

# NIA

NATIONAL  
INSTITUTE OF  
AEROSPACE



## 2010 ANNUAL REPORT

CUTTING-EDGE RESEARCH, INNOVATIVE TECHNOLOGY DEVELOPMENT AND EXTRAORDINARY EDUCATION





# Leadership and President's Message

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## Table of Contents

Leadership .....	1
President's Message .....	2
Research .....	3
Publications .....	8
Visitors @ NIA .....	11
Graduate Education .....	13
Outreach .....	16
Financials .....	21

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*Dr. Robert E. Lindberg, Jr.*

For the U.S. aerospace community, 2010 might be best remembered as a year of uncertainty. A dominant theme for the year was the future direction of the National Aeronautics and Space Administration. In February, President Obama unveiled a new plan for NASA, proposing a \$6 billion budget increase over five years, cancellation of the Constellation program, increased support for commercial spaceflight, new funding for 'green' aviation, and significant new investments in technologies to enable future human and robotic exploration of the solar system. To say that Congress did not fully embrace the plan would be an understatement. NASA's fiscal year 2010 appropriation from Congress signed by the President required a continuation of the Constellation program through at least September. Now, as we begin 2011, NASA is under a continuing resolution that holds their budget at FY10 levels with no reconciliation yet of the profound differences between the two houses of Congress and the White House.

With this backdrop, 2010 has been a year of firsts, new milestones and remarkable accomplishments at the National Institute of Aerospace. We welcomed two new faculty members to NIA, Prof. William Edmonson and Prof. William (Bill) Moore.

In January, Prof. Moore joined the Atmospheric and Planetary Sciences Department at Hampton University as H.U. Professor in Residence at NIA, a new position that is jointly supported by H.U. and the NIA Foundation. Formerly a member of the prestigious Institute of Geophysics and Planetary Physics at UCLA, Prof. Moore is an expert in the geodynamics of solid planetary bodies. Now at NIA, Prof. Moore is establishing a new research center in planetary dynamics.

In July, Prof. Edmonson joined the North Carolina A&T State University Department of Electrical and Computer Engineering as Langley Professor. Prof. Edmonson brings to NIA an exciting new research initiative in reliable autonomic satellite systems design. He joins A&T from North Carolina State University and serves as the co-PI for the NSF-supported Advanced Space Technologies Research and Engineering Center.

In August, NIA's first Fulbright Scholar, Dr. Elena Kukavskaya of the Russian Academy of Sciences arrived for a year-long collaboration with our own Dr. Amber Soja and members of NASA Langley's Science Directorate. Dr. Kukavskaya's research on the effects of biomass burning (e.g., forest fires) on our climate is featured on the cover of this Annual Report. The photo is of Dr. Kukavskaya participating in a fire experiment in the Angara region of Krasnoyarsk, Siberia, in 2007.

In partnership with NextGen AeroSciences (NextAero), NIA was awarded funding to perform research in support of NASA's Airspace Program. The project, which is funded through the American Recovery and Reinvestment Act, will lay the foundations for automation tools that will offer a new approach to managing the increasing autonomy of aircraft with the changing roles of pilots, controllers, and dispatchers. The result will be a reduction in delays, fuel consumption and air traffic.

NIA's international collaborations continued to expand in 2010, with more than thirty international visiting scholars and students in residence at NIA. We continued our collaboration with the Technical University of Delft (the Netherlands), hosting several graduate students for international internships in connection with their masters degree studies. Our partnership with the German Aerospace Center DLR expanded with an exchange of scholars. Carsten Schwarz of DLR spent the fall semester at NIA contributing to our wake turbulence research for the FAA, and our own Dr. Boris Diskin traveled to DLR in Braunschweig, Germany to contribute to a DLR research project at Center for Computer Applications in AeroSpace Science and Engineering at Braunschweig to help develop improved discretization methods.



*Dr. Elena Kukavskaya*

With 16 professors in residence at NIA, our graduate program offerings continued to expand in 2010. Our member universities conferred 20 graduate degrees in 2010 including seven Ph.D.s; both figures are records for NIA.

Our outstanding educational outreach team initiated two exciting new programs this year. NASA y Tú (NASA and You) is a collaborative effort between NASA and Univision to engage Hispanic students in STEM topics. RASC-AL Robo-Ops is a new NASA design competition for engineering undergraduates that builds on the very successful RASC-AL design competition that NIA has supported for several years.

Our public outreach team established a new partnership in 2010 with NASA Headquarters Office of the Chief Information Officer. The NIA Foundation managed sponsors and exhibits for the first-ever NASA IT Summit, working with more than 20 industry and professional society partners. Visionaries, entrepreneurs and technologists explored the future of aviation at NASA Langley's "Aviation Unleashed," a three-day forum held at the Hampton Convention Center with technical support from NIA.

NIA continued to garner its share of awards and accolades in 2010. Among the notable awards for research, Dr. Godfrey Sauti (and co-authors) received NASA Langley's prestigious H.J.E. Reid Award. Media specialists Tom Shortridge and Scott Bednar shared a regional Emmy award for their production of the educational video series "NASA Launchpad" and Harla Sherwood earned a national Webby Award for development of the popular NASA website "NASA City and at Home."

Working closely with Virginia Tech, the City of Hampton and the Hampton Technology Incubator, we completed the design of NIA's new research laboratories building. Together with Old Dominion University, NIA salvaged the 1/15<sup>th</sup> scale model of the venerable Langley Full Scale Tunnel and plan to install it in our new research lab in 2012.

In 2010, we bade farewell to three board members – Mel Bernstein, Gary Schuster and Alton Thompson – and welcomed three new members – Linda Adams, Norma Allewell and Steve Cross. The board approved the establishment of three new at-large board positions that we expect to fill in 2011 to expand our board's expertise in aerospace research and development, non-profit research administration and finance.

In times of uncertainty, it becomes essential to adhere to the organization's vision and mission. In 2010, through our core capabilities in research, graduate education and outreach, NIA successfully focused on strategic alignment with NASA Langley Research Center, collaboration with our member universities, and the development of a globally competitive 21st century aerospace workforce.

