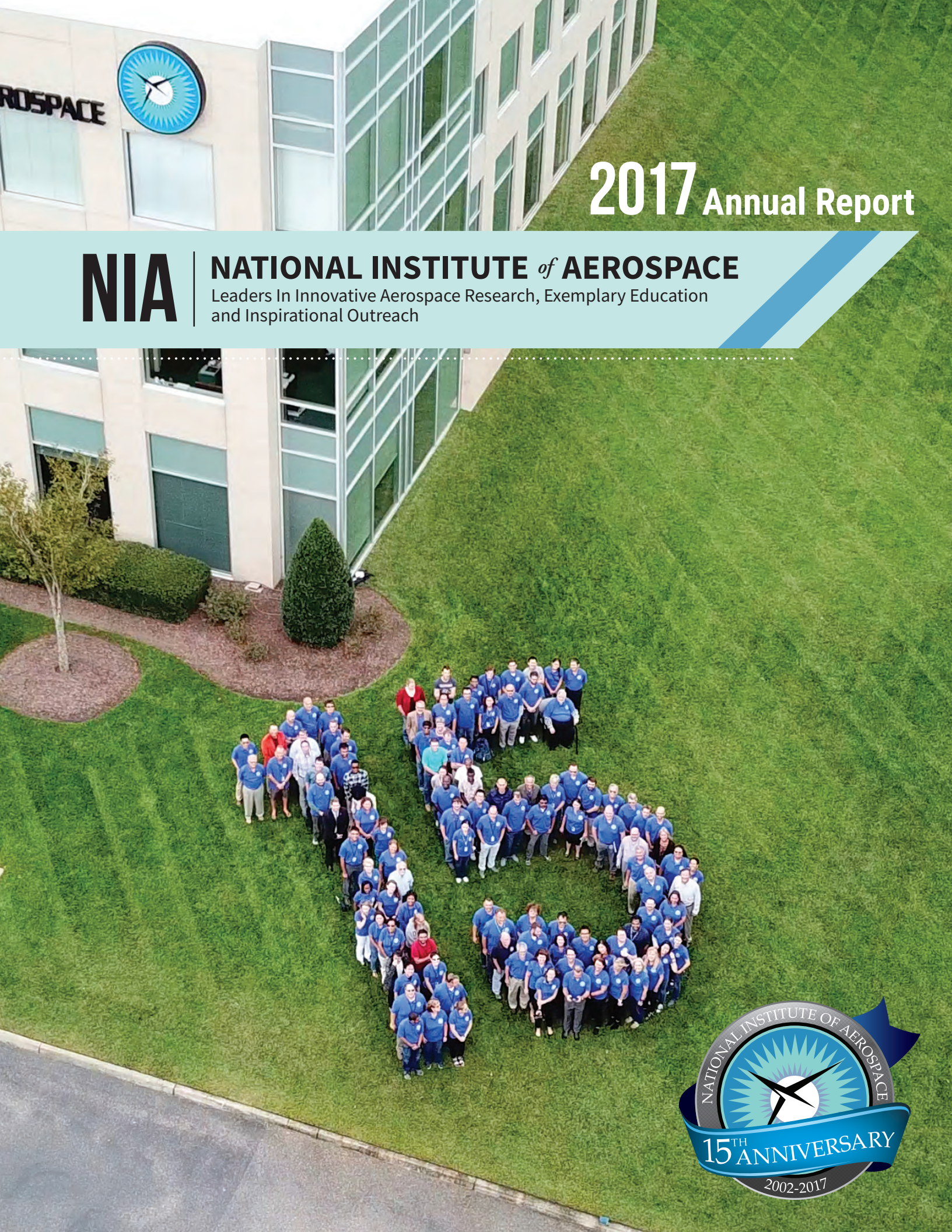

2017 Annual Report

NIA | NATIONAL INSTITUTE *of* AEROSPACE

Leaders In Innovative Aerospace Research, Exemplary Education and Inspirational Outreach

NATIONAL INSTITUTE OF AEROSPACE
15TH ANNIVERSARY
2002-2017

National Institute of Aerospace (NIA) is a non-profit research, graduate education, and outreach institute created in 2002 by NASA's Langley Research Center (LaRC). NIA collaborates with NASA, other government agencies and laboratories, universities, and industry to conduct leading-edge research and technology development in space exploration, aeronautics, and science. In addition, NIA offers a broad, multi-university graduate education program and award-winning outreach.

Our Vision:

To be a recognized leader in innovative aerospace research, exemplary education, and inspirational outreach.

Our Mission

- **Lead and conduct** synergistic research with government, academia and industrial partners to stimulate innovation and creativity.
- **Deliver** unique, collaborative, and comprehensive graduate and continuing education in science and engineering.
- **Inspire** the next generation of aerospace engineers and scientists and provide outreach for the public good.
- **Incubate** and commercialize new intellectual property developed through NIA's research activities.

Our Values

- Our people are our **strength**
- **Dedication** to every stakeholder's success through excellent service
- **Innovation** in research and education that impacts future generations
- **Trust** and accountability in all relationships
- We share one **vision** and act as one team
- We **embrace** change and reward innovation

Our Objectives

- **Establish** collaborative research and education centers that are internationally recognized for important intellectual contributions in aerospace-related engineering, science, and technology.
- **Remain** strategically aligned with NASA Langley and respond to NASA's research and development, education, and outreach priorities as they evolve.
- **Develop** and grow non-NASA support for research, education and outreach programs, including a robust collaborative research program with the global aerospace industry.
- **Collaborate** closely with university partners in fulfilling NIA's vision.
- **Attract** the highest quality researchers, faculty, and students to conduct a collaborative, multi-disciplinary education and research program.

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President's Message

In 2017, NIA celebrated our 15th Anniversary, as you can see from the cover of this Annual Report. We have had many accomplishments over these 15 years -- some of which are summarized in this report. Our researchers have published over 1800 papers and have generated 210 invention disclosures, provisional patents, and patents. We have awarded 176 graduate degrees and hosted over 1900 student interns. We have hosted over 450 visiting scholars and students and collaborated with 125 universities in funded research projects. We have helped 28 researchers become US permanent residents and 20 become US citizens. Over 2000 students have participated in our university design and development competitions, and our education outreach videos and resources have been downloaded over 20 million times. Our public outreach videos have been viewed by over 35 million people, and our current radio program reaches 13 million daily listeners. Thanks to all our employees, university partners, customers, and stakeholders for making these incredible accomplishments possible!

In 2017, our researchers continued to receive many awards and performed an array of innovative research. For the first time ever, four of our employees received the NASA Exceptional Engineering Achievement Medal for four different individual accomplishments: congratulations to Dr. Sang-Hyon Chu, Dr. Jae-Woo Kim, Dr. Yi Lin, and Dr. Godfrey Sauti! Dr. Lin's research is featured below in this report. Dr. Ron Krueger and Dr. Nelson de Carvalho won the Best Paper Award for the 31st Annual American Society of Composites Conference; Dr. Jason He won the Best Paper Award for the 11th International Workshop on Structural Health Monitoring; and Dr. Hiro Nishikawa won the Best Paper Award at the AIAA Computational Fluid Dynamics Conference. We could not be prouder of such an incredible year of research recognitions! Dr. de Carvalho's research is also featured in this report.

In 2017, our Center for High-Performance Aerospace Computations (HiPAC) under the leadership of NIA Fellow, Dr. Boris Diskin, completed a record $2.5M in research involving 19 different research projects and sponsored 16 CFD seminars. We also established a new $8.5M, 5-year research and outreach agreement with the William J. Hughes Technical Center of the FAA and continued in the third year of leading the $40M Advanced Composites Consortium (ACC) for NASA Langley.

Our Peninsula Technology Incubator was rebranded the REaKTOR Business Innovation Center and refocused on unmanned aerial systems companies. In 2017, it won a $50K Small Business Administration grant and a $500K Commerce Department grant. It also won the Donna Nobel Award for the best business incubator in Virginia.

Our unique graduate education program had 37 full-time and 26 part-time graduate students in 2017. Our students can earn degrees from any of our nine member universities and take up to half of their classes from other universities. We also sponsored 47 seminars at NIA and NASA from distinguished faculty and researchers from all over the world, as well as 2 workshops and 2 short courses. NIA also hosted 30 research, faculty and student visitors to perform collaborative research in 2017.

Our Langley Professors in residence at NIA from our member universities have all continued to excel in 2017. Five of the six are Fellows in their respective professional societies. In recognition of his lifelong accomplishments in pioneering active noise control, Prof. Chris Fuller of Virginia Tech was selected for the ASME Rayleigh Lecture and Award. We are pleased to welcome three new Langley Professors to NIA from the University of Maryland. They will each serve for a year working on the research projects outlined below. NIA will then select a single University of Maryland Langley Professor to replace former Langley Professor James Hubbard, to whom we wish all the best and thank for his decade of service to NIA.

Finally, our world-class educational and public outreach programs continued to garner new customers, audiences, and awards. In 2017, we broadcast 259 episodes of our Innovation Now radio program, which features exciting innovations in aerospace, and its audience increased to 13 million daily listeners. We also produced and distributed 74 new video episodes for our flagship NASA360 television program. Its Facebook followers increased to 5.4 million, and it achieved 6.5 million video views! Our Center for Integrative STEM Education (CISE) continued to provide unique and exciting teacher training, curriculum development, and a variety of educational outreach activities. CISE's successful NASA eClips program continued reaching classrooms all over the world with 91,000 downloads per month. A record number of student teams applied to the RASC-AL and Big Idea student challenges. We also began the new NASA iTech program discussed below to encourage start-up companies to address new technologies and ideas relevant to NASA.

