



Building the Future

Inventions & Contributions Board 2006 Annual Report to the Administrator



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2006 Annual Report to the Administrator

Inventions & Contributions Board

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Foreword

It is with humility and sincere admiration that I present this 48th annual report of the Inventions and Contributions Board to the NASA Administrator. This was another banner year for the NASA technology practitioners and scientists, with no break in the pace of extraordinary innovation.

This year represents NASA's first ever incident of an employee receiving the Nobel Prize for his work here. Since inception, our Space Act Awards Program has given nearly 100,000 awards to the NASA family of scientists and engineers for their achievements. We are proud of all of them. Enjoy the fruits of their labors, and see for yourself how their ideas become the foundation of the future.



Sincerely,

Christopher J. Scolese
Chair, Inventions and Contributions Board
NASA Chief Engineer

Introduction: Building The Future

As NASA begins its 49th year, the Inventions and Contributions Board (ICB) also finishes its first 48 years of operations. NASA's ICB delivered over 95,000 awards to deserving scientists, mathematicians, engineers, and software developers recognizing their technical achievements in support of NASA's missions. This year, over 3,000 awards were paid, reflecting the continuing high degree of productivity of our Agency's workforce.

The efforts of the ICB, its staff and support groups at our Centers enable this process to bring recognition to those whose innovations help to build the future. When NASA was created, fully one-sixth of the text of the Space Act of 1958 was devoted to establishing the ICB and delineating its functions. The Congress recognized the fact that intellectual property is the foundation of progress, and they endowed NASA with special powers relating to inventions developed during its missions. These powers legally bind NASA to become a "Title Agency", wherein NASA owns all intellectual property on behalf of the federal government that was created during our efforts with all other entities.

Two of these special powers from the Space Act were the creation of the ICB to offer a waiver of NASA's commercial rights to inventions developed by our contractors, and for the ICB to oversee the Space Act Awards Program. NASA conducts the only program in the Federal Government that can award money for scientific and technical contributions to any qualified person.

Background: Nearly 50 Years of Invention

So far during 48 years, over \$42 million (2006 dollars) has been paid to our contributors, about two-thirds to contractor and non-NASA employees.

NASA also saw a surge in software development over the past several years, with our developers now producing more high quality science and engineering software than all forms of software produced by the top five commercial manufacturers combined. NASA awarded 680 software developer authors for their 207 new releases this year.

NASA's innovations are abstracted and regularly published in *NASA Tech Briefs*, widely considered by R&D designers and practitioners worldwide as one of the best sources of new technology ideas. More than 400,000 read it each month, which makes it about 40 times as widely read as most technical journals. NASA awarded 1,456 *NASA Tech Brief* authors with recognition for their publications last year.

NASA has received over 6,500 patents since it was founded, about one in a thousand of all patents issued by the U.S. Patent and Trademark Office. Last year, 231 inventors received an award from the ICB for their 99 NASA patent applications.

2006 represented another year of great achievements and scientific triumphs for NASA and its technologists. 696 of them received ICB peer-reviewed board action awards this year for 186 technologies. These culminated with two superior cases receiving NASA's coveted Software of the Year award and Invention of the Year award. Each is an example of NASA's technological prowess being brought to bear to solve important problems in aviation and in the environment. Each is worth billions of dollars to the Nation and reflects a source of pride in American ingenuity.

Eleven exceptional cases are abstracted in this report, including an interview with the team lead on our Invention of Year. She is also our Board's newest member. You will learn firsthand about the dedication and professionalism of NASA's elite innovators.

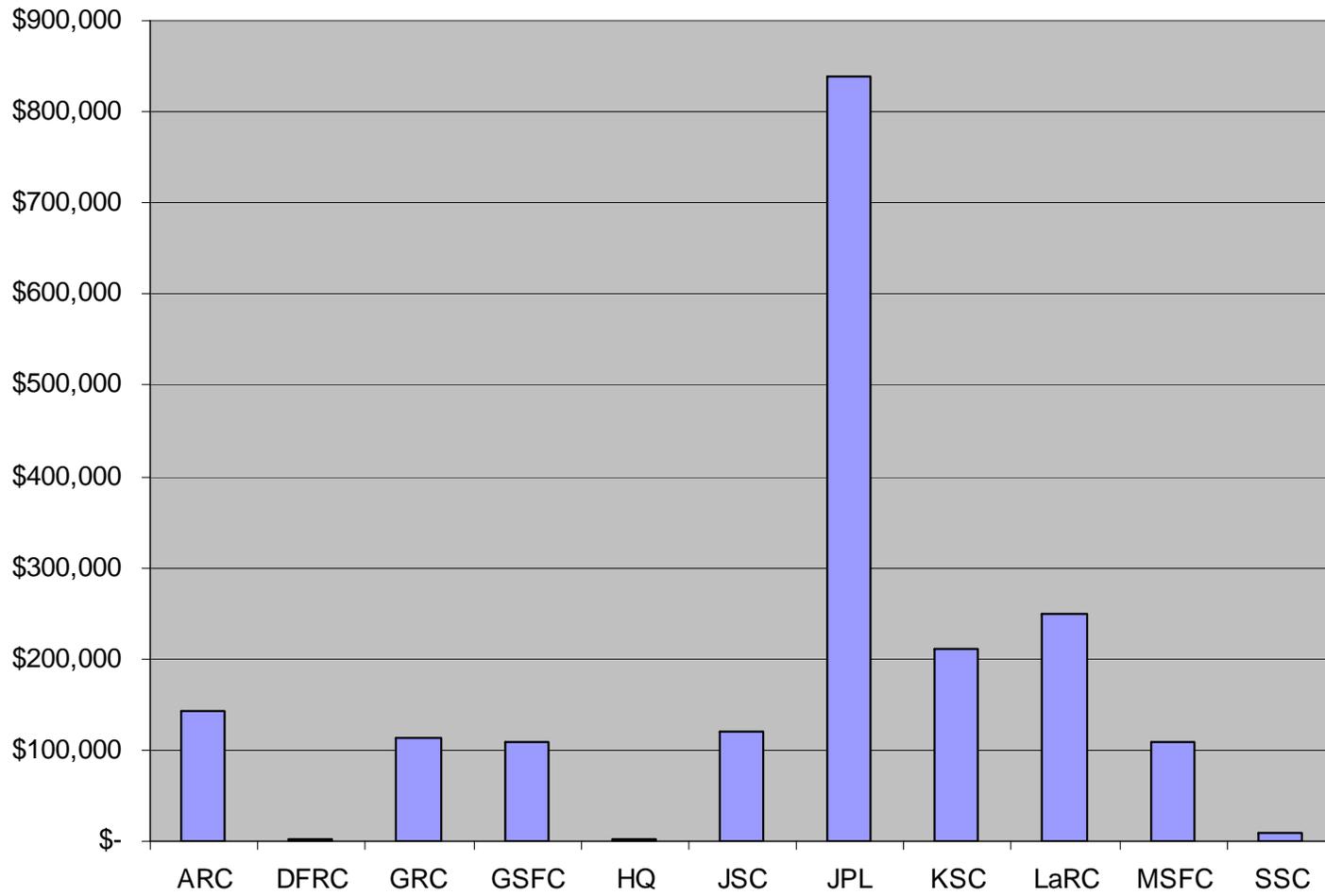
Performance: 2006 Awards Statistics and Metrics

