National Institute of Aerospace

2006 Annual Report

NIA BY THE NUMBERS

Research

- 48 Members of resident research staff
- 11 University research staff in residence at NIA
- 46 Scholars from around the world participated in the '06 Visiting Researcher Program
- 64 research projects funded at member universities
- 60 Collaborative NIA/NASA/university proposals submitted to other government agencies – 24 selected for funding
- 189 Peer-reviewed publications and conference presentations
- 29 Separate awards for NIA research contributions

Education

- 44 Full-time graduate students in residence
- 15 Part-time graduate students enrolled
- 17 Graduate (MS and PhD) degrees awarded
- 13 Full-time and part-time faculty in residence
- 20 Resident MS and PhD programs offered on-site at NIA by seven member universities
- 120 course offerings each semester in distance education catalog
- 30 Two-way video courses delivered (six outbound from NIA)
- 13 Short courses, 67 seminars, and 8 workshops, including 5 NESC Academy short courses

Outreach

- 32 Science and math teachers attended 4th Annual NIA Educators Workshop
- 350 Pre-service teachers from 55 schools and 34 states attended NASA/NIA Annual Conference
- 24 Pre-service teachers attended two-week Summer Institute
- 122 Summer interns participated in Langley Aerospace Research Summer Scholars Program, 24 continued into Fall semester
- 13 Faculty participated in 10-week Langley Faculty Fellowship Program
- 4 Final episodes of Emmy award-winning TV program, NASA's *Destination Tomorrow*, produced by NIA Media Communications Group

Financial

- FY06 revenue: $27.0M
- FY07 projected revenue: $28.2M
- FY06 member university cost-sharing: $1.5M

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LETTER FROM THE PRESIDENT

2006 witnessed the completion of the second Shuttle Return to Flight mission, and return of the Space Shuttle to full flight status; the start of engineering work on NASA's efforts to send humans back to the Moon; the launch of the CALIPSO spacecraft to measure the Earth's atmosphere with LIDAR; and the release of a new national policy on aeronautics research and development by the White House. The National Institute of Aerospace (NIA) was involved in all of these national events and much more. For NIA, 2006 has been a year of growth and maturity for our research, education, outreach and technology transfer missions.

Having completed all of the goals established at the formation of the Institute in 2002, we undertook our first major strategic planning effort to define challenges for the next five years. The result: three new research thrusts in Advanced Systems Engineering, Adaptive Structures (Sensors, Actuators and Advanced Materials), and Collaborative Autonomous Vehicles. The strategic plan also maps out goals to expand our graduate education program into one that is well-funded and world class; and to secure capital funding for a new NIA laboratories building.

In February, NIA continued our contribution to the Small Aircraft Transportation System research efforts by issuing the report, *Research and Development for Safe, Secure and Affordable Air Transportation for Every Community in America*. This report, produced by a national panel of experts, provides a five-year roadmap to achieve the technical goals that will enable a new class of commercial aviation that leverages underutilized small community airports and the next generation of small airplanes and very light jets.

In April, NIA was invited to participate in a roundtable with other non-federal government stakeholders to develop a national research plan that articulates the appropriate role for federal investment in US aeronautics R&D.

In June, DARPA awarded 'Phase 0' of the Sky Walker project to NIA. Our Sky Walker principal investigator, Dr. James Hubbard, is collaborating with colleagues from Georgia Tech, local industry and NASA to develop technology that will extend the range, flight duration and time on station for Unmanned Air Vehicles (UAVs). The approach is similar to that used by birds and by soaring pilots, exploiting thermal updrafts in the atmosphere.

In July, NIA submitted 25 proposals under NASA's Research Opportunities in Aeronautics NRA (NASA Research Announcement). NASA selected seven of our proposals for award, including collaborations with Georgia Tech, North Carolina A&T, MIT and Texas A&M University.

During 2006, NIA negotiated a six-year strategic relationship with Airbus under which Airbus will fund research conducted by the Institute and faculty from our member universities in a wide range of fields including active flow control, wireless data systems and advanced materials.

Also during 2006, students in residence at NIA received 14 MS degrees and three PhDs from five NIA member universities; our highest number of graduates to date.

We undertook the first significant technological upgrade of our distance learning facilities in 2006, implementing the new H.239 multi-channel communications standard in two classrooms. H.239 allows simultaneous transmission of a high-resolution video presentation, along with a video conference session. This capability dramatically improves the

resolution of text materials on the presentation screen, and allows the instructor to incorporate multimedia products into the classroom lecture.

Looking forward to 2007, we expect continued growth in our research, education and outreach programs. In January, we expect to begin the broadcast of NIA's new radio program Discovery Now on WHRV, public radio for Hampton Roads.

In 2007, we also hope to secure NASA Langley Research Center's (LaRC) exercise of the first five-year option on the Cooperative Agreement first awarded in 2002 to establish the institute. When exercised, the option will extend the period of performance to September 2012 and increase the funding ceiling to $144M.

We will celebrate our fifth anniversary on September 26, 2007. By then, the implementation of our new five-year strategic plan, developed in 2006, will be in high gear.

And, as we implement that plan, we will continue to adhere to our core values: to develop and maintain a culture of excellence in everything we do; to maintain a culture of respect for our students, faculty and staff; and to maintain a culture of respect for our customers, clients and partners.

Robert E. Lindberg, Eng.Sc.D.

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.

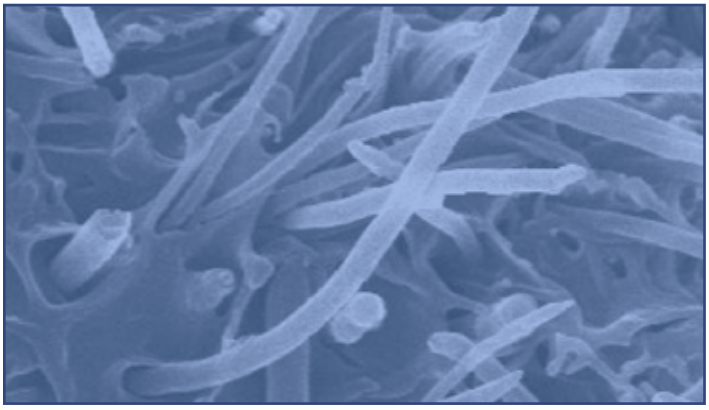
… Incubate and stimulate the commercialization of new intellectual property developed through the Institute's research activities, including radical ideas and disruptive technologies.

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

NIA Headquarters in Hampton, Virginia

CENTER OF NANOTECHNOLOGY FOR ADVANCED SENSORS, ACTUATORS & MICROSYSTEMS

Mool G. Gupta, Ph.D.
Samuel P. Langley Professor
University of Virginia



Nanocomposite foam structure

"It took hundreds of years for the industrial revolution to occur. The same kind of revolution on the nano-scale is occurring right now, in just a matter of a relative few years. And it's accelerating. Within 15 years, nanotech will bring major, major changes."

Professor Gupta currently serves as the Director for the NIA Center of Nanotechnology for Advanced Sensors, Actuators & Microsystems. In 2006, the Center conducted sponsored research in very high-speed laser applications, as well as in laser-related surface processing and hardening, alloying, cladding, annealing, doping, crystallization and decontamination.

Other Center projects focused on: investigating potential biomedical applications; laser processing of materials; micro-machining and welding; laser ablation and multi-energy processing; spectroscopic diagnostics; thin-film coatings; and plasma technology.

Prof. Gupta and his student cadre continue to build a strong partnership between the University of Virginia, NIA and NASA LaRC.

The following are illustrative of on-going Center research initiatives:

- *Laser micromachining, crystallization*
- *Nano-catalysts and nano-composites*
- *Electro-optic materials*
- *Surface etching, processing and coatings*
- *Finite element modeling*
- *Patterning and material synthesis*

"At NIA we are working at the cutting edge of technology. It's exciting work and it has real-world application. Nowhere else do we have seven universities working together with NASA and the entire NASA infrastructure. It's a unique experience."

"We offer an experience that no one else in the country can. You simply can't get these courses elsewhere. This program provides students with everything and anything they need for success... My students are number one in my professional life. When I get involved I solve problems immediately, so they won't be distracted."

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

Professor Hubbard currently serves as the Director for the NIA Center for Adaptive Aerospace Technology develops and supports multi-disciplinary teams pursuing revolutionary research to develop efficient multi-point vehicles that provide performance on demand and operate in an integrated airspace-vehicle environment.

The Center focus areas include: active flow and noise control and unsteady fluid mechanics; their integration with adaptive structural concepts; and intelligent distributed sensors and flight controls.

The Center explores the application of emerging technologies for revolutionary vehicle concepts, including the exploration of bio-inspired approaches for potential applications for controls and autonomous behaviors.

Prof. Hubbard's graduate researchers continue to focus on aerospace applications utilizing morphing materials and structures. The Center develops disruptive aerospace technologies, with an emphasis on simplicity of concept and elegance of design.

On-going research initiatives focus on:

- *Aerospace-relevant smart materials*
- *Flapping-wing airfoil design*
- *Passive-wing-load morphing*
- *Conformal sensors*

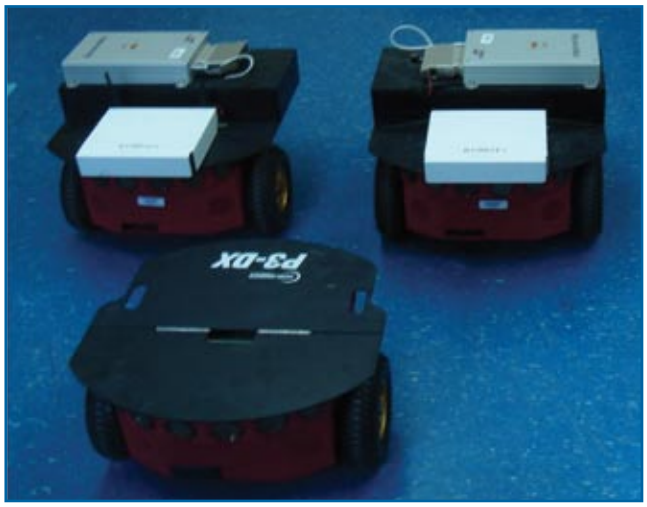
Sky Walker UAV concept for exploiting thermals

"Engineering is a contact sport. Students here train on software and simulators. Then they go out to an airfield and they learn to fly - so they will be well acquainted with all the problems of flight. We fly fixed-wing, we fly rotary wing, we fly robot birds. We're on the edge of the envelope."

CENTER FOR HIGH CONFIDENCE COOPERATIVE SYSTEMS

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

"The NIA advantage is that grad students work with established professors, a national laboratory and experienced scientists and engineers. You work at the cutting edge, directly related to advanced applications and can concentrate on problems that have relevancy to the real world."



Multiple Unmanned Ground Vehicles (UGVs)

Professor Song currently serves as the Director for the NIA Center for High Confidence Cooperative Systems.

Prof. Song's research includes dynamic modeling, path planning, trajectory tracking, vision-based control, motion coordination, close formation and simulation of multiple manned and unmanned vehicle systems. The primary objectives of Prof. Song's experiments are to validate the feasibility of practical implementation of methods and algorithms and to foster innovation to overcome potential obstacles.

