UNIVERSITY OF FLORIDA

MECHANICAL & AEROSPACE ENGINEERING

FALL 2005

NEW MAE CHAIRMAN

By Barbara J. Graham

S. "Bala" Balachandar

After an intensive search, S. "Bala" Balachandar has been chosen as MAE's new department chair. Balachandar also will hold the William F. Powers Professorship in Mechanical & Aerospace Engineering, and will assume his chairmanship Jan. 23.

Energized by the opportunities for service and the challenges ahead, Balachandar said he will face them with careful planning and hard work.

"I share your vision in taking the Department to greater heights, and I see a wonderful opportunity ahead of us," he said. "The overwhelming warmth, enthusiasm and excitement shown by MAE faculty and staff were the critical factors in shaping my decision."

Balachandar comes to UF from the University of Illinois, Urbana-Champaign, where he is a professor of mechanical and industrial engineering. Leadership is not unfamiliar to him—he served as associate head of the Department of Theoretical and Applied Mechanics at UIUC. Also, he is a key member of the multi-million dollar Department of Energy-funded Center for Simulation of Advanced Rockets (CSAR), where he is the co-leader of the fluids group and a member of its core science steering committee.

Balachandar's research interests include: combustion and propulsion; computational science and engineering; engineering mechanics; environmental engineering; fluid dynamics; heat transfer; and nano-, micro- and meso-technology. He is the author or co-author of many papers in refereed journals, conferences and book chapters. He is an associate editor of the American Society of Mechanical Engineers (ASME) *Journal of Fluids Engineering* and a member of the editorial board of the *International Journal of Multiphase Flow*.

A native of Madras, India, Balachandar received his undergraduate degree in mechanical engineering from the Indian Institute of Technology, Madras, in 1983. He received master's degrees in engineering and in applied mathematics and, in 1988, his Ph.D. in engineering, all from Brown University.

Balachandar replaces Gene Hemp, a UF vice provost and professor emeritus of MAE, who has served as interim chair since January 2005. Previously, MAE was lead by Wei Shyy, who is now chair of the University of Michigan Aerospace Engineering department.

For more information about Balachandar, visit his UIUC Web site: http://www.mie.uiuc.edu/content/about/directory/profile.php?user_id=7

Children will explore groundbreaking UF research at new MOSI exhibit

By Christine Hale

When B.J. Fregly recently asked children at a local elementary school to say some words related to medicine, the most common responses were "blood," "x-rays," "doctors" and other traditional medical terms.

No one said "engineering."

Fregly, MAE associate professor and director of the UF Computational Biomechanics Laboratory, is trying to change that with a revolutionary new kiosk at the Museum of Science and Industry in Tampa.

He collaborated with UF's Digital Worlds Institute to develop an educational kiosk featuring his groundbreaking knee replacement research in an exhibit called *The Amazing You*.

"The goal of the exhibit is to get kids excited about combining engineering, medicine and computers," Fregly said.

The kiosk puts visitors in the place of a biomedical engineer. Users learn how to collect data from a patient using various engineering technologies. They then analyze the data using a variety of computational and visualization

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Scrutinizing Foam: Space Shuttle Return to Flight Initiative

By Barbara J. Graham

If small chunks of space shuttle fuel tank foam insulation come off at twice the speed of sound, no one is physically there to see precisely what happens. That lack of first-hand information bothered NASA engineers working to safely return the shuttles to flight.

One of the multidisciplinary teams working on the Space Shuttle Return to Flight initiative is using high-speed tests to model foam behavior—for example, if it breaks up in the slipstream, stabilizes, or tumbles. Engineers are studying these traits to better understand how small pieces of foam travel. A foam strike led to the loss of the shuttle Columbia in February 2003. Since then, steps have been taken to minimize the chance of foam shedding during launch, but some foam loss can't be ruled out.

These small pieces of foam debris or "divots" are shed from the shuttle's external fuel tank (ET) during launch. NASA uses the lightweight BX-265 spray-on foam insulation, which is similar to the material used to insulate attics in residential construction. Small-scale divoting happens when the foam adhesive fails on the ET thermal protection system (TPS). This occurs as a result of decreasing atmospheric pressure combined with increased heating during shuttle ascent, which causes air trapped beneath the TPS to expand.

It's the failure of the foam which fascinates MAE professor Nagaraj K. Arakere.

"Engineers are always interested in failure analysis—it's a very practical endeavor and it is quite a challenge to figure out why things fail," Arakere said. "That's what we do, I guess."

NASA is very interested in understanding the processes that govern the breakup/fracture of the foam from the shuttle ET. Arakere is part of a NASA Marshall Space Flight Center (MSFC) effort to further understand the fracture properties of the shuttle's foam insulation material.

Arakere joined UF in 1996, and since then actively has pursued the study of tribology, fatigue and fracture of high temperature single crystal super alloys, and rotor dynamics, as part of the MAE Solid Mechanics, Design and Manufacturing research group.

