Department of Aerospace Engineering and Mechanics

AEM Update

2002-2003

Chairman's Corner

This was a difficult year for the University of Minnesota. As everyone knows, the State of Minnesota faced the largest deficit in its history and the University took a large hit as part of the strategy to eliminate the shortfall. The Administration did an admirable job in protecting the academic units; however, we all suffered. Student tuition has increased almost 50% in the last three years and this year the faculty and staff had to pay a larger fraction of their health care costs and received no pay increases. Even then, our budget shrank and we were forced to reduce our support staff and postpone two faculty searches that were in progress.

The University is not unique in facing budget reductions and all in all we came out better than many other states supported institutions of higher learning. Unfortunately, much of the burden of the state-mandated budget cuts has fallen on the students since financial aid has not increased enough to offset the increases in tuition. Students from middle-income homes are particularly hard hit as student aid is focused more financially disadvantaged students.

Despite our current financial restraints, I am very optimistic about the long-term prospects of our Department. We have an outstanding younger faculty who excel in both teaching and research. This year Krishnan Mahesh was one of ten faculty members who were awarded a McKnight-Land Grant Professorship. Over the past 10 years, six of our younger faculty have received these prestigious awards. I think that this is a record for a small department such as ours. Gary Balas received the Institute of Technology George Taylor Research Award in recognition of his contributions to aerospace control systems design.

Despite our current financial restraints, I am very optimistic about the long-term prospects of our Department. We have an outstanding younger faculty who excel in both teaching and research.

We graduated 30 BAEM students this academic year and one of our graduating seniors, Richard Johnson, gave the student commencement address at the IT Spring Graduation Ceremony in Northrop Auditorium. Richard's speech is covered later on in the Update. We also graduated 10 students with Masters Degrees and 7 with Ph.D's. The job market was not strong, but most students were getting offers or going to graduate school.

We have increased our efforts to provide a variety of opportunities for undergraduates to become involved in projects with faculty members. Some of the projects that involved students were the NASA Student Reduced Gravity Flight Experiments, the Solar Car, the SAE Heavy Lift Aircraft Contest, the high altitude Balloon Project and the effects of the ventilation system in the Metrodome on the flight of baseballs . All of these projects are described in this issue of the Update.

In addition a number of undergraduates are employed on faculty research projects. This year we sent one of the TA's for the Senior Design course to NASA's Marshall Space Flight Center in Huntsville Alabama to work with the Advanced Planning and Concepts Group to develop a space craft design project for our design class this next year. We have also extended our outreach to northern Minnesota with a human powered vehicle project at the Circle of Life School on the White Earth Reservation.

2004 marks the 75th anniversary of our Department. We are planning a big celebration with a keynote lecture on a topic in the history of flight.

Plans are in the formative stage, but we will keep you

Continued on pg 2

What's Inside

Chairmen continued

posted on our website – see: "http://www.aem.umn.edu/info/75_anniversary/75_anniversary.shtml"
We hope you will be able to attend this event.

Much of the success of our Department over the years has been due to the involvement and dedication of our alumni and friends. Financial giving was at an all time high this year despite the economy. Most of our student projects would not be possible without gifts

First Class of Seniors Taking Flying Lessons

and I want to thank you all on behalf of our faculty students and staff for your support. ■

Bill Garrard
Professor and Head

2002-2003 Undergraduate BAEM Program Evaluation and Improvement

The Department is continuing to examine and implement improvements to the undergraduate program as part of our quality improvement process required by ABET. These changes are based on inputs from our constituent groups, including students, employers, alumni, and faculty members. In the past year we have adding topics in engineering ethics into the design sequence. We have also changed the advising process, so that a core group of faculty act as Upper Division advisers. We are also continually improving our web-based course database system to help students chose appropriate courses and track their progress towards graduation.

Among the program improvements we are exploring are the introduction of a freshman seminar to introduce potential students to the field and the Department. We are also discussing ways to improve the design sequence, and especially to give the students more time to build and test their models. The design students had a very successful year with their projects; however, they could use a bit more time between testing and flight. We are also looking at new ways to organize the design sequence to better use the talents of our faculty. In fact, one of our graduate students (and a former undergraduate) is writing his Masters thesis on improving the design sequence.

One educational outcome required of engineering students by ABET is "the broad education necessary to understand the impact of engineering solutions in a global/societal context." To some extent we depend on students to select non-technical electives to satisfy this outcome. Results of our senior exit surveys have indicated that students do not believe that this outcome is achieved as well as we would like; consequently, this year we recommended several courses in the History of Science and Technology which explicitly address this outcome. We are considering requiring one of these courses if it can be used to satisfy the University of Minnesotaís Liberal Education Requirement.

