AEROSPACE RESEARCH AND GRADUATE EDUCATION FOR THE FUTURE

NATIONAL INSTITUTE OF AEROSPACE

2007 ANNUAL REPORT

www.NIAnet.org

NIA By the Numbers

Research

56	Members of resident research staff
8	University research staff in residence at NIA
47	Scholars from around the world participated in the '07 Visiting Researcher Program
80	Research projects funded at member universities
73	Peer-reviewed publications
68	Conference presentations
32	Separate awards for NIA research contributions

Graduate & Continuing Education

50	Full-time graduate students in residence
15	Part-time graduate students enrolled
34	Graduate (M.S. and Ph.D.) degrees awarded since inception
14	Full-time and part-time faculty in residence
30	Resident M.S. and Ph.D. programs offered on-site at NIA by 7 member universities
120	Course offerings each semester in distance education catalog
10	Short courses, 48 seminars, and 13 workshops, including 3 NESC Academy short courses

Outreach

32	Science and math teachers attended Fifth Annual NIA Educators Workshop
350	Pre-service teachers from 51 schools and 24 states attended NASA annual conference
24	Pre-service teachers attended two-week Summer Institute at NASA Langley
126	Summer interns participated in Langley Aerospace Research Summer Scholars Program, 25 continued into Fall semester
4	Faculty participated in ten-week Langley Faculty Fellowship Program

Financial

$29.1 M	FY07 Revenue
$1.0 M	FY07 Member university cost sharing
$30.9 M	FY08 Projected revenue

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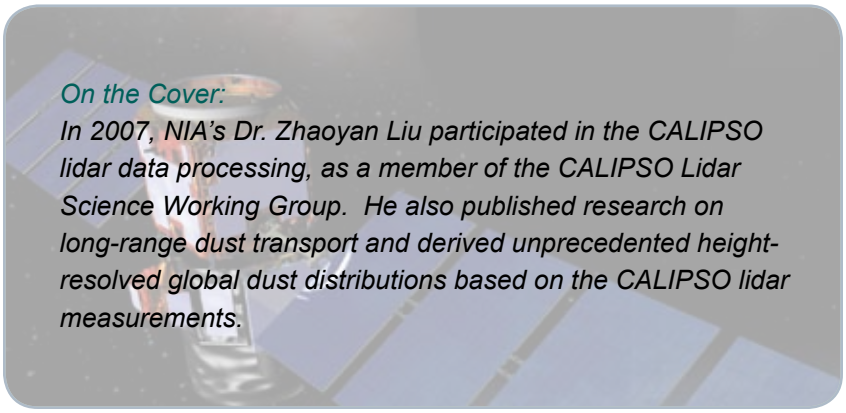


On the Cover:
In 2007, NIA's Dr. Zhaoyan Liu participated in the CALIPSO lidar data processing, as a member of the CALIPSO Lidar Science Working Group. He also published research on long-range dust transport and derived unprecedented height-resolved global dust distributions based on the CALIPSO lidar measurements.

Letter from the President

2007 was a momentous year for the National Institute of Aerospace. The year witnessed the culmination of five years of strategic investment by NASA's Langley Research Center in the formation of a new research and graduate education institute, and the transition of the Institute to self-sustaining, financially independent operations, as envisioned by NASA more than five years ago.

In 2002, our consortium of universities and AIAA committed to establish the National Institute of Aerospace and build programs in research, graduate education, outreach and technology transfer, consistent with Langley's vision for an independent collaborative partner.

In 2007, the institute has achieved each of the goals established five years ago. We are now in a position to become a leading aerospace research institution, capable of addressing the most important research challenges in aerospace engineering, technology development and the advancement of atmospheric, Earth and space science.

NASA envisioned an institute that would conduct leading edge aerospace and atmospheric sciences research and develop revolutionary technologies. In the pages of this annual report, we have highlighted some of NIA's most important accomplishments of the past year across a broad range of science and engineering disciplines.

NASA also envisioned an institute that would create innovative, creative, synergistic partnerships among LaRC, academia and industry. Since 2003, our collaborations have included industry (Boeing, Lockheed Martin, Airbus, Northrop Grumman, Aerojet, etc.), large research universities (Princeton, MIT, Texas A&M, etc.), local and minority serving universities (Norfolk State, Christopher Newport, University of Maryland Eastern Shore, etc.) and other non-profit organizations (e.g., Nortel LearniT). Our research programs have involved more than 150 international scholars from more than 40 institutions on five continents.

NASA envisioned that the institute would be home to a number of permanent faculty members, each pursuing research in emerging technical areas of importance to LaRC, and would provide comprehensive graduate and continuing education in science and engineering. In these pages you will find the latest scholarship, teaching and service accomplishments of our six chaired Samuel P. Langley Professors and their research staff and students. You will also find a summary of the graduate programs currently offered at NIA by our member universities, and our progress in educating those who will become the next leaders of our nation's aerospace enterprise.

In 2002, NASA envisioned an institute that would promote aerospace science and engineering and provide outreach to the region and the nation. In the last several years, NIA has built a comprehensive outreach program that employs strategies to meaningfully impact the quality and quantity of America's future technologically literate workforce. These programs, supported by grants from NASA, AIAA, DoD and others, l verage our strengths in teacher professional development, workforce training, multimedia communications, and 21st century information and communications technologies such as webinars, videostreaming and blogs.

During 2007, NASA Langley awarded new research projects to NIA on a wide range of topics including subsonic aeromechanics, advanced aircraft technology, lunar architecture analysis, CALIPSO aerosol and cloud measurements, spacecraft autonomy for in-space operations, and acoustic propagation. NIA-affiliated faculty and staff receiving new awards included Prof. Bobby Braun (Georgia Tech) for trajectory analysis and entry systems, Prof. John Knight (UVa) on software

Mission

…Foster research collaboration among national laboratories, academia, and industrial partners to stimulate innovation and creativity.

…Provide comprehensive graduate and continuing education in science and engineering via local campus presence and distance learning concepts.

…Incubate and stimulate the commercialization of new intellectual property developed through the Institute's research activities, including radical ideas and disruptive technologies.

…Promote aerospace science and engineering and provide outreach to the region and nation.

dependability for unmanned systems, Prof. Abdelmageed Elmustafa (ODU) for deposition of wireless nanosensors, and Dr. Wenbo Sun (Hampton Univ.) for atmospheric research.

During 2007, NIA research staff and faculty were selected for 11 awards under the NASA Research Opportunities in Aeronautics (ROA) competition, including research in rotorcraft aeromechanics, rotorcraft noise prediction, probabilistic design tools for high-cycle fatigue-resistant structures, time-dependent optimal control (with North Carolina A&T), multiscale modeling of nano-structured composites (led by Texas A&M), adaptive robust control for hypersonic vehicles (led by MIT), adaptive control for safety critical applications (with MIT), formal verification and automated testing for diagnostic and monitoring systems (with SRI), fault diagnosis and prognosis and reliable flight envelope assessment, LMI-based Analysis tools for learning algorithms (led by Georgia Tech), and adaptive control with guaranteed performance bounds (led by Virginia Tech).

Christopher Scolese (NASA Associate Administrator), Bob Lindberg (NIA President & Executive Director), Lesa Roe (LaRC Center Director), Bryan O'Connor (NASA Chief, Safety & MIssion Assurance)

Under a new six-year framework agreement with Airbus North America, NIA initiated in 2007 a collaborative research effort in laminar flow technology involving faculty from member universities, NIA research staff members, and faculty from non-member universities in the U.S. We also conducted Airbus-supported workshops on wireless communications for commercial aircraft and nanotechnology for commercial airframes. The results of these workshops have led to new collaborative proposals in these two fields.

In 2007, we also bid farewell to two of our original Board members: University of Virginia Provost Gene Block and University of Maryland Provost Bill Destler. We extend our heartfelt thanks to them for their guidance and unwavering support, as they move on to new academic leadership positions as Chancellor of the University of California at Los Angeles, and President of Rochester Institute of Technology, respectively. In their place, we also are delighted to welcome to our Board Dr. Tim Garson of the University of Virginia, and Dr. Herb Rabin of the University of Maryland.

Our research staff, affiliated faculty and students have received numerous awards in 2007 for their efforts; in the pages of this report you will find the details of these awards.

In addition to these many individual and team awards, in the spring of 2007, NASA Langley Research Center nominated NIA for the 2007 George M. Low Award for Quality and Excellence, NASA's highest award for contractor performance. In September 2007, on the eve of the 5th anniversary of the institute, we were notified that NASA Headquarters had selected NIA as a finalist for the Low Award. This important recognition from NASA comes as NIA now takes on the challenge of transitioning from five years of NASA strategic investment in the formation of the institute, to a new era of self-sustaining, financially independent operations. Thanks to the unwavering support of Langley Research Center, our member universities, AIAA, and our many collaborators, NIA today is well positioned to continue the mission to achieve our original founders' vision.

Robert E. Lindberg, Eng.Sc.D.

Center for Adaptive Aerospace Technology

"Our ornithopter work has been a challenge. The bird only weighs three pounds, so you can't add much … It was a huge effort to get the ornithopter data. These are some of the most sophisticated experiments ever done. In my opinion, it's groundbreaking work."

James E. Hubbard, Jr., Ph.D.
University of Maryland

Samuel P. Langley Professor Dr. James Hubbard received a bachelor's in mechanical engineering in 1977, a master's in mechanical engineering in 1979 and a doctoral degree in aero-acoustics in 1982: all from the Massachusetts Institute of Technology. Dr. Hubbard has also held senior research positions at the Charles Stark Draper Laboratory, Optron Systems Inc., Boston University and PhotoSense Inc. He was co-founder and Chief Technology Officer at iProvica, a firm specializing in wireless health-monitoring technologies. Dr. Hubbard is the recipient of the Black Engineer of the Year President's Award, the International Society for Optical Engineering Smart Structures Product Innovation Award, four Charles Stark Draper Engineering Vice President annual award and the IBM Young Faculty Development Award. A fellow of the Vertical Flight Foundation, Dr. Hubbard was selected in 1984 as a NASA astronaut candidate and in 2000 was honored in his hometown of Danville, Va. for lifetime achievement and community service. He is the author of more than 60 technical publications, has generated 12 U.S. patents, and has served on numerous technical boards and committees.

If fixed-wing flight one day gives way to craft able to flex their wings and move their bodies like birds, it may well be because of the work done by Dr. Hubbard and his students. Dr. Hubbard's Center explores the application of emerging technologies for revolutionary vehicle concepts, including the exploration of biologically inspired approaches to controls and autonomous behaviors.

In 2007, Dr. Hubbard's team conducted a series of flapping-wing experiments on a small craft known as an ornithopter. Seven cameras captured wing movements and sensors recorded reams of data on ornithopter aerodynamics. A series of papers scheduled to be published in 2008 will detail the results and experimental conclusions.

Synthetic jets are used to inject energy into flows through the transfer of momentum into or out of the system. They can be used to increase the efficiency of aircraft by increasing its lift to drag ratio. Synthetic jets come in a variety of forms, can be made compact, lightweight, low power, and mechanically simple.

Given that the jets would have to be small but robust for their size, Center students are exploring ways to optimize designs that would incorporate the jets internally, within the UAV wings themselves. The goal is to better understand the air flow that would affect both the external surfaces and the inner workings of the jet as the propellants combine.

In 2007, Dr. Hubbard, his graduate students, and post-doctoral fellows continued with a number of projects related to the Sky Walker research program, which aims to meld together lightweight metals, composite materials, advanced sensors and miniaturized control systems to constantly adjust lifting surfaces for maximum range and speed as do birds on the wing. Sky Walker-related projects are funded by the Defense Advanced Research Projects Agency.

NASA Langley hosts the Center's Morpheus Laboratory, which has recently been expanded to include design and construction of small, fixed-wing research aircraft.

Notional Sky Walker Demonstrator platform Stemme S-10 Motorglider

Center for Aerospace Systems Engineering, Modeling & Simulation

"Inspired by all that has come before, and guided by clear objectives, today we set a new course for America's space program. We will give NASA a new focus and vision for future exploration. We will build new ships to carry man forward into the universe, to gain a new foothold on the moon, and to prepare for new journeys to worlds beyond our own." With those words on January of 2004, President Bush announced a new Vision for Space Exploration. NIA, through Dr. Wilhite's Center, is playing a key role in making this vision a reality.

Center researchers and students have led a number of activities in support of NASA's Exploration Systems Architecture Study (ESAS) and Lunar Architecture Team (LAT) to define the systems and technologies required to return humans to the Moon and on to Mars. They are currently serving as an integral part of NASA's Constellation Architecture Team (CAT).

This artist's rendering represents a concept of departure stage engines firing to take a crew exploration vehicle (CEV) and a lunar lander further into space. (Credit: NASA)

Dr. Wilhite and his 12 graduate students are in various stages of developing a comprehensive, end-to-end human-to-Mars architecture, assessing how NASA's Constellation Program will use a combination of rockets and spacecraft to make interplanetary travel practical. As a part of this effort, the Center is evaluating how astronauts can "live off of the land" through *in-situ* resource utilization (ISRU). On Mars, for example, propellants and breathable air could be manufactured from naturally occurring elements in the Martian atmosphere and soil.

> *"We're modeling ways to live off the land, so to speak. The real key is to minimize the fuel burn, maximize performance and safely land and operate so nothing is damaged or destroyed."*

The Center's 2007 milestones included a study of lunar-descent performance requirements for Constellation, as well as trajectory optimization for a future lunar lander. The results, contained within a detailed report, have been submitted to NASA's Constellation Program Office.

Georgia Tech Visiting Professor Dr. Doug Stanley recently led a 40-person study in support of NASA's Constellation Program Office to trade and select the preferred propulsion systems for the lunar lander and Crew Exploration Vehicle. The results were presented to the NASA Administrator.

In 2007, Center students also won NASA's Revolutionary Aerospace Systems Concepts Academic Linkage (RASCAL) competition with the design of a lunar lander for a future lunar outpost and were invited to present their results at the AIAA Space2007 Conference.

