ÆE Illinois

2010 Annual Report of the Department of Aerospace Engineering University of Illinois at Urbana-Champaign

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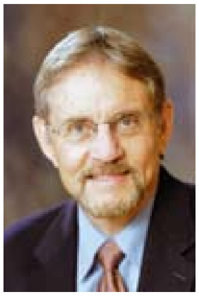


Craig Dutton

Welcome to the 2010 Annual Report of the Illinois Aerospace Engineering Department. Despite substantial budget uncertainty in the state of Illinois, our department continues to thrive. Our enrollments remain strong with 376 undergraduate and 150 graduate students this fall. We have emphasized the growth of our graduate program in particular in the last several years; its enrollment now stands at an all-time high.

The implementation of our recently revised undergraduate curriculum is going extremely smoothly. Both students and faculty alike are very pleased with the improved content and structure of this revision. Similarly, the implementation of our revised M.S. program, including a new non-thesis option, has gone quite well to date. A major portion of the increased enrollment in the graduate program is attributable to the M.S. non-thesis option. Next up will be revisions to our Ph.D. program.

Our research programs are thriving as well. In FY2010 we had the highest level of research expenditures ever within the department, and the initiation of some very exciting new programs. Several of these programs will be featured in the following pages, including the work of Joanna Austin, Tim Bretl, Bruce Conway, Ioannis Chasiotis, and Philippe Geubelle.

We are extremely proud of the honors our faculty have achieved. Some highlighted in this publication include: Joanna Austin (NSF CAREER Award and AIAA Best Paper Award), Tim Bretl (NSF CAREER Award), Bruce Conway (AAS Dirk Brouwer Award, IAC Breakwell Memorial Lecture, and AAS Fellow), Ioannis Chasiotis (NSF PECASE Award, SES Young Investigator Medal, SEM Journal of Strain Analysis Young Investigator Lecture, Willett Faculty Scholar, and Xerox Award for Faculty Research), Soon-Jo Chung (AIAA Best Paper Award), Jonathan Freund (Xerox Award for Faculty Research), John Lambros (ASME Fellow), and Scott White (ASC Fellow).

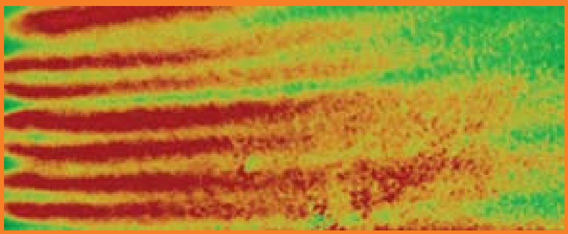
Our students and alumni also continue to achieve great things. In these pages you will read about the accomplishments of AE students Jie Hua Lin, Jonathan Yong, and Heather Arneson. Among our featured alumni are Robert Liebeck, who will soon receive the prestigious Guggenheim Medal, and Julia Laystrom-Woodard, who was recently featured in a Discovery Channel video concerning her AE career.

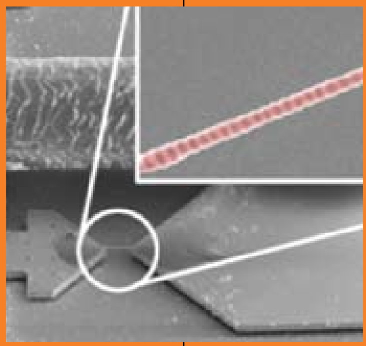
So, read and enjoy. We look forward to your comments; our contact information is readily available on our website at: www.ae.illinois.edu.

Sincerely,

Craig Dutton
Bliss Professor and Head

Highlights





Austin's Work Examines Hypervelocity Flight, Detonation and Shock Physics, Volcanic Eruptions

Joanna Austin

AE Assistant Prof. Joanna Austin's work in compressible fluid mechanics has led to projects ranging from planetary-entry experiments that are brought down to earth to unlocking the secrets of a 30-year-old volcanic eruption.

"We have a variety of projects all linked together because we examine high-speed reacting flows," Austin said. "At the core, we look at the physical gas dynamics of fluids moving at these high speeds and at high temperatures."

Hypervelocity Flight

In December 2005 Austin and her students finished construction of the Hypervelocity Expansion Tube (HET), a ground testing facility to replicate the environment of vehicles entering into a planet's atmosphere. Since that time, 850 experiments, or shots, have been conducted in the facility. Many of the experiments that Austin carries out with the help of graduate students Manu Sharma and Andy Swantek investigate flight environments that space vehicles experience upon re-entering planets such as Earth or Mars. Gases surrounding the vehicles behave differently when confronted with the very fast speeds and very high temperatures associated with planetary entry.

"The molecules themselves begin to play an important role," Austin said, "One of our main motivations in constructing the expansion tube facility is the gas is accelerated without a nozzle resulting in a 'thermochemically clean' free stream. This allows us to study the coupling between high-stagnation enthalpy thermal and chemical processes and the fluid motion."

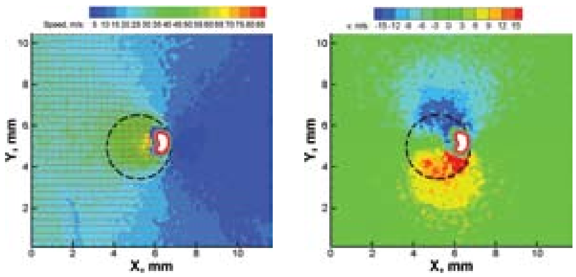
With the ground testing facility, Austin and her group have the diagnostic capability of visualizing and interrogating the gas flows. For example, in collaboration with Prof Nick Glumac of the Mechanical Science and Engineering (MechSE) Department at Illinois, the scientists use emission spectroscopy to make direct measurements of how the gas relaxes to an equilibrium state.

A Multidisciplinary University Research Initiative (MURI) grant that the Air Force Office of Scientific Research (AFOSR) awarded and that Texas A&M University leads provided for the HET's construction. AE Prof. Gregory Elliott shares in that MURI work.

Austin received an AFOSR Young Investigator Program award in 2007 that supports graduate student William Flaherty's use of the HET to study high-speed boundary layers over surfaces with concave curvature. "When the surface is curved this way, it destabilizes the (hypersonic) boundary layer, increases the heat transfer, and allows for additional centrifugal instability," Austin said. Axisymmetric engine components such as inward-turning inlets have higher theoretical efficiency, but models are needed to predict the aerodynamic and thermal loads. Austin and Flaherty work to quantify the heat transfer caused by the vehicle's curved geometry. They also introduce vortex structures into the boundary layer and watch the response to the surface geometry. The vortices dissipate when the surface is flat, but are maintained with the curved geometry. This makes a difference to the loading of the vehicle, Austin said.

Bubbles collapsing

Austin works with AE Profs. Jonathan Freund and John Lambros and AE Adjunct Prof. Thomas Jackson



on a project to gain microscale control of energetic materials. "When you have energetic materials, you want to predict their performance—or safety—at the device scale, at a few centimeters," Austin said. "But the processes responsible for ignition occur at the scale of the material microstructure, or even smaller." To observe the problem, researchers model the material at the scale of grains within it. Between the grains are pores or bubbles that, upon impact, can collapse, causing hot spots.

Austin and her colleagues examine the case when the graduated time-scale of a load on the material is comparable to the time-scale of the bubbles collapsing. They've gained insights about the chain reaction that occurs within the material. "While one bubble is interacting with the loading wave, it shields the others, but then the subsequent collapse of that bubble causes a jet that triggers the collapse of other bubbles. All the bubbles break, but they break in succession," she said. The Department of Defense's ASCI Rocket Center on the Illinois campus and the U.S. Air Force Research Laboratory support this work.

In addition to understanding explosive materials, this research has applications for other fields, including biomedicine. Medical procedures such as shock-wave lithotripsy (used in breaking up kidney stones), laser-induced plastic surgery and ultrasound involve the dynamic formation of cavities in tissue. However, collateral damage to the tissue can result if the cavities collapse. Austin's work to predict such damage recently earned her a 2010 Faculty Early Career Development (CAREER) Award from the National Science Foundation. Her work will involve model experiments that include high-speed imaging and the first velocity field measurements around collapsing voids. The group's work on distributed loading conditions is particularly relevant as stress gradient has been shown to be a more important parameter in cell injury than the peak pressure.

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Austin Earns NSF CAREER Award and Shares in Best Paper Award

AE Assistant Prof. Joanna M. Austin has earned a 2010 Faculty Early Career Development (CAREER) Award for research to help minimize tissue and cell damage during procedures such as shock-wave lithotripsy, used in breaking up kidney stones.

Austin and her co-authors also were selected by the The Fluid Dynamics Technical Committee of the American Institute of Aeronautics and Astronautics (AIAA) for the 2009 Best Paper Award.