During FY 2006, JPL produced the plurality of Space Act Awards. JPL reported 376 unique technologies this year, with 1,425 recipients of Space Act awards. These included 91 software releases (297 designers), 245 NASA Tech Briefs published (699 authors), and 116 cases undergoing ICB Board action review (429 contributors). The total amount paid in Space Act awards to JPL innovators was \$837,950. Across the civil servant Centers (which include Ames, Dryden, Glenn, Goddard, Headquarters, Kennedy, Johnson, Langley, Marshall, and Stennis), Langley provided the strongest performance in award payments. Langley reported 93 unique technologies for awards, with 364 awardees. These included 16 patents (45 inventors), 42 software releases (146 designers), 29 NASA Tech Brief publications (105 authors), and 17 Board action cases (68 contributors), totaling \$248,300. Kennedy, among the civil service Centers, produced the second best performance in Space Act awards in 2006, with 58 unique technologies developed by 217 recipients totalling \$211,450.

The grand total across the NASA family this year was 888 unique technologies receiving 3,063 awards. These included 99 patents, 207 software releases, 522 NASA Tech Briefs, and 186 Board action cases. \$1,908,400 was paid in awards.

The full array of metrics and statistics for the 2006 performance is available at http://icb.nasa.gov/ICB_Metrics/

Total Space Act Awards by Center



Exceptional Cases: 11 Contributions of Great Merit

The following describes the salient features of the top 11 cases peer-reviewed by the NASA Inventions and Contributions Board in FY 2006.

The JPL Table Mountain and Mauna Loa Stratospheric Ozone Lidars

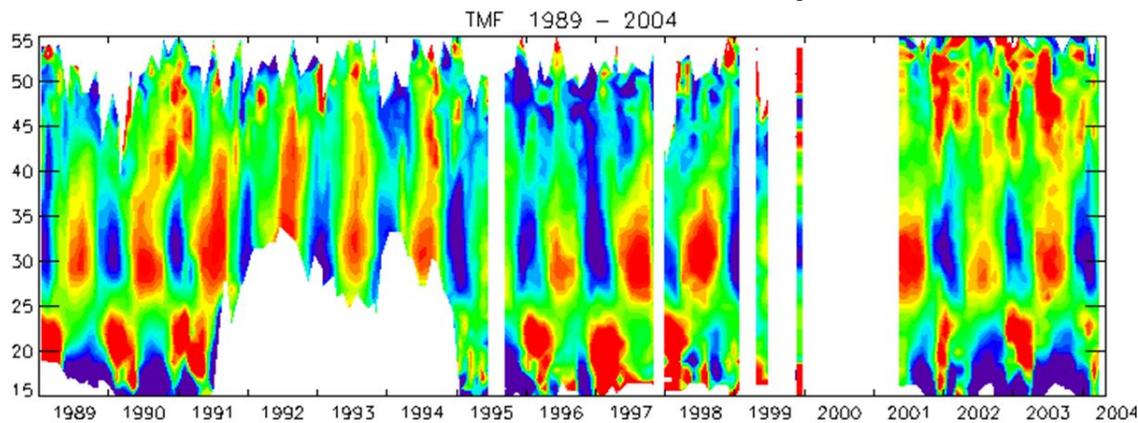


Figure 2. Ozone seasonal variations. Deviations (%) from the overall mean profile (red +20% - blue -20%).

The JPL lidars at Table Mountain Facility (TMF) and Mauna Loa Observatory (MLO) have proved to have the greatest range and accuracy of any systems deployed anywhere else in the world for monitoring ozone. For that reason they have become one of the instruments of choice in satellite validation programs. From a humanitarian viewpoint, atmospheric measurements related to ozone change, climate changes, and global warming, are important. For example, some signs of ozone recovery in the tropics and subtropics have been seen in the JPL measurements. This is an important indicator of the success and efficacy of various international agreements and protocols related to production and release of chemicals that have damaging effects in the atmosphere.

A New Algorithm for Routine Estimation of Global Vertical Electron Content Using 100+ Ground-Based GPS Receivers