Alan W. Wilhite, Ph.D.
Georgia Tech

Dr. Alan Wilhite began his career at NASA Langley Research Center learning how to program 1960s-era computers, then transitioning to wind tunnel testing in support of the Apollo program. He participated in tests and evaluations of the space shuttle, and was involved in modeling of supersonic and hypersonic aerospace planes, advanced rocket designs and proposed next-generation spacecraft. At Langley, he would serve as chief systems engineer and systems program manager of NASA's High-Speed Research Program and, later, director of NASA's Independent Program Assessment Office. Today, Dr. Wilhite is the Samuel P. Langley Professor of Advanced Aerospace Systems Architecture in the School of Aerospace Engineering at the Georgia Institute of Technology and also serves as the co-director of the Georgia Tech Center for Aerospace Systems Engineering, Modeling, and Simulation.

Center for High Confidence Cooperative Systems

When humans fall ill, the body's defenses rapidly and automatically mobilize: to staunch bleeding, control infections, kill viruses and repair cellular damage. Using the lessons of biology, especially natural immunology and human memory-learning mechanisms, as his inspiration and guide, Dr. Song and his students are exploring ways to make human-designed systems more fault-tolerant and better able to communicate and coordinate with one another.

Dr. Song's ultimate goal is to develop innovative-controls technology to achieve reliable and adaptive system performance. The Center's focus is on new control algorithms that exhibit intelligent attributes, such as fault-tolerance, robustness, adaptation and self-learning, and are capable of extreme performance under complex and changing mission scenarios.

The Center's research, in both theoretical and real-time experimental studies, includes dynamic modeling, path planning, trajectory tracking, vision-based control, motion and close-formation coordination, and simulation of unmanned vehicle systems. Dr. Song believes the ultimate goal of all advanced-controls efforts should be to propagate, quantify and timely detect possible failure modes to prevent any potential system disaster from occurring or, at the least, to mitigate its effects on system performance.

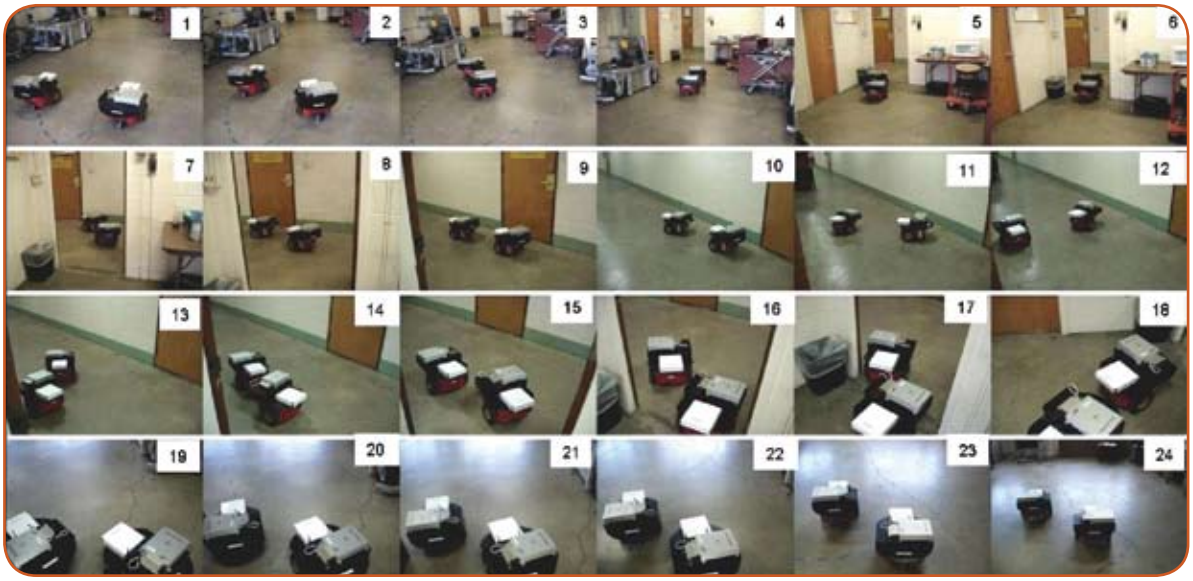
David Song, Ph.D., P.E.
North Carolina A&T State University

Samuel P. Langley Professor Dr. David Song has held the position of professor in the Department of Electrical Engineering at North Carolina A&T State University since 2004. He joined North Carolina A&T in 1993 as assistant professor and was promoted to associate professor in 1999. Dr. Song is the project director for A&T's contribution to NASA's third-generation Reusable Launch Vehicle program that has as a primary objective demonstration of technologies leading to a new generation of space boosters.

The Center is also evaluating ways of designing controls for unmanned ground vehicles, or UGVs, so the UGVs won't collide when, for instance, they travel in conveys for disaster response, search and rescue, or to deliver supplies. To that end, Song's team has built two UGV prototypes able to travel in a variety of formations. On-board UGV sensing technology includes range-finding lasers and sonar, as well as GPS (global positioning system) devices and stereo cameras.

Dr. Song is joined by both Ph.D. and master's students who are being exposed to multiple disciplines including machine and controls design, electronics, programming, and multiple systems integration.

"Our goal is more effective but not computationally expensive control systems. They have to be responsive and robust enough to changing conditions. They have to operate in the real world."



Multiple UGVs performing leading-following and obstacle avoidance operations

Center for Multifunctional Aerospace Materials

Making "Moon bricks" may seem a task more suited for characters in a fairy tale, but in 2007, it became a down-to-earth reality for NIA students led by Dr. Logan. Made in the Center's laboratory from materials called regolith that are similar to those materials found on the lunar surface, the bricks may become a viable building material for future off-world settlers.

Given their structure and density, the bricks also offer significant radiation shielding and protection from meteorite bombardment, key advantages given the Moon's lack of a protective atmosphere. Because of the high temperatures generated by the processing technology, the bricks could fit and connect snugly and securely to one another without the use of an adhesive or bonding material.

Other Center projects in 2007 included a variety of studies on impact-resistant materials, as well as those that would block health-threatening, high-energy cosmic and solar radiation. In addition, Dr. Logan and her students are preparing the laboratory space and equipment necessary to the development of leading-edge surfaces for hypersonic vehicles, proposed aircraft that could fly at least five times the speed of sound, or Mach 5, roughly 3,300 miles per hour at altitude.

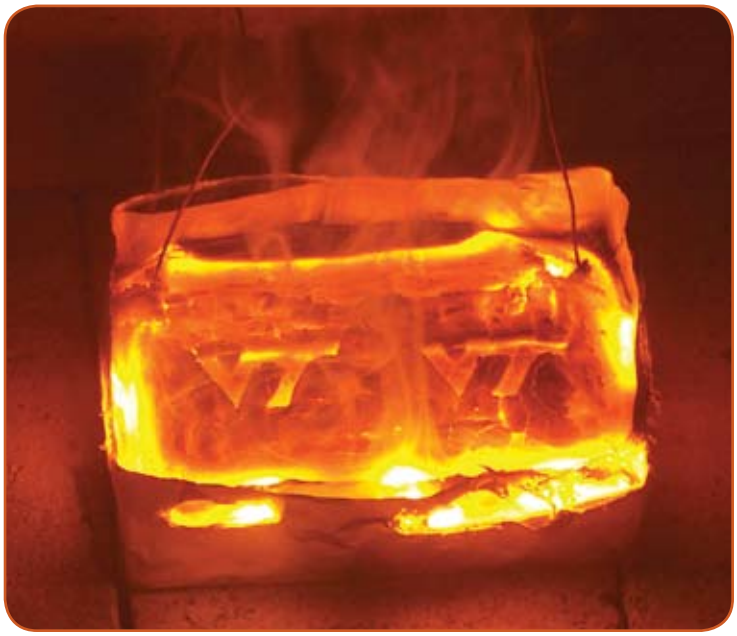
In her laboratory at NASA Langley Research Center, Dr. Logan plans to build a large radio-frequency induction hot press capable of forming large surface-area materials for testing – and a real-world testbed for hands-on graduate education.

Kathryn V. Logan, Ph.D
Virginia Tech

Dr. Logan holds simultaneous faculty positions as the Virginia Tech Samuel P. Langley Professor and as a full professor in Virginia Tech's Materials Science and Engineering Department. She is also principal research engineer emerita in the School of Materials Science and Engineering at the Georgia Institute of Technology. She is presently serving as a member of the Clemson University Department of Materials Science and Engineering External Advisory Board, a fellow of the American Ceramic Society and the National Institute of Ceramic Engineers, and a member of the International Academy of Ceramics. In September 2007, Dr. Logan was awarded the Arthur Frederick Greave-Walker Award by the American Ceramic Society in recognition of her accomplishments in the field of ceramic engineering.

To honor her achievements and outstanding service in the materials field, Dr. Logan was recognized by the American Ceramic Society in September 2007. She was given the Arthur Frederick Greaves-Walker Award. The purpose of this Award is to recognize and honor members of the National Institute of Ceramic Engineers (NICE) who have rendered outstanding service to the ceramic engineering and science professions and who, in their lives and careers, have exemplified the aims, ideals, and purposes of NICE.

"Materials are intrinsic to everything. They enable any technology - including aerospace technologies, which are characterized by severe, high-performance environments. In essence, materials are building blocks for these systems."



Prototype lunar brick made from a combination of aluminum scrap and the lunar regolith heated to temperatures reaching 1,500 degrees Centigrade, which initiates an oxidation-reduction reaction.

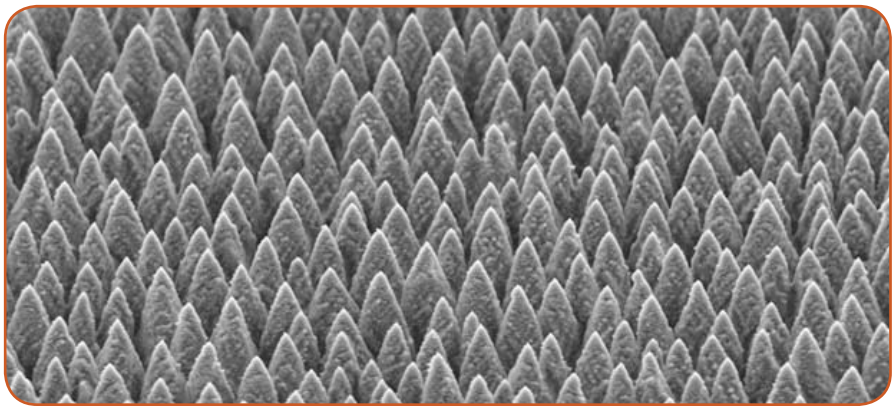
Center of Nanotechnology for Advanced Sensors, Actuators & Microsystems

Inexpensive, ultra-lightweight, electrically conductive and essentially made of … plastic: that's a short description of the Center's invention of a "nanocomposite" material that could become the choice for advanced sensors, shielding against radiation and electromagnetic interference, thermal insulation, even lightning protection. The advance was recognized by NASA's Nanotech Briefs magazine as one of 2007's top 50 technologies, products and innovators to significantly advance the field of nanotechnology, which deals with the creation of submicroscopic objects as small as just a few atoms.

The breakthrough is the latest for Dr. Gupta and his team of NIA-based undergraduate and graduate students and post-doctoral fellows. The material that he and his team devised contains small amounts of carbon nanotubes - one-atom-thick sheets of graphite rolled into a seamless cylinder - that convey its unique properties. The relatively long length and small diameter of carbon nanotubes form an interconnectivity within the plastic, making it electrically conductive and improving electromagnetic-interference shielding and heat-dissipation capacity. A foaming agent that introduces air pockets accounts for the dramatic weight reduction.

The Center for Lasers and Plasmas is a National Science Foundation funded Industry/University Cooperative Research Center that includes the Universities of Virginia, Columbia, Illinois, Michigan at Ann Arbor, and Southern Methodist; industrial partners such as General Electric, General Motors, Lockheed/Martin, Halliburton Energy Services, AREVA Corp., Toyota Motor Corp., etc; and government partners such as NAVAIR and NASA Langley Research Center. The goal of this center is to advance the field of photonics, solar energy, and sensors for use by NASA, other government agencies, and the private sector.

Dr. Gupta has been successful in obtaining significant third party funding, which had enabled him and his students to pursue cutting-edge research in areas such as nanomaterials and nanostructures for solar energy, metamaterials (materials with negative refractive index), optical sensors, and laser sintering of nanoparticles. He is currently supervising over a dozen graduate students working at NASA Langley, NIA, and the University of Virginia. Dr. Gupta is also providing expertise to NASA Langley, leveraging the ongoing external projects.



"Our students are working at NASA across a broad spectrum of branches and directorates. We've been able to find and work on a variety of projects of common interest … Awards are always satisfying in that, as a team working together and collaborating, it's gratifying to be recognized for our accomplishment - besides good, solid scientific work…We're definitely having an impact."

Mool G. Gupta, Ph.D.
University of Virginia

Samuel P. Langley Professor Dr. Mool Gupta completed his Ph.D. at Washington State University in 1973 and in 1976 became a postdoctoral fellow at Cornell University in Ithaca, New York. From 1978 through 1979, Dr. Gupta was a senior research fellow at the California Institute of Technology in Pasadena. He subsequently worked at Eastman Kodak Company for 17 years as a senior scientist and group leader, as well as an adjunct professor in materials science and engineering at Cornell University. In the late 1990s, Dr. Gupta accepted a new post as Old Dominion University's director of the Applied Research Center program at Jefferson Laboratory, as well as a research professor in ODU's Department of Electrical and Computer Engineering. In addition to heading the NIA Center of Nanotechnology for Advanced Sensors, Actuators, and Microsystems, Prof. Gupta is director of the NSF Center for Lasers and Plasmas at the University of Virginia. Dr. Gupta is editor-in-chief for the CRC Handbook of Photonics, has authored more than 100 research papers, possesses 25 patents, and has been inducted into Kodak's Inventors Gallery.