The $400,000 National Science Foundation CAREER award will support Austin and her group's study of shock- and stress wave-induced void collapse in biomedical applications. Tissue can be damaged during such applications if cavities develop and then collapse in the tissue. Austin's work to predict such damage could impact treatment decisions in procedures such as lithotripsy, laser-induced plasma surgery, and ultrasound. Model experiments include high-speed imaging and the first velocity field measurements around collapsing voids.

The Best Paper Award was presented at the 39th AIAA Fluid Dynamics Conference held in June 2009. Simon Sanderson of General Electric was lead author. Co-authors were Austin, Zhe Liang of AECL Chalk River Laboratories; Florian Pintgen of General Electric Global Research; and Joseph Shepherd and Hans G. Hornung, professor and emeritus professor, respectively, of aeronautics at the Graduate Aerospace Laboratories, California Institute of Technology.

The paper, entitled "Reactant Jetting in Unstable Detonation," was produced in honor of Hornung's 75th birthday. The work demonstrated the structural equivalence of the supersonic jet occurring in a hypervelocity shock impingement and reaction zone features in gaseous detonation, Austin said. The mechanism for jetting of bulk pockets of unreacted fluid observed in highly unstable detonations was explained.

Austin's research areas are fluid mechanics, compressible flow and combustion. She directs the Compressible Fluid Mechanics Laboratory at Illinois.

Austin began her career at Illinois after earning a PhD and master's degree in aeronautical engineering at the California Institute of Technology in 2003 and 1997, respectively. She had earned bachelor's degrees in mathematics and in mechanical and space engineering in 1996 from the University of Queensland in Australia.

The group's work on distributed loading conditions is particularly relevant as stress gradient has been shown to be a more important parameter in cell injury than the peak pressure.

Explosive Volcanic Eruptions

Working with Geology Prof. Susan W. Kieffer, Austin is interested in compressible flows in geological applications such as explosive volcanic eruptions. In the May 18, 1980, eruption of the Mount St. Helens volcano in the state of Washington, a dome containing pressurized gas dissolved in magma had been intruded into the mountain's side. The pressure difference between the inside and outside of the dome was as much as 150 to 1. A landslide relieved the overlying material and triggered the eruption of the pressurized material over the surrounding area.

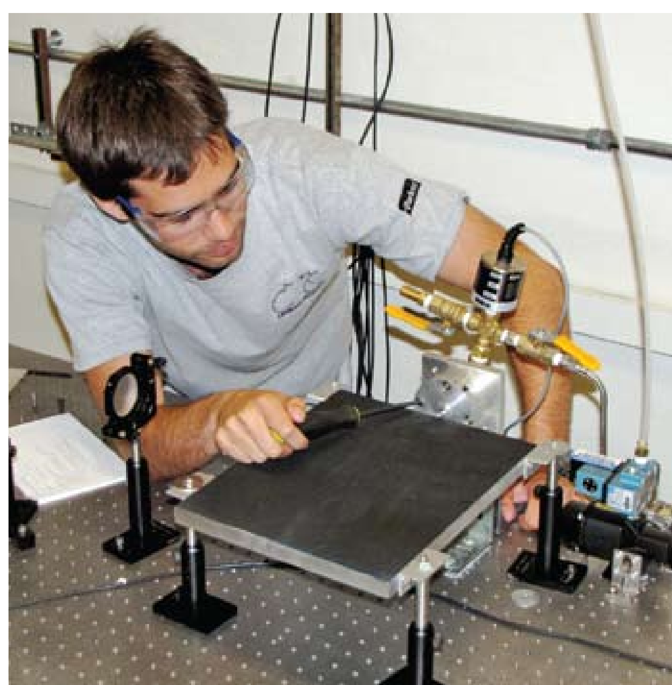
Austin and her colleagues have studied the volcano's forensic evidence to determine what happened. Directly near the vent, the trees were demolished, not leaving a trace. Outside that region was a channelized blast zone that left the trees uprooted but aligned with the topography. Their work has shown that in spite of the small reservoir, there was time for the volcano to have formed as an under-expanded jet with a supersonic region near the vent, supporting Kieffer's 1980 model, Austin said. The National Science Foundation funds the Mount St. Helens research.

Austin is also working with Kieffer on a project the National Aeronautics and Space Administration funds to understand the formation of sustained longitudinal grooves and ridges on selected impact craters. The group is looking at high-speed boundary layers over erodible surfaces to determine whether the craters' radial grooves provide evidence for the nature of the Martian subsurface. This work also draws on Austin's studies of vortices over concave surfaces in hypervelocity flows.

Jet Noise

Austin leads an effort in collaboration with Freund and Elliott on acoustics associated with the exhaust system of a supersonic business jet. Currently, commercial aircraft do not fly supersonically over land because of the sonic boom created at these speeds. Meeting Federal Aviation Administration guidelines on take-off noise levels is required if these jets are to use commercial airports.

Austin's portion of the project involves small-scale testing of nozzle configurations in an attempt to reduce take-off noise. For these experiments, together with her collaborators, Austin and student Ryan Fontaine, have built an anechoic chamber to house a Mach 0.9 jet, partnering with aerospace companies Gulfstream and Rolls-Royce.



Bretl Uses 'Mind-reading' to Improve Prosthetic Device Design, Fly Remote-controlled Planes

MODIFIED FROM ORIGINAL STORIES BY MEGAN KELLY, COORDINATED SCIENCES LABORATORY

AE Assistant Prof. Timothy W. Bretl's research using electroencephalography (EEG) connections to brain-machine interfaces (BMIs) has enabled mind control of machine movement.

So far, this technology has been applied to fly remote-controlled planes, and to improve the design of prosthetic devices, the latter of which has earned Bretl a 2010 Faculty Early Career Development (CAREER) Award from the National Science Foundation.

Prosthetic Device Design

"The game today is to make a functional prosthetic limb with as few motor degrees of freedom as possible, with the theory that it'll be easier to control," said Bretl, who also works as a researcher in the Coordinated Science Laboratory (CSL). "There's evidence from both neuroscience and robotics that this implicit assumption is not true, and that we should think much more carefully about the interface between the person and the device."

Bretl's unique interdisciplinary background in aerospace engineering, robotics and neuroscience—areas that traditionally do not go together—makes him well equipped to handle some of today's greatest challenges in prosthetic device design. His interdisciplinary tendencies also helped result in the CAREER Award, which carries a $400,000 monetary value and spans five years.

Bretl and his team of graduate students will begin by using the money to accelerate research on brain-machine interfaces (BMIs). These interfaces enable people to control prosthetic devices through direct measurement of brain activity.

For example, in collaboration with colleagues Todd Coleman in CSL and Ed Maclin in the Beckman Institute, Bretl's team uses EEG to predict motor intent. EEG is a noninvasive measurement of brain activity recorded by an electrode cap worn on a person's scalp. A BMI is a direct communication pathway between a person and a computer. In this case, the EEG is connected to a computer, and Bretl's team analyzes the voltage between electrodes. If an individual imagines moving his left arm, brain activity will stimulate specific electrodes that the computer reads. This technique may produce novel prosthetic devices that improve quality of life for people with disabilities due to amputation, spinal cord injury and stroke.

"Successful use of BMIs will allow individuals with impaired sensory-motor function to control a prosthetic limb by thought alone," Bretl said.

To improve the BMIs' performance, Bretl aims to derive new models of human motor control and learning. These models are based on the observation that motor control resembles a process of communication between the brain and the rest of the body and that motor commands are like words in a language. The key is to understand this language and how it can be used to describe human motion.

Bretl's students are also involved in other projects related to his work on BMIs. For example, a recent focus has involved robotic manipulation of deformable objects, such as a piece of paper without a fixed shape. Bretl believes that finding a simple way to describe this shape is similar to finding a simple way to describe human motion.

"It's a challenge but we've developed a principled approach to come up with the right set of parameters to describe these infinite-dimensional objects," said Bretl. "It's gratifying to see links between different parts of our work become more concrete. It makes future development that much easier."

The CAREER Award includes an educational component. BMIs will be demonstrated at Engineering Open House and at the Neuroscience Program's "Brain Day" to educate the elementary school level. With Diane Jeffers of AE, Bretl also co-directs the Illinois Aerospace Institute, a week-long program introducing high-school students to topics in aerospace engineering, including space robot

Timothy W. Bretl

"Successful use of BMIs will allow individuals with impaired sensory-motor function to control a prosthetic limb by thought alone."


Coordinated Sciences Laboratory

Student with sensor cap is Coordinated Sciences Laboratory graduate student Chris Quinn.

If Bretl's research continues to be successful, he predicts that BMIs based on EEG may, in some cases, prove better than traditional interfaces like a keyboard or a joystick.

teleoperation, which is directly relevant to Bretl's research.