As always, we would very much appreciate your comments on these changes, and your suggestions for other possible improvements. ■

Perry H. Leo
Professor and Associate Head
phleo@aem.umn.edu

Academics: Where Are We Now?

AEM Graduate Program

A total of 153 applications came from prospective students seeking entry into the AEM graduate program for the 2002-2003 academic year. The admissions faculty reviewed 139 of these applications, the remainder being incomplete. Sixty-four prospective students were admitted while 75 whose credentials were not sufficiently strong enough to warrant admission were rejected. Financial aid was offered to 21 of the admitted students in the form of teaching assistantships, research assistantships, and graduate school fellowships. Nine of the offers were declined, however, eighteen were accepted and those students enrolled in our graduate program in Fall 2002. Twelve of those students were from the United States; three were from China, one each from Bangladesh and India. One student from Venezuela enrolled with private funding.

During the 2002-2003 academic year, 17 students received graduate degrees in AEM. Four received their M.S. in mechanics, five received their M.S. in aerospace engineering, and one received a M.A.E. Seven students received their Ph.D., four in mechanics and three in aerospace engineering. Of the M.S. graduates, 2 continued on in the Ph.D. program in AEM while the others either returned to their home countries or secured employment here in the United States. ■

Gary Balas,
Director of Graduate Studies
AEM Graduate Program

AEM Undergraduate Program

We graduated 30 BAEM students this academic year. Twenty-one of these students responded to a survey on plans after graduation. Then are planning on graduate school, seven went to work in industry, one went into the air force advanced pilot training, and the rest are still seeking employment. In addition, we were honored by having one of our graduating seniors, Richard Johnson, give the student commencement address at the IT Spring Graduation Ceremony. We have increased our efforts to try and provide a variety of opportunities for undergraduates to become involved in projects with faculty members. Some of the projects that involved students were the NASA Student Reduced Gravity Flight Experiments, the Solar Car, the SAE Heavy Lift Aircraft Contest, the high altitude Balloon Project and the effects of the ventilation system on the flight of baseballs in the Metrodome. Our Undergraduate Student Advisory Board met during Spring Semester and gave us feedback on some of our undergraduate courses and other improvements in the undergraduate program. They will continue with the work they started during the upcoming fall semester.

For a second year, in a row, we held a graduation reception prior to the IT graduation ceremony. The reception gives an opportunity for student's families to meet the departmental faculty and staff and see a display of some of the projects the students have worked on in the senior design course. Parents this year saw the Wright Brothers replica and some other aircraft designs that the students made in our AEM shop. ■

Gordon S. Beavers
Director of Undergraduate Studies
AEM Undergraduate Program

2002-2003 Educational Objectives: How Are We Doing?

Educational objectives are statements that describe the expected accomplishments for our BAEM graduates during the first few years after graduation. These objectives should so far as possible be unique to the program and institution.

The educational objectives for students graduating from the Department of Aerospace Engineering and Mechanics at the University of Minnesota are:

1. To produce graduates with a broad background in aerospace engineering and mechanics, including fluid mechanics, structural mechanics and aerospace systems.
2. To produce graduates who can apply their knowledge of aerospace engineering and mechanics to achieve success in the aerospace industry, related government agencies, and other engineering industries.
3. To produce graduates with skills in the essential tools used in aerospace and other industries. These include experimental methods, problem-solving techniques, computational methods and engineering design.
4. To produce graduates with the ability to both seek out assistance when needed and to learn new skills throughout their careers.
5. To produce graduates with the oral and written communication skills needed to successfully work in a modern multidisciplinary environment.
6. To produce graduates who can be successful in graduate level work in engineering, as well as in other professional schools.

It is difficult for us to assess how well we achieve these objectives, so if you are a recent graduate or employ a recent graduate, a note to me would be much appreciated.

Bill Garrard, Head
garrard@aem.umn.edu

Results of Graduating Senior Exit Surveys

Each year we conduct an Exit Survey of our graduating seniors. The students are asked to respond to questions regarding their overall experiences in the BAEM program, both lower and upper division. Respondents are given a range from 1 (strongly disagree) to 3 (neutral) to 5 (strongly agree) to check off. The responses to the survey are summarized on the as below:

Number of Surveys: 45

Ninety-three percent of the respondents expected to receive their degree in 2003. The percentage of students who checked either a 4 or 5, "strongly agree," is shown in parentheses.