## Computational Fluid Dynamics

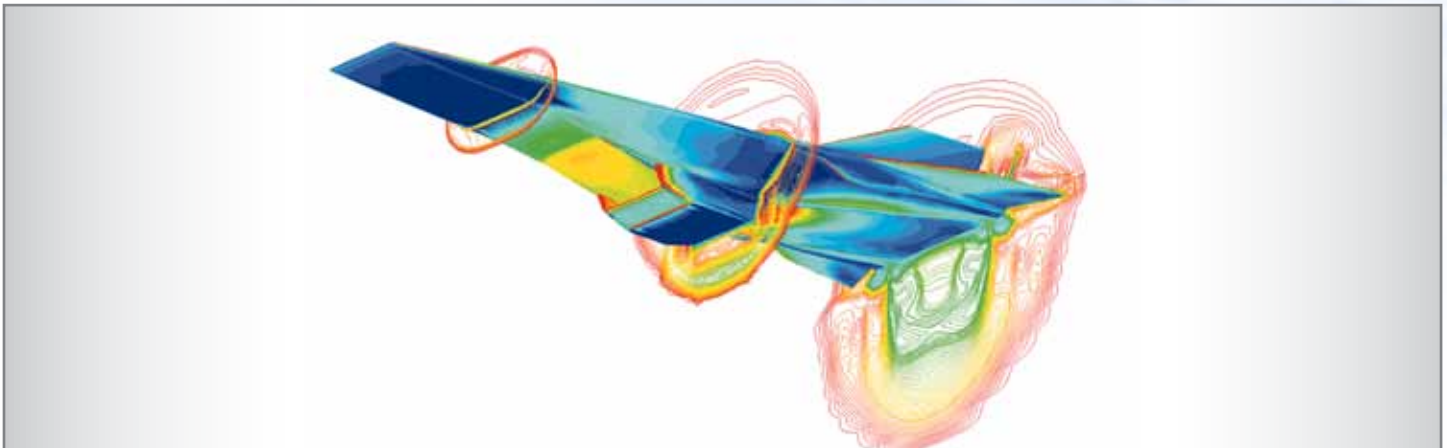
In recent years, NIA has developed a close collaboration with The German Aerospace Center (DLR), in the area of computational fluid dynamics (CFD). The NIA predecessor, ICASE, was known for its fundamental contributions to the theory and practice of CFD. Continuing this tradition of excellence, NIA has been involved in CFD research from its inception. In recent years, Dr. Boris Diskin, NIA Associate Fellow, has conducted collaborative research with NASA LaRC and North Carolina A&T State University on computational methods for analysis and optimization of unsteady turbulent flows.



*Dr. Boris Diskin*

In November 2009, Dr. Diskin was invited to visit The Institute of Aerodynamics and Flow Technology (IAS) of DLR. There he delivered three lectures on various aspects of discretization methods used in practical large-scale CFD computations. DLR was studying new discretization capabilities for implementation in the unstructured CFD code, TAU that was developed at DLR and is widely used in European industry and academia. The results presented by Dr. Diskin indicated certain ways to improve quality of discretization schemes.

DLR also invited Dr. Diskin to spend four weeks at Center for Computer Applications in AeroSpace Science and Engineering (C<sup>2</sup>A<sup>2</sup>S<sup>2</sup>E) at Braunschweig, Germany to participate in the efforts on developing the improved discretization methods. Dr. Diskin visited C<sup>2</sup>A<sup>2</sup>S<sup>2</sup>E in May/June 2010 where he collaborated with Dr. Axel Schwöppe. The successful collaboration led to breakthrough developments that dramatically improved accuracy and robustness of large-scale turbulent-flow solutions. The results of these efforts were reported at the STAB-Symposium in Berlin in November 2010 and in a paper submitted for publication in the series "Notes on Numerical Fluid Mechanics and Multidisciplinary Design" published by Springer.



Another idea generated during the first visit was to create a collaborative research initiative between DLR and NIA in a broadly defined area of Aeronautics and Space. In June 2010 Prof. Robert Lindberg, NIA President, met with Prof. Cord Rossow, Head of IAS, at Berlin Air Show and signed a letter of intent establishing the collaborative initiative. Through this initiative, DLR and NIA intend to form expert research teams for rapid advancements in areas of high importance, to encourage exchange of the research personnel. This will promote involvement of Ph.D. students in the cutting-edge research performed at DLR, NIA and their affiliated institutions. At the initial stage, the parties agreed to link four Ph.D. positions (two at C<sup>2</sup>A<sup>2</sup>S<sup>2</sup>E and two at NIA) to this initiative and to focus research on fundamental aspects of unsteady flow simulations.



## Boron Nitride Nanotube Research

NIA's research staff, led by Drs. Cheol.Park, Jin-Ho Kang and Godfrey Sauti, continued its work with NASA Langley Research Center (LaRC) scientists to develop new ways to make the most of boron nitride nano tubes (BNNT) for aerospace applications. BNNT properties of interest include their large strength-to-weight ratio, chemical stability to beyond 900°C, neutron and UV radiation resistance and non-toxicity. Research on the jointly developed laser-based, high pressure growth technique led to increased growth rates and techniques for incorporating carbon into the nano tube structure. The resulting BCN material is important because it allows the normally white nano tubes to take on other colors - thus extending their usefulness for inks and cloth.

## Center for Planetary Dynamics Established

Dr. William B. Moore, Hampton University Professor in Residence, joined NIA in 2010 and initiated the Center for Planetary Dynamics. The center's two research thrusts are planetary exploration and planetary dynamical modeling. Three graduate students were recruited and joined HU and NIA in the fall of 2010. Together with Prof. Weimer of Virginia Tech and NIA, Dr. Moore and his students are pursuing modeling research into the response of the Earth's magnetosphere to external forcing, the thermal history of the Moon and early Earth, and the evolution of Venus' atmosphere and interior. Dr. Moore also leads a team to develop a proposal for the Tidal Recovery, Atmospheric and Surface Experiment (TRASE), a lidar instrument to be flown on NASA's Jupiter Europa Orbiter. In collaboration with Prof. Webb of LSU, a research project modeling the formation of the Himalayas began. Further funding is being sought for the project.



Dr. William B. Moore

## Solar Energy and Sensors Research

Prof. Mool Gupta, a Langley Professor from the University of Virginia at NIA, is carrying out research in the area of solar energy and sensors for NASA needs. One of his graduate students, Devin Pugh Thomas is working at the LaRC in the area of quantum dot-based high temperature fluorescence sensors. Another graduate student, Duncan McGillivray, is working at LaRC in the area of high resolution sensors using metamaterials. Three graduate students (Ankit Shah, Craig Ungaro and Dennis Waldron) are working in the area of solar energy. Shah is looking at increasing efficiency of solar thermal systems by efficient light capture and minimization of heat loss. Ungaro and Waldron are working on the use of quantum dots for making efficient solar concentrators. All these students have a NASA researcher as a mentor and all are addressing one of the LaRC Revolutionary Technical Challenges. Prof. Gupta, the LaRC mentors and the team of graduate students have published several joint research papers and are addressing the future technology needs of NASA in the area of energy and sensors



Prof. Mool Gupta

### Selected Honors and Awards

Dr. Godfrey Sauti and Dr. Kenneth Sutton were recipients of NASA Langley's prestigious Henry J.E. Reid Award. Dr. Sauti was a first place winner for his paper entitled "Aligned-Single Wall Carbon Nanotube Polymer Composites Using an Electrical Field." Dr. Sutton won third place for his paper "Non-Boltzmann Modeling for Air Shock-Layer Radiation at Lunar-Return Conditions."

# Research

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## FAA NextGen Human Factors Research

As forecasted in the 2009 Annual Report, NIA's relationship with the FAA continued to develop in 2010. Within the multi-year Other Transactions Agreement (OTA), NIA currently has nine ongoing tasks with three completed and additional work forthcoming. Tasks such as "Flight Crew Training for NextGen Automation", "Technical Operations Work Integrated Environment", and "NextGen Stakeholder Equipage Impact Model" represent a sample of the valuable human factors research and studies that NIA is pursuing for the FAA. These and other studies are critical to the FAA's effective and safe ushering in of their all-encompassing NextGen program. NextGen addresses aviation challenges of the future and defines new paradigms that will require the full use of existing and new technologies, especially with regards to human factors. Under the OTA, NIA is providing essential research, studies and solutions to help the FAA meet the requirements of NextGen and the fundamental changes that will have profound effects in the cockpit and air traffic control centers while benefiting the customers and stakeholders.