"We get an amazing reaction from students who participate," Bretl said. "One of my students last year said the program changed her career direction, prompting her to go into neuroscience and pre-med. These students see the potential applications for this in 10 or 20 years, which is exactly what I'm going for."

At the collegiate level, undergraduate classes will be offered, with a focus on attracting students from diverse backgrounds. At the graduate level, Bretl plans to teach a neuroscience course within the Illinois IGERT (Integrative Graduate Education and Research Traineeship) program.

"I hope this is the start of something that will carry through my entire career," Bretl said. "There are so many interesting questions to be answered."

Remote-controlled Movement

Bretl and his group have expanded the basic premises of the research to other levels.

"I wanted to push the state of the art," he said. "I wanted to connect EEG to a vehicle with complex dynamics. Not necessarily because I'm interested in a brain-controlled aircraft, but because it's way beyond the current state of the art. It's a good test to see how far we could go."

Because controlling aircraft is far more advanced than present EEG/BMI applications, Bretl said he has encountered challenges.

"What makes this problem hard is that EEG is such a noisy reflection of what the pilot wants. I'm collaborating with Todd (Coleman) and using tools from control and feedback information theory to say precisely how the aircraft should fly in order to best match the pilot's intent," Bretl said. "We have a nice framework and we know how to apply it, but we still have a lot of questions."

Further, Bretl wants to convey to the aircraft not just what direction he wants it to move at a specific moment, but the entire path of its trip.

"When a subject thinks 'go right', he's not saying 'turn to the right, right now', but 'somewhere along the line, I want to deviate to the right'," Bretl said. "How to actually communicate this clearly is something we're still working on."

Bretl said that while this technology may never be used for flight in the real world—"Is this a practical way to fly a single aircraft? Probably not!"—he's using the complex dynamics of aircraft as a foundation for advanced applications in other areas, such as helping the disabled gain mobility.

"We want them to drive cars, draw pictures, do the things that you and I take for granted," he said. "These things are challenging, in the same way that the aircraft is a bigger challenge."

Abdullah Akce, a graduate student in computer science and a member of Bretl's team, said experiments so far have been fairly successful. However, their success depends largely on the subject.

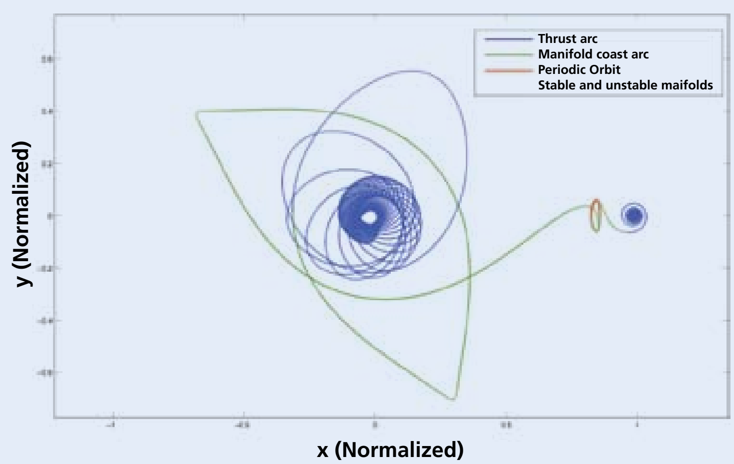
"Some subjects are able to make the aircraft follow a predetermined route with close accuracy," Akce said. "But other subjects have a more difficult time tracing the route."

If Bretl's research continues to be successful, he predicts that BMIs based on EEG may, in some cases, prove better than traditional interfaces like a keyboard or a joystick.

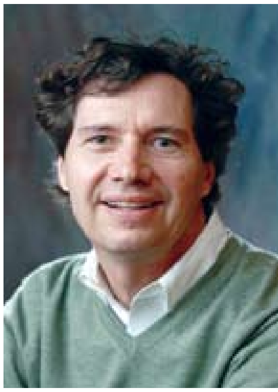
"We're in the process now of doing systematic trials with human subjects. It's a long road, and we're in the middle of it," he said. "Things are very much revving up now. I'm happy with our progress."

Conway Uses Numerical Methods for Best Ways to Plan Space Travel

Numerical methods to find optimal solutions for a host of problems—ranging from planning a journey from Earth to Mercury to strategies in fighter versus fighter air combat—has been the focus of AE Prof. Bruce A. Conway's research.



An example of a low-energy transfer from the Earth to the Moon, in this case taking approx. 123 days, but using very little fuel.



Bruce A. Conway

Automated Space Mission Planning

When planning a trip from Earth to another planet, say Mercury, is it best to fire rockets from Earth, then flyby at Venus to get a pull from that planet's gravity? Or would a departure from Earth followed by a return and flyby around Earth first help reduce the fuel needed for the journey?

"There are always many ways to approach a trip from Earth to another planet," Conway said. "The goal is to find the most efficient considering fuel consumption and time limitations."

Conway and his students have devised a system by which each variable in planning the trip is assigned a number, and a computer program generates possible sequences of those events. "But there could be millions of possible sequences," Conway said. "It's not feasible to determine the cost of every one and then take the best."

Instead, Conway's group takes a "nested loop" approach, looking at an outer and an inner loop.

The outer loop chooses the sequences; beginning with a population that is randomly generated. Considering the best dates for departure and arrival, and best dates for flybys, the inner loop examines the sequences more closely, determining the amount of fuel needed by each sequence. Then the infeasible and poorest-performing of those are discarded.

By comparing what the best solutions have in common, the researchers eventually arrive at one solution.

"It's called a genetic algorithm and it is based on the principle of the survival of the fittest," Conway said. "You take two solutions and combine them to get a new solution, mimicking what is done in nature. The resulting sequence is kept if it is an improvement over its parents and the best performing solution always survives into the next generation. That way the solution is always improved, until it reaches its best case. The fact that the initial population is generated randomly enables it to find some non-intuitive solutions that otherwise would never be found."

Conway's student Christian Chilan, PhD '09, began this research four years ago. Current student Jacob Englander has continued the work, which NASA's Graduate Student Researchers Program supports.

By comparing what the best solutions have in common, the researchers eventually arrive at one solution.

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Optimal Earth-Moon Transfer Using Invariant Manifolds and Low-Thrust Propulsion

The more a space vehicle weighs, the more it costs to be put into orbit. Reducing the mass of the propellant, then, is another means to optimize the mission.

Recent missions have used electric propulsion. These low-thrust engines have a much higher exhaust velocity than standard chemical rockets and are consequently more fuel-efficient.

Low-thrust propulsion requires engines to fire constantly as compared to the short period of time needed for a chemical rocket firing. The vehicle using low-thrust propulsion also might need to circle the departing planet several times to build up enough speed to continue the journey.

This fuel-saving option employs the invariant manifolds of the three-body problem, sometimes referred to as the Interplanetary Superhighways, and the Lagrange equilibrium points between the departing planet and destination. Fuel is saved because the spacecraft does not need to travel all the way to the Moon; it needs only to reach a point on the "superhighway" and then coasts to the Lagrange point. From there the spacecraft can travel almost freely to the Moon as it is pulled in by the Moon's gravity.

This option would take one-fifth to one-tenth as much fuel, but several more weeks to accomplish. "It's a viable option if there are no time pressures," Conway said. "This could be an option if you needed to deliver supplies or put a habitat on the Moon, for example, where flight time would not be so critical."

PhD student Chris Martin is doing this research.

Particle Swarm Optimization Applied to Space Trajectories

The swarming of bird flocks searching for food has inspired this research.

Conway said multi-dimensional search spaces are designed in which the coordinates represent the design parameters such as departure and arrival dates for an interplanetary trajectory, to give a simple two-dimensional example. "Particles" are then randomly inserted in the space. The coordinates of each particle are the values of the parameters and the cost of doing each mission using these parameters is then found for each particle. Of course, some of the particles will have been inserted at better points than others. The particles then "communicate" with one another, and each moves a step toward the best location found by any of the particles, that is, they flock toward the best solution then known. The process is repeated and as the particles travel in the search space they may find even better points.

The answer is reached when no meaningful improvement is found from a new step.

The work is extremely easy to program, Conway said, and can give the user some surprising answers.

"The user might find the 'best' solutions are counterintuitive; the answer might not be that obvious."

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Conway delivers Prestigious Lectures; Is Elected AAS Fellow

AE Prof. Bruce A. Conway was honored with invitations to present two prestigious lectures this past year, and was recently elected a Fellow of the American Astronautical Society (AAS).

As part of his being named the 2009 recipient of the ASA's Dirk Brouwer Award, Conway delivered the plenary lecture at the society's Winter Space Flight Mechanics meeting in February in San Diego. He was also asked to deliver the John V. Breakwell Memorial Lecture at the Astrodynamics Symposium of the 61st International Astronautical Congress, set for September 27 to October 1 in Prague, Czech Republic.