The Center facilitates learning, investigation and research in the multidisciplinary field of cooperative systems engineering. Students are able to develop a better understanding of cooperative systems theory and are able to put that theory into practice.

The following are illustrative of on-going Center research initiatives:

- *Practices of analogue, digital and computer control*
- *Process controls, adaptive systems and intelligent instrumentation*
- *High-speed motion control, robotics, vision sensing, recognition and machine perception*
- *CAD/CAM, integrated automation and intelligent robotic welding systems*
- *Process control and servo-training systems*

"Controls play an increasingly important role these days. It's the ability to be autonomous, to function without much human control, to adjust rapidly to an unanticipated event. The real emphasis is on coming up with radical solutions to make controls more reliable, more adaptive and less expensive. What's important and what's useful is self-healing, self-repair and reconfiguration on the move."

CENTER FOR MULTIFUNCTIONAL AEROSPACE MATERIALS

Kathryn V. Logan, Ph.D.
Virginia Tech

"Materials are intrinsic to everything. I teach design of materials from the atomic level up to macro scale. I accept students from any discipline; it's a great opportunity for interdisciplinary integration and interaction. NIA students have a unique opportunity to have a really in-depth educational experience."

Professor Logan currently serves as the Director of the NIA Center for Multi-functional Aerospace Materials.

In 2006, the Center conducted sponsored research in the development of lighter, stronger and multifunctional materials for extreme-environment aero applications. Future Center research will focus on the discovery and documentation of methods and processes that facilitate the design of multifunctional aerospace materials across the nano-to-meso range of spatial and time scales.

The design of multifunctional aerospace materials is being accomplished by developing and implementing advanced synthesis, processing, forming and characterization technologies. Theoretical and experimental models are being developed to verify experimental predictions about the resultant products' composition, configuration and performance from a systems respective.

Potential applications include:

- *Radiation shielding material for space suits*
- *Meteoroid shielding*
- *Landing brakes*
- *Sensors that operate at extremely high temperatures*
- *Liquid-cooled, leading-edge materials for areas of intense aerodynamic heating*
- *Pressure sensors*

Present and future research topics include:

- *Multifunction and bio-mimetic materials*
- *Advanced materials synthesis and processing*
- *High-temperature solid-state diffusion*
- *Refractory material development*
- *Analytical materials characterization*
- *Mechanical properties of materials*

Self-propagating high-temperature synthesis

CENTER FOR PLANETARY ATMOSPHERIC & FLIGHT SCIENCES

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

"We work on real-world missions. I know of no other place where students can be involved with critical mission elements. Their analyses and recommendations have a direct result on the decisions managers make every day."

Professor Tolson currently serves as the Director for the NIA Center for Planetary Atmospheric & Flight Sciences. Current and recent Center studies include:

- *Recovering upper atmosphere winds on Mars from the Odyssey aero-braking data;*
- *Analysis of the aero-braking phase of the Mars Reconnaissance Orbiter mission;*
- *Entry aerothermodynamics and flight mechanics studies for both the Mars Science Laboratory and the Phoenix mission;*
- *CEV aero-capture returning from the Moon or Mars;*
- *Titan-Huygens entry reconstruction and atmospheric characterization; and*
- *Mars Exploration Rover (MER) entry anomaly investigation and trajectories.*

Prof. Tolson's activities are integrated with the research efforts of NASA's planetary entry, atmospheric science and sensor development groups, as well as faculty and students from NIA member universities.

Prof. Tolson and his graduate researchers are involved in real-time operations during the aero-braking phase of the Mars Global Surveyor, the Mars Odyssey and the Mars Reconnaissance Orbiter missions.

The following are illustrative of on-going Center research initiatives:

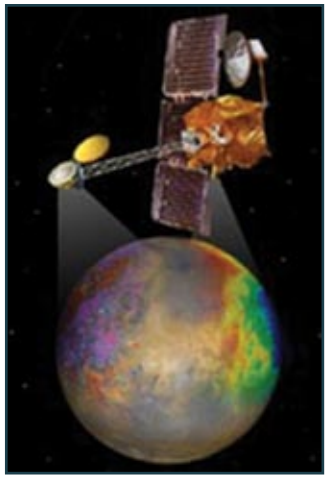
Astronautics

- *Spacecraft dynamics and control*
- *Optimal trajectories and orbit transfers*
- *Orbital mechanics and orbit determination*
- *Earth and planetary atmospheres and gravity fields*

Aeronautics

- *Aerothermodynamics*
- *Structural mechanics and dynamics*

"I try to keep my students directly involved in flight missions rather than paper studies. I have students looking at moon landings, crew-exploration vehicle return from the Moon, the radiation environment for the space station, and every Mars mission currently being planned. It's a pretty good way to start a career."



CENTER FOR AEROSPACE SYSTEMS ENGINEERING, MODELING & SIMULATION

"My students are on the forefront. They're creating everything. The decisions we make today will affect the next 30 years. I don't think there's anywhere else in the country where you can do these sorts of things."

Alan W. Wilhite, Ph.D.
Georgia Tech

Professor Wilhite currently serves as the Director for the NIA Center for Aerospace Systems Engineering, Modeling & Simulation. This Center supports NASA, the Department of Defense and industry, providing advanced systems engineering techniques, models, simulation and environments to improve cost, development time and system quality. The Center promotes excellence in the nation's systems-development efforts through research, education, creativity and innovation in

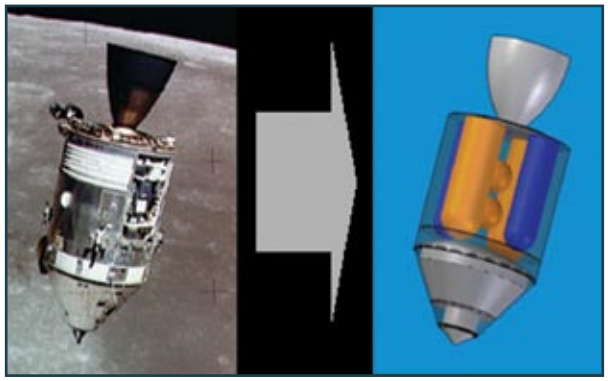
- *Modeling and simulation of systems and systems of systems*
- *Robust design and engineering practices*
- *Advanced engineering environments*
- *Systems engineering and engineering integration*

Within the Center, a systems engineering modeling and simulation lab is being developed to integrate systems engineering practices across the complete life-cycle system. An integration environment is also being developed to support industry and NASA's state-of-the-art multi-disciplinary engineering computational tools to model systems and associated technologies.

The following are illustrative of on-going research areas:

- *System-of-systems simulation, evaluation and design*
- *Risk analysis and robust systems design*
- *Simulations of flight mechanics and flight performance*
- *Space exploration systems architectures*
- *Lunar surface architectures*
- *Lunar ascent and descent*
- *Lunar surface access modules*

"We have a pretty exciting academic program. Our students are taught by some of the country's leading experts and mentored by the best in the world."

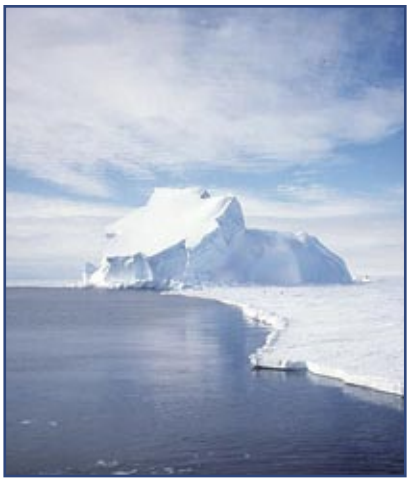


Apollo life cycle simulation

NIA conducts a broad range of scientific and engineering research sponsored by NASA LaRC, other government agencies and third parties. This work, performed either at LaRC or at NIA, is accomplished by a staff of more than 50 NIA scientists, engineers and consultants in seven principal areas of investigation. Group coordinators for these seven research teams on NIA's Research Council are:

Air Systems Research	*Frank Bussink*
Atmospheric Science	*Hongyu Liu*
Aviation Safety Research	*Sam Morello*
Exploration Systems	*Robert Maddock*
Materials Research	
Composites	*James Ratcliffe*
Metals	*Vesselin Yamakov*
Nanotechnology	*Cheol Park*
Mechanics of Flight and Control Systems Research	*Luis Crespo*
Rotorcraft Aeromechanics	*Phuriwat Anusonti-Inthra*

The technical accomplishments of the NIA researchers are represented in the following pages.

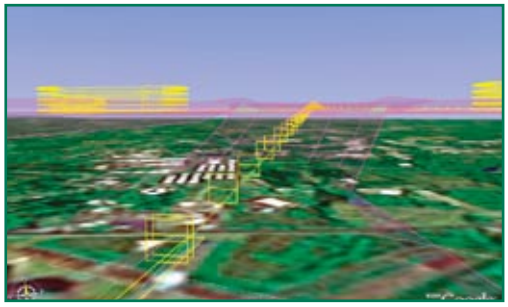


NIA Staff Research Summary

- *9 Invention Disclosures*
- *27 Awards*
- *189 Publications and Conference Presentations*

Objectives

- Enable major increases in captivity, mobility and throughput of the air transportation system through development of revolutionary concepts and technologies for operations and vehicle systems.
- Enable transportation to the Next Generation Air Transportation System (NGATS), as defined by the Joint Planning and Development Office (JPDO).



Intelligent auto-flight system

Approach

- Make use of emerging communication, navigation and surveillance (CNS) capabilities to employ human-centered automation and to assist air traffic management decision making of pilots and controllers.
- Areas of interest include system noise prediction, algorithms for conflict detection and resolution, airborne self-spacing and merging, and oceanic in-trail operations.

Synthetic vision

Accomplishments

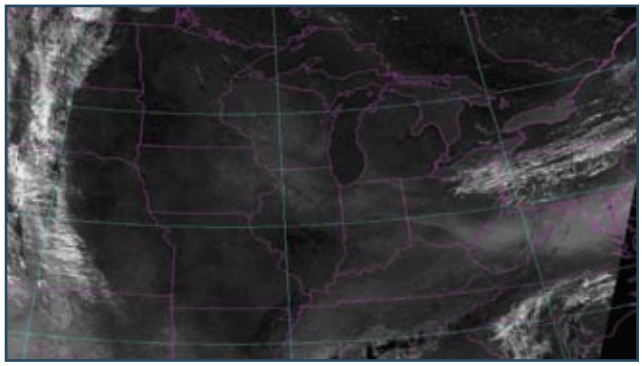
- Co-developed fast, real-time simulation environments for safety analysis and benefit studies.
- Implemented improved version of conflict detection and resolution algorithm.
- Developed library for interval analysis and completed revised model and proof of optimality for "first-come, first-served" strategy of greedy terminal-approach scheduler.
- Replacing empirical noise models with current and emerging physics-based noise prediction codes.

Objectives

- Advance scientific understanding of the role of aerosols and clouds in global climate and climate change.
- Improve the understanding of the sources, transport and transformation of radiatively and/or chemically important constituents in the troposphere and how these affect and are affected by climate change.