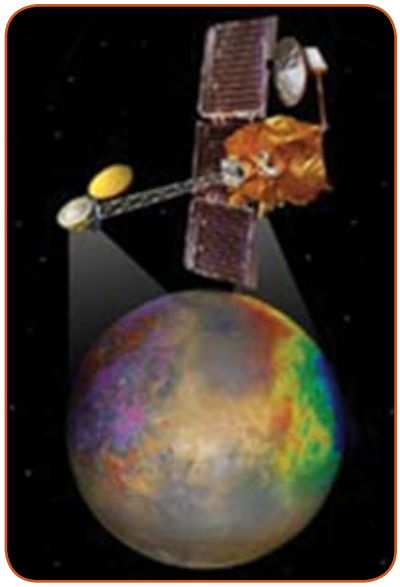
Center for Planetary Atmospheric & Flight Sciences

"We have a strong effort related to Mars. That's where the action is. You just can't beat good, old-fashioned space operations."

Robert E. Tolson, Ph.D.
North Carolina State University

A former chief scientist at NASA Langley Research Center, Samuel P. Langley Professor Dr. Robert Tolson has more than 40 years of research, management, and educational experience in aerospace science, engineering and technology. He holds a joint appointment in North Carolina State University's Department of Mechanical and Aerospace Engineering and the Department of Marine, Earth and Atmospheric Sciences. Dr. Tolson was a Professor of Engineering at George Washington University from 1991 through 2000. For his Phobos-Deimos encounter experiment during NASA's Viking mission to Mars, he received the Medal for Exceptional Scientific Achievement, NASA's recognition of unusually significant scientific contribution toward achievement of aeronautical or space exploration goals.

In science fiction novels, intrepid spacefarers on their way to epic adventures speed through the solar system and to nearby stars in record time. Real space travel in the early 21st century may be slower and more pedestrian, but for its practitioners it is just as exciting as any novelistic foray.



Dr. Tolson's latest practitioners are five new NIA graduate students, who in 2007 joined Tolson-led efforts in several key areas. To improve performance for future robotic and manned missions, Dr. Tolson has initiated synergistic research between NIA and atmospheric scientists, who develop and improve planetary atmospheric models, as well as NASA planetary-entry researchers, who rely on atmospheric models to design entry flight systems and trajectories.

One Center effort in 2007 involved defining atmospheric-sciences studies to be done with the proposed MAVEN mission, short for Mars Atmosphere and Volatile Evolution. This 2011 mission would provide first-of-its-kind measurements, address key questions about Mars climate and habitability, and improve understanding of dynamic processes in the upper Martian atmosphere.

The Center has also been archiving data for the Mars Reconnaissance Orbiter (MRO), now in orbit 250 kilometers (155 miles) above the Martian surface. Launched in 2005, the MRO continues providing up-close planetary images of unprecedented clarity and detail. In addition, as a prelude to the 2009 launch of the Mars Science Laboratory, Dr. Tolson's students are evaluating approaches to Mars entry, descent and landing.

The Center is sponsoring a post-doctoral candidate at the University of Michigan who is experimenting with a whole-Mars climate model to simulate that planet's atmosphere from the surface to 300 kilometers (186 miles) in altitude. Another sponsored activity, performed by a Ph.D. candidate at Virginia Tech, is applying uncertainty analysis to Mars atmospheric models. That venture is in the second year of effort.

Research Program

NIA conducts a broad range of scientific and engineering research sponsored by NASA Langley, other government agencies, and third parties. This work is accomplished by a research staff of more than 50 scientists, engineers, and consultants in seven principal areas of investigation: Air Traffic Research, Aviation Safety Research, Rotorcraft Aeromechanics Research, Flight and Control Systems Research, Nanomaterials Research, Composites Research, Metals Research, Exploration Systems Research, and Atmospheric Sciences Research.

NIA also actively engages in research projects for commercial aviation companies. These projects make use of the talents of our research staff, faculty at affiliated universities, and individual faculty members at universities throughout the nation. Accomplishments are highlighted in the following pages.

Visiting Researcher Program

The NIA Visiting Researcher Program welcomed a diverse group of national and international faculty, scholars, and students in 2007. In the Program, NIA accommodates visiting eminent scholars throughout the year with the most placements occurring during the spring and summer months. The success of the visitors' collaborations with NASA Langley and NIA, in terms of productivity and quality outputs from the research, is evidenced by more than 50% of the 2007 visitors continuing research previously begun in areas that will advance intellectual joint discoveries.

A total of 47 visitors from 24 separate institutions from the United States and abroad participated in this year's program. Research topics included:

- *Computational Structures and Materials*
- *Formal Methods*
- *Space Weather Research*
- *Rotorcraft Aeromechanics*
- *Numerical Simulations of Laminar Turbulent Transitions*
- *Multifunctional Aerospace Materials*
- *Spacecraft Autonomy for In-Space Operations*

Full-scale mock-up of Orion space capsule built at NASA Langley Research Center (Credit: Scott Belbin, NASA Langley)

Air Traffic Research

NIA Contributing to Next Generation Air Transportation System

Congested skies, increased airport delays and concerns about a potential threefold increase in aircraft operations within the next 15 years are fueling an ambitious attempt to remake the nation's air transportation system. Leading the effort is the federal government's interagency Joint Planning and Development Office (JPDO). JPDO is charged with developing concepts and plans for the 2025 Next Generation Air Transportation System, referred to as NextGen.

NIA is assisting NASA and the FAA in developing NextGen concepts and plans that will transform the U.S. air transportation system. NIA is also conducting research in support of NextGen plans. Specifically, NIA has been involved in the development of mathematical approaches to software refinements that will eventually give individual airplane pilots more operational autonomy than they have today. Such autonomy will be essential to achieving the NextGen vision, which calls for a system-wide transformation and a new set of capabilities that bolster safety while increasing capacity. Enhanced communications, navigation, surveillance, and air traffic management systems enable new procedures and the dynamic reconfiguration of airspace to respond rapidly to geographic and temporal demand.

Safely Increasing Airspace Capacity

NIA research is especially relevant to NextGen priorities for autonomous flight management, airborne precision spacing, and enhanced oceanic operations. Each concept relies on next-generation onboard software that would display and continuously monitor aircraft position relative to other flights; have rapid access to environmental data; and allow greater pilot involvement in some responsibilities traditionally assigned to ground controllers.

Although air traffic controllers would stay involved, individual pilots would be given wider latitude to manage their trajectories, maintaining appropriate distances from other in-flight aircraft. Onboard software would play a key role.

In 2007, NIA staff conducted research on a mathematical approach to specify design and verification of NextGen critical systems, based on the process known as Formal Methods. The goal of the research is to develop technology that will make aviation systems safer and increase the capacity of the nation's air transportation system. Areas of study included an extended safety analysis of operational concepts for air traffic management as well as development of theorem-proving and model-checking technologies for aerospace systems.

NIA supported the development of NASA's In-Trail Climb/Descent Procedure for oceanic operations, development of conflict-detection and resolution algorithms, and the verification of a new self-stabilization algorithm for computer-related fault-tolerant architectures.

Correctly Solving Multiple Conflicts

NIA researchers also led the algorithmic design and implementation of the software code integrated within NASA's traffic-simulation environment.

In collaboration with Brazilian and French researchers at the University of Brasilia and Ecole Polytechnique, NIA staff verified a geometrically optimal two-dimensional, conflict-resolution algorithm, and proposed a mathematical framework for specification and verification. The framework was illustrated with an original algorithm that correctly solves multiple conflicts among aircraft traveling at altitude.

In support of expanding the suite of verification tools, NIA staff designed and implemented advanced sequential and parallel model checking algorithms. NIA researchers also created the first-ever 64-bit version of the model checker known as SMART, built and used for the analysis of highly complex models of self-stabilization protocols under development at NASA Langley.

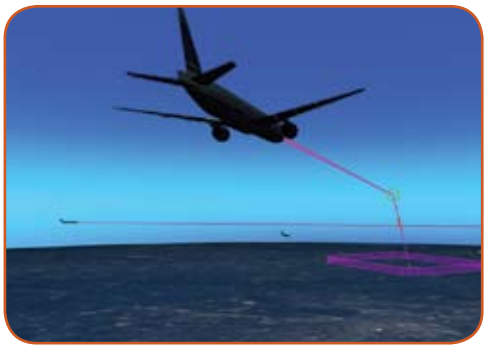


Image credit: NASA

Aviation Safety Research

Researchers Instrumental in the Development of Safety Strategic Plan for NextGen

A team of NIA specialists continues to consult with JPDO, which is overseeing a unique public/private partnership to reshape the nation's air system. JPDO is charged with developing the concepts, architectures, roadmaps and implementation plans for NextGen.

The demand for air transportation services, for both people and cargo, will likely increase as much as threefold within the next 20 years. The NextGen transformation must ensure that such increases in capacity are achieved safely. Failure to do so would result in costly air-travel delays and likely cause immense damage to the national economy.

JPDO has divided the planning of NextGen among nine government/industry working groups (WGs). These WGs focus on those aspects of aviation critical to capacity and efficiency improvements: airport infrastructure, security, air navigation services, aircraft, shared situational awareness, safety, environmental concerns, weather, and global harmonization of equipage and operations.

The NIA team has been responsible for drafting the NextGen National Aviation Safety Strategic Plan, which is intended to provide direction and focus for aviation safety research and implementation to the year 2025 by defining the vision, mission, goals, objectives, strategies, and investment roadmaps necessary to accomplish key results. The plan is organized into three goal areas: Safer Practices, Safer Systems, and Safer Worldwide.

In 2007 the NIA team surveyed key individuals and organizations in both the public and private sectors to create a safety-related issues database. A survey of numerous safety experts helped to assess the applicability of the strategies within the plan to the safety issues that had been identified. The issues and the strategies were also ranked in importance by safety experts. The results of the survey will be used to assure the strategic plan is addressing the most important issues. A final version of the Safety Strategic Plan will be delivered by September 2008.

Safety an Embedded Approach

As noted in the latest version of the plan, safer practices emphasizes an integrated, systemic approach to safety risk management through implementation of formalized Safety Management Systems (SMS) that incorporate safety data analysis processes. Safety-enhancing technologies must

be deployed, and safety must be an integral part of the NextGen transformation process. The design, manufacture, operation, maintenance, and control of air traffic, as well as the way humans interact with the equipment and systems, must be addressed using an embedded safety approach.

Today's air transportation system is not structured to handle the amount of air traffic anticipated in 2025. The current system is already showing signs of stress and the projected demand will soon surpass its capacity. Projected surveillance improvements, coupled with navigation and communication enhancements, should help to improve system safety, efficiency, and capacity.

Humans in the Loop

The plan also recognizes the necessity for human-centered interfaces that improve safety for both airborne and ground-based systems. Working together, all stakeholders in the air transportation system will create a strong safety culture and foster an environment in which safety is the primary focus and each person's role with respect to safety is understood and quickly implemented. The plan also calls for American leadership to harmonize regulations, procedures, and supporting systems and to facilitate the adoption of technologies worldwide.

All stakeholders in the air transportation system would collaborate annually to revise and implement plan changes, issuing annual reviews and updates to ensure that a strong safety focus is maintained and the most effective risk-management approaches are assessed and implemented.

The Safety Strategic Plan asserts that a just culture that encourages information sharing without fear of unjust retaliation should also be created and maintained. A common vision for safety, safety goals, and safety metrics will drive all aviation-safety improvement activities and investments, including prioritization of research and development efforts.

Rotorcraft Aeromechanics Research

Computational Fluid Dynamics Playing Essential Role

Although comprising a fraction of all vehicles in flight, rotorcraft represent virtually 100% of last-mile airlift capability during times of disaster. Rotorcraft have saved lives and provided relief during and after floods, earthquakes, mud slides, avalanches, and tsunamis.

Today's rotorcraft configurations include many varieties of helicopters and tilt rotors, both manned and unmanned. Rotorcraft defend the nation abroad and domestically, provide firefighting and medical services, transport workers to off-shore platforms run by the petroleum industry, and are used in construction, logging, and tourism.

NIA research is exploring ways to reduce rotorcraft exterior and interior noise, as well as vibration and weight, while increasing aerodynamic efficiency and enlarging safety margins.

Analyzing Rotorcraft Performance

In 2007, NIA scientists conducted analytical and experimental research to improve rotorcraft-system loads and stability characteristics for both conventional and tiltrotor aircraft. The objectives were to improve analytical capabilities for predicting aeromechanical behavior of rotor systems, to perform wind-tunnel tests to demonstrate rotor-enhancement concepts, and to develop sophisticated new active-control concepts.

Such studies may lead to reductions in vibration, performance improvements, reduction in maintenance requirements, a lowering of rotorcraft-induced noise, and enhancement of rotorcraft survivability.

NIA researchers are continually improving computational fluid dynamics (CFD) techniques to analyze and predict the flow of air over vehicle shapes, structures and components, including control surfaces. CFD takes into account the physical and thermodynamic laws that describe the behavior of air in motion, incorporating those laws into computer codes.

Hardware shapes and blade effects are represented by discrete points on a virtual mesh or grid, where the fluid behavior of air – and its effects on structures and components – is modeled and assessed.

Altering configuration parameters with CFD permits rapid analysis, visually displaying the impact of change before physical models are built and expensive, labor-intensive wind-tunnel testing begins in earnest.