I look forward to working with each of you and all our stakeholders in 2018 as we continue to create a unique research, education and outreach capability at NIA.

Dr. Douglas Stanley
President and Executive Director

Samuel P. Langley Professor Program

The Samuel P. Langley Professor Program was established by NASA Langley Research Center to enable an on-site high-value graduate education program for Langley personnel, as well as graduate students, that could ensure a pipeline of trained new employees. Langley Professors are selected to be in residence at NIA after establishing themselves as research and thought leaders in fields that are aligned with and complementary to the future strategic research directions at NASA's Langley Research Center. Branch Heads within NASA Langley's Research Directorate and researchers regularly seek Langley Professors for collaborative research, or to obtain high-valued research advice and direction. Langley Professors also assist in providing master's and doctoral students to work side-by-side with NASA Langley researchers for extended periods of time while performing their coursework and research on site at both the National Institute of Aerospace and NASA Langley. Each Langley Professor specializes in an area of research related to aerospace.

nianet.org/research/langley-professor-program/

NIA SAMUEL P. LANGLEY PROFESSORS

Dr. William Edmonson, *North Carolina A&T State University*
Small Satellites and Technologies
(Center for Small Satellite Systems & Technology for Observation & Exploration)

Dr. Christopher Fuller, *Virginia Tech*
Aerospace Acoustics, Active Noise Control, Metamaterials
(Center for Aerospace Acoustics)

Dr. Mool Gupta, *University of Virginia*
Photonics, Sensors, Solar Energy, Nanomaterials
(Center for Photonics, Sensors & Solar Energy)

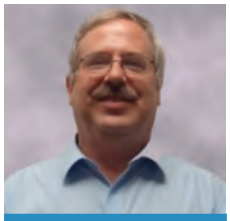
Dr. Dimitri Mavris, *Georgia Tech*
Design of Space Systems, Vehicles and Architectures

Dr. Fuh-Gwo Yuan, *North Carolina State University*
Advanced Smart Materials, NDE, ISHM
(Center for Integrated Systems Health Management)

Dr. Chris Fuller received the prestigious American Society of Mechanical Engineers 2017 Rayleigh Lecture Award for his pioneering contributions in acoustic meta materials.

New Langley Professors from the University of Maryland

We are pleased to welcome three new Langley Professors to NIA from the University of Maryland. They will each serve for a year working on the research projects outlined below. NIA will then select a single University of Maryland Langley Professor to replace former Langley Professor James Hubbard, to whom we wish all the best and thank for his decade of service to NIA.



James D. Baeder

Dr. James D. Baeder became an NIA Samuel P. Langley Associate Professor in 2017. His project is entitled "Heterogeneous Computing and GPU-based Adjoint Computational Fluid Dynamics (CFD)." The overall objective for this one-year project is to leverage and improve heterogeneous CFD solvers as well as to begin to develop a unique GPU-based adjoint capability for application to aerodynamic optimization.

Dr. Baeder is a faculty member in Aerospace Engineering and a member of the Alfred Gessow Rotorcraft Center at the University of Maryland. He holds a Ph.D. and M.S. in Aeronautics

Olivier A. Bauchau

Dr. Olivier A. Bauchau became an NIA Samuel P. Langley Associate Professor in 2017. His project is entitled "Development of Parallel Algorithms for Rotorcraft Comprehensive Analysis." The objectives of this project are to develop and implement computational structural dynamics algorithms that can harness the power of parallel computer architectures to increase the computational speed by orders of magnitude, while retaining the ability to evaluate 3D stress fields in the rotor blades and dynamic components.

Dr. Bauchau is the Igor Sikorsky Professor of Rotorcraft in Aerospace Engineering at the University of Maryland. He holds a Ph.D. in Structuring Dynamics and M.S. Aeronautics and Astronautics from the Massachusetts Institute of Technology; and Ingénieur Civil Physicien from the Université de l'État a Liège (Belgium).

Teng Li

Dr. Teng Li became an NIA Samuel P. Langley Associate Professor in 2017mm/17. His project is entitled "High-Performance Computing Assisted Discovery of Materials with Unprecedented Properties." By using multi-scale and multi-physics computational modeling to define design objectives, then integrating modeling into the synthesis, processing, fabrication, and testing, new material discovery can be realized within a much shorter time. Furthermore, the much-reduced cost of computing assisted material discovery allows for explorations of new materials with unprecedented properties that are otherwise often prohibitive in conventional material development approaches. To explore these fertile opportunities, this project aims to focus on the following two research thrusts to design new materials with unprecedented properties that are desirable for aerospace applications: (1) computational exploration of unconventional low-dimensional carbon nanomaterials; (2) computation guided design of cellulose-based lightweight yet super strong and tough structural materials.

Dr. Li is a Keystone Professor in Mechanical Engineering in the A. James Clark School of Engineering at the University of Maryland. He holds a Ph.D. in Engineering Sciences from Harvard University; a M.A. in Materials Science from Princeton University and a B.S. in Engineering Mechanics from Tsinghua University, China.

Centers of Excellence at NIA

As a part of our research strategy, NIA has established research Centers of Excellence that bring together experts from NIA, multiple universities, industry, and NASA to perform focused collaborative research activities. These centers are complementary to NASA's research and actively seek funding from outside sources. In addition to our Centers of Excellence led by the NIA Samuel P. Langley Professors, NIA Research and Programs staff also lead centers and consortiums. NIA assists in identifying new research opportunities, proposal preparation and submission, and program management and staffing on successfully proposed research programs.

nianet.org/research/centers-of-excellence/

NIA Research Centers and Centers of Excellence

Advanced Composites Consortium
Center for Aerospace Acoustics
Center for Aerospace Engineering
Center for Integrated Systems Health Management
Center for Photonics, Sensors & Solar Energy
Center for Planetary Atmospheric & Flight Sciences
Center for Planetary Dynamics
Center for Small Satellite Systems and Technology for Observation & Exploration
High Performance Aerospace Computing
Interdisciplinary Consortium of Modeling and Simulation

High Performance Aerospace Computing Center (HiPAC)

The High Performance Aerospace Computing Center (HiPAC) is part of the National Institute of Aerospace (NIA) at Hampton, Virginia, and works closely with researchers at NASA Langley Research Center. The center conducts research in the application of Computational Fluid Dynamics (CFD) towards aerospace applications. Its research can be broadly classified into the following areas:

• Development of novel numerical methods with improved accuracy and robustness that are suitable for modern high performance computational applications.

• Development of Adjoint-based methodologies for Multidisciplinary Design and Optimization (MDO); mesh adaptation and demonstration of these capabilities for practical aerospace applications.

• Modeling and Simulation of transitional and turbulent flows to improve our understanding of complex flows, development of better models to predict such flows and aid in the design of aerodynamic components.

Mission

The mission of the NIA High Performance Aerospace Computing (HiPAC) Center is to advance computational methods and technologies for aerospace applications and transition them from fundamental studies to practical tools.

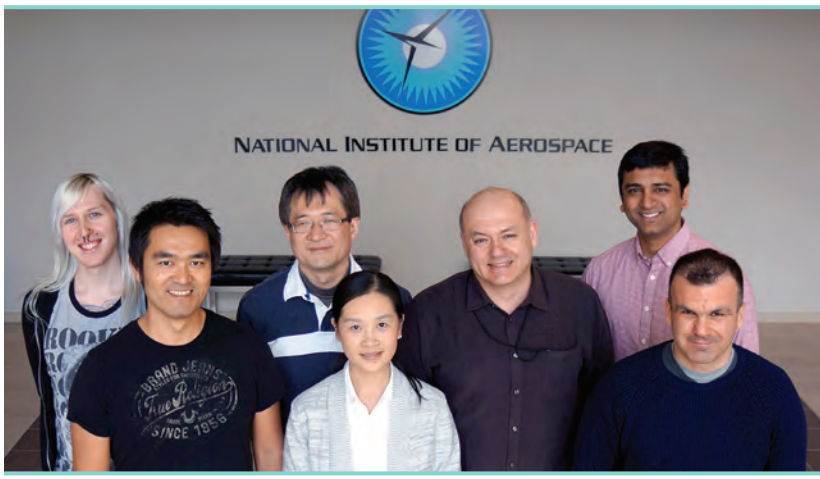
This mission is supported by expertise at NIA, the talent and resources of our strategic partners in academia and industry, and an unprecedented level of collaboration and integration with research programs at NASA and other government agencies.

Vision

The HiPAC vision is to mature computational aerospace technologies from a fundamental breakthrough in numerical analysis to integration within a practical tool.

To achieve this vision, HiPAC provides an innovative and interdisciplinary research environment for a group of dedicated aerospace engineers, applied mathematicians, and computer scientists with a passion for advancing physics-based computational technologies in general and their aerospace applications in particular. HiPAC researchers conduct cutting edge research, development, and demonstration of high performance computational methods and tools for large-scale aerospace applications. Specific areas of interest include High Performance Computing, Computational Aerodynamics, Physics-Based Modeling and Simulation, High-Fidelity Simulation-Based Multidisciplinary Design and Optimization.