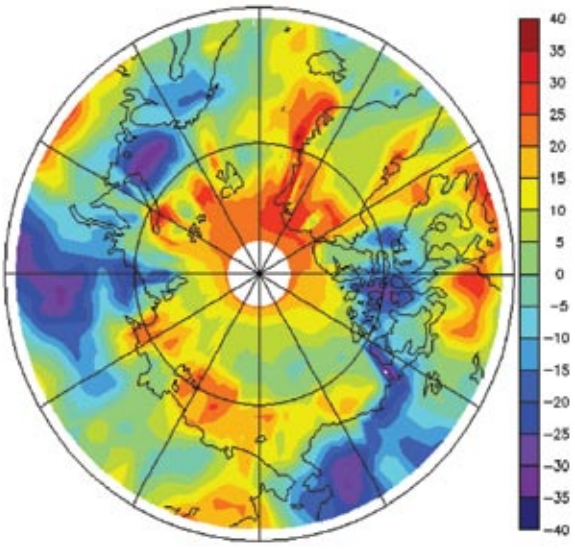
Approach

- Develop new ways to study the relationship between radiative transfer, clouds and aerosols by combining satellite and other scientific observations with state-of-the-art models.
- Use cloud-resolving models in conjunction with satellite observations of cloud properties to improve the representation of cloud processes in global models.
- Apply 3-D chemistry and transport models to quantify the impact of fire and lightning emissions, aerosols and clouds on air quality and tropospheric chemistry.



Enhanced NOAA-17 AVHRR imagery at 1701 UTC

Biomass burning emissions and aerosols affect air quality, cloud properties, surface radiation and climate.



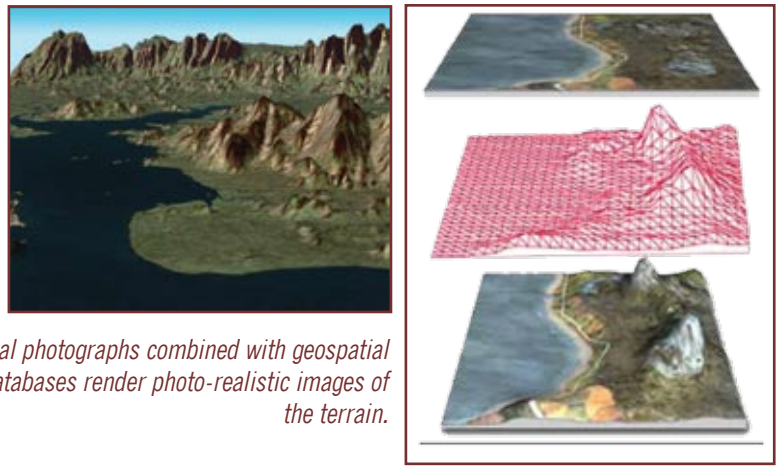
ERBE and CERES data was used to investigate the effects of the decrease in ice cover on the radiation balance over the Arctic Ocean.

Accomplishments

- Analyzed decadal-scale variations in surface solar fluxes from satellites and ground measurements and demonstrated an increase of net radiation over Arctic Ocean due to Arctic ice cap melting.
- Incorporated a new radiative transfer scheme and parameterization of ice cloud radiative properties into a cloud-resolving model; developed new contrail prediction models.
- Implemented scene classification and uncertainty estimate algorithms for LIDAR data.
- Quantified the impact of Alaskan fire emissions and the radiative effect of clouds on tropospheric chemistry.

Objectives

- Provide relevant technology assessments and integration utilizing systems engineering approaches and development.
- Provide assessment methods and tools for effective risk mitigation and reduction.
- Transfer research products generated to aviation community and national airspace system.



Aerial photographs combined with geospatial databases render photo-realistic images of the terrain.

Approach

- Develop concepts of operations and systems engineering planning and support to provide risk-reduction strategies and tools aimed at developing diagnostic safety assessment capability.
- Aim to transfer these methodologies to other national needs and programs.

Accomplishments

- Published two Concepts of Operations for health monitoring and maintenance, and flight interactive systems.
- Coordinated development of pre-emptive risk reduction technologies Concept of Operations document.
- Completed initial requirements mapping into JPDO's NGATS.
- Developed Logic Evolved Decision (LED) software tool for risk assessment, modeling and reduction.

Enhanced flight deck

Objectives

- Assist in mission development and vehicle design including entry, descent, aerocapture and aerobraking for planetary exploration of Mars, Titan, Neptune and Venus.
- Assist in development of large inflatable space structures.

Approach

- Investigate physics and chemistry of high-temperature, reacting flow field and define methods to accurately predict heating and aerodynamics associated with planetary entries.
- Define, analyze and calculate engineering and physics features in planetary entry science and high-temperature, shock-layer radiative heating associated with entry capsules.
- Develop and analyze inflatable "rigidizable" concepts for a 300-meter space-based radar.

Accomplishments

- Improved radiation modeling for NASA's Earth return missions.
- Provided independent technical assessment of the Cassini-Huygens Probe entry, descent and landing.
- Delivered re-entry software codes for use within NASA's exploration architecture program.
- Developed rigidizable test beam.

CEV with launch abort system and service module

Objectives

- Develop novel structures and materials for application in aeronautics and space industries.
- Develop empirical and analytical tools for characterizing the damage resistance/tolerance of composite structures and materials.

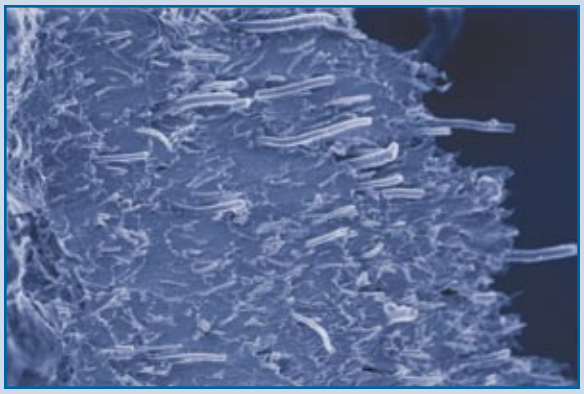
Approach

- Synthesize and characterize organic monomers and polymers for space applications.
- Enhanced organic-based polymers to be used in solar cells.
- Develop analytical methodologies to enhance structural integrity.
- Develop analytical methodologies for characterizing delamination onset and growth.

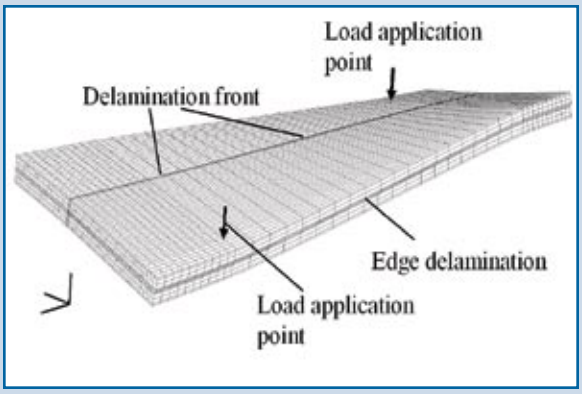
Accomplishments

- Designed and built silicon mirror with controlled deformation providing self-deployed, ultra-large, reconfigurable, ultra-lightweight, optical aperture.
- Developed jet-fuel resistant self-healing polymers.
- Invented fire retardant epoxy resin composites.
- Increased thermal conductivity (by order of magnitude) of polymer to be used in spacesuits.

Prototype fibers and tubing for advanced thermally conductive fabrics to be used in future space suits



Aligned multi-wall carbon nanotubes in a polymer matrix



Finite element model of an edge crack torsion (ECT) specimen

Objectives

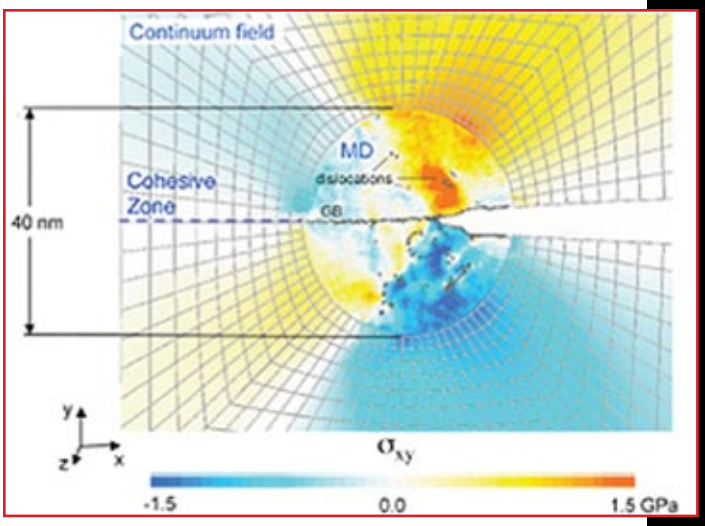
- Develop novel structures and materials for application in aeronautics and space industries.
- Develop computational and analytical tools to characterize the mechanical properties, deformation and failure of metals.

Approach

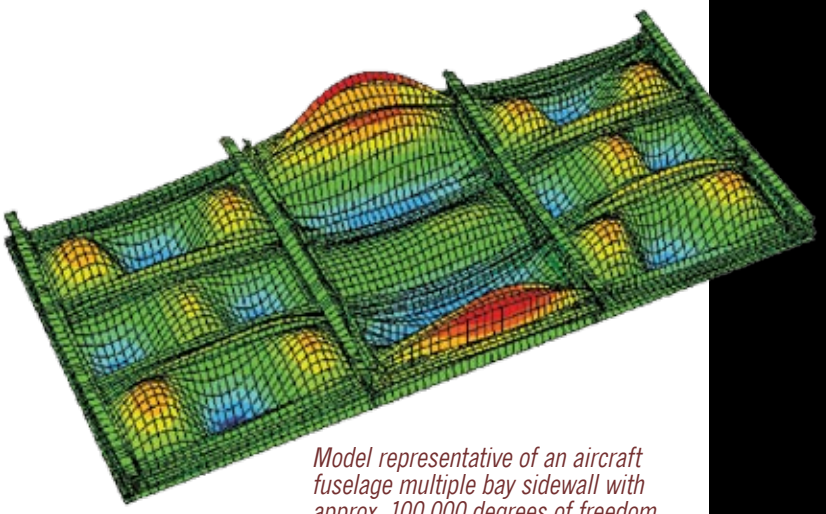
- Model multifunctional materials with tailored electromagnetic properties.
- Develop analytical methodologies to enhance structural integrity of metallic structures.
- Characterize damage resistance and tolerance of metallic structures and materials.