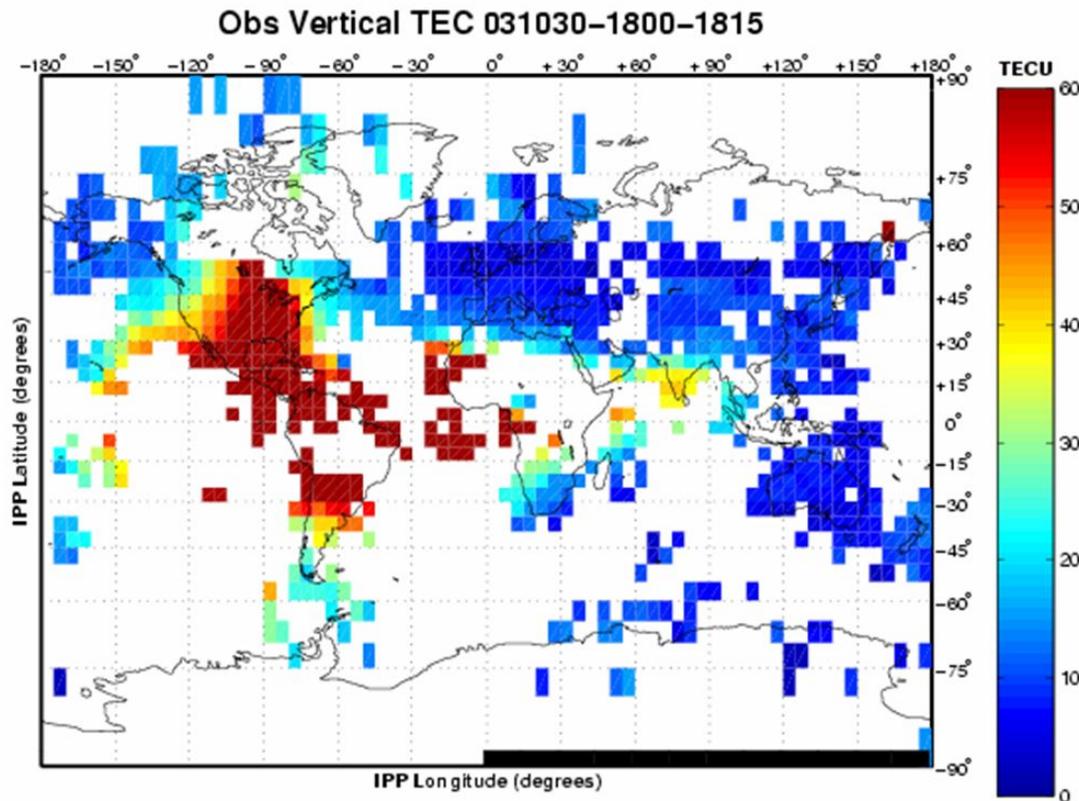
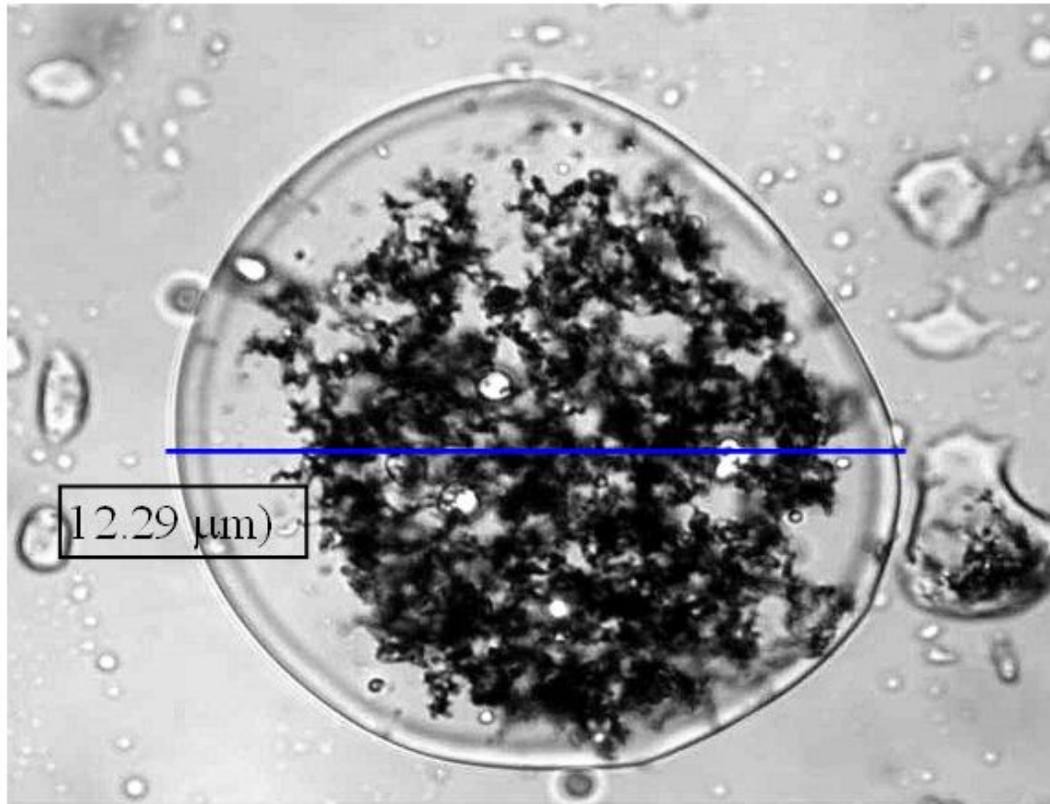


Figure 4. An example frame of daily all-site VTEC point-plot maps.

As the number of ground and space-based receivers tracking the Global Positioning System satellites (GPS) steadily increases, it is becoming possible to monitor changes in the ionosphere continuously and on a global scale with unprecedented accuracy and reliability. There are more than 1100 globally-distributed dual-frequency GPS receivers available using publicly accessible networks

including, for example, the International GPS Service (GPS) and Continuously Operating GPS Stations (CORS). To take advantage of the vast amount of GPS data, researchers use a number of techniques to estimate satellite and receiver interfrequency biases and the total electron content (TEC) of the ionosphere. Most techniques simultaneously estimate vertical ionospheric structure along with hardware-related biases treated as nuisance parameters. These methods often have a limitation of using up to a couple of hundred GPS receivers (up to 200 receivers), utilizing a sequential least squares or Kalman filter approach. This new, bias-fixing approach to calibrating GPS receiver and transmitter interfrequency biases takes advantage of all available GPS receivers using a new processing algorithm. This new capability is designed to estimate receiver biases for all stations. In this new approach, we solve for the instrumental biases by modeling the ionospheric delay and removing it from the observation equation using pre-computed ionospheric maps. The pre-computed maps use about 200 globally-distributed GPS receivers to establish the background used to model the ionosphere at the remaining 800 GPS sites. We found that this new bias estimation method results in a better than 1 TECU precision for middle latitude and better than 2 TECU precision for low-latitude station receiver biases. The new stand-alone software package downloads the data, edits and processes it to generate global vertical total electron content (VTEC) animations and calibrated slant TEC data files without user intervention. All NASA space missions are impacted by the most devastating space weather effects: the solar and geomagnetic storms. NASA directly benefits from this work to characterize the effects of solar and geomagnetic storms on the global ionosphere. Its direct impact on NASA's manned and robotic missions is evidenced where, for instance, the emission of energetic solar particles, caused by the same phenomena that result in ionospheric storms, could have devastating impact on manned and robotic space exploration missions. It has a direct bearing on the application of GPS to civil aircraft navigation, as the storms impact magnetic heading. Understanding the ionosphere on global scales has opened new areas of scientific investigation and the ability to pursue fundamental physics related to plasmas and the interaction of plasma with a dense neutral atmosphere.