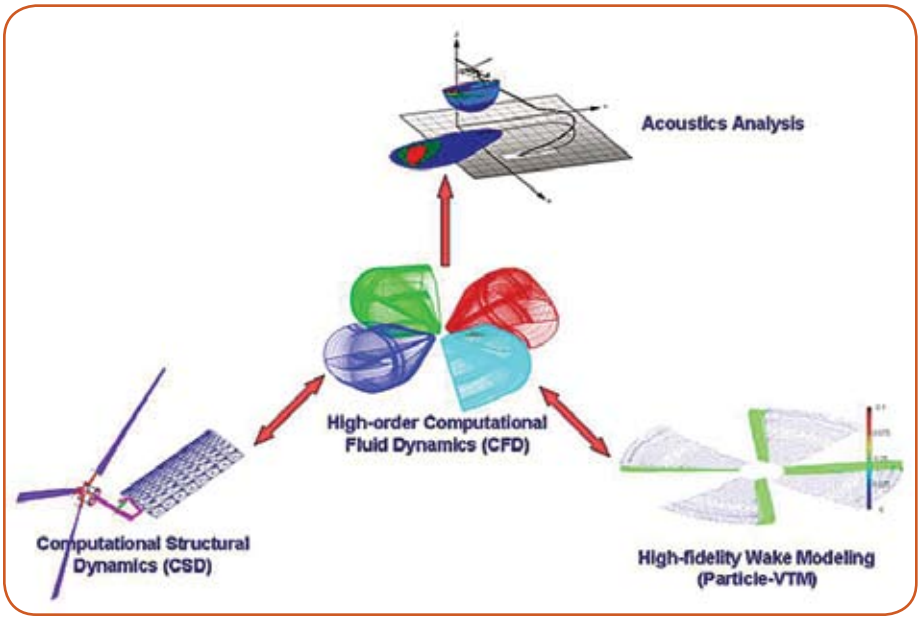
NASA Joins NIA-U.S. Army Partnership

One specific rotorcraft project concerns developing a high fidelity wake-vortex modeling, a project conducted in partnership with the U.S. Army Research Laboratory and NASA. The focus of the project is to improve the prediction of blade tip vortex properties such as vortex stregth and location. These blade tip vortex properties are extremely important for obtaining accurate prediction of rotorcraft noise and vibration.

The NIA team is also working on related research, such as modeling air flow over helicopter fuselages, developing finely granulated mathematical representations of rotorcraft structures – known as finite-element modeling – and a simulation of potential noise-reduction strategies.

The next step will be to validate the computer models with existing flight-test data and data generated from studies in wind tunnels.

Although rotorcraft-focused, the same methodologies could also be used for unmanned aerial vehicles and adaptive aerospace structures. Companies like rotorcraft-maker Sikorsky and airplane manufacturer Boeing are interested in the ongoing studies and are awaiting the outcomes of the data-validation and wind tunnel tests.



Flight & Control Systems Research

NIA Aims for Robust Next-Generation Aircraft Controls

Keeping aircraft aloft even during times of mechanical failure or environment hazard is a necessary but daunting challenge. For pilots in such extreme circumstances, reliable controls can mean the difference between life and death. Designing such controls is a complex and difficult problem as well. Helping are NIA research engineers, who are using mathematical approaches to simulate and evaluate the architectures of next-generation controls.

Their methods are proving faster, less expensive than previous approaches, more computationally efficient, and enable integration of verification and validation with design.

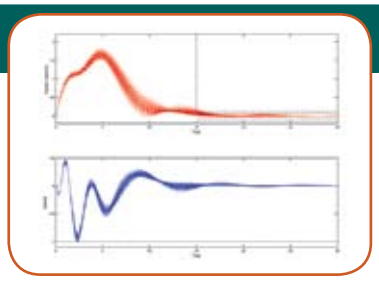
In 2007, NIA investigated robust and adaptive control methods for aircraft under adverse conditions, such as control-component failures or pilot errors, and in control-centric modeling of nonlinear dynamical systems, including distributed parameter systems. NIA scientists also examined how robustness analysis of an integrated-failure-identification and fault-tolerant control system plays an important role in its validation and ultimate certification.

If fault-tolerant control is robust on fault, for example, robustness will mask the effect of fault on performance. It therefore makes fault detection and isolation more difficult. Since a fault-tolerant control law and a fault-detection-and-isolation module are designed independently of one another, an integrated system requires robustness analysis and validation before the designed control law and detection module are implemented into a real-world system.

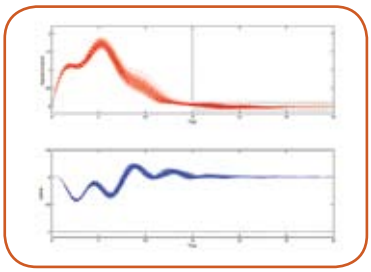
Examining Fault Tolerance

NIA engineers have also employed robustness-analysis methods to calculate the reliable flight regime of a transport aircraft with a fault-tolerant controller and with fault-detection-and-isolation modules. Research into the characterization of the aircraft loss-of-control phenomenon as well as loss-of control prevention and recovery system technologies are part of NASA's Integrated Resilient Aircraft Control program.

NIA researchers have undertaken development of a robust performance-analysis framework of a fault tolerant control system, including false identification cases. Generally, a fault tolerant control system consists of a controller, a fault detection and isolation (FDI) module, and a supervisory system. The fault-tolerant controller and FDI will be analyzed for robustness and performance degradation due to uncertainties in aerodynamic coefficients, actuator and sensor mathematical models, and un-modeled dynamics over the entire flight envelope.



Percentiles of the time responses of a baseline controller. Dashed-dotted lines show delimit regions of unsatisfactory performance.



Percentiles of the time responses of a tuned controller. Note how the excursions into regions of poor performance are eliminated.

Fault-tolerant control is generally designed based on an open-loop system under the assumption that faults are accurately measured for a very short time interval. In a real system, the FDI requires some time to detect faults which often leads to false alarms. NIA engineers expect that an analysis framework for a fault-tolerant control system should be able to be applied for the identification of such false positives.

Robustness Analysis

In 2007, NIA engineers also evaluated metrics for control verification that aim at quantifying the controller's ability to satisfy closed-loop stability and performance requirements in the presence of uncertain parameters, control failures and damage to aircraft components and structures.

The optimization-based methodology, which is applicable to nonlinear systems having nonlinear dependencies on uncertain parameters, enables assessment of and comparison between competing control alternatives regardless of the methods, assumptions, and control structure used to derive them. Figures of merit for deterministic and probabilistic uncertainty models, and tools for their calculation were also studied.

A particularly attractive feature of the tools developed is that their efficiency and accuracy grow exponentially along with the robustness of the compensator under scrutiny. This distinctive characteristic sharply contrasts with tools based on more traditional Monte Carlo simulations. Since the tools developed can be directly deployed over complex, high-fidelity simulations of the integrated system and only standard optimization algorithms are required for their implementation, they are readily applicable to practical engineering problems.

In addition, NIA researchers also developed a probabilistic sensitivity-analysis module. This module will be instrumental in identifying the dominant uncertain parameters responsible for most of the degradation in aircraft-controls system performance.

Nanomaterials Research

How the Very Small Could Revolutionize Technology

NIA researchers are learning from nature by going small – very small. By working at atomic and molecular levels, in 2007 NIA scientists investigated a variety of ways to develop and refine an emerging class of nanomaterials, each with unique properties that could dramatically affect technology development in the 21st century.

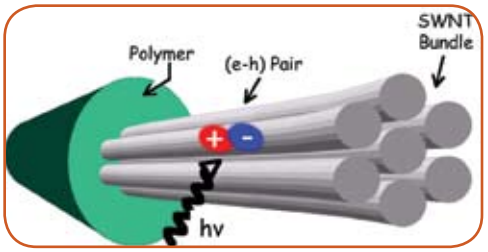
One initiative involved studies of multifunctional nanocomposites - resin-like plastics that include carbon nanotubes (CNTs) as a primary constituent. Carbon nanotubes are typically a one-atom-thick sheet of graphite rolled into a seamless cylinder. Extremely strong, and excellent conductors of heat and electricity, CNTs and their variants could within a decade make possible a radical redesign of everything from computers to spacecraft.

One continuing difficulty in nanocomposite creation is achieving uniform CNT dispersion. Because nanotubes tend to aggregate in bundles and clusters, their unique ability to conduct heat and electricity degrades or disappears altogether. In 2007, an NIA team collaborating with NASA had success in optimizing such dispersal, coming closer to the ultimate goal of achieving control of nanocomposites' electrical, dielectric, and mechanical properties across a broad range of applications.

Nanomaterials for Artificial Skin

Nanomaterials also took center stage in 2007 as NIA participated in an initiative to create an artificial arm and hand every bit as capable as its biological counterpart. Overseen by DARPA, the venture – known as the Revolutionizing Prosthetics Program – involves 28 participating research partners, including NIA.

The Institute's role is development of tactile sensors similar to the tiny nerve endings that allow biologically derived fingers, palms, and arms to feel temperature and pressure. Working with NASA, NIA researchers have also evaluated potential nanomaterials for artificial skin that will approximate the strength and resiliency of natural epidermis.



SWCNT bundle coated with a polymer

The team will devise small, centimeter-square, sensor-impregnated materials patches that will sense pressure and location in the same way skin reacts. The effort should lead to precise measurement of the forces that will allow the team to fine-tune sensor sensitivity and response.

The work builds on NIA's expertise with pressure sensing for a wide array of aerospace applications, research that one day may lead to bird-like, wing-morphing craft that can respond instantaneously to environmental conditions.

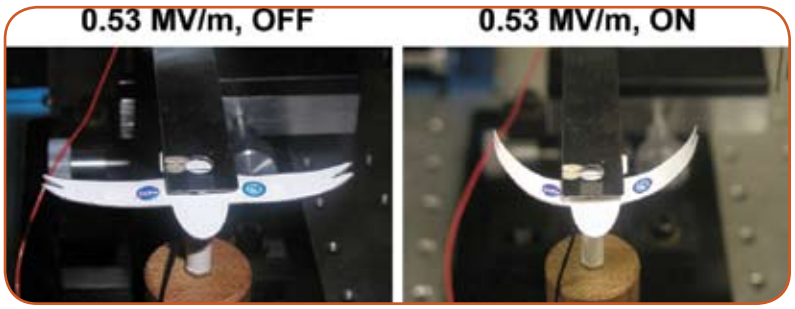
Excellent Candidates

Nanotechnology also presents a new spectrum of opportunities to build advanced space-exploration components and systems, such as networks of ultrasmall probes on planetary surfaces and micro-rovers that drive, hop, fly, and burrow. Advanced miniaturization should enable an array of new science and exploration missions whose constituents include tiny sensors, power sources, communications gear, navigation and propulsion.

One nanomaterials candidate for such innovations could be boron nitride nanotubes, or BNNTs. Similar to CNTs but more stable thermally, BNNTs are excellent candidates for radiation shielding. And, because boron nitride is far more resistant to oxidation than is carbon, BNNTs appear ideally suited to high-temperature applications that would cause carbon nanostructures to burn.

In 2007, in a joint effort with the Thomas Jefferson National Accelerator Facility (JLab) in Newport News, Va., NIA and NASA scientists made significant research progress with BNNT synthesis and characterizations using the JLab free-electron laser. That collaboration continues.

In addition, NIA researchers retrieved and analyzed samples of nanocomposites shipped to the International Space Station. The work was a continuation of earlier efforts to better understand the space-borne effects of atomic oxygen and ultraviolet radiation. The NASA-managed initiative known as the Materials International Space Station Experiment, or MISSE, is intended to characterize the performance of prospective spacecraft materials when subjected to the harsh temperature changes and radiation exposure typical of the space environment.



SWCNT polyimide composite morphing wing actuator

Composites Research

NIA Helps to Improve the Structural Integrity of Aerospace Design

For centuries, humankind has built structures using two or more materials, such as mud that hardens around wood or stone. One material offers strength and stiffness; the second surrounds and binds the first solidly in place. The resulting combination is a hybrid sturdier than its original constituents. These "composite" materials are often lighter and more durable than a single material alone.

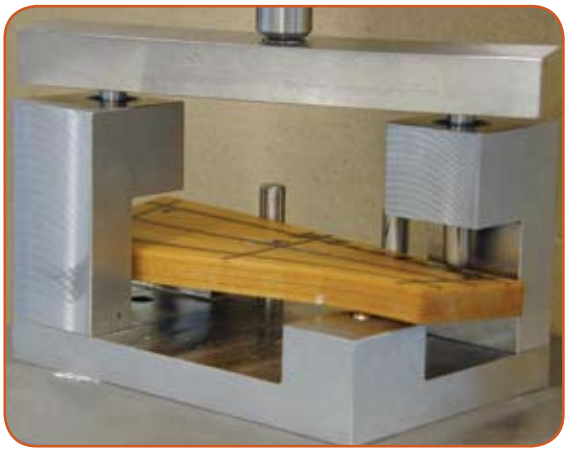
In 2007, NIA researchers continued to collaborate with colleagues at NASA to study, design, and engineer Space Age composites. Unlike their primitive forebears, many contemporary composites are made from a glue-like binder, such as plastic resins, and reinforcing fibers composed of carbon or glass.

For aerospace applications in particular, because their strength-to-weight ratio is so favorable, composites offer the prospect of significant performance improvements. Advantages include tolerance of damage, stress, and heat, and, in many formulations, little, if any, corrosion.

Tailoring Next-Generation Structures

A more complete understanding of composites' complex chemistries and structures requires the aid of modeling software. NIA researchers in 2007 developed and refined computer programs to identify the best ways to improve the structural integrity of aerospace structures and enhance the design concepts and procedures adopted by aerospace industry.

Finely tailoring the performance of structural composites will eventually enable the creation of "on-demand" aerospace materials that could drastically reduce or perhaps eliminate altogether the dangers posed by potentially catastrophic events such as extreme weather, in-flight structural impairments, or component failures. In particular, NIA is working on a predictive capability to model crack-path deflection under complex multi-axial loading, such as that experienced by vehicles under duress from structural failure or environmental hazards.



Torsion specimen for inducing mode III delamination growth in laminated composite plates.

Such an approach involves proven mathematical techniques, such as the development of three-dimensional, finite-element-based models to assess crack growth in integral and hybrid structures. The resultant software-based "tools" should help the aerospace industry to enhance design procedures and concepts with reductions in structural weight, improvements to performance and enhancement of the longevity of both metallic and hybrid structures.

NIA efforts also entail development of a delamination fatigue methodology for composite aircraft and rotorcraft structures. The goal is the creation of a best-practice guide and improved certification procedures for a damage-tolerant design of composite airframe and rotorcraft components.