Current projects can be found on the HiPAC web site at:
hipac.nianet.org/current-projects/



Message from Vice President of Research

During 2017, the population of researchers in the NIA Research Department continued to grow and now numbers more than 60, supporting the cutting-edge technology development efforts of NASA's Langley Research Center, and our other government and commercial aerospace customers. This growth is a reflection of the value those customers receive from the engagement of NIA researchers in the performance of their research pursuits.

That value is also evidenced by the fact that, in 2017, NASA Exceptional Engineering Achievement Medals were awarded to three NIA researchers, and the NASA Exceptional Achievement Medal to another. NASA Medals are the Agency's highest form of recognition, honoring individuals who have made significant contributions toward achievement of the NASA mission. An additional eight NIA researchers were members of teams that received NASA Group Achievement Awards, in the technical areas of autonomy, computational fluid dynamics, and nanotechnology. Also, three technical papers written by NIA researchers were selected as Best Papers at the international conferences at which they were presented. These publications described outstanding contributions in the diverse technical areas of computational fluid dynamics, damage analysis of composites materials, and integrated structural health monitoring.

The following pages provide snapshots of a select few of the exciting research contributions of NIA researchers in 2017; as well as a bibliography of technical publications that evolved from the efforts of the NIA research staff.

David Throckmorton
Vice President of Research

Aeronautical Sciences

S.A. Rizzi, D.L. Palumbo, J. Rathsam, A.W. Christian, and **M. Rafaelof**, "Annoyance to Noise Produced by a Distributed Electric Propulsion High-Lift System," AIAA Paper 2017-4050, in the *Proceedings of the 23rd AIAA/CEAS Aeroacoustics Conference*, AIAA AVIATION Forum, 5-9 June 2017, Denver, CO, doi:10.2514/6.2017-4050

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S. Balachandran, A. Narkawicz, C. Muñoz, M. Consiglio, "A Path Planning Algorithm to Enable Well-Clear Low Altitude UAS Operation Beyond Visual Line of Sight," in the *Proceedings of the 12th USA & Europe Air Traffic Management Research and Development Seminar*, 26-30 June 2017, Seattle, WA

S. Balachandran, C. Muñoz, M. Consiglio, "Implicitly Coordinated Detect and Avoid Capability for Safe Autonomous Operation of Small UAS," AIAA Paper 2017-4484, In the *Proceedings of the 17th AIAA Aviation Technology, Integration, and Operations Conference*, AIAA AVIATION Forum, 5-9 June 2017, Denver, CO, doi:10.2514/6.2017-4484

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High-fidelity Modeling of Advanced Composites Structures

Dr. Nelson Viera De Carvalho // NIA SENIOR RESEARCH ENGINEER

The reliable use of composite structures in aviation and aerospace has often required large and costly experimental programs. As a result, extensive research has been conducted to selectively replace testing with reliable simulations. However, predicting damage initiation and its development in advanced composite materials continues to pose a significant challenge, due to the complexity of the multiple interacting damage mechanisms. A key goal of NASA's Advanced Composites Project is to converge on methodologies and best practices that will enable the confident use of simulation to decrease reliance on testing and, therefore, cost and time when designing and certifying composite structures.

Current NIA research being performed in support of the Advanced Composites Project is addressing the development and assessment of numerical and analytical tools that can enable more confident prediction of damage initiation and progression in advanced composite materials. Specifically, recent research efforts have focused on development of a technique to model delamination growth in fatigue without the need for re-meshing, with the aim of facilitating the modeling of multiple interacting delaminations in fatigue.

The Advanced Composites Project has assessed existing modeling approaches, from both industry and academia, and selected several for further development. Among those are techniques proposed by the author, which have been compiled in a modeling software package that can be used to simulate damage initiation and progression in composite tape laminates. This methodology has been selected for further development; and is being verified and validated by multiple industry partners, to include The Boeing Company, Lockheed Martin and United Technologies. One of the key aspects underpinning the methodology, is the ability to represent, with high-fidelity, discrete damage events such as matrix cracks and delaminations and their interaction, both under quasi-static and fatigue loading conditions. This is illustrated qualitatively in Figure 1 for a skin/flange separation case study. By doing so, this methodology aims at capturing the complexity inherent in damage development in composite structures, with the goal of obtaining an approach that is general and can provide both qualitative and quantitative predictive capability.

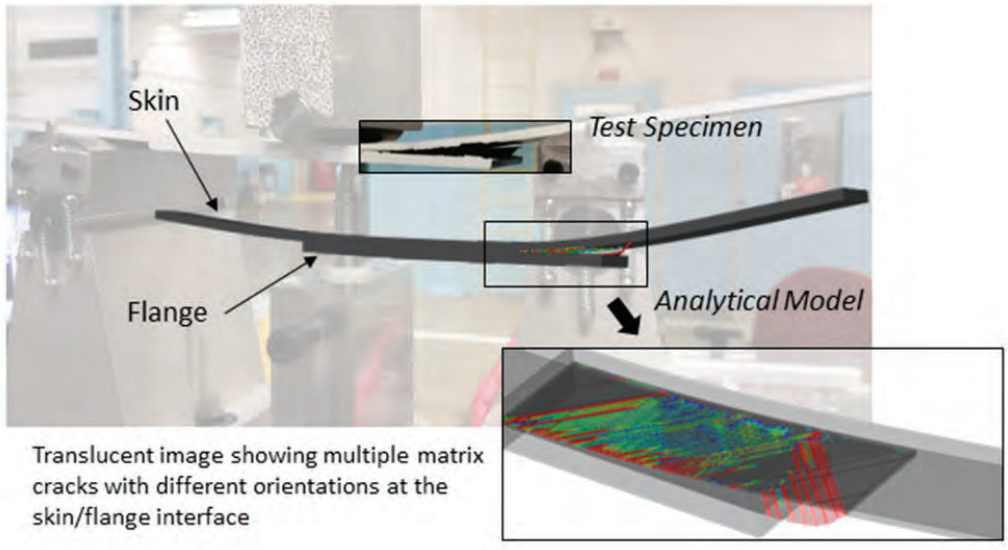

Figure 1.
Simulating skin/flange separation.

Holey Graphene Technology for Advanced Energy Storage Applications

Yi Lin \\ NIA ASSOCIATE RESEARCH FELLOW

Holey graphene is a structural derivative of graphene with arrays of through-thickness holes, which has recently received considerable attention for applications in sensors, catalysts, separation membranes, and energy storage (Figure 1). We recently discovered that the presence of holes through the graphene lateral surface led to unique compressibility of this material under solvent-free conditions, forming mechanically robust structures. Dry-pressed discs thus prepared were found to be useful as electrodes for various energy storage devices such as supercapacitors and lithium-air batteries. An important attribute of this approach is the facile scalability for electrodes with ultra-high areal mass loading with little impact on the intrinsic porosity, resulting in low ion tortuosity through the thickness of the thick electrodes. The dry-compressible holey graphene can also be used as a matrix material to host other active components such as catalysts, allowing more versatility in potential applications.

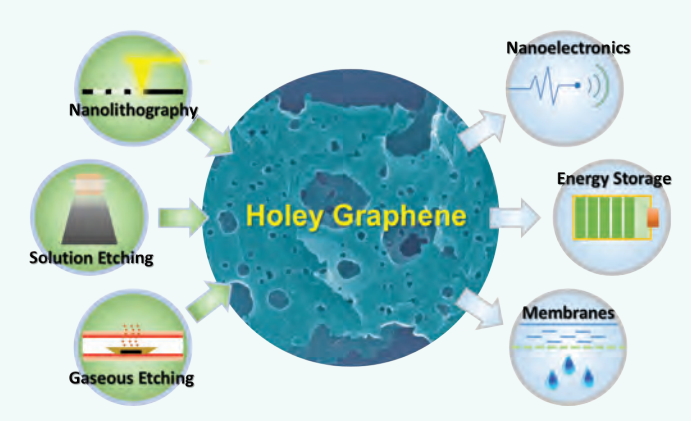

Figure 1.
Potential synthesis methods and applications for holey graphene material.

Since our discovery of this material some five years ago, team members, including the author, Dr. John Connell (NASA Langley Research Center) and Dr. Jae-Woo Kim (NIA), have continued to develop technology related to applications of the holey graphene material. In a NASA Langley Internal Research and Development effort begun in 2015, we partnered with Case Western Reserve University (Prof. Liming Dai) and University of Maryland - College Park (Prof. Liangbing Hu) to investigate the application of holey graphene in lithium-air batteries. A lithium-air battery platform is projected to have an ultra-high energy density (Figure 2) that significantly surpasses that of current lithium ion technology and might find uses in future electric aircraft.

Since 2013, two patents have been issued and a total of fourteen peer-reviewed journal articles have been published related to various aspects of holey graphene technology. Additional information regarding this remarkable material is publicly available on YouTube, as noted below.