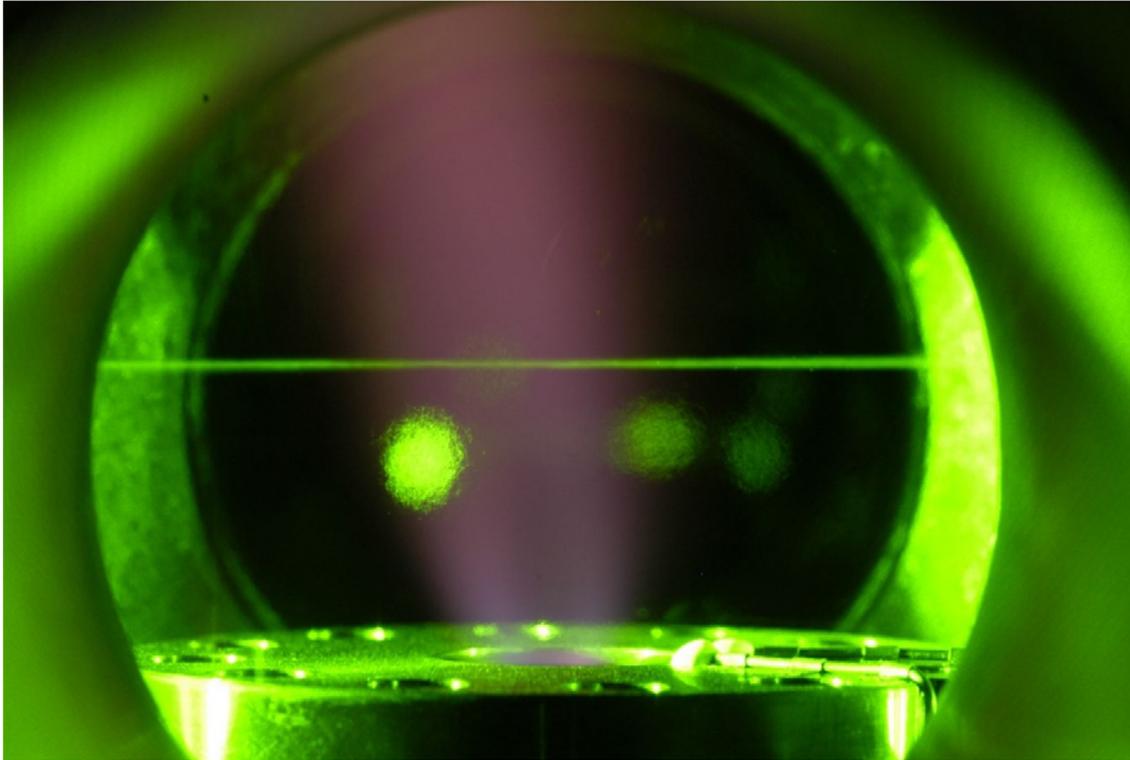
**2005 NASA Government & Commercial Invention of the Year –
Zero-Valent Metal Emulsion for Reductive Dehalogenation of DNAPL-Phase Environmental
Contaminants**



Micrograph of nano-iron emulsion.

Remediation of halogenated solvents, such as trichloroethene (TCE), halogenated hydrocarbons, other chlorinated solvents, is of great concern due to their toxicity and their persistence in the environment. Halogenated solvents, such as TCE, enter the groundwater and soil environments through improper disposal practices. These halogenated solvents are used by industry as degreasers in the production of dry cleaning fluids, spot removers, insecticides and pesticides, as well as in many other manufacturing processes. Because of halogenated solvents' wide variety of uses, they have become ubiquitous in the environment. According to the EPA, TCE has been found in at least 852 of the 1430 National Priorities List sites. When released into the ground, halogenated solvents, such as TCE, will sink through the subsurface soil and groundwater until it is contained by a nonpermeable surface such as bedrock. At this point it will pool and slowly dissolve into the aquifer in which it was released. Halogenated solvents, such as TCE, that have higher densities than water are referred to as Dense Nonaqueous Phase Liquids (DNAPLs). Due to the low solubility of many halogenated solvents, for example TCE's low solubility (1.1×10^{-3} mg/L), the pool will continue to contaminate groundwater for extended periods of time. As the groundwater is in constant motion, this pool can contaminate very large areas of potential drinking water. Breakdown of halogenated solvents in natural environments is very slow and produces other potential harmful by-products that are also regulated by the EPA in Title 40 Code of Federal Regulations. Currently, the maximum contaminant level of TCE acceptable in groundwater established by the EPA is 5 $\mu\text{g/L}$. Six licenses have been granted to use the patented techniques using Emulsified Zero-Valent Iron (EZVI). EZVI is a surfactant-stabilized, biodegradable water-in-oil emulsion with zero-valent metal particles contained within emulsion micelles. EZVI may contain either nanoscale zero-valent iron particles or microscale iron particles that are used to dehalogenate DNAPLs. However, other zero-valent metal particles and combinations may be used, including various bimetallic particle combinations and, more specifically, iron particles doped with palladium. EZVI was developed to degrade very high concentration halogenated compounds like the cleaning solvents that NASA used ubiquitously during the Gemini and Apollo programs. These solvents, which are now known to be carcinogenic, were often disposed of into the subsurface at a number of NASA Centers. Subsequently, it has become NASA's responsibility to return impacted natural media to as near pristine conditions as possible. The spinoffs into cleaning the environment are manifold and of immense value.

High Speed Electro-Mechanical Shutter for Imaging Spectrographs



Scientifically, the innovation was critical in enabling the development of a platform-independent Raman calibration database for the general scientific community. This transferable standards calibration database allows Raman scattering to be routinely used as a tool for the quantitative and non-intrusive measurement of chemical species and temperatures in high pressure flames and combustion systems. By temporally gating the background light and synchronizing the Raman signal with the excitation laser, a thousandfold gain in signal is achieved. The improved signals permit a high level of signal quality and fidelity ideally suited for the development of a transferable-standards calibration database for Raman scattering that can be used by other researchers in the field of combustion (which includes both the aeronautics and space community). The development of such a database permits the routine use of Raman scattering as a tool without having to perform the expensive and time-consuming calibration flame studies (involving hundreds of

flame conditions and multiple sets of fuel and oxidizers) that were required in the past. Technologically, the innovation is significant because it enables the measurement of very weak pulsed light signals buried in optically noisy environments. The high speed shutter system was critical to the utilization of a high dynamic range (200,000:1) back-illuminated charge-coupled detector (CCD) array, which enabled weak Raman scattering signals to be distinguished from a background of bright flame luminosity. The innovation allows the use of simple, low-speed, off-the-shelf electric motors (6000 rpm) to deliver microsecond optical gating performance with excellent longevity (in production use for over 4 years) and low temporal jitter (< 1.5 microseconds) through a unique electronically controlled phase-locked loop (PLL) synchronization system. By using multiple rotating chopper wheels, both the gate duration and duty cycle were controlled and reduced to a value suitable for synchronization with existing state-of-the-art pulsed Nd:YAG laser systems and large-area CCD array detectors. Previous to this innovation, mechanically geared high speed (22,000 rpm) rotating blades were required to achieve the same level of signal quality, and were difficult (and potentially dangerous) to implement and less robust due to the mechanical friction and wear of gears. Other alternatives included the use of much less sensitive intensified CCD arrays which suffered from poor quantum efficiency (15%) and low spatial resolution and dynamic range (1000:1). This invention benefits the general commercial market of spectroscopic chemical sensing instruments by providing a new signal-enhancing technology for Raman spectroscopic analysis.