Understanding Failure Modes

In 2007, NIA began experimental and analysis efforts in collaboration with Sikorsky Helicopter, Bell Helicopter, and The Boeing Company to develop analysis tools to better predict the fatigue life of both pristine and damaged composite structures where delamination is a key failure mode. The work is part of a larger venture to reduce the number of tests required for FAA certification of components fabricated from the new composites.

Studies were also underway to analyze how a range of composite materials responds and reacts to heat. These investigations could ultimately improve the structural integrity of both composites and leading-edge metal alloys.

NIA research included development of a simple analytical method for predicting the residual compression strength of impact-damaged sandwich panels. The purpose is to aid engineers in the efficient design of damage-tolerant components that meet exacting strength requirements. The method is tailored for honeycomb core-based sandwich specimens that exhibit an indentation growth failure mode under axial compression loading, which is driven largely by the crushing behavior of the core material.

New Energy, New Spacesuits

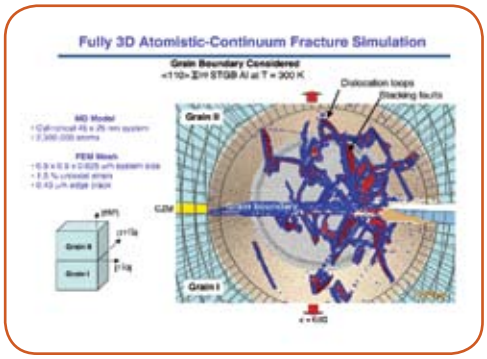
Future astronauts may benefit from another project in which NIA is participating, to improve personal protection for spacefarers. To decrease weight and increase the mobility and comfort of spacesuit assemblies, NIA is helping NASA develop flexible fabrics and plastics for incorporation into liquid-cooling and ventilation garments.

Metals Research

Understanding the Structural Longevity of Airplanes and Spacecraft

America's fleet of commercial and military airplanes is growing older. Although retrofits are common, many vehicles continue to fly even though they have exceeded their original design-service life. Understanding how aircraft age, how the metals that constitute the fuselage, wings, tail assemblies and control surfaces react to and survive repeated flight cycles is crucial not only to the safety of the traveling public, but also to those who rely on aircraft to protect the nation and sustain it economically.

In 2007, NIA researchers worked to better understand what happens to metals as they age. NIA completed the first year of what will be a five-year effort investigating how aluminum - which, despite the increasing prevalence of nonmetallic "composite" materials, continues to comprise the majority of aircraft structures and components - reacts to damage on an atomic level. Such understanding remains, to date, rudimentary.



A methodology to realistically simulate the growth and propagation of metallic fractures on a simple system of pure aluminum was developed. Studies are ongoing on a more thorough analysis of how aluminum reacts under a variety of structural loads and in concert with other metals.

NIA has been working closely with NASA, whose interest extends not just to the factors affecting aging aircraft, but to the next generation of vehicles, both aeronautical and space. Eventually, NIA scientists believe they can extend their analyses to more detailed multiscale models that will include both advanced metallic alloys and composites. Lessons learned from such investigations could ultimately enable self-healing aircraft or spacecraft structures in the event of an accident or structural failure.

Preventing Aircraft Aging Hazards

NASA is particularly interested in better identifying the aging and damage processes in structures that will make up new generations of emerging aircraft. Next-generation fabrication techniques may be able to reduce or perhaps even eliminate the potential hazards associated with aging-related degradation. The intent is to take a proactive approach to identify aging-related hazards before they would become critical, and to develop technology and processes to incorporate aging mitigation and maintenance into future aircraft design.

Three steps in addressing structural hazards are:

- Detection: How to locate and characterize damage or degradation of materials and structures;
- Prediction: Devising accurate life and strength predictions, accounting for accumulated damage associated with long-term exposure to thermal/mechanical/environmental loads; and
- Mitigation: Concepts to prevent, contain, or manage degradation associated with aging.

Although we can expect metals and/or metallic alloys to comprise a significant fraction of the materials used in airframe structures for many years to come, such materials will be produced in novel configurations. To be competitive with composite materials from a weight perspective, new integral metallic materials and hybrid laminate materials are being developed. Therefore, research must be conducted to understand damage processes and to develop non-destructive means to monitor damage.

Robust Aerospace Health

Building on the new structural approaches, Integrated Vehicle Health Management (IVHM) systems offer the potential to improve safety, reduce costs, and improve performance in every aircraft class - and, perhaps, for spacecraft. However, many IVHM technology components are too immature for aircraft application and the tools to support their implementation do not yet exist.

Over the next five years, NIA will help NASA close IVHM technology gaps and create a sustainable pipeline of tools and techniques for developing and deploying IVHM technology. NIA's efforts include on-board and off-board IVHM components. The on-board function monitors, detects, diagnoses, prognoses, and mitigates damage, degradation and/or failures. In most cases, mitigation consists of notifying the flight crew or ground support, but locally activated response mechanisms such as self-healing materials could also be invoked.

Integration of hazard information in diagnostic and prognostic reasoning would enable the IVHM system to account for deterioration in performance and/or expected useful life as a result of a variety of threatening conditions, including ice accretion, electromagnetic disturbances, and ionizing radiation. Structural failure, while still possible, would be minimized or prevented before serious threats to crew or passengers emerge.

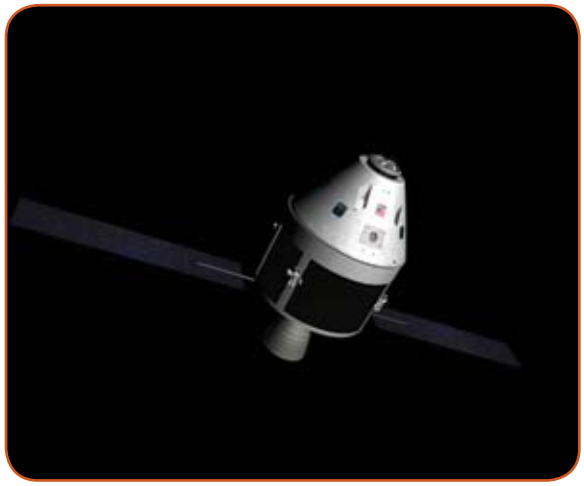
Exploration Systems Research

NIA Plays Crucial Role to Help NASA Choose Optimal Architectures

Returning humans to the Moon, exploring Mars and sending robotic and crewed missions throughout the solar system are central goals outlined in NASA's Vision for Space Exploration. NIA is assisting NASA by helping to enable safe and affordable public transportation to space and to develop sustainable and renewable human exploration systems.

In 2007, an NIA student team won NASA's Revolutionary Aerospace Systems Concepts Academic Linkage competition with the design of a lunar lander for a semi-permanent lunar outpost. NASA recognition also went to NIA students for their design of a modified Ares V launch vehicle and, in 2006, for a proposed Mars outpost.

Professor Alan Wilhite recently led a team of NASA researchers and NIA-affiliated graduate students from Georgia Tech and North Carolina State University to support NASA's Constellation Program Office to determine lunar lander descent-performance requirements. In 2007, one NIA graduate student used a NASA computer-aided design model to determine the mass inertias for trajectory analyses, while another developed a method to visually depict trajectory-state data. The team developed a lunar lander trajectory-simulation model to determine required fuel burn during lunar descent. Studies were also conducted of various propulsion systems, thrust levels, and trajectory constraints for navigation and landing sensors and pilot control. These results were compared to the Apollo XI landings for validation. NIA's presentation of these studies to the Lunar Lander Program Office at NASA Johnson Space Center resulted in an increase in required performance because of the depiction of realistic system constraints.



Georgia Tech visiting professor Dr. Douglas Stanley recently led a 40-person team in support of NASA's Constellation Program Office to trade and select the preferred propulsion systems for the Lunar Lander and Crew Exploration Vehicle. The team modeled the impact of the various propulsion options on performance, safety, reliability, programmatic risk, and cost. The results were presented to the NASA Administrator. NIA continues to work closely with NASA Langley, NASA's lead center for its Lunar Architecture Team's systems engineering and integration. The Architecture Team's objectives are to define the critical missions to be conducted on the lunar surface; the system architecture to support these missions; and the interface requirements for an exploration transportation architecture.

Over the next three years, NIA will continue to support these and other lunar and Mars-related architecture studies. Design and integration methods will be developed for the integration of the missions, surface support equipment, rovers, habitats, in-situ resource utilization, and the lunar surface-access module used to transport the integrated system to the lunar surface.

NIA will also explore techniques for creating complex models and simulations, using advanced decision analysis and risk methods. Support will be provided to develop a complete life-cycle analysis capability for system performance, cost, safety, and reliability to determine feasibility of concepts, importance and sensitivity of requirements, and the identification of enabling and enhancing technologies.

Atmospheric Sciences Research

Earth Grows More Combustible as Climate Warms and Dries

A warmer Earth means a drier Earth - at least at high latitudes in the Northern Hemisphere. According to NIA research, rapid warming there threatens centuries-old ecologies. Ominously, with the transformation, comes the growing threat of widespread wildfires.

Boreal forests occupy a little less than 20% of land in the Northern Hemisphere that runs just below the North Pole and includes areas of tundra and permafrost. In 2007, NIA scientists found that these areas are experiencing increases in fires and insect infestation, tree-species change, tree-species dieoffs, and melting permafrost. Certain plants seem to be migrating to new homes at higher altitudes while others appear headed for extinction.

Furthermore, in Siberia in Russia, five of the last seven years have been characterized as "extreme" fire seasons, and extreme fire years have likewise been recorded in both Alaska and Canada. Alaska has also recently experienced geographically expansive multi-year outbreaks of the tree-weakening spruce beetle, infestations of which had been previously limited by the prevalence of cold, moist weather.

The NIA research indicates that winter temperatures in the Tuvan region of Russia have already exceeded 2090 model estimates. Although long-term patterns of precipitation are difficult to foresee, precipitation amounts and large rainfall events have markedly decreased in south central Siberia. Both the growing season length and the number of extremely warm days have also increased.

Climate Change Accelerating

Boreal forests consist of such species as larch, a conifer that sheds its needle-like leaves in autumn; pine, spruce, and fir. Interspersed with these are deciduous hardwoods like birch, aspen, willow, and alder. Because boreal environments have historically remained cool or cold throughout most of the year, any shed leaves fall to the forest floor and decay slowly. Such regions are therefore the world's single largest known reservoir of terrestrial carbon, sequestering up to 35% of the planetary total.

NIA studies indicate that if fire becomes a regular occurrence in Russia or in regions just south of the Arctic Circle, more carbon will be released into the atmosphere and, in boreal regions at least, lead to a warmer and drier climate, which in turn will create conditions favorable to even more fire. This in turn will increase carbon emissions, which would continue to feed regional warming - and more fire.

Because temperature increases and climate warming are progressing so much faster than had been assumed, species-response time may not be enough to preserve boreal environments as they have been.

Satellite Imagery a Crucial Tool

In 2007, NIA used satellite measurements of areas in Oregon and Arizona as a means to validate remote sensing of fire incidence and extent. Satellite imagery offers researchers the opportunity to track fire across governmental and private boundaries in near-real time.

By comparing ground-based to satellite-based fire data, NIA scientists were able to quantify the satellite data to define burned areas and enhance the spatial and temporal estimates of biomass burning and emissions. In Arizona, 81% of all fires - categorized as wildfire, prescribed and rangeland - was thereby captured, as was 92% of all fires - wildfire, prescribed, and agricultural - in Oregon.

NIA employed telemetry from one satellite-borne NASA instrument and a primary National Weather Service satellite, respectively. The Moderate Resolution Imaging Spectroradiometer (MODIS), flies on two separate satellites and is designed to provide day-long measurements of large-scale global dynamics, including cloud cover, the amount of solar radiation absorbed by and reflected from Earth and the interaction between the planet's land masses, oceans and atmosphere. The Geostationary Operational Environmental Satellite (GOES), constantly monitors the continental United States from its in-synch orbit 22,000 miles high.

The crown fire, burning in boreal Canada (Redlake #7), is one of the largest fires in Canada's history. (Credit: Brian Stocks)

Technical Publications

NIA's research staff actively disseminates its research accomplishments through a variety of scientific venues. This year, 141 peer-reviewed publications and conference presentations were produced. Following is a listing of some of the most frequently cited journal articles published during this fiscal year.

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C. Chiteme, D.S. McLachlan, and *G. Sauti*, "AC and DC Percolative Conductivity of Magnetite-Cellulose Acetate Composites," Physical Review B, Vol. 75, p. 094202, 2007.

Andre Galdino, *Cesar Munoz*, and Mauricio Ayala, "Formal Verification of an Optimal Air Traffic Conflict Resolution and Recovery Algorithm," Lecture Notes in Computer Science, Springer-Verlag, Vol. 4576, pp. 177-188, 2007.

S. Ghose, *K.A. Watson*, *D.M. Delozier*, D.C. Working, J.W. Connell, J.G. Smith, Jr., *Y. Lin*, and Y.P. Sun, "Thermal Conductivity of Ultem™/Nanofiller Blends," High Performance Polymers, Vol. 18, No. 6, p. 961, Dec. 2006.

Y. Hu, M. Vaughan, *Z. Liu*, et al., "The Depolarization-Attenuation Backscatter Relation: CALIPSO Lidar Measurements vs. Theory," Optics Express, Vol. 15, pp. 5327-5332, 2007.

Christopher O. Johnston, Brian R. Hollis, and *Kenneth Sutton*, "Nonequilibrium Stagnation-Line Radiative Heating for Fire II," AIAA 2007-3908, July 2007.