While it was already known that foam impact damaged the TPS tiles, it was not considered to be a serious problem until the catastrophic failure during re-entry of the space shuttle Columbia.

"NASA hadn't previously thought the foam falling off was a problem, but now with more analysis they have figured out the foam hitting the wing is a critical thing," Arakere said.

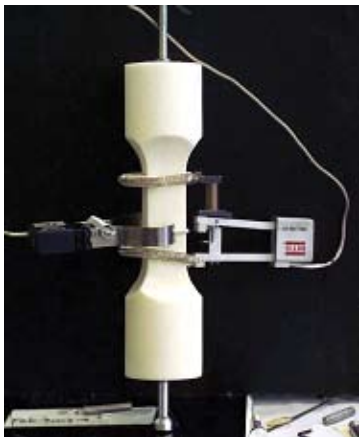
NASA's continuing exhaustive investigation of the failure shows that the breakup was caused by a segment of foam insulation—roughly the size of a suitcase—striking the wing during liftoff. The damage to the TPS tiles on the wing's leading edge is thought to have initiated thermal damage during re-entry, triggering a cascading series of events that led to the loss of the shuttle.

It is believed that when the foam insulation is applied to the ET, voids are created in certain areas where geometric discontinuities such as bolts, flanges and fittings are encountered. Since the ET is filled with liquid oxygen and hydrogen, the foam is exposed to cryogenic temperatures possibly allowing liquid nitrogen to condense into the small cavities.

During liftoff the outer surface of the foam is exposed to aerodynamic heating, which may raise the temperature of the liquid nitrogen and turn it into a gas. The pressure difference associated with the gas formation can cause pieces of foam to be blown out during liftoff.

"It is very important because this can cause the shuttle to fail during the re-entry—as the shuttle Columbia's re-entry showed," Arakere said.

Arakere and graduate student Erik Knudsen have been working on this project for about a year and a half. NASA awarded Arakere's group about $90,000 (through the NASA Graduate Student Researchers Fellowship) for a multi-year period.



(L) NASA uses a tensile test to evaluate the Poisson ratio. (R) Nagaraj K. Arakere (Below) Graduate Student Erik Knudsen (center) discussing foam divot project.

Chairman's Corner

In the spring 2005 issue of the MAE newsletter, I discussed Dr. Shyy's departure for the University of Michigan and the faculty search for a permanent successor. This search has had an outstanding outcome as we welcome Dr. S. Balachandar as Chair and the William Powers Professor of MAE. "Bala," as he likes to be called, will provide outstanding intellectual leadership to the Department.

With several vacant faculty positions due to retirements and departures, plus some additional resources provided by the College, we have the possibility of hiring up to 10 new faculty over the next two to three years. This will continue the growth and visibility of our teachers with the possibility of hiring outstanding young scholars and several nationally and internationally recognized senior faculty in emerging areas and in the areas of expertise.

During this year the faculty has been busy preparing for the accreditation visit by ABET scheduled for Fall 2006. This motivates a thorough report that captures the continuous improvement in the educational experience for mechanical and aerospace engineering students. One area that has received significant attention is the series of laboratory experiences in both the Aero and ME programs. Exit interviews with graduating seniors made clear we had problems that needed attention. There has been a substantial expenditure to purchase new equipment for all of the labs and to implement a plan to hire several instructors who will each focus on one or two of the lab experiences under the direction of a senior faculty member.

In December 2004, MAE graduated the first UF student to earn a joint degree with a university abroad. Laurent Grosset was awarded a Ph.D. with Ecole de Mines at St. Etienne. The final exam was conducted by four French faculty who traveled to the UF Center in Paris and by four UF faculty members in Gainesville via videoconference.

The metrics for the Department continue to be impressive. The research expenditures by MAE faculty last fiscal year continued above $12 million. There are 1,172 undergraduate students and 275 graduate students this Fall semester, making MAE the largest undergraduate program and second-largest graduate program in the College. MAE awarded 172 bachelor's degrees, 74 master's degrees and 18 Ph.D.s during the 2004-05 academic year.

Our faculty continue to excel and student groups also continue to be highly successful in national competitions. One area which we have not followed well is the accomplishments of our alumni. Beginning with this issue, this newsletter will feature those accomplishments. If you will send highlights to us, I know your fellow Gators will want to know what you are doing. We start this tradition with a very select section this time but look forward to its growth.

The Department is also in the process of re-establishing an external visiting committee composed of representatives of industrial and governmental agencies who will advise the faculty on program objectives and goals, and help us adapt the curriculum to meet the needs of our students as they move into their careers.

As I said in the last issue, these are exciting times and we are pleased to share the accomplishments of our students and faculty with you. It has been my privilege to serve as Interim Chair during this transition period. I look forward to following the progress of MAE in the years to come.

—Gene Hemp

Alumni Highlights

John D. Anderson Jr. (B.S. Aerospace Engineering, 1959) has been awarded the Elder Statesman of Aviation Award by the National Aeronautical Association. He was cited for his career at the forefront of aeronautical engineering, beginning with a position at the Aeronautical Research Laboratories at Wright-Patterson AFB and later as Curator for Aerodynamics at the Smithsonian Institution National Air and Space Museum.