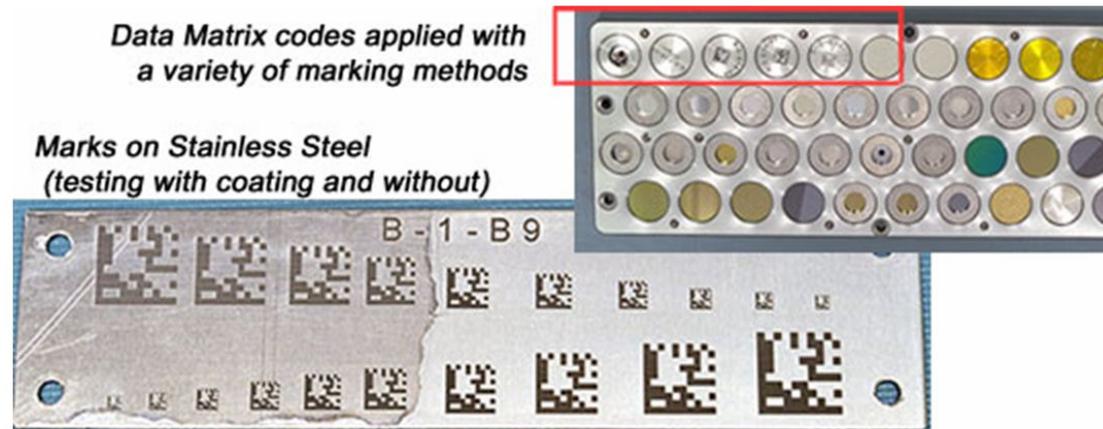
Application of Patented Airfoils to New Main Rotor Blades for the S-61 Helicopter



These inventions created a family of rotorcraft airfoil shapes designed for high lift and low pitching moments. These airfoils are especially applicable to the inboard region of a main rotor blade or a tail rotor blade. A second family of airfoil shapes designed for high drag divergence Mach numbers and low pitching moments. Airfoils of this second family are particularly applicable to the tip region of a main rotor blade or tail rotor blade. Airfoils for main rotors require low pitching moments to reduce the rotor blade torsional loads. These airfoils, as applied to the main rotor of a United Technologies Sikorsky S-61 helicopter, greatly increase the

lifting capacity, operational envelope, and forward flight speed of this helicopter. The application of these airfoils to new rotor blades for other helicopters could similarly improve their performance. These airfoils are also being applied to new tail rotor blades for the S-61 helicopter. The use of these new tail rotor blades will permit the S-61 helicopter to operate at higher altitudes (especially on hot days) with greater payloads. The overall market potential for reblading the S-61 fleet is about \$150 million. The patents have expired.

Data Matrix - A NASA Family of Technology Solutions for Safer Space Flight



The first feasibility study done on direct part marking using Data Matrix was after the last two shuttle orbiters were delivered to NASA by Rockwell. The studies showed that if Data Matrix had been used instead of the paper bar codes and manual data entry approach that was in use at that time to manufacture the vehicles, a savings of about 2 to 3 million dollars for each vehicle would have been realized. Since the cost of the system at that time would have been only a few hundred thousand dollars, the system would have returned the investment within the first year of use and many times over after that. To date the use of Data Matrix in NASA has been to solve specific problems. For example there was an incident in the manufacture of the RSRM where bar code paper labels were inadvertently left on rubber insulating blankets through the oven cure cycle. Obviously the layers of blanket material did not bond in the area of the labels when the layers melted together. The cost of the rework, lost material, management attention and months of meetings likely had a cost of millions of dollars. The problem was remedied by the implementation of Data Matrix direct marked on the rubber blankets with a dot peen machine to eliminate the paper labels. No one had to remember to remove the labels and stick them on a Quality Check board, no one had to check for label removal and no more meetings about this mistake again. The cost of the mistake was millions of dollars. The cost of the Data Matrix fix was in the thousands. The use of Data Matrix universally by NASA is imminent. Implementation studies are underway by several of NASA's prime contractors, who are already required to use Data Matrix for DoD contracts. For the Exploration Systems Projects, like the Crew Launch Vehicle, to meet safety, cost and schedule goals, automatic identification using the Data Matrix will offer tremendous advantages over all previously used manual processes.

PHANTOM – A Unified Flow Analysis for Turbomachinery Flows

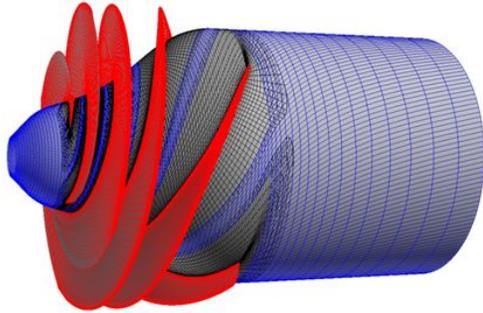


Figure 9. Computational grid for the inducer.

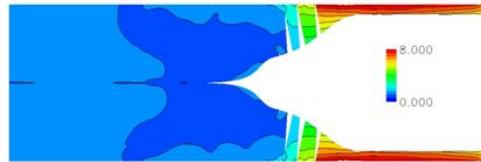


Figure 11. Cross-section view of the static pressure in the inducer.

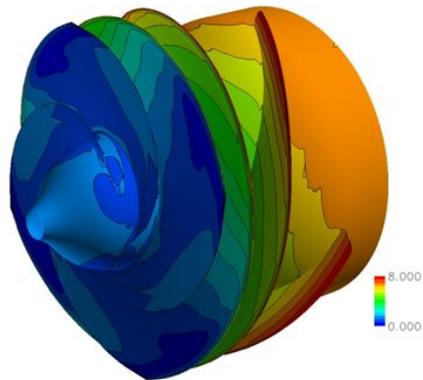


Figure 10. Time-averaged static pressure contours in the inducer.

