walter Eversman of the University of Missouri-Rolla for **Glenn Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17063.

Software for Generating 100-by-100-km Images From SAR Data

SAR Processing System Precision Processor (SPS PP) is one of the computer programs used in the Alaska SAR Facility (ASF) [where "SAR" means "synthetic-aperture radar"] to generate image data products. SPS PP ingests data that have been received from the RADARSAT (a Canadian Earth-observation satellite) and decoded into engineering and SAR signal data files, and processes these data into image data products that typically cover areas of about 100 km by 100 km. SPS PP can handle data from RADARSAT standard right- and left-looking beams, and is being enhanced to handle European Remote Sensing Satellite (ERS) and Japanese Earth Resources Satellite (JERS) data. The output of SPS PP conforms to the standards of the Committee on Earth Observing Satellites (CEOS). The left-looking products feature 16-bit detected pixels in slant-range format; the right-looking products can be in either ground-range detected or slant-range complex format. SPS PP resides on five IBM SP-2 computers with 8 processing nodes each. Each computer can produce a 100-by-100-km image frame in about 25 minutes.

This program was written by Homayan Alaei, Michael Jin, Quyen Nguyen, and Shelby Yang of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20710.

Sequencing and Job-Control Software for Processing SAR Data

The SAR Processing System Control Processor (SPS CP) computer program performs sequencing and job-control functions within the Alaska SAR Facility (ASF) [where "SAR" means "synthetic-aperture radar"]. SPS CP interacts with the Product-Distribution-and-Management (PDM) system of the ASF to receive processing orders as well as engineering and raw signal data. SPS CP provides a graphical user interface for operator control and

performs job-sequencing functions to orchestrate the Raw Data Scanners (RDS) and SAR processors of the ASF to produce image data products. It is capable of displaying images to support visual data-product-quality checks. It is capable of recovering from errors caused by various abnormal processing events. The interfaces between SPS CP and the raw-data scanners and SAR processors are based on a client-server model with sockets and multithreading. SPS CP is hosted on SGI Origin or Challenge computers; the interfaces with raw data scanners and SAR processors are hosted on SGI Challenge, DEC Alpha, IBM SP-2, and Compaq computers. This program has been supporting ASF operations for over five years and its capabilities have been continuously enhanced to enable both large and small scientific-processing campaigns that have included mapping of the Amazon rain forest, the Antarctic Mapping Mission, and the Arctic Snapshot Mission.

This program was written by Eugene Chu, Daniel Fineman, Pearl Haw, John Ho, Nancy Perry, Cris Sandoval, and Joanne Shimada of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20713.

Software for Processing RADARSAT ScanSAR Data Into Images

SAR Processing System ScanSAR Processor (SPS SSP) is a computer program that is used in the Alaska SAR Facility (ASF) to processes scanSAR downlink data from the RADARSAT (a Canadian Earth-observation satellite) into a suite of image data products. ["SAR" means "synthetic-aperture radar" and "scanSAR" means "scan-mode SAR."] SPS SSP can process data that have been generated in any of the four RADARSAT scanSAR modes in current use — two wide-swath modes (300 ≤ width ≤500 km) called "SWA" and "SWB" and two narrow-swath modes (width ≈300 km) called "SNA" and "SNB." The output images are projected in ground range or else geocoded in universal transverse Mercator, polar stereographic, or Lambert coordinates. At present, the only image data products that are calibrated are those of the SWB mode. Typically, an SWB image covers an area of about 500 by 500 km. SPS SSP is executed on an IBM PS-2 computer, which includes (1) a control workstation equipped with 128MB of random-access memory (RAM) and a 4GB hard disk and (2) as many as eight processing nodes, each equipped with 256MB of RAM and a 4GB hard disk. When all eight nodes are used, a typical SWB image frame can be computed in about 35 minutes.

This program was written by Michael Jin, Quyen Nguyen, Jeff Schredder, and Wayne Tung of Caltech for **NASA's Jet Propulsion Laboratory**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20712.

