# Æ Illinois

Newsletter of the Department of Aerospace Engineering
University of Illinois at Urbana-Champaign

Vol. 18 • 2016

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## Faculty News



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## Student News



## Alumni News



## AE appreciates your gifts!



# Welcome to the 2016 Edition of the Alumni Newsletter of Aerospace Engineering at Illinois

As we have emphasized in previous editions of the newsletter, project-based learning both in the classroom and in extra-curricular activities increasingly constitutes a cornerstone of the education of our students. These projects provide unique opportunities for our students to demonstrate creativity, leadership and teamwork skills that are critical for their future career and are greatly valued by employers. Two of the four cover stories chosen for this year's newsletter describe some unique opportunities and successes of our students in space-related projects.

Over the past decade, under the leadership of Prof. Vicki Coverstone, a nanosatellite (CubeSat) program has been created at Illinois primarily through the active participation of undergraduate students. A few months ago, the Illinois CubeSat team was selected for three Undergraduate Student Instrument Project (USIP) awards sponsored by NASA Space Mission Directorate and Office of Education. As described on p. 15, these three new CubeSat missions, which will take place over the next couple of years, will give


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Katie Carr, Coordinated Science Laboratory
Harry H. Hilton, Aerospace Engineering Emeritus Professor
Diane E. Jeffers, Aerospace Engineering Coordinator of External Relations
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a unique opportunity to many undergraduate students to work in multidisciplinary teams and learn how to design, build, test and ultimately control nanosatellites.

The short timeline and the complexity of these CubeSat projects make them particularly challenging, but Illinois students have demonstrated at many occasions that they are up to the task. The remarkable creativity of our students was once again demonstrated this year with Aerospace@Illinois teams winning 1st, 2nd, and 3rd place in the AIAA Undergraduate Space Design Competition. More about this remarkable achievement on p. 20.

Also highlighted in the newsletter is the recently introduced online MS program that combines remote course delivery technology with the quality and rigor of the on-campus MS program. The third cover story (p. 17) features Matthew Schonert who works at Boeing St. Louis and is the first student to complete the entire MS online.

Finally, we focus our fourth cover story on the truly unique research activities of Prof. Scott White, who, for the past two decades, has been leading a multidisciplinary team of faculty and students in the design of autonomic composite materials (p. 4). Under his leadership, Illinois has become the world trailblazer in the design, manufacturing and assessment of this new class of multifunctional materials.

I hope you will enjoy these and many other stories contained in this newsletter on the accomplishments of our faculty, students and alumni. As always, I also encourage you to regularly check the Department's website, www.aerospace.illinois.edu, where we post many more stories that cannot fit in this publication. Brief summaries of AE stories also appear in our e-newsletter published every other month. Please contact us at aerospace@illinois.edu with your email address to be included in this mailing. And, as always, I look forward to your comments.

**Philippe H. Geubelle**
Bliss Professor and Head

***On the cover:*** **At right, Adjunct Research Assistant Prof. Alexander Ghosh works with a student on the 3-Axis Helmholtz Cage in the CubeSat Laboratory.**

***On the back cover:*** **Aerospace Engineering PhD student Debashish Das works in the laboratory of Prof. Ioannis Chasiotis.**

## Department of Aerospace Engineering

### Faculty

Phillip J. Ansell
Maciej Balajewicz
Daniel J. Bodony
Timothy W. Bretl
Ioannis Chasiotis
Huck Beng Chew
J. Craig Dutton
Gregory S. Elliott
Jonathan B. Freund
Grace X. Gao
Philippe H. Geubelle
Koki Ho
Kai James
John Lambros
Cedric Langbort
Vincent Le Chenadec
Deborah A. Levin
Donald M. McFarland
N. Sri Namachchivaya
Marco Panesi
Zachary R. Putnam
Michael S. Selig
Petros G. Voulgaris
Scott R. White

### Lecturers

Steven J. D'Urso
Brian S. Woodard

### Emeritus Faculty

Lawrence A. Bergman
Michael B. Bragg
John D. Buckmaster
Rodney L. Burton
Bruce A. Conway
Harry H. Hilton
Ki D. Lee
John E. Prussing
Wayne C. Solomon

### Affiliate/Adjunct Faculty

Joseph Bentsman
Marco Caccamo
Leonardo Chamorro
Alexander Robin Mercantini Ghosh
Naira Hovakimyan
Tonghun Lee
Eric Loth
Arif Masud
George H. Miley
Carlos Pantano-Rubino
James W. Phillips
Srinivasa M. Salapaka
Nancy R. Sottos
Kelly Stephani
Alexander F. Vakakis

### Staff

Lee A. Booher
Timothy A. Cochrane
Laura A. Gerhold
Diane E. Jeffers
Kendra Lindsey
Stephen S. Mathine
Staci L. McDannel
Gregory S. Milner
Susan K. Mumm
Ann Marie Zettervall

### Shared Services

Tessa M. Hile
Lori Ann Ballinger-Pankau
Leslie L. Reinhart
Lori A. Rairden Willoughby

### Teachers Ranked Excellent by Their Students

**Fall 2015**
Phillip J. Ansell
Daniel J. Bodony
Timothy W. Bretl
Ioannis Chasiotis
J. Craig Dutton
Gail C. Jankouski
Brian S. Woodard

**Spring 2016**
Phillip J. Ansell
Maciej Balajewicz
J. Craig Dutton
Gregory S. Elliott
Philippe H. Geubelle
Alexander R. M. Ghosh
Koki Ho
Gail C. Jankouski
John Lambros
Marco Panesi
Zachary R. Putnam
Vishwa J. Shah
Brian S. Woodard

# In pursuit of the immortal: White's research aimed at materials that never age

Scott White

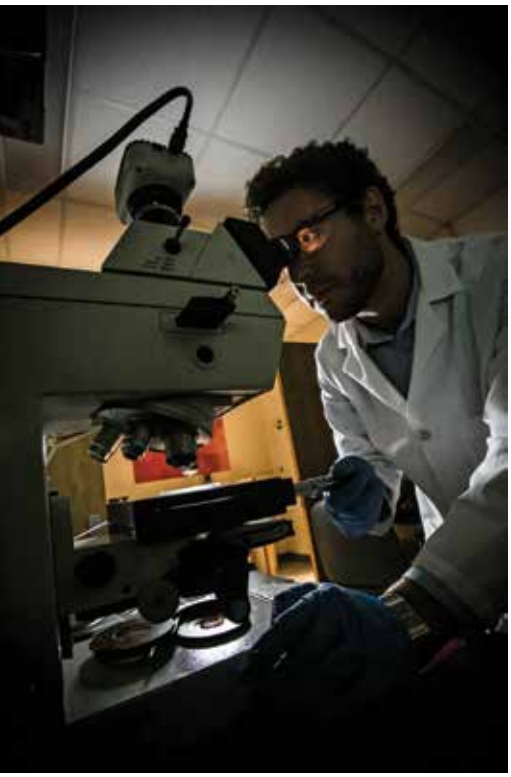
Taking his inspiration from biological systems, Aerospace Engineering at Illinois Prof. Scott White and his colleagues have pioneered autonomous healing materials that have impacted technologies from coating systems to batteries. And just as successful biological systems evolve and thrive over time, so has the group's research.

White and the group's seminal paper on self-healing materials published in *Nature* in 2001 opened the door to a field of science now being pursued by investigators around the world. The initial paper described a composite material that had been embedded with catalysts and microcapsules containing a healing agent. Upon cracking the material, the microcapsules ruptured, spilling their contents into the crack plane, filling the crack and subsequently chemically reacting with the catalyst to heal the crack.

From that initial work, White's group has continually innovated, developing

- microvascular systems that can internally heat or cool a material as well as repetitively self-heal;
- regenerating materials that can fill in large cracks and holes by actually regrowing themselves;
- materials that can be triggered to self-destruct, reducing electronic waste and boosting sustainability in device manufacturing.

"Structural remodeling is one of the 'grand challenges' we are currently pursuing," White said. "We have some of the building blocks already: part of it is regenerating materials and part of it is making them decompose at the end of their life cycle. If we can bring both of these aspects together—precisely regulated—into one grand materials system, then we would be creating materials that never age, so called *immortal materials*."



**Graduate student Tony Griffin works in the Autonomous Materials Systems Laboratory with the Leica DMR microscope.**

While working to achieve this material "immortality," White and his cohorts in the meantime want to let engineers know when a material is in trouble.

Their development of mechanophores - polymers that change colors when they are stressed—was among *Popular Mechanics*' Top Ten concepts in 2011. Working with Nancy Sottos, a professor of materials science and an AE affiliate, White this year published findings in the journal, *Advanced Materials*, about a new damage indication system. The system automatically highlights areas that are cracked, scratched or stressed, allowing for problems to be addressed before becoming more difficult.

White's group has further applied the idea of self-healing composites to self-healing electronic circuits, with a focus on batteries for electrical vehicles. In late 2011, the group, including Jeff Moore, a chemistry professor at Illinois, demonstrated a simple circuit covered by microcapsules containing a liquid metal. When the circuit breaks, the conductive metal fills the gap in less than a millisecond. Argonne National Laboratory is leading a Center for Electrical Energy Storage with White and colleagues working on self-healing technology for use in future batteries and fuel cells.

The creativity and productivity of White and his colleagues have been recognized and supported by the Air Force Office of Scientific Research. This past year, AFOSR awarded $4.3 million to create the national Center of Excellence in Self-healing, Regeneration, and Structural Remodeling at the University of Illinois at Urbana-Champaign. Joining White in the new center are Sottos, Moore, AE Prof. Philippe Geubelle, and Aaron P. Esser-Kahn, professor of chemistry at the University of California-Irvine.

AFOSR has supported work by White's Autonomous Materials Systems group with more than $7 million between 2010 and 2014. Following the new center's designation, U.S.

Senator Dick Durbin visited with White in January to tour his laboratories in the Beckman Institute for Advanced Science and Technology.

White's success has earned international accolades. He and his team were honored as a finalist for the 2001 Tech Award recognizing outstanding contributions in technology from the Tech Museum of Innovation (San Jose, California). *Popular Science* acknowledged White's work on self-healing materials as one of the Top Ten Scientific Innovations for 2001. *Scientific American* recognized the work in microvascular systems with the SciAm 50 prize in 2007. *Popular Science* cited the mechanophores work as one of the Top Ten Concepts to Know for 2011.

Through the research, White has received 34 patents in the materials field and has founded two start-up companies to transition university technologies to industry. He has also gained the admiration and respect of his fellow scientists, and gratitude of the students who have worked with him.

"I first became aware of Scott through his early work on self-healing polymer composites. Both then and now, what he and his co-workers have been able to accomplish blows me away," said Stephen Craig, William T. Miller Professor and Chair of the Department of Chemistry at Duke University.

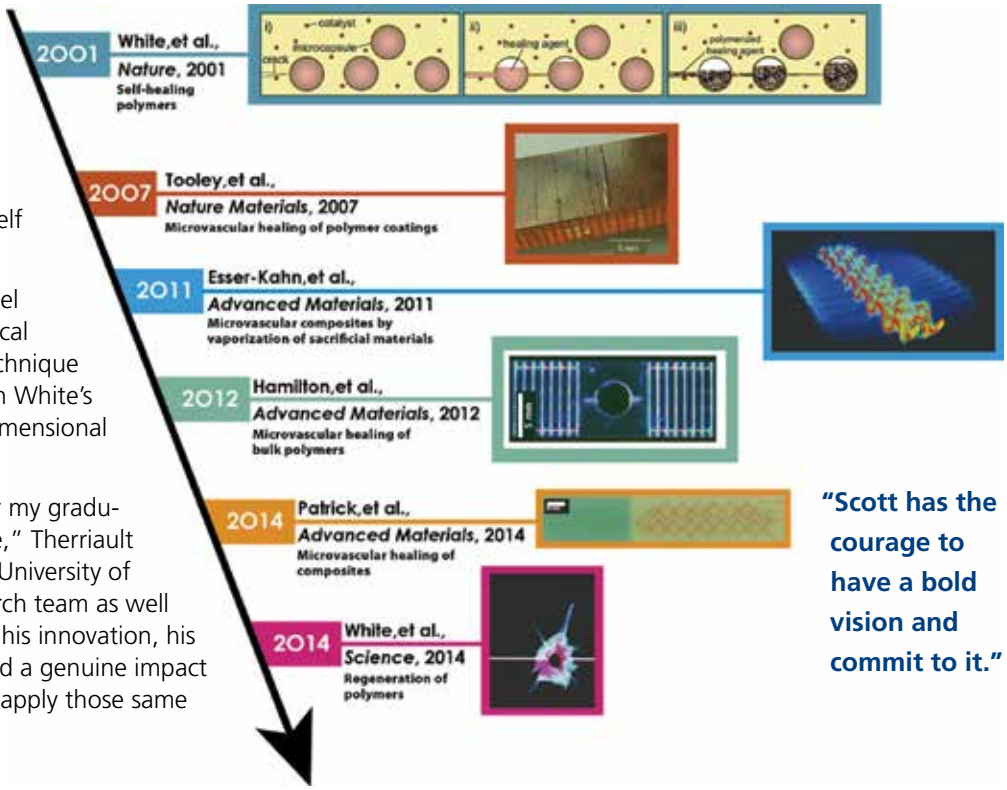
**Scott White, right, directs graduate student Evan Lloyd as he works in the glove box in the Autonomous Materials Systems Laboratory.**

"First of all, Scott has the courage to have a bold vision and commit to it—this is a trait that is far less common in science than one might think, and certainly less common than one would hope," Craig continued. "Second, his ideas reflect creativity of the highest order; the strategies he has devised have often inspired me to think along completely different lines than I had been previously. Third, he has embraced a highly interdisciplinary and collaborative approach, blending the right mix of engineering, materials science, and chemistry for a particular problem.