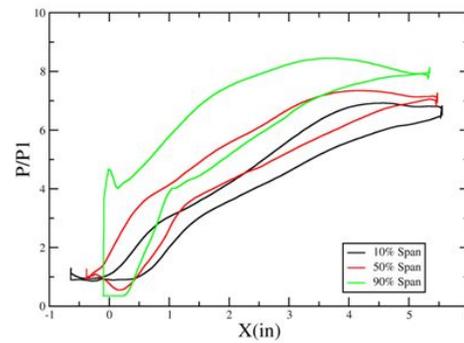
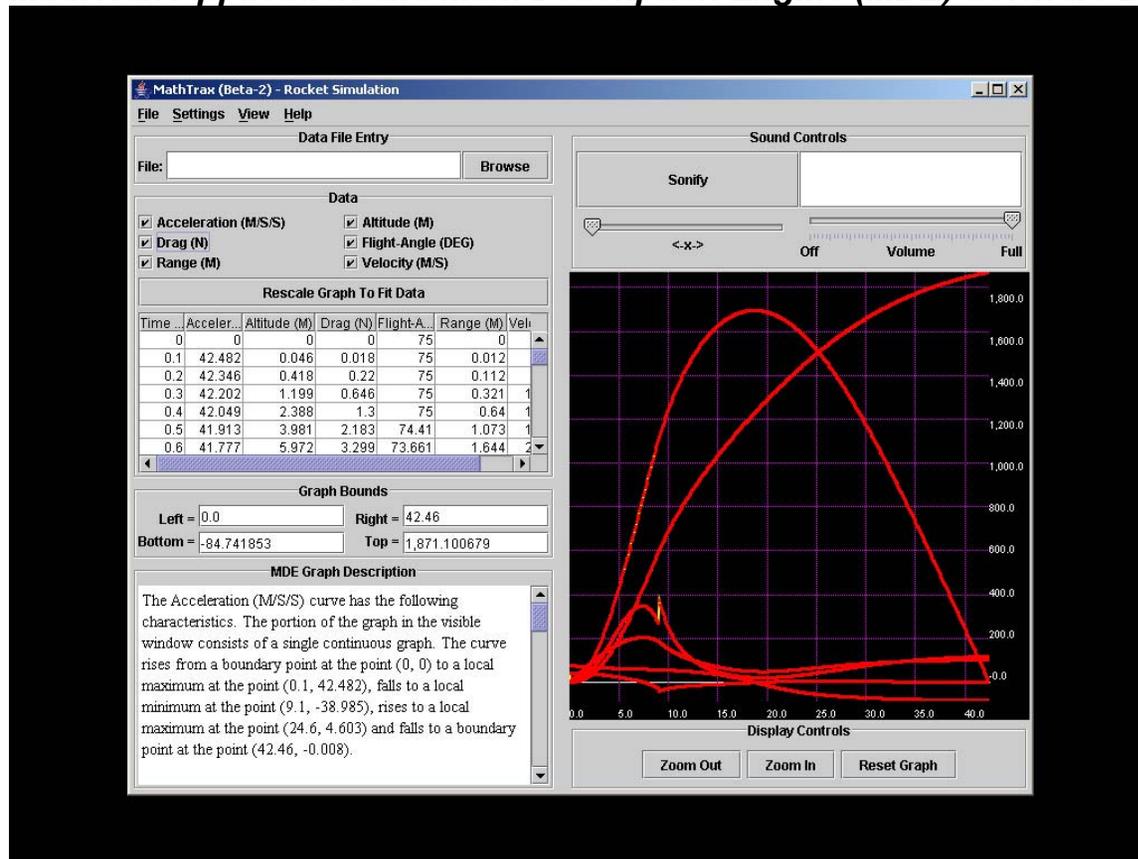


Figure 12. Time-averaged surface pressure distributions on the inducer.

A unified code, called PHANTOM, has been developed for predicting the flows in rotating turbomachinery components. The code includes modeling that enables its application to rocket-engine, jet-engine and air-handling geometries. The code can be used for liquids, gases, and two-phase flows. PHANTOM can be applied to flow regimes ranging from incompressible flow to supersonic flow with shock waves. The PHANTOM code is being, and has been, applied to both new designs and anomaly investigations. The code is currently being used in the design and analysis of turbomachinery and Main Propulsion System components for the CLV and CEV propulsion systems. The code was used to identify vortex shedding as the unsteady mechanism causing cracks on the first-stage vane in the SSME low pressure oxidizer turbine, as well as in the redesign of the vane. PHANTOM was also used in the investigation of cracks in the flow liner upstream of the SSME low pressure fuel pump inducer, and to characterize the flow in the Shuttle hydrogen tank diffuser core as part of the STS-114 pre-pressurization anomaly investigation. The PHANTOM code is used at all levels of the design and analysis process, from the design of basic blade profiles for pumps and turbines, to the final analysis of the pump/turbine system. The code has also been used in anomaly investigations to determine the sources of unsteadiness in turbine, pump, and duct geometries. The PHANTOM code is currently being used for turbomachinery design and analysis by government agencies (including NASA), industry (including Pratt & Whitney/Rocketdyne and Florida Turbine Technologies), and academia (including the University of Michigan and Ohio Northern University).

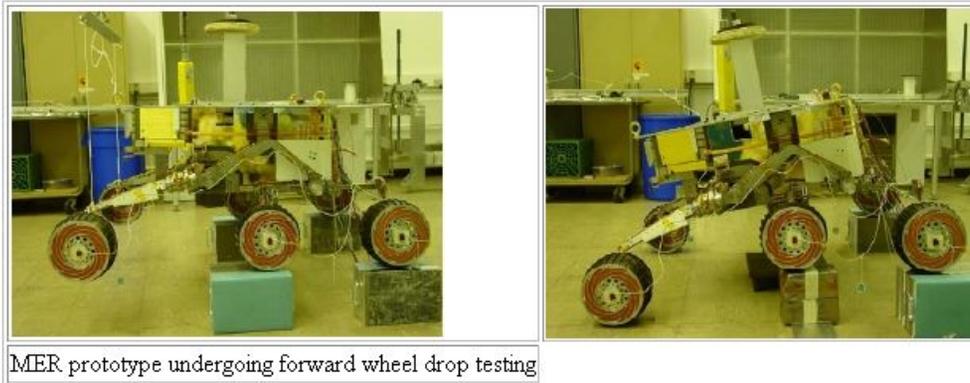
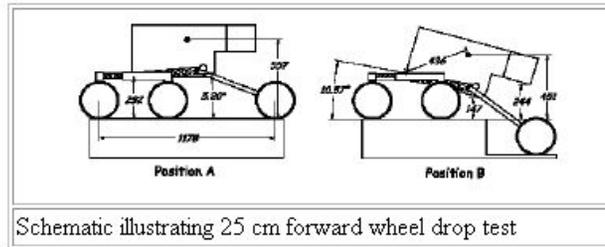
MathTrax Application and Math Description Engine (MDE) Software Development Kit (SDK)



MathTrax supports NASA's Education mission by providing a software tool to help students learn and understand mathematics. It was developed as an enabling technology which provides automated text descriptions and sonifications for graphical science and math content as alternative access for persons with vision or spatial perception disabilities. While originally developed for students with disabilities it is proving extremely useful for the student population in general in providing an alternate approach for the comprehension of math enabling for the first time in many cases an understanding of science and technology. MathTrax currently has