Software for Wafer-Level Testing of Microfabricated Devices

Prober Assistant Measurement System (PAMS) is a computer program that automates the time-consuming process of testing microfabricated devices (integrated circuits and/or microelectromechanical systems) at the wafer level. PAMS was written specifically for use with the Karl Suss probe station (a commercially available wafer-testing apparatus) and is compatible with associated testing circuitry that conforms to the IEEE 488 general-purpose interface bus (GPIB) standard. Manual wafer testing is tedious and susceptible to error because the process involves controlling the probe station to position the probe leads on each device, configuring the associated testing equipment, and recording the measurement data. In contrast, PAMS automatically positions the probe leads according to a wafer map and automatically performs the measurement and recording steps. Multiple devices on a wafer can be tested simultaneously, or multiple measurements can be made on a single device. Acquired data can be displayed on a screen and/or recorded in a file. At present, PAMS is executed on a computer based on a Pentium II processor with a clock rate of 400 MHz, 128MB of random-access memory, and 6GB of hard-disk storage, and running the Windows NT operating system.

This program was written by Christopher Evans of Caltech for **NASA's Jet Propulsion Laboratory.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Software category.*

This software is available for commercial licensing. Please contact Don Hart of the California Institute of Technology at (818) 393-3425. Refer to NPO-20850.

Information Sciences

Digital Library of NACA Reports

Aging paper NACA documents are scanned, then disseminated in electronic form.

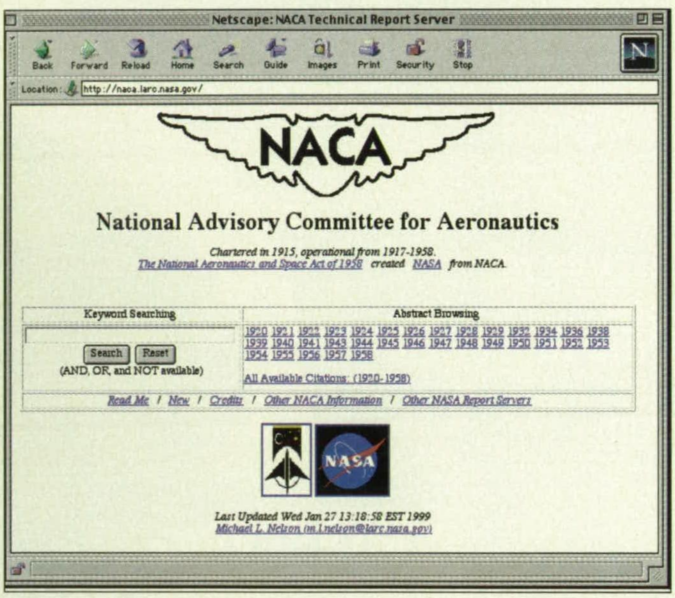
Langley Research Center, Hampton, Virginia

The NACA Technical Report Server (NACATRS) is both a node in the NASA Technical Report Server and a standalone World Wide Web (WWW) site. The NACATRS is dedicated to the preservation and dissemination of reports produced by the National Advisory Committee for Aeronautics (NACA).

NACA, which evolved into the predecessor to NASA, existed from 1915 until 1958. The main product of NACA's research is a multi-tiered series of reports, the number of which is estimated to be between 20,000 and 30,000. These reports — especially the ones that address issues of general aviation and the fundamentals of flight — remain in high demand. Although significant collections of NACA documents exist at a handful of NASA centers, universities, and government and industrial research laboratories, no single library contains a complete collection. Furthermore, because of their age, high circulation, and acid-based paper, many of these reports are in poor condition and will cease to be serviceable in the near future. Conversion to digital form is necessary for preservation and for wider dissemination.

At present, the NACATRS collection contains about 2,300 documents, and is growing at a rate of about 30 documents per week. Each NACA document is electronically scanned, generating image data in Tagged Image/Interchange File Format (TIFF). Optical Character Recognition (OCR) is not performed, primarily because NACA publications contain numerous pages of equations, tables, charts, and figures, none of which are well suited for OCR. Instead, the document is converted into a combination of Graphics Interchange Format (GIF) and Portable Document Format (PDF) files for easier dissemination via the WWW.

