Moreover, the large amount of resistive heat dissipated per launch imposes a substantial limitation on the rate of fire, since the heat cannot be extracted fast enough from the rail gun. Arcing at the point where the projectile leaves the gun is another source of wear and performance degradation. The massive amount of heat released in multi-shot applications also creates loss of accuracy due to bore thermal distortion. Induction launchers, on the other hand, essentially consist of two coaxial sets of coils: stationary coils along the launch tube and a set of moving coils attached to the projectile. The power transfer is contact-free, eliminating the problems inherent to sliding electrical contacts, such as rail gouging.

~Continued on page 3…

Electromagnetic launchers have the potential to provide significant advantages in cost and operational flexibility compared to conventional chemical propulsion. Two of the most widely studied electromagnetic launch technologies are rail guns and induction launchers (coil guns). Rail guns rely on direct electrical contact between the projectile and the track. Although rail gun technology has made substantial progress since its inception, several unresolved problems have prevented it from becoming reliable enough to be deployed. Metal-on-metal sliding contact at high speeds creates wear and reliability problems due to plasma-induced corrosion of the conducting rails.
We recently have achieved and exceeded the fundraising goal for Yarosh/Wiles Endowment. As reported in the last issue of TCE, the local chapters of ASHRAE and ASME have jointly created an endowed scholarship in our department with initial funding of $17,000. On Nov. 6, ASHRAE organized a successful golf tournament fundraising to bring the total endowment over $25,000. It is impossible to achieve our goal so quickly without the dedicated effort from David Poetker, Scott Seigel, and Todd Curlee of ASHRAE and Gretchen A. Sauerman in Florida Tech’s Development Office.

This fall our undergraduate enrollment is about the same as that of fall 2008. The rapid increase in our program enrollment over the last several years seems to have stabilized. However, the class size in junior and senior classes continues to pose a challenge for us. At the present time, we have the Allen Henry Chair Professor position advertised. The search committee headed by Dr. Larochelle will be recruiting a qualified candidate to fill the position. With an additional faculty member, not only we can alleviate the class size problem, but also enhance our research program.

In this issue of TCE, we highlight some of our student capstone projects and you can see how we integrate industry problems into our curriculum. In each of these industry sponsored projects, students are asked to attack a real world problem and work along side industry engineers from different disciplines.

We will much appreciate your suggestions and comments. Please send them to us at the department address or to me at phsu@fit.edu.

-Pei-feng Hsu

MAE Student Winner: Horizons Scholarship

Florida Institute of Technology junior Christina Lucas was awarded the prestigious HORIZONS Foundation scholarship by Women in Defense, a National Security Organization and an affiliate of the National Defense Industrial Association. Lucas received a $1,320 scholarship as did two students from Carnegie Mellon University and Georgetown University.

A mechanical engineering major, Lucas is an intern in the Robotics and Spatial Systems Lab (RASSL) at Florida Tech. Her work along with other interns in the lab resulted in the development of a six-legged robot prototype that could be instrumental in helping troops in dangerous environments. “We could design the robot to be able to go up and around obstacles where other robots are not able to go, therefore making it less dangerous for troops,” Lucas said.

Originally from Somerville, Mass., Lucas graduated high school from Clearwater Central Catholic in Clearwater, Fl, in 2007. She is interested in unmanned autonomous vehicles and mobile robots and is strongly considering a career in the development of advanced military systems. She and her colleagues have started a peer-reviewed paper to be published next year and are preparing patent applications.

"Christina is a gifted, mature and motivated student. She is bright and works hard. It’s great to see her efforts being rewarded with a HORIZONS Scholarship from Women in Defense," said Lucas’ advisor Dr. Pierre Larochelle, professor of mechanical engineering, who established RASSL in 1995.

Women in Defense created the HORIZONS Scholarship to offer financial assistance to U.S. citizens and encourage them to pursue careers in defense or national security areas. The scholarship is also intended to provide development opportunities for women who are already working in these fields.

