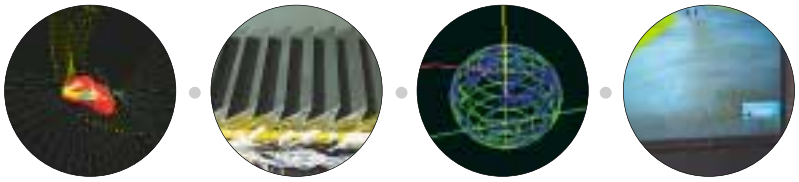
1999

NASA's Goddard Space Flight Center



TECHNOLOGY TRANSFER REPORT

1999

NASA's Goddard Space Flight Center

TECHNOLOGY TRANSFER REPORT

Since its inception, Goddard has pursued a commitment to technology transfer and commercialization. For every space technology developed, Goddard strives to identify secondary applications. Goddard then provides the technologies, as well as NASA expertise and facilities, to U.S. companies, universities, and government agencies. These efforts are based in Goddard's Technology Commercialization Office.

This report presents new technologies, commercialization success stories, and other Technology Commercialization Office activities in 1999.

a Technology Commercialization Office publication

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Technology Commercialization at NASA's Goddard Space Flight Center

NASA's Goddard Space Flight Center's challenging and technologically demanding Earth Science and Space Science missions generate a wealth of advanced technology. Goddard's technology, expertise, and facilities are a national asset that can be used to develop new products and processes that benefit the United States. These benefits include increasing the nation's competitiveness, creating jobs, improving the balance of trade, and enriching the lives of the citizenry.

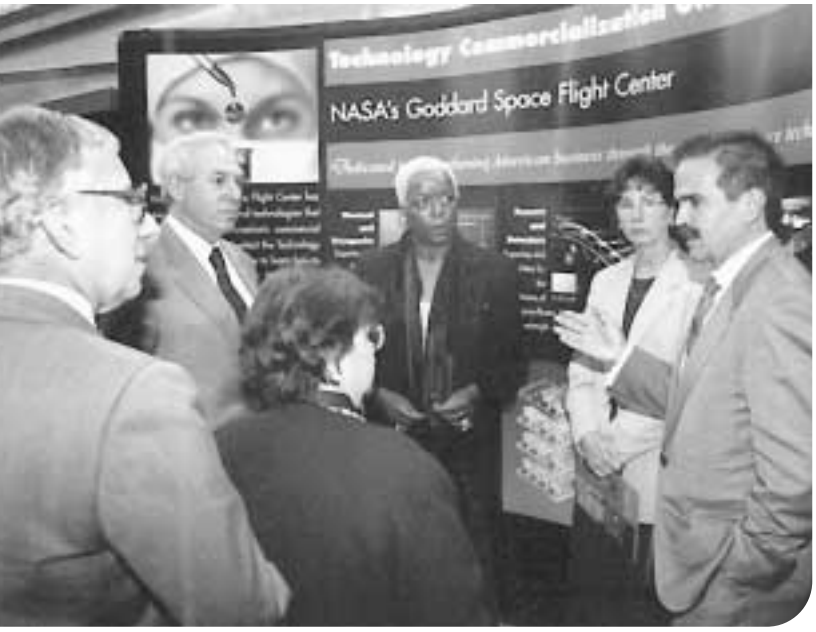
Goddard's Technology Commercialization Office seeks out Goddard research and development that has the potential of being successfully transferred to meet industry and national needs. Then, using its technical, legal, business, and marketing expertise, the office works with researchers and industry to transfer these technologies to the marketplace.

Identifying a Technology

Each year, scientists and engineers working at Goddard develop dozens of advanced technologies that may have the potential for successful transfer to a variety of industries. The Technology Commercialization Office encourages researchers to identify these technologies for possible transfer through its inreach program, which includes ongoing consultation with technical researchers, employee development programs, colloquia, and recognition programs. Once identified, the technologies become part of an inventory maintained by the Technology Commercialization Office. Pages 26–29 list the inventory of technologies reported by scientists and engineers in 1999.

Assessing Commercial Viability

Once a new technology is reported, the Technology Commercialization Office undertakes a technical, business, and legal assessment to determine its commercial potential. This assessment involves identifying possible applications and markets, considering cost and pricing information, and estimating market size and trends. The technologies described in this report received a full assessment and were determined to have commercial viability.



Building Commercial Interest

Once a technology is determined to have commercial potential, the Technology Commercialization Office undertakes a variety of outreach efforts to communicate its availability and possible applications. These outreach efforts include one-page descriptions highlighting technologies available for commercial transfer. The office also hosts and attends commercialization workshops and trade conferences, where staff demonstrate available technologies and build interest among industry and entrepreneurs. (See page 32–33.)

Small Business Outreach

Extra efforts to involve smaller businesses include Goddard's Small Business Incubator program. This program nurtures start-up enterprises that are undertaking efforts to commercialize NASA technologies. Under the incubator program, businesses receive a variety of benefits, including low-cost office space, planning assistance, and legal and financial advice. For more information on the incubator program, call (301) 286-9655 or (301) 286-5810.

In 1999, Goddard's Technology Commercialization Office launched the Technology into the Zone initiative. This initiative strives to revitalize economically distressed communities—designated as empowerment zones (EZ) and enterprise communities (EC)—by providing EZ/EC businesses greater access to NASA's technology commercialization network. Goddard offers specialized training on how to capitalize on NASA technology, encourages development of existing and future EZ/EC businesses, and facilitates partnerships between these businesses and academia. For more information on the Technology into the Zone initiative, call (301) 286-3901.

Selecting a Partner

The Technology Commercialization Office has devised a series of steps to ensure a fair and equitable process for selecting commercial partners for its technology. After receiving information through Goddard's various outreach efforts, prospective partners prepare and submit proposed commercialization plans. The Technology Commercialization Office reviews the submissions, selects the best proposal(s), and negotiates patent or copyright licenses and/or Space Act Agreements as appropriate. These agreements undergo legal review by general and patent counsel prior to being finalized. More information on these agreements is provided in the office's publication *Working with NASA's Goddard Space Flight Center: The Technology Commercialization Process*. For more information on how to be included in the company selection process, contact the Technology Commercialization Office.

Success

Through their partnerships with Goddard, U.S. companies are improving existing products, developing new products and markets, and saving time and money with improved processes. In turn, Goddard benefits through royalties and partnerships. All of this aids the U.S. economy through job creation and helps to improve the nation's quality of life.

1999 Technology Opportunities and Successes

Goddard's scientific and technical staff are continually developing technologies to achieve space mission goals. These technologies may offer benefits outside the aerospace industry. The technologies summarized here have been determined to have commercial potential, and some already have achieved commercial success.

ENVIRONMENTAL SYSTEMS

For more information on these technologies, call the
Technology Commercialization Office's contact for environmental systems at (301) 286-1098.

High-Performance Earth Data Exploration

Goddard has devised a new visualization system for displaying Earth-related information.

Goddard's Digital Earth Workbench is an interactive system that allows users to retrieve, view, and compare large amounts of Earth-related information. For scientists, it is a tool to identify the intricate correlations among the various geological, biological, climatic, and civilization forces that affect the Earth. For others, such as museums or the public, it is a tool for teaching about and exploring the Earth.

The system offers an interactive computer program that allows users to easily navigate the globe to view satellite imagery and topography of any location on Earth. The user can add "layers" of imagery and control how these layers blend together. Three-dimensional objects also can be imported and displayed. Extremely large images are supported, and the system can retrieve information stored at remote sites using standard protocols, such as http and ftp.

The system supports a head-tracked stereo and six degree-of-freedom interaction device (i.e., virtual reality) as well as a traditional monitor and mouse interface. The virtual reality interface is particularly easy to use, with navigation of the digital Earth and imagery data readily accomplished with intuitive hand movements.

The technology can be used in applications ranging from scientific investigation to agricultural and city planning to vacation planning. Companies interested in participating in the commercialization of this technology are encouraged to contact Goddard.

Teleradiology Systems Technologies

Goddard has a variety of technologies that may prove useful to companies developing teleradiology systems.