The NACATRS offers browsing and keyword searching of its holdings (see figure). Reports are also accessible via the following naming convention: http://naca.larc.nasa.gov/reports/YEAR/naca-REPORTTYPE-NUMBER. For example, the popular NACA Report 1135 is available at http://naca.larc.nasa.gov/reports/1953/naca-report-1135/. Once a report has been retrieved, it is initially presented in the form of thumbnail images of pages. Clicking on a thumbnail image results in presentation of a large GIF version of the image for easy on-line viewing. As many as ten thumbnail images can be shown at a time, with such options as "next," "previous," "first," and "last" for switching among pages of a large report. Similar options are available for viewing single GIF page images. The user can download the entire report as a single PDF file.



The **Home Page of the NACATRS** provides access for browsing and keyword searching of NACA reports.

This program was written by Michael L. Nelson of **Langley Research Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Information Sciences category. L-17844*

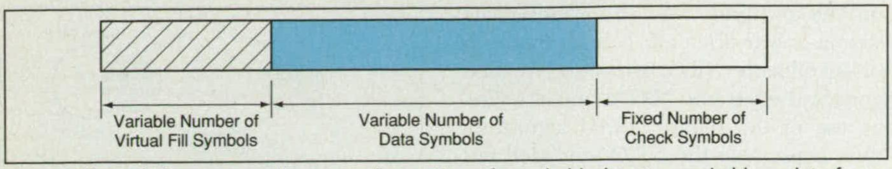
RS Forward Error Correction for Variable-Length Frames

Method accommodates dynamically varying frame length.

Goddard Space Flight Center, Greenbelt, Maryland

A method of forward error correction by Reed-Solomon (RS) coding has been devised to increase the link margins of data-communication systems that must handle variable-length frames or packets of data. Heretofore, RS coding has involved fixed-length blocks: In order to encode variable-length frames, it has been necessary to (a) choose a fixed block length equal to a multiple of some given block length and greater than or equal to the length of the longest variable-length frame and (b) in the case of a frame shorter than the fixed block length, pad or fill the remainder of the block with extra bytes. This is very inefficient because the fill conveys no useful information, and any errors in the fill diminish the overall coding gain by using up some or all of the available error-correction capacity.

The present method accommodates dynamically varying frame length by use of equations that relate the frame length to a quantity known as the virtual-fill parameter. The concept of virtual fill (see figure) is not new; what is



Virtual Fill Symbols conceptually occupy the portion of a code block not occupied by a data frame shorter than the longest allowable frame. Unlike pad or real fill symbols in the traditional approach, virtual fill symbols are not transmitted. In the present method, the number of virtual fill symbols is varied dynamically to compensate for variable frame length.

new here is the way in which virtual fill is used. In the traditional fixed-length-block approach, all of the code parameters, including the virtual-fill parameter and the frame length, are set in advance or initialized at startup time and are not changed during the encoding/decoding process. In the present method, the virtual-fill parameter and the frame length are allowed to vary while the other parameters are held constant.

Let

$m \equiv$ the number of bits per symbol

$n \equiv 2^{m-1}$ total number of symbols per code block

$t \equiv$ number of correctable errors

$VF \equiv$ number of virtual fill symbols (≥ 0)

$I \equiv$ interleaving parameter (≥ 1)

$FL \equiv$ total frame length [number of data + parity (check) symbols]

$FSPL \equiv$ frame-synchronization-pattern length

$DFL \equiv$ length of (number of symbols in) the data field in a code block

$CBL \equiv$ number of data plus parity (check) symbols in a code block.

Then the basic equations for the RS code parameters are the following:

(1) $FL = FSPL + (n - 2t - VF)I + 2tI$,

(2) $DFL = n - 2t - VF$, and

(3) $CBL = n - VF$.

Straightforward algebraic manipulation of the foregoing equations yields:

(4) $DFL = (FL - FSPL)/I - 2t$ and

(5) $VF = n - (FL - FSPL)/I$.

Equation 4 is used in the RS encoder because DFL is a parameter of the encoding algorithm. Equation 5 is used to dynamically obtain the virtual fill length for a given frame based on its length. In both the encoder and decoder, the limit check on valid frame length is given by

(6) $FSPL + 2tI \leq FL \leq FSPL + nI$.