Dr. David M. Jerome (M.S. Engineering Mechanics, 1987; Ph.D. Engineering Mechanics, 1996) has been appointed Executive Director of Arnold Engineering Development Center (AEDC), Air Force Material Command, Arnold Air Force Base, Tenn. The AEDC's test complex, valued at more than $7.6 billion, is comprised of 58 aerospace test facilities at Arnold and the Hypervelocity Tunnel 9 in White Oak, Md.

Dr. Michael K.L. Leung (Ph.D. Mechanical, 1995) is now Professor in Mechanical Engineering at Hong Kong University and was awarded the 2005 Hong Kong Institution of Engineers Transactions Prize for his paper, *Local Exhaust Ventilation for Infection Control in Hospitals*.

Please let us know where you are living and working and what you have been doing since graduating from MAE. We would like to share the news in the next issue. Send to mae-alumni@mae.ufl.edu.

Faculty Accomplishments

Best Papers

Nagaraj Arakere and co-authors won Best Paper at the June 2005 ASME International Gas Turbine Institute (IGTI) International Turbo Expo Conference (Structures and Dynamics) in Reno, Nev., for their paper, *Investigation of Three-Dimensional Stress Fields and Slip Systems for FCC Single Crystal Super-Alloy Notched Specimens*. Co-authors include Shadab Siddiqui, Shannon Magnan, Fereshteh Ebrahimi and Luis E. Forero.

Bill Lear, **S.A. Sherif** and their co-authors' paper, *Demonstration of a Novel Combined Cooling and Power Gas Turbine with Water Harvesting*, presented at the January 2005 AIAA Aerospace Sciences Meeting (Terrestrial Energy Systems) in Reno, Nev., was awarded Best Paper at the August 2005 AIAA IECEC meeting in San Francisco. Co-authors include J.R. Khan and J.F. Crittenden.

Unusual Papers

Graduate Research Professor Emeritus **Alex Green's** paper *How Slide Rules Won a War* develops a thesis that the two-dimensional programmable slide rule system used by the 20th Air Force was responsible for the U.S. victory over Japan in World War II (*Journal of the Oughtered Society*, Vol. 14, No. 1, Spring 2005).

Tenure and Promotions

B. J. Fregly: Tenure and promotion to associate professor

Peter Ifju: Promotion to full professor

Greg Sawyer: Tenure and promotion to associate professor

Professional Societies

Nagaraj Arakare was selected to become a Fellow of ASME. Arakare's substantial citations include work in tribology, analysis, design and testing of high temperature gas bearings, and fatigue and fracture of single crystal alloys.

Win Phillips received the Ralph Coats Roe Medal from ASME for his outstanding contributions toward bettering public appreciation of the engineer's worth to contemporary society.

Wei Shyy received ASME's 2005 Heat Transfer Memorial Achievement Award (General Category) for his outstanding and archival contributions to the thermal sciences, including modeling of phase-change and moving boundary heat transfer problems, convective flows in complicated domain, air-breathing and rocket combustion, materials thermal processing and turbo-machinery flows.

Graduate Research Professor Emeritus **Alex Green** was awarded a Gold Wreath for his long-time ASME membership and a Certificate of Appreciation for serving as the Chairman of the Coal, Biomass and Alternative Fuels Committee, at the 2005 ASME International Gas Turbine Institute Turbo Expo Conference, in Reno, Nev.

Distinguished Service Professor Emeritus **Erich Farber** received the International Solar Energy Society Pioneers Award, marking the 50-year history of the society and its National Sections, at the 2005 ISES Solar World Congress in Orlando. Farber was honored for his continuous exemplary research into renewable energy and energy conservation.

Leaving UF

Andy Kurdila will assume the W. Martin Professor Endowed Chair of Mechanical Engineering at Virginia Polytechnic Institute and State University in Blacksburg, Va. He will maintain a courtesy appointment with UF through Fall 2005.

Yogi Goswami will assume the John and Nadia Ramil Professor of Chemical Engineering at the University of South Florida in Tampa. He will maintain a courtesy appointment with UF.

Retired Professor Faced Ice Quandary

MAE Professor Emeritus **Marty Eisenberg** in June took a dangerous fall and suffered serious injuries as he climbed Quandary Peak near his new home in Colorado. According to Eisenberg, the steep snowfield is a "straight shot up the south flank to the summit (about 14,000 feet)," though he says it was just a "walk in the 'hood." Using ice axes and crampons, he and a friend reached the summit and were beginning their descent when rotten snow crumbled under Eisenberg's feet. Sliding and tumbling, he hit exposed rocks before coming to a halt. A severe thunderstorm forced the climbers to traverse a deep snow gorge, where they met the search and rescue team. Eisenberg's ordeal wasn't over, though—together they climbed down several hundred vertical feet to where the rescue team's stretcher was belayed to a rock anchor. The rain turned to snow while the rescuers laboriously lowered him to the trailhead. He suffered at least five fractured ribs, a fractured collar bone, and a partially collapsed lung, but Eisenberg is now on the mend.

