National Institute of Aerospace

2005 ANNUAL REPORT

NIA by the Numbers

Research

- 44 Members of resident research staff
- 8 University research staff in residence at NIA
- 32 Scholars from around the world participated in the '05 Visiting Researcher Program
- Over 64 research projects funded at member universities
- 19 Collaborative NIA/NASA/university proposals submitted to other government agencies – 5 awarded
- 152 Peer-reviewed publications and conference presentations
- 29 Separate awards for NIA research contributions

Education

- 42 Full-time graduate students in residence
- 15 Part-time graduate students enrolled
- 12 Full-time and part-time faculty in residence
- 21 Resident MS and PhD programs offered on-site at NIA by 7 member universities
- Over 100 course offerings each semester in distance education catalog
- 24 Two-way video courses delivered (6 outbound from NIA)
- 12 Short courses, 46 seminars, and 9 workshops

Outreach

- NESC Academy established
- In-service Teacher's Program expands to 32 participants
- NASA Pre-Service Teachers Program awarded to NIA
- NASA Center for Distance Learning support awarded to NIA

Financial

- FY05 revenue: $23.9M
- FY06 projected revenue: $27.6M
- FY05 member university cost-sharing: $1.6M

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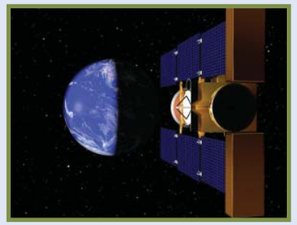


NIA

Today's Research and Education for Tomorrow's Technologies

Letter from the President

In 2005, the National Institute of Aerospace (NIA) continued to strengthen and grow in our mission to serve the public good through research, education, outreach and technology transfer. We achieved two major institutional milestones – the appointment of all remaining distinguished faculty positions, and the move to our new, permanent headquarters facility. As we continued to fulfill our role as strategic partner to NASA Langley Research Center (LaRC), we also expanded our work for other clients, and emerged as a contributor to the aerospace community at a national level.

The Langley Professor Program is the cornerstone of the Institute's research and graduate education programs. Early in 2005, NIA successfully achieved the most significant milestone to date in the development of the institute. Our effort to recruit six nationally recognized faculty members in new and emerging domains of research proved to be one of our most challenging goals, and is now complete. Each of these six distinguished scholars now holds the title of Langley Professor within their university, and serves as Director of a new research center at NIA. These centers provide a focus for growing collaborative research efforts that can involve faculty and students from multiple institutions, NIA research staff, university post doctoral fellows and research staff, and collaborators from LaRC.

NIA achieved a second historic milestone in May 2005 with the completion and occupancy of our new permanent facility. NIA's new headquarters facility at 100 Exploration Way in the Hampton Roads Center North complex was dedicated in a ceremony attended by dignitaries from LaRC, NIA's member universities, the Commonwealth of Virginia and the community on June 23, 2005.

The new headquarters building includes a 95 seat lecture hall, four classrooms equipped for two-way synchronous course delivery either to or from NIA, a multi-purpose workshop center and offices to support approximately 60 research and administrative staff and up to 40 students. Every week, our new facility hosts research scientists and engineers from NASA and the local community, faculty and students from our member universities and visiting scholars from around the world, participating in NIA's extensive program of seminars, short courses and workshops.

NIA Headquarters in Hampton, Virginia

In 2005, NIA led a team of over 250 aerospace industry and academic experts to produce a new comprehensive five-year plan for aeronautics research. This Congressionally mandated effort was documented in the 1000+ page report "Responding to the Call: Aviation Plan for American Leadership" that was delivered to Congress in April 2005. This report has since been cited in Congressional testimony and in legislation, and has served as a source document for the Decadal Survey of Civil Aeronautics currently underway at the National Research Council.

In the pages of this NIA Annual Report, you will find details of the new faculty-led centers of research, the accomplishments of NIA's research staff, the progress of our graduate education and outreach programs, our technology transfer efforts and our current financial status.

As we look to the future, we remain committed to the core principles that first brought NASA and our member institutions together to form this unique enterprise. NIA will continue to grow around our four original key functions: research, graduate education, outreach and technology transfer. We will actively pursue opportunities to grow and strengthen our Langley Professor research centers and their relevance to NASA's evolving space exploration, aeronautics and science missions. We will continue toward our goal of self-sufficiency by the end of 2007, and will seek to expand our work for other NASA centers, other government agencies, and commercial and international customers. Finally, we are committed to a culture of excellence in everything we do.

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.

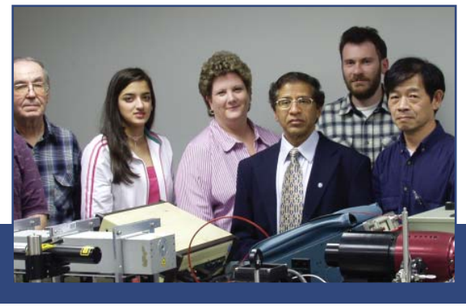
…***Promote*** aerospace science and engineering and provide outreach to the region and nation.

Ribbon cutting for the new NIA headquarters.

Centers of Research

Center of Nanotechnology for Advanced Sensors, Actuators and Microsystems

Prof. Mool Gupta



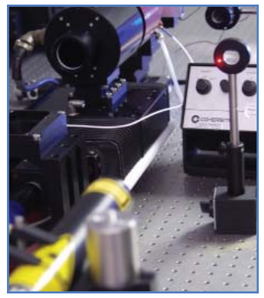
Professor Mool Gupta, Langley Professor for the University of Virginia, currently serves as Director of the Center of Nanotechnology for Advanced Sensors, Actuators, and Microsystems at NIA. The Center was established to utilize developments in nanomaterials and nanostructures to develop advanced sensors, actuators and microsystems to complement LaRC capabilities in advanced sensors and microsystems for space mission and aeronautics applications.

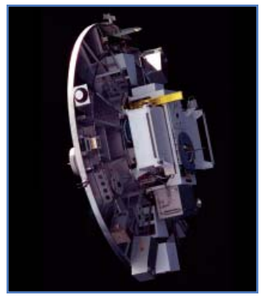
Current research thrusts are:

- *Exploring the use of carbon nanotubes as efficient electron sources so that a compact x-ray source can be built for composition analysis of planetary surfaces;*
- *Investigating carbon nanotubes and other nanomaterials for electrical, thermal and structural properties for electromagnetic shielding, antennae and other millimeter and microwave applications;*
- *Exploring the field of negative refractive index materials – including modeling, fabrication, design and applications for building unique structures for advanced sensors, antennae and other applications;*
- *Fabricating and examining laser crystallized silicon films for efficient photo detector applications; and*
- *Investigating the use of lasers, optics and photonics to build miniaturized sensors, actuators and microsystems.*

This research is performed in close collaboration with NASA LaRC through the Active and Passive Sensor Systems Branches, the Electromagnetics and Sensors Branch relating to new concepts for compact antenna design/fabrication and lightweight conducting polymeric materials for microwave/millimeter applications, and the Advanced Sensing and Optical Measurements Branch for advanced laser applications.

Despite its short time in existence, the Center already has over $1.5 million in outside funding to supplement the NASA LaRC core research funding. The Center has developed new curriculum to support the NIA graduate education program, including a course on Micro-Electro-Mechanical Systems (MEMS) and a course on Photonics with guest lectures from many industrial scientists.





Center for Adaptive Aerospace Vehicle Technology

Prof. James Hubbard

Professor James Hubbard, Langley Professor for the University of Maryland, currently serves as Director of the Center for Adaptive Aerospace Vehicle Technology. The Center develops and supports multidisciplinary teams pursuing revolutionary research to enable efficient multi-point vehicles providing performance on demand and operating in an integrated airspace-vehicle environment.

Center focus areas include active flow and noise control and unsteady fluid mechanics and their integration with adaptive structural concepts, and intelligent distributed sensors and flight controls. It was established to promote excellence in our nation's adaptive structures and systems development through research, education, creativity and innovation in:

- *Modeling and simulation of distributed parameter systems for space and aeronautics;*
- *Robust design and active controls with expertise in application to continuum structures and transducers;*
- *Advanced engineering concepts; and*
- *Free flight scale model test and evaluation.*

Principle activities focus on adaptive vehicle concept development, bio-inspired approaches, multi-disciplinary approaches, emerging technologies, autonomous behaviors and multi-functional materials.

During 2005, the Center led the development of the Sky Walker program. This program culminated in the submission of a large formal proposal ($11.8M) to DARPA, which represented an entirely new paradigm for NIA/NASA collaboration.

The Morpheus development team is working in the area of Adaptive Vehicle Concepts. This project involves wing load management and control for efficient flight. Initial focus was on drag reduction in low Reynolds number flight regimes such as loitering and thermaling, and now includes rotary wing applications with Dr. Mark Nixon, Head of the Army Research Laboratory's Aeroelasticity Branch located at NASA LaRC. Program Firefly is a bio-inspired flight effort to better understand the basic principles of flight using an RC controlled avian ornithopter test platform. A new class of small scale actuators that mimic the muscle fibers of birds is currently being developed.

Professor Hubbard continues to develop his five-year plan for academic study of Adaptive Vehicle Technology. He has developed two new courses on Spatially Distributed Transducers for Smart Structure Control and Morphing Aircraft Structures, and assumed responsibility for teaching fundamental courses, such as Structural Dynamics and Aeroelasticity (with Dr. Jerry Newsom).