Both talks focused on methods available to optimize space trajectories, with Conway favoring an option using "evolutionary algorithms," a research interest of his over the past four years.

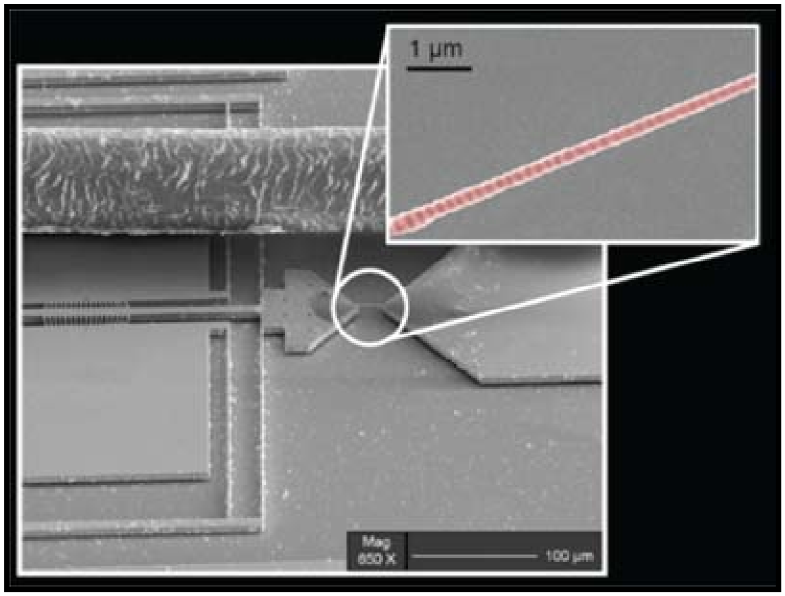
Conway's research interests primarily are orbital mechanics, optimal control, and improved methods for the numerical solution of problems in optimization. He has been a member of the AE faculty for 29 years.

In addition to his contributions to research, Conway also has been frequently recognized for his teaching skills. Conway consistently is included on the campus' List of Teachers Ranked Excellent by Their Students. Over his career AE students chose him eight times as "Teacher of the Year." He has won every College of Engineering teaching award available, as well as the 2007 Campus Award for Excellence in Undergraduate Teaching, the University of Illinois' highest teaching accolade.

Conway earned a bachelor's degree in physics in 1973 from Macalester College in St. Paul, Minnesota. He earned a master's in mechanics in 1974 from the University of Minnesota, and a PhD in aeronautics and astronautics from Stanford University in 1981.

Chasiotis Scales Up to Success

THIS ARTICLE IS BASED ON AN ORIGINALLY PUBLISHED ARTICLE BY STEVE MCGAUGHEY, BECKMAN INSTITUTE WRITER, ON JUNE 16, 2010



The unusual nature of nanoscale structures: A polymeric nanofiber mounted on a MEMS micromachine for tensile testing. A human hair at the upper half of the image provides a familiar scale. Inset: A polymeric nanofiber with periodic surface ripples induced by stretching it with the MEMS device. Such periodic ripples are uncommon in macroscale nanofibers which form only a single ripple (neck) when extended.

Ioannis Chasiotis

Understanding materials at their smallest scales improves applications at larger scales.

The approach Ioannis Chasiotis takes to research for advanced aerospace grade materials is that understanding materials at their smallest scales improves applications at larger scales. Chasiotis' professional life has reflected a similar storyline that also serves to validate his scientific approach: from his beginnings as a newly-arrived-in-America graduate student from Greece to less than 14 years later standing next to the President of the United States as one of America's top young scientists.

Since leaving his native Greece for America in 1996, Chasiotis has earned a Ph.D. in Aeronautics from Caltech, and assumed a faculty position at the University of Illinois in 2005. Earlier this year, Chasiotis went to the White House along with other honorees to receive a Presidential Early Career Award for Scientists and Engineers (PECASE), the highest honor bestowed by the United States government on scientists and engineers in the early stages of their independent research careers. Chasiotis said that the award and ceremony at the White House with President Barack Obama was a special, once-in-a-lifetime event for him.

"It was quite something, especially for me coming less than 14 years ago to this country," Chasiotis said. "Then getting to meet the President and receive an award for my research, it's beyond what I could dream. It was a major honor and it was very nice to see the President up close."

The arc of his American success story mirrors his approach to materials science research. Chasiotis says the best method for understanding and working with materials such as polymers and their nanocomposites is to start at the nanoscale and work up the scales; it is, he says, an approach that will lead to more effective and better designed materials for use in aerospace applications and many other commodity products.

"My research goes bottom up," he said. "We start at the bottom of the scale and move step by step up through the scales, rather than fabricate bulk materials and then dig in to discover why they behave the way they do. If I could find out how the individual building blocks function in a material, maybe I could then design materials with desired and unique mechanical properties at the macroscale."

Chasiotis is a Willett Faculty Scholar of Engineering at Illinois, with appointments in Aerospace Engineering, the Beckman Institute of Advanced Science and Technology, the Micro and Nanotechnology Laboratory and is an affiliate of the department of

"We find that most nanoscale structures such as nanofibers and nano-tubes have unusual behavior which we don't see in the nom-inally same materials at larger structures."

Mechanical Science and Engineering. His research investigates the nanoscale mechanical behavior of hybrid materials, and hinges upon experimentation starting with the smallest sizes. The PECASE award relates to his work trying to understand the inter-faces between polymeric nanomaterials.

"That involves understanding about how materials, particularly polymers, behave when we fabricate them in very small, nanoscale, volumes," Chasiotis said. "The issue is that we don't know what their interfaces with other materials are like, how they behave and what they should be so that they have a significant effect to the properties of bulk scale composites.

"And these interfaces involve very small volumes of polymers. The way materials behave mechanically when they are confined in small volumes is vastly unknown, especially for polymers. Because of their molecular structure they are not homogeneous at the nanoscale, which of course applies to all nano-structured composites. We would like to understand how nanoscale components interact with each other inside bulk materials so that we improve their mechanical durability and properties."

The approach of Chasiotis is that working at smaller scales provides the best way to take advantage of the nanoscale properties of small volumes of materi-als, similar to what happens when fabrics are made from strong microfibers, or even nanofibers, giving them greater flexibility and strength, or even the ability to repel stains.

"We find that most nanoscale structures such as nanofibers and nanotubes have unusual behavior which we don't see in the nominally same materi-als at larger structures," Chasiotis said. "Very small material structures, such as polymer nanofibers that consist of numerous molecular chains, will not behave the same in larger dimensions. This is because nanofibers are made out of discrete blocks that are of similar sizes as the nanofiber itself.

"Some properties of nanoscale building blocks are averaged out in microscale fibers but they are maintained in nanoscale ones. Therefore, instead of combining trillions of individual polymer molecules to make bulk materials, what if we use billions of nanoscale fibers, each of them including hundreds of polymer molecules, just like we weave fabrics out of fine threads to build hierarchical bulk materials? This is one of the objectives of my research lab: understand how the material organization could take advantage of great nanoscale properties and turn them into greater macroscale properties."

Chasiotis said research at his lab involves under-standing how mixing very small quantities of hard nanomaterials, such as nanotubes or nanofibers, with polymers affects the behavior of the polymer itself, resulting in greater strength.

"But the majority of the composite material is still a polymer which, however, does not behave as pure polymer any longer," he said. "It is still lightweight but we changed many of its other properties. The role of nano here is to modify some of the proper-ties of existing materials without affecting the rest of their advantageous attributes."

That work at the nanoscale is dependent on very small tools, especially the ones designed by Chasi-otis' Nanomechanics and Materials Research Labora-tory (NMRL).

"This research area is challenging because we are lacking potent tools," Chasiotis said. "We need spe-cialized microscale tools which are based on MEMS (microelectromechanical systems) and are finer than a human hair."

Designing tools for nanoscale research is criti-cal to Chasiotis' lab performing experiments with nanomaterials.

"We design and use MEMS as the tools to probe and understand how nanomaterials behave because the nanoscale is too small for existing mechanical testing tools," he said. "We also study the behavior of materials for the fabrication of MEMS so that we improve on the durability of micro-machines and micro-tools themselves."

Chasiotis Widely Recognized in Young Career

It's been quite a year for AE Associate Prof. Ioannis Chasiotis.

Topping it off was his trip in January to the White House to accept the 2008 National Science Foundation (NSF) Presidential Early Career Award for Scientists and Engineers (PECASE). President Barack Obama, himself, greeted Chasiotis, among 100 young researchers recognized. PECASE is the highest honor the U.S. government bestows on young professionals at the outset of their independent research careers.

Early this past spring, the Society of Engineering Science, Inc., chose Chasiotis to receive the SES Young Investigator Medal, a highly competitive, international award presented to a young researcher whose work has already impacted an engineering science field. The medal winner must be within 10 years of his or her terminal degree at the time of receiving the award. Chasiotis will be officially recognized during the SES 47th Annual Technical Meeting to be held at Iowa State University, October 4-6.