Solar Gator

A "solar gator" was cruising for snacks...hoping to pick off stray Ph.D. students during a visit to the Solar Energy Laboratory in May. The 5-foot-long reptile nosed around the Energy Research and Education Park, pausing at the solar detoxification pond before crawling off. The Energy Park is located on SW 23rd Avenue adjacent to UF's swine research pastures and several apartment complexes.

UF robot car, though not a winner, turns in exciting performance

By Aaron Hoover, UF News Bureau

NaviGATOR, a 4,300-pound fully robotic off-road vehicle built by UF and two corporate team members, traveled more than 20 times the distance of the car that UF entered in last year's race, called the Defense Advanced Research Projects Agency, or DARPA, Grand Challenge. However, the car ultimately ranked 18th among 23 finalists in total distance traveled in the Oct. 9 131.6-mile race across the desert near this small city on the California-Nevada border.

Stanford University's converted Volkswagen sport utility vehicle named Stanley was declared the race winner. It completed the course in 6 hours, 53 minutes and 58 seconds.

"I'm disappointed to some extent. I know we could have gone farther," said Dave Armstrong, team leader for Team CIMAR, the UF Center for Intelligent Machines and Robotics group that built the car. "I feel like, if we had another couple weeks of testing in the desert, I feel like we could have finished it."

The UF car's demise, which occurred just before 12:30 p.m., capped a dramatic morning that began at 3:30 a.m. when team members backed NaviGATOR out of its trailer and began final preparations for the race.

DARPA kept the route a closely guarded secret, giving teams CD-ROMs containing latitude and longitude coordinates only hours before the race.

Team CIMAR, scheduled as the 18th car out of the chute, received its CD-ROM shortly after 5 a.m. That set off a blur of activity in the team's trailer as members sought to plan the NaviGATOR's path and speeds using several laptops.

Contrary to expectations, the course looped and doubled back on itself, looking more like a child's scribble than a traditional race course.

"It looks insane," said Carl Crane, a team member and UF professor of mechanical engineering.

The team used software that depicted the terrain in three-dimensional images to plot the route, slowing NaviGATOR in a mountain pass and other tricky sections and accelerating it on straightaways.

There was no advance knowledge of potential obstacles, which were said to include three tank traps and other hazards. Like other competitors, NaviGATOR was equipped with sensors and computers designed to help it see and avoid those potential race-enders. In NaviGATOR's case, that equipment included 10 mainframe computers, three laser range scanners and two global positioning or GPS units.

At one point in the planning, Armstrong had the scheduled trip down to eight hours, 18 minutes, well within the 10-hour window. That would require NaviGATOR to reach speeds of 24 mph in some areas, exceeding the car's reliable speeds but also giving it the best chance to win, he said. That high speed may have contributed to the car's problems, but Armstrong said later he made the right decision.

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Student Activities

UF robot car, though not a winner, turns in exciting performance

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"We could have gone 16 mph the whole way and maybe we would have finished it, but I didn't want to go to the line knowing we weren't going to win," he said.

Carnegie Mellon University's "Red Team Too" was the first across the line at 6:40 a.m. with Highlander, one of two enormous red vehicles entered by the university. Hundreds of people in bleachers cheered as the Humvee-like vehicle made its way across a dirt field, turned and headed out into the desert, followed by a DARPA chase vehicle. Other cars, each tailed by a chase truck equipped with a kill switch, followed in regular intervals.

Shortly after 9 a.m., UF doctoral student Danny Kent led team members and several visiting family members in the stands in the Gator fight song. NaviGATOR launched at 9:10 a.m., making a flawless exit into the desert.

"We did everything we could. She's as good as she's going to get," said Steve Velat, the team's only undergraduate member.

The course required the cars to loop around and traverse a road by a nearby embankment, and Team CIMAR members headed over to await NaviGATOR's return. As they waited, the California Institute of Technology's van, launched just before NaviGATOR, drove along the road and then suddenly made a right-hand turn into a concrete barrier. The van knocked the barrier over and began climbing the embankment toward an area set aside for media observers, stopping just a few feet short of a chain link fence and assembled reporters and photographers.

NaviGATOR roars past spectators on its way out into the desert. (Aaron Hoover)

Race officials paused NaviGATOR and the other cars in the race until the van was towed off. NaviGATOR then roared past the embankment and headed out into the desert again. After following the road for awhile, it stopped and did a couple of nerve-wracking loops in the dirt before returning to the road—much to team members' delight.

NaviGATOR next flawlessly traversed a bridge over a railroad track, disappearing from sight at about 10:30 a.m. Everyone headed over to an enormous tent where contestants monitored the race on flat-screen televisions. At about 10:45, race members got a call that NaviGATOR had run about 10 feet off the road and was stalled in front of a bush.