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Autistic children have very particular needs related to air qualities and noise levels that require a more constrained HVAC design. As stated by Florida Tech’s School of Psychology in a memorandum to project engineers, “children of autism have a higher level of allergies and can be more susceptible during periods of outdoor pollen and mold”. This necessity will require a design with higher air filtration than a standard educational facility.

Other requirements requested by the School of Psychology in the memo include a low noise level HVAC design. Average noises we hear in our daily routine such as the sound of an air conditioning unit switching on or off, can interrupt clinical treatment and disrupt an autistic child’s focus. So a design with minimal noise must be attained to satisfy the customer’s needs.

This team is designing a sustainable building that encompasses a heating, ventilation, and air conditioning (HVAC) system for an autism research facility constructed on the Florida Institute of Technology’s Melbourne campus. The design must meet the Florida Tech School of Psychology’s needs for autistic children as well as specific building codes and ratings.

The research facility will encompass 22,000 square-feet over a two-story floor plan zoned for educational purposes. The building will consist of classrooms, training rooms, treatment rooms, and observation rooms predominantly occupied by autistic individuals. Other areas include conference rooms, equipment rooms, break rooms, and restrooms occupied by the general public as well as autistic children. All of these rooms must cater to the specific needs of autistic children as conveyed by Florida Tech’s School of Psychology.

The Hermes design team, sponsored by Harris Corp., consists of six Mechanical Engineering students: John Curls, Jai Mittal, Sam Roman, Garrett Lee, Charles Pearson, and Mike Mathews. The final objective of the project is to design a robot that can traverse and inspect high voltage transmission power lines without the need for constant human supervision. Just like the human inspectors, the robot will face numerous challenges while transversing the lines, including large obstacles, inclines, varying weather conditions, and an electric environment that can range up to half a million volts.

At this time the project is still in the early phases of design, with construction scheduled to begin early next semester. Once construction has progressed to the point of an operable mechanism, and with the aid of either Florida Power and Light or the Jacksonville Electric Authority, the robot will then be tested in some of the possible conditions it may encounter while in service.

A novel electromagnetic launch concept based on a linear multi-pole field with zero axial components has been developed in collaboration between Florida Tech’s MAE Department (Dr. Hector Gutierrez and Dr. Daniel Kirk) and Advanced Magnet Lab, Inc. (Dr. Ranier Meinke). Multi-pole fields have been extensively used in high energy physics.

The use of DC power requires no switching and makes the system reliable and cost effective, while providing contact-free power transfer between the projectile and launching tube. The proposed concept includes a passive radial stabilization scheme based on damping windings attached to the projectile. Self-centering forces and torques are induced in the damping coils when the projectile moves off axis. Simulations of the 6DOF projectile dynamics show that the trajectory during launch is self-centering, and the induced currents die away quickly once radial stability is achieved.

Advanced Magnet Lab is a world leader in high power magnetic systems for applications including high energy physics, biomedical, power generation, and advanced custom magnet design.

One of the main challenges of induction launchers is the design of an efficient and reliable pulsed power source to transfer power to the projectile as it gains speed.

A novel electromagnetic launch concept is the design of an efficient and reliable pulsed power source to transfer power to the projectile as it gains speed.
Projects and Research

Siemens-FIT: Turbine Snubber

Our senior design team has us working in conjunction with Siemens to increase the efficiency of their turbines. The team consists of seven undergraduates and one graduate student; we are under the guidance of Florida Tech Professors Dr. Hsu, Dr. Kirk, and Dr. Subramanian (Figure 2).

Our work primarily addresses the aerodynamic and structural effects of adding different types of snubbers to the turbine blades at a certain distance along the axial length. A snubber is a device that dampens vibration and adds structural support. However, snubbers disrupt the turbine mass flow since they resist the flow, and thereby increase the overall pressure loss. This reduces the efficiency of the overall system.

We are currently using computational fluid dynamics to create a parametric study of different snubber shapes and testing conditions. We started our computational analysis by looking at 2-dimensional control volumes and have now moved on to doing 3-dimensional simulations. Our overall goal is to create a snubber that would be able to withstand the structural loading while not constraining the mass flow too much.