Also this summer, the Society of Experimental Mechanics chose Chasiotis to deliver the 2011 *Journal of Strain Analysis* Young Investigator Lecture, making him only the third individual to be so honored. Again, presented to a young researcher within 10 years of having earned a PhD, this award recognizes an SEM member in early to mid-career who demonstrates considerable potential in the field of experimental mechanics. Chasiotis will present the lecture during the SEM Annual Conference and Exposition on Experimental and Applied Mechanics scheduled for June 13-15, 2011, in Uncasville, Connecticut.

Locally, in December the College of Engineering at Illinois named Chasiotis a Donald Biggar Willett Scholar. Michael B. Bragg, the College's Associate Dean for Academic Affairs and a former AE Department Head, noted the Department's wisdom in recruiting the young researcher. "You make us look smart for bringing you here," Bragg said. In April, the College chose Chasiotis for a 2010 Xerox Award for Faculty Research; he had also received a Xerox Award in 2007.

Chasiotis came to Illinois after starting his career at the University of Virginia, having earned a master's degree and PhD in Aeronautics from the California Institute of Technology in 1998 and 2002, respectively. He earned his first degree in chemical engineering in 1996 from the Aristotle University of Thessaloniki, Greece.

Chasiotis' research interests focus on MicroElectro-Mechanical Systems (MEMS), nanostructured composite materials, mechanical behavior of polymeric and ceramic nanofibers and metal nanowires and the application of atomic force microscopy in experimental mechanics.

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PECASE is the highest honor the U.S. government bestows on young professionals at the outset of their independent research careers

Official White House Photo: Lawrence Jackson

President Barack Obama with the Presidential Early Career Award for Scientists and Engineers (PECASE) winners in the East Room of the White House, Jan. 13, 2010. AE Associate Prof. Ioannis Chasiotis is in the back row, seventh from the right.

Teamwork Key in Geubelle's Modeling Work

Philippe H. Geubelle

AE Prof. Philippe H. Geubelle teams with experimentalists when he carries out his computational modeling work.

"I always try to work with experimentalists to get insight on physical phenomena to decide the best model, and to provide data needed to validate my simulations," he said. "There are very good experimentalists here (at Illinois), so it works like a charm."

Geubelle collaborates on a number of projects with experimentalists such as Scott White, John Lambros, and Ioannis Chasiotis, all AE faculty members, and Nancy Sottos, an AE affiliate and professor of the Materials Science and Engineering Department.

Microvascular Networks

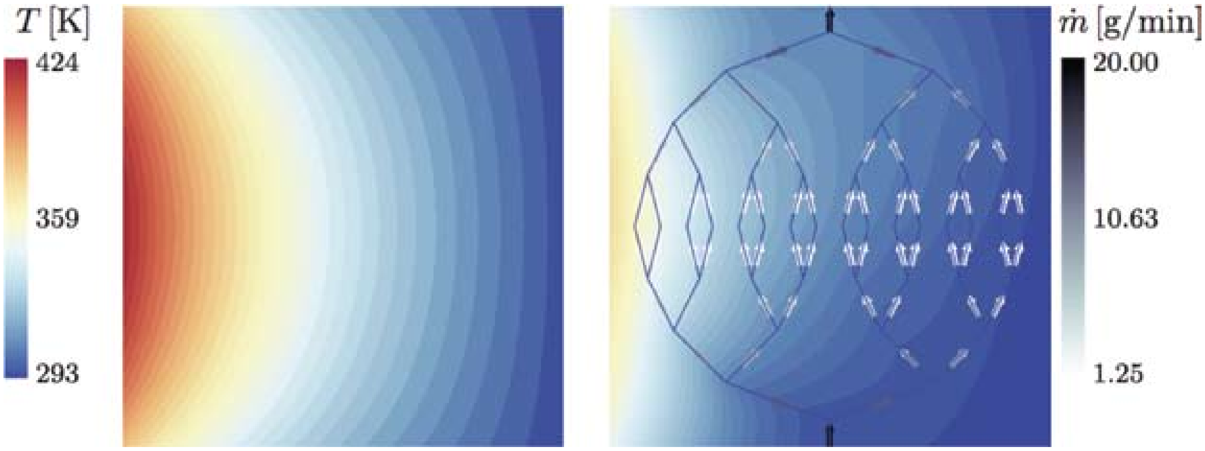
Working with White and Sottos, Geubelle is involved in a project to develop a fiber-reinforced polymeric-matrix composite material that can cool itself by use of an inner structure that mimics biological veins and arteries. The idea is to flow fluid through the material's circulatory system to lower its temperature.

The project is funded through a Multi-University Research Initiative (MURI) grant from the U.S. Air Force in collaboration with Texas A&M, Virginia Tech, Stanford and UDRI. Geubelle said the Air Force is interested in developing a hypersonic vehicle able to reach any point on the globe in very little time. At very high speeds and/or during reentry, this type of aircraft would need to withstand very high temperatures. "One material can not really do it; you need a hybrid," Geubelle said.

Researchers are developing a Functionally-Graded Material (FGM) that blends high temperature-resistant ceramic with metal that is less brittle and subject to breaking. Under that layer designers propose using a lighter composite material that can still handle high temperatures. Geubelle, Sottos and White want to increase the amount of composite material used to lighten the vehicle even more, making it less costly. Their idea is to sacrifice and dissolve some of the fibers embedded within the material to create "veins" through which cooling liquid can flow.

Geubelle's role is to create a model that predicts how well the microchannels work in cooling the

Geubelle and his colleagues want to sacrifice and dissolve some of the fibers embedded within composite materials to create 'veins' through which cooling liquid can flow.



Computational design of microvascular materials. Generalized finite element analysis of the effect of a microvascular network on the thermal field in a square polymeric component. Left: Temperature field in the absence of flow. Right: Thermal solution obtained for a hierarchical network with a 20 g/min mass flow rate of cooling fluid.

material. He considers both the effect of the microchannels on the temperature in the composite, the pressure needed to get the fluid flowing and the impact of the microchannels on the mechanical properties of the composite.

"We need to optimize how many microchannels to use and where to place them from a thermal point of view," Geubelle said. "We want more microchannels but not so many that the material won't be able to withstand the load."

Optimizing Load Mitigation

Geubelle is working with Lambros and a host of other researchers at the University of Illinois and Caltech to design material with wave-tailoring capability. "When a structure is subject to impact, we want to divert the waves away from what we want to protect," Geubelle said.

The Army Research Office supports this MURI project that has applications in protecting electronic components of cell phones to armor protection systems.

"Our focus so far has been on granular material, and in particular with model materials made of contacting spheres," he said. "When they're pressed against each other, the contact between them makes this material intrinsically nonlinear, which translates into very unique wave propagation properties."

Geubelle's graduate student Kyle Smith is using static and dynamic finite element codes to model the effect of plastic dissipation in the propagation of waves in one-dimensional systems. A postdoctoral research fellow, Amnaya Awasthi, is studying how waves propagate in these granular materials in 2D and 3D.

Hypersonic Vehicles

Another aspect of the Air Force's interest in hypersonic aircraft has led to Geubelle working with his AE colleague Dan Bodony on structural/acoustic research.

"As hypersonic vehicles reenter the atmosphere, they experience very high thermal, mechanical and acoustic loads," Geubelle said. For the space shuttle, the thermal protection system was made of thick tiles. But the system was quite heavy and needed frequent repairs. The Air Force is interested

continued on next page

ISGC Promotes Aerospace Education

In addition to his teaching, research and administrative responsibilities for the Aerospace Engineering Department, Prof. Philippe H. Geubelle also directs the Illinois Space Grant Consortium.

Established by the National Aeronautics and Space Administration, ISGC strives to positively influence and support students in the pursuit of space sciences and aerospace engineering careers through education, research and outreach.

ISGC works to attract undergraduates to fields in science, technology, engineering and mathematics (STEM) by:

- Providing graduate and undergraduate training through fellowship and scholarship awards, emphasizing awards with a student research component.
- Developing interdisciplinary courses, including introductory courses designed for undergraduate students not majoring in scientific or technological disciplines.
- Developing advanced design and systems courses to provide linkage with the graduate program.
- Developing community college initiatives to promote continued progress in education.
- Focusing on involving underrepresented groups, women and persons with disabilities.
- Helping attract resources that will provide for high quality classroom and laboratory facilities.

The organization promotes research experiences by:

- Providing graduate student support in critical targeted areas through fellowships.
- Capturing new faculty participation in research with NASA centers.
- Initiating inter-consortium disciplinary projects.
- Implementing research activities linked to industry.
- Focusing on involving underrepresented groups, women and persons with disabilities.
- Collaborating with industry.