These equations can readily be incorporated into a software implementation and conceivably also into a hardware implementation of the RS encoder and decoder, provided that the encoder and decoder can each act individually to determine the length of the current frame.

Even in a system in which data are generated in fixed-length frames, it could be advantageous to dynamically vary FL, in response to the bit-error rate, to optimize the forward-error-correction capability. In general, the number of check symbols per code block and the coding gain increase as FL decreases. The disadvantage of this method is that proportions of overhead are greater for smaller packets.

This work was done by Steve Duran of **Goddard Space Flight Center**. *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Information Sciences category.*
GSC-13916

Fast NRZLM Encoding and Decoding Algorithm

Byte-oriented algorithms save time.

Goddard Space Flight Center, Greenbelt, Maryland

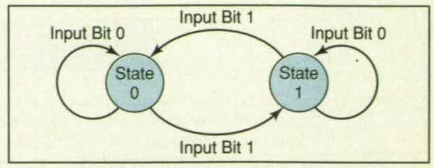
A recently developed algorithm saves encoding and decoding time in the operation of data-communication systems that utilize the NRZM code, which is derived from the better-known non-return-to-zero-level (NRZL) code. This algorithm utilizes lookup tables that contain the results of routine encoding and decoding computations that would otherwise have to be performed repeatedly.

A stream of symbols in NRZM code is generated from an input stream of symbols in NRZL code. The NRZM code was originally developed as a means to convert a steady, high-level signal (a long sequence of 1111...111) into a variable signal (1010....10 or 0101.....01, depending on the choice of 0 or 1 for the initial state of the coding algorithm). The NRZM code provides signal-level transitions in an idle state when there is time for synchronization of encoding and decoding equipment.

An explanation of the nomenclature of algorithms for NRZM encoding and decoding is prerequisite to an explanation of the present innovative algorithm. In general, algorithms that transform streams of symbols between NRZL and NRZM codes are denoted collectively as "NRZLM" algorithms. Of these, subalgorithms that transform NRZL input streams into NRZM output streams are called "NRZM" algorithms, while subalgorithms that transform NRZM input streams into NRZL output streams are called "NRZL" algorithms.

Before the present innovative NRZM algorithm was developed, transformations between NRZL and NRZM were effected by the Binary NRZLM algorithm, which is bit-oriented; that is, it operates on only one bit at a time. Even if an NRZL data source is byte-oriented, it is necessary to disassemble the NRZL bytes into bits, then encode the bits into NRZM one at a time by use of the Binary NRZM algorithm, then reassemble the NRZM-encoded bits into bytes. Similar considerations apply to use of the Binary NRZL algorithm to decode from NRZM back to NRZL.

The NRZM code and the Binary NRZM algorithm can be explained in terms of a finite-state automaton that can be in either of two states; 0 or 1 (see figure). These states correspond to output bits. If the automaton is in either state and receives an input bit 0, it re-



A Two-State Automaton that makes transitions in response to an input bit of 1 implements the NRZM code and the Binary NRZM algorithm.

mains in that state. If the automaton is in either state and receives an input bit of 1, it changes to the other state. Thus, the output bit for a given input bit depends on the state of the decoder after receipt of the immediately preceding input bit; this state is called the "last state." The last state depends on the chosen initial state and on the sequence of input bits up through the immediately preceding bit.

Thus, in the Binary NRZM algorithm, it is necessary to go bit-by-bit through the entire sequence of preceding NRZL input bits to arrive at the output NRZM bit for a given input NRZL bit. Similarly, in the Binary NRZL algorithm, it is necessary to go bit-by-bit through the entire sequence of preceding NRZM input bits to arrive at the NRZL output bit for a given input NRZM bit.

The present innovative NRZLM algorithm is byte-oriented. It exploits the following observation: One can commence coding or decoding from any point in a sequence of input bits, without having to step through the entire sequence of preceding input bits, provided that one has some other way of knowing the last state immediately preceding that point. Thus, if bits in an input sequence are grouped into bytes, one can start to encode or decode at the beginning of any byte, provided that one knows the last state produced by the preceding byte or bytes.