NASA Langley Technology Webinar:
https://www.youtube.com/watch?v=F9__-Gga1vk

NASA Technology Transfer Video:
https://www.youtube.com/watch?v=OGyn2PjBTN0

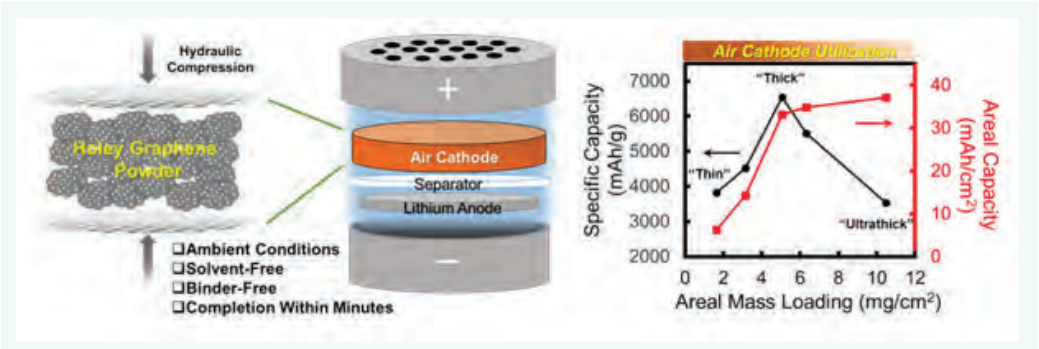

Figure 2.
Holey graphene can be facilely dry compressed into densified yet highly-porous discs, which could be readily used as "air cathodes" for lithium-air batteries with record performance.

Improving Global Model Estimates of Cloud Radiative Effects on Tropospheric Chemistry using Satellite Observations of Cloud Vertical Distributions

Dr. Hongyu Liu // NIA RESEARCH FELLOW

Clouds play an important role in the chemistry and composition of the atmosphere. They scatter and absorb incoming solar radiation, modifying the actinic flux that determines photolysis frequencies of key chemical species. Additional roles of clouds in tropospheric chemistry include convective transport of trace gases and aerosols, nitrogen oxides emissions due to lightning associated with deep convective clouds, heterogeneous chemical reactions, and precipitation scavenging.

Atmospheric observations have shown enhanced photolysis frequencies above and in the upper levels of clouds, and reduced frequencies below optically thick clouds and absorbing aerosols. Since photolytic processes are the sources of free radicals, cloud radiative effects lead to significant perturbations to tropospheric ozone and hydroxyl radical (OH). Ozone is an important greenhouse gas and the main source of OH, which determines the oxidative capacity of the troposphere. Consequently, cloud radiative effects on ozone and OH are important components of global tropospheric chemistry-climate interaction. Their understanding is essential for predicting how climate change may affect tropospheric chemistry.

Quantifying cloud radiative effects on photolysis frequencies and key oxidants on a global scale requires using global 3-D atmospheric models. However, current models have difficulty in representing cloud amount and distributions faithfully. Our earlier studies showed that large differences in cloud distributions among models contribute substantially to inter-model discrepancies in key tropospheric oxidants, especially OH. While the differing magnitudes of column cloud optical depths explain part of these discrepancies, the differing vertical distribution of clouds plays a more important role.

Observations of vertical cloud distributions were not available until launching of the CloudSat/CALIPSO satellites. We have used C3M, a 3-D cloud data product developed at the NASA Langley Research Center and merged from multiple A-Train satellite (CERES, CloudSat, CALIPSO, and MODIS) observations, to constrain or correct the vertical cloud distributions in a global model of tropospheric composition (GEOS-Chem, Figure 1). We evaluated the model clouds and their vertical distribution with global satellite observations as represented by C3M. The aim of our study was to quantify the impact of model biases in cloud optical depths and spatial distributions on the simulated key tropospheric oxidants. We found that the C3M data product allows us to significantly reduce the model biases in simulated global mean OH due to uncertainty in cloud optical depths and vertical distributions. This is the first time satellite observations of cloud vertical distribution have been used to improve global model estimates of cloud radiative effects on tropospheric oxidants.

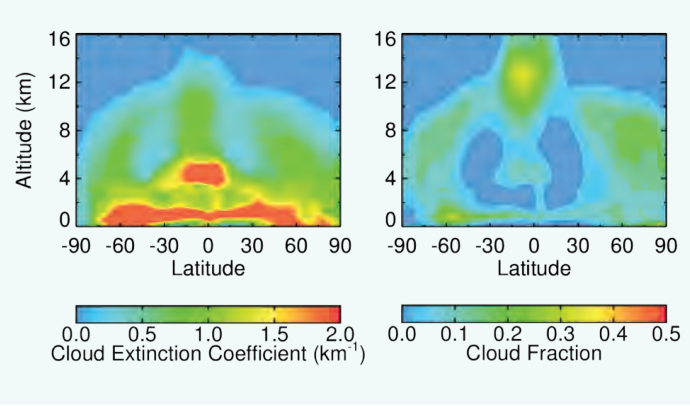

Figure 1.
Latitude-height cross section of monthly zonal mean cloud extinction coefficient (left) and cloud fraction (right) for January 2008 in NASA's MERRA reanalysis data set. The approximate random overlap scheme is used to obtain MERRA grid-box effective cloud optical depths and extinctions.

High-fidelity Multidisciplinary Sensitivity Analysis and Design Optimization for Rotorcraft Applications

Li Wang \\ NIA SENIOR RESEARCH ENGINEER **Boris Diskin** \\ NIA RESEARCH FELLOW

Accurate analysis of rotorcraft aeromechanics requires many disciplines such as aerodynamics, aeroacoustics, structural dynamics and deformations, flight mechanics, and others to capture complex interactions of unsteady flows with highly flexible rotor blades.

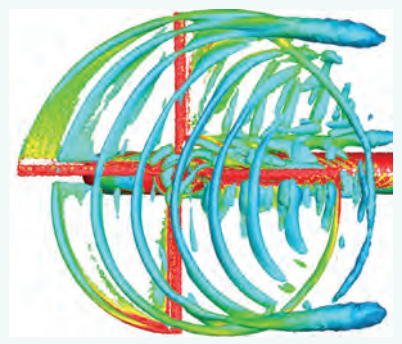

Figure 1.
Blade vortex interactions of rotorcraft

Figure 1 illustrates the complex blade vortex interactions encountered in descent flight of a HART-II rotorcraft. To account for complicated three-dimensional effects and compressibility of the flow field, state-of-the-art high-fidelity rotorcraft simulations couple a comprehensive analysis (CA) model with a physics-based computational fluid dynamics (CFD) model.

An adjoint-based multidisciplinary design optimization approach has been developed for high-fidelity, tightly-coupled CFD/CA simulations utilizing an unstructured-grid, highly-scalable CFD solver (FUN3D) and a nonlinear flexible multibody dynamics CA solver (DYMORE). Multidisciplinary sensitivities arising from the coupled system were conducted by integrating discretely consistent adjoint-based CFD sensitivities from unsteady flows on dynamic, overset grids, with sensitivities from the CA model conducted with a finite-difference, complex-variable analysis.

A constrained rotorcraft design optimization, which employed a geometry parameterization tool (MASSOUD) for surface grid deformation, was performed for the HART-II rotorcraft configuration. A set of aircraft-centric shape design parameters was used, including 8 twist parameters, 35 thickness parameters, and 36 camber

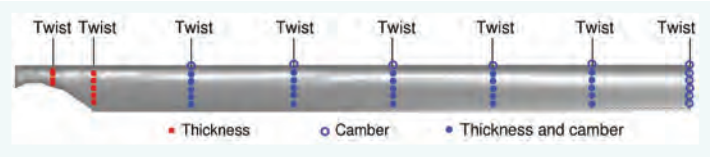

Figure 2.
Locations of aerodynamic shape design parameters

parameters on each rotor blade, as indicated in Figure 2. Additionally, three pitch control angles describing the collective and cyclic control inputs were selected as design parameters to enable constrained rotorcraft designs.

The objective of the design optimization was to reduce the rotor torque while maintaining baseline targets including thrust, rolling and pitching moments of the rotor. After 13 multidisciplinary design optimization cycles, as depicted in Figure 3, a 3.23% reduction in the rotor torque was successfully achieved. Since the rotor power is linearly dependent on the rotor torque, this design result indicates that the rotor power for the optimized configuration was effectively reduced by the same extent. Meanwhile, all constraints were sufficiently converged to the target values, showing that the baseline flight condition was satisfied.

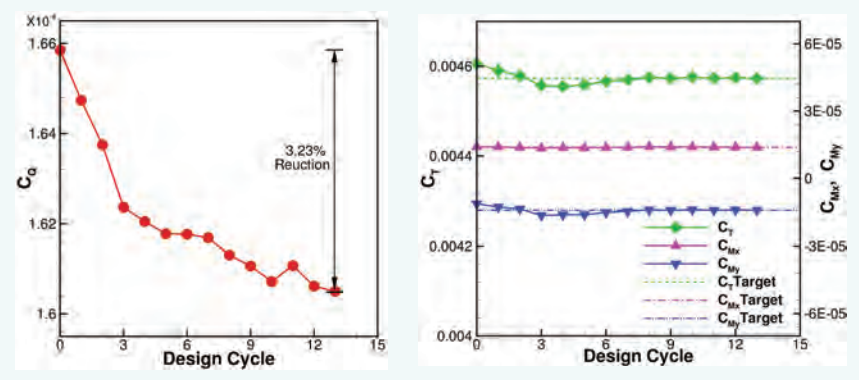

Figure 3.
Convergence of design objective function and constraints

MILESTONES IN THE HISTORY OF THE

SEP 2002 — Cooperative Agreement with Langley signed on September 25, 2002

SEP 2003 — NIA Graduate Program begins with six enrolled students

APR 2005 — NIA moves to new HQ building at 100 Exploration Way, Hampton, VA

FEB 2007 — First NIA researcher is named AIAA Hampton Roads Young Engineer of the Year

DEC 2007 — Creation of NIA Foundation

JUN 2009 — NIA wins its first Emmy for "NASA 360"