ISGC reaches beyond higher education to precollege students and the general public by:

- Establishing a pipeline to education institutions of Illinois.
- Enhancing precollege teacher education programs with emphasis in STEM fields.
- Providing information and activities to increase public appreciation for the direct and indirect benefits of NASA-sponsored research.

continued on page 17

Geubelle and Bodony, together with their graduate student Mahesh Sucheendran, are developing a coupled structural/acoustic solver to understand and quantify the relation between acoustic loading to the structure and acoustic radiation from the structure.

in building lighter-weight vehicles that can be used more frequently. One of the design challenges for thinner panels used for this type of application is the response of these structures to high acoustic loads, sometimes in excess of 175 dB.

To understand the coupling between acoustic loading and vibration-created acoustic radiation, Geubelle and Bodony, together with their graduate student Mahesh Sucheendran, are developing a coupled structural/acoustic solver to understand and quantify the relation between acoustic loading to the structure and acoustic radiation from the structure.

Thin Films

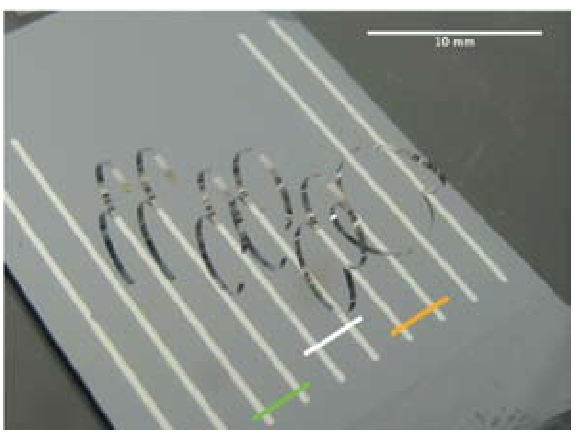
Sottos and Geubelle are developing a new method to study the failure of thin films in a project supported by the Semiconductor Research Corporation and the National Science Foundation.

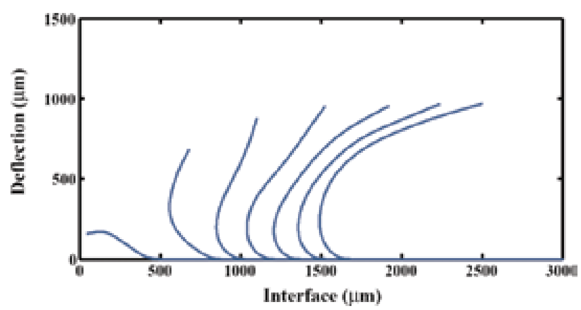
"These films are so thin that it's hard to pull on them without breaking them," Geubelle said. "It's also difficult to prepare the specimen for conventional testing techniques, and results are often qualitative and not quantitative."

With graduate students Martha Grady, Phuong Tan and Premsainath Selvarasu, Sottos and Geubelle use laser-induced spallation to study the failure. In this method, a laser is shined into an absorbing aluminum layer located on the opposite side of the substrate on which the film of interest is deposited. The laser expands the metal layer, causing a compressible pulse to move through the substrate toward the film. Once the pulse reflects from the free surface of the film, it becomes tensile and pulls on the film.

The researchers specifically hope to determine (i) the force needed to detach the film, and (ii) the amount of energy needed to cause the film to peel off the substrate.

Geubelle's modeling work supports the experimental work performed in Sottos' lab by modeling how fast and how far the delamination of the film off its substrate takes place. "Industry likes (this work) because it's a non-contact test," he said. "We can do many tests very quickly, and multiple tests with one specimen."





Laser-induced delamination of thin films. (left) Laser-induced delamination of aluminum film on silicon substrate. (above) Numerical simulation based on dynamic nonlinear beam model

ISGC Promotes Aerospace Education, *continued from page 15*

- Focusing on involving underrepresented groups, women and persons with disabilities.

AE at Illinois is the lead institution in ISGC, which has an annual budget of about $900,000, Affiliate institutions are Bradley University; the University of Chicago; Chicago State University; Illinois Institute of Technology; Northwestern University; DePaul University; University of Illinois-Chicago; Southern Illinois University-Edwardsville; Western Illinois University; the Adler Planetarium; the Discovery Center Museum in Rockford, Illinois. ISGC's industrial and national laboratory partners are Argonne National Laboratory; CU Aerospace in Champaign, Illinois; Fermi National Accelerator Laboratory; IllinoisRocstar of Champaign, Illinois; Ingenium Aerospace of Roscoe, Illinois; and Packer Engineering of Naperville, Illinois.

ISGC is one of 52 consortiums established in each of the 50 states, Washington, D.C., and Puerto Rico. More information on ISGC can be gained at http://www.ae.illinois.edu/isgc/.

Chasiotis Widely Recognized, *continued from page 13*

He has been very productive, publishing 25 journal articles and four book chapters since joining AE. Among them has been a landmark paper reporting the first direct measurements of local deformation and crack growth in polycrystalline thin films—materials widely used in MEMS devices—with important implications in probabilistic analysis of brittle failure of a wide range of materials. More recently, his group reported on the very first deformation experiments with nanofibers and thin films at small time scales, which will elucidate fast physical phenomena at the nanoscale.

As a testament to the creativity, breadth, and depth of his work, Chasiotis' funding record includes substantial support from the NSF, the National Aeronautics and Space Administration (NASA), the U.S. Air Force Office of Scientific Research (AFOSR), the U.S. Army Research Office (ARO), the U.S. Office of Naval Research (ONR), and the Defense Advanced Research Projects Agency (DARPA). His research has been widely recognized with four best paper awards, the ONR Young Investigator Award, the NSF Faculty Early Career Development (CAREER) Award, the Xerox Awards, and two First Prizes in the Sandia MEMS Design Competition.

The past year's honors have been both humbling and inspiring, Chasiotis said. "It makes you feel good about the research you do and, when people recognize you, you want to do more."

Conway Uses Numerical Methods, *continued from page 10*

Working with Conway on this project are Mauro Pontani, a postdoctoral research associate from the University of Rome, and graduate student Pradipto Ghosh.

Optimizing Maneuvers Using Game Theory for the Interception of Ballistic Missile Warheads

This research, based on game theory, evolves from the 1980s "Star Wars" defense initiative. "Some ICBM warheads now have a limited capability to maneuver to defeat a missile defense system. We're looking at the optimal strategy for maneuvering of both the evader (incoming warhead) and pursuer (our defensive missile)," Conway said.

The researchers seek an equilibrium solution in which the evader can't delay capture by any change to its maneuvering and the pursuer can't speed it up. "When there's no change that improves either player's situation the optimal trajectories have been found," Conway said.

"Our goal would be to accomplish interception as quickly as possible. That means the warhead is intercepted as far from its target as possible. It's important to find the sequence of evasive maneuvers that is optimal for the incoming ICBM because that yields the 'worst case scenario' for the defender, which drives the design of the defensive missile system."

Pontani also works on this project with Conway.

AIAA Conference Chooses Chung's Work for Best Paper Award

Soon-Jo Chung

Research work by AE Assistant Prof. Soon-Jo Chung and his students was selected as the Best Paper presented during the American Institute of Aeronautics and Astronautics 2009 Infotech@Aerospace (I@A) Conference.

The paper, "Neurobiologically Inspired Control of Engineered Flapping Flight," was published in the March-April 2010 issue of the *AIAA Journal of Guidance, Control, and Dynamics.*

Along with Chung, the paper's authors are Jeremiah Stoner, a master's degree student who worked with Chung when he was at Iowa State University, and Michael Dorothy, who earned a bachelor's degree at Iowa State and is now a PhD student of Chung's at Illinois.

The award was presented during the awards luncheon held in Atlanta, Georgia in April.

Chung's paper presents a new control approach and a dynamic model for engineered flapping flight with many interacting degrees of freedom.

Chung came to Illinois in 2009 after having been on faculty at Iowa State for two years. His research interests include aerospace systems, autonomous systems, and robotics. In particular, he studies nonlinear control theory; cooperative control and synchronization of multi-vehicle systems; neurobiologically inspired control of flapping flight and robot locomotion; robust nonlinear control of robots and high performance aerospace vehicles; formation flying of UAVs/MAVs and spacecraft; innovative concepts for space systems; space tethers; control experimentation and instrumentation; vision-based Simultaneous Localization and Mapping (SLAM) and path planning in GPS-denied environments.

The paper chosen at the I@A Conference presents a new control approach and a dynamic model for engineered flapping flight with many interacting degrees of freedom. Applications of neurobiologically inspired control systems are explored in the form of Central Pattern Generators (CPGs) to control flapping flight dynamics. A rigorous mathematical and control theoretic framework to design complex three-dimensional wing motions is presented based on phase synchronization of nonlinear oscillators.