Accomplishments

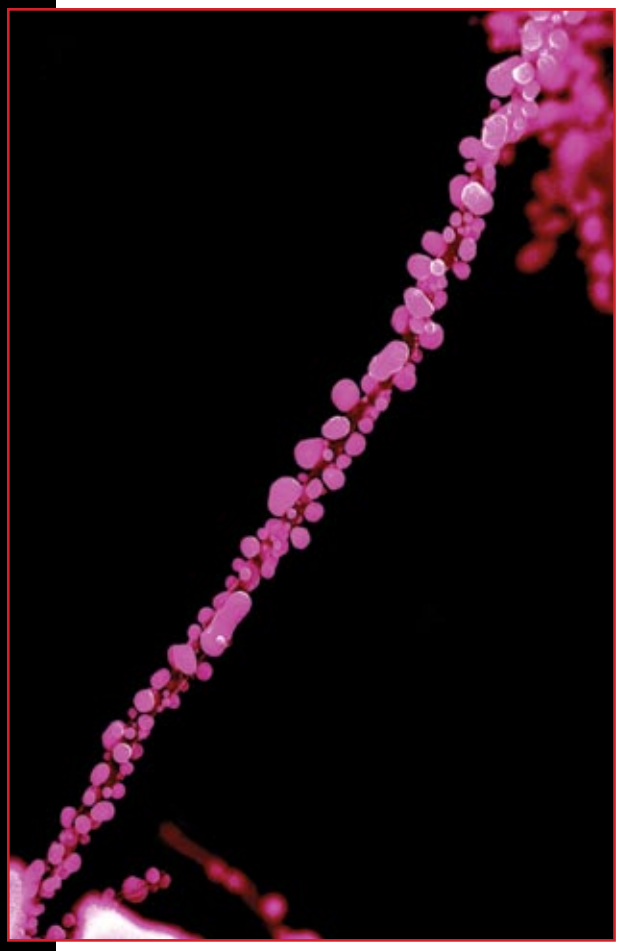
- Characterization of deformation and failure in metals through detailed atomistic and continuum finite-element simulations.
- Development of multi-scale computational model for quantitative analysis of mechanical properties of metals.
- Development of coupled molecular-dynamics with finite element model for intergranular crack propagation in aluminum.



Molecular dynamics - FEM model for intergranular crack in Al



Model representative of an aircraft fuselage multiple bay sidewall with approx. 100,000 degrees of freedom



Nanotube (CNT) covered with metallic silver particles

Objectives

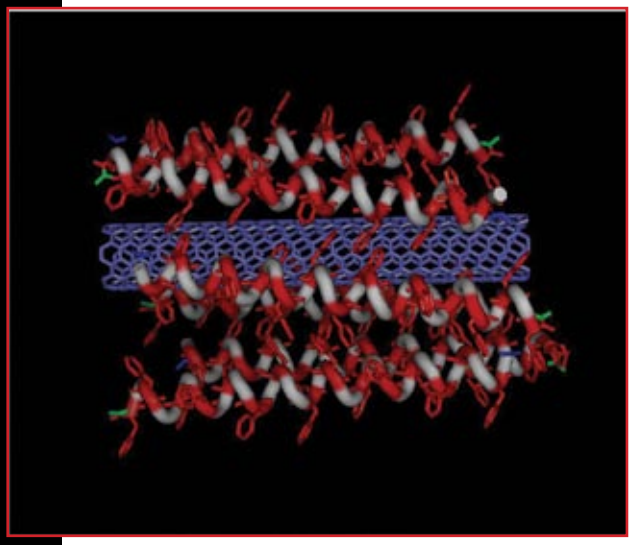
- Develop novel multifunctional structures and materials for application in aeronautics and space industries.
- Enable transformation to the NGATS, as defined by JPDO.

Approach

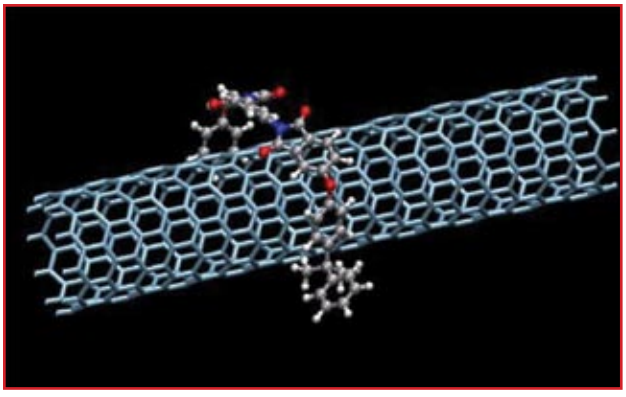
- Develop nanostructured materials for energy storage/harvesting and sensing/actuating.
- Characterize magnetic/electric/dielectric properties of nanostructured materials.
- Optimize multifunctional nanostructured materials based on the characterization results and modeling studies.

Accomplishments

- Development of bionanobattery (0.44V production).
- Fabrication of nano-size magnetic field sensor.
- Invented bionanocomposite sensors and actuators and polymer nanocomposite pressure sensors.



Bionanocomposite modeling



Polymer Ultem adhering to a single wall carbon nanotube

MECHANICS OF FLIGHT, CFD & CONTROL SYSTEMS RESEARCH

Objectives

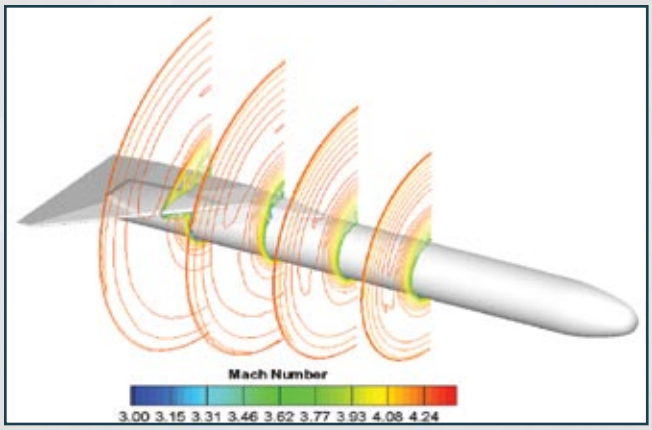
- Develop methods for the analysis and design of systems having deterministic and probabilistic models of parametric uncertainty.
- Develop robust analysis methods for the Integrated Fault Tolerance Control (FTC) system of a transport aircraft with fault identification filters.
- Improve the accuracy of general mixed-element finite-volume discretization schemes for unstructured grids in NASA's FUN3D code.

Approach

- Bounding the design-requirements violation set via the homothetic deformation of hyper-spheres and hyper-rectangles.
- Using miu-analysis on a LFT model, which is a nonlinear polynomial aircraft model, with FTC laws and fault detection and isolation.
- Analyzing and improving the multigrid solvers for unstructured grid, finite-volume discretizations.

Accomplishments

- Optimization-based strategies based on the calculation of critical parameter values and parametric safety margins have been developed.
- Analysis framework has been developed for the Boeing 747-100/200 aircraft with fault tolerant control law with LPV-FDI filters.
- New computational method has been developed and tested for various flows, including compressible viscous flow with turbulence models. The test provided sharp accuracy estimates.



Mach number contours around a flight vehicle

Objectives

- Improve analytical capabilities for predicting aeromechanical behavior of rotor systems.
- Perform wind-tunnel tests to demonstrate rotor enhancement concepts.
- Develop sophisticated new active control concepts designed to reduce vibration, improve performance, reduce maintenance requirements, reduce noise emission and enhance survivability of rotorcraft.

Approach

- Improve analytical capabilities by integrating computational structural and fluid dynamics into unified analysis.
- Perform wind-tunnel tests to provide critical validation data.

Accomplishments

- Validated and conducted aeroelastic analysis for tiltrotor models using multi-body dynamic codes.
- Validated CFD/CSD integrated analysis with rotorcraft flight test data.
- Validated CFD/wake integrated analysis with fixed and rotary wing experimental data.
- Developed methodology for integrated CFD/CSD/wake analysis.

TECHNICAL PUBLICATIONS

NIA Research Staff actively disseminates its research accomplishments through a variety of scientific venues. This year, 189 peer-reviewed publications and conference presentations were produced. Following is a listing of many journal articles published during this fiscal year.

D. Atlas, Z. Wang, and D.P. Duda, "Contrails to Cirrus - Morphology, Microphysics, and Radiative Properties," J. Appl. Meteorol., Vol. 45, pp. 5-19, 2006.

Silvie Boldo and Cesar Munoz, "A Formalization of Floating Point Numbers in PVS," NASA/CR-2006-214298, 2006.

T.C. Clancy and T.S. Gates, "Modeling of InterfacialModification Effects on Thermal Conductivity of Carbon Nanotube Composites," Polymer, Vol. 47, pp. 5990-5996, 2006.

D.M. Delozier, K.A. Watson, J.G. Smith, T.C. Clancy, and J.W. Connell, "Investigation of Aromatic/Aliphatic Polyimides as Dispersants for Single Wall Carbon Nanotubes," Macromolecules, Vol. 39, pp. 1731-1739, 2006.

T.S. Gates, G.M. Odegard, S.J.V. Frankland, and T.C. Clancy, "Computational Materials: Multi-Scale Modeling and Simulation of Nanostructured Materials," Composites Science and Technology, Vol. 65, pp. 2416-2434, 2005.

S. Ghose, K.A. Watson, Donavon M. Delozier, Dennis C. Working, Emilie J. Siochi, and John W. Connell, "Incorporation of Multiwalled Carbon Nanotubes into High Temperature Resin Using Dry Mixing Techniques," Composites Part A: Applied Science and Manufacturing, Vol. 37, No. 3, pp. 465-475, 2006.

S. Ghose, K.A. Watson, K.J. Sun, J.M. Criss, E.J. Siochi, and J.W. Connell, "High Temperature Resin/Carbon Nanotube Fabrication," Comp. Sci. and Tech., Vol. 66, p. 1995, 2006.

D.-H. Han, J.-W. Kim, and S.-M. Park, "Electrochemistry of Conductive Polymers: 39. Electrodeposited Poly(3,4-ethelenedioxythiophene) Studied by Current Sensing AFM," J. Phys. Chem. B, Vol. 110, No. 30, pp. 14874-14880, 2006.

P.M. Hergenrother, J.G. Smith, Jr., J.W. Connell, and K.A. Watson, "Polyimides from a-BPDA and Aromatic Diamines," NASA Tech Briefs, LAR-16430-1, Vol. 30, No. 2, 2006.

Y. Hu, Z. Liu, D. Winker, M. Vaughan, V. Noel, L. Bissonnette, G. Roy, and M. McGill, "Simple Relation Between Lidar Multiple Scattering and Depolarization for Water Clouds," Optics Letter, Vol. 31, 2006.

Christopher O. Johnston, Brian R. Hollis, and Kenneth Sutton, "Radiative Heating Methodology for the Huygens Probe," AIAA 2006-3426, June 2006.

J.H. Kang, C. Park, S. Gaik, S.E. Lowther, and J.S. Harrison, "The Effect of Single-Walled Carbon Nanotubes on the Dipole Orientation and Piezoelectric Properties of Polymeric Nanocomposites," Nano, Vol. 1, p. 77, 2006.

S. Kato, L.M. Hinkelman, and A. Cheng, "Estimate of Satellite-Derived Cloud Optical Thickness and Effective Radius Errors and their Effect on Computed Domain-Averaged Irradiances," J. Geophys. Res., Vol. 111, D17201, 2006.

K. Lim, J-Y. Shin, and D. Moerder, "Bias Momentum Sizing for Dual Spin Platforms," NASA-TP-2006-214317.

Y. Liu, L.N. Sankar, J.E. Robert, K.K. Ahuja, and R. Gaeta, "Computational Evaluation of the Steady and Pulsed Jet Effects on a Circulation Control Airfoil," Chapter 22, AIAA Book Series, Applications of Circulation Control Technologies, pp. 557-575, 2006.

Z. Liu et al., "Estimating Random Errors Due to Shot Noise in Backscatter Lidar Observations," Applied Optics, Vol. 45, pp. 4437-4447, 2005.