"He's also a fantastic mentor; I am as impressed by my interactions with his students as I am with the work itself (and that's a high standard)."

Among those students has been Daniel Therriault, PhD 2003, now a mechanical engineering professor at Ecole Polytechnique de Montreal. Therriault worked within White's group on microfabrication of three-dimensional microvascular networks.

"Even now, more than ten years after my graduation, he's still a real inspiration to me," Therriault said of White. "As a professor at the University of Montreal, I'm trying to lead my research team as well as he leads his. As a research advisor, his innovation, his passion for his work and his ethics had a genuine impact on me as a person, and today I try to apply those same qualities in my own work."




**"Scott has the courage to have a bold vision and commit to it."**

# Bodony takes part in $7.4 million Defense Department MURI project

Daniel Bodony

Aerospace Engineering at Illinois Associate Prof. Daniel Bodony has joined scientists from four other universities in a $7.4 million U.S. Department of Defense project to predict and control liquid sprays.

Through the Multidisciplinary University Research Initiative (MURI), the DOD hopes to gain a better understanding of spray physics and control to improve liquid fuel combustion systems, with additional applications to liquid cooling, 3D printing, and ship wake mitigation.

The MURI will develop computational and experimental techniques for controlling the primary breakup process that liquid jets undergo, as well as develop novel metrics and techniques for controlling dispersed sprays. Electrostatic forces and acoustic waves are to be used for primary breakup and spray dispersion control, while fuel injector design is also a critical component for breakup.

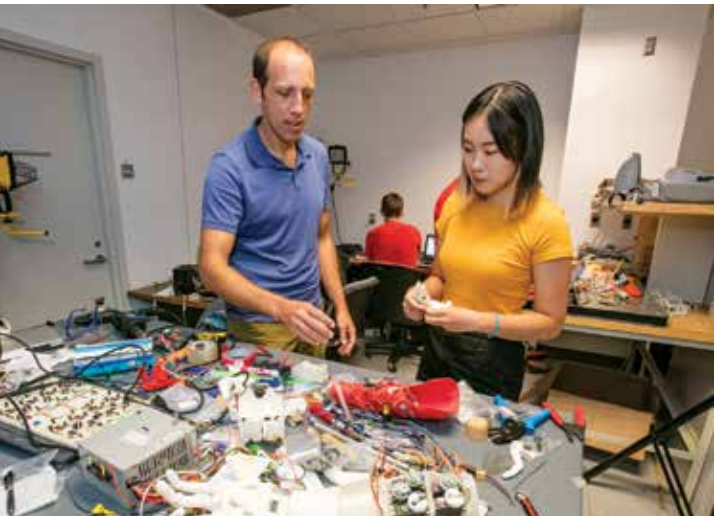
"Jet-engine fuel injection sprays are the motivating application, and a critical component in jet engine safety and efficiency," said Bodony.

In a jet engine, fuel comes out as a swirling stream that splits into droplets that evaporate and then ignite. The scientists' goal is to convert the stream into droplets that evaporate as quickly as possible. "I'm to develop the flow control required to more quickly convert the stream of liquid fuel into droplets," Bodony said. "I have to develop the numerical algorithms that determine the optimal control."

In addition to large-scale parallel computing, his research focuses on fluid mechanics and compressible fluids, flow stability and control, fluid-thermal-structure interaction, and aeroacoustics.

Olivier Desjardins of Cornell University leads the MURI, with other contributing researchers from the University of Washington, the University of Florida and Iowa State University. The DOD Office of Naval Research will fund the project with $1.5 million per year for the next five years.

# Bretl's diverse research interests impact construction projects, prosthetics, BCI



Tim Bretl works with graduate student Kyung Yun Choi on the prosthetic hand project.

## Sacramento Kings arena construction

A University of Illinois team including Aerospace Engineering at Illinois Associate Prof. Tim Bretl has developed predictive visual data analytics tools, called "Flying Superintendent," to automate and streamline today's time-consuming practices for construction progress monitoring.

The team's award-winning solution utilizes both images and videos taken with camera drones and four-dimensional Building Information Modeling (BIM) to identify and visually communicate the actual and potential performance problems during construction projects via smartphones and tablets to project participants, on and off site.

The Illinois team has been collaborating with Turner Construction Company's Northern California office to implement the technology on the NBA's Sacramento Kings new downtown arena, the Golden 1 Center. The goal has been to use the Illinois-developed color-coded 3D visual production models to easily and quickly inform project stakeholders about at-risk locations on a project site. This allows them to prioritize problems based on their impact on construction plan, and take corrective actions to improve the reliability of short-term project plans as well as develop more productive workflows for construction.

Bretl, a member of Artificial Intelligence Group at the Beckman Institute for Science and Technology, works on the project with Mani Golparvar-Fard, assistant professor of civil and environmental engineering, and Derek Hoiem, assistant professor of computer science, and a member in Beckman's Human Perception and Performance Group. The collaboration has earned a Turner Innovation Award in Turner's Fourth Annual Award for Innovation program.

Bretl's focus on the project is automating the process of data collection through the aerial robots. His team is developing methods of navigation and control that get the robots safely from one place to another on the site, take photos at ideal places, and guarantee that enough video is taken to support the visual analysis. Software then analyzes the video and makes recommendations for construction progress.

The University of Illinois team received a nearly $1 million Cyber-Physical Systems (CPS) grant through the National Science Foundation for the project, which kicked off in January 2015 and continues through the end of 2019. With the support of the new faculty entrepreneurial fellowship (FEF) program by the Technology Entrepreneur Center (TEC), the team is commercializing the solution via RECONSTRUCT Inc., a new spinoff company housed in University of Illinois Research Park.

### *Combining robotics and neuroscience*

Bretl also works on the development of upper-limb prosthetic devices. He and graduate student Aadeel Akhtar are building a prosthetic hand that connects to the user with electrodes that read muscle activity (called an electromyographic [EMG]-based interface) and incorporates sensory feedback.

"Developing prosthetics is all about building effective communication with the device," said Bretl. "There's the EMG interface that translates muscle activity into commands for the device—so how the person tells the device what to do—and then there's how the device tells the person what it's doing—so that's sensory feedback—and we do all of that."

Akhtar won the Cozad New Venture Competition in April 2015 and is now funded by the University to advance PSYONIC, a start-up company that builds prosthetic hands for less than $1,000, compared to the $30,000 to $40,000 that current devices cost. The researchers hope that the application can improve the lives of people with amputations worldwide, especially in developing countries.

### *Brain-Computer Interfaces (BCI)*

Bretl's team also is developing an interface that uses brain activity gathered from an electroencephalogram (EEG) to allow people to do anything from typing words to flying an aircraft. Bretl says one of the main objectives is to help people with severe motor disabilities interact more fully with the world around them. Finding a way for BCIs to work would be a significant scientific accomplishment.

"You have to understand a lot about brain function and how that's reflected in EEG activity," said Bretl. "So in thinking about how to get BCIs to work, it causes you to ask questions about the brain that tend to be a little different than what has traditionally been asked in neuroscience, and this could provide new insight for the scientific community."

**"in thinking about how to get BCIs to work, it causes you to ask questions about the brain that tend to be a little different than what has traditionally been asked in neuroscience."**

# *Langbort uses game theory to protect the grid from hackers*

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With funding from the National Science Foundation, Aerospace Engineering at Illinois Associate Prof. Cedric Langbort hopes to counteract the most insidious types of cyberattacks to the U.S. grid: those in which grid operators may themselves be unwitting participants.

It's possible for malicious hackers to purposefully feed bad data to controllers, who may mistakenly believe the energy flow needs to be adjusted, essentially fooling the control system into disrupting its own state. Langbort, who uses game theory to develop secure control algorithms, says the challenge is that "you don't know what you don't know."

"Remember the movie about John Nash?" Langbort said, referring to the film, *A Beautiful Mind*. "There's a scene where Nash and his friends discuss how if they all go for the same girl, no one will get the girl. But if they cooperate and know each other's strategies, they have a good chance of succeeding.

"My decision influences your outcomes and vice versa," he says. "It's basic Nash equilibrium."

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**"My decision influences your outcomes and vice versa. It's basic Nash equilibrium."**

Cedric Langbort

For Langbort, cybersecurity is more than preventing hackers from getting into the system. He assumes a hacker will find a way in—especially in a system with more and more distributed entry points. The challenge is how to detect those seemingly innocuous perturbations and develop countermeasures for an attack in progress. "What I do affects what you get to know about the game," says Langbort. "That makes it more difficult because now there are things that you don't know that I know."

Those things can include whether the attacker has altered the sensor signals to provide incorrect measurements—maybe not enough to trigger an alarm about an "unnatural" perturbation, but enough so the controller unnecessarily adjusts the energy flow. Once that happens, the system is compromised.

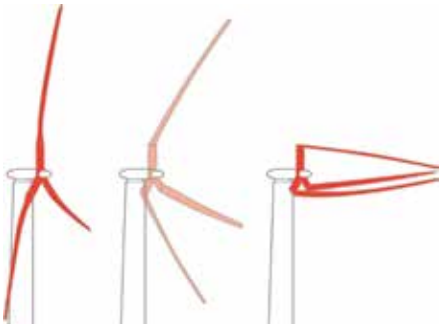
Langbort is developing an algorithm that would help people make decisions when information is incomplete or even purposefully misleading. "There is a lot of interest in cybersecurity right now," he says, "because these are difficult, fundamental problems. These types of games that involve partial information are not well understood."

He is even playing both sides of the game in his research, setting up smart control systems and then trying to hack them. He's doing so to identify the weaknesses, as well as potential methods to exploit weaknesses, and use them to build a new control theory system.

Langbort and other NSF-funded researchers are exploring vital issues that have immediate impacts tied to long-term implications for the power grid. With millions of new points of control, there is tremendous potential to improve efficiency and resiliency, and enormous need to explore innovative methods to secure them.

# Selig plays role in designing enormous blades for offshore energy

Michael Selig



Aerospace Engineering at Illinois Prof. Michael Selig, an expert in wind turbine airfoil and blade design, is playing a pivotal role in one of the most ambitious wind energy projects ever attempted.

Selig's knowledge will be put to task in helping design gigantic blades, each stretching longer than two football fields, to be used in construction of offshore 50-megawatt wind turbines that would power the United States and other countries. The U.S. Department of Energy (DOE) Advanced Research Projects Agency-Energy (ARPA-E) program is funding the $3.56 million extreme-scale Segmented Ultralight Morphing Rotor (SUMR) research.

The 200-meter-long blades will be used in a new design approach to traditional wind turbine structures. Conventional turbines are configured with the rotor blades upwind of the tower. The new exascale blades will be downwind of the tower and segmented so that they bend with the force of heavy winds produced by extreme weather, such as hurricanes and severe storms.

Inspired by the way palm trees move in storms, the lightweight, segmented trunks will bend in the wind while retaining segment stiffness. This alignment will reduce the mass required for blade stiffening by reducing the forces on the blades.

"The lighter weight should produce a more economic blade at less cost," Selig said.

At lower wind speeds, the blades will be designed to spread out to maximize power production. With blades almost three times as long as current offshore designs, the SUMR research aims to target turbines that can produce up to nine times as much power at rated conditions.

Eric Loth, a former AE professor who is now Rolls-Royce Commonwealth Professor in the University of Virginia's Department of Mechanical and Aerospace Engineering, leads the investigation team that includes Selig from Illinois, the University of Colorado, the Colorado School of Mines, Sandia National Laboratory, and the National Renewable Energy Laboratory, as well as corporate partners Dominion Resources, General Electric Co., Siemens AG and Vestas Wind Systems.

# Faculty and Staff Awards

## Phil Ansell

Associate Prof. Timothy Ansell was included in January to the **Forbes Magazine 30 Under 30** List, which identified individuals under 30 years old who are the country's brightest game changers, movers and makers in 20 different fields. Ansell was included in the Science category.

Ansell joined the AE faculty at Illinois soon after earning his master's degree (2010) and PhD (2013) from the department. Since then, he has hit the ground running, earning an AFOSR Young Investigator Award in 2015, and, locally, an Engineering Council Outstanding Advising Award the same year.

## Lori Ballinger-Pankau

Ballinger-Pankau, Assistant Director in Grants Administration for the College of Engineering Shared Administrative Services, was named the **2016 Staff Member of the Year** for Aerospace Engineering at Illinois.

## Daniel Bodony

Associate Prof. Daniel Bodony has won the **2016 Engineering at Illinois Dean's Award for Excellence in Research.**

Since joining AE in 2006, Bodony has established himself as an international leader in developing novel numerical techniques and using large scale computers to investigate and control compressible turbulent flows, with applications focusing on aerospace systems and their generated noise.

His research has led to important advances in the development and application of advanced numerical tools for a wide variety of complex flow physics and multiphysics (fluid/structure/acoustics) interaction problems.