2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009

JAN 2003 — First NIA employees hired and operations begin at 144 Research Drive

APR 2004 — First Distinguished Langley Professor appointed

JAN 2006 — NIA AIAA Student Chapter chartered and first meeting is held

SEP 2006 — NIA and Airbus sign six-year Framework Research Agreement

OCT 2007 — 25th provisional patent filed

MAR 2008 — Collier Trophy awarded for NIA's contributions to "The Automatic Dependent Surveillance-Broadcast Team of Public and Private Sector Groups"

SEP 2009 — NIA achieves $30M mark in revenue

National Institute of Aerospace

NATIONAL INSTITUTE OF AEROSPACE

OCT 2011 — NIA Researcher receives NIA's first R&D 100 Award

APR 2012 — New NIA Research and Innovation Laboratories facility opens with newly incorporated subsidiary, the Peninsula Technology Incubator (PTI)

SEP 2013 — Boron Nitride Nanotube (BNNT) Lab begins operation

MAY 2014 — NIA researcher wins H.J.E. Reid Best Paper Award for the first time

JAN 2015 — Selected by NASA to manage the new Advanced Composites Consortium

JUN 2016 — NASA Invention of the Year awarded to BNNT

JUL 2016 — NASA 360 hits 5 million Facebook friends

OCT 2016 — PTI services 20 small business start-ups

JAN 2017 — NASA EClips has over 8.35 million views

2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017

JUL 2011 — 100th NIA Graduate Research Assistant (GRA) graduates from program

JAN 2012 — First time NIA named in the top 50 Best U.S. Non-Profits and one of the Best Places to Work in Virginia

JAN 2014 — Center for High Performance Aerospace Computations established

DEC 2014 — NIA's 150th GRA graduates

AUG 2015 — Innovation Now hits 10 million listeners

SEP 2016 — Awarded First Army Research Laboratory Cooperative Agreement

AUG 2016 — NIA for the first time exceeds 100 employees and 50 researchers

NIA by the Numbers

AS WE CELEBRATE OUR 15TH ANNIVERSARY,

we want to acknowledge all those who have helped our organization become the exceptional research, education and outreach institution that it is today. NIA would not have reached this significant milestone without your expertise, encouragement and kind support.

To our employees, faculty, students, partners and clients we express our heartfelt thanks, and we look forward to our shared success during the next fifteen years.

Since 2002, NIA has been awarded...

274 separate contracts, grants and agreements, and has recognized...

More than $407 million
in revenue including...

$17 million in cost sharing from member universities and industry partners.

We also celebrate...

176 graduate degrees awarded, including **59** doctoral degrees.

NIA has collaborated with...

More than 125
U.S. and international colleges and universities.

We have achieved...

Over 1800
research papers published and/or presented.

More than 225
invention disclosures, provisional patents and/or patents,

238 Visiting Researchers

226 Visiting Students, and

402 Employees since inception.

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NORTH CAROLINA A&T STATE UNIVERSITY

NORTH CAROLINA STATE UNIVERSITY

OLD DOMINION UNIVERSITY

UNIVERSITY OF MARYLAND

VIRGINIA TECH

UNIVERSITY OF VIRGINIA

WILLIAM & MARY

Our People

THE NIA TEAM consists of just over 200 employees, resident university professors, post-doctoral and graduate students, and consultants, who are highly educated and qualified research scientists and engineers, education specialists, students, and program and operational support staff.

Among the research staff, 88% hold graduate level degrees and of those, the majority are doctoral level degrees in fields related to aerospace. Since 2002, 70 NIA employees and students have been hired by NASA; 28 employees have become permanent US residents; and 20 employees have become US citizens.

Some of our accomplishments in 2017

NELSON DE CARVALHO, NIA Senior Research Engineer, was recognized as an **Outstanding Emerging Professional** by the **American Society for Testing and Materials.**

SANG-HYON CHU, NIA Associate Research Fellow; **JAE-WOO KIM**, NIA Associate Principal Scientist; **YI LIN**, NIA Associate Research Fellow; and **GODFREY SAUTI**, former NIA Senior Research Scientist, were individually awarded ***NASA Exceptional Engineering Achievement Medals*** in 2017 for work on unique projects.

HIRO NISHIKAWA, NIA Associate Research Fellow, and **YI LIU**, NIA Senior Research Engineer, received the **2017 Bo Walkley NIA Best Research Paper Award** for their paper titled Accuracy-preserving source term quadrature for third-order edge-based discretization.

HIRO NISHIKAWA, NIA Associate Research Fellow, was recognized by the **AIAA** with the award for **Best Paper in Computational Fluid Dynamics for 2017**

JASON HE, NIA Research Scholar, received the **Best Paper Award** for his technical paper presented at the 11th International Workshop on Structural Health Monitoring, at Stanford University.

ROSS BURNS, NIA Research Engineer, was recognized by the AIAA Hampton Roads Section for outstanding on-the-job technical accomplishments of young members

JAE-WOO KIM, NIA Associate Principal Scientist, received a **NASA Honor Award** for work on the **Nanotechnology Incubator Team.**

BORIS DISKIN, NIA Research Fellow; **HIRO NISHIKAWA**, NIA Associate Research Fellow; **YI LIU**, NIA Senior Research Engineer; and **LI WANG**, NIA Senior Research Engineer, received **NASA Honor Awards** for their work on **FUN3D Software Development**.

Martin L. Drews Memorial Scholarship

This supplemental scholarship is awarded each year to a student engaged in research related to the exploration of space. The 2017 Martin L. Drews Memorial Scholarship was awarded to Tyler B. Hudson, Ph.D. North Carolina State University. Dr. Hudson, who graduated in 2017, is the tenth recipient of the scholarship.

Continuing Education

NIA recognizes the importance of continuing and lifelong learning for all individuals engaged in technical fields of study. We also understand that the education and training needs of engineers and scientists established in their fields often differ from those of individuals entering the field for the first time. For those seeking to enhance and expand their knowledge in focused fields, NIA offers programs of short courses, workshops, conferences, seminars, and colloquia. Invited speakers include subject matter experts from NIA, NASA, academia, and industry. In 2017, NIA offered 47 seminars, including an ongoing series of Computational Fluid Dynamics (CFD) seminars; 2 short courses; and 3 workshops related to specific aerospace topics. Many of the seminars are open to the public and are video recorded and archived on the NIA web site.

NIA's Peninsula Technology Incubator – REaKTOR Business Technology Innovation Center

NIA and the Peninsula Technology Incubator are committed to the mission of economic development in the City of Hampton and the Virginia Peninsula, and strongly believe that entrepreneurship can and should play a more significant role in job creation and retention of the best and brightest graduates from regional universities. PTI is a member in good standing with the National Business Incubator Association (NBIA), and where practical, follows NIBIA's established best practices.

PTI was incorporated in April 2012, by NIA as a subsidiary 501(c)3 Virginia Corporation and received an initial grant from the City of Hampton Industrial Development in July 2012. PTI is led by Daniel Morris, J.D., LL.M, a seasoned entrepreneur with a history of successful startup and exits and deep domain knowledge in aspects of company formation and funding. Under Mr. Morris' leadership, PTI has shifted its vison and mission to focus on business and economic development that support the exploding growth of unmanned systems and peripherally related technologies.

As part of the continuing evolution of PTI, NIA has re-branded PTI as the REaKTOR Business Technology Innovation Center (REaKTOR). In addition to performing incubation services, business acceleration, and technology commercialization, REaKTOR will focus on Unmanned Aircraft Systems (UAS) and other UAS-related technologies of interest to NIA and the aerospace industry. As a result, 10 of the 20 existing clients are developing technologies and services supporting this initiative.

PTI fosters an environment designed to motivate member companies to effectively and efficiently move through the incubator process by providing business training, counseling and mentorship, technology transfer information, and educational resources related to fundamental business development and growth. Pre-acceleration workshops focus on introductory business model development, business validation, and the basics of accounting, legal, intellectual property, marketing and sales. For companies ready to move forward, The REaKTOR Landing, located in the PTI office on the third floor of the NIA Lab Building at 1100 Exploration Way, Hampton, provides a collaborative, cost-effective work space for growing companies to flourish.

PTI connects founders with experienced mentors, investors, support services, working space and startup education to move from idea to viable high growth venture. The outcome is an energetic technology innovation center leading the convergence of regional entrepreneurial leaders and leveraging the burgeoning unmanned systems industry.

ptincubator.org

PTI received the Donna Nobel Award in October 2017 as Virginia's number 1 Business Accelerator.

PTI was awarded a $50,000 grant from the Small Business Association to assist in the development of the REaKTOR acceleration program.

PTI won a$500K Dept of Commerce grant to support Entrepreneurship in Hampton Roads. NIA partnered with local investment group 757 Angels and the economic development organization Reinvent Hampton roads to propose the 757 Accelerate program.

Start! Peninsula, a program created by PTI, celebrated its seventh year in 2018. This event for passionate entrepreneurs allows regional incubators to cooperate with NASA Langley Research Center, Jefferson Laboratory, NIA, regional universities, and other business leaders to identify the best ideas and create new businesses within one weekend.

REaKTOR was featured in Virginia's Unmanned Systems Industry 2018 book. **vus.virginia.gov**

NIA Visitor Program

NIA's Visitor Program facilitates research collaborations between scientists and engineers at NIA, 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 and transportation, visas for our international guests, access badges for NASA Langley Research Center, office accommodations and compensation. Participants usually conclude their stay with a seminar for our resident faculty, research staff, students and researchers from the NASA Langley Research Center community. In 2017 NIA hosted 43 visiting students, researchers and professors.