Mary Kae Lockwood, Richard W. Powell, Kenneth Sutton, Ramadas K. Prabhu, Claude A. Graves, Chirold D. Epp, and Gilbert L. Carman, "Entry Configurations and Performance Comparisons for the Mars Smart Lander," Journal of Spacecraft and Rockets, Vol. 43, No. 2, pp. 258-269, March-April 2006.

D.S. McLachlan, C. Chiteme, C. Park, K.E. Wise, S.E. Lowther, P.T. Lillehei, E.J. Siochi, and J.S. Harrison, "AC and DC Percolative Conductivity of Single Wall Carbon Nanotube Polymer Composites," Journal of Polymer Science Part B: Polymer Physics, Vol. 43, p. 3273, 2005.

Cesar Munoz, Victor Carreno, and Gilles Dowek, "Formal Analysis of the Operational Concept for the Small Aircraft Transportation System," Rigorous Engineering of Fault-Tolerant Systems, Lecture Notes in Computer Science, Vol. 4157, pp. 306-325, 2006.

T.K. O'Brien and R. Krueger, "Influence of Compression and Shear on the Strength of Composite Laminates with Z-Pinned Reinforcement," Applied Composite Materials, Vol. 13, pp. 173-189, 2006.

C. Park, J. Wilkinson, S. Banda, Z. Ounaies, K.E. Wise, G. Sauti, P.T. Lillehei, and J.S. Harrison, "Aligned Single Wall Carbon Nanotube Polymer Composites Using an Electric Field," Journal of Polymer Science Part B: Polymer Physics, Vol. 44, p. 1751, 2006.

A. Przekop and S.A. Rizzi, "A Reduced Order Method for Predicting High Cycle Fatigue of Nonlinear Structures," Computers and Structures, Vol. 84, No. 24-25, pp. 1606-1618, 2006.

A. Przekop and S.A. Rizzi, "Nonlinear Reduced Order Finite Element Analysis of Structures with Shallow Curvature," AIAA Journal, Vol. 44, No. 8, pp. 1767-1778, 2006.

S.A. Rizzi and A. Przekop, "The Effect of Basis Selection on Static and Random Acoustic Response Using a Nonlinear Modal Simulation," NASA/TP-2005-213943, December 2005.

J. Shen, M. Yang, and I. Chopra, "Swashplateless Helicopter Rotor System with Trailing-Edge Flaps for Flight and Vibration Controls," Journal of Aircraft, Vol. 43, No. 2, pp. 346-352, April-May 2006.

J-Y. Shin and C. Belcastro, "Performance Analysis on Fault Tolerant Control System," IEEE Transactions of Control Systems Technology, Vol. 14, No. 5, pp. 920-925, 2006.

G.L. Smith, Z.P. Szewczyk, D.A. Rutan, and R.B. Lee, III, "Comparison of Measurements from Satellite Radiation Budget Instruments," J. Geophys. Res., Vol. 111, D04101, 2006.

A.J. Soja, H.H. Shugart, A.I. Sukhinin, S.G. Conard, and P.W. Stackhouse, Jr., "Satellite-Based Mean Fire Return Invervals as Indicators of Change in Boreal Siberia (1995-2002)," Mitigation and Adaptation Strategies for Global Change, Vol. 11, pp. 75-96, 2006.

Dean M. Tigelaar, Daniel J. Klein, Tian-Bing Xu, Ji Su, and Robert G. Bryant, "Synthesis and Chartacterization of Poly(pyridinium triflate)s with Alkyl and Aromatic Spacer Groups for Potential Use as Nonlinear Optic Materials," High Performance Polymers, Vol. 17, No. 4, pp. 515-531, December 2005.

K.A. Watson and J.W. Connell, Chapter entitled "Polymer and Carbon Nanotube Composites for Space Applications" in Carbon Nanotechnology: Recent Developments in Chemistry, Physics, Materials Science and Device Applications, pp. 677-698, Liming Dai, Ed., Elsevier, Amsterdam, The Netherlands, 2006.

V. Yamakov, E. Saether, D.R. Phillips, and E.H. Glaessgen, "Molecular-Dynamics Simulation-Based Cohesive Zone Representation of Intergranular Fracture Processes in Aluminum," J. Mech. Phys. Solids, Vol. 54, pp. 1899-1928, 2006.

V. Yamakov, D. Modovan, K. Rastogi, and D. Wolf, "Relation between Grain Growth and Grain-Boundary Diffusion in a Pure Material by Molecular Dynamics Simulations," Acta Mater., Vol. 54, pp. 4053-4061, 2006.

Li Yan, C. Park, Zoubeida Ounaies, and Eugene A. Irene, "An Ellipsometric Study of Polymer Film Curing: 2,6-bix(3-aminophenoxy) benzonitrile/4,4' oxidiphthalic anhydride poly(amic acid)," Polymer, Vol. 47, p. 2822, 2006.

B. Zhang, J.H. Harb, R.C. Davis, S. Choi, J.-W. Kim, T. Miller, S.-H. Chu, and G.D. Watt, "Electron Exchange Between Fe(II)-Horse Spleen Ferritin and Co(III)/Mn(III) Reconstituted Horse Spleen and Azotobacter Vinelandii Ferritins," Biochemistry, Vol. 45, No. 18, pp. 5766-5774, May 2006.

OUR PEOPLE

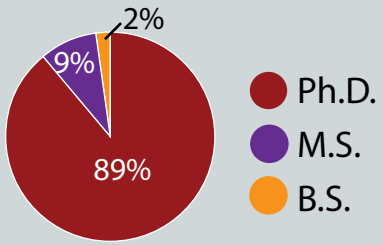
NIA's growth continued during 2005 and 2006 with a 30% increase in population. At the end of FY06, NIA had a total of 193 employees, faculty, consultants and students associated with the institute. Additionally, NIA's Visitor Program included 54 researchers from all over the world.

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, 89% 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 56 journal articles and presented 148 conference papers, technical reports and other talks in FY06. They also received a wide range of awards and recognitions.

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



AWARDS & RECOGNITIONS

Frank Bussink

2005 TGIR Award for his participation in the Small Aircraft Transportation System Project Team

NASA Langley 2006 Group Achievement Award to the Small Aircraft Transportation Systems Project (SATS) Team for successful completion of a challenging endeavor to bring air mobility to small communities, establish enabling public-private relationships, and transform generation aviation into a key element of the Next Generation Air Transportation System

Luis Crespo

AIAA Hampton Roads Section Laurence J. Bement Young Professional Paper Competition First Runner-up for the paper titled "Reliability-Based Control Design for Uncertain Systems"

NASA Certificate of Recognition for the creative development of technically significant software which has been accepted and approved by NASA, entitled "MASCOT – Matlab Stability and Control Toolbox"

Donovan Delozier

NASA Certificate of Recognition for the creative development of a technical innovation which has been approved for publication as a NASA Tech Brief entitled "Multifunctional Composites"

Ronald Krueger

American Society for Composites Plaque of Appreciation for position as co-chair of the Second Technical Conference on Composite Materials

NASA Langley Center Team Award to the RTF Team for outstanding performance and commitment to preparing for NASA's Return to Flight

Daniel Litton

NASA Group Achievement Award in appreciation of his significant contribution to the Exploration Systems Architecture Study, which charted NASA's first steps back to the Moon and on to Mars

Cesar Munoz
2005 TGIR Award for his participation in the Small Aircraft Transportation System Project Team

NASA Langley 2006 Group Achievement Award to the Small Aircraft Transportation Systems Project (SATS) Team for successful completion of a challenging endeavor to bring air mobility to small communities, establish enabling public-private relationships, and transform generation aviation into a key element of the Next Generation Air Transportation System

Cheol Park
NASA Certificate of Recognition for the invention entitled "Mechanically Strong, Thermally Stable, and Electrically Conductive Nanocomposite Structure and Method of Fabricating Same"

Adam Przekop
NASA Certificate of Recognition for the creative development of technically significant software which has been accepted and approved by NASA, entitled "RANSTEP – Reduced order Analysis using a Nonlinear STiffness Evaluation Procedure"

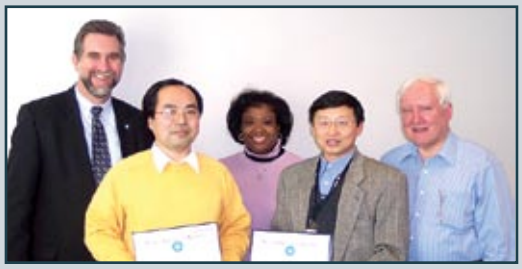
Noah Schiller
Royster Student Scholarship Award for poster titled "Numerical Simulation of an Aircraft Style Panel Excited by a Random Pressure Field"

Jeremy Shidner
NASA Inventions and Contributions Board Action Award for "POST II Trajectory Animation Tool Using MATLAB"

Douglas Stanley
NASA Distinguished Public Service Medal in appreciation for outstanding leadership of the Exploration Systems Architecture Study (ESAS)

Robert Tolson
Inducted into the Virginia Tech College of Engineering's Academy of Engineering Excellence

Shannon Verstynen
NASA Langley Center Team Award for providing logistics and exhibit support for NIA participation in the first-ever Aero-Space Day event



NIA 2005 Best Research Publication Award
Awarded January 2006

Tian-Bing Xu

Dr. Tian-Bing Xu and Dr. Ji Su (NASA Langley) received NIA's 2005 Best Research Publication award for their paper titled "Design, Modeling, Fabrication, and Performance of Bridge-Type High-Performance Electroactive Polymer Micromachined Actuators." This paper was published in the Journal of Microelectromechanical Systems, Vol. 14, No. 3, June 2005.

Bo Walkley
NASA Langley Center Team Award for providing logistics and exhibit support for NIA participation in the first-ever Aero-Space Day event

Alan Wilhite
NASA Group Achievement Award in appreciation of his significant contribution to the Exploration Systems Architecture Study, which chartered NASA's first steps back to the Moon and on to Mars

Phillip Williams
Peninsula Engineers Council 2006 Doug Ensor Award for Young Engineer of the Year

Kristopher Wise
NASA Langley 2006 Group Achievement Award to the On-Orbit Tile Repair Team for exceptional contributions to the development of a predictive on-orbit cure model for the Shuttle tile repair material STA-54

Tian-Bing Xu
NASA Langley Center Team Award to the RTF Team for outstanding performance and commitment to preparing for NASA's Return to Flight

FY06 NIA Invention Disclosure Reports

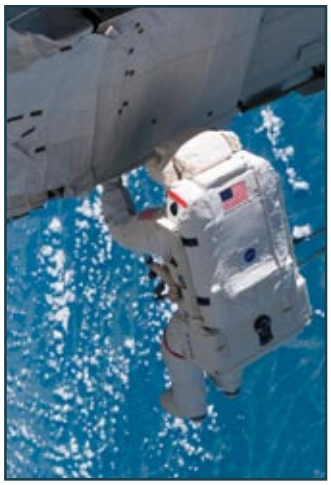
Case Number	Invention Title
LAR 17262-1	RANSTEP Software Design
LAR 17267-1	Method of Depositing Metals onto Carbon Allotropes and Compositions Therefrom
LAR 17269-1	Conformal Sensors for the Measurement of Aerodynamics and Hydrodynamic Lift and Drag
LAR 17270-1	A Low Altitude, Long Enduring Vehicle
LAR 17318-1	Preparation of Metal Nanowire Decorated Carbon Allotropes
LAR 17357-1	Fabrication of Metal Hollow Nanoparticles and Core-Shell Nanoparticles by a Bio-Templated as Bio-Scaffold
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 17386-1	Fine-Grained Targets for Free Electron Laser Synthesis of Carbon Nanotubes
LAR 17390-1	Advanced High Performance Horizontal Piezoelectric Hybrid Synthetic Jet Actuator (ASJA-H)