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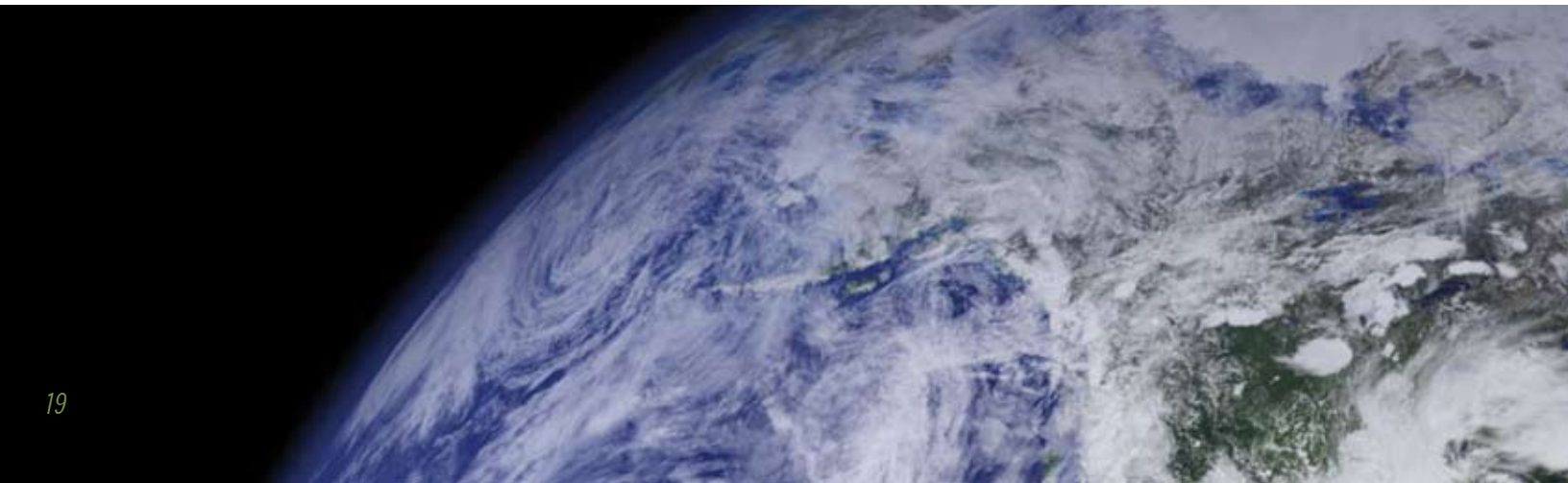

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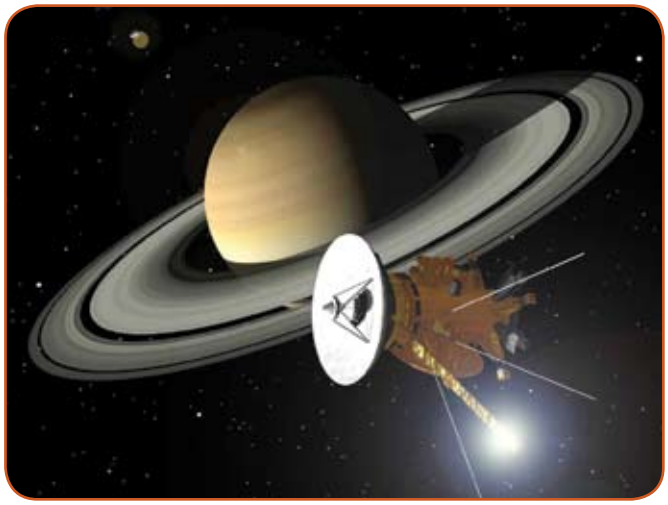

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Graduate Education Program

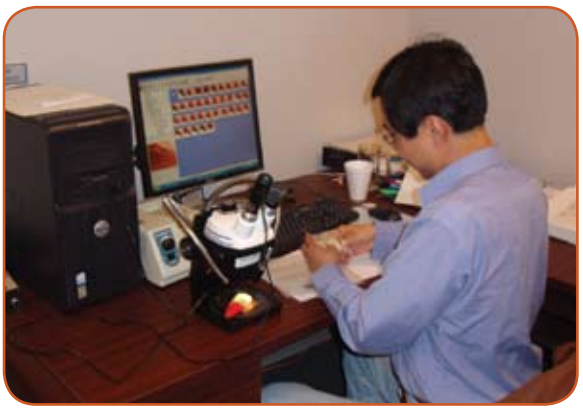
NIA has developed a unique graduate program to educate the next generation of scientists and engineers in technologies of the future. Students are given the opportunity to be supervised by eminent professors and work side-by-side with NASA Langley researchers on tomorrow's most pressing problems. Six highly regarded universities have pooled their resources to offer innovative courses designed and delivered by the best in their fields from each of these universities. Students in the program have the opportunity to participate in leading-edge research programs and take unique graduate courses that are not available at any single university.

Participating in NIA's Graduate Program are Georgia Tech (GT), North Carolina A&T State University (NC A&T), North Carolina State University (NCSU), the University of Maryland (UMD), the University of Virginia (UVa), and Virginia Tech (VT). While students enroll in a M.S. or Ph.D. program at one of the member universities, and ultimately receive a degree from that institution, NIA students may take up to 50% of their courses from the other participating universities. Classes offered at NIA, both on-site and via distance learning, include required core courses as well as state-of-the-art electives in new and emerging technologies.

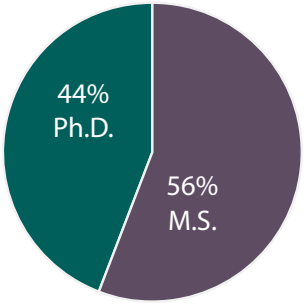
Professors from member universities, including the chaired S.P. Langley Professors, create a significant faculty presence at NIA. On-site researchers, post-docs, graduate students, and visiting faculty create a vibrant intellectual climate. Our seminar, workshop, and short course activities contribute to the learning experience. NIA is considered an extended campus and students satisfy all university residency requirements while conducting their research at NIA and NASA Langley. Graduate degrees are available in aerospace engineering, mechanical engineering, engineering mechanics, engineering physics, materials science and engineering, electrical engineering, ocean engineering, and systems engineering. In addition, degrees and coursework related to atmospheric sciences are available at nearby Hampton University (HU).

During the 2007 Fall semester, 15 faculty members were in residence at NIA. The Program emphasizes its unique and innovative courses taught by on-site faculty. NIA's course offerings use a mixture of distance learning technologies, including synchronous (live, two-way video) and asynchronous (video-recorded) classes as well as live, on-site instruction. A total of 120 courses were offered to our students. Approximately 30 of the courses were offered through live, interactive video.

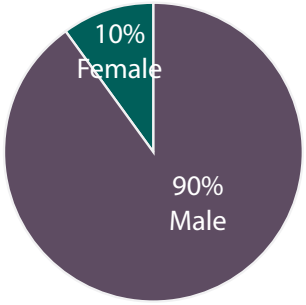
Classroom video is transmitted via internet protocol, using two separate data streams: a standard TV signal for the video of the instructor and a second, high-resolution data stream for the projected educational material.



FY07 DEGREE DISTRIBUTION



FY07 GENDER DISTRIBUTION



Graduate Students

NIA's graduate program provides educational opportunities for students recruited nationally to pursue full-time study at NIA, and for NASA employees, contractors, and members of the local community seeking to pursue part-time graduate study. Students are supervised by faculty in residence or by faculty from the home campus.

The number of full-time graduate students studying at NIA has grown rapidly. Over the past four years, the program has increased from six to 50 full-time students. As of September 2007, the NIA program has produced 27 M.S. graduates and seven Ph.D. graduates.

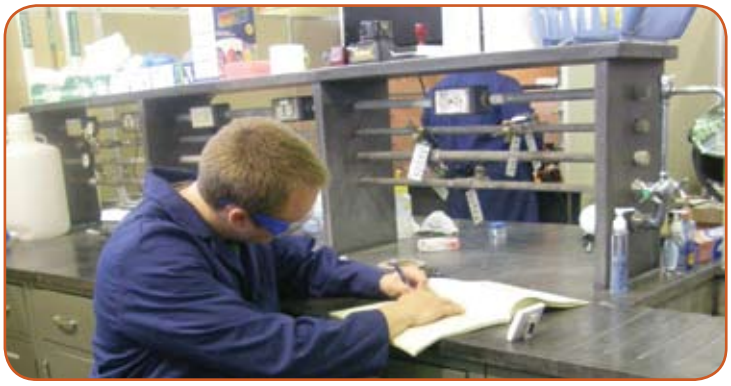
NIA's Graduate Research Assistantship

To attract the best possible graduate students, NIA offers a generous support package. All full-time graduate students at NIA receive a research assistantship with a stipend based on degree progress. Students in the program are required to devote at least 20 hours per week on a research topic within the NIA domain. Those accepted into the program are expected to perform their research on-site at NASA Langley whenever possible.

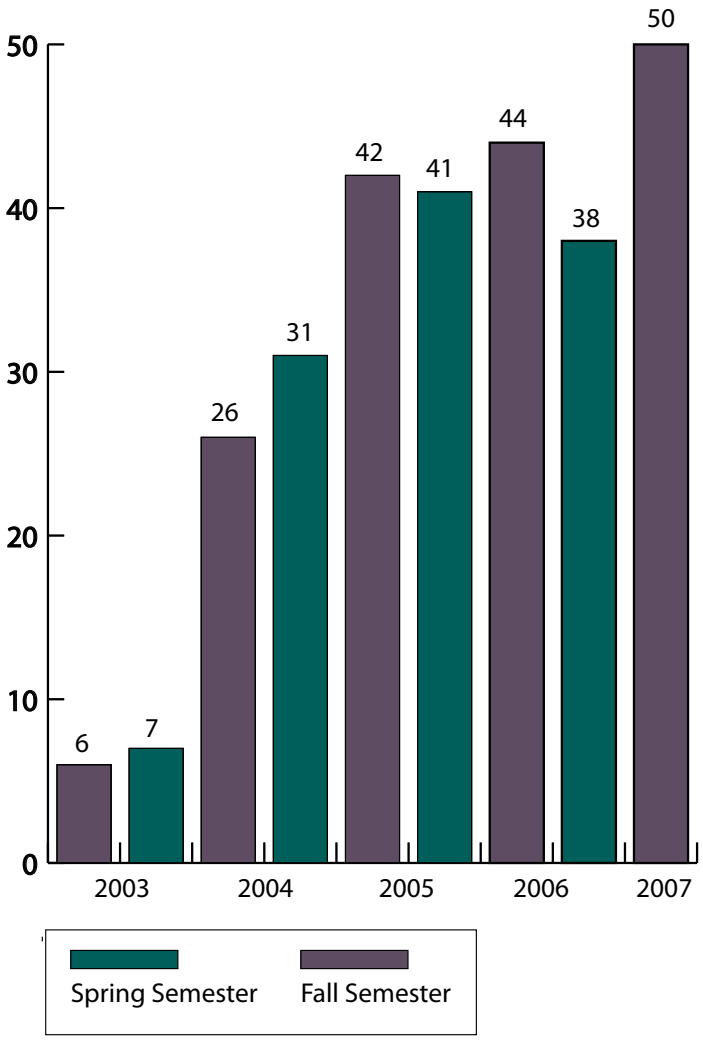
Graduate Student Enrichment

In April 2007, NIA hosted the AIAA Region 1 Mid-Atlantic Student Conference. The Conference provides a venue for students to share AIAA experiences, participate in social activities, and exchange ideas about current topics in aerospace engineering. More than 100 undergraduate and master's students attended from the states of Pennsylvania, Maryland, Delaware, West Virginia, and Virginia.

Two NIA graduate students served as conference co-chairs, responsible for the planning and execution. Other NIA students volunteered to help with the conference as session chairs and logistical support. Over 50 student papers were presented in four divisions: undergraduate, masters, team, and exhibition.



GROWTH OF FULL-TIME NIA GRADUATE STUDENTS



Postdoctoral Program

In 2007, NIA established a Postdoctoral Program to provide recent Ph.D. recipients an opportunity to expand the research skills acquired in their doctoral programs or to learn new research techniques. Each appointment is for a limited term, typically for one year, renewable for up to three additional years. The primary purpose is to provide additional career-related research experience without distractions or other duties, and to provide postdoctoral scientists and engineers with opportunities for involvement with projects compatible with NIA research interests and those of the sponsoring agency. By September 2007, seven post-docs were in residence at NIA.

Continuing Education

NIA provides a robust program in continuing education and lifelong learning. In addition to innovative graduate education opportunities, we offer a comprehensive program of short courses, workshops, and conferences as well as seminars and colloquia. During NIA's first five years of operation, we have averaged 60 seminars, nearly 10 short courses, and 10 workshops annually.

Workshops

The 13 workshops held this year explored emerging areas of research and featured national and international speakers. Brainstorming activities and technical discussions between NASA and NIA researchers, faculty from our consortium universities, other partner universities, and industry addressed new developments and their applicability to NASA and NIA's research thrusts.

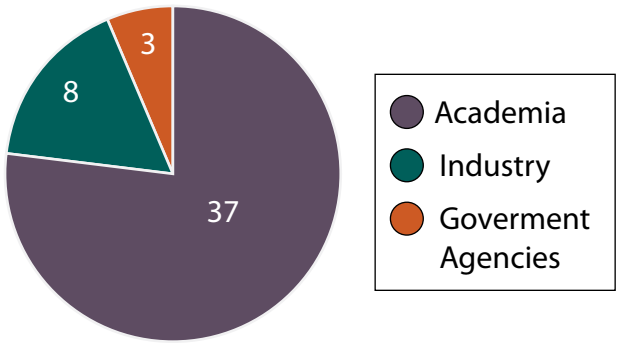
Short Courses

Faculty at NIA consortium universities, on-site research staff, and other industry and university partners develop and offer short courses on a wide variety of leading-edge research topics in aerospace and atmospheric sciences research which would be of interest to NASA researchers and the broader research community. In the past year, ten courses were offered. Most of the courses are held at NIA headquarters.