three modes of use for educational purposes. MathTrax Equations mode is a graphing calculator that provides descriptions of graphs using text and sound, in addition to drawing graphs of equations. The graphs are generated by entering an equation or selecting an equation from a drop-down menu. MathTrax Data Analysis mode permits importation of independent datasets that are analyzed and graphed. MathTrax Physics mode simulates either a roller coaster car moving along a mathematically described track or a rocket launch. A successful simulation is achieved through the right combination of variables that are determined by the user. In addition to graphical feedback on the simulation run, accessible descriptions are provided in the forms of text and sound. The interactive MathTrax application uses rule and computation based Artificial Intelligence to synthesize text descriptions for graphs of mathematical equations, tables of data, and results of simulations. The sonification engine renders any planar curve as a mixture of stereo tones. MathTrax utilizes the Java Accessibility Bridge and is completely accessible to all persons including those using standard screen reading assistive technology. MathTrax debuted in 2004 as the key technology which enabled 12 blind high school students to fully participate in a summer science camp sponsored jointly by NASA and the National Federation of the Blind. The students used MathTrax to perform the mission planning (trajectory design) and data analysis required for a sounding rocket mission launched from the Wallops Flight Facility. MathTrax provided the unique technological solution that gave these students full engagement in the science camp rather than being passive participants. This first-of-its-kind activity was repeated in 2005, again using MathTrax as the key analytical tool. In the past year, over 11,000 sites have downloaded the MathTrax software. The Math Description Engine Software Development Kit (MDE SDK) is the underlying technology of MathTrax. The Java-based MDE SDK provides MathTrax capabilities to other applications that can benefit from the addition of accessible text and sound descriptions of graphs and data displays. Consider the large number of web pages offered by NASA to the public which contain graphical representations of live data. To comply with Section 508 of the Americans with Disabilities Act (ADA), these pages must include alternate description of the graphical content. The MDE SDK technology provides a way to automate creation of these descriptions - a capability not known to exist elsewhere.

Rocker Bogie Suspension System



This is the suspension system for a six wheeled vehicle that uses a single (non-articulated) body. This is a thermal advantage on Mars. It does not involve springs or elastic deflection members. A 'sprung' wheel increases downward force as it climbs. This makes it more difficult to climb and reduces traction on the other wheels. The unit is completely passive (not robotically power actuated). This is in use on the two MER vehicles and was used on Pathfinder in 1997. The suspension linkage allows the wheels to climb obstacles while raising the overall vehicle by approximately one-sixth as much as the wheels must elevate. The use of linkage analysis allows the wheel torque reactions to be included in an optimization of the geometry. It allows a vehicle to be very robust in its travel over obstacles which are much larger than that allowed by prior art while being unattended.

Short-Term Forecasting of Radiation Belt and Ring Current

FOK AND MOORE: RING CURRENT MODELING IN A REALISTIC MAGNETIC FIELD

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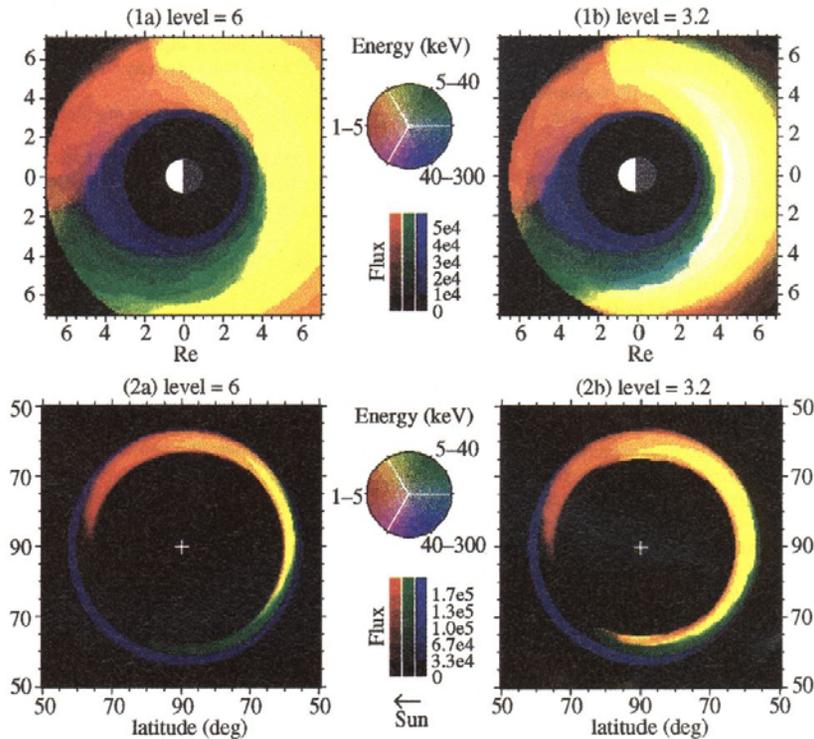
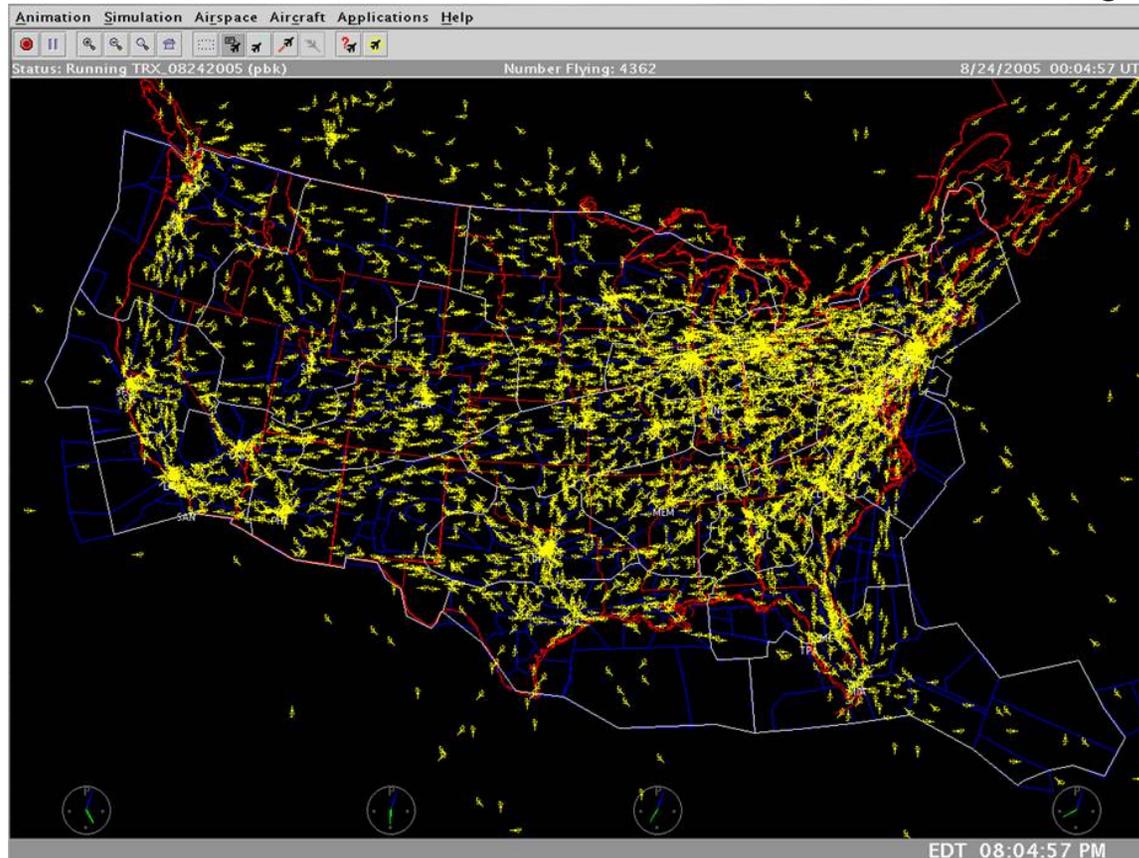


Plate 1, 2. Plate 1: equatorial H⁺ fluxes ($\text{cm}^{-2}\text{s}^{-1}\text{sr}^{-1}\text{keV}^{-1}$) and Plate 2: precipitating H⁺ fluxes ($\text{cm}^{-2}\text{s}^{-1}\text{keV}^{-1}$) at (a) substorm onset, and (b) at the end of the expansion phase. Ions with energies 1–5, 5–40 and 40–300 keV are represented in red, green and blue, respectively. The color bars indicate the minimum and maximum flux levels shown in the plates.