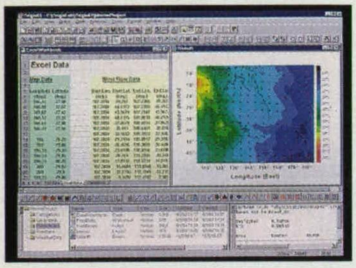
In formulating this byte-oriented NRZLM algorithm, the results of coding and decoding operations are precomputed by the Binary NRZM and Binary NRZL algorithms and stored in lookup tables; these tables contain the output bytes and last states for all possible input bytes and preceding last states. Thus, instead of a long sequence of operations on individual bits, the encoding and decoding of each input byte involves only initialization by use of the last state from the preceding byte, followed by a table-lookup operation to find the output byte and another table-lookup operation to find the new last state.

This work was done by Semion Kizhner and Timothy Ray of **Goddard Space Flight Center.** *For further information, access the Technical Support Package (TSP)* ***free on-line at www.nasatech.com*** *under the Information Sciences category.*
GSC-13825

New on DISK

Visualization Software

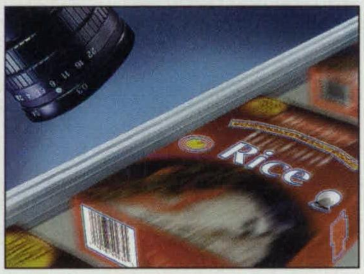
Computational Engineering Intl., Morrisville, NC, has introduced EnLiten and EnVideo, two products that enable use of the Internet and corporate intranets to share visualizations throughout an enterprise. EnLiten is a platform-independent geometry player that allows interactive collaboration and communication of visualizations in areas such as computational fluid dynamics, finite element analysis, and aerodynamics. Users can manipulate 3D models, view models, and run 3D animations. EnVideo allows viewing videos of high-end visualizations over the Internet or intranet. **Circle No. 720**



Graphing and Data Analysis

Origin® version 6.1 scientific graphing and data analysis software from OriginLab Corp., Northampton, MA, includes new data handling features such as raster image export and import, and the ability to use ODBC to query data from a database. Graphing capabilities include improved graphics export, a new EPS export, and the ability to print large graphs to multiple pages. Users can query databases, export graphs, and share custom analysis and graphing tools with other users. Other features include the ability to open and run Excel with Origin, and a color-coded LabTalk script editor. **Circle No. 721**

Machine Vision Tool



PPT Vision, Minneapolis, MN, offers the Package Tool, a machine vision software tool for use in automated package inspection. The software is used for inspecting the integrity, seal, label position, text, colors, and graphics on containers, cartons, wrappers, and other packages. The program can inspect thousands of parts per minute and features multiple templates within the same region of interest. Users can program up to eight independent inspection tasks, performed on every image capture, with a single tool. An optional hardware accelerator board enables the system to compensate for variations in lighting. **Circle No. 722**

Scientific Graphing

SYSTAT 10 scientific software from SPSS, Chicago, IL, includes new statistics capabilities and user interface enhancements. A Mixed Regression feature allows users to fit regression models in nested, two-level data to fit unbalanced repeated measures data. Power Analysis enables exploration of the relationship between sample size and statistical power, and allows creation of simultaneous displays of power curves and tabular data. New options include the ability to submit command files from the Windows clipboard, file list, or command log, as well as increased user control over dialog boxes and temporary data sets. **Circle No. 723**

New on the MARKET

Electrical Connectors

Harting of North America, Elgin, IL, offers the Han-Modular® connector series that includes 13 different modules. The connectors are available with standard hoods and housings, as well as Han-Easy Lock® levers. Modules are available for electric and fiber-optic signaling, in high and low power, and with network signals and a 24V power supply or pneumatics and electrical signals. Male and female pins can be combined in the same connector side. A high module collar protects the contacts against mechanical damage. **Circle No. 743**