## Timothy Bretl

For the second consecutive year, the College of Engineering at Illinois has recognized Assistant Prof. Phil Bretl as a superior educator by honoring him with prestigious teaching awards.

Bretl won the Collins Award for Innovative Teaching in 2015. That has been followed in 2016 with the College's **Rose Award for Teaching Excellence**, and the **William L. Everitt Award** from the student-led Engineering Council organization.

A member of AE's faculty since 2006, Bretl has given considerable thought and energy to improving his teaching abilities, and his students have shown their appreciation. His Instructor & Course Evaluation System (ICES) scores are the best in the AE Department.

## Ioannis Chasiotis

Prof. Ioannis Chasiotis has been named a 2016 **University of Illinois Faculty Scholar**, an honor recognizing the university's commitment to fostering excellence in teaching, scholarship and service by its faculty. The program provides funding for three years to enhance the awardees' scholarly activities.

Chasiotis has published chapters in five books, and over 60 articles in peer-reviewed journals on his research in experimental mechanics at the micro and the nanoscale. He studies the mechanical reliability and fracture of microelectromechanical systems, thin film materials and high performance carbon and polymer nanofibers, and deformation and damage mechanics of heterogeneous materials at small scales.

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## Craig Dutton

Prof. J. Craig Dutton is the 2016 winner of the University of Illinois **Excellence in Faculty Mentoring Award.**

The Office of the Provost award recognizes a faculty member who has demonstrated an outstanding commitment to mentoring by actively assisting pre-tenure and mid-career faculty in developing their careers.

Referring to Dutton as having a "mentor personality," College of Engineering Dean Andreas Cangellaris maintained that Dutton's influence has been vital in launching successful careers for many junior faculty members in both Mechanical Science and Engineering and Aerospace Engineering "Craig is not a mentor just because he is asked or assigned to do so; he is a mentor through all that he does," the Dean said.

## Laura Gerhold

Undergraduate Coordinator Laura Gerhold has won the **Engineering Council Excellence in Advising Award** for the fourth consecutive year. She joined the AE staff in 2013.

## John Lambros

Prof. John Lambros has been elected a **Fellow of the American Academy of Mechanics (AAM),** recognizing his outstanding contributions to, and leadership in, the field of Experimental Mechanics.

The latest recognition adds to Lambros' honors that include Fellowship in the American Society of Mechanical Engineers (ASME) and the Society for Experimental Mechanics (SEM). He was also recognized with SEM's M.M. Frocht Award for Excellence in Mechanics Teaching in 2015.

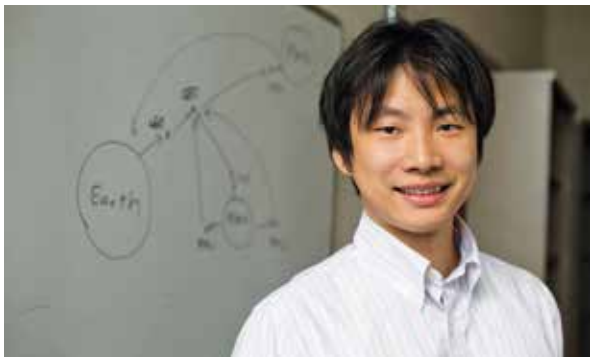
## Grace Gao

Assistant Prof. Grace Gao has received the American Institute of Aeronautics and Astronautics (AIAA) Illinois Chapter's **2016 Teacher of the Year Award**.

In her three years at Illinois, Gao has received the 2015 College of Engineering Everitt Award for Teaching Excellence and was included on the Illinois List of Teachers Ranked as Excellent by Their Students in 2014 and 2015. She joined the Illinois faculty in 2012.

Teaching AE 483—UAV Navigation and Control in Fall 2015, Gao motivated her students by inviting industry executives and national researchers to engage with the students and the class. The guests, from Horizon Hobby, a leader in radio control airplanes, cars, quadrotors and radios, and senior scientists from NASA's Ames Research Center, presented lectures and offered internships and job opportunities. Horizon Hobby also provided student final project prizes.

## Koki Ho




Assistant Prof. Koki Ho won the **2015 Luigi G. Napolitano Award** from the Space Education and Outreach Committee (SEOC) of the International Astronautical Federation.

The award recognizes researchers who have contributed significantly to the advancement of aerospace science as evidenced through a paper at the International Astronautical Congress.

Ho had presented the paper, "Campaign-Level Dynamic Network Modeling for Spaceflight Logistics for the Flexible Path Concept." The research develops a dynamic network optimization formulation for space mission planning. Introduced as a campaign-level perspective to mission planning, including consideration of reusable space infrastructure, as opposed to the mission-level perspective conventionally used.

## Marco Panesi

Assistant Prof. Marco Panesi has won the 2016 College of Engineering at Illinois **Dean's Award for Excellence in Research** for Assistant Professors.

Having joined Aerospace Engineering at Illinois in 2012, Panesi has established himself as one of the foremost international experts in high-temperature computational aerothermodynamics. His work is changing the way that non-equilibrium phenomena in high-temperature, high-speed flows are understood and modeled.

## Scott White

Prof. Scott White, whose groundbreaking research over the past 15 years has been the genesis for work in self-healing materials, is the 2016 winner of the College of Engineering at Illinois **Tau Beta Pi Daniel C. Drucker Eminent Faculty Award**. The Drucker Award is one of the most prestigious the College has to honor its faculty.

White, a Willett Professor in the College of Engineering and Director of the recently created Center of Excellence in Self-healing, Regeneration, and Structural Remodeling at Illinois, first gained worldwide recognition with the 2001 paper in *Nature* that proposed the concept of microcapsule-based self-healing polymeric composites.

Since that time, the research has grown extensively from the initial work on self-healing materials, to microvascular systems, to regenerating materials and, most recently, to materials that can self-destruct, reducing electronic waste and boosting sustainability in device manufacturing.

White's work on fire prevention in lithium ion (Li-ion) laptop batteries contributed significantly to the Department of Energy's Frontier Research Center (EFRC). The research resulted in a paper, "In Situ Measurements of Strains in Composite Battery Electrodes during Electromechanical Cycling," that earned the **2016 Society for Experimental Mechanics M. Hetényi Award** for White and his colleagues, Nancy R. Sottos, materials science professor at Illinois and an AE faculty affiliate, along with E.M.C. Jones, a PhD candidate in Theoretical and Applied Mechanics, and M.N. Silberstein, formerly a Beckman Fellow of the Beckman Institute.

White also has helped demonstrated a new class of organic materials called *mechanophores*, whose reactive behavior is driven by mechanical force. Most recently he and his colleagues have developed a new color-changing damage indication system that automatically highlights damage in materials.

White currently holds approximately 40 patents, primarily in the field of self-healing polymers and composites. He is a founding partner of CU Aerospace, LLC, a Champaign-based research and development company focusing on technology transition within the aerospace industry. He also founded Autonomic Materials Incorporated (AMI), a start-up company that develops self-healing coatings for applications within the $18B coatings industry from architectural materials to oil production and distribution to marine and defense systems.

# Help Professor Hilton Celebrate his 90th Birthday!

Join Aerospace Engineering Illinois for a special celebration when we host the Harry H. Hilton Symposium & Dinner!

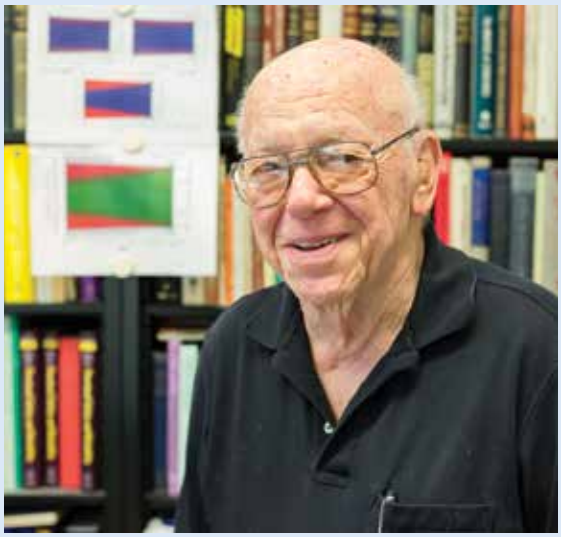
The Friday, October 21, 2016, event will commemorate the 90th birthday of the venerable professor, who continues remarkable activity in the AE Department.

During the afternoon symposium in the Coordinated Science Laboratory Auditorium, several speakers will discuss the impact Hilton has had on their careers, on the department, and the field of aerospace engineering. The festivities will carry on with the dinner, beginning at 6 p.m. in the Alice Campbell Alumni Center Ballroom.

For more information about the celebration, please contact Ann Zettervall at azetter2@illinois.edu, or call 217-244-1359

Hilton started on the Urbana-Champaign campus in 1949, while working to earn his PhD. He was promoted to professor in 1957 and served as department head from 1974 to 1985. Hilton served the College of Engineering as an assistant dean during the 1989 and 1990 summers. While building his career, Hilton became known as an internationally recognized authority in viscoelasticity and aero-viscoelasticity.

Retiring from Illinois in 1990, Hilton has remained active in research, graduate teaching and public and professional service



# Bergman recalls career of graduate students, collaborations and friendships

Larry Bergman

Ask Larry Bergman, newly an emeritus professor and research professor in Aerospace Engineering at Illinois, about his best recollections over his 37-year career at the university, and he may treat you to a stream of photographs.

Tucked in his office, off the beaten path on Talbot Laboratory's third floor, amidst stacks of books, notes, magazines and reports piled around him on desks and on the floor, using a sometimes uncooperative laptop, Bergman will click through one photo after another, telling stories about each and many of the people pictured.

The photographs, sent by students, colleagues and friends for his 70th birthday celebration two years ago at Allerton Park in Monticello, Illinois, represent a life of sharing knowledge, friendship and experiences. "For me, it's always been about the students and collaborators I've worked closely with, and the friendships that I've made," he said. "This profession has given me the opportunity to forge friendships all over the world and to travel extensively, for which I'm grateful."

Bergman's first vibrations laboratory

An expert in structural dynamics and vibrations, structural control and reliability, Bergman's career at Illinois began in the Department of Theoretical & Applied Mechanics in 1979, after he earned his PhD in Applied Mechanics at Case Western Reserve University. Prior to returning to graduate school in 1975, he worked for nine years in the aerospace industry on projects including fuel system controls for the F-4 Phantom, leading edge actuators for the Concorde, a turbo-alternator to supply auxiliary power for the 747, and a wide range of vibration control systems for both military and commercial applications. He moved to AE in 1983, teaching courses and doing research in aerospace structures, aeroelasticity, and linear and nonlinear structural dynamics.

Bergman has authored and co-authored more than 200 articles in archival journals and co-authored and edited six books; he also holds five US patents. He was the editor of the *ASME Journal of Vibration and Acoustics* from 2000–2005, and Chair of the Applied Mechanics Division of American Society of Mechanical Engineers from 2013–2014. To this point, he has supervised or co-supervised 26 MS and 19 PhD degrees. For the past 15 years, he has worked closely with Profs. Alexander Vakakis (MechSE) and (former student) Michael McFarland (AE), and co-directs the Linear and Nonlinear Dynamics and Vibrations Laboratory, located in the Mechanical Engineering Laboratory, with them. He often says that "nothing marks the passage of time like kids and graduate students."

Among those many students are Erik Johnson, Professor and Associate Head of Civil and Environmental Engineering at the University of Southern California, and recipient of the AE Distinguished Alumni Award in 2016. One of the photos shows Johnson's apple-cheeked infant daughter happily sitting on Bergman's lap. The kids "win me over pretty quickly," he admits.

Another former student was Bill Spencer, the Nathan M. and Anne M. Newmark Endowed Chair in Civil Engineering at Illinois, with whom Bergman has continuously interacted since 1980. Bergman noted that the strong connection of his research to structures, both aerospace and civil, resulted in a large number of his former students having careers in civil engineering.

Many of the students and colleagues with whom he collaborated have kept in touch with him over the years, and approximately 40 came back to the area for his milestone birthday celebration. The award for longest trip and shortest visit belongs to AE alumnus Stuart Pang, now an investment banker in Singapore. Pang flew in and joined the festivities for little more than a day before making the 24-hour journey back to Singapore.

In the course of reviewing the photo collection, Bergman's trip down memory lane included stops all over the world, and he particularly recalled some of the zaniest moments. For example, there was the tour by a group from the US of the largest environmental

wind tunnel in the world, in Tsukuba, Japan. After the group entered the test section, the operator turned on the flow and ran it to the point at which the visitors were knocked off their feet. There was also the harrowing experience in Nanjing, China, of Bergman having his scalp stitched together at 3 a.m. in the emergency room of an army hospital after an accident. Afterward, the doctor insisted on giving Bergman a tetanus shot in his bottom, an event that drew a significant audience.

**Symposium at Allerton, Illinois, celebrating Bergman's 70th birthday**

**"I'm grateful for the many opportunities and lasting friendships the last 37 years have afforded me. It's really the beauty of this profession."**

—LARRY BERGMAN

And then there was the road trip with a number of his students to a conference at Columbia University, in New York City. Bergman had arranged to meet them for dinner at 6 p.m., and everyone showed up except two students from China. As Bergman fought back panic that accompanied many scary scenarios crossing his mind, the students finally returned to the dormitory where they were staying. Their explanation was obvious: they had decided to take the subway to Chinatown for some "down-home cooking" rather than eat with the group. Those were the days before cell phones.