An example of the computational work we have done so far can be seen in Figure 1. This figure shows the blade angled into the flow with predetermined boundary conditions. If we keep on schedule we should be able to start low speed experimental cascade wind tunnel testing by December.

Northrop Grumman-FIT Tanker Lighting

The Northrop Grumman-FIT Tanker Lighting Design Team project outlines the fabrication of a proof of concept LED display that will enable communication from the boom operator to the receiving pilot during an air-to-air refueling. Since the display is a visual device, it will help maintain radio silence during refueling operations. The display will also provide the receiving pilots with more information about their position than the current refueling position lights do.

With guidance from Northrop Grumman Aerospace Systems in Melbourne and the cooperation of Lighting Science Group in Satellite Beach, a 3’x3’ LED display will be used to demonstrate this new aircraft rendezvous concept. The final display will accept simulated boom-position inputs from a joystick or video game controller and show the corrective action (up, down, left, right, forward, aft) on the display. It is intended to reduce the number of accidental break-offs and emergency break-offs by giving pilots more pertinent information on their position and therefore the stresses they are putting on the boom.

This new tool is designed to replace the outdated and ineffective Pilot Director Lights (PDLs), which are currently in use to guide refueling aircraft into the proper position. The design project aims to prove that an LED “screen,” similar to that used on the Goodyear blimp, can be used to make air refueling safer and more efficient.

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Professor Spotlight

Dr. Shengyuan Yang Receives Prestigious NSF CAREER Award

Dr. Shengyuan Yang received his Bachelor of Engineering degree from the University of Science and Technology of China in 1993, and his Ph.D. degree from the University of Illinois at Urbana-Champaign in 2007, all in mechanical engineering. After his Ph.D., Dr. Yang joined the faculty in the Department of Mechanical and Aerospace Engineering at Florida Tech as an Assistant Professor. Before he came to the U.S., Dr. Yang worked as a researcher in the Tokyo University of Agriculture and Technology in Japan for three months, and in Nanyang Technological University in Singapore for four years.

Dr. Yang’s research interests include cell mechanics, micro and nano-electromechanical systems (MEMS/NEMS), and mechanics of materials. He established himself with both the mechanical and biological backgrounds. He developed and offered the new graduate course “Cellular Biomechanics” after he joined Florida Tech. He has published one book and more than 25 journal and peer-reviewed conference papers. He was invited to be a laboratory instructor for the GEM (Global Enterprise for Micro-Mechanics and Molecular Medicine) Summer School on Cell and Molecular Mechanics in Biomedicine with a focus on infectious diseases held during August 7-18, 2006, at Massachusetts Institute of Technology (MIT). This year (2009) he received the NSF (National Science Foundation) CAREER Award.

Dr. Yang’s undergraduate teaching at Florida Tech is in the area of engineering mechanics, and he teaches Statics, Dynamics, Mechanics of Materials, and Solids Modeling.

Dr. Yang’s long-term research goal is to apply micro and nano-electromechanical methods to advance our understanding of cell and tissue mechanosensitivity and mechanotransduction for realizing micromechanical control of cell and tissue development. In pursuit of this goal, the title of Dr. Yang’s CAREER proposal is: Micro and Nano Methods to Reveal Cell Sensitivities to Local Stiffness. In the project, a class of three-dimensional micro-force sensors and a class of substrates with integrated micro force sensors will be developed to measure the cell sensitivities to local stiffness; A class of continuous substrates with stiffness patterns at micro- and nano-meter scales will be developed to study cell sensitivities to local substrate stiffness (SS); A class of substrates with magnetorheological and magnetic fluids will be developed to study cell response to changing SS; Based on the obtained experimental results, a detailed biophysical model will be established at the molecular level to describe the dynamic cell mechanosensitive mechanism and process to SS.

Cell adhesion, spreading, migration, and differentiation have been found to be extremely sensitive to the stiffness of the substrates on which the cells were grown. But the mechanism through which the cells sense the SS locally and how the cells integrate the local SS information and transfer this information into biological behaviors remain largely unclear, and was the motivation for the proposed research.