Although the car managed to get back on the road, it traveled only a short distance in the next hour and a half before stopping for good.

Team members said they anticipated the car's computers would reveal the cause of its problems. Whatever the case, they said were glad they had been a part of the project—not the least because it would form the backbone for several doctoral dissertations.

"Where else do you find a lab like this?" said mechanical engineering student Bob Touchton. "For all of the students involved, this is like night and day with what we could have contrived in a laboratory."

Children will explore groundbreaking UF research at new MOSI exhibit

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techniques, formulate an educated diagnosis of the patient's knee problem, and simulate different surgical solutions.

Fregly said the Digital Worlds Institute was critical to putting together the software and bringing his scientific ideas down to a level that children can understand.

"One of the benefits of coming to Digital Worlds to do this project is we're good at telling stories in a Hollywood-type manner, and in this case we're telling a story about biomedical engineering research going on at the University of Florida," associate director Andy Quay said. "Another benefit of the Digital Worlds Institute is we are very multi-disciplined. We have computer scientists, graphic artists, architects, medical people—all associated with the Institute. We're constantly exposed to these fields so we have a good idea of what's going on in the University."

Arturo Sinclair, a digital artist at the Digital Worlds Institute, created the graphics and animation for the software. His extensive experience designing video games was an asset to the project.

"Children are exposed to high technology every day. Game engines are the most sophisticated computer programs children have access to and they're very familiar with user interfaces," Sinclair said. "We had to bring some of the scientific and technology lingo down to their level, but we couldn't do a simplified user interface that would bore them."

The National Science Foundation awarded Fregly an NSF CAREER grant in May 2003 that provides him $400,000 over five years. The grant places an emphasis on inquiry, active learning through working together and new uses of technology.

"Kids that walk away from the exhibit will realize engineering doesn't have to be cars and planes and other traditional engineering systems," Fregly said, "but that the human body is an engineering system as well, a system that we can analyze and hopefully learn to repair better."

For more information about this project, visit http://www.eng.ufl.edu/elinks/news/research/detail_article.php?id=686

Student Activities

COE 2nd in Nation for Student Competition Wins

By Barbara J. Graham

Making ideas actually work—that's the juice for engineers, and student competitions offer opportunities to put classroom knowledge to work in real-world situations.

Competitions offer a rare opportunity for students to get real hands-on experience constructing something practical. The degree of immersion students obtain in these applications has enormous impact on their learning absorption.

A recent study explored a variety of undergraduate student engineering and engineering technology competitions to determine which institutions consistently win and what factors support their winning. Of the 44 contests studied, UF's College of Engineering ranked second in the nation with the number of competition awards during 2001-2003, with 19 overall wins (9 first places, 6 second places, and 4 third places). Virginia Tech claimed first place in this tabulation with 28 overall wins; Cal Poly/San Luis Obispo came in third with 14 overall wins.

Advisers of winning institutions reported that their schools won consistently because of a dedicated faculty adviser and the close alignment of the competition with the college's curriculum. For instance, the very close alignment of the Ferris State Heating, Ventilation, Air-conditioning and Refrigeration Engineering Technology curriculum with the ASHRAE contests appears to be a major reason for their students' continued successes.

Yet it is often the tradition of winning that may tip the scales toward success. Students want to continue doing well in the competitions to carry on the winning tradition—and that in turn helps multidisciplinary teams recruit new members.

The importance of motivated, high-quality students is crucial in driving the team to success. Increased student confidence following a strong competition performance inspires young engineers to go further and take on challenging tasks. This in turn can lead to greater willingness to engage in self-taught education on the job.

Above—SAE members presented the Mini Baja Car to a group of incoming freshmen at eSwamp Day 2005. Below—The SAE team drove their Formula Race Car in the UF Homecoming Parade Oct 7.

Another factor for hands-on contests is the importance of tangible university support such as a space in which to work, tools and start-up money.

MAE's students regularly test their education in competitions sponsored by the Society of Automotive Engineers (SAE), the American Institute of Aeronautics and Astronautics (AIAA), and the American Society of Mechanical Engineers (ASME). But students do more than compete. In addition to building the Florida SAE "Formula Race Car" and "Mini Baja Car," Team SAE spends time in the community promoting engineering to youth at the Engineering Fair and the Homecoming Parade, as well as bringing the cars to area schools like the on-campus preschool Baby Gator.

See: Phillip C. Wankat, *Undergraduate Student Competitions*, Journal of Engineering Education, July 2005, pp. 342-347.

Student Activities

By Barbara J. Graham

MAV Team Keeps Flying To Victory

MAE's micro-air vehicle continued its dominance in the field at the 9th International Micro Air Vehicle Competition held in Seoul, Korea, on May 21. It finished first overall for the seventh consecutive year, against 12 other teams. The competition consists of four separate categories: surveillance, endurance, ornithopter and design report.