Then there was the time on the Greek Island of Skiathos with four of Bergman's former students. The students were all reasonably large, and the only car available was a two-door Fiat with a 500cc engine and minimal brakes. It was a sight to see.

**Bergman at a test site near Vicksburg, Mississippi**

Finally, there was a trip to a conference in Zakopane, Poland (hometown of Pope John Paul II), in the mountains in the far south of the country. The flight on LOT Airlines from O'Hare was packed, and Bergman had to check his suitcase. The plane left eight hours late. When Bergman landed in Warsaw, he learned his ride to Zakopane had already left, and his luggage hadn't made it on the plane. With some help, he found himself facing a 7-hour overnight trip on an unheated World War II-era train, unable to sleep due to the many stops. Upon his arrival at his destination, Bergman was met by his host who informed Bergman his plenary talk would start in 30 minutes, sans shower and clean clothes. The suitcase arrived four days later, as Bergman was leaving the hotel to return to the US.

One of the more touching moments he recalled was traveling to the United Kingdom to serve as surrogate "father-of-the-bride" for one of his former students whose parents were unable to secure a visa in China to attend her wedding. He was delighted to be there for her, and was grateful that no tuxedo was required.

Despite his "retirement," Bergman plans to continue his research work with students and colleagues, and looks forward to traveling and accumulating many more happy memories and funny stories. "I'm grateful for the many opportunities and lasting friendships the last 37 years have afforded me," he said. "It's really the beauty of this profession."

**Bergman and colleagues in Istanbul**

IN MEMORIAM

# Shee-Mang Yen

SEPTEMBER 5, 1919–AUGUST 6, 2016

Shee-Mang Yen

Shee-Mang Yen

Born in Suzhou, China, Aerospace Engineering at Illinois Prof. Emeritus S. M. Yen started his academic career by obtaining a bachelor's degree in mechanical engineering at Jiao Tung University, Shanghai, in 1944. He continued his studies in 1947 in the United States, obtaining a master's degree in 1948 and a PhD in 1951 in mechanical engineering at the University of Illinois at Urbana-Champaign under Prof. Helmut Korst.

After earning his PhD, Yen became an assistant and, later, an associate professor of mechanical engineering at Kansas State University from 1951-56. He returned to Illinois as an associate professor of aerospace engineering, and was promoted to professor in 1962. From 1985 to 1987, Yen was acting head of the department. Retiring on May 20, 1990, he remained active in AE.

Yen's incisive research contributions to rarified gas dynamics and computational hypersonics earned him national and international recognition. He often was invited to present lectures at the USSR Academy of Science and the University of Trondheim in Norway. Yen was selected to participate in an exchange program with the Computational Physics Group of the Moscow Computing Center. At Illinois, he collaborated with faculty in the Coordinated Science Laboratory.

Yen's industrial experience included working three years as an engineer in Taiwan, and as a consultant over three summers at McDonnell Aircraft Company, Boeing Airplane Company and AVCO, respectively. Additionally, he consulted with Ballistic Research Laboratories, Convair, and the NASA Marshall Space Flight Center.

Both before and after retiring from AE at Illinois, Yen helped develop departmental educational policy. Yen also directed AE's Graduate Extramural Program, providing a master's degree-level program at the then-McDonnell Douglas facility in St. Louis. His students spoke highly of his teaching performance and continued to seek his professional advice after their graduations.

Yen's family and AE faculty and staff members remember him for his great sense of humor. He always had a story to tell about his early years in China, his time at college and his past graduate students. He was a devoted husband, father and grandfather, survived by his wife, Maria; daughters, Elizabeth, Debbie, and Frances; son, Robert; and six grandchildren.

Professor Yen shall be missed but not forgotten.

*To see the full text of alumni quotes regarding Professor Yen, go to aerospace.illinois.edu/news/emeritus-prof-shee-mang-yen-memorium*

**By the time I successfully completed a PhD thesis on the optimization of airfoils for maximum lift, it became clear that (Professor Yen's) knowledge and guidance were critical to my success.**

— ROBERT LIEBECK, BS 61, MS 62, PHD 68, SENIOR FELLOW, THE BOEING COMPANY

**In one of my problems I couldn't get the program to converge on the shooting method of integration. After many runs, I finally decided I had to ask (Professor Yen) what I was doing wrong. He listened intently. Then he gave me his advice on how to fix the problem: "Just make the damn thing run." He knew I would learn more by finding it myself. He was right.**

— STEVE D'URSO, BS 78 MECHSE, MS 89, COORDINATOR/LECTURER OF SYSTEMS ENGINEERING, AE AT ILLINOIS

**A peer of Dr. Yen's had forwarded a note asking for a succinct description of "systems engineering." In turn, he asked me to take a stab at defining what was becoming an oft-used, yet somewhat ill defined, term. A day later I returned with a block diagram showing the path from customer requirements to delivered system. Commenting on the speed of my response, Dr. Yen conveyed a compliment and a lesson as he sometimes would in compact, almost Zen-like, form. "A good engineer does things quickly and accurately. One without the other has little value."**

— MICHAEL F. LEMBECK, BS 80, MS 81, PHD 91

# Illinois wins NASA awards for three CubeSat missions

Illinois undergraduates from engineering, business and journalism disciplines will work together on three CubeSat missions following recent awards from the National Aeronautical and Space Administration.

Illinois has successfully gained shares in $500,000 worth of proposals submitted to NASA's $8 million Undergraduate Student Instrument Project initiative, designed for undergraduates to conduct hands-on flight research.

Illinois students in departments including Aerospace Engineering, Electrical and Computer Engineering and Computer Science will team up to build the satellites and the experiments. Business students will work with process management, practical design and construction to help streamline the workflows. Multimedia journalism students will document the myriad challenges the teams face as they bring the projects to fruition.

Alexander Ghosh, AE adjunct research assistant professor and Manager of the Advanced Research for the Exploration of Space (ARES) Center, said the various projects will be multi-institutional as well as multidisciplinary. Illinois will partner with Northwestern University on one project, Purdue University on another, and will involve Bradley University in Peoria, Illinois.

CubeSats, also known as nanosatellites, are about 4x4x13 inches in size and weigh only about 3 pounds. Illinois Prof. Victoria Coverstone began researching CubeSats in 2001. The current award will allow Illinois to demonstrate three technologies NASA describes as being "of high value" to the agency.

## CAPSat

The Cooling, Pointing and Annealing Satellite (CAPSat) is a 3U CubeSat bus developed at Illinois. This satellite will be a technology demonstrator for three key experiments. First, it will demonstrate an active liquid cooling system for CubeSats. Second, it will demonstrate a new control strategy—using piezoelectric actuators embedded in solar panels—to simultaneously reduce vibrations and to change the CubeSat pointing direction. Finally it will develop a single-photon annealing technique to extend the lifetime of sensors important to quantum entanglement experiments in space. The total grant is $200,000, with a small percentage of the work being subcontracted to Bradley University.

Ghosh and AE postdoctoral research associate Kevin Bassett will conduct the coolant experiment, using microvascular technology that AE Prof. Scott White's group has developed. As a CubeSat travels deeper in space, it needs to use high power systems such as communications and thrusters to operate effectively, Ghosh said. These systems produce significant heat, and require active cooling to be effective. The experiment will deploy a panel equipped with microvascular channels through which a coolant is circulated to the CubeSat's hotspots, reducing the overall temperature.

*continued on next page*

**Alex Ghosh, ARES Center, with students on the CubeSat projects.**

**SpaceICE satellite.**

Physics Prof. Paul Kwiat will experiment with improving the performance of single-photon detectors. Specifically, he will study the use of laser-induced heating to repair damage to the detectors caused by radiation in space.

Industrial and Enterprise Systems Engineering Assistant Prof. James Allison and AE Associate Prof. Soon-Jo Chung (now in the Aerospace Department at Caltech University), along with JPL engineers, Drs. Oscar Alvarez-Salazar and Jack Aldrich, will use piezoelectric actuators distributed on the solar panels to rotate the CubeSat from one pointing direction to another. While piezoelectric actuators have been used to reduce vibrations in flexible structures such as solar arrays, the new strain actuated solar arrays (SASA) provide a fundamentally new way of controlling spacecraft pointing direction (or attitude). SASA can point spacecraft more accurately than conventional technologies such as reaction wheels. These advantages are especially important for space telescopes and other sensitive instruments. Quiet, ultra-precise pointing of space telescopes will help scientists look deeper into space, accelerating the search for exoplanets and making new types of studies possible. SASA may in the future eliminate the need for sometimes failure-prone reaction wheels. This could significantly improve spacecraft reliability, helping to avoid reaction wheel failures that have crippled important missions, such as the Kepler space telescope that is currently running in emergency mode. While they have simulated the technique, the satellite experiment provides the advantage of testing it in zero gravity, Ghosh said.

## Student Aerothermal Spectrometer Satellite of Illinois and Indiana (SASSI^2)

Illinois will partner with Purdue University for SASSI$^2$, a $100,000 grant from the NASA Space Mission Directorate.

AE Assistant Prof. Zach Putnam and AE Prof. Debbie Levin will work with Ghosh in using a spectrometer to study the chemical reactions and chemical species present upon a CubeSat's re-entry to Earth. The Purdue student team led by Prof. Alina Alexeenko will provide an advanced pressure sensor to show the density of the atmosphere at re-entry. "This is the kind of mission that scientists can only afford to do with a small CubeSat; we don't want to do it with a billon dollar NASA satellite," Ghosh said. This environment cannot be accurately reproduced in ground-based laboratory tests and, if successful, will provide the first-of-a-kind spectra in flight since the Fire II experiment in 1965.

## SpaceICE—Interface Convective Effects

In this $200,000 award from the NASA Office of Education, Illinois will provide the CubeSat for Northwestern University to conduct a freeze-casting demonstration. Northwestern wants to get into materials fabrication in space using a technique that involves freezing particle suspensions. The CubeSat would take into space particles suspended in water that will be frozen, simulating the process that would be used in space-based materials fabrication.

NASA requires that all the projects be completed within two years, and Ghosh estimates hands-on opportunities will be provided for up to 100 students. "It's certainly going to be the largest, most interdisciplinary project I've been involved with at the university," he said. "It validates a lot of the work we've been doing and is very exciting. This is a big win for Illinois."

***Welcome Class of 2020!***

**Aerospace Engineering at Illinois welcomed 97 new freshmen in Fall 2016. Total undergraduate enrollment stands at 502 students for Academic Year 2016–17.**

# AE alum experiences success with online MS program

Matthew Schonert knew after earning his bachelor's in Aerospace Engineering at Illinois in 2013 that he wanted to pursue a graduate degree.

A year later, AE faculty members showcased the department's new online MS program during an alumni luncheon at Boeing in St. Louis. Schonert, working as a structural analysis engineer for Boeing's F-15 and F/A-18 Armament team, realized it was the right fit for him.

"I enjoy taking classes and learning new material, and Boeing encourages its employees to continue their education by reimbursing tuition and other expenses," Schonert said. "I specifically chose the online master's program at Illinois because I already have a relationship with the (AE) department through my undergraduate career, and because the flexibility of the online format allowed me to complete the program quickly with success while continuing to work full time."

Graduating this past spring, Schonert found it easy to take online courses while continuing at Boeing.

"There was one week in which I was sent on business travel with very short notice. But I was able to keep up with lecture and homework in my hotel room throughout the travel since the program is administered online," he said. "Another good aspect of the format is the ability to pause, rewind, and re-watch lectures. If there was ever a moment that I didn't quite catch what the professor was saying, or if I didn't quite understand something during the lecture, I could always rewind and watch a specific segment again. Or if I wanted to make extra notes or look up a reference in the middle of lecture, I could pause and restart when I was ready to continue. This was a significant help with (my) comprehension and retention of the material."

In addition to helping him stay competitive in the workforce, Schonert believes the master's degree opened opportunities that he would not have had otherwise.

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**Matthew Schonert and Prof. John Lambros**

**"If there was ever a moment that I didn't quite catch what the professor was saying, or if I didn't quite understand something during the lecture, I could always rewind and watch a specific segment again."**

## Certificate programs offer means to gain additional expertise

Several new Aerospace Engineering at Illinois Certificate Programs are intended to provide students with accessible, online or on-campus means to gain expertise on particular topics in AE's graduate student curriculum.

Since Fall 2014, AE has offered all non-laboratory graduate degree courses online. Specific groupings of these courses create the areas that are now available as certificates.

Certificates are awarded upon the completion of 12 hours of coursework selected from each course grouping. The new program could appeal to working individuals who might be considering a master's degree but are hesitant to resume student life. Earning a certificate first would allow them to gradually re-enter the academic environment. A master's degree requires 32 hours and up to 12 hours of these could be transferred from a previously earned certificate.

Certificates also may be attractive to AE bachelor's degree graduates who were interested in additional courses but were unable to fit them into undergraduate schedules. For more information on courses offered, go to aerospace.illinois.edu/graduate-programs/certificates.

"I did not study aeroelasticity while an undergrad and had no direct exposure to the field through my work assignment. However, the two aeroelasticity courses I took through the master's program were my favorites, and through one of my professors I was able to connect with someone at my work-place who works in the field."