Visiting Researchers

John Aldrin
COMPUTATIONAL TOOLS
UNITED STATES
HPC Incubator Speaker Series

Siddhartha Bhattacharyya
FLORIDA INSTITUTE OF TECH
UNITED STATES
Enabling Collaborative Human-Machine (H-M) Decision Making

Chloe Dedic
UNIVERSITY OF VIRGINIA
UNITED STATES
Femtosecond laser measurement techniques

Paul DeMott
COLORADO STATE UNIVERSITY
UNITED STATES
Femtosecond laser measurement techniques

Aditya Devarakonda
UNIVERSITY OF CALIFORNIA - BERKELEY
UNITED STATES
The theory and practice of communication-avoiding algorithms

Lucas Freidrich
UNIVERSITY OF COLOGNE
GERMANY
Revolutionary Computational Aerosciences (RCA) Institute Support

Ralph Gailis
MULTI-INTELLIGENCE ANALYTICS NSID
INTELLIGENCE ANALYTICS BRANCH DEFENCE
SCIENCE & TECHNOLOGY GROUP F2-1-59
AUSTRALIA
Quantum Computing Workshop

Craig Johansen
UNIVERSITY OF CALGARY
CANADA
Application of theoretical hypersonic testing to flight test

Lorena Martin
NORTHWESTERN UNIVERSITY
UNITED STATES
Predictive Analytics

Neil McDonnell
UNIVERSITY OF GLASGOW
SCOTLAND
Software Assurance and Formal Method

Harry Millwater
UNIVERSITY OF TEXAS AT SAN ANTONIO
UNITED STATES
Computational Materials

Yuri Mishin
GEORGE MASON UNIVERSITY
UNITED STATES
Computational Materials

Carl Ollivier - Gooch
UNIVERSITY OF BRITISH COLUMBIA
CANADA
Revolutionary Computational Aerosciences (RCA) Institute Support

Matt Otten
CORNELL UNIVERSITY
UNITED STATES
High Performance Computing (HPC) Support: GPU Hackathon

Vincent Perrier
INRIA
FRANCE
Radically New, Hyperbolic Navier-Stokes Methods for Complex Simulations

Damian Rousen
SOURCERY INSTITUTE
UNITED STATES
High Performance Computing (HPC) Support: GPU Hackathon

Robert Schoelkopf
YALE UNIVERSITY
UNITED STATES
Quantum Computing Workshop

Robert Searles
UNIVERSITY OF DELAWARE
UNITED STATES
High Performance Computing (HPC) Support: GPU Hackathon

Philippe Spalart
BOEING
UNITED STATES
Revolutionary Computational Aerosciences (RCA) Institute Support

Jeffrey Yepez
UNIVERSITY OF HAWAII AT MANOA
UNITED STATES
Quantum Computing Workshop

Visiting Faculty

James Atlas
UNIVERSITY OF DELAWARE
UNITED STATES
High Performance Computing (HPC) Support for Seminars, Workshops, and Visiting Experts

Philippe Bardet
GEORGE WASHINGTON UNIVERSITY
UNITED STATES
Diagnostic Techniques for Velocimetry, Species Concentration, and Temperature Measurement in Flowing Gaseous Systems

Graham Candler
UNIVERSITY OF MINNESOTA
UNITED STATES
Revolutionary Computational Aerosciences (RCA) Institute Support

Sunita Chandrasekaran
UNIVERSITY OF DELAWARE
UNITED STATES
High Performance Computing (HPC) Support for Seminars, Workshops, and Visiting Experts

Graduate Education

The NIA Graduate Program offers M.S. and Ph.D. degrees in various engineering and science disciplines from the member universities: Georgia Tech, Hampton University, University of Maryland, North Carolina A&T, North Carolina State, Old Dominion University, University of Virginia, Virginia Tech, and William and Mary. Programs are available to NASA employees, contractors, and others through local instruction and distance-learning facilities. With professors-in-residence, visiting and adjunct faculty, and on-site research staff, we have a department-sized academic presence. Students can earn graduate degrees from prestigious universities, including classes from multiple universities, while performing critical research in a renowned national laboratory, working with renowned researchers and state-of-the-art facilities.

Che-Yuan (Joik) Chang graduated from North Carolina State University in December 2017 with a Ph.D. in Mechanical and Aerospace Engineering. His thesis topic was "Chirp Signal for Wave Dispersion Relationships and Nonlinear Ultrasonic Damage." His advisor was Dr. Fuh-Gwo Yuan. His is currently employed by a private firm.

Andrew Coffey graduated from Georgia Tech in August 2017 with an M.S. in Aerospace Engineering. His thesis topic was "On-Orbit Maintenance Technology Development." His advisor was Dr. Dmitri Mavris. He is currently employed by the Jet Propulsion Laboratory in Pasadena, CA.

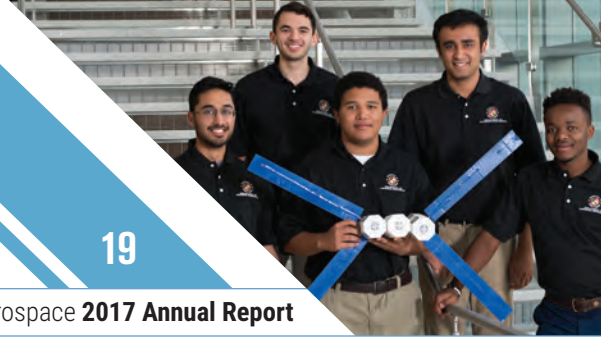
Kaitlyn Fields graduated from Georgia Tech in May 2017 with an M.S. in Aerospace Engineering. Her thesis topic was "Machine Learning Methods Applied to Space Exploration Campaign Modeling." Her advisors were Dr. Dmitri Mavris & Dr. Stephen Edwards. She is currently employed by The Aerospace Corporation as a System Architecture Modeler and Coverage Analyst.

Tyler Blake Hudson graduated from North Carolina State University in December 2017 with a Ph.D. in Aerospace Engineering. His thesis topic was "Real-time Cure Monitoring of Composites Using a Guided Wave-based System with High Temperature Piezoelectric Transducers, Fiber Bragg Gratings, and Phase-shifted Fiber Bragg Gratings." His advisor was Dr. Fuh-Gwo Yuan. He is currently employed by the National Institute of Aerospace as a contractor for NASA Langley Research Center in the Advanced Materials and Processing Branch.

Patrick Leser graduated from North Carolina State University in December 2017 with a Ph.D. in Aerospace Engineering. His thesis topic was "Probabilistic Prognostics and Health Management for Fatigue-Critical Components Using High-Fidelity Models." His advisor was Dr. Fuh-Gwo Yuan. Patrick is now employed by NASA Langley Research Center in the Durability, Damage Tolerance, & Reliability Branch

Nicholas Matthew Pera graduated from Virginia Tech in May 2017 with an M.S. in Aerospace Engineering. His thesis topic was "Development of a Method for Analysis and Incorporation of Rotorcraft Fluctuation in Synthesized Flyover Noise." His advisor was Dr. Christopher Fuller. He is currently employed at The Boeing Company as an Aerodynamic Performance Engineer.

Educational Outreach



NIA'S EDUCATIONAL PROGRAMS AND OUTREACH

team continued to support NASA Langley Research Center and the national Science, Technology, Engineering, and Mathematics (STEM) education community with numerous K-20 inspirational and educational outreach programs, products, and services. Our goals are to improve STEM literacy and to advance opportunities in STEM through authentic learning experiences. We collaborate closely with federal, state, and local governments, industry, and non-profits that reach learners in both formal and out-of-school learning environments.

Of central importance is capturing students' early fascination in discovery and problem solving through project and problem-based learning and maintaining and feeding that interest through the university level. NASA missions and people are featured to provide an exciting context and content that brings STEM alive in the classroom and provides experiences and pathways to professional careers in aerospace.

Higher Education University Programs

NIA's higher education programs primarily focus on rigorous university level student team competitions that challenge students to tackle current and future human space exploration system architectures and technology gaps. Multi-disciplinary and international university collaborations are often required to meet the level of concept development and engineering analysis requirements need to advance.

In 2017, NIA continued program manageent of NASA's Advanced Exploration Systems' annual **Revolutionary Aerospace Systems Concepts – Academic Linkage (RASC-AL)** Engineering Competition. RASC-AL offers university-level engineering students with the opportunity to design projects based on real NASA engineering challenges as well as offers NASA access to new research and design projects by top collegiate talent. Participation includes a two-tiered down select proposal process, technical paper, oral presentation/design review, and poster presentation on one of 4 themes related to NASA's Deep Space Gateway: Lightweight Exercise Suite, Airlock Designs, Commercially Enabled LEO/Mars Habitable Module or a Logistics Delivery System. Fourteen (14) teams convened in Florida in June to compete at the RASC-AL Forum before a panel of NASA and industry experts. **www.rascal.nianet.org**

The RASC-AL Mars Ice Challenge was featured on NASA social media platforms and was promoted through special NASA 360 live broadcasts that reached 1.5 million people.

The successful Mars Ice Challenge is featured in NASA's Global Exploration Roadmap as an effective means of both analogue mission testing and engagement for the Agency.