MAVs are tiny, radio-controlled airplanes (some with wingspans of only four inches) equipped with cameras. Designed for search-and-rescue missions and law enforcement or military surveillance, they can be used in dangerous situations.

"The competition was especially tough this year, with records set in all categories. This is the first year UF won the design report category," said faculty adviser and MAE professor Peter Ifju.

In other competitions, UF placed 2nd in Surveillance, 3rd in Endurance, and 3rd in Ornithopter.

Members of the 2004-2005 team were Frank Bori, Scott Bowman, Carlo Francis, President Kim of Woojoo Aerospace, Daniel Claxton, Aaron Crespo, Kyu Ho Lee, Baron Johnson, Mike Sytsma, and Mike Morton.

For more information about the MAV team, see the *MAE Newsletter*: Fall 2003, pp. 1-2, 5; Fall 2004, pg. 3; Spring 2005, pg. 6.

L-R: Scott Bowman, Carlo Francis, President Kim, Daniel Claxton, Aaron Crespo, Kyu Ho Lee, Baron Johnson, Mike Sytsma, Mike Morton, Dr. Peter Ifju

Team Members: Jake Stoval, Casey Gipson, Jacob Bryan, Bryan Williams, Josh Murphy, Caleb Freeman, Alina Soderholm, and Mariely Morales.

Solar Activities

In April, MAE's student chapter of the American Solar Energy Society (ASES) coordinated Alachua County's portion of the National Tour of Solar Homes, which showcases homes and government buildings using renewable energy or energy conservation. Student ASES members made presentations in local community high schools on the fundamentals and applications of solar energy and also volunteered as judges for the 2005 Alachua Region Science and Engineering Fair, and gave special awards to students whose projects involved renewable energy and energy conservation. The club has begun sponsoring lectures on renewable energy topics, including one by Dr. Svetlana Olbina on "Daylighting in Buildings as a Sustainable Strategy."

HPV Team Wins Big

The 2005 ASME Human Powered Vehicle Challenge took place on the East and West coasts during April and May. These aerodynamic, highly engineered vehicles that have been known to achieve speeds of more than 60 mph were judged on design, safety and performance. Each team of students competed in a number of performance events in three vehicle categories: Single Rider, Tandem and Utility Vehicle.

The UF HPV team once again dominated the races, which were held at the University of Alabama in Tuscaloosa, Ala., April 22-24. Pitted against 30 teams at the East Coast Competition, UF took 1st Place overall and 1st Place in the Multi-Rider Sprint and Multi-Rider Sprint Endurance classes, where it reached a speedy 27.9 mph. UF took 2nd Place in the Multi-Rider Designer and 3rd Place in Utility Endurance.

"The team won a nice trophy for our new ASME lounge trophy case, $500 for the HPV account, and $500 for the team members," said faculty adviser and MAE professor Bill Lear.

A comprehensive design report and design presentation supplemented the scores on the performance events. The "practical vehicle" event emphasizes its usefulness for daily activities, such as shopping, transportation or recreation. Entrants must navigate a slalom course with the challenge of carrying packages, going over bumps, potholes or other obstacles while stopping at signs and obeying the rules of the road. Single and Tandem vehicles compete in sprint and endurance events.

Student Activities

Student Scholar Awardees
Awards Presented at Spring 2005 Commencement

Jennifer Gusteric (B.S. MAE, 2005) was awarded the Gator Engineering Four-Year Scholar Award for her continued excellence in research, leadership and internships. Graduating cum laude, she plans to attend graduate school at the Massachusetts Institute of Technology and pursue a career in space policy formulation and implementation. In 2002, Gusteric won the University Scholar Award as she studied the effects of thicknesss on the strain response of UF patented paint

See *MAE Newsletter* Spring 2005 "Strain Sensitive Paint Highlights Flaws on Car and Plane Parts", p. 7.

Stephen Hagberg (B.S. MAE, 2005) was awarded the UF Outstanding Two-Year Scholar Award for his years of superior efforts in researching machine tool proof-of-concept devices, and designing and implementing testing equipment to study wear and friction. He previously won the College of Engineering's W.H. Chen Scholarship, the Fin Jorgensen Memorial Scholarship and a State of Florida Bright Futures Scholarship. Hagberg counts his time with the Society of Automotive Engineers (SAE) as his most rewarding extracurricular activity at UF. Hagberg will work for ExxonMobil on high strength polymers and solid lubricants.

Professional Society Awards

MAE Ph.D. candidate **J. Suzanne Canning** was named runner-up in the first Student Research Presentation Contest at the 33rd North American Manufacturing Research conference (NAMRC) in May. Canning presented her paper, co-authored by MAE professors John Ziegert and Tony Schmitz, *Uncertainty of Spatial Coordinate Measurements using Trilateration*. The presentations were judged by a panel of North American Manufacturing Research Institution/Society of Manufacturing Engineers (NAMRI/SME) honor committee members.