In particular, the researchers show the flapping flying dynamics without a tail or traditional aerodynamic control surfaces can be effectively controlled by a reduced set of CPG parameters that generate phase-synchronized or symmetry-breaking oscillatory motions of two main wings.

Furthermore, by using Hopf bifurcation, Chung's group shows that smooth wing motions driven by the CPG network can effectively stabilize tailless aircraft alternating between flapping and gliding. Results of numerical simulation and experimental work with a robotic bat testbed validate the effectiveness of the proposed neurobiologically inspired control approach.

Infotech@Aerospace (I@A) is the AIAA's premier forum addressing the information-enabled aerospace technologies, systems, and capabilities that are shaping the 21st century. I@A serves as AIAA's main interface between the Aerospace and Information Systems communities, and provides a unique opportunity for fostering interaction among the varied disciplines across these communities. The conference was held in Seattle this year for four days and about 270 papers were presented.

Freund wins 2010 Xerox Award for Faculty Research

AE faculty member Jonathan B. Freund was presented the 2010 Xerox Award for Faculty Research by the College of Engineering at Illinois in April.

Jonathan B. Freund

Jointly appointed in Aerospace Engineering and Mechanical Science and Engineering, Freund has been at Illinois since 2001 where he has emerged as one of the most recognized and talented researchers and leaders in the international fluid mechanics community. He was promoted to full professor in July.

Early in his career, Freund undertook the first-ever accurate simulations of turbulent jets and their sound fields, and the results are still the benchmark for research in the field. A graphic image from that work was chosen in 2000 for the American Physical Society Division of Fluid Dynamics Gallery of Fluid Motion.

Freund's current research, funded by NASA, seeks to optimize the actions of actuators for actively suppressing jet noise. In addition, he has led the research efforts of the Fluids and Combustion Division of the Center for Simulation of Advanced Rockets at Illinois.

Freund's ability to see through the complexity of physical systems and to develop original and plausible models for them has also led to several key health-related discoveries – such as mechanisms for the collateral damage to kidney tissues that occurs during shock-wave lithotripsy, and the transport of red and white blood cells in microvessels. This work was recognized in 2008 when APS's Fluid Dynamics Division recognized Freund with the Francois Frenkiel Award.

Freund currently advises seven doctoral students and has already graduated four doctoral and six master's degree students. A prolific author, Freund has published 42 articles in top journals, and he has lectured throughout the world on a variety of topics.

Lambros Named ASME Fellow

AE Prof. John Lambros has been named a Fellow within the American Society of Mechanical Engineers (ASME). Fellowship status in the 129-year-old organization is conferred upon veteran members who have contributed significant engineering achievements.

Lambros has distinguished himself both nationally and internationally in research, teaching and service. He has led research projects funded by many branches of government and industry, and has made lasting contributions to the understanding of dynamic failure of advanced materials through multi-scale experimentation.

Over his 15-year professional career, Lambros's research interests have included dynamic and quasi-static crack initiation, growth and arrest in multiphase systems; quasi-static and dynamic fracture of functionally graded materials; dynamic fracture, failure and wave propagation in composite materials; dynamic constitutive response of traditional and advanced materials; thermomechanical effects and adiabatic shear banding; experimental micromechanics and multiscale experimentation; and thermomechanical fatigue of metals and ceramics.

Lambros' honors include the 2007 University of Illinois College of Engineering Xerox Research Award; the 2005 American Institute of Aeronautics and Astronautics UIUC Teacher of the Year Award; and a 1999 National Science Foundation Early Career Award. Lambros also was named to the 2005 Urbana campus Outstanding Advisors list, and served as Associate Technical Editor for *Experimental Mechanics* from 1999 to 2005.

He currently is involved in two research centers and serves on the Executive Board of the Society for Experimental Mechanics. Lambros has supervised the research of 21 graduate and 21 undergraduate students, and has instructed over 1,000 undergraduates.

He has been a member of the AE faculty since 2000, after being on faculty five years in the University of Delaware Mechanical Engineering Department. From 1994 to 1995 he was a postdoctoral research fellow at the California Institute of Technology.

Lambros earned a bachelor's in aeronautical engineering in 1988 from the Imperial College of Science and Technology at the University of London. He earned his master's and PhD in aeronautics from Caltech, in 1989 and 1994, respectively.

Founded in 1880, ASME is a not-for-profit professional organization that promotes the art, science and practice of mechanical and multidisciplinary engineering and allied sciences throughout the world. The core values of ASME are rooted in its mission to better enable mechanical engineering practitioners to contribute to the well-being of humankind.

John Lambros

Lambros has led research projects funded by many branches of government and industry, and has made lasting contributions to the understanding of dynamic failure of advanced materials through multi-scale experimentation.

Scott R. White

An internationally recognized materials engineer, White has played a leading role in the development of self-healing materials and multi-functional materials systems.

White Named ASC Fellow

AE Prof. Scott R. White, the Donald Biggar Willett Professor of Engineering at the University of Illinois at Urbana-Champaign, has been named a Fellow of the American Society of Composites.

The Society awards fellowship status to distinguished members who have made genuinely outstanding contributions to the composites community through research, practice, education, and service.

An internationally recognized materials engineer, White has played a leading role in the development of self-healing materials and multifunctional materials systems. His contributions in this nascent field have sparked world-wide interest in self-healing and other autonomic functionality from industry, academia, and government. When realized, the promise of these materials will enable fundamental and revolutionary advancements across a broad spectrum of industries from aerospace to microelectronics.

White also has made important contributions to three-dimensional microvascular materials systems, their functionality, fabrication, and analysis. Inspired by the circulatory networks found in biological systems, microvascular networks in engineered materials are used to supply nutrients, repair and healing, cooling, sensory feedback and other functionalities.

White has been widely recognized for his work. The Tech Museum of Innovation in San Jose, California, honored White and his team as a finalist for the 2001 Tech Award recognizing outstanding contributions in technology. The magazine *Popular Science* acknowledged his research on self-healing materials as one of the Top Ten Scientific Innovations for 2001. *Scientific American* recognized White's work in microvascular systems with the SciAm 50 prize in 2007.

He also received the 2008 Innovation Discovery Award from the U of I Vice Chancellor for Research, the U of I Academy for Entrepreneurial Leadership, and the Champaign County Economic Development Corporation. White was a finalist for the University of Padua's 2009 international Bepi Columbo Prize.

White holds 23 patents and applications in the materials field and is a founding partner in two start-up companies seeking to transition university technologies to industry. Joining the faculty of the Beckman Institute for Advanced Science and Technology in 2000, White leads the Autonomic Materials Group, bringing together students and faculty from a broad cross-section of scientific and engineering disciplines.

White joined the AE Department in 1990 after earning a PhD in engineering mechanics from The Pennsylvania State University. Majoring in mechanical engineering, he received a bachelor's from the University of Missouri-Rolla in 1985 and a master's degree from Washington University, St. Louis, in 1987.

White also holds appointments in the Mechanical Science and Engineering and the Materials Science and Engineering departments.

Emeritus Prof. Sentman Dies in Plane Accident

Emeritus Prof. Lee H. Sentman III died Saturday, March 20, 2010 in a midair airplane collision.

"Prof. Sentman was a tough, but effective educator and a world-renowned researcher in the high-energy laser area," said AE Department Head J. Craig Dutton. "Over his 35-plus year career, he made many substantive contributions to the well-being of the Aerospace Engineering Department. He will be sorely missed."

Sentman, 73, died when his RV-6 experimental aircraft collided with a Piper 32 in Levy County, Florida. Two people aboard the other plane, a man and woman, also were killed. Sentman, who had a home in Summerfield, Fla., had been heading to the Williston Municipal Airport when the accident occurred.

Sentman began his career as an assistant professor at Illinois in 1965, after earning a bachelor's degree in aeronautical engineering at Illinois in 1958, and a PhD in aeronautics and astronautics from Stanford University in 1965. He moved up the ranks, being named a full professor in 1979, and then retired in 2002. He served as AE Associate Department Head for a dozen years starting in 1987.

Among Sentman's research interests were chemical lasers, mode-medium interactions, commercialization of high-energy chemical lasers, molecular dynamics, supersonic mixing reacting flows, fluid mechanics, kinetic theory and statistical mechanics and passive satellite attitude control. He directed the Chemical Laser Laboratory, involved in developing fundamental understanding of the fluid dynamic, chemical kinetic and radiative interactions that determine continuous wave chemical lasers' performance.

Sentman had received the American Institute of Aeronautics and Astronautics Plasmadynamics and Lasers Award in 2002, and was a Fellow of that society. He was honored with the W.L. Everitt Undergraduate Teaching Excellence Award from the College of Engineering at Illinois in 1969, and was named to the Outstanding Educators of America. Illinois' AIAA Student Chapter twice chose Sentman as the Outstanding Teacher of the Year.