Prof. David Song

Center for High Confidence Cooperative Systems

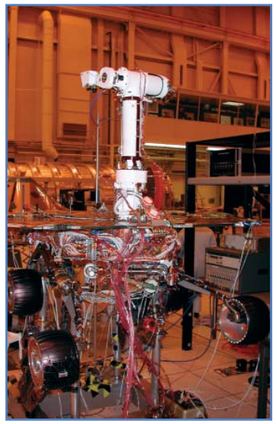
Professor David Song of North Carolina A&T State University is currently serving as Langley Professor in High Confidence Control Systems. In that role he also serves as Director of the Center for High Confidence Cooperative Systems (HCCS) at NIA. The mission of the HCCS Center is to perform high-impact research in aerospace, space exploration and biomimetics. The Center's main focus is on the analysis, design and simulation of advanced cooperative systems technologies for making current and future aerospace transportation more affordable, efficient and reliable.

The Center promotes excellence in our Nation's aerospace systems development through research, education, creativity and innovation in the specific research thrusts of:

- *High confidence avionic system technologies for enhancing space vehicle mission planning and analysis;*
- *Flight dynamics, guidance/navigation and control for space exploration vehicles;*
- *Examining innovative algorithms and approaches for crew system health diagnosis/monitoring, fault accommodation and reliability;*
- *Advanced strategies for manned and unmanned vehicle formation and cooperation; and*
- *Biomimetics for system adaptation and reconfiguration.*

The Center also continues to pursue joint proposal activities through these collaborative efforts to bring in funds from sources outside of NASA LaRC. The Center already has secured over $1.6 million in outside funding to supplement the NASA LaRC core research funding. Current outside funding sources include the National Science Foundation, the Army Research Office, the Office of Naval Research and industry.

The Center has developed new curriculum to support the NIA graduate education program, including courses on Intelligent Systems and High Performance Computing with guest lectures from many industrial scientists. The Center also continues to sponsor educational activities in support of NASA LaRC as requested, including training and short courses.



Prof. Kathryn Logan

Center for Multifunctional Aerospace Materials

Professor Kathryn Logan, Langley Professor for Virginia Polytechnic Institute and State University is currently serving as Director of the Center for Multifunctional Aerospace Materials at NIA. The mission of the Center is to develop new methods and processes to facilitate the design of multifunctional aerospace materials across the nano- to meso-range of spatial and time scales. The design of multifunctional aerospace materials will be accomplished by developing and implementing advanced synthesis, processing, forming and characterization technologies on the nano- and meso-scale. Theoretical and experimental models will be developed that will be iteratively verified experimentally for the purpose of predicting the resultant product composition, configuration and performance from a systems perspective.

Specific research thrusts include:

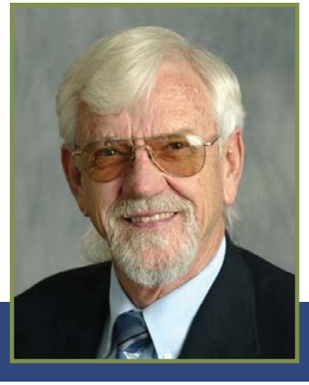
- *Design of multifunctional materials (ceramics, metals, polymers, composites);*
- *Synthesis and processing of high performance pure titanium diboride and composite alumina/titanium diboride; and*
- *Experimental and theoretical modeling and simulation of material phenomena to facilitate prediction of the resultant product performance.*

Recently developed examples of high performance multifunctional materials of interest are a unique pure titanium diboride and composite alumina/titanium diboride. Potential applications include radiation and meteoroid shielding material for space suits and lunar habitats, landing brakes, high temperature sensors (>1000° C), leading edge material (liquid cooled) and pressure sensors.

A synthesis and processing laboratory has been established at LaRC. A synthesis reaction chamber has been designed and is now operational. The Center is also establishing an Ultra High Temperature Lab (UHTL) in the Department of Materials Science and Engineering at Virginia Tech for ultra high temperature research. It is expected that the UHTL will provide a means to characterize materials in-situ in extreme environments relevant to space exploration. The Center will further collaborate in flying diboride materials on the Space Shuttle in May 2007, where active and passive testing will be conducted in the space environment.

Unique curriculum has also been developed to support the NIA graduate education program, including two new courses entitled "Design of Materials" and "Design With Materials."

Prof. Robert Tolson



Center for Planetary Atmospheric and Flight Services

Professor Robert Tolson, Langley Professor for North Carolina State University, is currently serving as Director of the Center for Planetary Atmospheric and Flight Sciences at NIA. The mission of the Center is to develop end-to-end atmospheric and flight system analysis capabilities that include Mars global circulation and mesoscale models, physics-based atmospheric uncertainties, advanced flight system methods and real-time data assimilation for atmospheric model updates.

Specific research thrusts include:

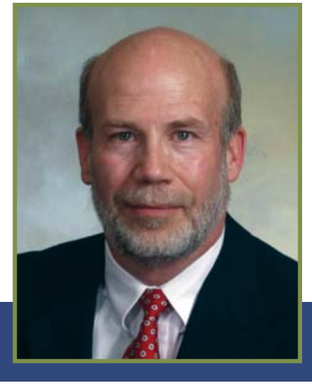
- *Developing a whole atmosphere global circulation model for Mars (MWGCM) that includes physical models of atmospheric processes from the surface to 250 km to provide LaRC with a unique scientific capability;*
- *Developing a Mars mesoscale model (MMM) with adaptive grid to enhance simulation of small scale phenomena for scientific and precision landing analyses;*
- *Developing an integrated physics-based uncertainty analysis capability so that errors in MWGCM and MMM predictions of flight system parameters can be evaluated in a rigorous physical and mathematical manner;*
- *Developing data assimilation methods to accommodate the latest data for WMGCM and MMM improvements, and using data assimilation and the physics-based uncertainty analysis to permit experimental design for Mars atmospheric measurement campaigns; and*
- *Enhancing data assimilation capability to support flight operations by providing near-real-time model predictions based on measurements.*

This research is expected to greatly enhance NASA Mars missions by reducing uncertainty in atmospheric conditions to allow improved mission reliability and enhance payload/science capability through improved performance margins.

The Center already has one full-time and three part-time faculty members, three research staff members, 12 graduate students, and total funding of $1 million per year. Research activities are successfully supporting the Mars Reconnaissance Orbiter Program and the Mars Science Laboratory effort.

A multi-university graduate program offering a concentration in Space Exploration has recently been developed with a current focus on flight mechanics and system engineering/simulation.

Prof. Alan Wilhite



Center for Aerospace Systems Engineering

Professor Alan Wilhite of the Georgia Institute of Technology is currently serving as Langley Professor in Advanced Aerospace Systems Architecture. In that role he also serves as Director of the Center for Aerospace Systems Engineering at NIA. The mission of the Center is to promote excellence in our Nation's aerospace systems development through research, education, creativity and innovation in the specific research thrusts of:

- *Modeling and simulation of systems and systems of systems;*
- *Robust design, risk and life-cycle analyses;*
- *Advanced engineering environments; and*
- *Systems engineering and integration.*

The Center's expertise in space architecture design was recently recognized when Dr. Doug Stanley, Georgia Tech Faculty-in-Residence at the Center, was selected to lead NASA's Exploration Systems Architecture Study to define NASA's future human and robotic architecture for exploration of the Moon and Mars. For these efforts Dr. Stanley was awarded the NASA Distinguished Public Service Medal.

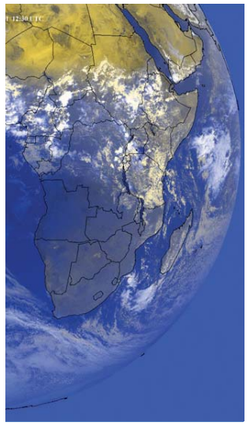
To support NASA's $2 billion a year investment in exploration systems technologies, Professor Wilhite led a Georgia Tech team of graduate students and research assistants to develop methods and tools to prioritize technology selection based on mission impact, cost and risk. Research is continuing, in collaboration with NASA LaRC, in developing new tools and methods for annual assessment and prioritization of the exploration systems technology portfolio.

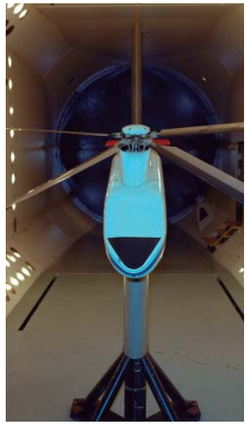
The Center already has two faculty members and eight graduate students and has taught over 100 students from four universities in systems engineering and spacecraft design. A multi-university graduate program offering a concentration in Space Exploration has recently been developed with a current focus on flight mechanics and system engineering/simulation. In addition, the Center is sponsoring a government/industry workshop to develop an aeronautics and space system safety certification program in collaboration with other NIA universities. The Center will also continue to sponsor educational and training activities in support of NASA LaRC such as short courses and guest lectures.

Continuing research goals include creating a seamless level of modeling and simulation from conceptual to detailed engineering to support all phases of system development by integrating systems engineering practices across the complete system life-cycle. This research is envisioned to support NASA, DoD, and the Hampton Roads modeling and simulation strategic plans.

Research

NIA conducts a broad range of scientific and engineering research sponsored by NASA LaRC and other government agencies. This work, performed either at LaRC or at NIA, is accomplished by a staff of more than 45 NIA scientists, engineers and consultants in seven principal areas of investigation. The group coordinators represent these seven research teams on NIA's Research Council:





Air Traffic Research:	Mr. Frank Bussink/Dr. Cesar Munoz
Aviation Safety Research:	Mr. Sam Morello
Flight and Control Systems Research:	Dr. Luis Crespo
Materials Research:	
Nanotechnology Materials	Dr. Cheol Park
Composite Structures	Dr. James Ratcliffe
Metals	Dr. Vesselin Yamakov
Rotorcraft Aeromechanics:	Dr. Phuriwat Anusonti-Inthra
Exploration Systems:	Dr. Robert Maddock
Atmospheric Sciences:	Dr. Hongyu Liu

NIA Staff Research Summary

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

The following discussion provides brief summaries of the research activities and accomplishments of each research group for Fiscal Year 2005.