In this enterprise, NIA has the advantage of drawing on the expertise of highly skilled professionals in the fields of commercial, corporate and general aviation as well as the FAA's Air Traffic Control administrators. NIA's associations include the FAA's Aviation Safety and Technical Center offices, numerous cutting-edge companies and individual subject matter experts in the relevant fields of study, and universities including Virginia Tech and Ohio State. As the FAA deploys NextGen and its new operational concepts and technologies related to human factors, NIA is positioned to assist the FAA in exceeding its future goals.

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## FAA Wake Vortex Research



NIA's Wake Vortex activities support the FAA in planning, conducting and coordinating leading-edge research into aircraft wake turbulence in support of NextGen objectives. The research is focused on the characterization of wake physics, wake turbulence impacts on the National Airspace System, assessment wake turbulence impacts on aircraft, and support for national and global wake mitigation activities. NIA is working with AeroTech Research, Inc. to develop techniques to detect and assess the severity of wake encounters using typical aircraft state parameters. NIA is also working with Georgia Tech and applying state-of-the-art wake vortex models under development by NASA to develop recommendations to the FAA and RTCA for required resolutions in transmitted aircraft-derived weather data for potential dynamic wake separations.

Other NIA activities include supporting development by the FAA and EUROCONTROL of new air traffic control wake mitigation standards which, if approved by ICAO, will be used globally by air navigation service providers. NIA research also encompasses analysis of wake data and wake model results for use by the FAA in setting wake separation standards for new aircraft entering operational service. Additionally, NIA supports and participates in planning and coordinating of national and international wake mitigation research activities and wake-specific airspace procedure/process developments on behalf of the FAA.

## NIA Research Lab



Design of NIA's new laboratory building is complete. Several rounds of value engineering have aligned the design with the available funding while preserving the original plan for flexible research laboratory space and a new home of the Hampton Technology Incubator. A 1/15<sup>th</sup> scale model of NASA Langley's recently retired Full Scale Wind Tunnel will be among the first experimental facilities to move into the building. This tunnel offers approximately a 2' x 4' test section and wind speeds up to 120 miles per hour. It is an excellent teaching tool for our graduate students and for research on low speed Unmanned Aerial Vehicles (UAVs). Preparations are underway for clearing the construction site. The Virginia Native Plant Society surveyed the site and removed some 450 plants ahead of the earth movers. Many of these will be transplanted back into the building's final landscaping scheme which is designed for water conservation with drought-tolerant plants. The building is designed to LEED Silver standards and will feature as much natural landscaping as possible.

## Reflections from Dr. Robert H. Tolson

*Langley Professor in Planetary Atmospheric and Flight Sciences, North Carolina State University (NCSU)*

Little did I know that President Bush's "Vision for Space Exploration" in February, 2004 would be my first step to becoming the Langley Professor from North Carolina State University (NCSU). That announcement sparked the NASA centers into planning their roles in the new direction. The LaRC upper management planned a retreat in Williamsburg to define the path forward.

I submitted a one page white paper for the retreat outlining the obvious unique capabilities at LaRC that were needed for landing a man on Mars, in particular, the entry, descent and landing (EDL) expertise that LaRC had demonstrated on every Mars landing. LaRC also had expertise in atmospheric science and sensors, both necessary to improve our knowledge of the Martian atmosphere. A unique "one-stop-shopping" capability in Planetary Atmospheric Flight Systems (PAFS) could be built around this existing expertise. Increasing detail to the PAFS program developed through the spring and summer with the numerous planning team activities and with the help of some LaRC colleagues.

In September, I outlined the PAFS program to Fred DeJarnette, the NIA Liaison Professor from NCSU. Fred asked if I would like to propose parts of that program as a basis for the NCSU Langley Professor opportunity. In October, I proposed five specific goals to the Chairs of the MAE and MEAS departments and their Deans at NCSU. After their approval,



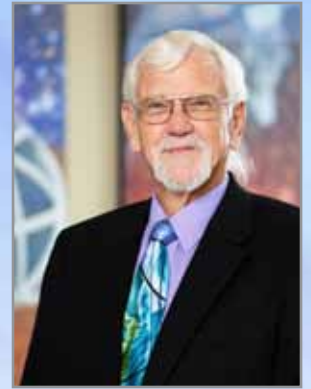
# Research

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(Continued from page 6.)

I presented the same program to Dr. Lelia Vann and Steve Sandford at LaRC in October 2004. Everyone agreed with the program, so in January 2005, I became the Langley Professor from NCSU, and the Center for Planetary Atmospheric Flight Sciences (CPAFS) was established at the NIA. Having the resources to implement a program that would supplement existing LaRC capabilities was a very exciting opportunity.

One of the goals of the program was to develop a “whole” Mars global circulation model, i.e. the first model of the neutral atmosphere from the surface to the exosphere. The model could provide model results for both aerobraking and EDL missions. A subgrant to Prof. Steve Bougher (UMich) was used to hire Dr. Steve Nelli as a post-doc to work at UMich for two years to develop the thermospheric part of the model. Nelly was a 2005 graduate from Prof. Jim Murphy’s (NMSU) program and had considerable experience with the Ames Mars GCM. In return, UMich would provide NIA and NASA Langley with access to the new model to perform climate studies for Mars and we hoped to hire Nelli at the completion of this work. The model would also provide boundary conditions for a Mars meso-scale model, another goal of the program.



Prof. Robert H. Tolson

A mesoscale model is necessary to predict the weather in the vicinity of landing sites with horizontal spatial resolution of a few kilometers. This effort was supported by subgrants to the faculty and students in both the MEAS and MAE departments at NCSU. We had a couple of false starts here, but eventually selected the NCAR Weather and Research Forecasting (WRF) model as the basis for Mars WRF. About the time we had the Earth version converted to Mars, a global Mars version was also developed by NCAR. Combining these two models was a relatively straight forward task and was completed in 2010. Being a derivative of Earth WRF meant that all the data assimilation capabilities are inherently available and the dynamic core and assimilation code would be updated and maintained by the NCAR WRF community. Having a data assimilation capability was also one of the original goals.

One of the final two goals was to develop the ability to quantify the uncertainties in the output of mesoscale models. Mesoscale models solve the energy, momentum and mass balance equations like most CFD programs. Likewise, there are modeling assumptions that must be made to represent most of the physics. For example, radiative properties of dust, thermal properties of the surface, dust vertical distribution, etc. are all parameterized. Many of these parameterizations are based on limited amounts of observational data. It is therefore important to know the uncertainty in the predicted density, temperature and winds based on uncertainties in these parameters. A grant to Prof. Bob Walters (VT) was initiated to study this problem. Bob had performed research on CFD uncertainty quantification and gave the problem to a Ph.D. candidate, Michael Balch. His research, which focused on the uncertainty in the dust distribution profile, was completed in 2009. This research not only answered the uncertainty question, but also demonstrated the benefit of new uncertainty quantification methods beyond the usual probabilistic approach.