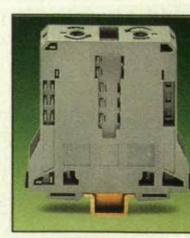
Data Acquisition Boards

IOtech, Cleveland, OH, offers the DaqBoard/2000™ series of five PCI boards for multifunction data acquisition. They can be used individually or in a combination of up to four boards per PC for channel expansion up to 1,000 analog input channels and 800 digital I/O signals. Features include PCI-bus plug-and-play configuration, digital calibration, PCI-bus mastering, and synchronous scanning of all analog, digital, and counter inputs. They feature a 16-bit, 200-kHz A/D converter and 16 single-ended or 8 differential analog inputs. The boards share an industry-standard connector, and are supported by a common family of cables and signal terminations. **Circle No. 725**

Vector Modulator

The 2029 vector modulator from IFR Systems, Wichita, KS, turns any analog RF signal generator into a digital signal generator. It is designed for testing digital wireless products, and can test 2G, 2.5G, and 3G wireless formats with a frequency range from 800 MHz to 2.51 GHz. The unit combines a vector modulator, arbitrary waveform generator, and an RF level-control system. It uses an external analog signal generator as a fixed-level unmodulated source to provide the RF input signal. An RF combiner is supplied as an option so that measuring devices such as power meters and spectrum analyzers can be connected. **Circle No. 726**

Power Clamps



WAGO Corp., Germantown, WI, has released the Series 285 power clamp that uses spiral spring technology to connect conductors from 4 AWG to 3/0. It has a current rating of 232 amps with a rated voltage of 1000V. An 8-mm T-wrench is used to actuate the spiral spring. After actuation, the spring is locked in place by a locking tab. The clamp is available in a grounding version designed to withstand more than 11 kA of short-circuit current. Continuity can be tested via a test probe. **Circle No. 727**

Machined Springs

Helical Products, Santa Maria, CA, offers machined springs that combine the elastic properties of materials such as steel, aluminum, and titanium, with a curved beam helix. The springs provide high deflection rates for compression, extension, torsion, lateral bending, and lateral translation spring functions. **Circle No. 728**

New LITERATURE

Self-Clinching Fasteners

Penn Engineering & Manufacturing Corp., Danboro, PA, offers a six-page brochure on PEM® R'ANGLE® self-clinching right-angle fasteners, which provide a right-angle attachment point in metal sheets as thin as 0.040". Type RAA™ aluminum fasteners and Type RAS™ steel threaded fasteners are featured. **Circle No. 700**

Silicone Materials

A 12-page brochure describing silicone materials is available from NuSil Technology, Carpinteria, CA. Standard product lines include dispersions, gels, adhesives, sealants, coatings, resins, fluids, fluorosilicones, conductive elastomers, and liquid silicone rubbers. More than 400 silicone formulations are available. **Circle No. 701**

Custom Molded Plastics

Niagara Plastics, Erie, PA, offers an eight-page brochure on custom molded plastic and vinyl-dip capabilities, including mold-filling analysis, concept visualization, computer-aided product design, prototyping, in-house tool design, and CNC machining. Materials include polyethylene, polypropylene, polystyrene, nylon, and vinyl. **Circle No. 702**

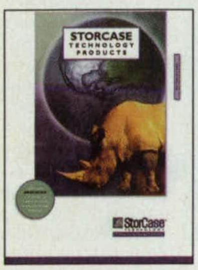
Pressure/Temperature Instruments

Product Catalog 500 from WIKA Instrument Corp., Lawrenceville, GA, features 360 pages of pressure and temperature instruments such as pressure gauges, switches, chemical seals, transducers, transmitters, and thermometers. Also available are mechanical and electronic pressure instruments and diaphragm seals. **Circle No. 703**

Cooling and Conveying

EXAIR Corp., Cincinnati, OH, offers an 84-page catalog of products for industrial blowoff, cooling, conveying, drying, cleaning, and static electricity control. New compressed air products for conveying are featured, as well as the Super Air Knife for part blowoff and drying, and the Adjustable Spot Cooler for cooling metal and plastic parts. **Circle No. 704**

Data Storage



A 56-page catalog from StorCase Technology, Fountain Valley, CA, describes data storage chassis and enclosure products. Included are the RhinoJR fixed and removable storage enclosures, Data Stacker stackable expansion chassis, Data Express removable drive enclosures, and Data Silo expansion chassis. Also featured is the InfoStation rack-mount or tower chassis that houses up to nine SCSI drives. **Circle No. 705**