Air Traffic Research

Objective: Enable major increases in the capacity, mobility and throughput of the air transportation system through development of revolutionary concepts and technologies for operations and vehicle systems.

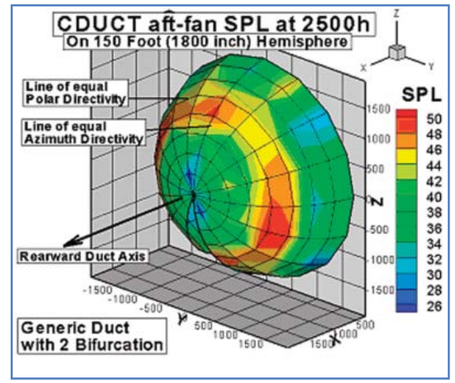
Approach: Communication Navigation and Surveillance (CNS) capabilities are emerging that can employ human-centered automation and assist air traffic management decision-making of pilots and controllers. Areas of interest include algorithms for conflict detection and resolution, airborne self-spacing and merging, system noise prediction and Enhanced Oceanic Operations.

NIA's air traffic research group is involved in determining the feasibility and potential benefits associated with distributed air/ground air traffic management concepts for the Advanced Air Transportation Technologies (AATT) project and the Small Aircraft Transportation System (SATS) project. Research included the development of airborne flight planning and guidance technology; the development and evaluation of operational and system infrastructure requirements; the design and assessment of human/computer interfaces; and the assessment of concept operational feasibility and viability.

The group conducted research in formal methods for the specification, design and verification of real-time, safety-critical systems. Towards its goals, the staff identified critical systems used in commercial aviation and their associated safety properties. The following types of safety properties were explored: algorithmic correctness, algorithmic certainty, lack of unintended function, timeliness of warnings and alerts, absence of deadlock and recovery in presence of faults. Formal methods for analyzing these critical systems were developed and the effectiveness of these methods was demonstrated.

Additionally, the research to produce tools for noise prediction followed two main thrusts: an assessment of operational and architectural requirements, and the development of prototype components. An assessment review of requirements included evaluations of alternative computational-framework concepts and the capabilities (and limitations) of the existing Aircraft Noise Prediction Program (ANOPP).

Accomplishments: The air traffic research group co-developed fast-/real-time simulation environments for safety analysis and benefits studies and implemented an improved version of a conflict detection and resolution algorithm. They also developed a library for interval analysis and completed a revised model and proof of optimality for the "first-come-first-serve" strategy of a greedy terminal-approach scheduler. NIA researchers are replacing empirical noise models with current and emerging physics-based noise prediction codes.



Aviation Safety Research

Objective: Provide relevant technology assessments and integration utilizing systems engineering approaches and development; transfer new research products to the aviation community and the national airspace system and assess the feasibility and potential benefits associated with distributed air/ground air traffic management concepts.

Approach: NIA research staff and consultants have pursued the development of concepts of operations (CONOPS) and systems engineering planning and support to provide risk reduction strategies and tools aimed at developing a diagnostic safety assessment capability. The aim is to transfer these methodologies to other national needs and programs.

Accomplishments: The aviation safety research group completed a formal aviation safety systems engineering management plan. They also fulfilled the initial requirements mapping into the Joint Program and Development Office's (JPDO) next generation air transportation system transformation effort. A logic-evolved decision software tool was developed to use in risk assessment, modeling and reduction.

Flight & Control Systems Research

Flight and control systems research at NIA focused on two areas for 2005: Aerodynamics and Uncertainty Control Systems.

Aerodynamics

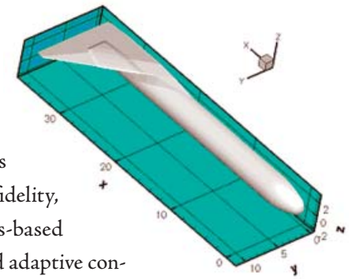
Objective: Accelerate convergence of iterative solutions of Euler and Navier-Stokes equations and predict and model laminar/turbulent transition in complex flow geometries.

Approach: The convergence research was focused on evaluating and improving multi-grid components, such as relaxation and coarse-grid correction for large-scale unstructured-grid computations, e.g., large eddy simulations of flows over full aircraft configurations.

Transition modeling research and laminar flow control techniques used computational fluid mechanics to provide the mean-flow definition for the complex flow geometry of a high-speed and high-altitude flight experiment. The mean flow fields obtained in the computations were then used for stability analyses.

Accomplishments: The flight and control systems research group developed new quantitative analysis methods for multi-grid solutions and extended them to unstructured-grid formulations. They also examined the quality of mean flow fields and tested the quality of the CFD design software.

Uncertainty Control Systems

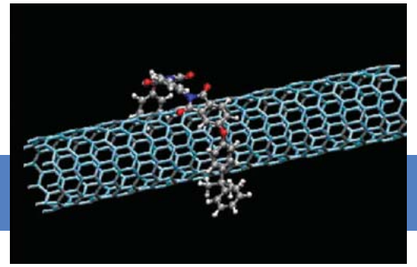


Objective: Model, design, propagate, quantify and decompose the effects of uncertainty in variable-fidelity, multi-disciplinary physics-based models. Develop robust and adaptive control methods for aircraft under adverse operating conditions.

Approach: Research in uncertainty-based methods was conducted in the field of aircraft stability and control. Activities included the identification of reliability- and robustness-based formulations for synthesis and the development of efficient numerical techniques for probabilistic analysis and robust design. Problems in aircraft conceptual design, probabilistic robust controls and the synthesis of fault-tolerant control systems were considered.

The research into robust and adaptive control methods included studying aircraft under adverse conditions, such as control component failures or pilot errors, and in control-centric modeling of nonlinear dynamical systems, with distributed parameter systems.

Accomplishments: The uncertainty and control systems group developed a generic, physics-based stability and control module for the analysis of aircraft flight. They also developed a confidence software module that allows for uncertainty propagation and design space exploration in the presence of parametric uncertainty. The group modeled nonlinear dynamic simulations for hardware-in-the-loop tests and constructed a flying platform for the testing of controls.



Materials Research

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

Approach: Materials research at NIA consists of three major thrusts: nanotechnology, composites and metals. In the nanotechnology arena, the focus is on nanostructured materials with specific aim toward energy storage and harvesting. NIA researchers are also working to characterize the magnetic properties of nanostructured materials and perform thermal management using nanocomposites.

Research on composite materials is working to synthesize and characterize organic monomers and polymers for space applications, including the enhancement of organic based polymers to be used in solar cells. Composite researchers are also developing flexible, thermally conductive fabrics and plastics for application to liquid cooling and ventilation garments while increasing the thermal conductivity of these materials to decrease weight, mobility and comfort of spacesuit assemblies. On the aeronautics side, composite material research is focused on modifying existing aerospace-grade epoxy resins to increase flame retardant properties without changing original mechanical and material properties and developing analytical methodologies for characterizing delamination onset and growth in composite structures.

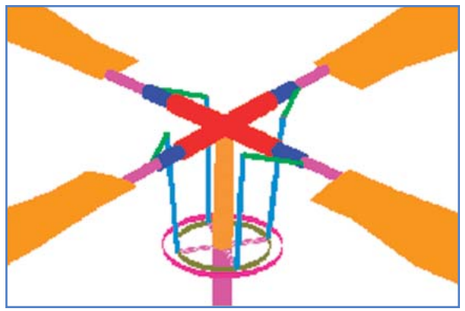
Metals research is poised toward modeling multifunctional materials with tailored electromagnetic properties, developing test methods and analytical tools for characterizing the damage resistance and tolerance of structures and materials, and developing analytical methodologies to enhance structural integrity of metallic structures.

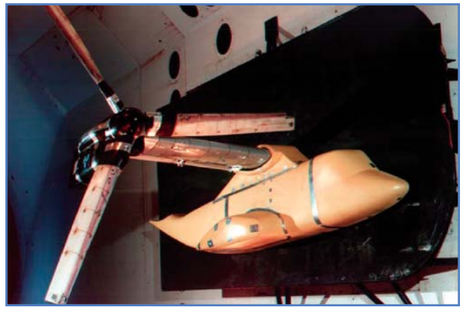
Accomplishments: The major accomplishments of the nanotechnology group consist of the development of a novel bionanobattery based on bioinorganic proteins with demonstration of a bionanobattery cell (0.44V production), fabrication of a nano-structured magnetic field sensor, and development of a hybrid force/stress amplified piezoelectric energy transducer system which provides a 10-fold increase of energy harvesting efficiency over conventional devices. The team has also created multifunctional structural carbon nanotube (CNT) electroactive polymer composites for sensors and actuators, bionanocomposite sensors and actuators using carbon nanotube copolypeptide composites, and CNT polymer nanocomposite pressure sensors.

The major accomplishments of the composites group include designing, modeling, fabrication and demonstration of a G-elastomer-based silicon mirror with a controlled deformation feature providing a self-deployed, reconfigurable, ultra-large, ultra-lightweight, optical aperature and invention of novel self-healing polymers that are jet-fuel resistant and fire retardant epoxy composites for aircraft. Other accomplishments include increasing the thermal conductivity (by an order of magnitude) of a polymer to be used in spacesuit assemblies and development of several polymers that were tested for photovoltaic properties. One of the polymers exhibited potential for use in solar cells. The polymer is undergoing further evaluation.