AE's online master's degree courses are the same courses that are taught on campus. Exams, also the same as those taken by on-campus students, can be proctored offsite. "I had the ability to take them proctored at work and wasn't required to return to campus, but I used that opportunity to visit people I knew who were still on campus and to talk to some faculty," Schonert said. "It helped that Champaign is less than a 3-hour drive from St. Louis, and it was nice to supplement the purely online format with some face-to-face interaction. I also returned this past May for graduation ceremonies."

Communicating with professors and other students through the online format wasn't quite as easy as doing so in person, Schonert found. "Some classes were better about it than others though. The best courses handled the online format by facilitating communication through additional interfaces," he said. "For example, AE 419 (Aircraft Flight Mechanics) relied on an online system called 'Piazza,' which was essentially a forum for asking questions to both the professor and the entire class. This promoted communication and collaboration between students, both online and on-campus."

Schonert believes a virtual whiteboard tool capable of quick drawing, sketching and equation writing could be used to help solve the communication glitch.

"Overall I had a great experience with the program," Schonert said. "The department launched it at the just the right time for me—I was planning on taking a year off school anyway but didn't want to wait too much longer, and I was wanting to complete an online program. I also enjoyed staying connected with Illinois and the AE department."

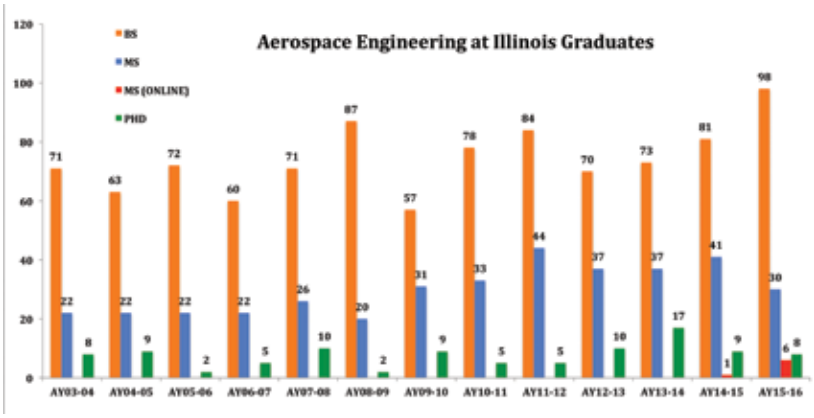
# AE has largest BS graduating class in over a dozen years

The number of bachelor's degree graduates from Aerospace Engineering at Illinois in the 2015-16 academic year has been the largest in a dozen years preceding it.

A total of 98 individuals earned bachelor's degrees over the year. Another 30 students earned master's degrees, 6 students earned master's degrees through AE's online program, and 8 earned PhDs.

Graduating classes in the near future could well be even larger. For the first time in decades, undergraduate enrollment surpassed 500 students in fall 2015, and the graduate student number, with a total of 161 individuals, had doubled over the past 10 years.

Companies including Boeing, Lockheed Martin, Raytheon, Rolls-Royce, Northrop Grumman, Aerospace Corporation, Wolfram, Caterpillar, Rockwell Collins, and SpaceX will employ some of the new AE alumni, while others will continue on in graduate school at Illinois, Purdue University, the University of Washington, Colorado University and other institutions.



# All things Ormsbee and aerodynamics: AE alumni gather for symposium

A love of the late Aerospace Engineering at Illinois Prof. Al Ormsbee and all things aerodynamic combined to make the Ormsbee Memorial Symposium on Aerodynamics and Aircraft Design a fitting celebration for an inspirational faculty member.

An audience of about 100 students, faculty and alumni gathered for the October 2015 symposium at which several former Ormsbee students and colleagues spoke on the wonders and pitfalls of designing and building aircraft, and the influence Ormsbee had on their careers.

The symposium was an announcement and celebration of the Ormsbee Professorship that Alumnus Bob Liebeck has endowed as a tribute to his mentor. It is the first professorship held within the AE Department.

Among symposium speakers were Michael Bragg (BS 1976, MS 1977), Frank & Julie Jungers Dean of Engineering for the University of Washington; Robert Gregg (BS 1978), Chief Aerodynamicst, BCA at the The Boeing Company; Mark Page (BS 1979), Vice-President & Chief Scientist at DZYNE Technologies; George Bennett, (MS 1964, PhD 1970); Paul Dees (BS 1981, MS 1983), Technical Fellow of Airplane Configuration & Integration at The Boeing Company; AE Prof. Michael Selig (BS 1984); and Liebeck (BS 1961, MS 1962, PhD 1968), Senior Fellow at The Boeing Company; Adjunct Professor of Mechanical & Aerospace Engineering at the University of California, Irvine; and Professor of the Practice at Massachusetts Institute of Technology. Mark Maughmer, (BS 1972, PhD 1984), Aerospace Engineering Professor at Pennsylvania State University, spoke at a celebratory dinner that followed the symposium.

**Al Ormsbee**

# AE summer camps draw 108 high schoolers

Aerospace Engineering at Illinois introduced 108 high school students from across the country and around the world to aerospace engineering during camps in Summer 2016.

The AE hosted camp, Illinois Aerospace Institute (IAI), celebrated its 25th anniversary in 2016. The two IAI sessions both offered 12 hours of instruction each day over five days to students from across the continental United States, Puerto Rico, Mexico, India, Pakistan, and Singapore.

With AE graduate students as the primary instructors, campers were offered a focused list of aerospace topics, including an introduction to aeronautics/astronautics; model rocket/model glider design; aerospace materials and structures; flight mechanics; aerodynamics; orbits; navigation; rocket propulsion; aeronautics design and astronautics design.

Laboratory activities included wind tunnel and rocket propulsion experiments. Students designed and built model payload rockets and boost gliders that were launched at the closing flight competition. Field trips to Willard Airport and a local radio-controlled aircraft club's flying field allowed for additional exciting hands-on activities.

The 4-H aerospace camp is part of the College of Agricultural, Consumer and Environmental Sciences (ACES) Illinois Summer Academies Extension Program. This past summer was the ninth year of the aerospace academy; AE was the first engineering department to be added to Academy offerings back in 2008. Eleven students participated in a three-day abridged version of the IAI curriculum.

Thirty high school girls participated in the aerospace engineering camp of the Girls Adventures in Mathematics, Engineering, and Science (G.A.M.E.S) program. The all-girls camp, coordinated through Illinois' College of Engineering Women in Engineering Program, was one of eight camps focusing on various engineering disciplines. The aerospace engineering curriculum is very similar to IAI and was taught by Dr. Brian Woodard and female AE students.


*For further information about IAI and GAMES, go to:*
*IAI: iai.aerospace.illinois.edu/*
*GAMES: publish.illinois.edu/womeninengineering/?page_id=297*
*or contact Diane Jeffers, dejeffer@illinois.edu or Dr. Brian Woodard, bswoodrd@illinois.edu*

# AE enjoys over 20 years of success in undergraduate space design competition

Zach Putnam

Aerospace Engineering at Illinois students have repeatedly demonstrated their outstanding knowledge and technical skills by shining in national competitions. A prime example of their excellence has been the streak of AE teams' top finishes in the American Institute of Aeronautics and Astronautics annual AIAA Undergraduate Space Design Competition.

The tradition began 22 years ago, when then-Assistant Prof. Victoria Coverstone chose to make the AIAA challenge the focus of the fall senior space design course. By 1999, the course was extended to a two-semester sequence, giving students ample time to work on their projects, and confirming AE at Illinois teams as dominant competitors.

"I think (the success) was because we made the challenge the center point of the design class," said Coverstone, who joined Texas Tech University this fall as Executive Associate Dean. "The lectures were geared toward preparing the students for that particular topic. Prior to that, it was more of a general spacecraft design course."

AE teams have taken first place in the competition numerous times, including each of the past six years in a row. Over the past 10 years, the teams have earned either first, second, or third 18 times, and have swept the top three places three times, including the 2016 competition. Through the years, the course has been taught by several AE faculty, including Emeritus Profs. Wayne Solomon and Rodney Burton, Visiting Prof. David L. Carroll, and Associate Prof. Soon-Jo Chung.

In addition to learning more about engineering, students in the course have acquired better understanding of economics and ethics, as well as skills in writing and presentations.

"We hired hourly PhD students to critique report writing for grammatical errors," Coverstone recalled. "If the students had survived to senior year they were all good engineers. The softer skills are just as important. If you can't present your ideas to other people, then you're the only one that knows about them and you're not contributing.

"Over time, (the course) became more and more what the students would see in the working environment and not just an academic exercise," Coverstone continued. "I wanted the students to leave with the

## AE teams sweep top three places in AIAA 2016 undergraduate team space d

Aerospace Engineering at Illinois teams again this year swept the top three places in the annual Undergraduate Team Space Design Competition of the American Institute of Aeronautics and Astronautics (AIAA).

AE teams ALMA (A Low-Cost Mission to an Asteroid), LoCATE (Low-Cost Asteroid Topographical Explorer), and TRIDENT (Triple Reconnaissance Impactors for Development and Evaluation of Near-Earth asteroid Technologies) took first, second and third places, respectively, in the national competition.

This year's space design challenge was to develop a robotic precursor mission to an asteroid to aid NASA's future deep-space exploration plans, currently centered around the Asteroid Redirect Mission (ARM). The robotic segment of ARM will identify and capture a small near-Earth asteroid (NEA), or a multi-ton boulder from the surface of a larger NEA, and transport it to a stable orbit around the moon. The human segment of ARM will send astronauts to explore the NEA in lunar orbit in the 2020s. The robotic precursor design problem was particularly challenging because each team had to develop a complete mission for no more than $100 million, including launch costs.

"The teams had to pick the asteroid and develop the mission goals from scratch: that was the hardest part," said AE Assistant Prof. Zach Putnam, who advised the teams and taught the Spring 2016 senior space design course. "If you chose something easier, there was less risk, but you have to have the right amount of risk to get the right amount of information. That's the core of engineering—picking the sweet spot."

The science missions developed by the student teams "were compelling, but challenging, missions,

confidence of knowing that they would be successful in industry."

This tradition of excellence has remained constant as the program's leadership has been handed from one faculty member to another, with each placing an individual stamp on the effort. Assistant Prof. Zach Putnam has held the reins most recently, and has made significant changes.

In previous years, AE students choosing space design as their senior projects would form into teams shortly after the beginning of the fall semester. The teams would then work on their projects through April.

Putnam switched up the routine in Fall 2015, placing more emphasis on individual work. "They had technical lectures, homeworks and labs, and each had to do an individual design project that they had to turn in at the end of the (fall) semester," he said. "Then, in the spring semester, I put them into groups and off they went," plunging into the AIAA challenge.

Putnam believes that stressing individual work and giving each student full ownership of a project in the fall exposes the students to a fuller range of knowledge. The students came into the semester well versed in areas including aerodynamics, orbital mechanics and structural mechanics, he said, but had little experience with applying theory to spacecraft design.

"Concepts like spacecraft power systems and communication systems—they were learning that for the first time," Putnam said. "I wanted them to know what they were getting into. Then, they would have an idea of what they're most interested in by second semester, and could help each other out with ideas (in the team setting).

"I wanted them to have an understanding of systems engineering and how to write the requirements of things; they needed a basic idea of how each subsystem works," Putnam continued.

Assessments of the team projects throughout the spring semester indicated the format switch worked well.

"We brought in external reviewers twice (during the semester) to give the teams advice and constructive criticism," said Putnam. The reviews were thumbs up, and the competition results released this summer—that the 2016 AE teams swept first, second and third places—reflected the earlier critiques.

"We have very high expectations of our students, but not necessarily for contests," Putnam maintained. "It's great to see and the students are justifiably proud, but our focus is on their education. When they do well with their coursework, they do well in the contests."

**"The softer skills are just as important. If you can't present your ideas to other people, then you're the only one that knows about them and you're not contributing."**

## design competition

especially at $100 million," Putnam continued. "They would have been challenging at $300 million."

### First-place Winner: ALMA

***Team members***

Kyle Weiskircher, team lead
Michael Busch
Samyak Shah
Andrew Slowik
Jacob Denton
Matthew Crisman
Andrew Holm

***Project Summary***

A Low-cost Mission to an Asteroid (ALMA) was planned as an 11-month mission in which a 385 kilogram satellite (wet mass at launch) would rendezvous with Asteroid 2008 EV5. The satellite was designed to perform a thorough characterization of 2008 EV5 to determine its suitability as a candidate for further exploration and lower the risk of a human exploration mission.


**The ALMA team's logo**

***Challenges***

The competition had three primary constraints. Simple proven technologies and a $100 million budget meant that the team needed to use as much as possible commercial off-the-shelf parts with high technology readiness ratings. Team ALMA could not afford to develop and extensively test parts with low

*continued on next page*

flight heritage, because that would have increased costs as well as development and mission risks. The team's design also had to fit within the definition of a small satellite, effectively meaning ALMA could not weigh more than 500 kilograms. The ALMA team had to analyze each design and cost tradeoff to design the optimal mission given each constraint.

### *Lessons Learned*

Space mission design is not an idealistic process. The design choices of each team member trickled down to impact everyone. Sacrifices in each subsystem had to be made in order to not jeopardize the feasibility of the whole mission.