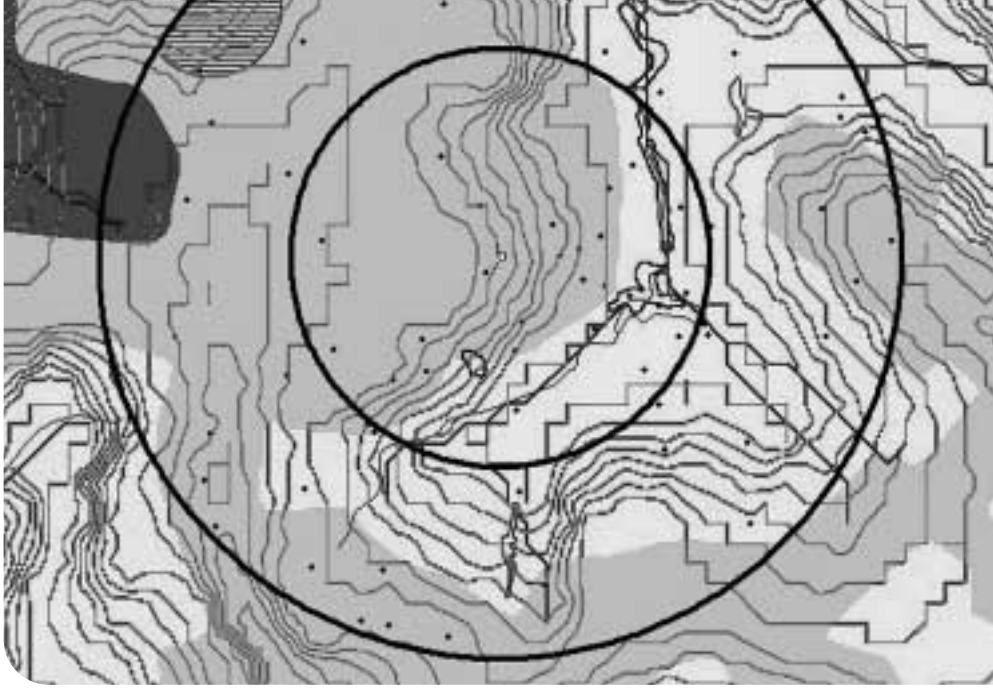
Goddard is applying several developed and emerging technologies related to digital image archiving and communications. Relevant technologies include data compression algorithms, data communications hardware, and satellite transceiver systems to handle terabytes of image data generated by the Earth Observing System. Some of these technologies may offer the opportunity to advance image communications architectures for digital medical images.

The technologies that may be of greatest interest to commercial developers of teleradiology systems include the following:

- ***High data rate parallel digital receiver and demodulator***—This small, low-cost receiver that can operate in a desktop computer is capable of processing data faster than 600 megabits per second (Mbps).
- ***RM subcode Viterbi decoder***—NASA and the National Science Foundation are funding research to develop a Viterbi decoder that operates at 600 Mbps.
- ***Reconfigurable data path processor***—This technology offers real-time, high-speed processing of algorithms and can be configured to perform any specific image processing function.

Goddard researchers envision developing systems with data processing rates of up to 2 gigabits per second at a lower cost than existing technologies. As Goddard further develops these technologies for its own uses, commercial partners are invited to assist in simultaneously developing the technologies for commercial applications.

Technologies for Digital Aerial Observation

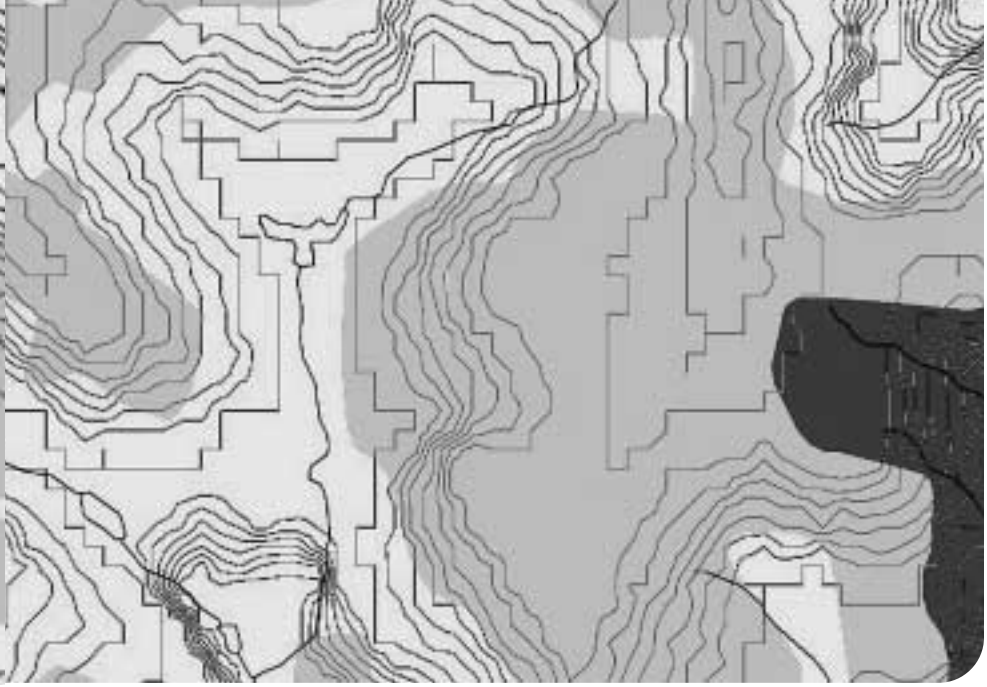


This series of technologies has the potential to dramatically advance the process of terrain mapping.

Goddard researchers are developing several technologies that improve the acquisition and processing of digital images of the Earth's surface. Each of these technologies may have commercial mapping applications. Companies are invited to consider partnering with Goddard to transfer these innovations to the commercial marketplace.

Digital Aerial Camera System

Goddard researchers have designed a new digital aerial camera system. This concept uses a line scan system to acquire images sequentially. Compared to scanning film-based images or using a digital framing system, this technology requires less image storage space, flight time, and processing time. The camera system also includes a precision position and altitude determination system. Several advantages over film cameras exist, including greater dynamic and spectral ranges, greater radiometric accuracy, direct production of digital product, automatic rectification and geolocation of images, and on-the-fly digital terrain mapping.



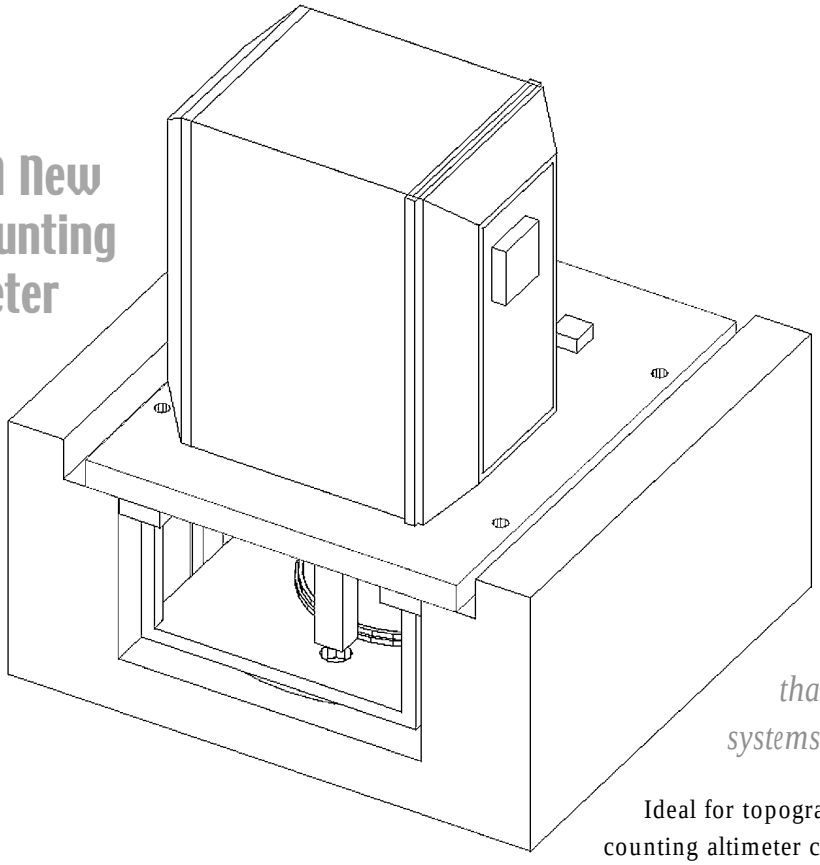
Multisensor Terrain Mapping System

This digital terrain mapping system combines a photogrammetric system for high spatial resolution and a laser ranging system for accurate absolute range determination. The system was designed to produce stereo images with embedded absolute ranging information. Combining forward- and aft-looking digital line scan images produces elevation information without the tedious processing required by other photogrammetric systems. The raw data generated by this mapping system can be used to produce digital terrain maps without extensive postprocessing of the data for georectification or geolocation.

Hexapod System for Pointing Airborne Instruments

This technology stabilizes and orients instruments aboard an aircraft or other moving vehicle. A mounting platform built on a hexapod configuration (i.e., a Stewart platform) is fitted with an inertial navigation system (INS) and actuators. When the INS detects the vehicle's pitch, roll, and yaw, the actuators counter the motion. By providing six degrees of freedom, the hexapod allows the mounted instrument to maintain its spatial orientation or hold a line of sight in an unsteady environment. The technology currently can compensate for 15 to 20 degrees of roll and pitch and up to 30 degrees of yaw. The hexapod system can be manufactured at a relatively low cost.