The major accomplishments of the metals group were characterization of deformation and failure in metals through detailed atomistic simulations, development of a multi-scale computational model for quantitative analysis of the mechanical properties of metals and the development of a molecular-dynamics model for steady-state crack propagation to a grain-boundary in aluminum.

Rotorcraft Aeromechanics





Objective: Perform analytical and experimental research to improve rotor system loads estimation and rotorcraft stability and control characteristics. Specific objectives include improving analytical capabilities for predicting aeromechanical behavior of rotor systems, performing wind-tunnel tests to demonstrate rotor enhancement concepts, and developing sophisticated new active control concepts designed to reduce vibration, improve performance, reduce maintenance requirements, reduce noise emission and enhance survivability of rotorcrafts.

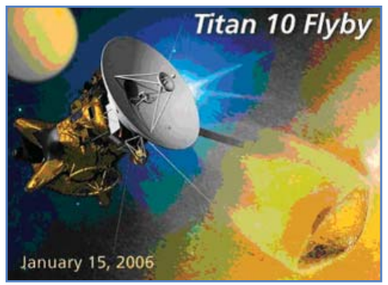
Approach: Improvement in the analytical capabilities can be achieved by integrating computational structural and fluid dynamics into a unify analysis. The computational structural dynamics is based on a multi-body methodology, which is capable of handling complex structures such as a rotor hub that contains various inter-connected components. In computational fluid dynamics analysis, the entire flow domain is divided into several near-body and off-body regions, and the flow parameters in each region are calculated using different flow solvers depending on flow characteristics. The integration of the above analyses is performed by exchanging information at every instant in time to ensure consistency of the simulation. Wind-tunnel tests will also be performed in support of the analysis to provide critical validation data.

Accomplishments: The rotorcraft aeromechanics group developed a method for satisfactory prediction of wing properties, rotor frequencies and rotor couplings. They also developed loads and stability analyses for rotor system and elastic wing models.

Exploration Systems

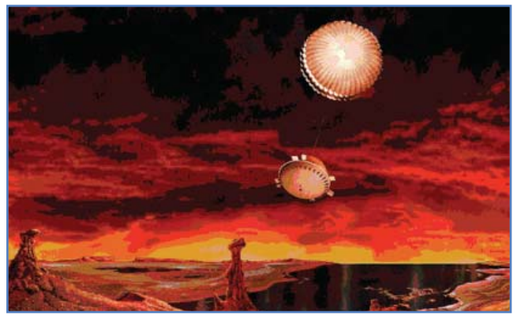
Objective: Assist in mission development and vehicle design including entry descent, aerocapture and aerobraking for planetary exploration of Mars, Titan, Neptune and Venus. Assist in the development of large inflatable space structures.

Approach: NIA's exploration systems group has conducted research in atmospheric flight for planetary exploration missions and studies. This research assists in mission and vehicle design development and improves the planetary atmospheric flight analysis methods. Planetary exploration missions include entry, descent, aerocapture and aerobraking. Mission destinations are Mars, Titan, Neptune and Venus, as well as Earth return from planetary and lunar missions. The survival of such vehicles depends greatly on the accurate prediction of the aerodynamics and surface heating, which are strongly influenced by the high-temperature, highly reacting chemistry flow-field formed by the shocked flow over the vehicle during its high velocity passage through the planetary atmosphere. The purpose of the research is to investigate the physics and chemistry of a high-temperature, reacting flow field and define methods to accurately predict the heating and aerodynamics associated with these high-speed entries. Gaseous radiation can potentially be a major source of the heating at the higher speed entries for many future missions. This area of research involves the definition, analysis and calculation of engineering and physics features in planetary entry science and the high-temperature, shock-layer, radiative heating associated with entry capsules.



In the space structure arena, studies over the past few years have indicated that there may be potential for the application of inflatable, "rigidizable" assemblies for dimensionally large space structures. An objective of this research is to assist in the development and analysis of inflatable "rigidizable" concepts for a 300-meter long space-based radar. The concept must be capable of being packaged in a single launch vehicle and deployed reliably in orbit.

Accomplishments: The exploration systems group provided an independent technical assessment of the Cassini-Huygens Probe entry descent and landing and delivered reentry software codes for use within NASA's exploration architecture program. The group also developed a rigidizable test beam.



Images on this page are courtesy of NASA/JPL-Caltech.

Atmospheric Sciences

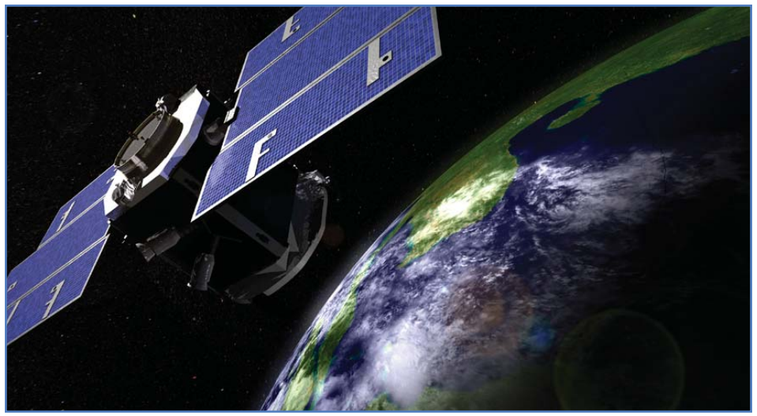
Objective: Advance scientific understanding of cloud, radiative and chemical processes in the atmosphere and their relation to global climate. Represent clouds in global models.

Approach: Cloud representation in global models poses a significant challenge, since most cloud processes occur on subgrid scales and must be parameterized. Uncertainties in cloud distributions and optical properties are, therefore, a limiting factor in model assessments of the radiative effect of clouds on global tropospheric chemistry. The atmospheric sciences group conducted an analysis of the sensitivity of the radiative effect of cloud–to-cloud vertical distributions and optical properties.

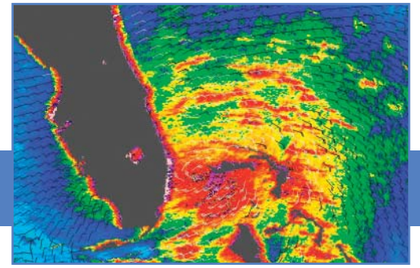
Satellite-retrieved surface radiative flux data is important for global climate monitoring and decision-making in solar power applications. The overall aim of this research is to improve satellite retrievals of surface radiative fluxes, methods for the evaluation of these retrievals and estimates of retrieval accuracy. These projects involve the computation of solar radiative transfer in cloudy atmospheres using plane-parallel radiative transfer methods together with satellite radiances and retrievals.

The climate of the Earth is intimately related to the radiation from the Sun, which is absorbed and then emitted by the Earth. Under this research, the group is studying existing data sets to learn about the climate system and working with satellite instruments to measure the radiation balance.

Research also focuses on cloud modeling and parameterization to understand cloud feedback mechanisms in the climate system, more specifically, on the evaluation and improvement of cloud-resolving models through development and application of innovative methods that use new data from earth observation satellites to provide insight into a model's performance.



Artist's concept of NASA's CloudSat spacecraft, which will provide the first global survey of cloud properties to better understand their effects on both weather and climate.
Image credit: NASA/JPL



Atmospheric Sciences

Research on airborne in-situ CO_2 mesaurement and analysis of field campaign data provides highly precise, rapid in-situ CO_2 measurements aboard NASA and commercial research aircraft, to elucidate atmospheric CO_2 source/sink distributions over North America and the calibration/validation of developing remote CO_2 sensors with subsequent analyses of resulting data sets. These data sets are important to the understanding of missions affecting global warming.

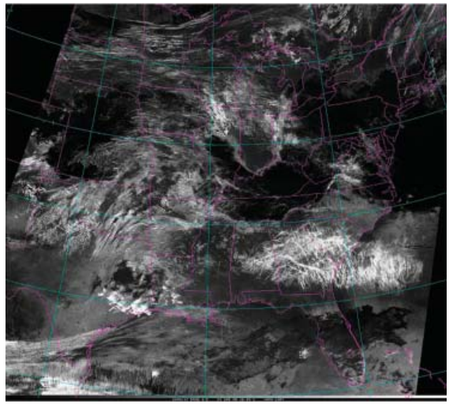
Research was also conducted to support the goals of the Global Modeling Initiative, a NASA-led activity to develop state-of-the-art modeling tools for the purpose of quantifying and reducing uncertainties in global atmospheric model results, understanding the coupling between atmospheric composition and climate, and contributing to assessments of the effects of anthropogenic and natural perturbations of atmospheric composition.

Atmospheric research collaboration is being done to produce more accurate flux estimates at the top of and within the atmosphere, and better assessments of the direct and indirect effects of clouds on the Earth's radiative energy balance. NIA is developing contrail parameterizations for use in climate models, which will improve assessments of contrail-climate effects and provide a means for predicting contrails in future air traffic situations.

A space-based LIDAR was recently launched to probe the vertical structure and properties of thin clouds and aerosols over the globe. Data provided by this system will lead to a large improvement of our understanding of the role of clouds and aerosols in the Earth's atmospheric system. NIA led a number of research activities in preparation for this launch including the development and testing of LIDAR data processing algorithms.