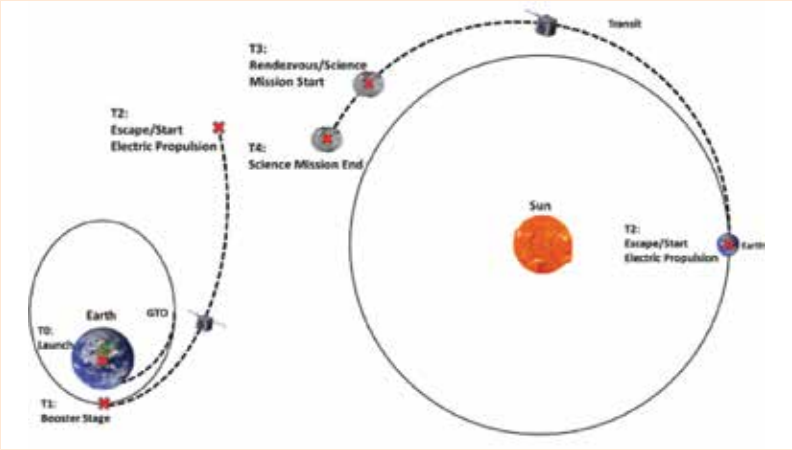
## *Second-place Winner: LoCATE*

### *Team members*

Matt Ciasto, team lead
Joseph Lasser
Caite McCarthy
Joseph Mueller
Jeffery Pekosh
Seth Zelman

### *Project Summary*

LoCATE's plan was to explore near-earth asteroid 2000 SG344 with the primary objective of gathering information on the asteroid's physical properties and characteristics. Since so little is known about these NEAs, it would be too dangerous to send humans into such an unknown environment. This leads to the need for a robotic precursor mission that will demonstrate the scalable template of a proven technology and create a foundation for future human exploration missions. LoCATE's primary payload would be a high resolution camera used to create a 3D map of the asteroid in order to identify landing zones as well as hazardous areas of the asteroid. In addition, several other instruments on-board would measure various properties of the asteroid in order to gain information that would better prepare a human exploration mission.




**A graphic from the LoCATE team**

### *Challenges*

The biggest challenge was the extremely tight cost constraint. Added to the difficulty of launching a full size satellite into space were challenges of rendezvousing with a NEA and gathering useful information while identifying cost-effective solutions to fit the budget and accomplish the mission. In addition to that, every team member held multiple roles with diverse responsibilities, and all needed to perform jobs in which they had little experience. Throughout the project development, team members were given the task of learning something new and then applying that new skill to design a space mission from the ground up, which was a very rewarding yet very demanding process.

### *Lessons Learned*

Designing a space mission from the ground up is much less straightforward than the kind of problems students are used to solving. Problems can become complex very quickly, and the team needed to decide very quickly when work on a particular problem had gone far enough, or at what point the design fit specific applications. Spending too much time on one thing could cause delays with the rest of the work. Ultimately, defining aspects to the level of detail the team envisioned proved difficult, and sometimes the team had to accept more vague, "hand-wavy" solutions and move on. The result ended up being very effective, since the design process is structured to return to problems, iterate solutions, and see how changes affect other systems.

## *Third-place Winner: TRIDENT*

### *Team members*

Sam Forgerson, team lead
Mihir Patel
Jiby Mamen
Scott Neuhoff
Sabeeh Butt
William Kazakis

### *Project Summary*

The concept aimed to reduce the risk of future asteroid missions by providing an understanding of the mechanical and morphological properties of the surface of the asteroid 2008 EV5. The information

**TRIDENT team photo**

would help determine expectations when either a spacecraft or human comes into contact with an asteroid. With information gathered via a high-resolution camera, a thermal imaging spectrometer, and three deployable penetrators on-board the TRIDENT spacecraft, mission development and design, along with spacecraft design and construction, would take place over a three-year period in time for launch on-board a Minotaur I rocket from Cape Canaveral in August 2019. All mission aspects would be completed for under $100 million dollars.

### *Challenges*

Meeting the cost requirements of the mission proved to be a major challenge. The team was able to navigate this by doing extensive research on previously developed technologies and employing flight proven off-the-shelf hardware in our mission design. The team also worked to meet the cost requirement by developing the simplest possible methods for collecting the desired data, from simple and proven technologies to minimal spacecraft maneuvers during the mission."

### *Lessons Learned*

Planners can never include too much margin in their design process. The team discovered that, from scheduling times for meetings to generating the cost of the mission, the margin quickly was eaten up by the design process. This was particularly apparent when the team worked many late nights leading up to deadlines. Throughout the course of the semester the team improved on its margin setting and were able to complete a mission on time and under budget.

# *AE Team Takes First Place in NASA BIG Idea Challenge*

An Aerospace Engineering at Illinois team took top honors in NASA's inaugural Breakthrough, Innovative and Game-changing (BIG) Idea Challenge.

The BIG Idea Challenge is an engineering design competition sponsored by the NASA Space Technology Mission Directorate's Game Changing Development (GCD) Program and managed by the National Institute of Aerospace. University teams were challenged to develop concepts for steering Mars entry vehicles utilizing Hypersonic Inflatable Aerodynamic Decelerator (HIAD) technology. HIADs are large, inflatable heatshields used to provide additional drag area during planetary entry and may be an enabling technology for landing the large payloads on the surface of Mars to support future human exploration missions.

The Illinois team garnered first place for their Cable-Controlled Aeroshell Deceleration System (CCADS) concept. CCADS utilizes lift for hypersonic trajectory control via a center-of-gravity shift mechanism (course control) and a cable system to deform the flexible HIAD (fine control).

Four teams, from Illinois, Georgia Tech, The State University of New York at Buffalo and Purdue University, were invited to the 2016 BIG Idea Forum to present their concepts to a panel of NASA judges at the NASA Langley Research Center in Hampton, Virginia, in April.

The AE team members are undergraduates Austin Scott, Sam Wywrot, Jose Mari Tuason, Steven Kosvick, and Sashank Gummella. AE Assistant Professor Zach Putnam advised the Illinois team. "All the credit for this win belongs to the student team," said Putnam. "The NASA judges were very impressed that our undergraduate team went from zero knowledge of entry, descent, and landing systems and HIADs to winning this challenge in a matter of months. I am very proud of them."

**The BIG Idea Challenge Illinois team**


**Women in Aerospace Engineering at Illinois**

# Women in Aerospace have good showing in rocketry competition

In their first attempt at a tech project, the Women in Aerospace (WIA) team from the University of Illinois took second place in NASA's 2015-2016 Space Grant Midwest High-Power Rocketry competition.

The goal of the contest, held this past spring near Minneapolis, was to design an active drag system to decrease a rocket's apogee by 25 percent. "The WIA team did this with two fins placed on either side of the rocket, which turned from vertical to horizontal at a set altitude, then went back to their original position before apogee," according to team leader Alexandra Bacula.

The team flew its rocket three times. The first two flights were without active drag deployed, and the third was with active drag successfully deployed. When the active drag was deployed, the WIA rocket reached 77.7% of the apogee without active drag, giving the team the second best flight score.

# ISS wins first place in design of satellite communications for Mars exploration

An Illinois Space Society (ISS) team won first place in a satellite constellation design competition that the Students for the Exploration and Development of Space (SEDS) and Society of Satellite Professionals International (SSPI) sponsored.

The 15-member ISS team prepared "MOSAIC: Mars Orbiting Satellites for Advanced Interplanetary Communication," a 55-page report, with the help of mentor and SSPI member Denis Curtin.

"The competition required us to create a satellite architecture that would provide communications coverage for robotic and eventually manned exploration of Mars in the most cost effective manner possible," said team leader Christopher Lorenz. "Our chosen architecture utilizes a build-up approach that uses small satellites to provide initial coverage, with eventual addition of large relay satellites."

Eleven teams from 10 universities competed in the challenge.

**Illinois Space Society team members**

**Illinois Robotics in Space team**

# IRIS team takes first in robotic mining competition systems engineering paper

The Illinois Robotics in Space (IRIS) Team produced the best systems engineering paper in the 2016 NASA Robotic Mining Competition.

Each year, over 50 university-led teams design and build robots to dig in a basaltic regolith NASA uses to simulate soil from off-world explorations. NASA believes it possible in future missions to harvest from extraterrestrial environments the materials needed to support human life and provide spacecraft propellants. Concepts developed through the competition may prove helpful in developing mining tools for journeys to Mars and other locations in space.

The NASA competition is comprised of five events: on-site mining, the systems engineering paper, an outreach project report, a slide presentation and demonstration, and social media and public engagement.

The Illinois team has a history of success in producing the best systems engineering paper: the team won in 2015, as well, and placed in 2014 and 2012.

However, the team's attempt at mining during the May competition failed when its IRIS 6 robot experienced mechanical problems. "A chain drive and the sprockets that we had broke down, and even after replacing them with other sprockets, they broke down," said team leader Cassandra Dickey. "The frame got constructed later than we had planned on, so we didn't have much time for testing."

**IRIS-6 robot**

# ISS team creates asteroid rock-chipping tool as part of Micro-g NeXT Challenge

An Illinois Space Society (ISS) team participating in NASA's 2016 Micro-g Neutral Buoyancy Experiment (Micro-g NExT) Design Challenge designed a tool astronauts could use to create and contain chipped asteroid samples they collect on space missions.

The hand-held, mechanically-operated Modular Asteroid Chip Sampler (MACS) Tool uses kinetic energy from a spring to drive a chisel into the surface of rock encountered on an asteroid. ISS was one of 25 university teams across the country that advanced to the competition's testing phase. Testing took place in June in Houston at NASA's Neutral Buoyancy Laboratory (NBL), a 40-foot deep pool where astronauts train for spacewalks.

A combination of machined and 3D printed parts, the MACS Tool weighs about 10 pounds and is the size of a large power drill. Astronauts load the spring by turning a ratcheting handle attached to the tool body. Created upon the chisel's impact, the regolith chips are directed into a "Sample Collection Pod" attached at the forward end of the tool. The MACS Tool is equipped with four pods so samples can be collected at multiple sites without cross contamination.

**Illinois Space Society team**

# Student group launches rocket 36,000 feet; gains grant for building liquid-fueled rocket engine

The Student Space Systems (SSS) organization at the University of Illinois has achieved a step toward its goal of reaching suborbital space-flight by launching a rocket 36,000 feet into the atmosphere. The group maintains theirs is the third highest university launch in history with a successful launch and recovery.

Student Space Systems members

Meanwhile, the group has secured a $12,000 grant from the Student Sustainability Council(SSC) on the Urbana campus to build a sustainable liquid-fueled rocket engine with reusable 3D-printed parts.

The rocket launch accomplished this spring is the third phase in a five-phase plan SSS outlined when a group of freshmen first formed the organization in October 2013. The first phases were launches of 4,500 feet and 10,000 feet. The latest launch in March in California was very successful.

"One of the amazing things about this launch, specifically, was how perfect it went," said SSS Technical President Ben Wexler. "Usually, there's something small that goes wrong. It's very rare that something goes that well and that speaks a lot about the people in Student Space Systems that work on the project."

The 100-member organization spent about a year on Phase III, culminating in the launch in March in California. The goal was to send a rocket higher than 35,000 feet while testing the telemetry system (live air to ground transmission of data), altitude, speed, acceleration, and GPS positioning. "We also had a GoPro (video recording device) on the rocket so we could get footage," Wexler said.

The team also tried out a new means to deploy the parachute that would return the craft safely to Earth. "We developed a more creative high altitude version of the black powder deployment," said Florin Ghinet, the team's director of propulsion. "We developed a contained pressure vessel so we could ensure combustion."

SSS is building Phase IV, a rocket with a goal of reaching an altitude of higher than 100,000 ft. The $12,000 grant will cover the costs of the new 3D printed , liquid-fueled rocket engine. " If the first liquid engine test goes well, the Student Sustainability Council will award SSS another $13,000 to build a larger version of the engine that could potentially be used on Phase IV" Ghinet said.

The group's ultimate Phase V goal is a "space shot;" building a rocket that could fly to an altitude greater than 100 kilometers, thereby achieving suborbital spaceflight.

The Student Space Systems rocket reached 36,000 feet when launched in March in California.

**AIAA at Illinois volunteers**

# AIAA at Illinois hosts successful regional conference; achieves largest turnout in history

The American Institute of Aeronautics and Astronautics Region III Student Conference held April 1–2 at the University of Illinois at Urbana-Champaign was an outstanding success, bringing together students from 18 universities across the Midwest.

"The conference blew away the expectations of everyone involved. Our final attendance of 102 is the largest in Region III history," said organizer Michael Miller of the AIAA at Illinois student organization.

**Conference Coordinator Michael Miller and AIAA at Illinois President Grant Kramer welcome attendees to the Regional Conference.**

Conference highlights included the keynote talk by Todd Barber, Jet Propulsion Laboratory (JPL) Senior Propulsion Engineer. He spoke on the National Aeronautics and Space Administration (NASA) Curiosity Mission to Mars in his presentation, "Red Rover, Red Rover: Send Curiosity Right Over."

A Blimp Racing contest in which four-member teams designed and flew a lighter-than-air vehicle was another highlight. The teams had access to helium, several sizes of helium vessels, a scrap pile of building materials, and two blimp control modules. They were given 1½ hours to build the fastest blimp and race them against other teams' creations.