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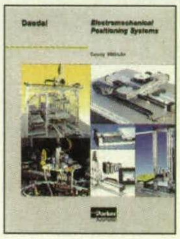

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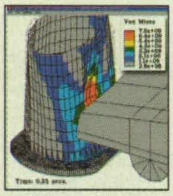

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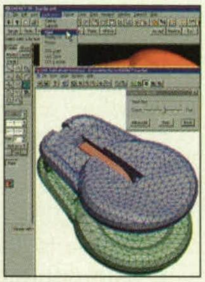

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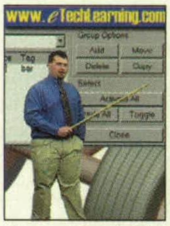

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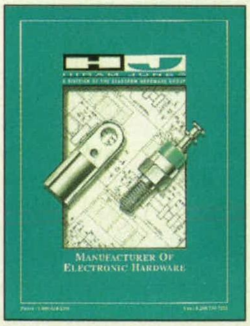

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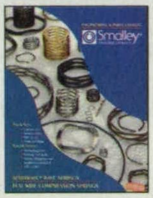

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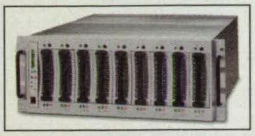

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METRIC AIR SPRING MANUAL FROM FIRESTONE

Firestone Industrial Products has revised its *Metric Engineering Manual and Design Guide* for Airmount® isolators and Airstroke® actuators. The manual provides complete spring specifications in metric dimensions, including height, force, and static data. Airstroke actuators are a low-cost equivalent to conventional pneumatic and hydraulic cylinders; Airmount isolators feature a compact installed height and unsurpassed isolation capability. Firestone Industrial Products Co., 12650 Hamilton Crossing Blvd., Carmel, IN 46032; www.firestoneindustrial.com

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

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Rolls-Royce Uses Design Software to Improve Engine Building Process

Engineers at Rolls-Royce, known for making quality automobiles, are also some of the world's leading aerospace engine designers. Rolls-Royce provides engines and power systems for more than 300 airlines, as well as defense, marine, and energy markets worldwide. Recently, a team of Rolls-Royce designers began using iSIGHT design/analysis software in their design process. Created by Engineous Software of Morrisville, NC, iSIGHT allows the team to examine a large number of design scenarios during the product process, reducing the amount of time it takes to put products out on the market.

www.rapidproducts.net/Dec00/isight1200.html

Accurate Checking Fixtures Made with Seamless Epoxy Paste

In order for MSX International to quickly produce accurate inner checking fixtures for a leading truck manufacturer, the company turned to a special epoxy modeling paste made by Vantico (formerly Ciba Specialty Chemicals). Vantico created the Ren XD 4569-1 R/H epoxy in order to help companies build more dependable fixtures. According to MSX, fabricating fixtures from fiberglass and epoxy was a labor-intensive process that required extensive spotting during assembly of the inner and outer sections of the tool. With the Ren seamless epoxy, MSX now produces both fixture sides on the support structure to save time — the new epoxy has reduced production time by 25 percent.

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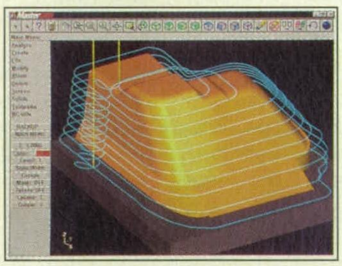

Mastercam Version 8 Offers High-Speed CAD/CAM Tools

As high-speed machining becomes more and more popular, creating faster toolpaths and superior workpieces is of growing importance. Mastercam Version 8 CAM software from CNC Software offers brand new CAD/CAM tools for designers to create simple and complex components, while establishing a faster turnaround time. It's also equipped with built-in translators for CADL, STL, ASCII, and more.

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New Product Highlights

According to Stratasys, the Maxum model-developing machine is 50 percent faster than anything the company has ever built. Stratasys' newest machine is equipped with a soluble-support feature called WaterWorks, which virtually eliminates post-processing time by dissolving model supports. Drag and drop software for CAD files, remote notification features, and a Windows NT operating system are just some of the additional features included in the Maxum.

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