The successful completion of this project will significantly enhance our understanding of cell mechanosensitivity and mechanotransduction, cell behaviors in tissues, and tissue development. Like the widely used patterning the surface topography and chemistry, the concept of micro- and nano-patterning the stiffness of the substrates, introduced in this project, opens a new paradigm and is transformative for the study of cell and tissue mechanobiology and engineering and its applications.

Dr. Daniel Kirk Among Few Selected for National Academy of Engineering Symposium

Dr. Daniel Kirk, Florida Institute of Technology professor of mechanical and aerospace engineering, was selected to participate in the National Academy of Engineering’s (NAE) first Frontiers of Engineering Education (FOEE) symposium in Herndon, VA. The two-and-a-half day event offered a platform for faculty members to share effective ways of teaching and learning and bring what they’ve learned back to their home institutions. The symposium was held November 15-18.

Kirk was one of 49 faculty members in the country to be chosen for this honor. Participating colleges and universities include Princeton University, Carnegie Mellon University, Yale University, and Georgia Institute of Technology. The participants were nominated by fellow engineers or deans and chosen from a highly competitive pool of applicants.

Established in 1964, the NAE is an independent, nonprofit institution that serves as an adviser to government and the public on issues in engineering and technology. Its members consist of the nation’s premier engineers, who are elected by their peers for their distinguished achievements.

Kirk is also a 2009 Boeing Welliver Faculty Fellow and participated in an eight-week summer program that exposed a small number of competitively selected professors from U.S. and international universities to technical, business, and management career paths at Boeing.
Alumni and Student News

Recent Graduate Working On Space Shuttle Thermal Protection

Now an Aerodynamics Engineer for Boeing in support of NASA’s Space Shuttle program, Garry Livesey II started out as an undergraduate in Florida Tech’s Aerospace Engineering program. During his junior year, he took advantage of the opportunity provided by Dr. Daniel Kirk to lead a team of students in researching the behavior of fluids in low gravity, dubbed the “Slosh Dynamics” project. With the objective of developing a CFD model capable of predicting the movement of fluids in space, Garry lead the team’s experimental effort, focusing on the design and operation of the testing apparatus which flew aboard Zero-G’s “Vomit Comet” in 2008.

Hired by The Boeing Company soon after graduation, Garry now works on the Thermal Protection System of the Space Shuttles at Kennedy Space Center. At KSC, he is part of a team responsible for determining the appropriate repairs for the numerous silica tiles and thermal blankets damaged during each mission. In addition, his team also provides oversight for the manufacturing of those parts on site, addressing non-conformances to design and determining acceptability for use in flight. Currently, Garry is pursuing his master’s in Combustion & Propulsion at Florida Tech, and is in the early stages of researching a thesis on the concept of propellant densification, the idea that space vehicles can achieve additional performance by super-cooling their propellants. Ultimately, Garry’s career goal is to enter the U.S. Astronaut Corps., and help further the exploration of space and the advancement of space technology.

When asked what advice he would give to other students, he responded: “Everyone graduates with a degree and a GPA, but not everyone graduates with research experience. Talk with your professors on what they’re currently working on, and get involved early. That additional experience outside of a textbook can carry you very far when it comes time to enter the professional world.”

Photo: Garry Livesey

Florida Tech Student Leads NASA Microgravity University Research Team

Nick Avery, a Florida Institute of Technology senior in mechanical engineering, is leading a research team hoping to fly an experiment in microgravity through NASA’s Microgravity University competition. Proposals were submitted on Oct. 28th.

A 2006 graduate of Leland and Gray High School in Townshend, VT, Avery is currently participating in the Cooperative Education program with United Space Alliance in Houston, TX. His group, the Ferrofluid Research Team (FERRET), is a collaboration of five undergraduate co-ops from different universities. These include Rensselaer Polytechnic, Embry Riddle Aeronautical University, Syracuse University and Louisiana State University. Dr. Mark Archambault, assistant professor in Florida Tech’s Department of Mechanical and Aerospace Engineering, is the team’s advisor.