NIA co-developed and executed the **RASC-AL Special Edition: Mars Ice Challenge** which challenged engineering students to develop and demonstrate innovative systems to harvest water on Mars. Teams put their systems to the test by drilling into a simulated Martian ice deposit and withdrawing water—simulating new approaches to in-situ resource utilization for future human missions and using approaches. Teams competed at Langley and presented their research to a panel of NASA and industry experts. The competition was featured on NASA social media platforms with live broadcasts that reach 1.5 million people. **http://specialedition.rascal.nianet.org**

The 2017 BIG Idea Challenge, sponsored by NASA's Game Changing Development, solicited innovative ideas for in-space assembly of spacecraft – particularly tugs, propelled by solar electric propulsion (SEP), that transfer payloads for low earth orbit (LEO) to a lunar distant retrograde orbit (LDRO). Teams traveled to LARC for a forum to present their research to a panel of NASA experts and the winning teams were offered summer internships. **http://bigidea.nianet.org**

Through the 2017 BIG Idea Challenge, nine (9) students were awarded NASA summer internships at Langley Research Center, Ames Research Center, and Glenn Research Center.

CENTER FOR INTEGRATIVE STEM EDUCATION
NATIONAL INSTITUTE OF AEROSPACE

NIA's Center for Integrative STEM Education (CISE) K-12 Programs

The Center for Integrative STEM Education (CISE) is an NIA Center of Excellence for its K-12 program initiatives. CISE falls within the Educational Outreach Department. NIA's CISE prepares educators to facilitate learning that empowers students to use STEM knowledge and practices to ask "why" and design solutions on their way to becoming STEM-literate citizens. CISE's team of STEM education specialists, Educators-in-Residence (EIR), program managers and in-house producers offer a diverse portfolio of products, services, and training that meet the unique needs of K-12 educators and encourages students' natural curiosity through NASA-inspired learning experiences. NIA's diverse portfolio of programs and activities, led by our award-winning Educational Outreach team include: pre- and in-service teacher training and graduate course work; web-based programs for elementary, middle, and high school students; virtual world modeling and simulation programs; video production; and classroom science and engineering resources.

NIA offers an EIR program through CISE in partnership with Hampton City Schools. EIRs are part of the collaborative learning network focusing on leading-edge best practices and resources in STEM education. EIRs maintain close relationships with their home districts and serve as active liaisons between the national STEM education community and their school system. Impacting change and improving student achievement is at the core of NIA's EIR program.

During FY17, NASA eClips Outreach efforts shared STEM activities, reaching 2,287 students and 248 teachers. And its website has received over 8.4M lifetime hits.
nasaeclips.arc.nasa.gov

McDANIEL COLLEGE

CISE continues to deliver seven graduate courses that it developed in partnership with McDaniel College in Westminster, Maryland. These courses comprise the McDaniel College Elementary STEM Instructional Leadership (ESIL) program, one of the first accredited programs in Maryland. This program was approved by the Maryland Higher Education Commission (MHEC) and the Maryland State Department of Education (MSDE). The courses are offered both on-campus and off-campus and can be differentiated to align with school systems' STEM initiatives. The NIA-McDaniel course design follows research-based best practice incorporating active learning; job-embedded tasks; systemic and coherent design; on-going and sustainable learning; and reflective feedback. The courses are hybrids with both online and face-to-face instruction.

NASA eClips™

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NASAeClips

During FY17, NIA continued development and dissemination of NASA eClips 4D, a multi-media educational program selected for a five-year grant by NASA's Science Mission Directorate to address the continued needs of the country's formal and non-formal K-12 educators. The program Designs, Develops, Disseminates, and Discovers (4D) new strategies to enable STEM education resulting in an increase in science content understanding. Video segments and educator resources developed as part of this program are available on the NASA eClips™ site, **nasaeclips.arc.nasa.gov**.

Educational Outreach

Credit: NASA

NASA Out of School Learning Network

For FY17, CISE worked closely with the NASA Langley Office of Education to develop NASA's Out of School Learning (NOSL) Network's professional development (PD) strategy, instruments and training modules for a NASA train-the-trainer model for use with out-of-school providers that accommodate a range of settings, audiences, and needs. A beta testing prototype instrument was also developed for use by the three participating centers to gather feedback about the PD instruments and modules during summer trainings and workshops. The NOSL Network interacts with local school districts, community and youth serving organizations and informal education institutions to provide out-of-school time STEM educational opportunities for elementary and secondary students.

Partners and Collaborators

Aiming to maximize the resources and abilities of the Institute, NIA strategically partners with and leverages its relationships and resources with those of other organizations. Such organizations include the Federal and state government and local school districts. We also work closely with professional organizations and non-profit entities including: International Technology Engineering Educators Association (ITEEA), National Science Teachers Association (NSTA), NASA Museum Alliance, Global Learning and Observations to Benefit the Environment (GLOBE), public television (WHRO, WGBH), the Challenger Learning Center, NASA Earth to Sky and the Virginia Air and Space Center, Virginia Aerospace Business Association, American Institute of Aeronautics and Astronautics (AIAA), and numerous colleges and universities. Education and outreach corporate collaborators include: Promethean, NearPod, SpaceX, Blue Origin, Honeybee Robotics, Spadework's Engineering, Aerojet Rocketdyne, and Maryland Aerospace.

NIA initiates programs through internal funding and via submission of proposals to funding agencies. NIA also makes sub-awards to organizations, including our university consortium partners, thus allowing the Institute to leverage the capabilities and reputations of these collaborators and maximize the impact of the Institute's educational outreach program.

Media Communications and Public Outreach

NIA collaborates with government, industry, universities, professional societies, non-profits and others to develop and implement projects and campaigns that build excitement and support for NASA and the aerospace community.

NIA's multi-layered support and world-class creative services are crafted to deliver award-winning campaigns. With internationally recognized work in radio, web, live broadcasts, conferences, and events, NIA provides valuable support for marketing and media, outreach and communications.

NASA 360

NASA 360 is a premiere NASA outreach program that brings you the latest in NASA science, engineering and aeronautics. From understanding our changing Earth to preparing humans for a journey to Mars - this is YOUR space agency, get to know it.

Videos in the NASA 360 production suite include compelling videos in traditional formats, as well as text videos, animations, and promotional trailers that meet client needs and capitalize on current media trends. NASA 360 is hosted on NASA.gov and other broadcast platforms such as YouTube and Facebook and engages millions of viewers each year.

NASA 360 is available on **www.NASA.gov/nasa360**

NASA 360 has more than 5 million Facebook, Twitter, and YouTube followers.

Follow NASA 360:

Facebook.com/FollowNASA360 **Twitter.com/NASA360**

NASA 360 TEAM WINS SILVER AND BRONZE AT 38TH ANNUAL TELLY AWARDS

Scott Bednar, Caleb Stern, Jim Lucas, Tom Shortridge, Rebecca Jaramillo, and Harla Sherwood were recipients of two Telly Awards in March 2017. NASA 360 Talks: "The Exploration of Pluto" and NASA 360: "NASA's Vascular Tissue Challenge – Improving Life in Space and Earth" earned the silver and bronze awards, respectively.

Innovation Now

Innovation Now brings listeners the stories behind the ideas that shape the future and benefit our lives.

Developed in collaboration with NASA Langley Research Center and launched in Sept. 2011, NIA produces and distributes ~260 radio segments annually. The 90-second interstitial is designed to air daily, Monday-Friday, for broadcast during programs like National Public Radio's "All Things Considered." WHRO/WHRV Hampton Roads is the public radio partner supporting online distribution of the program nationally to public radio stations.

Innovation Now promotes advocacy for NASA research and technology programs while communicating the societal impact of NASA technology investments.

The series reaches ~13.5 million listeners worldwide daily via public, college and commercial broadcast radio stations, on the web through Internet radio stations like Stitcher and Altradio, and through news media distributors such as iTunes. In 2017, Innovation Now became available through the NRP One app, making it accessible at any time on demand on any mobile device.

www.innovationnow.us

What can you discover in 90 seconds?

Follow Innovation Now:

@InnovationNow

@innovationradio

Media Communications and Public Outreach

NASA iTech

NASA iTech is a unique initiative to find innovative ideas that address critical problems here on Earth and hold great potential to solve critical technology challenges in future space exploration. Those ideas may come from small or large businesses, academia, other government organizations – or others who may not have previously had a forum to present their solutions to NASA leadership or their industry partners.

Finalists from across the U.S. have represented 20 of their most promising innovative technologies at the NASA iTech Forum during the first two cycles of the initiative in 2017 addressing focus areas including autonomy; big data: data mining and machine learning; medical systems and operation; radiation protection and mitigation; and x-factor innovations: solutions for unspecified future challenges.

For more information visit, **www.NASAiTech.com**

Finalists from NASA iTech Cycle 1 and 2 included teams from Aequor, Inc., InnaMed, Inc., Liberty Biosecurity, Children's National Health System – Omniboros Team, Context AI, and University of Houston.

NASA Langley Centennial

NIA was honored to support the NASA Langley 100th Anniversary. A live web broadcast of the Langley Centennial Symposium, production of Innovation Now radio segments that aligned with the Centennial communications themes for the year, event planning, and social media support helped share the celebration with a broad, national audience.

livestream.com/viewnow/NASALangleyCentennialSymposium

Live Streaming and Event Support

The NIA Media Communications Group provides live web broadcast and public engagement support for identified conferences, events, and workshops to broaden public exposure to some of the most exciting new developments in the aerospace industry, and to stimulate an interest in science, engineering, and technology relevant to NASA. Working with both the National Park Service and NASA TV, NIA's largest broadcast endeavor for the year was the webcast of the 2017 Total Solar Eclipse from three remote geographic locations simultaneously: Clingmans Dome in the Great Smoky Mountains; Ft. Moultrie, SC; and on a Coast Guard boat off the coast of Charleston, SC.