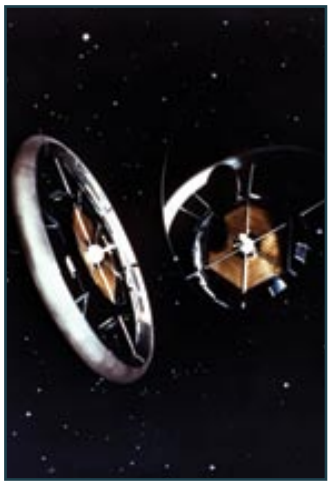
NIA Patents Filed in FY06

Case Number	Invention Title
LAR 17269-1	Conformal Sensors for the Measurement of Aerodynamic and Hydrodynamic Lift and Drag
LAR 17270-1	A Low Altitude, Long Enduring Vehicle
LAR 16958-1	Multilayer Ferritin Array for Bionanobattery
LAR 17126-1	Dispersions of Carbon Nanotubes in Polymer Matrices
LAR 17169-1	Hybrid Piezoelectric Energy Transducer System
LAR 17135-1	Fabrication of Metal Nanoshells Derived by a Biotemplate
LAR 17213-1	Configuration and Power Technology for Application-Specific Scenarios of High Altitude Airships
LAR 17366-1	Stable Dispersions of Carbon Nanotubes in Polymer Matrices Using Dispersion Interaction
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)

In FY06, NIA focused on expanding its marketing and licensing areas of the technology transfer program. The Technology Commercialization Center (TeCC) has partnered with NIA in establishing a marketing and licensing approach that assists NIA in crafting a successful licensing and royalty income stream program. NIA's researcher assets and resources created research results leading to technologies and intellectual properties (IP) that have technology transfer and commercialization value.

This year, NIA employees filed 10 Invention Disclosures with NASA LaRC, which covered a range of potential commercial applications. As a result of previous year filings, 11 patent applications were filed.

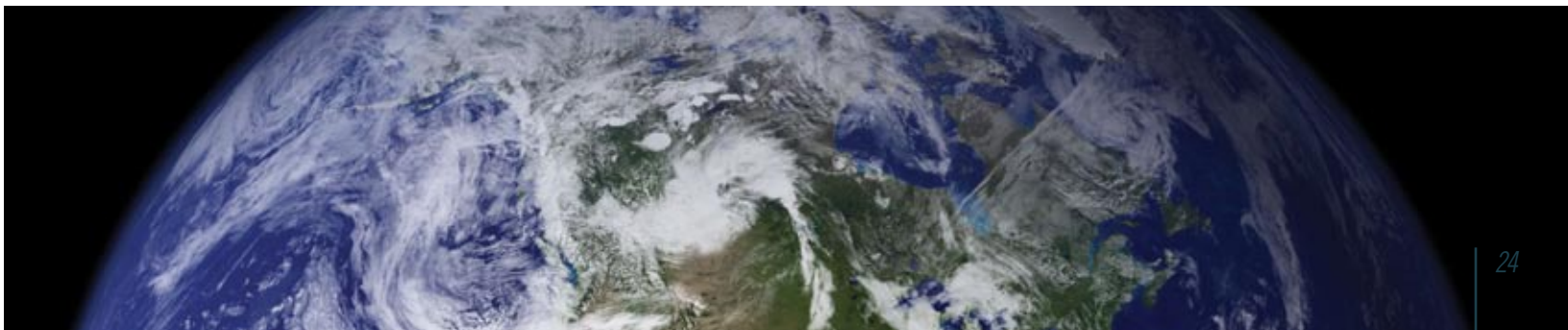




The NIA Visiting Researcher Program welcomed a diverse group of national and international faculty, scholars and students in 2006. NIA accommodates visiting eminent scholars throughout the year with most placements occurring during the spring and summer months. The program begins with a rigorous selection process that includes residency requirements that each visitor must meet prior to traveling to NIA. Each visitor is required to write a summary of activities and collaborations before departing. The success of the visitors' collaborations with NIA and LaRC is witnessed by more than 60% of these visitors receiving invitations to return in FY07.

A total of 46 visitors from 29 separate institutions from the United States and abroad participated in this year's Program. Of which, 19 were eminent scientists and engineers and 27 graduate students. Research topics included:

- *Analytical and Experimental Research in Structural Mechanics*
- *Computational Structures and Materials*
- *Electro-Active Materials*
- *Microwave-Driven Smart Actuators*
- *Morphing Structures for UAVs*
- *Planetary Entry*
- *Spacecraft Autonomy for In-Space Operations*
- *Formal Methods*
- *Computational Fluid Dynamics*
- *Hypersonic Aerodynamics*
- *Numerical Simulation of Laminar-Turbulent Transitions*
- *Unsteady Aerodynamics*



CONTINUING EDUCATION

2006 NIA Workshops

Aerospace Systems Safety Process Workshop
NIA, Hampton, VA

Materials & Structures Workshop
NIA, Hampton, VA

UAS Airworthiness Improvement Symposium
NIA, Hampton, VA

Workshop on Advanced Systems Analysis Program Planning
NIA, Hampton, VA

Airborne Radiometric Detection of Aviation Hazards
NIA, Hampton, VA

NIA/DARPA/AFRL/NASA Large Space Systems Workshop
Oxnard, CA

LaRC Retiree Think Tank Workshop
NIA, Hampton, VA

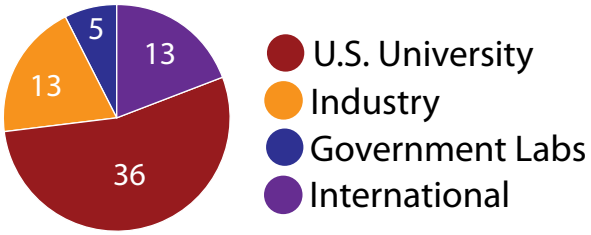
NIA provides a robust program in continuing education and lifelong learning. In addition to innovative graduate education opportunities, we offer a comprehensive program of short courses, workshops and conferences as well as seminars and colloquia.

This year, NIA conducted eight workshops. Several of these workshops sought to bring in researchers to focus on new developments and breakthroughs and to see how they may be applicable to NASA and NIA's current programs.

Sixty-seven seminars were offered this year in six main seminar series. The Science Lecture Series is organized by NIA and Hampton University to stimulate progress in the atmospheric, earth and space sciences by bringing together researchers for expert presentations on the latest advances and future research directions in these areas. In addition, several long-term series for NASA-funded research have continued, such as the Autonomous Vehicles and Systems (AuRA) Lecture Series and the Distinguished Lecture Series in Systems Analysis.

The faculty at our NIA consortium universities, our on-site research staff and other industry and university partners are well equipped to develop and offer short courses on a wide variety of leading-edge research topics in aerospace and atmospheric sciences research that would be of interest to the research community. Last year, there were 13 short courses taught through NIA, most addressing issues related to space exploration.

SPEAKER AFFILIATIONS



Large Space Systems Workshop, September 2006

NASA turned to NIA and our subcontractor CIBER to establish the NASA Engineering Safety Center (NESC) Academy to capture the corporate knowledge currently available from NESC's 15 Super Problem Resolution Teams (SPRT), which are focused on critical competencies required to meet the Agency mandate. Each of these SPRTs is headed by an NESC Discipline Expert (NDE). The NESC Academy enables these experienced senior NASA scientists and engineers to share their expertise and knowledge to guide the next generation of NASA scientists and engineers in developing their technical expertise in problem resolution. As a by-product of this training, an outreach effort to college students is being conducted in order to foster interest in NASA.

Space Propulsion Systems: Learning from the Past and Looking to the Future with George Hopson, October 2005

Power & Avionics: Learning from the Past and Looking to the Future with Robert Kichak, December 2005

Satellite Attitude Control Systems: Learning from the Past and Looking to the Future with Cornelius Dennehy and Colleagues, June 2006

2006 NIA Short Courses

NESC Academy:
Space Propulsion Systems
George Hopson

Verification & Validation in Computational Simulations
William Oberkampf & Christopher Roy

Technology Engineering
Douglas Stanley

NESC Academy:
Power & Avionics
Robert Kichak

Higher Order Spectral Analysis
Muhammad Hajj & Walter Silva

Decision Analysis & Risk in Aerospace Design
Alan Wilhite & Douglas Stanley

Supportability Engineering for Aerospace Systems
Ray Smiljanic

NESC Academy:
Satellite Attitude Control Systems
Cornelius Dennehy

Planetary Entry, Descent & Landing
Robert Braun

Space Flight Mechanics for Exploration Systems
Robert Tolson

Computational Thermal Analysis
Dean Schrage

Spacecraft Attitude Dynamics
Paul Cooper

GRADUATE EDUCATION

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 LaRC 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 this 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 MS or PhD 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 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 university campus and students satisfy all university residency requirements while conducting their research at NIA and LaRC. 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 2006 Fall Semester, 13 faculty members were in residence at NIA, including the six Langley Professors. The NIA Graduate Program emphasizes its unique and innovative courses taught by on-site faculty, particularly by the Langley Professors. A sampling of the courses delivered by the Langley Professors are listed below.

- *Spacecraft & Launch Vehicle Design, Prof. Wilhite*
  AE 6322 (GT)
- *Morphing Aircraft Design, Prof. Hubbard*
  EN 788 (UMd)
- *Space Flight Guidance and Navigation, Prof. Tolson*
  MAE 589C (NCSU)
- *Intelligent Methods for Control Design, Prof. Song*
  ELEN 868 (NC A&T)
- *Design of Materials, Prof. Logan*
  MSE 5984 (VT)
- *Photonics, Prof. Gupta*
  ECE 541 (UVa)

NIA continues to offer a very broad list of courses involving a mixture of distance learning technologies including synchronous (live, two-way video) and asynchronous (video-recorded) classes as well as live, on-site instruction. More than 120 courses are available via interactive video conferencing, with approximately 30 of these courses offered through live, on-site instruction.

This year, NIA has taken responsibility for the operation, maintenance and upgrade of our distance learning facilities. Previously the facilities were operated by the Virginia Consortium of Engineering and Sciences (VCES), which was co-located at NIA Headquarters. NIA now has five distance learning classrooms.

To improve our course delivery capabilities, the distance learning facilities are being upgraded to a new delivery system designated H.239. 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 data stream for the projected educational material, such as presentation graphics and charts or output from an Elmo (opaque projector). This second data stream will project at the remote sites with VGA level graphics. This system went online in 2006 for broadcast or reception in one classroom, with additional classrooms scheduled to be upgraded in 2007.

Graduate Degrees Available through NIA

2006-2007 Academic Year

	Aerospace Engineering	Electrical & Computer Engineering	Mechanical Engineering	Ocean Engineering	Engineering Physics & Mechanics	Materials Science & Engineering	Systems & Information Engineering	Atmospheric Sciences
Georgia Tech	✓		✓					
Hampton University								✓
North Carolina A&T		✓	✓					
North Carolina State	✓		✓					✓
University of Maryland	✓							✓
University of Virginia	✓	✓	✓		✓	✓	✓	
Virginia Tech	✓		✓	✓	✓	✓		

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.