Accomplishments: The atmospheric sciences group illustrated that the radiative impact of clouds on global tropospheric chemistry is more sensitive to cloud vertical distribution than to the magnitude of column cloud optical depth. They completed a comparison of surface solar fluxes determined from satellite retrievals and surface measurements as a function of sky cover characteristics. The Fu-Liou radiative transfer scheme and a newly developed parameterization of ice cloud radiative properties were incorporated into a cloud-resolving model and results were evaluated.

The group designed and conducted six ensembles of cloud-resolving model simulations (582 total simulations) of tropical convective cloud systems and conducted a preliminary study of the impact of uncertainties in precipitation scavenging on simulated tropospheric chemistry. They developed new statistical contrail prediction models that use meteorological data and surface-based contrail observations as predictors in a multiple logistic regression technique. Group members also led the implementation of scene classification and uncertainty estimate algorithms in LIDAR data products.



NIA Visiting Researchers

NIA's Visiting Researcher Program welcomed a diverse group of national and international faculty, scholars and students in 2005. 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. NIA negotiates arrangements with local businesses in Hampton, VA (apartment rental and car rental agencies, being two prime examples) to support visitors with the most cost-effective, quality facilities and services.

Thirty-four eminent scientists and engineers from 25 separate institutions were resident at NIA during 2005.
Their research topics included:

- Morphing
- Unsteady Aerodynamics
- Formal Methods
- Turbulence Modeling
- Computational Fluid Dynamics
- Software System Safety
- Structures and Materials
- Development of Code Validation Data for High Energy & Hypersonic Flows
- Structural Mechanics
- Evaluating Precision Approach Spacing with Continuous Descents
- CEV Reentry Analysis
- Development of Software for Data Display and Computer Control of Equipment
- Micro Air Vehicle System Integration
- Electrification Processes for Martian Dust
- Development of Artificial Muscles and Gio Power Requirements
- Engineering for Complex Systems

The success of the visitors' collaborations with LaRC (and NIA), in terms of the productive and quality outputs from the research, is witnessed by more than 70 percent of these visitors receiving invitations to return in FY06 to advance their intellectual joint discoveries.

International Connections…

Imperial College
Univ. Manchester
Cardiff Univ.
Univ. Limerick
Von Karman Institute
Politecnico di Bari
Ecole Central De Lyon
Ecole Polytechnique
Univ. Paris Sud
Univ. Tubingen
Delft Univ
Univ of Porto
CNRS
INRIA
Uppsala Univ
Univ of Bristol
Univ of Girona
Univ of Sevilla
Univ of Ulm
Technion
Tel-Aviv Univ
Weizmann Inst.
Kolon
Inha Univ
Hanyang Univ
Kyoto Univ.
University of Queensland
University of the Witwaterstrand

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 NASA 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 different 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.

Adjunct Prof. Johnson teaching a live mathematics course at NIA to students from the University of Maryland, NC State and Virginia Tech.

Prof. Hubbard using distance-learning facility to teach students at NIA and on-campus at the University of Maryland.

Participating in the NIA Graduate Program are: Georgia Tech (GT), North Carolina A&T State University (NCAT), 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 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 by conducting their research at NIA and NASA 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 January 2005, graduate research opportunities were established with the Center for Atmospheric Sciences at Hampton University where students will conduct their research within the Science Directorate at NASA LaRC while taking classes at Hampton University.

During the 2005 Fall Semester, 12 faculty members were in residence at NIA including all six Langley Professors: Alan Wilhite (GT), James Hubbard (UMd), David Song (NCAT), Robert Tolson (NCSU), Mool Gupta (UVa) and Kathryn Logan (VT); Douglas Stanley (GT); Robert Lindberg (UVa); Bernard Grossman (VT); and adjunct faculty Jaroslaw Sobieski (VT), Arthur Johnson (VT) and Paul Cooper (NCSU). During the Spring semester, Vinod Saxena (NCSU) and Richard Barnwell (VT) also taught courses from NIA headquarters.

For the academic year 2005-2006, we have continued the very broad list of course offerings begun during our first two academic years 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. For the Fall Semester 2005, NIA offered more than 100 courses, with approximately 30 of these courses offered through live, interactive video conferencing.

Although distance learning programs are well-established, the NIA Graduate Program emphasizes its unique and innovative courses taught by on-site faculty, particularly the Langley Professors. Several of the courses delivered in the past two semesters are listed below.

- AE6322 (GT) Space Launch Vehicle Design (Spring 2005); Prof. Wilhite and Prof. Stanley
- MSE 5984 (VT) Design of Materials (Spring, Fall 2005); Prof. Logan
- MAE 589C (NCSU) Astrodynamics (Fall 2005); Prof. Tolson
- MAE 589D (NCSU) Spacecraft Attitude Dynamics (Fall 2005); Prof. Cooper
- EN651 (UMd) Smart Structures (Fall 2005); Prof. Hubbard

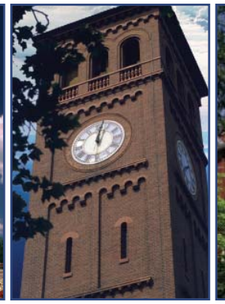
Graduate Degrees Available at NIA

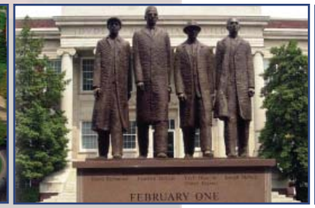
2005-2006 Academic Year

(Member University with Degree Programs Offered)

Georgia Tech	Aerospace, Mechanical
North Carolina A & T	Mechanical, Electrical
North Carolina State	Aerospace, Mechanical, Earth & Atmospheric Sciences*
University of Maryland	Aerospace, Meteorology*
University of Virginia	Aerospace, Electrical and Computer, Mechanical, Materials Science & Eng., Engineering Physics, Systems & Info. Eng.
Virginia Tech	Aerospace, Mechanical, Ocean, Materials Science & Eng., Engineering Mechanics
Hampton University	Atmospheric Sciences*

**courses available on campus only.*





Graduate Students

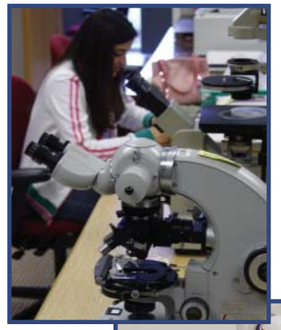
NIA's graduate program provides educational opportunities for students recruited nationally to pursue full time study at NIA, and for NASA employees, contractors and members of the local community seeking to pursue part-time graduate study. Students may be supervised by faculty in residence or by faculty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

The number of full-time graduate students studying at NIA has grown rapidly to 42 students in the 2005 Fall Semester.

Twenty six of these full-time graduate students are funded by NASA under the NIA Graduate Research Assistantship (GRA) Program and one student is supported through an industry-sponsored NIA GRA. The remainder of the students are supported through the Langley Professor program. Exceptional students accepted into the NIA GRA Program receive a stipend of $22,000-$26,000 per year, a $1,500 travel allotment and payment of tuition, fees and health insurance. NIA GRAs devote at least 20 hours per week on a research topic, usually on-site at NASA LaRC.

A snapshot of the growth of the program is given in the table at right. In addition, there are 15 part-time students who are civil servants or contractors at NASA LaRC.

Visiting student Aagya Mathur working in Prof. Gupta's Laser and Plasma Lab for Advanced Manufacturing at NIA.



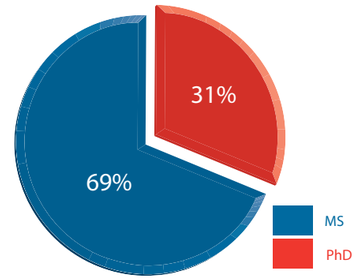
Graduate Students at NIA Headquarters

Growth of Full-Time NIA Graduate Students

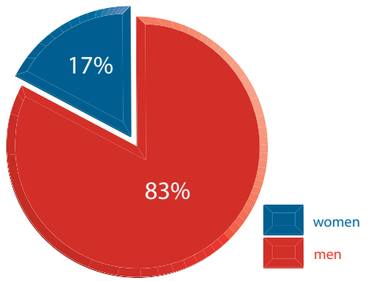
Semester	Students	
	NIA	NIA GRA
Fall 2003	6	6
Spring 2004	7	7
Fall 2004	26	24
Spring 2005	31	23
Fall 2005	42	26

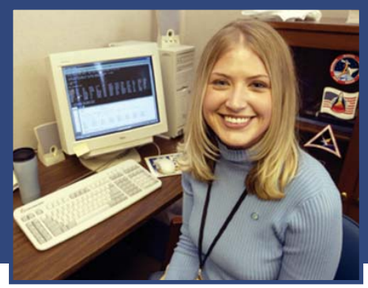
During the last academic year, we graduated our first student to complete her course of study entirely at NIA. Jody Fisher completed her M.S. degree in Aerospace Engineering from UVa and is currently a research engineer at NIA working in the Exploration Systems Engineering Branch at NASA LaRC. Five additional students will complete their degrees at NIA after the 2005 Fall Semester.

Student Distribution by Degree Type



Student Distribution by Gender





Jeff Caplan image courtesy of NASA LaRC.

Continuing Education

NIA provides a robust program for the greater LaRC community 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.

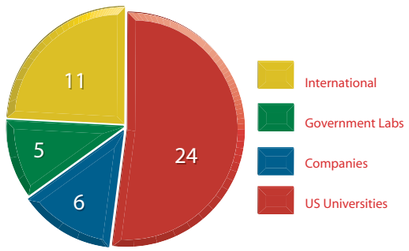
This year, NIA conducted nine workshops. Several of these workshops sought to bring in researchers to focus on new developments and breakthroughs and to see how they may be applicable to NASA and NIA's current programs.