A New Photon-Counting Microaltimeter



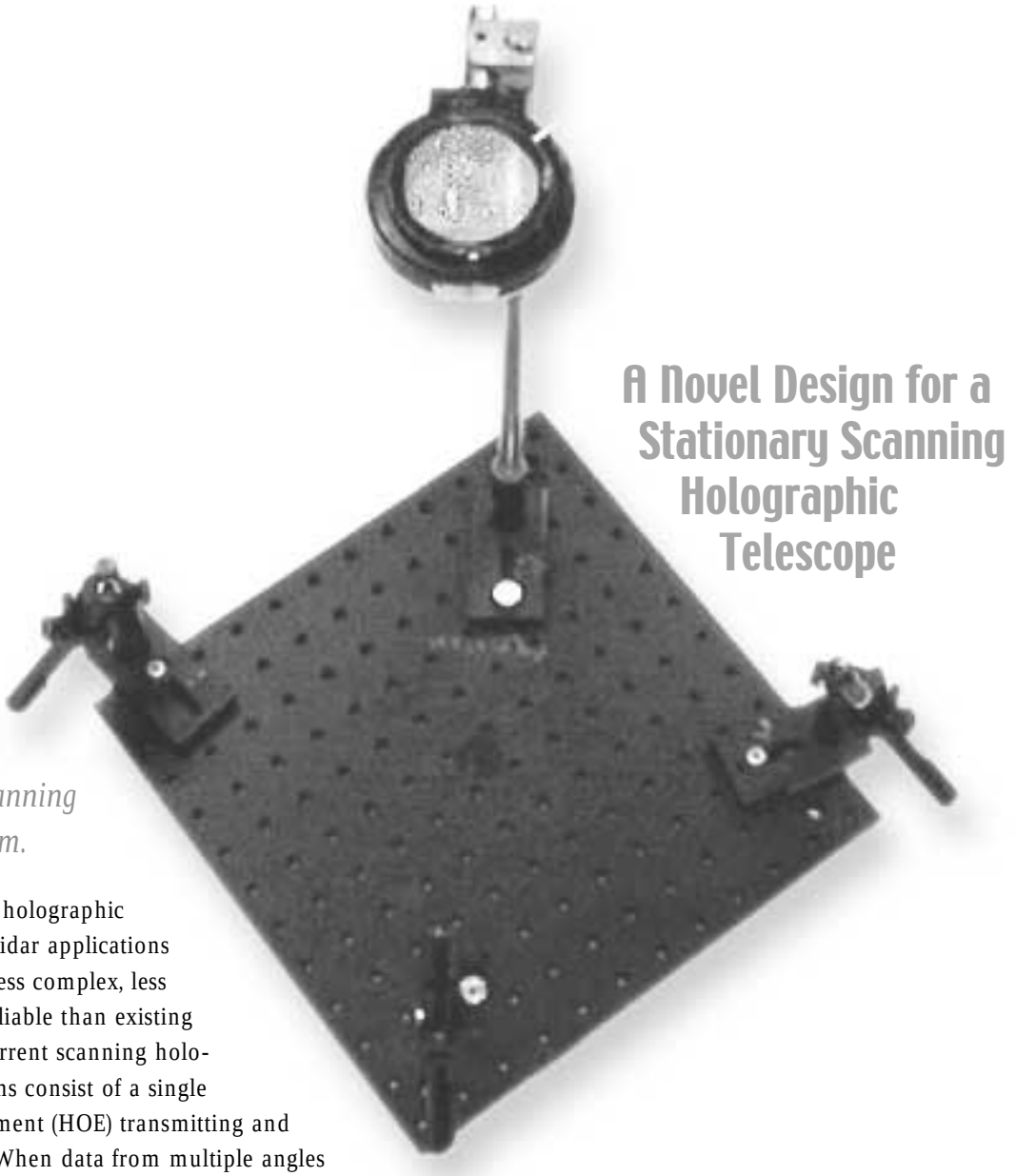
This instrument is smaller, lighter, less expensive, more robust, and more energy efficient than other laser altimeter systems.

Ideal for topographical mapping, this photon-counting altimeter can be used on satellites in 600 km or lower orbits or on a conventional aircraft platform operating at cruise altitudes between 25,000 and 40,000 feet. The technology uses low-energy laser pulses at multikilohertz fire rates to obtain high-resolution spatial data from the surface being examined.

Although conventional laser altimeters can detect nearly 100 percent of laser returns with low probability of error, this new microaltimeter can increase the surface sampling rate by up to two orders of magnitude for the same average laser power and with a much smaller telescope (10 cm vs. 100 cm). Furthermore, it can accurately identify where in the field of view the detected photon originated, removing much of the ambiguity characterizing conventional multiphoton surface returns and improving spatial resolution. In addition, single pulse energies in the microaltimeter are typically two orders of magnitude smaller than in current systems, making the instrument inherently more eye-safe and less prone to internal optical damage.

This technology is ideal for mapping land, ice, sea, and forest settings on Earth as well as surfaces of celestial bodies. Goddard has filed a provisional patent application for this technology and seeks commercial partners to assist in further developing the technology for commercial applications.

A Novel Design for a Stationary Scanning Holographic Telescope



This telescope has multiple fields of view, eliminating the need for primary aperture scanning and a rotating system.

Goddard has devised a holographic scanning telescope for lidar applications that is smaller, lighter, less complex, less expensive, and more reliable than existing scanning telescopes. Current scanning holographic telescope designs consist of a single holographic optical element (HOE) transmitting and receiving laser energy. When data from multiple angles are required, the HOE must be rotated, requiring a dedicated mechanical system. This rotating mechanical system adds weight, cost, and complexity to the telescope.

Goddard's innovative shared aperture multiplexed telescope replaces the single HOE with multiple HOEs in the same holographic film. The lidar laser beam is transmitted through any one of these HOEs, and the backscattered signal is collected by the same HOE when it returns. Offering multiple fields of view through a single aperture eliminates the need for the rotating system. Combining multiple wide fields of view with linear or two-dimensional array "pushbroom" detection techniques enables lidar imaging applications.

This innovation can be used for most lidar applications, including space and satellite applications, atmospheric wind measurements, vegetation canopy profiling, and altimetry. A provisional patent application has been filed, and Goddard seeks industry partners to further develop the technology for commercial applications.

For more information on these technologies, call the
Technology Commercialization Office's contact for guidance, navigation, and control at (301) 286-2198.

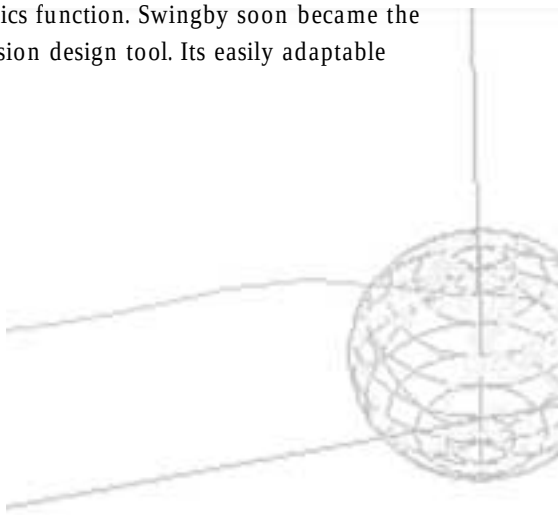
Spotlighting Success

Mission Analysis and Design Software Licensed

A software tool developed to plan missions to the moon and Earth Lagrange points has recently been licensed by Princeton Satellite Systems.

In 1999, Goddard issued a nonexclusive license for its successful mission analysis and design software—Swingby—to Princeton Satellite Systems. Originally developed in the early 1990s, Swingby provided a much-needed PC version of the traditional mainframe tool for calculating trajectory and orbits for spacecraft. In addition, a graphics interface allows users to see the results of the programmed trajectory as it evolves.

With assistance from Computer Sciences Corporation, Goddard researchers transferred the original mainframe code and new targeting algorithms to a PC-based tool and integrated the graphics function. Swingby soon became the leading high-fidelity trajectory and mission design tool. Its easily adaptable