Automotive Competitions Rough

Conceiving, designing, building and competing with a small single-seat racing car is what the Formula SAE annual competitions are all about. This real-life exercise in design and manufacturing and the business elements of automotive engineering represents a blending of academic learning with the development of practical engineering skills. UF's SAE Formula car is an 8-foot version of a Formula 1 race car, with more than 90 percent of it student-designed and built.

The 2005 Society of Automotive Engineer's (SAE) Competition (May 18-22) held in Pontiac, Mich., attracted entries from 66 universities in 19 countries. Of the 122 teams, MAE's Team SAE was ranked 53rd overall, placing it in the 56th percentile. The team showed strength in individual events—bright spots included placing 14th in the skidpad, 11th in the autocross, and scoring more points in both the cost event and the sales presentation than previously scored.

The team also attended the Saginaw Valley State University (SVSU) Grand Prix in east-central Michigan following the Formula SAE races. Here the team was consistently faster than its competitors on a 25-second lap track.

"This year's formula car was lighter, more powerful and faster than ever before," said UF SAE president Colin Wheeler. "Although our overall finish in Pontiac was not what we had hoped for, our car proved itself by being consistently faster than the 3rd, 5th, and 8th finishing teams when we went to Saginaw."

The 2005 SAE Mini Baja competition (June 16-19) held in Troy, Ohio, also proved a steep challenge for MAE's team. UF placed 30th out of 144 teams, ranking it in the 79th percentile, yet the team took 6th place in the design event, with high scores in both originality and comfort. The team also received impressive scores during the tractor pull despite rolling over on one pull.

The SAE Mini Baja regional competitions also simulate real-world engineering—students design and build an off-road vehicle that will survive the severe punishment of rough terrain (and also water in the East competition). This challenging project involves all of the planning and manufacturing tasks found when introducing a new product to the consumer market.

Southeast Region ASME Competition

MAE's undergraduate ASME chapter competed at the ASME Annual Southeast Region Student Conference April 7-9 in Jacksonville. During the three-day event, students from more than 20 institutions and five states competed in oral presentations, poster display and Web site design contests, and a robotic design competition. MAE's strong undergraduate program was represented by 20 students competing. Murray Fisher was awarded 5th Place in the Old Guard Oral Competition.

MAE Student AIAA Hosts Conference

MAE's student branch of the American Institute of Aeronautics and Astronautics (AIAA) hosted the 2005 Southeastern Regional Student Conference in Gainesville April 5-6. More than 230 delegates from 13 universities in the Southeastern Region attended.

AIAA is the world's largest professional society devoted to the progress of engineering and science in aviation, space and defense.

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Engineers Develop Undetectable Means of Measuring Speed, Motion

By Aaron Hoover, UF News Bureau

A police officer may soon pull a motorist over for speeding, but rather than relying on a radar gun to calculate the car's speed, the officer will consult a camera that has captured an image or series of images from the car and used computer algorithms to determine how fast it was going.

Research aimed at teaching robots to "see" may soon make it possible to bag speeding motorists, track enemy planes, and automatically safeguard the nation's borders and resources without any chance of detection.

A University of Florida engineering researcher is developing a method to determine speed and other characteristics of a moving object using computer algorithms, or instructions, that rely on data from standard visual cameras rather than radar or lasers. The technique has the potential to render current detection systems in so-called "fuzz busters" and some military technologies useless. That's because, instead of painting a target with radar waves or laser beams, a camera merely needs to capture an image or series of images from the target.

"If it can view the object moving, that's all it needs. The computer figures out everything else," said Warren Dixon, a UF assistant professor of mechanical and aerospace engineering. "We're trying to use both regular and infrared cameras, so night or adverse weather conditions don't present a problem."

Dixon's most recent co-authored article on the research appears in the March issue of the journal *Automatica*. Related articles, also co-authored by Dixon, are scheduled to appear shortly in the journal *Transactions on Robotics and Automation*.

Achieving computerized speed and motion detection requires overcoming several challenges. One is figuring out how to get a computer to understand the surrounding environment by interpreting images recorded by a video or still camera.

"The information from a camera is just a flat-screen, two-dimensional image," Dixon said. "The challenge is figuring out the mathematics of how do you take two images and understand how things are moving in our three-dimensional world."

People and animals can perceive depth because their brains combine each eye's snapshots. Two cameras can also achieve stereo vision, but computers can make sense of it only if they know the exact position of each camera. That allows them to triangulate the target and learn its position relative to the camera. Part of Dixon's achievement is developing the underlying mathematics and software to circumvent this requirement.

"With my work, you don't need to know that specific location information," he said. "You could have one camera taking an image from an airplane and another mounted on a car taking a picture of the same image—and not know how the airplane and car are related to each other—and through this new mathematics you can understand how they're related to the target."

The technology has law enforcement and military applications.

Police in moving or parked squad cars could use the computer-camera systems much as they do radar and laser guns to track and ticket suspected speeders. The target would have to be within the line of sight, with the range varying according to the power of the lenses in the camera. Dixon said the UF engineers have not built such a system, but "any camera with the right software could be used," and a prototype could be built within a year.