46 seminars were offered this year in six main seminar series. The NIA Formal Seminar Series is primarily for visitors to NIA, many of whom are from our consortium and affiliated universities. Others are visitors who have direct connection to work being performed at NASA, NIA and our member universities. The NIA Distinguished Lecture Series presents highly regarded speakers who are invited to NIA specifically to give a seminar on a topic of broad interest. The Informal Seminar Series allows NIA resident researchers and graduate students to informally present their research in order to foster collaboration among NIA and NASA colleagues.

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 in the LaRC community 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, the Engineering for Complex Systems Lecture Series and the Morphing Lecture Series.

The faculty at our 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 are of interest to NASA researchers as well as the broader research community.

Seminar Speaker Affiliations



NIA Workshops FY 2005

October 14, 2004
NESC Academy Planning Workshop
NIA, Hampton, VA

December 7-9, 2004
Preparing for the Human Exploration of Mars Workshop
Williamsburg, VA

December 15, 2004
Hypersonics Workshop
NIA, Hampton, VA

December 16-18, 2004
Workshop on Smart Actuators and Control Systems (SACS) for the 21st Century
Hampton, VA

May 24-26, 2005
Health Monitoring and Maintenance Systems Workshop
NIA, Hampton, VA

June 1-3, 2005
Flight Interactive Systems Workshop
NIA, Hampton, VA

June 7-9, 2005
Preemptive Risk Reduction Technologies Workshop
NIA, Hampton, VA

June 30-July 1, 2005
Workshop on Turbulence Closures & Applications
NIA, Hampton, VA

August 16-17, 2005
NIA/DARPA/AFRL/NASA Large Space Systems Workshop
Santa Fe, NM

NIA Short Courses FY 2005

December 6-10, 2004
Daniel Raymer
Aircraft Conceptual Design Short Course

December 8-9, 2004
Daniel Schrage
Systems Engineering Short Course

December 16-17, 2004
William Oberkampf, Christopher Roy
Verification and Validation in Computational Simulations Short Course

January 25-26, 2005
Mikel Petty
VMASC Modeling & Simulation Short Course

March 31-April 1, 2005
William Oberkampf, Christopher Roy
Verification and Validation in Computational Simulations Short Course

April 5-7, 2005
Daniel Raymer
Spacecraft & Launch Vehicle Design Short Course

April 25-26, 2005
Steve Bond
Air Safety Management Course

May 24-27, 2005
Cesar Munoz
Formal Methods Short Course on PVS

June 6-7, 2005
Scot Rafkin
Proper Use of Mars Atmospheric Models

July 7 - Aug 11, 2005
Griffin Anderson
Toward Practical Scramjet Propulsion

August 4-5, 2005
William Oberkampf, Christopher Roy
Verification and Validation in Computational Simulations Short Course

September 7-9, 2005
Hank Rotter
NESC Academy: Space Life Support Systems

Participants in the first NESC Academy short course on Space Life Support Systems. Instructor and NASA expert Hank Rotter on first row with arms folded.

NESC Academy

NIA began a new short course activity in June 2005 called the NASA Engineering Safety Center (NESC) Academy. NASA turned to NIA and our partner CIBER to establish the 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 a 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.

Three-day short courses will be presented over a two-year period between May 2005 and May 2007. The courses are held at universities across the country. The first course on Space Life Support Systems was taught by Hank Rotter at the University of Houston. The next courses are Space Propulsion Systems at Alabama A&M University in October 2005 and Power and Avionic Systems at the University of Maryland in December 2005.

Student presentation by NIA Grad Student Matthew Bolton (standing front), along with advisor, UVa Prof. Ellen Bass (right front) and NASA mentor Ray Comstock (seated left).

Outreach

One of the missions of NIA is the development of a well-educated future workforce. Thus, in addition to the graduate and continuing education initiatives already described, NIA has enlarged its scope by undertaking a set of K–12 and undergraduate activities. This outreach program has focused on helping to ensure that the best and brightest students maintain an interest is science and technology. In order to ensure that we have the largest possible pool of future students we must make certain that this future talent draws from the largest possible pool and hence must include under-represented minorities.

The outreach program at NIA is intended to aid in the development of a well-educated workforce in science and engineering for NIA, NASA and the nation. A substantial part of the NIA outreach program is dedicated to teacher training and enhancement activities that will keep middle and high school students interested in science and technology.

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

In-Service Teacher's Program

NIA organizes and supports a two-week educator's workshop for middle and high school teachers. A goal of the workshop is to facilitate the teachers so they can develop instructional materials that will educate and motivate 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 Third Annual NIA Educator Training Workshop was held on July 11-22, 2005, and was a joint effort between NIA, the NASA LaRC Office of Education, the Virginia and North Carolina Space Grant Consortia and NIA University partners from Virginia and North Carolina.

Hands-on activities at the 2005 Educator Training Workshop.

Over 40 educators from Virginia and North Carolina were involved this year in the summer workshop, which involved two weeks of intensive activities including lectures, analysis of experiments and operating specialized equipment. The teachers first spent one week in their home states participating in activities associated with their state universities and space grant consortia.

The North Carolina teachers spent the first week of the workshop split between NC State and NC A&T where they were exposed to technical demonstrations from NIA affiliated faculty as well as outreach specialists such as the Kenon Institute and the Science House. The technical activities at NCSU included lectures, presentations and demonstrations on the Tumbleweed Competition, Wind Tunnel Testing, Mars art, Life in Space and a space station lecture. The activities at NC A&T included lectures and demonstrations of Composite Materials fabrication and testing, optical microscopy, the Big Bang, Gas Turbine testing and plants in space.

Virginia teachers spent the first week with the Virginia Space Grant Consortium participating in a variety of activities. These included: a one-day program on Astronomy taught by the University of Virginia Astronomy Department and a one-day program on the Mars Mission and Space Exploration which is part of the NASA/JPL Solar System Educator Program. Also included was a one-day session on GPS/GIS in the Classroom from Virginia Tech and the VSGC OVERspace Program; a one-day program on Atmospheric and Earth Science from Hampton University's Center for Atmospheric Sciences; a half-day program on Remote Sensing in the Classroom from Old Dominion University's Center for Coastal Physical Oceanography; and a half-day activity on Student Hands-On Projects taught by Prof. Larry Richards, MAE Dept., University of Virginia.

Student-teacher "ambassadors" at previous Pre-Service Teacher Conference

Both groups then spent the second week of the workshop at NASA LaRC, where NIA and the Office of Education arranged lectures, demonstrations and tours of many of the NASA programs and educational resources. In addition, time was provided for the teachers to develop curricular material that they will be incorporating into their classroom as well as sharing with their colleagues. These teachers gained knowledge about ongoing NASA research, visited the Center's research labs and facilities (including wind tunnels), and were exposed to NASA's vast educational resources. The teachers also spent an afternoon at the Virginia Air and Space Center.

Pre-Service Teacher's Program

This program seeks to improve the pre-service teacher preparation programs in science and mathematics at minority serving institutions, particularly Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (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 confidence and skills to effectively teach mathematics and science using technology.

To achieve these goals, NASA LaRC has turned to NIA and our partners, University of Maryland Eastern Shore and Bennett College, to conduct a National Conference and a Summer Institute. The intent of the Conference is to engage pre-service teachers and their faculty advisors in an intensive training session in mathematics, science and technology enhancement as well as National Education Goals, systemic reform issues and emerging mathematics and science standards.

Center for Distance Learning

The NASA Langley Center for Distance Learning (CDL) was created in 1996 as a learning laboratory with the purpose of developing technology-based, educational programs that are research-, inquiry- and standards-based and use NASA content to enhance and enrich the teaching and learning of science, technology, engineering, and mathematics (STEM) in the elementary, middle, high schools; college and universities; and among adult learners. Five programs were created in response to identifiable "learning needs." They are used in both formal and informal education settings; in rural, suburban and urban learning environments; and are designed to accommodate a variety of learning styles. The programs are continually upgraded, based on input from educational theorists, experimentalists and practitioners, to increase their effectiveness as programs designed to increase student (especially females and minorities) interest, engagement, and understanding of science, technology, engineering, and mathematics.

NIA became a partner with CDL and Virginia Tech to perform the effective application of (1) pedagogy; (2) instructional design; and (3) educational technology to operate, manage, develop, maintain, modify, field-test, evaluate, and diffuse, within the formal and informal education communities, a series of existing, STEM-related distance learning programs. These award-winning programs are:

Outreach

- NASA's Kids Science News Network™
- Noticiencias NASA™
- The NASA SCI Files™
- NASA CONNECT™
- NASA's Destination Tomorrow™

These CDL programs span the education horizon from grades K-12 to adult (lifelong) learners. This suite of STEM-related distance learning programs will constitute the test-bed or platform for all research, development, test and evaluation (RDTE) associated.

The methods and approaches that CDL uses are very applicable to future activities for the in-service and pre-service teachers programs. The CDL approaches are enabling technologies for reaching larger groups of teachers and bringing these programs to the national level.

NIA Supported Student Activities

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. The annual FIRST Robotics Competition program provides students with access to engineering mentors and effective hands-on technology-based education. The Competition's goal is to inspire our next generation of scientists, engineers, researchers and technicians, by exposing them to the excitement of science and engineering while they are in school.

Students give robotics demonstration before the annual FIRST Robotics Competition.