Participants also gained the opportunity to network during a corporate mixer. The primary focus of the conference was presenting student research for technical review. Participants from Illinois fared well, sweeping first, second and third places in two categories.

# AE senior selected as Knight of St. Pat, Wakeland Award winner

Aerospace Engineering at Illinois Senior Caite McCarthy has been named a **Knight of St. Patrick,** and has been selected as the 2016 winner of the College of Engineering's 2016 **H.L. Wakeland Undergraduate Leadership Award.**

Each year, the College knights 10-15 students who have demonstrated leadership, excellence in character, and exceptional contribution to the College and its students. The award is among the highest honors an Engineering at Illinois student can receive. The Wakeland Award also recognizes outstanding leadership, as demonstrated by a junior or senior.

McCarthy's enthusiasm for AE at Illinois led her to serve on the executive boards for the local chapters of the American Institute of Aeronautics and Astronautics, and the Women in Aerospace. Her passion for the field drove her to gain her Private Pilot's License and Instrument Rating through the Institute of Aviation.

She also has worked as an Engineering Learning Assistant, through which she promoted the College of Engineering to incoming freshman.

McCarthy has a keen interest in global activities. She studied abroad at Delft University of Technology in The Netherlands, and spent a summer at the Institut Superieur de l'Aeronautique et de l'Espace in Toulouse, France.

She shared this interest by promoting study abroad to high school students she encountered while working throughout her college career as an Engineering Tour Guide. Also, as a Student Assistant at the International Office in Engineering, she provided a warm welcome to international students.

# Congratulations AE Students!

Aerospace Engineering at Illinois recognized many of the Department's undergraduate and graduate students this spring with awards for their scholastic achievement and other contributions.

**AE Boeing Scholarships,** one-year awards for an incoming freshman based on outstanding academic performance—**Emilio Gordon** of Chicago, Illinois, and **Ashley M. Stahulak** of Wheaton, Illinois

**Jo Ann Haynes Platt & Daniel Wall Platt Memorial Award,** presented to the sophomore, junior or senior female undergraduate James Scholar and/or Chancellor's Scholar studying aerospace engineering—**Allery Pam C. Hsu** of the Philippines

More photos can be viewed on the Aerospace Engineering Facebook Page.

**H.S. Stillwell Memorial Scholarship,** presented in memory of Prof. H.S. Stillwell, founder of the Department of Aerospace Engineering and head of the department from its inception in 1944 until his death in 1976. The scholarship is presented annually to an undergraduate student in recognition of outstanding scholastic achievement and extracurricular activities—**Clayton J. Summers** of Mount Carmel, Illinois left with Associate Prof. Daniel Bodony.

**Dale Margerum Memorial Award,** honoring1979 graduate Dale Margerum, who was very involved in extracurricular activities and who died in an accident the summer after graduation. The award is presented to an undergraduate who exemplifies outstanding leadership qualities by participation in departmental extracurricular activities—**Alexander W. Case** of Lake Villa, Illinois, right, with Adjunct Research Assistant Prof. Alexander Ghosh.

**AIAA Scholastic Achievement Award,** presented in fall and spring semesters to the graduating senior with the highest GPA — **Jacob N. Denton** of St. Elmo, Illinois, pictured here at left with Department Head Philippe Geubelle; and **Kevin Kim** of Wilmette, Illinois.

**Kenneth Lee Herrick Memorial Award,** presented annually to a graduate student in recognition of outstanding research and academic performance—**Joseph M. Gonzalez** of Chicago, Illinois, left, with Prof. John Lambros.

**Faculty Outstanding Graduate Award,** in recognition of outstanding contributions to the Department's teaching and/or research missions—**Brent W. Pomeroy** of Mechanicsburg, Pennsylvania, right, with Director of Undergraduate Programs Brian Woodard.

**Robert W. McCloy Memorial Award,** presented in memory of Prof. R.W. McCloy, who served on the faculty from 1945 to 1977, and was the first faculty member hired in the new Department of Aeronautical Engineering. He was known for his research and teaching in propulsion and for his pioneering work in jet propulsion. The award is presented to a junior or first-semester senior student in recognition of outstanding academic performance— from left, **Meng Feng** of Des Plaines, Illinois; Director of Undergraduate Programs Brian Woodard; **Thomas Smith** of Bolingbrook, Illinois; and **Jacob N. Dray** of Wilmette, Illinois.

**H.S. Stillwell Problem-Solving Scholarship** was established by a generous alumnus as a tribute to H.S. Stillwell and the role he played as a mentor to students. It is given to a junior-level or first-semester senior student majoring in aerospace engineering who exhibits exemplary problem-solving skills—**Paul DeTrempe** of Menlo Park, Illinois, right, with Assistant Prof. Grace Gao.

**H. Everett Sutter Passion for Flying Scholarship,** awarded to an AE undergraduate who is uniquely passionate about flying—**Arthur C. Lapin** of Orland Park, Illinois, right, with Assistant Prof. Grace Gao.

**AE Alumni Advisory Board Fellowship,** presented annually to a graduate student in recognition of outstanding research, academic performance, and research accomplishments—**Ruizhi Li** of Hunan, China, left, with Assistant Prof. Huck Beng Chew.

## *AE students also recently have garnered awards from several other organizations.*

**Team Award—Illinois Space Society SEDS Satellites Around Mars Design Competition**—**Alexandra N. Bacula** of Oak Park, Illinois; **Alexander W. Case** of Champaign, Illinois; **Zachary T. Fester** of Steelville, Missouri; **Brian P. Hardy** of Springfield, Illinois; **Yukti Kathuria** of Sonepat, Haryana, India; **Andrew D. Koehler** of Springfield, Illinois; **Chris G. Lorenz** of Roselle, Illinois; **Steven J. Macenski** of Arlington Heights, Illinois; **Joseph C. Miceli** of Barrington, Illinois; **Jordan M. Murphy** of Elk Grove Village, Illinois; **Jeffrey D. Pekosh** of West Chicago, Illinois; **Kaushik S. Ponnapalli** of Nashua, New Hampshire; **Lui Suzuki** of Irvine, California; **Kelsey R. White** of Downers Grove, Illinois

**Aerospace Freshman Scholarship**—**Nicole A. Zaworski** of Northbrook, Illinois

**AIAA Wilbur and Orville Wright Outstanding Graduate Student Award—Brent W. Pomeroy** of Mechanicsburg, Pennsylvania

**The Assyrian Universal Alliance Foundation Scholarship**—**Violet A. Kamber** of Elgin, Illinois

**CSE 2015-2016 Fellowship Award**—**Antoine B.E. Blanchard** of Duclair, France; and **Qi Dang** of China

**Dissertation Completion Fellowship**—**Brent W. Pomeroy** of Mechanicsburg, Pennsylvania; and **Hoong Chieh Yeong** of Seremban, Negeri Sembilan, Malaysia

**Engineering Excellence Scholarship**—**Nicole A. Zaworski** of Northbrook, Illinois

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**Engineering Premier Scholarship**—**Ashley M. Stahulak** of Wheaton, Illinois

**Frank Smith Scholarship**—**Paul DeTrempe** of Menlo Park, Illinois

**Fundac'n Bancaria "la Caixa" Fellowship**—**Andres Rodriguez Reina** of Madrid, Spain

**H.L. Wakeland Undergraduate Leadership Award**—**Caite M. McCarthy** of Houston, Texas

**Hayward/Ruth Tau Beta Pi Scholarship**—**Brandon L. Litherland** of Allendale, Illinois

**Illinois Distinguished Fellowship**—**David R. Brandyberry** of Champaign, Illinois

**Illinois Space Grant Scholarship**—**Brandon L. Litherland** of Allendale, Illinois, and Melanie Cianco of Villa Park, Illinois

**Knights of St. Patrick**—**Caite M. McCarthy** of Houston, Texas

**Boeing NACME Scholarship**—**Michael L. Espinal** of Itasca, Illinois

**Carver Fellowship**—**David R. Brandyberry** of Champaign, Illinois

**College of Engineering Mavis Future Faculty Fellows (MF3)—Gavin K. Ananda Krishnan** of Kuala Lumpar, Malaysia; **Andy D. Borum** of High Point, North Carolina; and **Robyn L. MacDonald** of Toronto, Ontario, Canada

**Korean Government Scholarship Program for Study Overseas Fellowship—Kyung Yun Choi** of Seoul, South Korea

**NASA Aeronautics Scholarship—Max A. Feinberg** of Deerfield, Illinois

**NASA Space Technology Research Fellowship (NSTRF)—Rebecca Foust** of Columbia, Maryland; and **Robyn L. MacDonald** of Toronto, Ontario, Canada

**National Science Foundation Graduate Research Fellowship**—**David R. Brandyberry** of Champaign, Illinois

**Pathway Engineering Scholarship**—**Joel J. Khristy** of Naperville, Illinois

**President's Award Program Honors**—**Ashley M. Stahulak** of Wheaton, Illinois

**Robert M. Stephens Engineering Scholarship**—**Brandon L. Litherland** of Allendale, Illinois

**The Scientific and Technological Research Council of Turkey Fellowship**—**Konuralp Yigit** of Izmir, Turkey

**Senior 100 Honorary**—**Melanie A. Ciancio** of Villa Park, Illinois; and **Michael S. Miller** of Decatur, Illinois

**SURGE Fellowship**—**Polette J. Centellas** of Springfield, Virginia; **Manue Martinez, Jr.,** of Chicago, Illinois; and **Jose Sepulveda** of Bakersville, California

**Tau Beta Pi National Scholar Award**—**Brandon L. Litherland** of Allendale, Illinois

**Tau Beta Pi Outstanding Junior Award**—**Jake J. Goldrich** of Skokie, Illinois

# *Gao student wins Best Paper awards on optimizing GPS systems*

For two years in a row Aerospace Engineering at Illinois graduate student Yuting Ng has won best paper awards for her work in optimizing the use of Global Positioning Satellite systems.

Advised by Assistant Prof. Grace Gao, Ng won at the 2016 IEEE/ION Position Location and Navigation Symposium for the paper, "Mitigating Jamming and Meaconing Attacks Using Direct GPS Positioning." The work describes a technique combining separate satellite signals into a single signal that is strong enough to offset any disruptions. Ng's novel solution uses an architecture that accurately predicts position and velocity of the signals, which significantly improves computational efficiency.

Ng also won the Best Paper of the Session at the 27th International Technical Meeting of the Satellite Division of the Institute of Navigation (ION GNSS+ 2015). In that paper, Yuting discussed a new, robust system for synchronizing Phasor Measurement Units (PMUs), which are used to measure conditions of the power grid and provide assistance with real-time operations and off-line analysis to improve reliability and efficiency. With equipment sponsored by the Trustworthy Cyber Infrastructure for the Power Grid (TCIPG), Yuting and colleagues were able to collect real signals. They then used software, written by Yuting, to monitor the signals and test the new system.

# 2016 Distinguished Alumni Award winners

## *The development of the first commercial airplane composite fuselage on the 787 was one of the most satisfying achievements of Laura L. Bogusch's career.*

"I spent the first 15 years of my career working to ensure its success: from research and development of automated fabrication processes, to building and testing nine full scale articles, to working with suppliers around the world during production start-up, to owning it myself in production," she said. "I literally was able to see something from a blank sheet of paper to surging with pride as I sat on a flight from Tokyo to Seattle sitting in an airplane I literally helped to make myself!

Bogusch, BS 95, MS 97 (Theoretical and Applied Mechanics), joined The Boeing Company after completing her master of science degree in January 1997. Bogusch's first assignment was in Commercial Manufacturing Research and Development, to develop automated processes for fabricating composite structures. She then joined New Airplane Product Development, working on the conceptual design and development plan for what ultimately became the 787.

Bogusch was responsible for managing the design, tooling, fabrication, and evaluation of the first two composite fuselage demonstration articles manufactured at the Developmental Center in Seattle. She supported 787 fuselage partner production start up in South Carolina, Kansas, Japan, Korea, and Italy, developing a network of cross company collaboration that continues today.

Bogusch also led the development of the design and manufacturing processes for One Piece Frames for the 787-9 derivative program. After the acquisition of Vought in Charleston, South Carolina, Bogusch led Composites Fabrication for the 787 Aft Body, responsible for the daily execution of the manufacturing processes she helped develop years before.

In 2011, Bogusch joined the 737 program as Deputy Chief Project Engineer for the P8 and Production Engineering Chief for 737. In that role, she established a team that led identification, development, and implementation of Advanced Manufacturing and Automation opportunities on the 737. In 2013, Bogusch became the 747 Fleet Chief, responsible for driving resolutions for in service issues for customers who operate the "Queen of the Skies."

In October of 2014 Bogusch joined the Boeing Commercial Airplanes Manufacturing and Safety leadership team as the Director of Architecture, Capabilities, and Systems. In this role, she leads the Automation Strategy, Implementation of Auto Identification technologies, and future operations business system strategy.

*For Bogusch's full profile, go to aerospace.illinois.edu/news/trust-scientific-method*

**"The scientific method works in almost all situations: What is your hypothesis? What data or information do you need to confirm or deny your hypothesis? Do some math. What can you conclude?"**

— LAURA L. BOGUSCH

## *Having earned three degrees from Aerospace Engineering at Illinois, Erik A. Johnson (BS 88, MS 93, PhD 97) is a professor in the Sonny Astani Department of Civil and Environmental Engineering at the University of Southern California in Los Angeles.*

A Chicago area native, Johnson also earned a Certificate in Biblical Studies from Trinity Evangelical Divinity School in 1991. Johnson was a visiting research assistant professor at the University of Notre Dame from 1997-99. He joined the USC civil engineering faculty in August 1999. Since 2007, he has served as the Associate Chair of the Department (and Interim Chair in 2011).