Soldiers, meanwhile, could mount the cameras on airborne drones or truck convoys and set them to look for and automatically report potentially hostile objects moving toward the convoys—again, without any fear of giving away the convoys' locations.

Robotic drones or remote camera-based monitoring posts outfitted with the technology also could be used for applications ranging from private security in warehouses and shopping centers to continuous remote monitoring of borders to protecting water supply reservoirs.

Warren Dixon, MAE assistant professor. (David Blankenship)

In addition to the robotic applications, the technique is being refined for a project led by Andy Kurdila, a UF professor of mechanical and aerospace engineering, to provide vision systems for tiny airborne surveillance drones called micro-air vehicles.

The goal of that five-year project, which is jointly funded by a $5 million grant from Eglin Air Force Base in Florida and by the Air Force Office of Scientific Research and involves several UF faculty members, is to give the drones the ability to fly without the assistance of a remote human operator. Instead, they would base navigational decisions solely on what onboard cameras view in the terrain as they fly, mimicking a human pilot.

Dixon also has been also been working with Thomas Burks, a UF assistant professor of agricultural engineering, to apply the technology to robotic harvesting in orange groves.

Rick Lind and one of MAE's MAV morphing wing fleet. (David Blankenship)

Media Flocking to Morphing Wing

By Barbara J. Graham

MAE's innovative and practical research into morphing micro-air vehicles is attracting international media attention as more of the toy-sized drones are being developed for tricky urban and military missions. The aircraft can zip around tight and dangerous places while photographing the terrain and detecting biological agents. The military has already employed similar drones in Iraq and Afghanistan to take pictures and fire missiles.

Some of the media links include:

http://news.bbc.co.uk/1/hi/sci/tech/4185648.stm
http://news.nationalgeographic.com/news/2005/08/0824_050824_birdplane.html
http://dsc.discovery.com/news/briefs/20050829/birdplane.html
http://msnbc.msn.com/id/9069342

MAE professor Rick Lind is excited about this research and its implications for the future. Lind previously worked at NASA and helped develop shape-changing wings for the F-18 fighter jet. Since then he has re-examined how the Wright brothers controlled their early planes by twisting wings instead of using flaps. Then he studied the true masters of flight—birds.

"Birds morph all the time, and they're very agile," Lind said. "There's no reason we can't achieve the same control that birds achieve."

Doctoral student Mujahid Abdulrahim photographed agile seagulls in action then developed a prototype drone based on the gulls' ability to flex at the shoulder and elbow.

The morphing wing and other movies can be seen at MAE's Center for Morphing Control Web site:

http://mav.mae.ufl.edu/morph/morph_flight.html

The *MAE Newsletter* highlighted Lind's and Abdulrahim's work in the Fall 2003 issue on pages 1-2 and 5.

Useful Work from Wasted Energy: Researchers Harvest Vibrations

By Barbara J. Graham

Interdisciplinary microelectromechanical systems (MEMS) researchers' co-authored paper *Useful Work from Wasted Energy, MEMS Style* was highlighted in *Electronic Design* e-zine in July. The self-powered wireless sensor system seems like an electrical analogy to the old-fashioned self-winding watch.

Tevide, built by ECE's T. Nishida and K. Ngo and MAE's L. Cattafesta and M. Sheplak, is generating electricity—admittedly in very small amounts right now—by "harvesting" the vibrational energy created by rotating machinery. The goal is to eventually use the electrical power to run wireless sensors that would monitor machinery for condition-based maintenance.

The researchers have built a meso-scale version already.

"We're now in the process of fabricating a version using micro-machining," Nishida said.

This meso-scale harvester prototype, which is about 2 inches long, generates approximately 10 microwatts for a 1-g vibration at 100 Hz.

The team is working on creating a MEMS version of the vibration energy harvester using fabrication processes at a MEMS foundry and the University of Florida's Nanofabrication Facility.

Companies interested in working on commercializing this technology should contact Karl R. Zawoy of the University's Office of Technology Licensing at kzawoy@ufl.edu.

MAE Student AIAA Hosts Conference

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The conference provides a forum for AIAA student members to present technical papers in undergraduate- and graduate-level public competition for 1st, 2nd and 3rd place prizes of $500, $300 and $250, respectively. MAE's Amanda Roderick won 3rd place in the graduate student competition for her paper, *Integrating Optic Flow Techniques with Waypoint Navigation for Reactive Control Purposes*.

UNIVERSITY OF FLORIDA

Mechanical & Aerospace Engineering
231 MAE-A
PO Box 116250
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Thanks for your generosity! Gene Hemp, MAE Interim Chair

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Contact Information

Mechanical & Aerospace Engineering
231 MAE-A
PO Box 116250
Gainesville, FL 32611-6250
352-392-0961

www.mae.ufl.edu

Editor: Prof. John K. Schueller
E-mail: schuejk@ufl.edu
Assoc. Editor: Ms. Barbara J. Graham
E-mail: walkerbj@ufl.edu