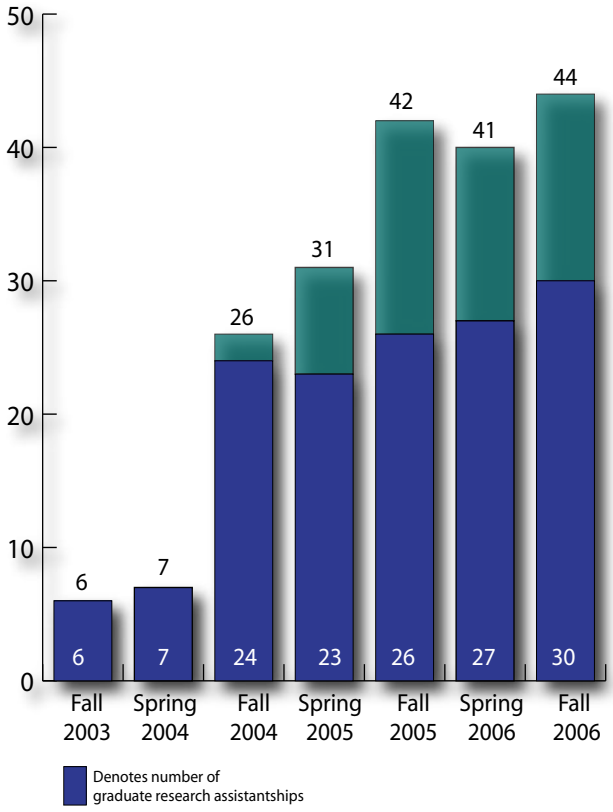
The number of full-time graduate students studying at NIA has grown rapidly to 44 in the 2006 Fall Semester. Fifteen part-time students are LaRC civil servants or contractors.

Thirty of these full-time graduate students are funded by NASA under NIA's Graduate Research Assistantship (GRA) Program and two students are supported through an industry-sponsored GRA. In addition, there are two NASA civil servants who are studying for their PhD degree under the NASA Graduate Program. The remainder of the students are supported through the Langley Professor program.

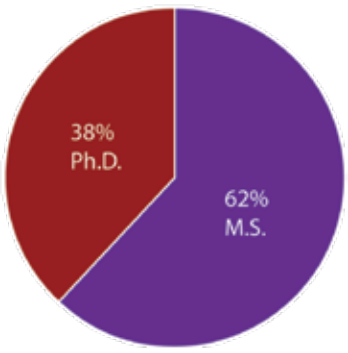
NIA Graduate Students

Through September 2006, 19 students have graduated from our program, earning 17 MS degrees and two PhD degrees.

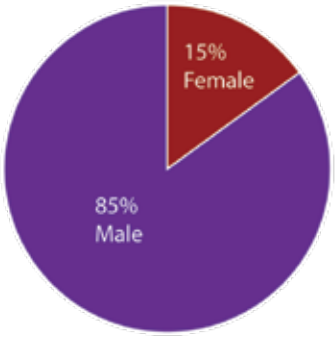
GROWTH OF FULL-TIME NIA GRADUATE STUDENTS



STUDENT DISTRIBUTION BY DEGREE TYPE



STUDENT DISTRIBUTION BY GENDER



NIA's outreach mission is focused on aiding the development of a well-educated workforce in science and engineering, NASA and the nation. Teacher training and enhancement activities that will keep middle and high school students interested in science and technology is a substantial focus of the program.

2006 Educator Training Workshop participants

Our outreach partners include the LaRC Office of Education, NIA member universities and the space grant consortia in our region. Major activities include the In-Service Teacher Program, the Pre-Service Teacher Program, the Center for Distance Learning and a variety of student-support programs.

Continuum of Education

NIA's holistic approach to educational outreach and long-term workforce development needs is summarized in the enclosed chart. This chart connects the steps in the pipeline for the development of the aerospace workforce. On the chart, one can see the specific needs at each step of the pipeline, such as "introducing inquiry-based learning" for grades 3-5 and "sustaining and growing competency in mathematics" for grades 6-8. Further on the chart towards higher education are needs such as "competence and confidence to teach STEM subjects" on the teacher pipeline, and "development of new curricula in emerging disciplines" for engineering and science students. Even further we see needs such as "curriculum enhancement materials" for the teacher workforce, "real-world experience for engineering and science faculty" to "awareness of the importance of STEM to careers, to economic well-being and to society" for the general public. Also described on the chart are many NIA and partner programs that directly address some of these needs at each step. The feedback loops on the chart illustrate the importance of reinforcement through teaching, parenting and mentoring.

In-Service Teacher Program

NIA organizes and supports a two-week educator workshop for middle and high school teachers. A goal of the workshop is to facilitate development of instructional materials by the teachers that will educate students on how science, technology and mathematics can improve their quality of life, as well as provide career objectives for future scientists and engineers. The Fourth Annual NIA Educator Training Workshop was held on July 9-21, 2006, and was a joint effort between NIA, the LaRC Office of Education, the Virginia and North Carolina Space Grant Consortia and NIA university partners from Virginia and North Carolina.

The program was expanded this year to include 32 middle school and high school teachers from Georgia, Maryland, North Carolina and Virginia. The first week of the workshop was spent at NASA LaRC, where teachers attended lectures, demonstrations, tours of many of the NASA programs and educational resources. They developed curricular material that will be incorporated into their classroom and shared with their colleagues.

The teachers then spent the second week participating in activities associated with their state universities and space grant consortia closer to their homes. The North Carolina and Georgia teachers spent the second week split between NCSU and NC A&T where they were exposed to technical demonstrations from NIA-affiliated faculty as well as being introduced to outreach specialists such as the Kenon Institute, the

Pre-Service Teacher Institute

Science House, and the Friday Institute. Technical activities in NC included demonstrations, hands-on activities and lectures covering future exploration vehicles for Mars, space biology, cosmology, PARI science laboratory, composite materials manufacturing demonstrations, robotics and gas turbines. Virginia and Maryland teachers participated in a week of activities at the Virginia Space Grant Consortium in Hampton, VA, where they took part in a variety of space activities including programs involving space science, atmospheric science, astronomy, microgravity as well as geospatial technologies including Global Positioning Systems (GPS) and Geographic Information Systems (GIS) in the classroom.

Pre-Service Teacher Program

This program seeks to improve the pre-service teacher preparation in science and mathematics at minority serving institutions, particularly Historically Black Colleges and Universities (HBCUs), Hispanic Serving In-stitutions (HSIs) and Tribal Colleges and Universities (TCUs). The means to accomplish this includes professional development, external partnerships, and systemic reform. 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.

This program includes a national conference and a summer institute. The Conference serves to engage pre-service teachers and their faculty advisors in an intensive two and one-half day training session in mathematics, science and technology enhancement as well as National Education Goals.

The NASA/NIA 11th Annual Pre-Service Teacher Conference was held on February 16-18, 2006 in Alexandria, VA. More than 350 students attended from approximately 55 schools, representing 34 states. The future science and math teachers attending the conference received valuable and true-to-life advice from one of America's finest and most recognized teachers, Jaime Escalante. Mr. Escalante, 1999 National Teachers Hall of Fame inductee, was the conference keynote speaker.

This year's Pre-Service Teacher Institute at LaRC was held on July 17-28, 2006. The 24 students attending had opportunities to deepen their conceptual understanding of topics in math and science. They participated in the development and teaching of integrated lessons using problem-based learning techniques for elementary students. They also had an opportunity to take part in NASA tours and to interact with scientists, researchers and engineers. Students participating in the Institute were able to earn three credits for an undergraduate education methodology course.

Media and Communications Programs

Outreach activities conducted to address the general public on issues ranging from increasing awareness of the importance of STEM to careers, to economic well-being, to society itself by conveying information on aerospace technology, research, and innovations worldwide. Two new activities were initiated toward the end of this year.

"NASA 360" is a 30-video public outreach broadcast program that builds awareness and support for NASA's Vision for Space Exploration. NASA 360 is scheduled to air on public television in a 30-minute format beginning in 2007. The program will support NASA's strategic communications goal to inform, educate and engage the general public in order to create broad understanding of the importance of taking the next steps in space exploration.

Summer 2006 LARSS Students

"Discovery Now" is a daily radio program supported through a grant from the American Institute of Aeronautics and Astronautics. This program, scheduled for launching in January 2007, will feature 240 interstitial programs annually, 90 seconds in length that present information on aeronautics and astronautics technology, science, history, innovations, research and inventions worldwide.

NIA Supported Student Activities

On June 1, 2006, NIA assumed responsibility for the Langley Aerospace Research Summer Scholars Program (LARSS). The Virginia Space Grant Consortium manages this effort. The program structure involves a 10-week summer internship at LaRC. Participants are rising 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 LaRC. There were 122 summer LARSS program participants this year. In addition to research assignments at LaRC, students participated in a series of seminars and workshops, social events and activities, NASA tours and a report-out session.

NIA also assumed responsibility for the Langley Faculty Fellowship Program (LFFP). The purpose of LFFP is to provide faculty researchers having scientific, technical and educational expertise an opportunity to conduct leading research at LaRC. The program provides science and engineering faculty hands-on exposure to LaRC's research challenges through 10-week summer research residencies and extended research opportunities at the Center, working closely with NASA colleagues on basic, formative and leading-edge research challenges. NIA subcontracted with the Virginia Space Grant Consortium to coordinate the program. There were 13 faculty participants in the LFFP program during the summer of 2006.

NIA participated in several student-based outreach efforts, such as FIRST (For Inspiration and Recognition of Science and Technology), a non-profit organization that conducts the FIRST Robotics Competition. FIRST is designed to promote interest in science and technology, while also teaching problem-solving, critical thinking and teamwork to students. NIA supported two teams of home-schooled students for this year's competition.

NIA also participates in mentoring high school students from the New Horizon Governor's School in Hampton, VA. In addition, several of the Langley Professors routinely mentor undergraduate students from their home campuses to work on research projects during the summer and occasionally during the academic year.

NIA Supported Student Conferences

NIA encourages student participation in conferences, particularly when they involve minority and undergraduate students. An on-going activity that NIA continues to support is the National Educators Workshop (NEW). NEW brings researchers together with the aim of providing materials experiments for undergraduate and high school classes. This year, NEW was held at the University of Cincinnatti. NIA sponsors teachers from local high schools to participate in this event as well as undergraduate students from HBCUs/OMIs.