Mesoscale models generate enormous amounts of data on grids that are of higher resolution than required for EDL trajectory simulations. The final research goal was to develop methods to interface the mesoscale output with the EDL simulation programs. This research was completed in 2010 by Jamie Wilson, a NCSU MS student. The method she developed is based on principal component analysis and provides the analyst with a spectrum of accuracy. By keeping all the principal components, the results agree exactly with the mesoscale results. However, a less accurate representation can be obtained by only maintaining a subset of the components. The accuracy of the representation can be selected in engineering units. For example, the components to reproduce the winds with 1 m/s accuracy can be selected automatically.

By the fall of 2010, all the goals proposed in the original, multi-university plan had been accomplished and I felt it was time to step aside and give someone else the extraordinary opportunity to contribute to LaRC and the Langley Professor program.



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# Visitors @ NIA

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NIA's Visitor Program facilitates research collaborations between scientists and engineers at NIA, the NASA Langley Research Center, and researchers, faculty and graduate students from other institutions. The typical visit is for a semester or summer, but longer or shorter durations are easily accommodated. NIA supports this program with concierge services to assist with securing local lodging, visas for our international guests, and access badges for the NASA Langley Research Center. Participants usually conclude their stay with a seminar at NIA for our resident faculty, research staff, students and researchers from the NASA Langley Research Center.

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## Visiting Scholars:

### **Mauricio Ayala-Rincon**

*University of Brasilia; Automatic Proof of Program Termination in Prototype Verification System*

### **Michael Baginski**

*Auburn University; ADS-B Radar Field Test Results Analysis*

### **Josef Ballman**

*RWTH Aachen University, Germany; HIRENASD Research Seminar*

### **Geoff Brian**

*Defence Science and Technology Organisation, Australia; Aircraft Modeling*

### **Hector Cadavid-Rengifo**

*Colombia School of Engineering; Space Autonomy for In-Space Operations*

### **Gianfranco Ciardo**

*University of California, Riverside; Formal Verification and Automated Testing for Diagnostic and Monitoring Systems Using Hybrid Abstraction*

### **Taro Imamura**

*University of Tokyo; Airframe Noise*

### **Romain Jobredeaux**

*Georgia Tech; Verification and Certification of Safety Critical Systems*

### **Craig Johansen**

*Queen's University; Development of Laser Vased Measurement Techniques for Hypersonic Flows*

### **Elena Kukavskaya**

*Russian Academy of Sciences; Siberian Biomass Burning Emissions Estimates*

### **Young-Ju Lee**

*Rutger's University; Systematic Upscaling of Turbulent Flows*

### **Xiaomei Lu**

*Beihang University China; Building Climate Record Using CALIPSO Data*

### **Matthew Lythgoe**

*Newport News Public Schools; Aeroelastic Rotor Experimental System Data Acquisition System Development*

### **Humberto Araujo Machado**

*Rio de Janeiro University; Improved Gas Conduction Modeling in Insulations*

### **Richard Morgan**

*University of Queensland; Uncertainty Qualifications in Impulse Facilities*

### **Jan Nordstroem**

*Uppsala University; Preservation of Discretely Conservative Finite Volume Schemes when using High-order Methods*

### **Adrian Orifici**

*Royal Melbourne Institute of Technology; Benchmarking Delamination Propagation & Growth Capabilities in Commercial Finite Element Codes*

### **Parag Patre**

*NASA Postdoc Program; Adaptive Control Methods for Uncertain Systems Under Anomaly*

### **Carsten Schwarz**

*DLR; Wake Vortex Encounters and Mitigation Techniques*

### **Michael Smart**

*University of Queensland; Design System for Three-Dimensional Inlet Compression Systems*

### **David Spencer**

*Georgia Tech; Tracing of Chemical Distributions in the Coastal Oceans Utilizing Collaborative Observations from Remote Sensing and In-Site Assets*



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## Visiting Students:

### **Eric Avadikian**

*University of Maryland; Ornithopter Development*

### **Massimiliano Bogge**

*Politecnico di Torino, Italy; Structural Mechanics Testing & Test Method Development*

### **Chase Brown**

*Georgia Tech; Reliability and Robustness for Earth-to-Orbit Launch Vehicles*

### **Erwin Dekens**

*Delft Univeristy of Technology; Small Spacecraft Systems Design*

### **Austen Duffy**

*Florida State University; Transition Modeling & Assessment of Laminar Flow Control Techniques*

### **Inga Jensen**

*Delft Univeristy of Technology; Polymer materials for Space Applications*

### **Romain Jobredeaux**

*Georgia Tech; Verification & Certification of Safety Critical Systems*

### **Benedikt Kriegesmann**

*Leibniz University, Hannover Germany; Buckling Processes of Cylindrical Shells under Axial Loading*

### **Jiming Li**

*Stevens Institute of Technology; Development of Innovative Lidar Remote Sensing Techniques for Cloud Microphysics Retrieval*

### **Whitney Lohmeyer**

*Georgia Tech; Advanced Space Architecture Planning & Systems*

### **Marco Maspoli**

*Politecnico di Torino, Italy; Structural Mechanics Testing & Test Method Development*

### **Megumi Matsutani**

*Massachusetts Institute of Technology; Adaptive Control Technology for Safe High-Performance Aircraft*

### **Robin Clement Vincent Morisset**

*Ecole Normale Supérieure de Paris, France; Implementing Copilot: A Monitoring Framework for Embedded Systems*

### **Sebastian Niller**

*Technische Universität Ilmenau, Germany; Implementing Copilot: A Monitoring Framework for Embedded Systems*

### **Yeisson Oviedo-Florez**

*University of the Andes; Prototype Verification System - Java Code Research*

### **Maria Elisa Palena**

*Politecnico di Torino, Italy; Structural Mechanics Testing & Test Method Development*

### **Bruno Filipe Rocha**

*University of Victoria, Canada; Incorporating Aeroelasticity into Aircraft Design*

### **Joana da Rocha**

*University of Victoria, Canada; Boundary Layer Coupling to Aircraft Fuselage Panels*

### **Camilo Rocha-Nino**

*University of Illinois – Urbana – Champaign; Software Verification Algorithms*

### **Pierre Roux**

*ENS Lyon, France; Formal Verification & Automated Testing for Diagnostic & Monitoring Systems Using Hybrid Abstraction*

### **Riccardo Vescovini**

*Politecnico di Milano, Italy; Structural Mechanics*

### **Vivek Vittaldev**

*Delft Univeristy of Technology; 3D Mapping of Planetary Environments*

### **Ryan Walker**

*Fullsail University; Multi-Attribute Task Battery (MATB) Modernizing*

### **Leng Wei**

*Rutger's University; Systematic Upscaling of Turbulent Flows*

### **Yiquiang Zhang**

*Sun Yat-ern University, China; Vertical Distribution & Sources of Tropospheric Ozone over South China in 2004*

### **Yang Zhao**

*University of California, Riverside; Formal Verification & Automated Testing for Diagnostic & Monitoring Systems Using Hybrid Abstraction*

# Graduate Education

In 2010 NIA continued our robust graduate program, with 64 full-time graduate students in the spring semester and 55 full-time graduate students in the fall semester 2010. Of the 55 students in the fall semester, 29 were Ph.D. candidates. In addition to the full-time graduate students, we had 37 part-time graduate students in the program.