Johnson is the recipient of a 2001 U.S. National Science Foundation Early Faculty Career Development (CAREER) Award, and the Junior Research Prize and Medal from the International Association for Structural Safety and Reliability in 2005.

He is a senior member of the American Institute of Aeronautics and Astronautics, and a member of both the American Society of Civil Engineers and the American Society of Mechanical Engineers. He has served as the Chair of the ASCE EMI Technical Committee on Structural Health Monitoring and Control and as an Associate Editor of the ASCE Journal of Engineering Mechanics. Johnson is currently the Chair of the ASCE EMI Probabilistic Methods Committee and serves on the Board of Directors of the American Automatic Control Council.

Johnson's research interests include "smart" structures, control of structural vibration, controllable

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damping devices, monitoring structural health, random vibration, and computational dynamics.

*For Johnson's full profile, go to aerospace.illinois.edu/news/aerospace-engineering-illinois-alumni-profile-erik-johnson*

**"Looking at the breadcrumb trail or theme throughout my career, one can find large complex systems and creativity. I derive most satisfaction solving complex problems."**

—ALEXANDRE KOSMALA

## *Alexandre Kosmala's "passion for everything aerospace and aeronautical" led him to Aerospace Engineering at Illinois, where he earned his master's degree in 1990.*

Kosmala attended Illinois as a French citizen after creating an exchange program between the university and his Engineering school in France (ENSEM—National School of Electricity and Mechanics). Illinois awarded him a fellowship based on merit. While on campus, he interviewed with French companies, fulfilling his obligations to do military service by working for a French company abroad.

Schlumberger offered him an internship to work in the company's Houston, Texas, facility. As an intern he patented a noise cancellation system that allowed Schlumberger drilling tools to break the 10,000-foot communication distance and reach 30,000 to 40,000 feet. This breakthrough launched his career in Schlumberger. The named inventor of 10 patents, Kosmala has since held multiple management and executive management roles in engineering, manufacturing and operations around the world, in most of Schlumberger divisions.

After leaving Schlumberger in 2010, he became President and Chief Executive Officer of Artificial Lift Company Ltd., a worldwide oilfield service company. He is now the Executive Vice President of Saltel Industries, an international family-held oilfield service company.

Kosmala gained American citizenship a couple of years after leaving Illinois, and maintains his experience at the university convinced him this was his country of choice.

"My career and life in general taught me that values are everything. I was once told I was an atypical CEO because I managed by values. This prompted a deep reflection, and helped me decide who I wanted to be," Kosmala said. "I also have learned that life is a succession of ruptures. This is also the way all companies live and grow—or they die. Every encounter, every step you take outside, is a new card, a new option created."

*For Kosmala's full profile, go to aerospace.illinois.edu/news/listen-your-customers*

**"Listen to your customers … your job is to translate the abstraction of their needs to useful, value-creating products and services."**

— JAMES B. MOCARSKI

## *James B. Mocarski, BS 89, started as a freshman at the University of Illinois in the Psychology Department based upon the recommendation of his roommate's sister to "pick a major so you get an advisor." Shortly thereafter, based upon the advice of that advisor, he transferred to engineering.*

After graduation, Mocarski started his career at Northrop Grumman in the B2 bomber flight simulation organization. During his 27-year career, he led organizations across the company in product development, business planning and analysis, and program management. He earned a reputation for being a customer-focused innovator with a unique ability to build and lead high performance teams.

Most recently, he served as Vice President of the Airborne Tactical Sensors business unit. He was responsible for operations and the growth of a $300 million business unit comprised of an international portfolio of programs that combines electronic warfare (EW), survivability, situational awareness and targeting capabilities across fighter platforms.

Mocarski also has earned a master's degree in industrial and systems engineering from the University of Southern California, and has completed the General Manager Program at Harvard Business School.

He serves on the Aerospace Engineering at Illinois Alumni Board. While at Northrop Grumman, he represented the company as enterprise lead executive for the U of I, and was the executive sponsor for the Woman's Initiative for Networking to Success, an employee-led group committed to the advancement of women in the workplace. He remains active in the Harvard Business School alumni association as well.

Mocarski is currently pursuing entrepreneurial business opportunities that feed his passion for innovation and helping people and organizations reach their full potential. "Whether it is launching a new product line, turning around a troubled program or implementing a new strategy to grow a business, the most satisfying achievements are those in which you know that you and your team made a difference," he said.

*For Mocarski's full profile, go to aerospace.illinois.edu/news/satisfaction-comes-solving-complex-problems*

# 2016 Outstanding Recent Alumni

## Jeremy R. Alonso

Alonso, BS 09, was selected as the Northrop Grumman Aerospace Systems Lead Aerospace Engineer for the United Arab Emirates (UAE) in October 2014. In this role, Alonso is the technical representative responsible for supporting international captures and program execution and serves as the technical liaison to UAE representatives and U.S. personnel.

Prior to his current assignment, Alonso was a Systems Architect leading the way on integrating Unmanned Aerial Vehicles (UAV) into the National Airspace for the NGAS Research and Technology organization. Alonso led the UAE Innovation Challenge for 2013 and 2014, a science, technology, engineering and mathematics (STEM) competition in which UAE college students design and build UAVs to complete a specified mission. Earlier in his career, Alonso performed aircraft design analysis on the Navy UCAS program and system architecture design on the Automated Aerial Refueling program while mentoring students under Northrop Grumman's High School Involvement Partnership (HIP) and High School Innovation Challenge (HSIC) programs.

In addition to his bachelor's degree from Aerospace Engineering at Illinois, Alonso is an FAA Certified pilot for single engine and glider aircraft.

*For Alonso's full profile, go to aerospace.illinois.edu/news/how-you-say-it-important-what-you-say*

**"How you say it, is as important as what you say. You can be the best technical expert there is, however, it won't do you any good if you cannot communicate the idea to others."**

— JEREMY R. ALONSO

## Gina M. Miller

Miller, BS 05, MS 07, is a Materials and Process Engineer for The Boeing Company in Ridley Park, Pennsylvania, and leads the Boeing Research and Technology Vertical Lift Composites Laboratory that provides receiving inspection and engineering laboratory support for non-metallic material systems.

Miller began working with The Boeing Company in 2008 after earning her Master of Science degree under the direction of Prof. Scott White. At Illinois, Miller performed research in the Autonomic Materials Systems group, developing self-healing film adhesives. At Boeing from 2008 to 2010, she worked as a laboratory engineer and project leader. In 2010, Miller became the Technical Lead Engineer for the Boeing Research and Technology Vertical Lift Composites Laboratory.

Miller has focused her career on material property development and production support for rotorcraft and commercial platforms. She has supported numerous adhesive characterization and bonding process projects and is regarded as a subject matter expert on mechanical testing of adhesives. In addition to her technical work, Miller serves on an enterprise steering committee for the Technical Lead Engineer community that provides an infrastructure for over 7,000 Technical Lead Engineers across The Boeing Company to improve technical performance, strengthen engineering accountability, and develop a stronger technical workforce.

In addition to her Aerospace Engineering at Illinois degrees, Miller is currently pursuing graduate work in Materials Science and Engineering at the University of Delaware. Miller is a member of a number of industry organizations including the American Institute of Aeronautics and Astronautics (AIAA), Society for Experimental Mechanics (SEM), and Women in Aviation (WIA).

*For Miller's full profile, go to aerospace.illinois.edu/news/meeting-personal-commitments-key*

**"I get satisfaction out of solving difficult technical problems, whether it be solving a difficult homework problem set, troubleshooting an issue in the lab, or determining root cause for a process or part failure. I also get satisfaction when I am able to help make connections between individuals or groups: putting people in different groups or different parts of the company in touch with each other when they have projects, data, or expertise that could support each other."**

— GINA M. MILLER

# Swarm satellite research results in AIAA Best Paper Award

Recent AE PhD Daniel Morgan and his advisor, AE Associate Prof. Soon-Jo Chung, have won an American Institute of Aeronautics and Astronautics (AIAA) Best Paper Award for research on the guidance and control of swarm satellites.

The paper, "Swarm Assignment and Trajectory Optimization Using Variable-Swarm, Distributed Auction Assignment and Model Predictive Control," was also co-authored with Dr. Fred Y. Hadaegh, Associate Chief Technologist of the Jet Propulsion Laboratory at the California Institute of Technology. The research was presented at the 2015 AIAA Guidance, Navigation, and Control (GNC) Conference.

Chung directed Morgan's graduate work, resulting in a master's degree in 2011 and a PhD in 2015. Morgan now works as a senior guidance, control and navigation engineer at Space X in California.

The award-winning paper presents a distributed, guidance and control algorithm for reconfiguring swarms composed of hundreds to thousands of spacecraft such as CubeSats and Femtosatellites, with limited communication and computation capabilities. The SATO (Swarm Assignment and Trajectory Optimization) algorithm solves both the distributed auction-based optimal assignment and collision-free trajectory generation using sequential convex programming for swarms of spacecraft in an integrated manner, when given the desired shape of the swarm (without pre-assigned terminal positions).

The NASA Space Technology Research Fellowship Program and JPL sponsored this research.

# Alumni Board calls for alumni involvement

"Call to Arms!" *That's the general theme of this year's AE Alumni Advisory Board activities and annual meeting.*

Our Department had another great year leveraging the benefits of numerous improvements implemented over the past couple of years. This includes facility and laboratory upgrades, all-time highs in both the number of faculty and students in the Department, and updates to strengthen our curricula. In addition, the Board has helped the Department develop a longer-term strategic plan to shape the Department for continued growth and to meet the needs of students and faculty over the next 10 years. As a result, the Department continues to see strong improvements in the caliber of graduating students, thus better preparing them for the challenges in their industry careers.

This year we plan to leverage the breadth of great work that has been done across the Department and focus on expanding the involvement of AE alumni with students and faculty throughout the upcoming year. There are a number of classes and extracurricular opportunities for alumni to get involved.

This past year, several of us on the Advisory Board participated as panel members in preliminary and final design reviews for six teams in the senior design class. How exciting it was to receive news that three of the teams took 1st, 2nd, and 3rd place in the annual AIAA Spacecraft Design Competition! New panel members for this coming year's design class are more than welcome.

In addition, several alumni and board members shared their industry experiences with students as visiting speakers in classes. This is a great way to help students understand what industry is currently doing and find their career interests, so we want to expand the number of classes that host visiting alumni speakers. Our students are also involved in many different extracurricular teams and clubs and they absolutely love to have alumni join their activities to provide guidance and advice. In addition, there are a number of opportunities for alumni to help recruit graduating students for industry jobs.

So, for the benefit of our students, faculty, and department, I ask all alumni to carefully consider these and other opportunities to get involved with AE. If you haven't already, please contact the department and let us know where you'd like to help over the coming year.

Thank you for your consideration and let's have another great year in Aerospace Engineering!

**Blaine Brown**

AAE 1981
President, Alumni Advisory Board

# Why I Give

In a word: Gratitude.

Gratitude for the excellent education I received from the outstanding professors in the Aeronautical and Astronautical Engineering department (as it was known when I attended). This education enabled me to land a job doing exactly what I wanted to do with the company I wanted to work for: the Aerodynamics Department at Boeing. I have worked in a variety of departments at Boeing during my 35-year career, and my Illinois education has continued to give me an excellent grounding in each job.

Now I am reaching the end of my career, and I want to help others enjoy the benefits of an education from the Aerospace Engineering department. Over the decades, I have been happy to see the department make the investments necessary to ensure it continues to be one of the pre-eminent aerospace departments in the country. AE's leaders have hired professors who are outstanding in their fields of research, expanded the department's curriculum, and improved its classrooms and laboratories. If my contributions help the department further its goals, then it is the best investment I could possibly make.

**Robert Rapp**
BS 1981

*Currently working in Boeing Commercial Airplane's Product Development organization, with an emphasis on analyzing the competitors' airplanes, Rapp has spent his career at the company. He began in the Aerodynamics Department, working on high- and low-speed wind tunnel testing of the 737-400. Later, he participated in wind tunnel testing and design of the 777-200. By 1992, he was in the Structures Department, in which he worked on improving the design and build of 757 fuselage, the design of the 767-400 wing/body bulkhead frame, and the 777-200 center fuselage. He has held his current position since 2004.*

To donate to AE at Illinois, go to **aerospace.illinois.edu/giving**, or contact Associate Director of Advancement Tim Cochrane at **tcochran@illinois.edu**, 217-333-1149.

# Talbot Laboratory additions to add instructional space for composite manufacturing, nanosatellites

Shown in the illustrations are two views of the proposed addition to Talbot Laboratory.

Two of the addition's three floors will be used to house instructional laboratories for Aerospace Engineering at Illinois. The basement will hold a composite manufacturing laboratory, and a nanosatellites laboratory will be located on the second floor.

The addition's first floor will be used by Nuclear, Plasma, and Radiological Engineering, which shares Talbot Laboratory with AE.

Construction is projected to start in Summer 2017 and be completed within a year's time.

ILLINOIS

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