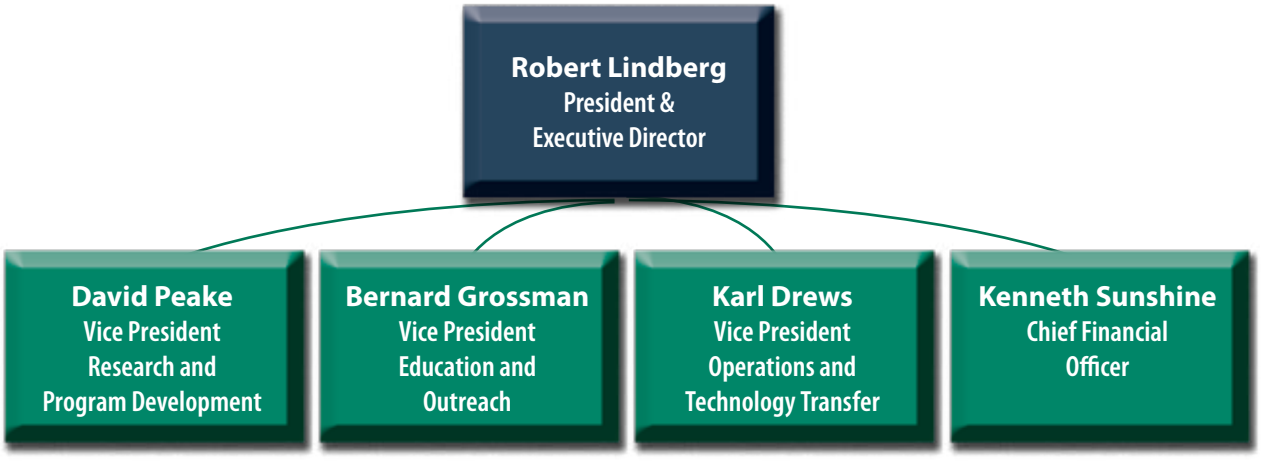
NIA supported student participation in the Southeastern Atlantic Mathematical Sciences Workshop (SEAMS) held in Charleston, SC and sponsored an undergraduate student design session at the 2006 IEEE Systems & Information Engineering Design Symposium (SIEDS 2006) held at the University of Virginia.

VISION

NIA is a non-profit research and graduate education institute created to conduct leading-edge aerospace and atmospheric research, develop new technologies for the nation and help inspire the next generation of scientists and engineers.

NIA was formed by a consortium of leading research universities. Members include: Georgia Tech, Hampton University, North Carolina A&T State University, North Carolina State University, the University of Maryland, the University of Virginia, Virginia Tech, The College of William & Mary, Old Dominion University, and the AIAA Foundation.

NIA serves as a strategic partner with NASA Langley Research Center and the aerospace community to enable research creativity and expand technology development opportunities. The Institute integrates research and graduate education while creating new government/academia/industry partnerships to solve tomorrow's problems today.



President & Executive Director

ROBERT E. LINDBERG, ENG.SC.D.

Dr. Robert Lindberg has served as President and Executive Director of the National Institute of Aerospace since October 2003. He joined NIA at its inception in October 2002 and initially served as Vice President of Research and Program Development. He is also a Research Professor in the Mechanical and 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 Corporation, and in government with the Naval Research Laboratory. He holds a doctorate in Mechanical Engineering from Columbia University. He is a Fellow of the American Institute of Aeronautics and Astronautics, a Fellow and past president of the American Astronautical Society and an elected member of Sigma Xi and Sigma Pi Sigma.

Vice President of Operations and Technology Transfer

KARL L. DREWS, J.D.

Dr. Karl Drews serves as Vice President of Operations and Technology Transfer, and as the Secretary for the National Institute of Aerospace. 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. Dr. Drews received his Doctor of Jurisprudence from the Marshall-Wythe School of Law, The College of William and Mary.

Vice President of Education and Outreach

BERNARD M. GROSSMAN, PH.D.

Dr. Bernard Grossman has served as Vice President of Education and Outreach since the formation of NIA in October 2002. He coordinates all aspects of NIA's graduate education, short course, workshop, seminar and outreach programs. He is a full professor in the Department of Aerospace and 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 Corporation. He earned his doctorate in Astronautics from the Polytechnic Institute of Brooklyn. He is a Fellow of the American Institute of Aeronautics and Astronautics.

Vice President of Research and Program Development

DAVID J. PEAKE, PH.D.

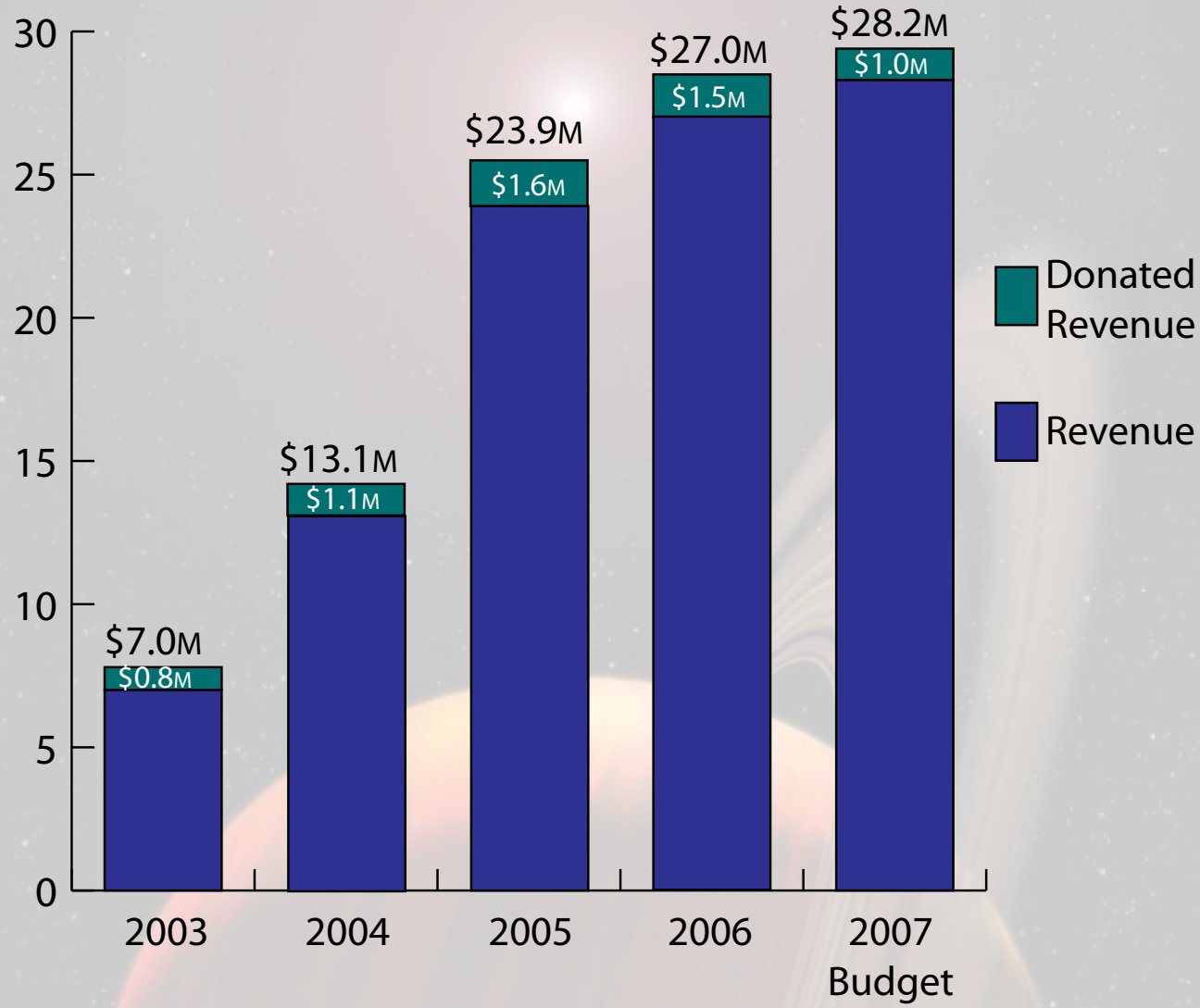
Dr. David Peake joined NIA in June 2004 as Vice President of Research and Program Development. He is responsible for NIA's resident research staff, university research programs, industry partnerships and the development of new research initiatives. Previously, he held a research and lecturing appointment as Head of the Centre for Aeronautics (and Chair of Aero- & Fluid Dynamics) at City University, London. He holds a PhD Eng. degree from the University of Bristol, UK, and a PhD Aero. Eng. degree from Carleton University, Ottawa, Canada. He is a Fellow of the Royal Aeronautical Society, Fellow of the Canadian Aeronautical and Space Institute and Associate Fellow of the American Institute of Aeronautics and Astronautics.

Chief Financial Officer

KENNETH H. SUNSHINE

Mr. Kenneth 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, Mr. Sunshine was Chief Financial Officer of Aurora Flight Sciences Corporation and earlier served as Senior Vice President of Finance and Treasurer of Orbital Sciences Corporation. He holds a BS in Mechanical Engineering and Computer Science from Tufts University and an MBA from the Wharton School of the University of Pennsylvania.

FINANCIALS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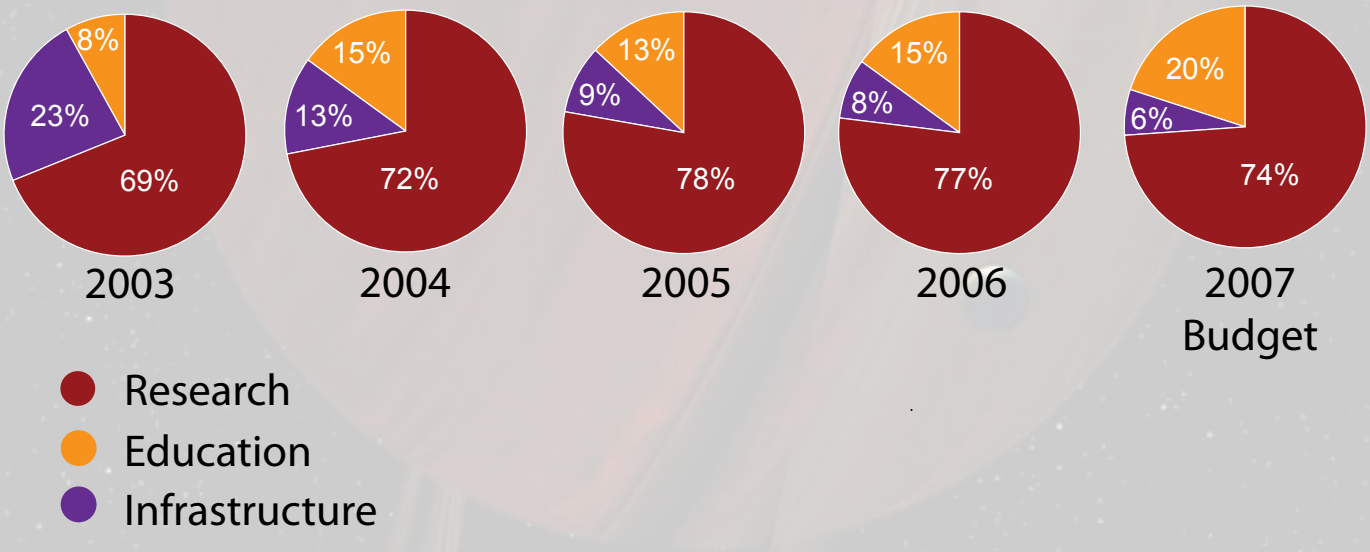
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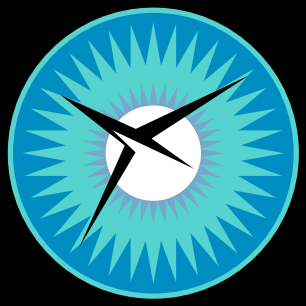

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