## GRADUATES:



### Michael Balch

University/Date: Virginia Tech, December 2010  
Degree/Advisor: Ph.D., AOE, Dr. Robert Walters,  
Dr. Robert Tolson  
Present Position: Applied Biomathematics, Setauket, NY



### Alexander Brown

University/Date: University of Maryland, December 2010  
Degree/Advisor: M.S., Aerospace Engineering, Dr. James Hubbard  
Thesis Title: "Investigation of Spacing and Phasing on Synthetic Jet Actuator Arrays"  
Present Position: Ph.D. candidate at NIA with the University of Maryland



### Scott Ciampa

University/Date: University of Virginia, August 2010  
Degree/Advisor: M.S. Mechanical Engineering, Dr. Robert Lindberg  
Thesis Topic: "Back-Drive Torque Analysis for Motor Wear Monitoring"  
NASA Mentor: Tony Tyler  
Present Position: Knolls Atomic Power Laboratories, Saratoga Springs, NY



### Eric Compher

University/Date: University of Virginia, May 2010  
Degree/Advisor: M.S. in Electrical Engineering/SEAS, Dr. Mool Gupta  
Thesis Topic: "Ambient Light Powered Sensors for Space Applications"  
NASA Mentor: Cy Wilson  
Present Position: Bettis Atomic Power Laboratory, Pittsburgh, PA



### John A. Dec

University/Date: Georgia Tech, May 2010  
Degree/Advisor: Ph.D., Aerospace Engineering, Dr. Alan Wilhite  
Thesis Title: "Three Dimensional Finite Ablative Thermal Response Analysis Applied to Heatshield Penetration Design"  
Present Position: Structural & Thermal Systems Branch, NASA Langley Research Center



### Artem Dyakonov

University/Date: North Carolina State University, December 2010  
Degree/Advisor: Ph.D., Aerospace Engineering, Dr. Fred R. DeJarnette  
Thesis Title: "Effect of RCS Thruster Plumes on Entry Capsule Aerodynamics and Aeroheating"  
Present Position: NASA Ames Research Center



### Michael Grimes

University/Date: Georgia Tech, August 2010  
Degree/Advisor: M.S., Aerospace Engineering, Dr. Alan Wilhite  
NASA Mentor: Bill Doggett



### Kevin Hollingsworth

University/Date: Virginia Tech, May 2010  
Degree/Advisor: M.S. in Aerospace Engineering, Dr. Bernard Grossman  
Present Position: Aerospace Computing Inc., NASA LaRC



### Steven Kelley

University/Date: Georgia Tech, May 2010  
Degree/Advisor: M.S. in Aerospace Engineering, Dr. Alan Wilhite  
Thesis Title: "Design and Implementation of a 3-Dimensional Laser Scanning System"  
NASA Mentor: Jeff Antol



### Jasper Lewis

University/Date: Hampton University, May 2010  
Degree/Advisor: Ph.D. in Atmospheric and Planetary Sciences  
Thesis Title: "Regional Aerosol Transport Study"  
NASA Mentor: Lelia Vann



### Rafael Lugo

University/Date: North Carolina State University, August 2010  
Degree/Advisor: M.S., Aerospace Engineering, Dr. Andre Mazzoleni  
Thesis Topic: "CEV Aeroballistic Re-entry Dynamics"  
NASA Mentor: Mark Schoenenberger



# Graduate Education



## Eric Lundgren

University/Date: Virginia Tech, February 2010  
Degree/Advisor: M.S. in Aerospace Engineering, Dr. Rakesh Kapania  
Thesis Title: "Durable Joining Technology for NASA's Ares V Launch Vehicle"  
NASA Mentor: Dr. Stanley St. Clair Smeltzer, III  
Present Position: Structural Mechanics and Concepts Branch, NASA LaRC



## David Masse

University/Date: Georgia Tech, June 2010  
Degree/Advisor: M.S. Aerospace Engineering, Dr. Alan Wilhite  
NASA Mentor: John Martin  
Present Position: Ph.D. candidate at NIA with Georgia Tech



## Andrew Maxwell

University/Date: Georgia Tech, June 2010  
Degree/Advisor: M.S. Aerospace Engineering, Dr. Alan Wilhite  
NASA Mentor: Daniel Mazanek  
Present Position: Ph.D. candidate at NIA with Georgia Tech



## John "Ryan" Somero

University/Date: Virginia Tech, August 2010  
Degree/Advisor: MS/AE, Dr. Bernard Grossman  
Thesis Topic: "Computational Simulations of an Ellipsoidal Model Utilizing RANS"  
Future Plans: Continued employment at Northrup Grumman Shipbuilding, Newport News, VA



## Taylor Spalt

University/Date: Virginia Tech, August 2010  
Degree/Advisor: M.S., Mechanical Engineering, Dr. Christopher Fuller  
Thesis Topic: "Background Noise Reduction in Wind Tunnels using Adaptive Noise Cancellation and Cepstral Echo Removal Techniques for Microphone Array Applications"  
NASA Mentor: Tom Brooks  
Present Position: Ph.D. candidate at NIA with Virginia Tech



## Chen-Nan Sun

University/Date: University of Virginia, August 2010  
Degree/Advisor: Ph.D., Electrical Engineering, Dr. Mool Gupta  
Thesis Title: "Laser Sintering of Ultra High Temperature Materials"



## Ligu (Luke) Weng

University/Date: North Carolina A&T, May 2010  
Degree/Advisor: Ph.D. May 2010, Prof. Gary Leppy; M.S. August 2006 in Electrical Engineering, Prof. David Song  
Thesis Topic: Immunology-Inspired Fault Identification and Swarm Coordination



## Aimy Wissa

University/Date: University of Maryland, December 2010  
Degree/Advisor: M.S., Aerospace Engineering, Dr. James Hubbard  
Thesis Title: "Passively Morphing Ornithopter Wings"  
Present Position: Ph.D. candidate at NIA with the University of Maryland



## Ran Zhang

University/Date: North Carolina A&T State University, July 2010  
Degree/Advisor: Ph.D., July 2010, Dr. Marwan Biddash; M.S., July 2006, Dr. David Song, Electrical Engineering  
Thesis Title: "Nonlinear Intelligent Control of Space Vehicles"



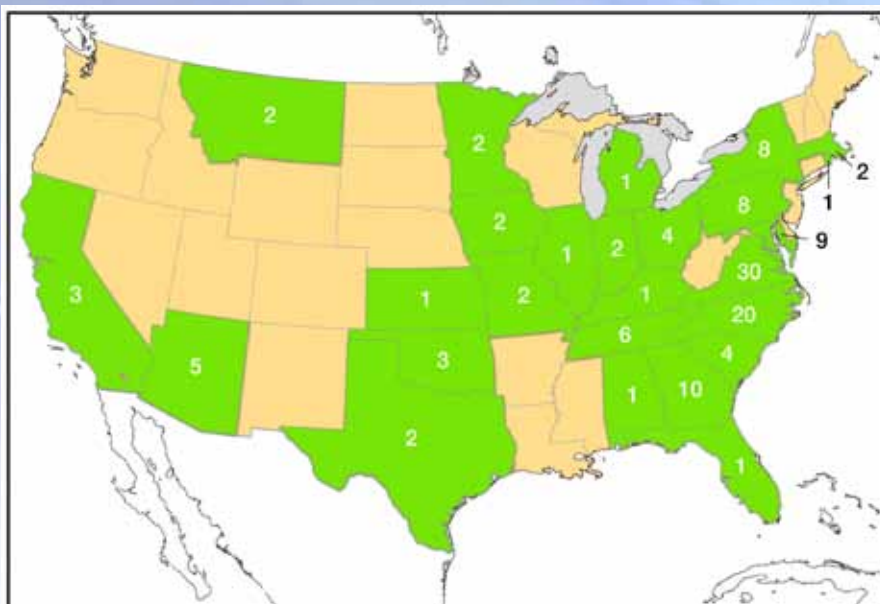
## Martin L. Drews Scholarship

The 2010 Martin L. Drews Scholarship has been awarded to Mr. Eric Faierson, a Virginia Tech Ph.D. candidate studying at the National Institute of Aerospace.