Teams selected through the competition will fly parabolic trajectories aboard a modified aircraft. The flights will provide about 20 seconds of microgravity per parabola. The team will use the magnetic attraction properties of ferrofluids to control lubrication behavior in bearings. The goal is to observe and combat lubricant migration in bearings under varied gravitational loads. They hope to use a specially designed ferrofluid thrust/radial bearing that uses permanent magnets to contain a ferrofluid lubricant. This will be tested alongside a traditional ball bearing.

The team’s choice of experiment was inspired by the failure of the Solar Alpha Rotary Joint on the International Space Station. Lubrication problems have been deemed a major root cause of the failure. If selected in December, the team will construct their experiment in the spring semester before their microgravity flight aboard the modified aircraft in the summer of 2010.

Photo: Nick Avery

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AIAA Florida Tech Chapter

The student chapter of the American Institute of Aeronautics and Astronautics (AIAA), one of the most prestigious organizations on the Florida Tech campus, will continue a year of excitement and engagement in aerospace engineering to its members and campus. The AIAA chapter welcomes its newest addition of student members, the aerospace engineering class of 2013.

The AIAA has several trips and presentations planned for both semesters of this academic year. The featured dinner of AIAA was held on October 27th. The dinner featured a social between the Florida Tech chapter of AIAA and the Cape Canaveral professional chapter of the AIAA. Robert Atkins, who is the senior manager for Lockheed Martin’s Kennedy Space Center operations, gave an amazing presentation. Mr. Atkins’ presentation introduced a reaction to the Augustine Report and what it means locally. The Augustine Report will determine the fate of funding for NASA and other space operations. The effect will be felt the most here in Florida where 90% of space operations function. The AIAA also featured a NASA trip which was held in mid November, along with a trip to tour the facilities at Patrick Air Force Base.

ASME Florida Tech Chapter

The American Society of Mechanical Engineers (ASME) is a student run chapter that is dedicated to improving students and working with faculty of the Mechanical & Aerospace Engineering (MAE) Department. We encourage professors and professionals to come and present current mechanical engineering topics to us. Also, throughout the year ASME plans to offer tours of companies and participate in competitions.

Currently, ASME has done an excellent job promoting the MAE department and we are planning to complete significant goals for the upcoming year. So far we have toured Liberty Aerospace; it is a small company that manufactures the XL2 (a two passenger plane). Students really enjoyed touring their facilities and learning about how they manufacture aircraft. Additionally, ASME promoted a presentation by M.W. Barsoum; a professor from Drexel University. The presentation was on mechanics and materials of the ancient pyramids of Egypt. Undergraduate and graduate students attended, and ASME provided pizza afterwards.

ASME Florida Tech Chapter

This fall we promoted a forum for MAE students to discuss how they feel about the programs at Florida Tech. The forum was held on November 20th in the Olin engineering building. ASME also attended the ASME Student Design Competition Finals for 2009 on November 15th in Orlando. New officers were voted in during the end of November. Our goal is to prepare for 2010 as best as possible, and hopefully enter one of our national ASME competitions.

Tau Beta Pi Honor Society

Tau Beta Pi is an honor society that accepts undergraduate and graduate students studying all engineering majors. It is the largest and the second oldest honor society in the United States, founded in 1885. Our chapter at Florida Tech was established in 1986 and has inducted 780 members to date. This semester, we were invited to participate in an inspection committee of Embry Riddle Aeronautical University, who is petitioning to found a new chapter of Tau Beta Pi. The committee consisted of Tau Beta Pi student leaders from colleges in the southeastern district and the executive board of Tau Beta Pi. This semester we have elected 42 candidates and our initiation took place on Friday, November 13.

Photo: Tau Beta Pi national conference this year, held at Rutgers University October 15th-17th.
Pledge your support for the Mechanical and Aerospace Engineering Department!

I would like to make a donation to support the students, faculty, and improve the facilities of the MAE Department at the Florida Institute of Technology.

*Florida Institute of Technology is a non-profit educational organization, and as such, any donations made to Florida Institute of Technology are tax-deductible.

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