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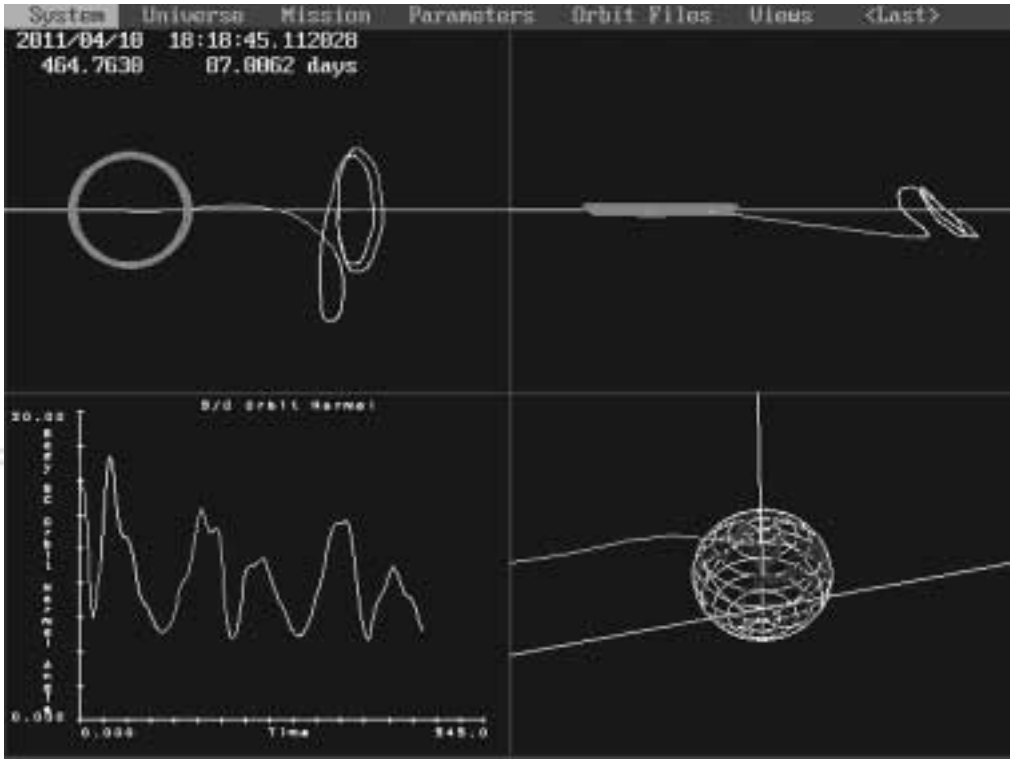


format enables the inclusion of the latest cutting-edge models. Swingby has supported numerous NASA missions, including the Solar and Heliospheric Observatory (SOHO), the Deep Space Probe Science Experiment, and the Lunar Prospector Mission. The software earned recognition from NASA for its performance in the 1995 Clementine mission to the moon.

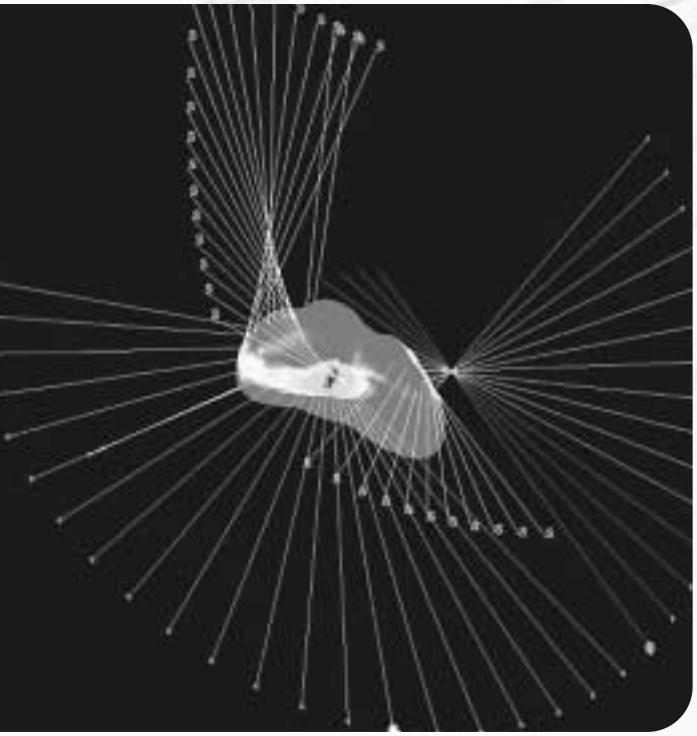
Princeton Satellite Systems will incorporate Swingby into its own commercial Matlab toolboxes. By adding Swingby's targeting and orbit capabilities to Princeton's attitude control and mission planning software, the company can offer a more comprehensive software package. Goddard also is adding capabilities to the original Swingby software for use by universities. For more information about this software, please contact Goddard.

For more information on these technologies, call the
Technology Commercialization Office's contact for information systems at (301) 286-0561.

Spotlighting Success

Fighting Crime with NASA Remote Sensing Data Analysis Technology

A technology developed to map the surface of near-Earth asteroids is being used to analyze gunpowder residue at crime scenes.



Spec3D—a Goddard technology developed cooperatively with Cornell University, Hampton University, and the University of Arizona—is a geographical information, visualization, and analysis tool for remotely sensed spectral databases. Specifically developed to analyze data collected by the Near Earth Asteroid Rendezvous (NEAR) satellite, the software renders graphical, interactively derived scenes of these data. Researchers also have been working with the National Institute of Justice to determine how this technology can be used to analyze crime scenes remotely.

As originally envisioned, Spec3D will help map the surface of 433 Eros, one of the largest and best observed near-Earth asteroids. A spectrometer aboard the NEAR satellite will remotely sense X-ray and gamma-ray emissions from the asteroid. Spec3D will analyze these data and create visual images representing Eros's surface composition of magnesium, oxygen, hydrogen, uranium, and other elements.

Goddard researchers, forensic scientists, and law enforcement specialists also are using the NEAR instruments and the Spec3D visualization and analysis software to study crime scenes remotely. With further development, the Spec3D technology also might be transferable to other commercial applications that use data from visible wavelengths, gas chromatography, or mass spectroscopy. Companies interested in participating in this development are encouraged to contact Goddard.

Goddard Licenses Technology for Large Flat-Panel Displays

TelSpanServices, Inc., has licensed Goddard's segmented cold cathode technology for large, multicolor displays.

In 1999, Goddard issued a license for an innovative technology that uses segmented cold cathodes to greatly improve multicolor flat-panel display capabilities. The technology consists of segmented photocathodes set orthogonal to an array of control grids. The display panel's resolution is defined by the number of control grids (horizontal resolution) and the number of segmented photocathodes (vertical resolution). The control grids and photocathodes are housed between an input window and an equipotential mesh grid. Displays made using this technology may be less than 10 cm deep and have 1 mm^2 pixels. This is sufficient resolution for large-screen home entertainment systems, public message boards, network control room displays, flight simulations, video games, and other large displays. The technology also creates a video image that is brighter than active matrix liquid crystal and comparable to cathode ray tube displays.

The technology has been licensed to TelSpanServices, Inc., an information management systems company based in Maryland. TelSpanServices designs, develops, and manufactures outdoor public audio/video display systems. Projected Reality Corporation, a start-up technology company established to focus totally on the commercialization of the NASA technology, will work closely with TelSpanServices in this endeavor, beginning with the development of a prototype display.

New Filter Algorithms Enhance Electronic Images

Original JPEG

With Goddard's filtering algorithm

The quality of compressed JPEG images is significantly improved by Goddard's new filtering algorithms.

Goddard researchers have developed two new algorithms that provide frequency-based, pixel adaptive filtering for low bit rate (≤0.25 bits per pixel) compressed images. The estimated spectrum adaptive postfilter and the iterative pre-post filter algorithms were designed to minimize "blocking" distortion. This distortion occurs when images are highly compressed with the Joint Photographic Expert Group (JPEG) standard.

Goddard's filtering algorithms significantly reduce blocking distortion by reusing the discrete cosine transform coefficients. The adaptive postfilter uses these coefficients to directly estimate the two-dimensional (2D), pixel-adaptive bandwidths. The iterative pre-post filter uses inverse pair 2D filters for high-frequency preemphasis before encoding and deemphasis after decoding. These algorithms minimize the mean square error, improving the objective, subjective, and visual quality of the image.

This technology has been successfully proven with JPEG images, and it may be applicable to low bit rate Internet video or MPEG compressed video sequences. A provisional patent application has been filed, and companies are invited to explore licensing options for this Goddard technology.

OPTICS

For more information on these technologies, call the
Technology Commercialization Office's contact for optics at (301) 286-2642.

An Innovative Process for Polishing Aluminum Mirrors

Mirrors fabricated using this process are lighter, less expensive, and more robust than nickel-plated aluminum mirrors.

Researchers at Goddard have developed a revolutionary process for precision optical polishing of bare aluminum to an unprecedented smoothness. Goddard's process begins by using a single-point diamond turning machine; grinding cannot be used on bare aluminum because it leaves behind particles that scratch the surface during polishing. After the aluminum is diamond turned to a 30- to 80-angstrom finish, a special compound is used to polish the mirror to a roughness of 5 angstroms rms with a surface figure accuracy of 0.125 of wave peak to valley.

The major benefit of this innovative process is the ability to make pure aluminum mirrors, which are less expensive and lighter than optics made from other pure materials. Although nickel plating aluminum optics is another lightweight option, the technique has several drawbacks. Plating faults can ruin the optic, and the process can be expensive. Also, the bimetal thermal characteristics of nickel over aluminum are poor, which is problematic for applications with dramatic temperature swings.

By enabling the fabrication of high-quality aluminum mirrors, Goddard's process can dramatically reduce component fabrication cost while improving the performance of the optical system. Manufacturers of optics, metal optics, and diamond turning and polishing equipment as well as other interested companies are invited to license Goddard's process for incorporation into their products.

New Developments with the Circle-to-Point Converter

This holographic optical element represents a potential breakthrough in reducing the cost, size, and complexity of Doppler lidar systems.