# Graduate Education

## Geographic Diversity of NIA Graduate Students 2010

NIA students have been recruited from...



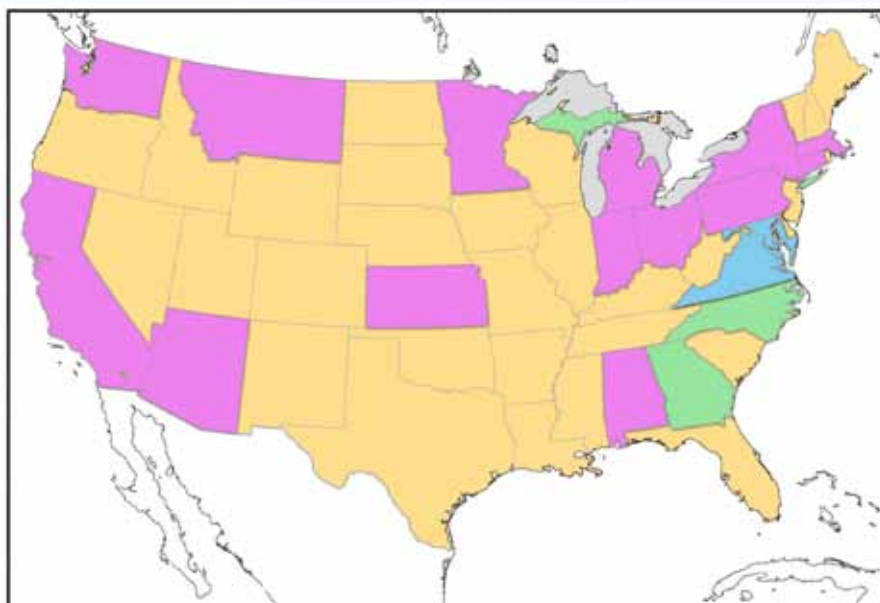
### United States

- Alabama 1
- Arizona 5
- California 3
- Florida 1
- Georgia 10
- Iowa 2
- Illinois 1
- Indiana 2
- Kentucky 1
- Massachusetts 2
- Maryland 9
- Michigan 1
- Minnesota 2
- Montana 2
- North Carolina 20
- New York 8
- Ohio 4
- Oklahoma 3
- Pennsylvania 8
- Puerto Rico 1
- Rhode Island 1
- South Carolina 4
- Tennessee 6
- Texas 2
- Virginia 30
- Wisconsin 1

### International

- Austria 1
- China 5
- India 1
- Israel 1
- Korea 1
- Morocco 1
- Taiwan 1
- United Kingdom 1

## Geographic diversity of NIA graduates



### Industry and Non-profits

- Applied Biomathematics**  
Seatauket NY
- Knolls Atomic Power Laboratories**  
Saratoga Springs NY
- Bettis Atomic Labs**  
Pittsburgh PA
- Charles Stark Draper Laboratory**  
Cambridge MA
- Boeing**  
Renton WA and Mesa AZ
- Orbital Sciences Corp**  
Dulles VA
- Raytheon Missile Systems**  
Tucson AZ
- The Aerospace Corporation**  
El Segundo CA
- Johns Hopkins Univ / Applied Physics Lab**  
Laurel MD
- General Electric Aircraft Engines**  
Evendale OH
- National Institute of Aerospace**  
Hampton VA
- a.i. solutions**  
Lanham MD
- Integrity Applications, Inc.**  
Chantilly VA
- Analytic Mechanics Associates**  
Hampton VA
- Cessna**  
Wichita KS
- Dynamic Concepts**  
Huntsville AL
- United Technologies Research Corp**  
East Hartford CT
- Exxon Mobil Research and Engineering**  
Fairfax VA
- Applied Materials Inc.**  
Santa Clara, CA

Graduates have been employed by...

### Government

- NASA Langley Research Center**  
Hampton VA
- NASA Goddard Space Flight Center**  
Greenbelt MD
- Air Force Research Laboratory**  
Dayton, OH
- Army Research Laboratory**  
Hampton VA
- Army Research, Development and Engineering Command**  
Fort Eustis VA
- Naval Research Laboratory**  
Washington DC

NIA graduates have continued their studies at...

### Member and Non-member Universities

- National Institute of Aerospace**
- Columbia University**
- Georgia Tech**
- North Carolina State Univ.**
- University of Maryland**
- University of Massachusetts**
- University of Michigan**
- University of Virginia**



## *Educational and Public Outreach*

To stimulate development of a workforce prepared to work in Science, Technology, Engineering and Math (STEM) disciplines, NIA designs and implements a multifaceted educational and public outreach program that serves the general public, students, educators and the professional STEM community.

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### **Educator Programs and Classroom Resources**

#### **NASA Pre-Service Teacher Institute**

NASA's Pre-Service Teacher Institute is an exciting professional development opportunity that teams underrepresented college students who are preparing to student-teach with novice teachers who are actively working with elementary and middle school students.

The 2010 Institute led 30 pre-service teachers and 10 novice (less than five years experience) teachers in learning about Earth system science and climate change; practicing 21st Century learning skills; participating in hands-on activities; applying the effective use of instructional technology; utilizing professional collaboration tools; interacting with NASA engineers and scientists; exploring supporting NASA resources; and implementing lessons with local students in both formal and informal settings.



# Educational and Public Outreach

## Modeling and Simulation

In 2010, NIA continued its leadership role in delivering Modeling and Simulation (MODSIM) instructional technology and best practices into core academic subjects through partnerships with NASA Langley Research Center and area schools. Teachers in local school districts received ongoing professional development from NIA staff to support the design of MODSIM-based lessons. NIA staff also presented MODSIM educational technology at workshops locally, regionally, and nationally.

In addition, NIA led the K-20 STEM Education track, which consisted of eight concurrent sessions; four panel discussions; and nine submitted papers. Enhancing the Education track were two outreach events, Dream, Create, Go! and MODSIM STEM Day, which engaged students and the public.

## Virginia 21eTeacher Graduate Series

NIA, in partnership with the University of Virginia and LearnIT-TeachIT, developed and implemented 21eTeacher Graduate Series pilots with Albemarle County Public Schools and Virginia Beach City Public Schools, both in Virginia. The courses were delivered through an on-line asynchronous format and were facilitated by NIA Educators in Residence (EIRs) who are also adjunct faculty members at UVA. Forty-two teacher leaders completed the four, 3-credit, UVA graduate courses in 2010.