In Virginia, a goal of the FIRST program is to engage high school students from throughout the Commonwealth - particularly from inner city, at-risk schools and rural communities. FIRST strives to promote participation from a diverse population, with emphasis on involving more women and minorities in the program. The FIRST program connects classroom lessons and real-world applications and prepares students for rewarding careers in science, technology, engineering and business. In FY05, NIA supported two FIRST teams in Virginia and one in North Carolina. The Virginia teams were both groups of home-schooled students and the NC team was coordinated through NC A&T.

NIA is also involved with supporting an activity geared towards middle school children, the FIRST Lego League (FLL). In 1992, the FIRST Robotics Competition for high school students was created. Following that success, FIRST and the LEGO Company partnered in 1998 to create the FIRST LEGO League for children ages 9-14. Each year in September, FIRST Lego League International issues a robotic challenge that engages teams of children in hands-on design and research. After eight intense weeks, the FLL season culminates in high-energy, sports-like tournaments. FLL is a worldwide program for children created in a partnership between FIRST and the LEGO Company. NIA supports the FLL through Virginia Tech, which is a State-wide leader in this activity.

The cast of NASA Sci Files' The Tree House Detectives.

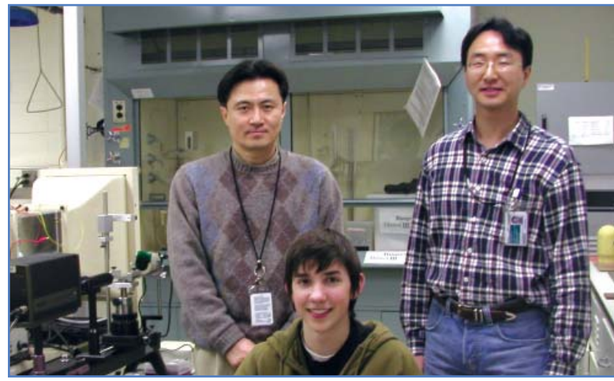
NIA also participates in mentoring high school students from the New Horizon Governor's School. Last year, Dr. Cheol Park and Dr. Jin-Ho Kang mentored Travis Meyer from Bruton High School on the research topic: "Multi-Functional Carbon Nanotube Composites." Students in this program generally come twice a week for 3-4 hours over a period from October to May. In addition, Langley Professor James Hubbard mentored a NASA Summer High School Apprenticeship Program (SHARP) student, Erik Fors on an aircraft RPV project.

Additionally, NIA participates in supporting and mentoring Langley Aerospace Research Summer Scholars (LARSS) Program students. Five outstanding undergraduate students were supported, with four of them doing research in the Advanced Materials and Processing Branch. One student was mentored by Langley Professor Robert Tolson.

NIA Supported Student Conferences

The NIA Outreach Program is involved in supporting 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). This particular workshop brings materials researchers together with the aim of providing materials experiments for undergraduate and high school classes. This year, NEW was held at Arizona State University. NIA sponsors teachers from local high schools to participate in this event as well as undergraduate students from HBCUs.

Students from Ocean Lakes High School touring NASA Langley Research Center.



NIA Researchers Cheol Park and Jin Ho Kang with New Horizon Governor's School mentorship participant, Travis Meyer.

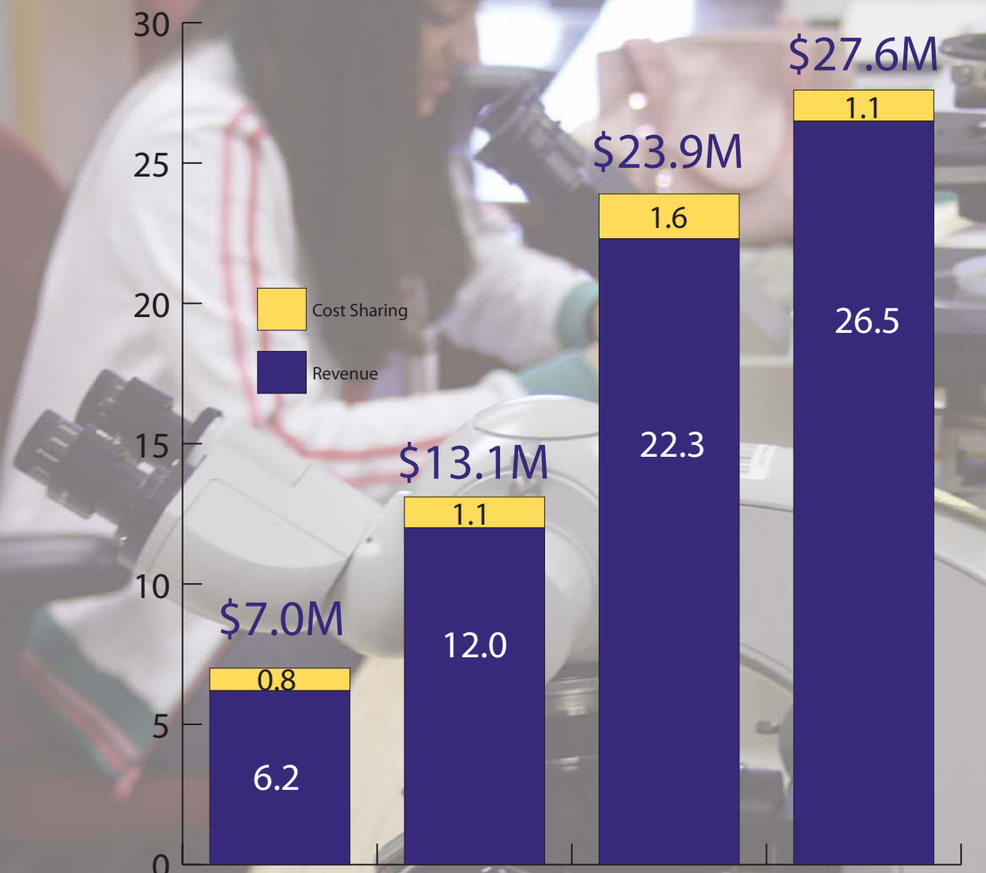
The event is run by Prof. Jim Jacobs of Norfolk State University. NIA plans to continue to support this and other conference activities involving under-represented minority students.

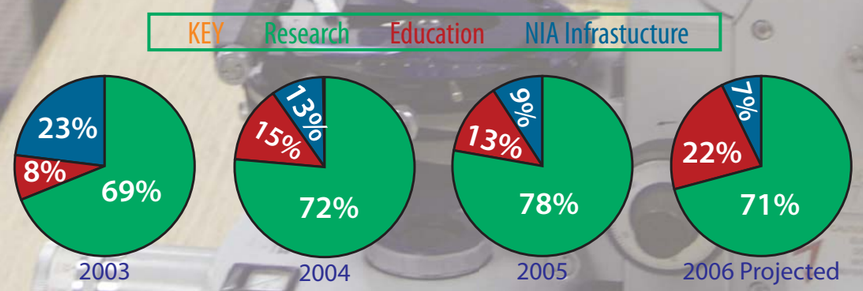
NIA helped sponsor HBCU participation in this event. We also sponsored an undergraduate student design session at the 2005 IEEE Systems & Information Engineering Design Symposium (SEIDS 2005) held at the University of Virginia on April 29, 2005.

Ocean Lakes students tested wing strength during a visit to NASA Langley Research Center.

Financials

Revenue ($M)





Technology Transfer & Commercialization

FY05 NIA Invention Disclosure Reports

Case Number	NIA Researcher	Invention Title
LAR 16958-1	Sang Hyon Chu	Fabrication of Multilayer Ferritin Array for Bionanobattery
LAR 17082-1	Kent Watson	Multifunctional Composites
LAR 17087-1	Daniel Klein	Synthesis of Polymers that Self-Heal upon Bullet Penetration
LAR 17088-1	Cheol Park	Nanotubular Toughening Inclusions for Improved Mechanical Reinforcement
LAR 17112-1	Cheol Park	Multilayer Electroactive Polymer Composite Material
LAR 17126-1	Cheol Park, Kris Wise	A Method for Producing Stable Dispersions of Single Walled Carbon Nanotubes in Polymer Matrices Using Noncovalent Interactions
LAR 17134-1	Sang Hyon Chu	Fabrication of Metallic Hollow Nanoparticles
LAR 17135-1	Sang Hyon Chu	Fabrication of Metal Nanoshells Derived by a Biotemplate
LAR 17169-1	Tian-Bing Xu	Hybrid Force/Stress Amplified Piezoelectric Energy Harvesting Transducer System

NIA Patents Filed in FY05

Case Number	NIA Researcher	Invention Title
LAR 16941-1 filed 8/9/2005	Jong-Yeob Shin	A Robust Attitude Stabilization and Control Method Using Multiple Internal Wheels for VTOL Aircraft during Low Airspeed Operations
LAR 16958-1 filed 3/11/2005	Sang Hyon Chu	Fabrication of Multilayer Ferritin Array for Bionanobattery
LAR 17088-1 filed 7/18/2005	Cheol Park	Nanotubular Toughening Inclusions for Improved Mechanical Reinforcement
LAR 17126-1 filed 5/13/2005	Cheol Park, Kris Wise	A Method for Producing Stable Dispersions of Single Walled Carbon Nanotubes in Polymer Matrices Using Noncovalent Interactions
LAR 17169-1 filed 7/14/2005	Tian-Bing Xu	Hybrid Force/Stress Amplified Piezoelectric Energy Harvesting Transducer System

In FY05, NIA saw the broadening of its technology transfer and commercialization mission. NIA's researcher assets and resources created research results leading to technologies and intellectual properties (IP) that have technology transfer and commercialization value. NIA employees filed nine Invention Disclosure Reports with NASA LaRC, which covered a range of potential commercial applications.