Goddard's newly advanced holographic optical element resolves the circular fringe patterns generated by Fabry-Perot interferometers into focused points. Each point represents a wavelength component of the fringe light and may be focused into a single plane or even into a single line, allowing for the use of certain linear detectors. This invention is particularly useful for Doppler lidar systems and possibly for commercial multispectral measurement systems, multifield-of-view telescopes, optical radar, particle counting, and contamination monitoring.

When used in conjunction with solid-state optical detectors, the circle-to-point converter overcomes the limitations of circular photomultiplier-type detectors. Goddard's technology does not require high voltages or a cooling system and is easily manufactured using standard holographic techniques. Reducing the cost, complexity, and size of Doppler lidar systems can create opportunities for a variety of commercial applications.

The inventors of this technology also are investigating a concept that uses the converter in reverse to combine, rather than divide, incident light. This concept could work for inputs of equal or different wavelengths. This would allow an efficient means for combining several input light beams into one common beam. This capability has potential application in telecommunications and end pumping of laser rods.

Goddard invites companies interested in developing commercial systems that use this device to apply for a license.

New Technologies for Assembling Fiber Optics

These four new technologies can improve the quality and dependability of fiber optic assemblies used in applications where high reliability is essential.

Goddard seeks qualified partners to bring these technologies to the commercial marketplace.

Fixture for Chemical Stripping of Optical Fibers

This device is used in the chemical stripping of coatings from optical fibers so that they may be assembled with other component elements. The fixture fits over the end of a cable or fiber and exposes the coated portion to be stripped, which is then placed in a chemical bath. This fixture and stripping process are particularly useful for removing hard, thin, polyimide coatings that cannot be removed mechanically or thermally.

Fixture for Reduced Bubbles in Adhesives

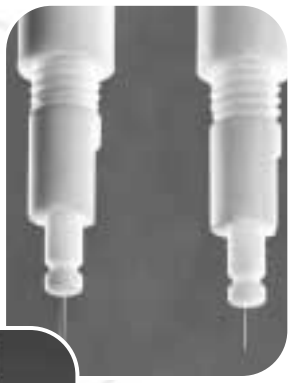
This device helps to remove the bubbles that can appear in the termination adhesive during injection processes. The fixture holds and seals a termination filled with adhesive, which is then placed in a centrifuge. Spinning the filled termination and fixture in the centrifuge for 2 or 3 minutes drives bubbles out of the adhesive, making the termination ready for installation on the optical fiber.

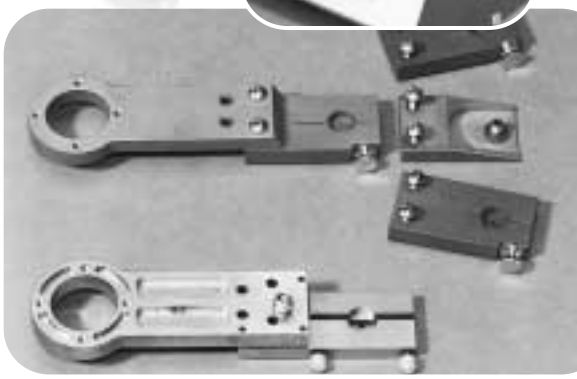
Fixture for Adhesive Curing in Open-Cell Ovens

This device holds a termination and optical fiber firmly in place during elevated temperature epoxy bonding in an open-cell oven. The fixture centers and controls the depth of the fiber optic assembly within the oven's cell cavity. The fixture also can be used to hold thermocouples, allowing them to provide more accurate cell temperature readings.

Fixture for Optical Fiber Connector Polishing

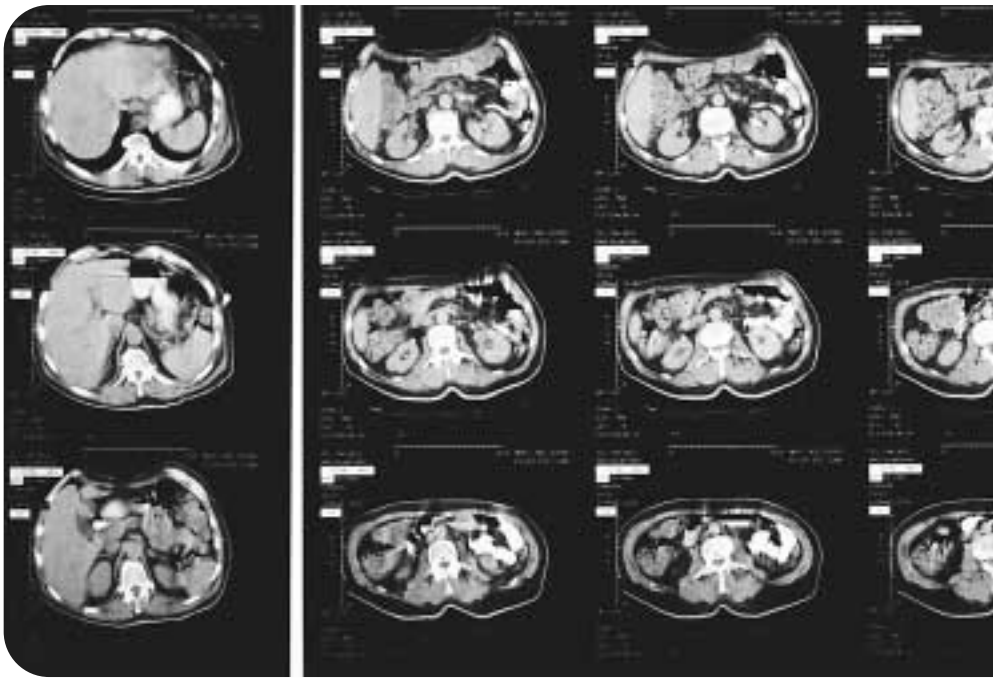
When retrofitted on a connector polishing machine, this device controls and allows adjustment of the connector's apex offset—that is, the difference between the apex of the spherical polish and the center of the fiber core. The ability of this device to control apex offset to less than 50 µm improves fiber-to-fiber contact, reduces insertion loss, and reduces reflectance over the operating environment.





SENSORS AND DETECTORS

For more information on these technologies, call the
Technology Commercialization Office's contact for sensors and detectors at (301) 286-5979.



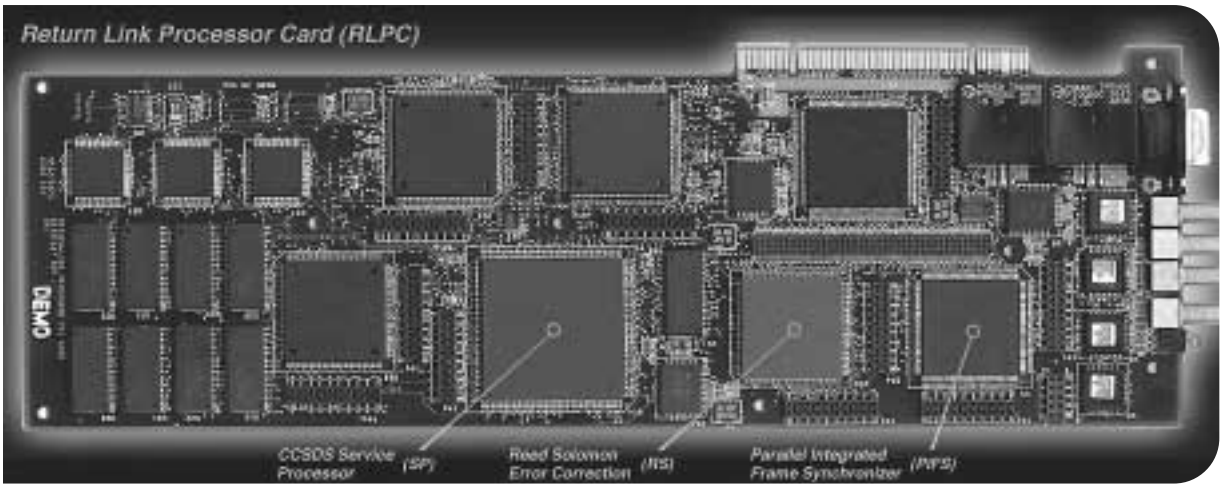
Clearer Images with a New CCD

Useful in a variety of applications, Goddard's innovative charge coupled device (CCD) system reduces cooling requirements and improves imaging.

Goddard has developed an improved charge coupled device detector that is ideal for extremely low background observations. Applications include spectrographic imaging, medical imaging, industrial material inspection, fluorescence observations, and amateur astronomy.

Goddard's innovative device yields clearer images than provided by standard CCDs by reducing any scattering that results from light that passes through the CCD. It also reduces potential absorption of thermal infrared radiation, thus reducing the cooling system requirements for the detector.

The financial cost incurred to achieve these significant imaging improvements is minimal. Prototypes have been constructed, and NASA is including this technology on the Hubble Space Telescope's next mission. Goddard has applied for a patent and invites companies to consider licensing this technology.



New Chips to Handle High Data-Transfer Rates

Goddard's integrated circuit components for real-time data processing in return-link data systems can receive and process 450 megabits per second (Mbps).