2017 Livestream Webcasts included:

- AIAA SciTech 2017
- Vision 2050 Workshop
- 48th Lunar Planetary Science Conference
- Humans to Mars Summit 2017
- Mars Ice Challenge
- AIAA Aviation 2017
- NASA Langley Centennial Symposium
- AIAA Propulsion and Energy 2017
- Total Solar Eclipse from the Great Smoky Mountains and Charleston, SC
- NASA's 3D-Printed Habitat Challenge
- 2017 Women in STEM Forum
- Hampton University's Center for Atmospheric Research and Education Seminar Series
- NIAC Symposium 2017

https://livestream.com/viewnow

In addition to Livestream broadcasts for the 2017 Total Solar Eclipse, NIA produced a series of short videos to prepare viewers for the eclipse and build excitement about the celestial event. The videos achieved >1M views and reached more than 4.8M people.

IN 2017, NIA WAS NAMED ONE OF NONPROFIT TIMES (NPT) TOP 50 BEST NONPROFITS TO WORK FOR IN THE UNITED STATES.

The top 50 nonprofits are chosen from data compiled from thorough organizational assessments. Each participating nonprofit completes a questionnaire and employees are asked to complete a confidential survey to rate company performance in categories such as leadership, planning, corporate culture, communication, role satisfaction, work environment, and relationships with supervisors. These survey categories have been identified by NPT's Employee Benchmark Report as the top 10 key drivers for employee satisfaction and company success. NIA was previously cited as one of the NPT Best Nonprofits to Work For in 2014.

2017 Financials

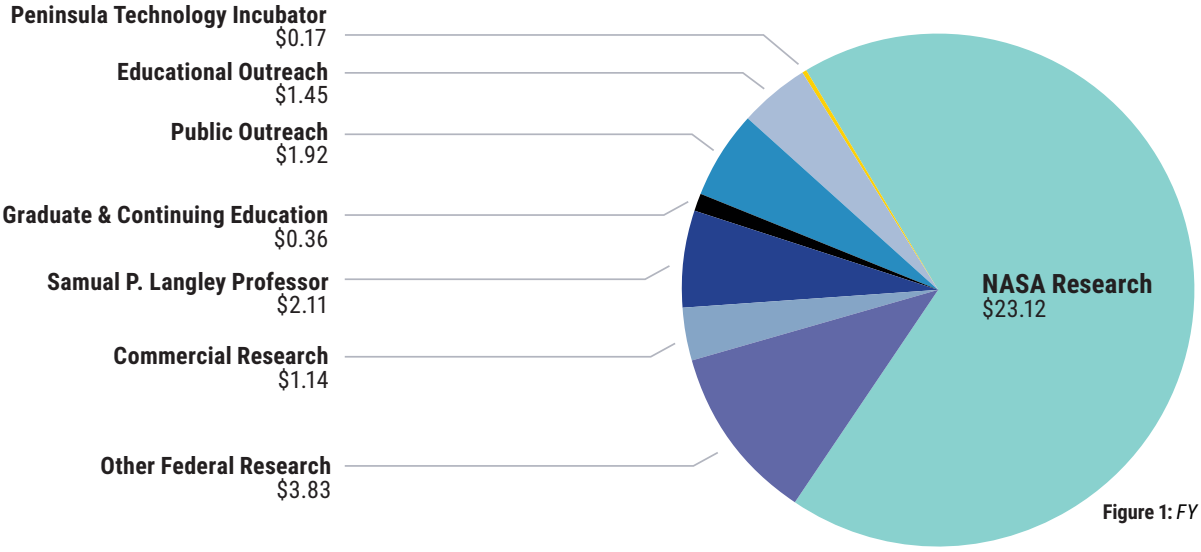

Figure 1: *FY 2017 Earned Revenue by Category*

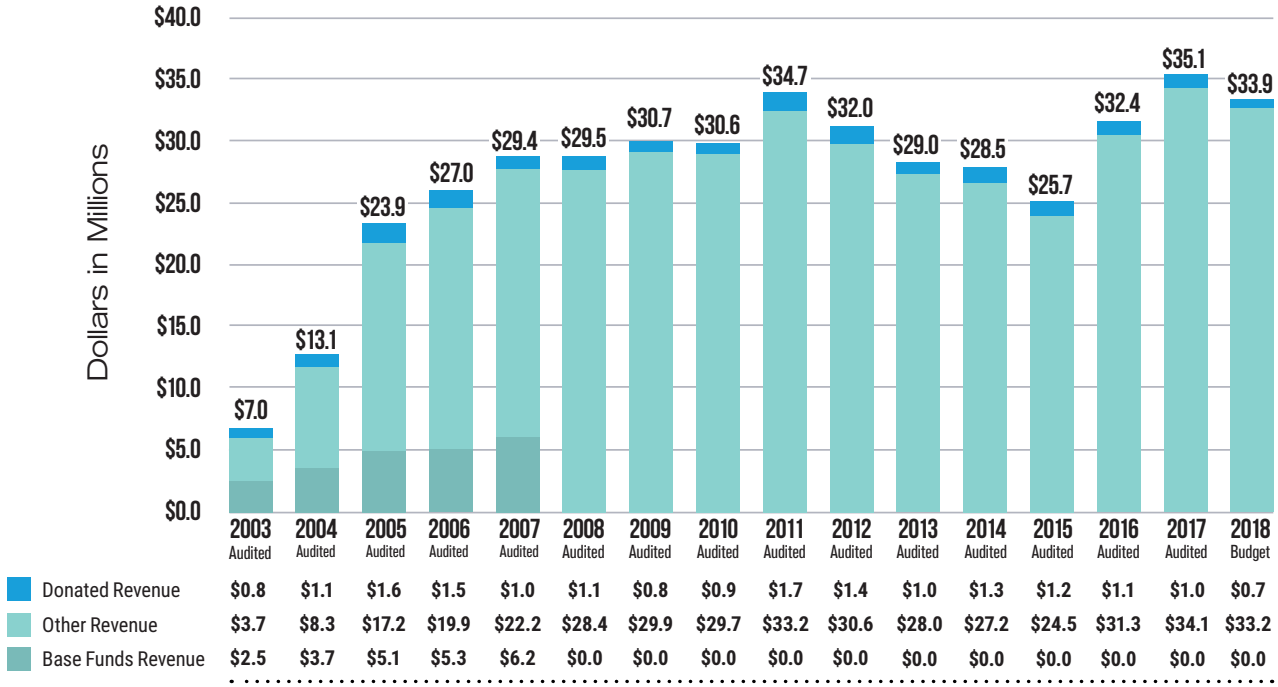

Figure 2: *NIA Total Revenue by Year*

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VICE PRESIDENT OF RESEARCH

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Electrical & Computer Engineering
University of Virginia

Dr. Mark Hinders
LIAISON PROFESSOR
Applied Science
William & Mary University

Tom Irvine
LIAISON
American Institute of Aeronautics & Astronautics

Dr. Teng Li
NIA SAMUEL P. LANGLEY ASSOCIATE PROFESSOR
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University of Maryland

Dr. Robert Loughman
LIAISON PROFESSOR
Atmospheric & Planetary Sciences
Hampton University

Dr. Dimitri Mavris
NIA SAMUEL P. LANGLEY PROFESSOR
Aerospace Systems Design
Georgia Institute of Technology

Dr. Jim McDaniel
LIAISON PROFESSOR
Mechanical & Aerospace Engineering
University of Virginia

Dr. Wiliam Moore
NIA PROFESSOR IN RESIDENCE
Atmospheric & Planetary Sciences
Hampton University

Dr. Brett Newman
NIA PROFESSOR IN RESIDENCE
Mechanical & Aerospace Engineering
Old Dominion University

Dr. Walter O'Brien
LIAISON PROFESSOR
Mechanical Engineering
Virginia Polytechnic Institute & State University

Dr. Leonard Uitenham
LIAISON PROFESSOR
North Carolina A&T State University

Dr. Daniel Weimer
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Dr. Fuh-Gwo Yuan
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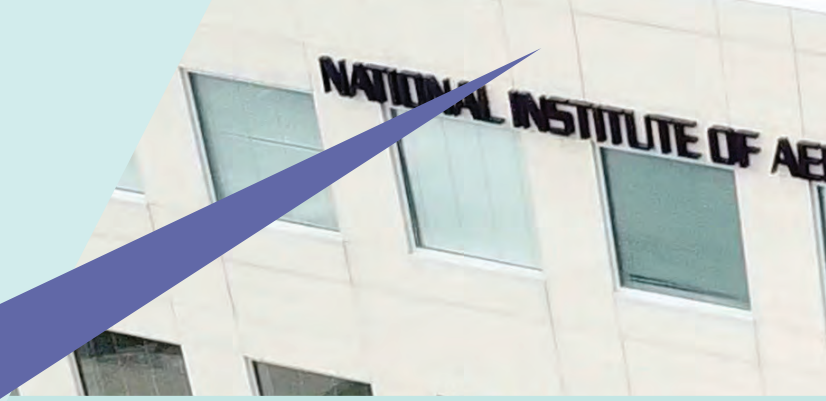
Mechanical & Aerospace Engineering
North Carolina State University



NATIONAL INSTITUTE OF AEROSPACE

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