This year, five NIA researchers filed patents on their work, several of which were previously issued invention disclosures. This was a major milestone for the NIA technology transfer and commercialization program.

Anticipating an influx of licensing and royalties, NIA is entering joint licensing arrangements with NASA LaRC and other third parties.

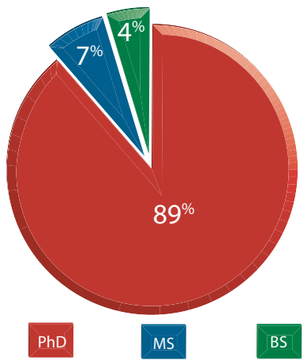
Our People

NIA experienced a 50% increase in personnel from 2004 to 2005. At the end of the fiscal year 2005, NIA had a total of 148 employees, faculty, consultants and students associated with the institution. NIA's full- and part-time regular employees continue to make up about half of the total population. Additionally, NIA's Visitor Program included 34 visitors, and was host to researchers from all over the world.

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 staff scientists produced 152 peer-reviewed publications and conference presentations. They were also the recipient of a wide range of awards and recognitions in 2005.

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

2005 Awards & Recognitions

Dr. Hongyu Liu of NIA received a three-year grant award from NASA Headquarters for the proposal "Constraints from AURA Observations on the Impact of Convection and Lightning on Upper Tropospheric Chemistry." The proposal was submitted to the Science Mission Directorate's Earth-Sun System Division (formerly the Office of Earth Science) in response to NASA Research Announcement (NRA) "Measurements, Modeling, and Analyses in Support of AURA and Other NASA Satellite Observations of the Earth's Atmosphere."

The project is a joint effort between NIA, NASA LaRC, and the University of Wisconsin-Madison (UW). Dr. Liu serves as the project's Principal Investigator. Co-investigators are Dr. James H. Crawford and Dr. R. Bradley Pierce of LaRC, and Professors Matthew H. Hitchman and Gregory J. Tripoli of UW.

Frank Bussink : Letter of Appreciation for outstanding work on the Self Separation and Sequencing (SSS) Flight Experiment essential to the development of the SATS HVO concept.

Yonghoon Choi : NASA Group Achievement Award to the Intercontinental Chemical Transport Experiment – North America Science Team

Sarah-Jane Frankland : Letter of Appreciation from NASA Langley Center Director for ASME/Boeing Best Paper Award

Sarah-Jane Frankland : ASME/Boeing Best Paper Award for G.M. Odegard, S.J. Frankland, M.N. Herzog, T.S. Gates, C.C. Fay, "Constitutive Modeling of Crosslinked Nanotube Materials," AIAA 2004-1606 presented during the AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference, Austin, TX April 20, 2005

Jin-Ho Kang, Kris Wise, Tian-Bing Xu : Certificate of Appreciation for support and dedication as a mentor to Langley Research Center's Office of Communication and Education 2005 summer program participants

Daniel Klein : Letter of Commendation for research contributions in the area of Bioinspired Smart Nanotechnology

Ronald Krueger : Certificate of Appreciation for outstanding effort as Chairman of the Workshop on Computational Fracture Mechanics for Composites held March 2004

Robert Lindberg : NASA Group Achievement Award to the NASA Langley Contractor's Steering Council for Implementation of the Real-time Aerospace Careers Information Program

Robert Lindberg : Elected Fellow of AIAA

Cesar Munoz, Alfons Geser, Frank Bussink : Group Achievement Award to Advance Air Transportation Technologies Project Team for the highly successful research and technology transfer leading to improved operations of the National Aerospace System

Cheol Park, Kristopher Wise : NASA Langley Reid Award, third place (Best Paper Award)

Cheol Park : Elected on a Proposal Review Committee for Center for Nanophase Materials Sciences (CNMS) at Oak Ridge National Laboratory

Cheol Park : NASA Space Act Award for Development of "A Novel Surface Treatment for Titanium Alloys" Co-authors: Sharon E. Lowther (NASA LaRC), and Terry L. St. Clair (NASA LaRC currently NIA)

Cheol Park : NASA Langley Certificate of Recognition for an invention disclosure entitled "Sensing/Actuation Materials Made from Carbon Nanotube Polymer Composites and Methods for Making Same" Co-authors: Zoubeida Ounaies (VCU), Joycelyn Harrison (NASA LaRC), Greg Draughn (NASA LaRC), Nancy Holloway (NASA LaRC)

Cheol Park : NASA Langley Certificate of Recognition for an invention disclosure entitled "Multilayer Electroactive Polymer Composite Material" Co-authors: Zoubeida Ounaies (VCU), Joycelyn Harrison (NASA LaRC), Greg Draughn (NASA LaRC), Nancy Holloway (NASA LaRC)

Cheol Park : Certificate of Recognition for Mentorship of NASA LARSS program

Cheol Park : NASA Langley Space Act Award for Development of Electrospun Electroactive Polymers

Adam Przekop : Awarded Senior Member grade by AIAA

Adam Przekop : AIAA HRS Laurence C. Bement Young Professionals Paper Competition (First Runner-up)

James Ratcliffe : Elected as the membership secretary of the American Society for Testing and Materials subcommittee D30 on Composite Materials

Terry St. Clair : NESC Group Achievement Award for the NESC Liquid Oxygen Bellows Ice Prevention Team

Terry St. Clair : Certificate of Recognition for the creative development of a technological contribution entitled "A Novel Surface Treatment for Titanium Alloys"

Kenneth Sutton : NASA Engineering and Safety Center Group Achievement Team Award for "Independent Technical Assessment Team for the Cassini-Huygens Probe Entry, Descent and Landing"

Kenneth Sutton : NASA Group Achievement Award to the NASA Aerocapture Systems Analysis Team in recognition of outstanding technical achievement and exceptional work in development of high fidelity aerocapture systems analyses for missions to Titan and Neptune

Kent Watson : NASA Space Act Award - Patent Grant for US Patent No. 6,841,562, "Space Environmentally Durable Polyimides and Copolyimides"

Kent Watson : NASA Space Act Award – NASA Tech Brief Publication, "Polyimides from 2,3,3',4' – Biphenyltetracarboxylic Dianhydride and Aromatic Diamines"

Kent Watson : NASA Space Act Award – NASA Tech Brief Publication, "Space Environmentally Durable Polyimides and Copolyimides-II"

Kristopher Wise, Terry St. Clair, Mark James, Ronald Krueger, Tian-Bing Xu : Letter of Appreciation for contribution to the Return-to-Flight from Director and Deputy Director of NASA Langley Research Center

Tian-Bing Xu : Best Poster Paper Award, 12th SPIE International Symposium on Smart Structures and Materials, San Diego, CA

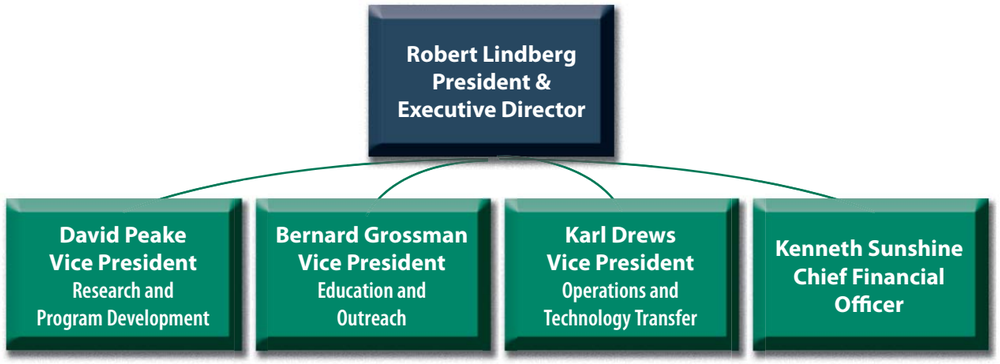
Executive Staff

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, Old Dominion University, The College of William & Mary 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 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 & 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 Ph.D. Eng. degree from the University of Bristol, UK, and a Ph.D. 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

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. Mr. Sunshine 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.

NIA Liaison Professors

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J. Bernard Jones Professor of Mechanical Engineering
Virginia Tech

Professor William Fourney
Chair, Dept. of Aerospace Engineering
University of Maryland

Professor James C. McDaniel
Dept. of Mechanical and Aerospace Engineering
University of Virginia

Professor William Craft
Dept. of Mechanical Engineering
North Carolina A&T State University

Professor Fred DeJarnette
Dept. of Mechanical & Aerospace Engineering
North Carolina State University

Professor Daniel Schrage
School of Aerospace Engineering
Georgia Tech

Dr. Mohammad Karim
Vice President - Research
Old Dominion University

Dr. Len McMaster
AIM Program Deputy
Hampton University

Dr. Dennis M. Manos
CSX Professor of Physics & Applied Science
The College of William and Mary

NIA Technical Advisory Committee *(left to right): Fred DeJarnette, William Fourney, Daniel Schrage, Walter O'Brien, William Craft, Klaus Dannenberg (AIAA, 2006), and James McDaniel. Missing from photo: Mohammad Karim, Len McMaster, and Dennis Manos.*

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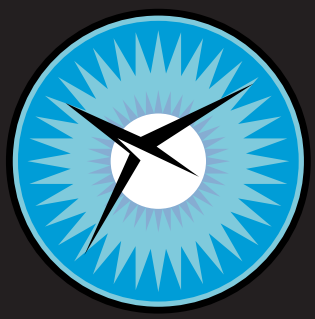
* Resigned from Strategic Advisory Board in 2005



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