Goddard's high-speed parallel integrated frame synchronizer and service processor chips can be used in ground station systems that receive and process data from airborne or in-space sources. These chips, with processing speeds of 450 Mbps, offer a significant advantage over current chips, which can process less than 100 Mbps.

The frame synchronizer receives incoming bit streams of telemetry or weather satellite data and assigns them to framed data structures. The synchronizer requires less than 10 watts of power and uses 0.6 µm complementary metal oxide semiconductor technology. Then the service processor extracts data packets and other service data units from the telemetry frames. The chip is highly configurable, allowing the user to selectively "accept or discard" data from any given data source (e.g., a specific instrument on a spacecraft).

Goddard's service processor offers several advantages over current chips. Goddard's chip allows the user to configure the frame and packet quality checking process and to select quality annotations for the extracted service data units. The chip's hardware-based processing eliminates the need for service processor software.

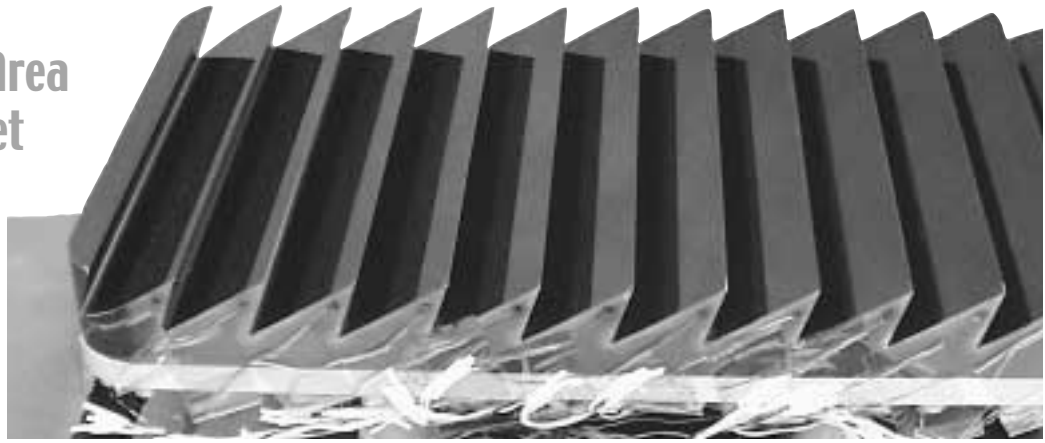
A patent application has been filed for these chip technologies. Companies interested in licensing this technology should contact Goddard to explore the various partnering options.

THERMAL AND CRYOGENICS

For more information on these technologies, call the
Technology Commercialization Office's contact for thermal and cryogenics at (301) 286-5169.

Spotlighting Success

A Large-Area Blackbody Target for Sensor Calibration



Using heat pipe technology, this technology enables calibration of large sensor arrays.

Goddard has entered into a Space Act Agreement with Electro Optical Industries, Inc., of Santa Barbara, California, to further develop a large-area, highly isothermal blackbody target for calibrating radiometric (e.g., infrared) sensors. Typical calibration targets maintain their temperature by circulating a fluid through the hollow structure. Although these systems function well, they must be kept to a small size to remain portable.

Goddard's large-area target achieves exceptional temperature uniformity by using a heat pipe-based system. A porous wick wetted by a two-phase working fluid is sealed behind the target surface. Heat is absorbed by vaporizing the fluid, creating a pressure gradient inside the target. This pressure gradient forces the vapor to a cooler section where it condenses and gives up its latent heat. The condensed working fluid is then redistributed by capillary forces in the wick. A 15-inch diameter proof-of-concept target demonstrated a less than 0.1 K temperature gradient from 270 to 315 K.

Under the Space Act Agreement, Electro Optical is developing a working terrestrial-based prototype of this technology with technical assistance from Goddard researchers. For more information on this technology, please contact Goddard.

Automated Liquid Helium Transport System

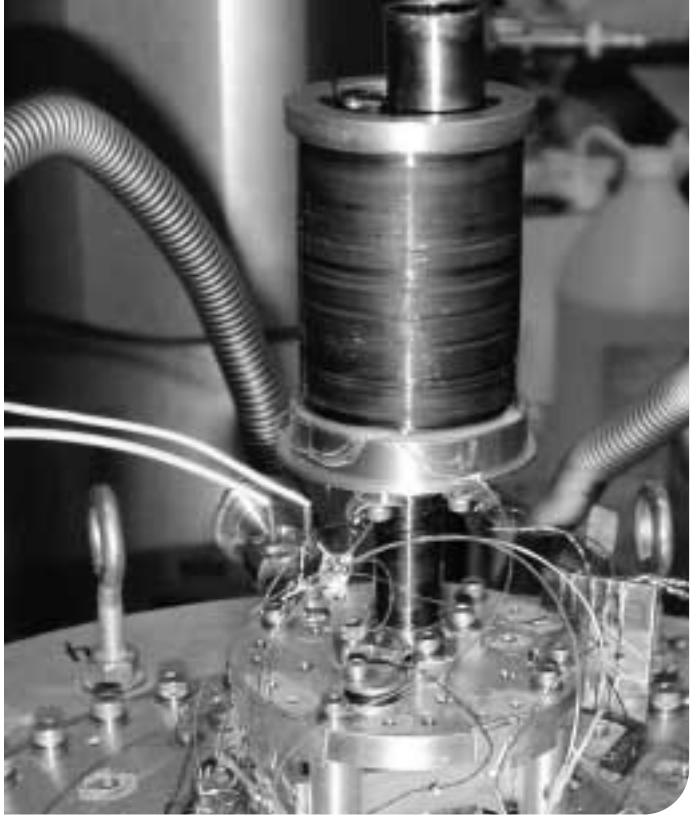
This technology allows unmanned replenishment of cryogens while using less helium than current automated systems.

Automated transport of cryogens such as liquid helium save man hours and enhance safety. However, most automated systems have imperfect transfers. Many systems allow gaseous helium to enter the cryostat, consuming additional cryogen. Goddard has developed a new automated transport system that addresses this drawback.

The innovative device consists of an arrangement of a transfer tube and an arrangement of valves that connect the helium storage dewar to the cryostat. Control electronics determine the helium level in the cryostat and activate the transfer of liquid helium. While the helium is en route, temperature sensors determine whether it is in liquid phase or a gaseous state. If the helium is liquid, control valves direct it to the cryostat. If the helium is gas, because of exposure to warm transfer lines for example, the valves direct it to a collection tank.

This system is the only autonomous helium transport system that vents gaseous helium, which prevents the cryostat from consuming extra cryogen. A provisional patent application has been filed for this technology. Companies interested in licensing this technology for laboratory use are invited to contact Goddard.

A New Adiabatic Demagnetization Refrigerator (ADR)



This technology offers continuous cooling, a significant improvement over other ADRs.

Goddard researchers have devised a new multistage magnetic refrigerator that can provide continuous cooling at cryogenic temperatures. Designed to cool high-resolution detectors, this technology uses multiple adiabatic demagnetization stages to achieve true continuous cooling with high thermodynamic efficiency. The current design uses three stages to cool from 10 K to 50 mK.

Operation of ADR refrigerators relies on the magnetocaloric effect, whereby certain materials become warmer when they are exposed to an increasing magnetic field and cool off under a decreasing magnetic field. A typical ADR magnetizes a magnetocaloric material, dumps the excess heat, then demagnetizes it in a controlled manner, refrigerating the material.

The innovation with Goddard's new ADR is the serial configuration of the stages, which allows heat to be periodically cascaded up from the continuous stage to a warm heat sink. At any one time, two stages provide cooling while the third stage is recharging. Having this third stage allows for a continuously cooling ADR that can accommodate large detector arrays and has a smaller mass than traditional ADRs of similar cooling power.

Researchers have built a proof of concept model, and several system components have been fabricated and tested. Companies interested in participating in additional development efforts are invited to contact Goddard.

1999 Technology Commercialization Office Activities

Goddard's Technology Commercialization Office undertakes a variety of activities to promote technology transfer within Goddard and among commercial industries. These include identifying new technologies, attending conferences and symposia, and recognizing the contributions of Goddard's scientific and technical staff to the technology commercialization process. This section outlines the office's activities in 1999.

NEW TECHNOLOGIES REPOR

NASA's Goddard Space Flight Center has amassed a wealth of advanced technologies with the potential to be transferred to a variety of institutional and commercial industries. In addition to the technologies highlighted in this report, these pages list all of the transferable technologies reported to Goddard's Technology Commercialization Office in 1999. Also included are laboratory facilities available for use by private companies.

Environmental Systems

Contact: (301) 286-1098

Facilities include Terrestrial Physics, Atmospheric Sciences, and Hydrospheric Processes Laboratories

Autonomous Day/Night Full Sky Cloud Sensor

Curved Crystal X-ray Imaging Spectrometer

Gasline Repair and Inspection System for Live Entry Environments (GRISLEE)

Global View from Space—An Automated Data Engine Software System for the Retrieval, Processing, and Derived Product Generation of Multidisciplinary Earth Data

New Method for Atmospheric Compensation

Vision-Based Motion Sensing and Control for Automated Mining Machines

Guidance, Navigation, and Control

Contact: (301) 286-2198

Facilities include a Global Positioning Systems Laboratory.