"Lee had a no-nonsense approach to being a professor," said his colleague, AE Emeritus Prof. John E. Prussing. "He was a tough taskmaster in the classroom and in his thesis advising. He expected and got the best from his students."

Commented AE Emeritus Prof. Harry H. Hilton, "I have known Lee since the middle 1950s, when he attended several undergraduate classes that I then taught. He was an ardent contributor to the well being of the Department. He expected a great deal from his students but in the end they all benefited from his demands and attention. He shall be missed by all."

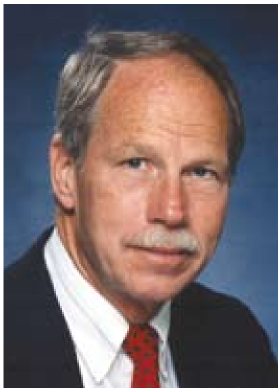
Before finishing his PhD, Sentman worked as an engineer for Douglas Aircraft Corp., in Santa Monica, Calif., in 1957 and 1958; was a Guggenheim Fellow at Princeton University from 1958 to 1959; and was a senior dynamics engineer at Lockheed Missiles and Space Company in Sunnyvale, Calif., from 1959 to 1965.

He continued summer work as a research specialist for Lockheed (1968 and 1969); an aerospace engineer and a National Research Council Senior Postdoctoral Resident Research Associate for the Edwards Air Force Base Rocket Propulsion Laboratory (1971 and 1972, respectively); and a principal scientist for Bell Aerospace Co. in Buffalo, N.Y., (1973–1977).

AE Alumnus to receive Guggenheim Medal

TAKEN FROM AN ORIGINAL ARTICLE BY WILLIAM LITANT, MASSACHUSETTS INSTITUTE OF TECHNOLOGY AERONAUTICS AND ASTRONAUTICS DEPARTMENT

AE Alumnus Robert H. Liebeck, Professor of the Practice of Aerospace Engineering at the Massachusetts Institute of Technology, will receive one of the most prestigious awards in aviation: the Daniel Guggenheim Medal.



William Litant

Robert H. Liebeck

Jointly sponsored by the American Institute for Aeronautics and Astronautics (AIAA), American Society of Mechanical Engineering (ASME), the American Helicopter Society (AHS) and the Society of Automotive Engineers (SAE), the medal recognizes individuals who make profound contributions to advancing aeronautics. Liebeck's award cites him for "distinguished engineering as evidenced by the conception and development of Liebeck airfoils and blended wing body aircraft."

Philanthropists and aviation supporters Daniel and Harry Guggenheim established the Guggenheim Medal in 1929. Its first recipient was aviation pioneer Orville Wright. Over the ensuing years, recipients have included some of the greatest names in aerospace such as William Boeing, Igor Sikorski, Charles Lindberg, and Charles Goddard.

Liebeck, BS 61, MS 62, PhD 68, all from Illinois' AE Department, also recently was named an AIAA Honorary Fellow. Honorary Fellows are persons of eminence in aeronautics or astronautics, recognized by a long and highly contributive career in the arts, sciences, or technology thereof.

Liebeck is a member of the National Academy of Engineering and a world-renowned authority in the fields of aerodynamics, hydrodynamics and aircraft design. He attained world recognition starting in the 1970s with his novel designs for high-lift "Liebeck airfoils." He has made substantial contributions to a variety of related fields, including propeller design, windmill analysis, wing design for supersonic transports, and the design of high-altitude unmanned aircraft.

A 48-year Boeing employee, Liebeck is program manager of Boeing's Blended Wing Body project, developing a 500-passenger flying wing advanced concept subsonic transport aircraft that offers a 30 percent reduction in fuel burn when compared to a conventional tube and wing configuration. The BWB X-48B, a subscale prototype with a 21-foot wingspan, is undergoing development by Boeing and NASA.

In his spare time, Liebeck has designed wings for Indianapolis 500 and Formula One racing cars, the keel for the 1991 America's Cup winning yacht, and the wing for a World Aerobatics Championship airplane.

Liebeck was appointed to MIT's AeroAstro faculty in 2000. Professor emeritus and former MIT AeroAstro Department Head Earll Murman, who nominated Liebeck for the Guggenheim Medal, says, "Bob brings incredible aircraft design experience and wisdom to the classroom, and is always eager to work one-on-one with our students. He's a wonderful mentor to young people and young faculty."

Liebeck will receive the Guggenheim Medal at a ceremony in Washington in May 2011.

Julia Laystrom-Woodard

AE Alumnae Featured in Discovery Channel Video Clip

AE Alumnae Julia Laystrom-Woodard, BS 00, MS 04, talked about her career as an aerospace engineer in a video clip series, "STEM Careers for Students," a production of the Discovery Channel.

The clip can be viewed on YouTube at http://www.youtube.com/watch?v=xfDE0Ki8HA8.

Laystrom-Woodard works for CU Aerospace, operating in the Electric Propulsion Laboratory on the University of Illinois Urbana-Champaign campus. Her projects are the Micro Cavity Discharge thruster and CubeSail.

Enjoying math and science since her childhood days, Laystrom-Woodard tells how poor vision kept her from realizing her dream of being an astronaut.

Instead, she became an aerospace engineer, and is enthusiastic about her choice of the Department of Aerospace Engineering at Illinois for her education.

The STEM video clips are part of Discovery Communications "Be The Future" initiative. The venture has launched a programming block, education curriculum and tools to inspire student learning and careers in the sciences, and support the White House's efforts behind science, technology, engineering and mathematics (STEM) education.

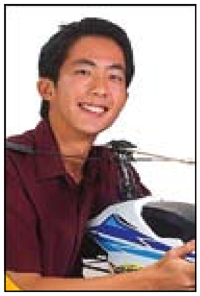
AE Student Awarded Wickham Scholarship

Jie Hua Lin of Bolingbrook, Illinois has won an Armed Forces Communications and Electronics Association General John A. Wickham Scholarship.

These scholarships are awarded to American citizens who have achieved sophomore or junior year status; who are working toward a degree in a C41-related field, such as aerospace engineering; and who have an overall GPA of 3.5 or better.

Jie Hua Lin

AE Junior Wins AIAA National Scholarship



Jonathan Z. Yong

AE junior Jonathan Z. Yong is among 30 undergraduates across the nation to recently have won an annual scholarship from the American Institute of Aeronautics and Astronautics.

Yong came to Illinois after earning a 2005 diploma in Mechatronics Engineering from Ngee Ann Polytechnic University in Singapore. The top student in his class of 500, Yong's senior design project there led to his developing a Micro Aerial Vehicle (MAV).

He designed the craft to be flown autonomously, and introduced in it a Touch-and-Fly system, reducing its operator controls and simplifying take-off and landing maneuvers. The work earned the Silver Award in the Tan Kah Kee Young Inventors' Competition and the Omron-Precicon Prize for outstanding performance in Automation & Robotics Technology. He later represented Singapore in the Creativity-in-Action Contest in Taiwan, and he earned an Outstanding Award for his invention's creative design and innovation.

In addition to his scholarly work, Yong also served as a 1st Lieutenant in the Singapore Armed Forces during his national service stint. Upon graduating from Officer Cadet School, he was recruited into the Military Intelligence Battalion as an instructor to assist in training pilots in radio-controlled flight and Unmanned Aerial Vehicle (UAV) operation.

He also worked as an assistant engineer and radio-control pilot for projects with the National University of Singapore and Defense Science Organization. There, he worked for a year on UAVs, both indoor and outdoor rotary, and fixed wing and flapping wing models while networking with various companies in the aerospace industry.

Currently, Yong works in the AE Department with Assistant Prof. Soon-Jo Chung on his projects in autonomous flapping flight. Yong also is enrolled in Illinois' aviation school with plans to earn his private pilot's license.

AE Grad Student Wins Ames Honor Award

Heather Arneson

The National Aeronautics and Space Administration (NASA) Ames Research Center awarded AE PhD student Heather Arneson a 2009 Ames Honor Award, considered one of the Center's most prestigious honors.

Arneson was nominated for the work she did during internships at NASA Ames during the summers of 2008 and 2009. According to Arneson's mentor, Michael Bloem, and co-nominators Bob Windhorst and Shon Grabbe, Arneson made an impact on air traffic flow management research.

She developed an innovative method for scheduling flights that travel through severe weather-restricted airspace. Arneson's method for calculating ground and airborne delays for such flights makes use of an established aggregate traffic flow model and leverages updated probabilistic weather forecasts. Simulation results showed a 13 percent cost reduction over a rough approximation of current practices.

Arneson also investigated an enhancement for Traffic Management Advisor, a tool that controllers use to manage arrivals at airports. Delays imposed on flights far away from the arrival airport currently are not coordinated with those imposed on flights close to the arrival airport. To build the connection, Arneson applied a distributed sliding mode controller developed through her PhD studies. The method proved that certain maximum flow rates at airports can be matched.

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