## Selected Honors and Awards

**NASA @ Home and City**, an interactive online experience developed by NIA with Woodpile Studios and Bully Entertainment, won the 14th Annual Webby Award in the Government Category. Created for NASA's Exploration Systems Mission Directorate, the feature provides an innovative tool for educating the public on how technology developed by NASA has found wide application in your home and everyday life.

<http://www.nasa.gov/city>



## Public and Educational Media

### NASA and You (NASA y Tú)

"NASA and You" is a joint venture between NASA and Univision Communications working together to inspire and engage Hispanic students to pursue STEM careers. Combining NASA's unique STEM education content with Univision's media platforms substantially increases awareness and interest in STEM among Hispanic children and parents.



In 2010, NIA producers and educators began production of a series of 30-second video segments using NASA's Hispanic community of astronauts, scientists and technicians. "NASA and You" enables middle school students to discover what it takes to prepare for a career that will help shape the future of NASA. <http://www.nasa.gov/education/nasaandyou>

## Selected Honors and Awards

"NASA Launchpad" took home an Emmy award in the Informational/Instructional category for its episode "Bernoulli's Principle" at the 52nd Capital Regional Emmy Awards held in Washington, June 5, 2010. The segments are produced by Scott Bednar and Tom Shortridge of the National Institute of Aerospace.



(L to R) Tom Shortridge and Scott Bednar at the 52nd Capital Regional Emmy Awards

# Educational and Public Outreach

## NASA eClips™

"NASA eClips" are short, relevant educational video segments designed to inspire and engage students, helping them see real-world connections with STEM education. The programs target K-12 students and are augmented by teacher resources and training to support the use of best practices and effective implementation in a 21st Century classroom. Educational material for this program is selected based on national curriculum standards identified by NCTM, NSTA and ISTE.



Since the project began, 220 high-definition videos have been produced and made available through YouTube and the NASA.gov websites. This includes 79 "Our World" (grades K-5), 71 "Real World" (grades 6-8), and 70 "NASA Launchpad" (grades 9-12) videos. The program has received numerous awards including the prestigious 2009 National Capital Chesapeake Bay Chapter Emmy Award™ and iParenting Media Award for Outstanding Television Product of 2009.



## NASA 360™

"NASA 360" is a series of 30-minute magazine style video programs created in collaboration with the NASA Langley Research Center. "NASA 360" highlights NASA's current research, informs and educates us on ways to conserve and sustain life on Earth, and looks ahead to life beyond Earth.

"NASA 360" airs in every major market of the U. S. on approximately 450 television stations including NASA TV; is featured in museums around the country, and airs on international airlines and cruise lines.

"NASA 360" enjoys an immense following on non-NASA web and social media platforms including Hulu, Facebook and iTunes.

[www.nasa.gov/nasa360](http://www.nasa.gov/nasa360)

## Discovery Now™

NIA, through a generous grant from the American Institute of Aeronautics and Astronautics (AIAA), produces a daily radio program and podcast, "Discovery Now."

Produced in partnership with National Public Radio (NPR) station WHRV 89.5 in Hampton Roads, "Discovery Now" highlights aeronautics and astronautics technology, science, history, innovations, research and inventions from the aerospace industry, worldwide.



[www.discoverynow.us](http://www.discoverynow.us)

# Educational and Public Outreach

## Internships and Design Competitions



### Langley Aerospace Research Summer Scholars (LARSS) Program

The LARSS Program for NASA Langley Research Center (LaRC) provides year-round paid internship opportunities at LaRC for rising undergraduate juniors and seniors, and graduate students who are pursuing degrees in STEM. Participants gain exciting hands-on research experience while working side-by-side with NASA's finest scientists and engineers who serve as mentors.

Managed by NIA and implemented through the Virginia Space Grant Consortium (VSGC) this competitive, Center-unique program is the oldest running NASA internship - boasting more than 170 participants in 2010.

### Revolutionary Aerospace Systems Concepts – Academic Linkage

RASC-AL is a popular, annual, university-level engineering competition that provides students the opportunity to design projects based on NASA engineering challenges as well as offering NASA access to new research and creative approaches to solving real problems faced by the agency.



Design teams include a minimum of two students and a faculty member. Teams choose one of four themes for their project and submit a summary of their proposed project with an outreach plan. A steering committee comprised of NASA and industry experts evaluates the proposals and selects teams to compete against each other at the annual RASC-AL Forum, held in Cocoa Beach, FL each June. Selected teams submit a written report, prepare a poster and give an oral presentation at the Forum. In 2010, six graduate teams and 13 undergraduate teams competed against each other.

### RASC-AL Exploration Robo-Ops

In 2010, NIA and NASA launched an exciting new design competition built on the premise of RASC-AL - the RASC-AL Exploration Robo-Ops competition. University teams designed and built a tele-operated planetary rover to perform a series of competitive tasks at NASA Johnson Space Center's Rock Yard in May 2011. Scoring is based on the ability to perform the tasks, adherence to requirements and the inclusion of education and outreach activities.



### RealWorld-InWorld NASA Engineering Design Challenge

The RealWorld-InWorld NASA Engineering Design Challenge is a unique education initiative for students in grades 9-12. It encourages them to explore and to build skills essential for successful STEM careers through two phases of project-based learning and team competition. In the RealWorld phase, teams of high-school-aged students and teachers/coaches work face-to-face collaboratively as engineers and scientists. After exploring and designing solutions in the RealWorld phase, participants move InWorld to continue working in a 3D virtual universe. There, each newly-formed team uses 21st Century tools to refine designs and to create 3D models of the Webb telescope. Webb engineers visit and "chat" InWorld with participants throughout the challenge. The winning team receives scholarships and technology awards.

The Challenge is a collaboration between NASA, NIA, USA TODAY Education, and LearnIT-TeachIT. Funding for this project was awarded to NIA by NASA through a competitive grant solicitation.

<http://www.nasarealworldinworld.org/>



## Knowledge Transfer: Professional Studies, Conferences, Workshops, Lectures Series

### NASA IT Summit 2010

The NASA IT Summit was hosted by NASA's Office of the Chief Information Officer and held in National Harbor, Maryland, August 16-18, 2010. The 2010 IT Summit gathered 941 participants and featured more than 100 speakers, who presented on themes around collaboration, social networking, innovation, infrastructure, operations, and IT security and privacy.



Our foundation managed sponsors and exhibits for NASA's first-event IT Summit working with industry and society partners including AAIA, Hewlett Packard, Cisco, Lockheed Martin, Microsoft, InDyne, PTC, Belarc, Grant Thornton Co., Google, Verari Technologies Inc., ESRI, Unisys, VMware, CDW-G, RIM/Blackberry, ARCSight and Apple.



### TEDxNASA 2010

Co-hosted by NASA Langley Research Center and NIA, TEDxNASA "What Matters Next" was held at the Ferguson Center for the Arts on the campus of Christopher Newport University, Newport News, Virginia, on November 4, 2010. The event brought together over 1,700 attendees and 22 intriguing presenters – each at the top of their respective field - across a variety of disciplines.