The contribution is a simulation code that is able to predict the energetic ion (10 keV to 1 MeV) and electron (10 keV to 5 MeV) fluxes and radiation environment in the radiation belt and the ring current 1-hour ahead of time. The core of the code is the solution of the advection-diffusion equation of the energetic electron and ion distribution functions. The ring current ion flux and the corresponding neutral atom emissions generated from this simulation code were used to guide the design of the neutral atom imagers

on the NASA Imager for Magnetopause-to-Aurora Global Exploration mission. This code is also operated and run in the Community Coordinated Modeling Center at the Goddard Space Flight Center to provide now-casting of energetic ion and electron fluxes in space. This code was used to support the mission planning for the Living with a Star Radiation Belt Storm Probe (LWS RBSP) mission. Simulated electron fluxes were generated as seen by the particle instrument on the RBSP with different spacecraft spin axis directions. The purpose of the study was to determine whether ecliptic normal attitude or Sun-pointing attitude for spacecraft spinning provides better resolution of the electric field and particle pitch-angle distribution. This radiation belt-ring current simulation code is a very powerful tool for studying the transport, energization, and decay of the energetic plasmas in space. Radiation belt forecasting capabilities of this code can provide warnings for appropriate actions to protect satellite systems and humans in space.

2006 NASA Software of the Year -- FACET: Future Air Traffic Management Concepts Evaluation Tool



FACET models, designs, and operates the large and complex U.S. National Airspace System (NAS). It has two primary uses: (1) as a simulation, modeling, and analysis capability at the national level and (2) as an environment for the development and evaluation of real-time decision support tools for the Federal Aviation Administration (FAA) and the airlines.

FACET has performed the following operations: (1) benefits assessment study of a new decision support tool for direct routing, (2) calculation of the feasibility of cockpit-based self-separation for free maneuvering operations (a key element of the Free Flight concept), (3) synthesis of a method for modeling and predicting air traffic controller workload, and (4) development of traffic flow management technologies for increased NAS throughput and capacity utilization. Technologies derived from FACET are used by the FAA's Air Traffic Control Systems Command Center (ATCSCC), the airlines, and General Aviation for cooperative decision making. ATCSCC employees use FACET's traffic flow management techniques such as rerouting, metering, and ground delay, along with its traffic forecasting ability, to develop ATCSCC's daily strategic plan of operations to achieve efficient traffic flow through the entire NAS. Airlines use FACET's traffic forecasting abilities to determine airport demand and regions of congestion for planning their fleet operations. Use of FACET-based technologies improves NAS throughput and utilization, reduces flight delays and/or cancellations, and provides common situational awareness. Better utilization of existing resources will allow the existing NAS infrastructure to accommodate growth of air traffic for several years. Reduction of delays and better schedule adherence will improve airline profitability, which will directly benefit the U.S. economy, with impacts of savings in fuel and productivity in the billions of dollars. Airline passengers will also experience a higher degree of satisfaction due to fewer delays and cancellations.

Invention of the Year -- Interview with Dr. Jacqueline W. Quinn, Team Lead, EZVI

Q: When you look back over your NASA career, have opportunities provided by NASA enabled your career success as a scientist? How?

A: Most definitely! NASA has supported my efforts to return to school for two graduate degrees. Pursuit of these degrees allowed me to work with some amazing professors and helped to mold my research skills.

Q: In what ways do you believe that NASA's approach to R&D and science has not only helped NASA but also mankind?

A: NASA encourages its scientists to be “out of the box” thinkers, and by doing so the Agency allows for a type of creative explosion. This fostering of non-traditional engineering and science brings about so many useful tools for every day life, from computer programs, polymer coatings and new alloys to even environmental cleanup technologies.

Q: In what ways did the team approach with UCF enhance your project (and your invention)?

A: Teams in general always enhance an innovation, as everyone sees something the other did not. Our team was particularly effective because we brought together such different expertise. Working with two brilliant Chemistry Professors (Dr. Chris Clausen and Dr. Cherie Geiger), an incredible graduate researcher (Kathy Brooks) and an outstanding Environmental Engineering Professor (Dr. Debbie Reinhart) on the EZVI project was an amazing scientific adventure!

Q: What new discoveries and inventions do you see coming from your current line of research?

A: Our team is now focused on a bimetallic reactant that is capable of degrading polychlorinated biphenyls (PCBs) that are found on structural paints, caulking or in adhesive binders. The technology is also portable to sediment systems within our environment.

The Board and Staff Making It Work

The Inventions and Contributions Board is made up of the following membership:

Christopher J. Scolese, Chair and NASA Chief Engineer

Walter D. Hussey, Office of the Chief Engineer, Vice-Chair

Dr. Biliyar (Bil) N. Bhat, MSFC, EM30

Dr. Donald C. Braun, GRC, VCD0

Sandra A. Cauffman, GSFC, 417.0

Christopher J. Culbert, JSC, Automation, Robotics, and Simulation Division

Dr. Anngienetta Johnson, Office of Education

Alan J. Kennedy, Office of the General Counsel

Carey F. Lively, GSFC, Systems Engineering, 593

Reginald (Reg) S. Mitchell, GSFC, 542.0

Dr. Ruth H. Pater, LaRC, RTD

Dr. Jacqueline (Jackie) W. Quinn, KSC, KT-D-2

Pamela R. Rinsland, LaRC, SED

Dr. Robert (Bob) C. Youngquist, KSC, KT-D-1

vacancies (3)

The Board Staff is composed of:

Mr. Anthony (Tony) J. Maturo, ICB Staff Director; Ms. Iona Butler, Records Manager; Dr. Paul A. Curto, ICB Chief Technologist; and Ms. Gail M. Sawyer, Patent Waivers Examiner; Robert F. Rotella, Counsel to the Board, Office of the General Counsel

In addition, the ICB is supported by a field operation of Awards Liaison Officers, Patent Counsels and Attorneys, technology transfer and software release authority personnel. Our Awards Officers and their contact information is shown next.

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