Aerodynamic Trim Actuators for Solar Array Panels

Aerodynamic Trim Panels for Spacecraft

Autonomous Satellite Navigation System

Autonomous Unified Onboard Orbit and Attitude Control System for Satellites

Confused-in-Space Stellar Attitude Acquisition Using Multiple Star Trackers

Low-Cost, Autonomous Navigation for Low Earth Satellites

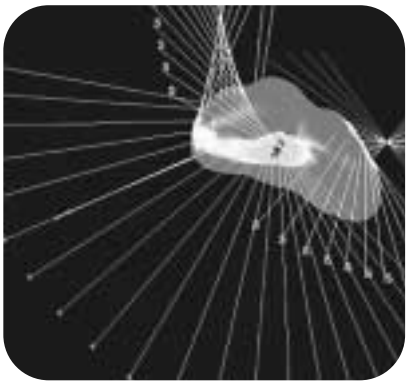
Onboard Star Selection for Stellar Inertial Attitude Determination Performance Enhancement

Plasma Charge Balancing System for Spacecraft Floating Potential Control

Precision Nano-Satellite Propulsion

Reduction of Spacecraft Instrument Induced Jitter via Multi-Frequency Cancellation

Solar Wind TRIM Activities for Solar Array Panels



Information Systems

Contact: (301) 286-0561

Facilities include the Fiber Optic Interconnect Laboratory, Electromagnetic Test Facility, Large Area Pulsed Solar Simulator Facility, and Battery Test Facility.

AI-Based Planning and Scheduling for Near-Real-Time Satellite Data Processing

Archer File Storage Management System

Computer-Assisted Data Analysis System

Coordinated Data Analysis Workshop Web

Cost Savings of Telemetry Processing System

Cross Correlator for Actel FPGAs

Data Visualization Environment Tool (DVET) Software Application

Direct Readout Terra/MODIS Level 0 Processing Software

Dynamic Powering of Memory Banks Based on Compiler-Introduced Directives and/or Fuzzy Coprocessor

Dynamical Interpretation of the Broad-Scale: Zodiacal Cloud Observer

Empirical Mode Decomposition Apparatus, Method, and Article of Manufacture for Analyzing Biological Signals and Performing Curve Fitting

Extension of the Empirical Mode Decomposition Method to a Time Series of Two-Dimensional Grid Maps

Hierarchical Segmentation and its Recursive Implementation on MIMD Parallel Computers

Instrument Remote Control via the Astronomical Instrument Markup Language

Internet Information

Landsat 7 Enhanced Thematic Mapper-Plus (ETM+) Data Processing Software

Level 1B Converter

NASA Industrial Property Management Information System (NIPMIS)

New Technology Ground Support Equipment

Nonlinear Mapping Function for Computer File Encryption

Photo Interpretation Tool

Responsive Applications Tool

Space Network WWW Scheduling Interface

Standard CCITT Cyclic Redundancy Code

Synchronous Product Generator Prototype

Three-Dimensional Surface Matching Engine

Web-based Directives/Document Management System

WinDAP Shock and Vibration Data Analysis Software

Optics

Contact: (301) 286-2642

Facilities include the Diffraction Grating Evaluation Facility, Surface Metrology Laboratory, Optical Coating Facility, Vacuum UV Optical Measuring Facility, Laser and Electro-Optic Laboratory, and Cryogenic Optical Test Facility.

Dual-Frequency Direct-Detection Wind Lidar Receiver Technique

Etalon Recirculating Multiplexer/Multichannel-Spectrometer

Holographic Optical Element for Power Coupling and Wavelength Multiplexing

Improved Method of Producing Continuous Optical Modulation with Discrete Level or Other Noncontinuous Light Modulating Arrays

Integrated Optic Grating Filter Designs Using Apeiodic Positioning of Reflective Stripes

Liquid Crystal Volumetric Three-Dimensional Display

Low-Cost Fabrication of Lightweight Optics, Mirrors, and Benches

New Computer Architecture Using “Free Space Input-Output” via Active Light Source and a Passive Modulating Optical Retroreflector Technology

Novel and Efficient Calibration Lamps

Passively Q-Switched Microchip Laser Development

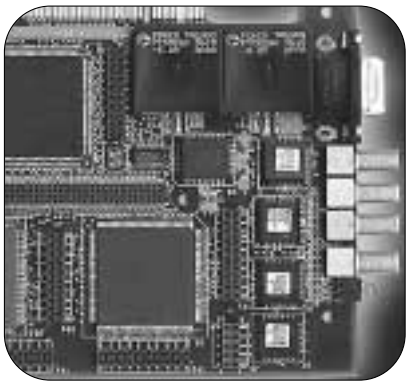
Pigtail Star Coupler

Reflective and Conductive Metal Oxides

Solid State Electro-Optic Tunable Fabry-Perot Filters

Staggered Lead Star Coupler

Tunable, Single-Frequency, Fiber Fabry-Perot Surface Emitting Lasers



Sensors and Detectors

Contact: (301) 286-5979

Facilities include the Detector Development Laboratory.

AIN Insulating Layer for MISFET Devices with Enhanced DC Performance

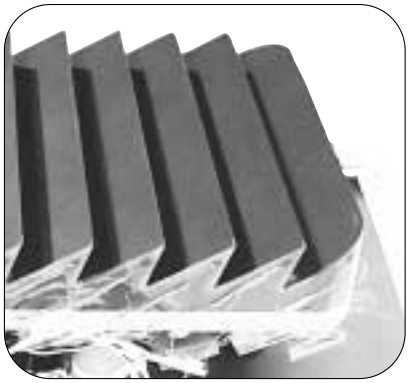
High Density MCM-D Substrates with Integrated Capacitors

High-Precision Object Localization System for Autonomous Fork Vehicles

Low-Noise, Low Temperature Coefficient Resistor Array

Two-Dimensional Microshutter Arrays

Ultrahigh Dynamic Range, High Speed A/D Converter for Laser Ranging



Thermal and Cryogenics

Contact: (301) 286-5169

Facilities include the Cryogenics Laboratory, Thermal Engineering Coating Facility, Cryocooler Test Bed, and Cryogenic Research and Integration Facility.

Deflection and Stresses in Circular Membranes Due to Transverse and In-Plane Loading Conditions

Engineering Properties of Al-Li X2096-T8A3 Alloy

High Heat Flux Loop Heat Pipe Evaporator with Bidisperse Structures

Innovative Thermal Design Concept for Plasma Spectrometer in Solar Probe Near-Sun Flyby Mission

Low-Power, Lightweight, Solid State Thermal Control Technology

Magnetostrictive Magnetically Controlled Locking Motor

MEMS Devices for Spacecraft Thermal Control Applications

Miniature Hybrid Microcircuit Proportional Temperature Controller

Modified Wine-Rack Design for Thermal Management of Nickel-Hydrogen Batteries on Spacecraft

Multilayer Braze Foils for Joining Silicon Carbide to Inconel 600

Nested Planetary Transmission

Net Shape Woven Wheel

Nondestructive Evaluation of Cadmium Zinc Telluride

Permanent Magnet Device for Levitation of Diamagnetic Materials

Pipe Repair Method Utilizing a Corrugated Shape Memory Metal Sleeve

Practical Thermal Design Concept for Next Generation Space Telescope Sunshields

Preventing Molecular and Particulate Infiltration in a Confined Volume

Rails for Shuttle Side-Mounted Payloads

Spacecraft Solar Wind Trim Panels for Pointing and Disturbance Torque Abatement

Stageable, Actuable, Anti-Clogging J-T Cryostat

Voice Coil Damping System for High-Speed Rotating Shafts

Other Technologies

Contact: (301) 286-6705

Center-Cutting End Mill Modified by Grinding for Plunge-Cutting into Titanium and its Alloys

Double Parallelogram Carriage

Genetic Material (Gene) Involved in Osteoporosis/Bone Adaption

Modification of Twist Drills to Cut Titanium and Titanium Alloys

Modified Reamers to be Used to Ream Titanium and its Alloys

Tap Modified by Grinding for Thread-Cutting in Titanium and its Alloys

AWARD PROGRAMS

The Technology Commercialization Office strives to gain recognition for the valuable participation of Goddard employees in technology transfer and commercialization. The office therefore nominates technologies and their inventors for a number of awards. These awards are presented by NASA, Goddard, and other organizations.

Government Technology Leadership Awards

Sponsored by *Government Executive* magazine, the prestigious Government Technology Leadership Awards recognize projects that have boosted efficiency and effectiveness, lowered costs, and/or improved service to the public by finding innovative uses for technology. Two Goddard technologies were selected as winners for 1999, and a third technology was a finalist.