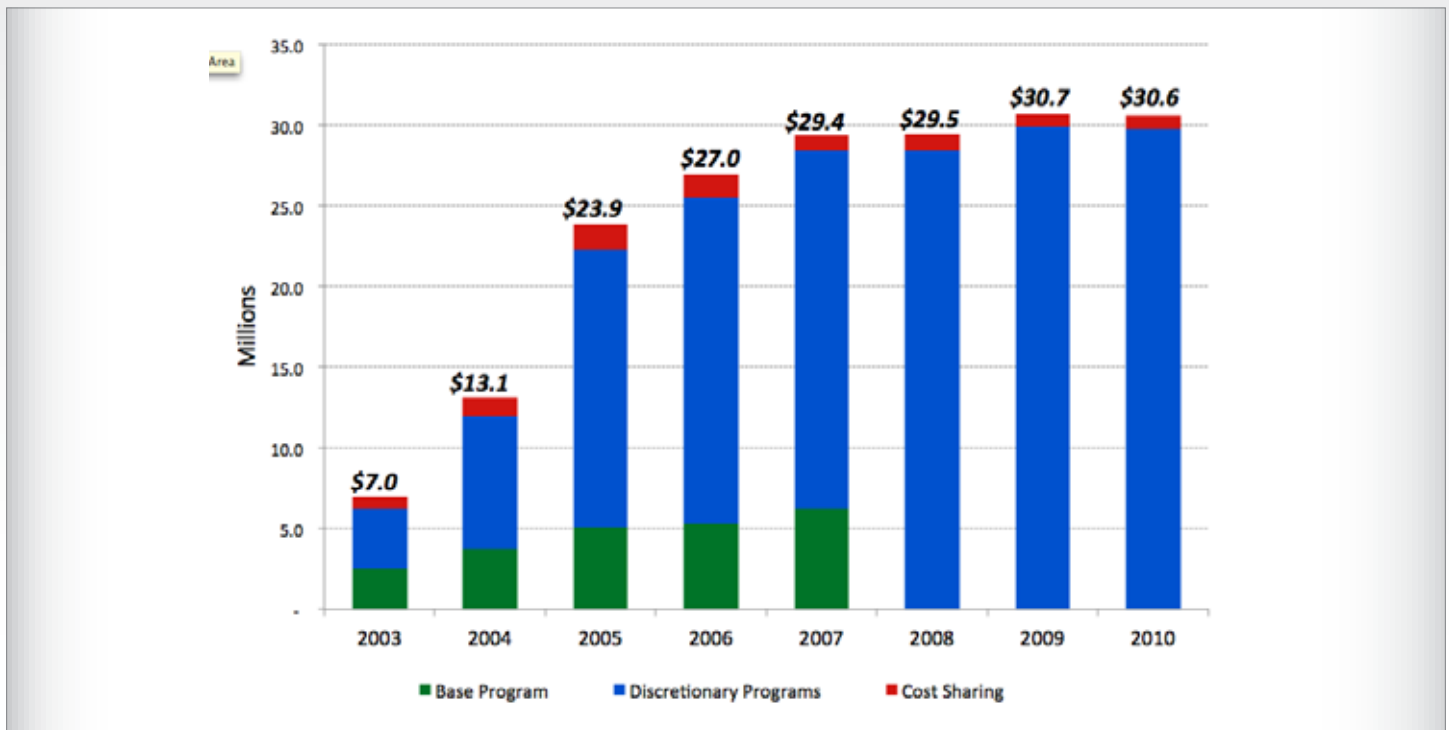


A companion youth event, TEDxYouth@NASA "Be Astronomical", was held at the Virginia Air and Space Center, Hampton, Virginia, on November 20th. Attendees were immersed in a scientific and technologically rich interactive environment as they heard presentations from scientists, artists, researchers and poets.

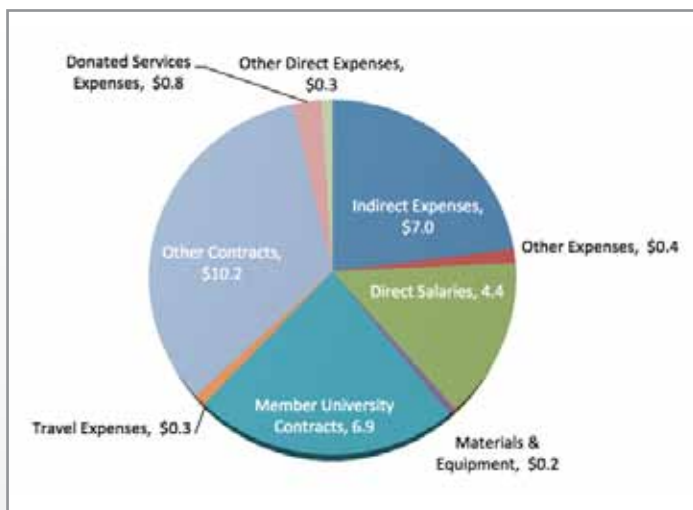
[www.tedx.nasa.com](http://www.tedx.nasa.com)

*James Green, Director, Planetary Science Division, NASA Headquarters*

# Financials

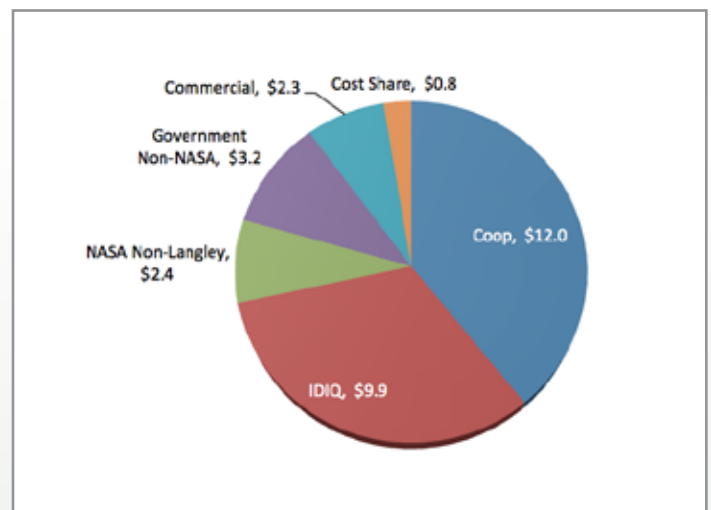


## 2010 Revenue Uses



- \$4.4 - Direct Salaries
- \$6.9 - Member University Contracts
- \$10.2 - Other Contracts
- \$7.0 - Indirect Expenses
- \$0.2 - Materials and Equipment
- \$0.3 - Travel Expenses
- \$0.3 - Other Direct Expenses
- \$0.4 - Other Expenses
- \$0.8 - Donated Services Expenses

## 2010 Revenue Sources



- \$12.0 - Coop
- \$9.9 - IDIQ
- \$2.4 - NASA Non-Langley
- \$3.2 - Government Non-NASA
- \$2.3 - Commercial
- \$0.8 - Univ. Cost Share

COOP: NASA Cooperative Agreement  
 IDIQ: NASA Task Order Contract

# 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 technologies.

**...Incubate** and stimulate the commercialization of new intellectual property developed through NIA's research activities.

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

**Image:**

**Morphing Wing Ornithopter Concept**

NIA continues to develop novel morphing wing UAV's with NASA, UMD and other partners. Ornithopter platforms combine aerodynamic performance at low speeds, mission adaptability and agility.







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