2007 NIA WORKSHOPS

Higher-Order Methods and High-Fidelity Flow Simulation
Intelligent Optical Systems
Multi-Terrain Impact Simulations
Conducting FlexSkins
Materials Challenges for Lunar Exploration
Workshop on Next Generation Laminar Flow Technologies
Collaborative Autonomous Vehicles
Revolutionary Aircraft for Quiet Communities
Workshop on Nanotechnology
Workshop on Wireless Technologies
Commercial Spacecraft Transportation Systems
Large Space Systems
MODSIM 2007: Education and Training Track

SPEAKER AFFILIATIONS



Seminars and Colloquia

NIA's seminar program offered 48 lectures, 11 of which were given by international speakers from Canada, England, Italy, France, and Germany. Participants in the program were primarily visitors from our consortium and affiliated universities, and scientists with direct connection to work being performed at NASA, NIA, and at our member universities.

NIA's Science Lecture Series is organized by NIA and Hampton University to stimulate progress in the atmospheric, Earth, and space sciences by bringing together researchers in the NASA Langley community for expert presentations on the latest advances and future research directions. The Informal Seminar Series provided an opportunity for NIA resident researchers and graduate students to informally present research in order to foster collaboration between NIA and NASA. An Education & Outreach Lecture series also has established in the past year.

Hypersonic Education Initiative

NIA's Hypersonics Education Initiative (HEI), funded by NASA Headquarters, in developing new education materials that can be incorporated in advanced undergraduate and graduate engineering courses at universities across the nation. These materials, in the form of viewgraphs,

charts, tables, animations, and video clips, will be based on the latest research in the field of hypersonics and will incorporate advances in the field developed under all recent programs, including NASA's Hyper-X (X-43) program.

The methodology will initially be presented to faculty, students, and researchers in the form of a series of short courses, which will give the educational-material developers an opportunity for feedback so that needed improvements can be made prior to release.

The results of this program will support NASA's Aeronautics Mission Directorate (ARMD), which is developing a unified, multifaceted educational program with the objective of drawing students into the study of engineering, with the ultimate aim of encouraging entry into the aerospace workforce. Materials used in the courses are available to all participants and by any faculty request. The courses are also available through live webstream.

The first course on "The Fundamentals of Hypersonic Flight" held in September 2007, was given by 19 national experts from academia, industry, and government. Ninety-six people attended in person with 20 additional attendees by web conference. Five additional courses will be delivered in the next year.

NESC Academy

NASA engaged NIA and its partner CIBER, Inc. to establish, develop, and implement the NASA Engineering Safety Center (NESC) Academy. This program involves the development of a training curriculum geared towards young NASA engineers based on experience of senior NESC disciplinary experts with case studies and lessons learned from Apollo, Shuttle, and other NASA operational programs. The curriculum involves a series of short courses which are presented at universities across the nation. Three courses were presented in FY07, bringing the total to seven. The courses are now available online at the NESC Academy website, www.nescacademy.org.

2007 NIA SHORT COURSES

Risk-Based Design for Exploration Systems by Joseph R. Fragola
Decision Analysis Training for ESMD Rick Management Officers by Doug Stanley
NESC Academy: Human Factors by Cynthia Null
Systems Analysis for Aerospace Systems by Alan Wilhite
NESC Academy: Software as an Engineering Discipline by Michael Aguilar
Theory and Design Techniques of Adaptive Control by Gang Tao
NESC Academy: Materials Durability - Understanding Damage Modes by Robert Piascik
Lessons Learned Applied to Space Systems Development by Larry Ross
HEI: Fundamentals of Hypersonic Flight
Robust and Adaptive Control Theory by Kevin Wise and N. Hovakimyan

NESC Academy courses: Human Factors, Software as an Engineering Discipline, and Materials Durability - Understanding Damage Modes

Outreach Activities

NIA's outreach program helps to ensure that the best and brightest students develop and maintain an interest in science, technology, engineering and mathematics (STEM). We are dedicated to teacher training and enhancement activities, as well as cultivating future talent to include underrepresented sectors of the school-age population.

NIA couples and leverages resources with those of other organizations that have existing programs and demonstrated expertise in the establishment and delivery of results. This includes government entities such as the NASA Langley Office of Strategic Communications and Education, the U.S. Departments of Defense and Commerce, and non-profit entities such as AIAA and Nortel LearniT.

In-Service Teacher Program

NIA organizes and supports a two-week educator workshop for middle and high school teachers. The workshop goal is to empower and prepare teachers to develop instructional materials that strengthen and motivate students' understanding of ways that STEM content affects their everyday lives and provides future career objectives.

The Fifth Annual NIA Educator Training Workshop, held July 9-20, 2007, was a joint effort involving NIA, NASA Langley Research Center's Office of Education, the Virginia and North Carolina Space Grant Consortia, and NIA university partners from Virginia and North Carolina. This year's program included 32 middle and high school teachers from Georgia, Maryland, North Carolina, and Virginia.

NIA also took a leadership role in a number of additional in-service teacher's workshops held during the summer of 2007. Five one-week Teacher Training Institutes were developed and implemented for the Center for Advancement of STEM Education (CASE) by NIA and its partner Nortel LearniT. Another week-long workshop involved the Virginia Math Science Partnership with participation from NIA, Nortel LearniT, and Christopher Newport University. Additionally, several shorter duration workshops were held in partnership with Nortel. Overall, the in-service teacher workshops and institutes reached over 380 STEM educator in 2007.

NASA Pre-Service Teacher Program (PSTP)

PSTP aims to improve pre-service teacher preparation in science and mathematics primarily at minority-serving institutions. The program supports elementary and middle school pre-service teachers from underserved populations and provides opportunities for pre-service teachers to develop the confidence and skills to effectively teach mathematics and science using technology. It is managed for NASA by NIA, supported by the University of Maryland Eastern Shore.

Two proven vehicles NASA employs to accomplish these goals include a national conference and a summer institute. The focus of the conference is to engage and immerse pre-service teachers and their faculty advisors in an intensive 2½-day training session in mathematics, science and technology enhancement as well as National Education Goals.

The NASA/NIA 12th Annual Pre-Service Teacher Conference (PSTC) was held February 15-17, 2007 in Alexandria, VA. The conference was created to help undergraduates and aspiring teachers develop the confidence and skills to effectively teach mathematics and science using cutting-edge technology and educational materials. More than 350 students attended from 51 schools, representing 24 states and the District of Columbia.

NIA also facilitated Pre-Service Teacher Institutes (PSTI) at NASA Langley and NASA Ames Research Centers. On July 15-17, 2007, the NASA Langley PSTI focused on deepening the conceptual understanding of the 24 students attending on topics in math and science through effective use of technology. PSTI participants taught lessons of their own design to local elementary students, toured Langley facilities and interacted with NASA scientists, researchers, and engineers. In collaboration with the California Teaching Fellows Foundation, NIA facilitated the NASA Ames PSTI August 12-14, 2007 to provide an intensive, hands-on, teacher enhancement experience for 16 elementary and middle school pre-service teachers.

2007 PSTI Participants

Summer 2007 LARSS Students

A significant improvement to the 2007 program involved the addition of an online professional development program to the national conference and the summer institutes. PSTC attendees were given the opportunity to develop online learning communities to support ongoing and continuous instruction in best practices in the use of STEM-enriched curriculum using state-of-the-art Internet communication tools (ICT), which were provided by NIA's partner, Nortel LearniT.

Television and Radio

NIA, through a project from the NASA Langley Office of Public Affairs, initiated a public outreach broadcast program, *NASA 360*, to build awareness and support for NASA's Vision for Space Exploration. *NASA 360* is produced to air on public television in a 30-minute format to support NASA's strategic communications goal to inform, educate and engage stakeholders and the general public to create broad understanding of the importance of taking the next steps in space exploration.

Discovery Now, funded by a grant from AIAA, is a daily radio program that highlights topics in aeronautics and astronautics technology, science, history, innovations, research and inventions worldwide. A total of 240 interstitial radio programs, 90-seconds in length, air per year. NIA writes and produces *Discovery Now* and distributes the program in collaboration with WHRO, which airs the show during NPR's "All Things Considered." For the first year, the program aired on limited public radio stations. Spots are delivered via web streaming at www.discoverynow.us, audionewsfeed.com and iTunes. The program is expanding to include additional Public Radio International (PRI) outlets, additional NPR stations, college and community stations, and additional FM, AM, and XM radio.

Internship Programs

The Langley Aerospace Research Summer Scholars Program (LARSS), established by NASA in 1986, provides 10-week summer internships at NASA Langley. Participants are rising college juniors and seniors, and graduate students who are pursuing degrees in aeronautical engineering, mechanical engineering, materials science, computer science, atmospheric science, astrophysics, physics, chemistry, and other selected disciplines of interest to NASA Langley. A "Bridge Program" allows outstanding high school seniors and first- and second-year college students to be accepted for the LARSS internship. NIA, supported by the Virginia Space Grant Consortium, has managed the LARSS program since June 2006. In 2007, 126 students participated in the summer session and 25 during the fall. In addition to research assignments at Langley, students participated in a series of seminars and workshops, social events and activities, NASA tours, and a report-out session.

NIA also helps manage the Langley Faculty Fellowship Program (LFFP), which gives faculty researchers with scientific, technical, and educational expertise an opportunity to conduct leading research at NASA Langley. The program provides science and engineering faculty hands-on exposure to Langley's research challenges through 10-week summer research residencies and extended research opportunities at Langley, working closely with NASA colleagues on basic, formative, and leading-edge research assignments. Faculty members also foster unique opportunities to collaborate on projects and programs where there is synergy between the university faculty member and the NASA researcher. In FY07, there were four faculty participants.

NIA-Supported Student Conferences

NIA supports student participation in conferences such as the National Educators Workshop, particularly to involve minority and undergraduate students. This particular workshop brings materials researchers together with the aim of providing materials experiments for undergraduate and high school classes. NIA also sponsored student participation at the Southeastern Atlantic Mathematical Sciences Workshop and an undergraduate student design session at the Institute of Electrical and Electronics Engineers-sponsored Systems & Information Engineering Design Symposium.

Awards & Recognitions

Larry Battle
- NASA Certificate of Appreciation for outstanding support of the 5th Quarterly Exploration Systems Mission Directorate Risk and Knowledge Management Workshop conducted at NIA on November 28-30
- United States Air Force commendation from Maj.Gen. Kennedy for support of Global Cyberspace Integration Center Programming Plan Conference

Michael Bibbo
- Davey Award Gold Winner for Small Firms
- NASA Digital Television Working Group Videographer of the Year Third Place for outstanding achievement in the category of Production

Latisha Bristow
- United States Air Force's Air Education and Training Command Air University for completion of the Education with Industry Program in Engineering Management

Frank Bussink
- NASA Commendation for contributions to NASA Enhanced Oceanic Operations Research

Yonghoon Choi
- NASA Group Achievement Award for the Intercontinental Chemical Transport Experiment for outstanding accomplishments in the successful Intercontinental Chemical Transport Experiment Mission conducted in the United States and Mexico

Luis Crespo
- AIAA Hampton Roads Young Engineer of the Year Award

Donavon Delozier
- NASA ICB Space Act Award for Novel Aromatic/Aliphatic Diamine Dericatives for Advanced Compositions and Polymers

Mark Dunn
- NASA ICB Space Act Award for Fast Scattering Code (FSC)

Marcia Gibson
- Project Management Institute Hampton Roads Chapter Project of the Year Runner-Up for the NASA Engineering and Safety Center (NESC) Academy

Lara Hawthorne
- NASA Certificate of Appreciation for outstanding support of the 5th Quarterly Exploration Systems Mission Directorate Risk and Knowledge Management Workshop conducted at NIA on November 28-30

James Hubbard III
- NASA Certificate of Appreciation in recognition of invaluable support provided to the Quiet Flow Facility RTD-Aeroacoustics Branch

Jae-Woo Kim
- NASA ICB Space Act Award for Ferroelectric Light Control Device

Kevin Krigsvold
- Davey Award Gold Winner for Small Firms

Ronald Krueger
- NASA Center Team Award to the Reinforced-Carbon-Carbon Damage Tolerance Team for outstanding efforts to understand and model the damage tolerance capabilities of the RCC shuttle leading edge material

NIA 2006
BEST RESEARCH PUBLICATION AWARD

Dr. Amber J. Soja

"Climate-Induced Boreal Forest Change: Predictions Versus Current Observations," Amber J. Soja, Nadezda M. Tchebakova, Nancy H.F. French, Michael D. Flannigan, Herman H. Shugart, Brian J. Stocks, Anatoly I. Sukhinin, E.I. Parfenova, F. Stuart Chapin III, and Paul W. Stackhouse, Jr., Global Planetary Change, 2006.

Zhoayan Liu

- NASA Center Team Award to the CALIPSO On-Orbit Commissioning, Operations, and Data Processing Team for successfully initiating the CALIPSO on-orbit commissioning, operations and data processing
- NASA Center Team Award to the CALIPSO Validation Team for outstanding contributions in validating CALIPSO LIDAR data
- NASA Group Achievement Award to the CALIPSO Team for exceptional achievements in the successful development, launch, and operation of the CALIPSO satellite

Douglas Stanley

- AIAA Region I Engineer of the Year

Kenneth Sunshine

- Virginia Business Finalist for the 2007 CFO of the Year Award for Small Nonprofit Companies

Craig Thompson

- NASA ICB Space Act Award for Space Environmentally Durable Polyimides and Copolyimides

Robert Tolson

- NASA Group Achievement Award to the Mars Reconnaissance Orbiter Navigation Team for outstanding success in navigation of the Mars Reconnaissance Orbiter during launch, cruise, MOI, and particularly aerobraking (with graduate students Angela Brickler, Shaun Brown, Michael Scher, Paige Thomas, Eammon Bemis, Kristina Zaleski, Jeremy Shidner, and Steven Hough)

Shannon Verstynen

- NASA Certificate of Appreciation for outstanding support of the 5th Quarterly Exploration Systems Mission Directorate Risk and Knowledge Management Workshop conducted at NIA on November 28-30
- United States Air Force commendation from Maj.Gen. Kennedy for support of Global Cyberspace Integration Center Programming Plan Conference

Kent Watson

- NASA ICB Space Act Award for Space Environmentally Durable Polyimides and Copolyimides
- NASA ICB Space Act Award for Composite Material Having a Thermally Reactive Encapped Imide Oligomer and Carbon Nanofillers
- NASA ICB Space Act Award for Photogrammetric System and Method Used in the Characterization of a Structure
- NASA ICB Space Act Award for Novel Aromatic/Aliphatic Diamine Dericatives for Advanced Compositions and Polymers

Our People

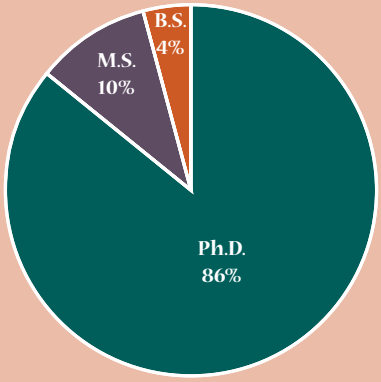
NIA's growth continued during 2006 and 2007 with a 15% increase in population. At the end of the fiscal year 2007, NIA had a total of 222 employees, faculty, consultants and students associated with the institution. Of that total, 90 were employees and continue to make up a large portion of the total population. Additionally, NIA's Visitor Program included 43 visitors, and was host to researchers from all over the world.