Winner: Airborne Lidar Topographic Mapping System (ALTMS)

Certified by the Federal Aviation Administration, ALTMS provides rapid, efficient, and accurate three-dimensional virtual digital mapping of more of the land's surface than ever seen before. Operating at altitudes up to 20,000 feet, the system uses a pulsed laser to acquire data with an absolute vertical accuracy of approximately 1 foot. Unlike traditional methods, ALTMS can map an area under various lighting, vegetation, and weather conditions in days instead of months and at one-tenth the cost.

Winner: Hilbert–Huang Transform

Traditional energy-frequency analyses are based on the Fourier transformation, which provides accurate results only for linear and stationary signals. Hilbert-Huang transform algorithms were designed for the analysis of nonlinear, nonstationary data. It can be executed on any PC or workstation and provides more precise analysis of signals than with currently used methods. Applications for this innovation are numerous. It allows scientists to accurately process and study data on everything from ocean waves to earthquakes and from the structural soundness of the nation's bridges to heart arrhythmia.

Finalist: Regional Applications Center Program

Designed to foster the use of environmental and Earth resource data from satellites and other sources, the Regional Applications Center program allows participating institutions to directly receive, manipulate, and customize localized satellite data effectively, inexpensively, and on a routine basis to meet regional needs.

Kerley Award

Named after the late James Kerley, a Goddard scientist who championed technology transfer and commercialization, the Kerley Award is presented annually to recognize a Goddard researcher's commitment to new technology reporting and the technology transfer process. The 1999 award was presented to John Kolasinski, who has worked closely with the Technology Commercialization Office to transfer several of his new fiber optic technologies. Some of his technologies are described on page 19.

NASA's Government Invention of the Year

This prestigious award was presented to Goddard researcher Charles Clagett for his reaction/momentum wheel. Developed for the Small Explorer program, the invention is a compact, high-torque, low-vibration device to stabilize and point satellites and other space vehicles. Currently, the invention is successfully flying aboard three NASA satellites. The wheel also has been licensed to Ithaco Space Systems and Orbital Sciences, Inc., which sells its version of the invention commercially.

CONFERENCES, BRIEFINGS, AND

NASA's Goddard Space Flight Center disseminates information about its space technologies and potential commercial applications by hosting and attending conferences, briefings, and symposia. At these events, the Technology Commercialization Office demonstrates technology, distributes informative literature, and offers one-on-one counseling to industry about partnership and commercialization opportunities at Goddard. Through these events, Goddard successfully reached many small and large companies, academic institutions, and trade and professional organizations in 1999, enabling several license and partnership arrangements.

Goddard-Sponsored Programs

40th Anniversary Celebration and Exhibit Showcase
Community Day
University Day

Air and Space

International Space Business Assembly
Johnson Space Center's Inspection '99

Education

National Science Teachers Association Conference

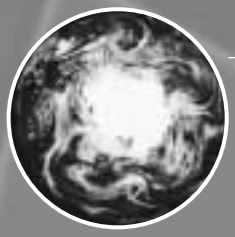
SYMPOSIA

Empowerment Zone/Enterprise Community

Boston Small Business Finance Expo
NASA Technology and Business Conference
White House Community Empowerment Conference

Engineering and Manufacturing

National Design and Engineering Show
Society of Automotive Engineering International Congress and Exposition



Sensors

International Forum for Advancing Measurement and Control Technologies
Sensors Expo '99

Small Businesses

Goddard's Annual Small Business Conference
New England Small Business Conference

Technology Exhibitions

Discover Awards
High Technology Council of Maryland Techfast
High Technology Council of Maryland Technology Showcase
Maryland Technology Showcase
National Technical Association Conference
Technology 2009

INNOVATOR RECOGNITION

Technology transfer would not be possible without innovators. The scientific and technical staff at Goddard must identify, document, and report their new technologies to the Technology Commercialization Office. In addition, many of these innovators are deeply involved throughout the transfer and commercialization process. Goddard extends its appreciation to the innovators who participated in these activities in 1999.

James Abshire
Dennis Andrucyk
Yuval Anviel
Graeme Aston
Martha Aston
Tin Aye
Youn Bae
John Bane
John Barnes
Itzhack Bar-Itzhack
Richard Barry
Thomas Burton
Craig Bearer
Jessie Bhangoo
Geoffrey Bland
Scott Boehmke
John Bolton
Karim Boutros
Matthew Buchko
Barton Bull
Madeline Butler
Steven Cagiano
Bryan Campbell
Charles Campbell
William Campbell
Elizabeth Chandler
Brian Chemel
Ed Cheng
Michael Choi
Robert Cohn
Alexander Coleman
David Content
Donald Cornwell
Patrick Coronado
Michael Craghead
John Cranston
Robert Cromp
William Crowley
George Daelemans
Steven Davis
John Degnan
Stanley Dermott
Julie Deutschmann
William Devereux
Michael DiPirro
David Dryer
Denise Duignan
Howard Dunn
Darell Engelhaupt
William Farrell
Rainer Fettig
Eugene Fike
Yury Flom
Samuel Floyd
Chris Fromme
Norbert Fruehauf
Patrick Gary
Michael Ghee
Parminder Ghuman
C. Giese
Per Gloersen
Alex Govyadinov
Thierry Guillerm
Michael Hadjiargyrou
J. Halley
Mark Hanning-Lee
Richard Harman
Leonard Haynes
Tim Heggadorn
Martial Herbert
Dave Herdle
Herman Herman
Alfonso Hermida
Frank Higgins
Ernest Hilsenrath
Zvi Horovitz
Kevin Hsu
Norden Huang
Donald Jennings
Andrew Johnson
Mark Johnson
Richard Katz
Alonzo Kelly
William Kelly
Robert Kerr
Dmitry Khrustalev
Daniel Knowlton
John Kodis
K. Kohuth
John Kolasinski
Michael Krainak
Alexander Kutyrev
Amy Lanksy
Renato Levy
Rongsheng Li
Irving Linares
Lloyd Linstrom
Ketao Liu
Yong Liu
Allen Lunsford
James Lyons
Stephen Maher
Anthony Mallama
Peter Mardilovich
Marzouk Marzouk
Elaina McCartney
Timothy McClanahan
Jan McGarry
Matthew McGill
Robert McGuire
Timothy McKechnie
Robert Menrad
Irina Mikheeva
Calvin Miller
Rich Moore
Samuel Moseley
Richard Mullinix
Bruno Munoz
Edward Mutschler
David Needelman
David Nelms
Eldar Noe
Mark North
John Noto
Mark Ollis
Scott Olson
James Osborn
Melanie Ott
Bradford Parker
Shabbir Parvez
Leslie Payne
Jorgen Pedersen
Thomas Perricone
Lawrence Piper
Richard Rallison
John Ralph
Brian Ramsey
Ference Raski
Joan Redwing
Kenneth Reed
Christoper Rice
Merrill Ridd
Jacob Rosenberg
John Rosenfeld
Dmitri Routkevich
Clinton Rubin
Babak Saif
Mina Samii
David Sarraf
Gajendra Savant
Fredrick Schamann
Hagen Schempf
Jacob Schmidt
William Schneller
Geary Schwemmer
John Scialdone
Vibart Scott
Harry Shaw
Mark Sherman
Peter Shirron
Nicholas Short
Anthony Stentz
Mark Stephen
Edwin Stevens
Xiaoli Sun
Theodore Swanson
Jack Syage
Michael Ta
Joseph Teter
Ralph Thompson
James Tilton
Dan Tredell
David Uetrecht
John Van Sant
Michael Viens
John Vranish
David Walser
Liqin Wang
Paul Westmeyer
Jim White
John Williams
Margaret Williams
Daniel Worth
Michael Wright
Yeong-Wei Wu
Zack Wu
George Xing
Tapesh Yadav
John Zaniewski
Mingjun Zhao
Jizu Zhi
Yu Zhong
Barbara Zukowski

How to Reach Goddard's Technology Commercialization Office

To best respond to inquiries, the Technology Commercialization Office has divided Goddard's assets into six core competencies. Readers interested in obtaining information on Goddard technologies, partnership opportunities, or the availability of facilities are encouraged to contact the relevant area of interest.

Environmental Systems

Phone: (301) 286-1098
E-mail: environment@tco.gsfc.nasa.gov

Guidance, Navigation, and Control

Phone: (301) 286-2198
E-mail: navigation@tco.gsfc.nasa.gov

Information Systems

Phone: (301) 286-0561
E-mail: information@tco.gsfc.nasa.gov

Optics

Phone: (301) 286-2642
E-mail: optics@tco.gsfc.nasa.gov

Sensors and Detectors

Phone: (301) 286-5979
E-mail: sensors@tco.gsfc.nasa.gov

Thermal and Cryogenics

Phone: (301) 286-5169
E-mail: thermal@tco.gsfc.nasa.gov

General Inquiries

Phone: (301) 286-6705
E-mail: general@tco.gsfc.nasa.gov

Internet Addresses

Goddard Technology Commercialization Office

http://techtransfer.gsfc.nasa.gov

Goddard Space Flight Center

http://www.gsfc.nasa.gov

NASA Commercial Technology Network

http://nctn.hq.nasa.gov

INDEX OF TECHNOLOGIES

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