A quality workforce is essential to the success of NIA's research and educational programs. The NIA workforce consists of highly educated and qualified research scientists and engineers, and administrative support staff. Among NIA's research staff, 86% hold doctoral level degrees.

Our researchers are sought-after experts in their field and present their research to others through conferences, seminars, workshops and publications. NIA research scientists published a total of 73 journal articles, presented 68 conference papers, and technical reports and other talks in FY07. They were also the recipient of a wide range of awards and recognitions in 2007.

NIA employees are active participants in numerous committees and collaborations, act as mentors and advisors to high school students, university students and postdoctoral scientists, and contribute to the community through service to various organizations in the area.

EDUCATIONAL LEVEL OF NIA RESEARCH STAFF



Technology Transfer

FY07 INVENTION DISCLOSURES

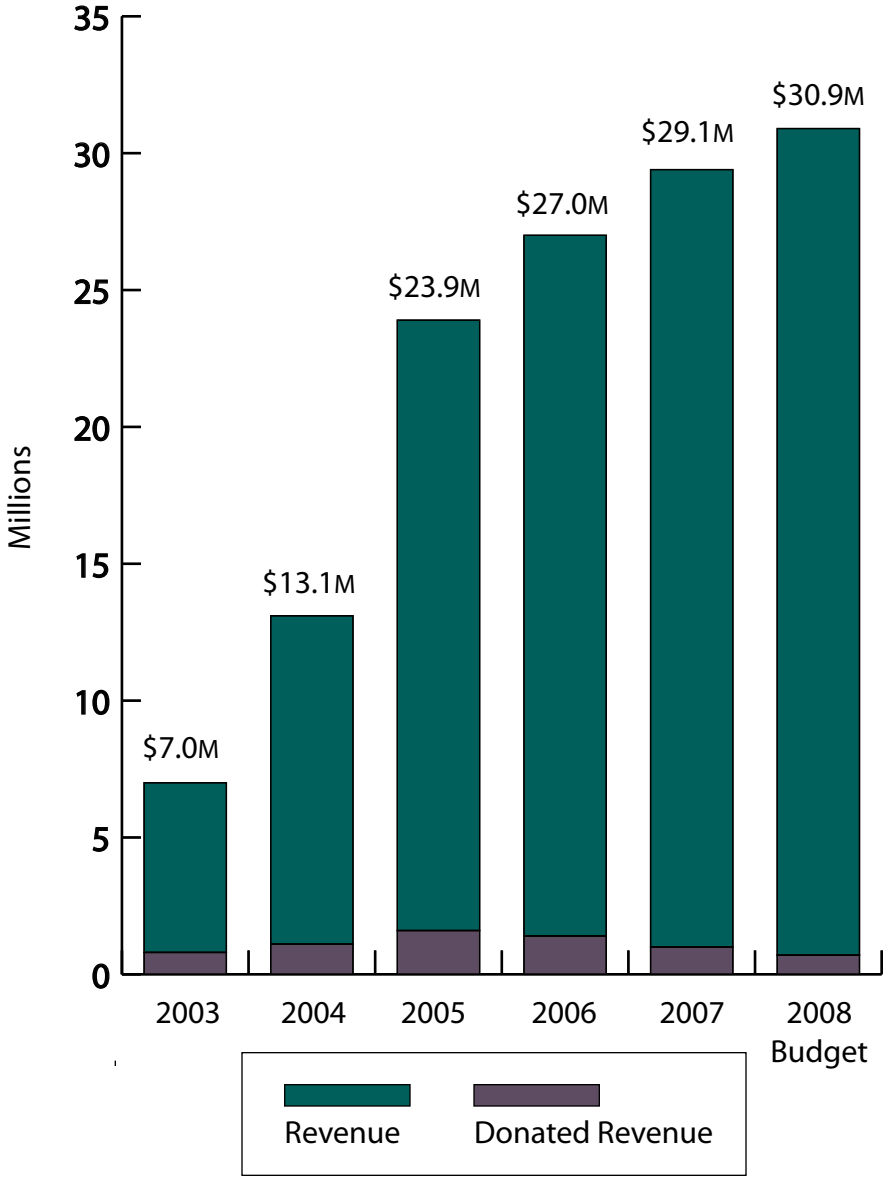
Case Number	Invention Disclosure Title
17455-1	All-Organic Electroactive Device Fabricated with Single Wall Carbon Nanotube Film Electrode (SWNT-FE)
17267-1	Depositing Nanometer-Sized Particles of Metals onto Carbon Allotropes
17535-1	Boron Nitride Nanotubes
17169-1	Hybrid Piezoelectric Energy Harvesting Transducer System
17427-1	Tailorable Dielectric Materials with Complex Permittivity Characteristics Providing High Dielectric Constraints
17390-1	Advanced High Performance Horizontal Piezoelectric Hybrid Synthetic Jet Actuator (ASJA-H)

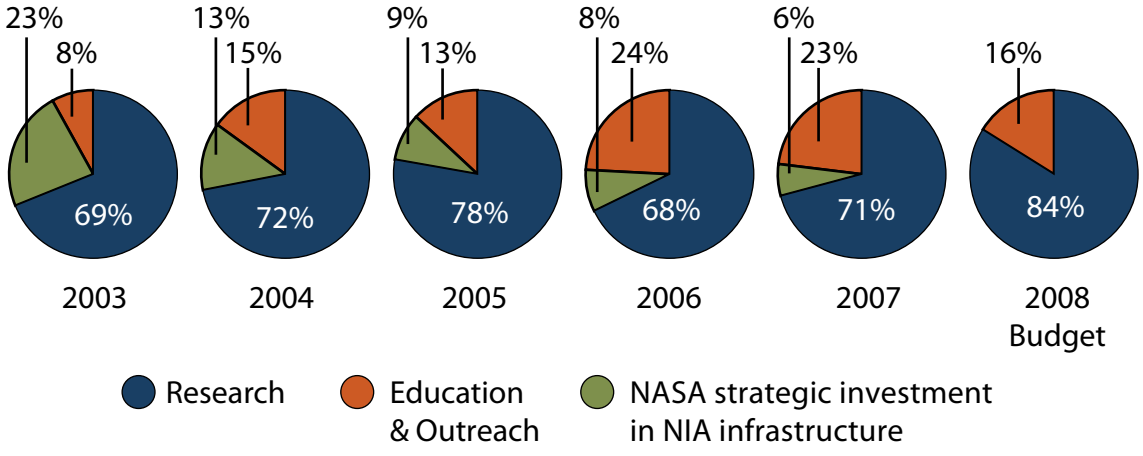
NIA has a number of quality applications and inventions that are now ready for licensing that can be viewed on NIA's Technology Transfer website, www.nianet.org/techtransfer/. Our Technology Transfer Program is structured to provide research support to any interested party seeking to exploit and expand any NIA-licensed applications and inventions. In Fiscal Year 2007, NIA filed 18 new patent applications and six new invention disclosures that covered a wide range of research areas. In conjunction with the Technology Commercialization Center (TeCC) in Hampton, VA, NIA organized and hosted the "Workshop for Developing Advanced Materials in Virginia - Impact of Nanotechnology" that featured NIA nanotechnology licensing opportunities.

PROVISIONAL PATENTS FILED IN FY07

Case Number	Patent Title
LAR 17455-1	All-Organic Electroactive Device Fabricated with Single Wall Carbon Nanotube Film Electrode (SWNT-FE)
LAR 17269-1	Pressure Sensor System
LAR 17270-1	Unmanned Vehicle
LAR 16845-1	Advanced Thermo-Electric Materials with Nano-Voids
LAR 17239-1	Advanced Electroactive Single Crystal and Polymer Actuators for Cryogenic Actuations
LAR 16920-1	Fabrication of Advanced Thermoelectric Materials by Hierarchical Nanovoid Generation
LAR 17224-1	Effective Dispersion of Carbon Nanotubes in an Aqueous Solution
LAR 16906-1	Fabrication of Nanovoid Bismuth Telluride with Low Dimensional System
LAR 17134-1	Farication of Metallic Hollow Nanoparticles
LAR 17366-1	Nanocomposites from Stable Dispersions of Carbon Nanotubes in Polymeric Matrices Using Dispersion Interaction
LAR 17087-1	Self-Healing Polymers
LAR 17267-1	Depositing Nanometer-Sized Particles of Metals onto Carbon Allotropes
LAR 17535-1	Boron Nitride Nanotubes
LAR 17135-1	Fabrication of Metal Nanoshells
LAR 17427-1	Tailorable Dielectric Materials with Complex Permittivity Characteristics Providing High Dielectric Constraints
LAR 17382-1	Advanced High Performance Vertical Hybrid Electroactive Synthetic Jet Actuator (ASJA-V)
LAR 17384-1	Advanced Modified High Performance Synthetic Jet Actuator with Optimized Curvature Shape Chamber (ASJA-M)
LAR 17390-1	Advanced High Performance Horizontal Piezoelectric Hybrid Synthetic Jet Actuator (ASJA-H)

Financials


35
30
25
20
15
10
5
0
Millions
$7.0M
$13.1M
$23.9M
$27.0M
$29.1M
$30.9M
2003
2004
2005
2006
2007
2008 Budget
Revenue
Donated Revenue


23%
8%
69%
13%
15%
72%
9%
13%
78%
8%
24%
68%
6%
23%
71%
16%
84%
2003
2004
2005
2006
2007
2008 Budget
Research
Education & Outreach
NASA strategic investment in NIA infrastructure

Executive Staff

PRESIDENT & EXECUTIVE DIRECTOR

Dr. Robert E. Lindberg, Eng.Sc.D. has served as President & Executive Director of NIA since October 2003. He joined NIA at its inception in October 2002 and initially served as Vice President of Research & Program Development. He is also a Research Professor in the Mechanical & Aerospace Engineering Department at the University of Virginia, and supervises graduate student research and study at NIA. Dr. Lindberg has prior experience in industry as an executive with Orbital Sciences Corp., and in government with the Naval Research Laboratory. He holds a doctorate in Mechanical Engineering from Columbia University. He is a Fellow of AIAA, a Fellow and past president of the American Astronautical Society, and an elected member of Sigma Xi and Sigma Pi Sigma.

VICE PRESIDENT OPERATIONS & TECHNOLOGY TRANSFER

Dr. Karl L. Drews, J.D. serves as Vice President of Operations & Technology Transfer, and as the Secretary for NIA. He brings more than 30 years legal and technology transfer experience to this position and currently oversees NIA's technology transfer, contracts, purchasing, business administration, human resources, information technology, and public relations operations. Prior to joining NIA, Dr. Drews served as the Assistant General Counsel for Software AG and as Acting General Counsel for SAGA Software, Inc. He received his Doctor of Jurisprudence from the Marshall-Wythe School of Law at the College of William & Mary.

VICE PRESIDENT EDUCATION & OUTREACH

Dr. Bernard M. Grossman, Ph.D. has served as Vice President of Education & Outreach since the formation of NIA in October 2002. He coordinates all aspects of NIA's graduate education, short course, workshop, seminar, and out reach programs. He is a full professor in the Department of Aerospace & Ocean Engineering at Virginia Tech, and served as Department Head from 1993 to 2002. Prior to joining the Virginia Tech faculty, he was Head of the Theoretical Aerodynamics Laboratory in the Research Department at Grumman Aerospace Corp. He earned his doctorate in Astronautics from the Polytechnic Institute of Brooklyn. He is a Fellow of AIAA.

VICE PRESIDENT RESEARCH & PROGRAM DEVELOPMENT

Dr. Calvin W. Lowe, Sc.D. joined NIA as Vice President of Research & Program Development in April 2007. Dr. Lowe oversees NIA's research programs and directs efforts to expand the Institute's research portfolio. Dr. Lowe is a past president of Bowie State University and vice president for research at Hampton University. He received a B.S. in Physics from North Carolina A&T State University, and both a M.S. in Plasma Physics and Sc.D. in Solid-State Physics from the Massachusetts Institute of Technology.

CHIEF FINANCIAL OFFICER

Mr. Kenneth H. Sunshine joined NIA in February 2004 as Chief Financial Officer and Treasurer of the corporation. Mr. Sunshine is responsible for all of NIA's financial operations. Prior to joining the NIA management team, he was Chief Financial Officer of Aurora Flight Sciences Corp. and earlier served as Senior Vice President of Finance and Treasurer of Orbital Sciences Corp. He holds a B.S. in Mechanical Engineering and Computer Science from Tufts University and an M.B.A. from the Wharton School of the University of Pennsylvania.

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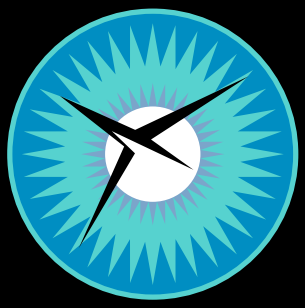

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