A high percentage of students agreed that their education has prepared them to:

- apply knowledge of math, science and engineering fundamentals (86.7%)
- design and conduct experiments and to analyze and interpret data (75.5%)
- design a system, component or process to meet desired needs (64.4%)
- identify, formulate and solve engineering problems (88.9%)
- communicate effectively in both oral and written form: (73.4%)
- have the fundamentals for continued learning throughout life (82.2%)

There were some areas in which students felt not as well prepared. The percentages of 4s and 5s were much lower when students were asked if they felt that they were well prepared:

- to use modern tools (e.g., CAD) necessary for engineering practice (51.1%)
- with a good understanding of professional and ethical responsibilities: (57.7%)
- with an understanding of the impact of technology on society: (48.8%)

Students had the following response to questions about their Lower Division and Liberal Education coursework. They did not feel that lower division academic advising was good since 25.0% of the students agreed, 25.0% remained neutral and 50.0% strongly disagreed to the question of whether lower division advising well prepared them for upper division. Only 48.9% of the students felt that their liberal education courses gave them an appreciation of the societal context in which engineering is practiced. However, students felt that the science components (75.6%) and math components (82.2%) had prepared them well for their major courses.

Students were a bit more satisfied regarding

- whether computational facilities were available for their use (51.1% with 26.7% remaining neutral)
- whether instructors provided adequate feedback on their class performance (68.9% with 24.4% remaining neutral)
- whether instructors were available to discuss course related issues outside of class (86.6%); and
- whether their courses included active learning experiences, such as discussion and team work (82.3%)

Students were very positive about their Upper Division experience. 59.1% of the students felt that the upper division academic advising was good. The majority of the students felt that their education provided them with:

- a good understanding of engineering materials (75.5%)
- a good understanding of aerodynamics (88.9%)
- a good understanding of aerospace structures (57.7%) with 26.7% remaining neutral.
- a good understanding of aerospace propulsion systems (73.3%)
- a good understanding of atmospheric flight mechanics (84.5%)
- a good understanding of orbital mechanics and space flight (73.3%)

However, only 39.0% strongly agreed (with 33.3% remaining

Continued top of next page

neutral) that they had gained

- a good understanding of flight dynamics and control

The balance of the survey asked the students to respond to:

a. whether they felt the design experiences provided throughout the BAEM curriculum. 48.9% responded positively while 24.4% were neutral.

b. whether the intern and/or work experience enhanced their education. 44.2% responded positively while 48.8% remained neutral.

c. whether the quality of the laboratory facilities provided were good. 57.8% responded positively while 28.9% remained neutral.

d. whether the quality of the computational facilities provided were good. 51.1% responded positively, 22.2% remained neutral and 26.7% responded negatively.

e. whether the senior design courses improved their ability to work as part of a team. 57.8% responded positively while 20.0% remained neutral.

f. whether the hands-on laboratory experienced provided them with a good understanding of how to conduct and design experiments as well as analyze and interpret data. 73.4% responded positively.

Although the majority of the graduating seniors were generally satisfied with their educational experiences in the BAEM programs, there are clearly areas that need improvement. These areas will be addressed by the AEM faculty.

Details of the survey can be found at: http://www.aem.umn.edu/teaching/undergraduate/BAEM_prog_assessment.shtml ■

Findings from AEM Professional Advisory Board Site Visit

Our AEM Professional Advisory Board met November 8, 2002 to review our programs. The following members attended: Mr. Eric Kaduce (Boeing), Dr. Data Godbole (Honeywell Laboratories), Dr. David Khemakhem (Exxon Mobil), Dr. Carl Peterson (Sandia National Laboratories), Dr. Dennis Cronin (Goodrich Corporation), and Dr. Dave Sippel (Retired from Pemstar)

Since recent meetings of the advisory board had focused on the undergraduate program, the Board focused on the graduate program. The Advisory Board met with faculty, undergraduates, graduate students and IT Dean Ted Davis. They also reviewed the last external review of or graduate program and were given a presentation on the Department by Professors Garrard and Leo. The committee made a number of recommendations which are summarized as follows:

Graduate Student Recommendations

- Need stronger affiliation with professional societies
- Metrics and objectives similar to those for the undergraduate program need to be put in place for the graduate program
- Provide support for grad students to attend conferences (even without presenting a paper)
- Coordinate course offerings across departments
- Introduction/orientation of new grad students should be improved
  - Student/advisors matching
  - Present current faculty research overviews
  - Social event with students and faculty
- Maintain Graduate Student Council to bring recommendations to AEM Department
- Provide additional computer support for Graduate Students
- Weekly seminars should be expanded to include all research groups in AEM
- Improve networking opportunity for students
  - Bring in industry speakers
  - Provide industry contacts through professors
  - Organize industry visits
- The impression that the TA position is undesirable needs to be changed
- Provide adequate space for TA office hours

Comments on the AEM Department

- Metrics need to be defined for undergraduate program objectives
- Improved methods for getting feedback from alumni is needed
- Develop and articulate the information to support resolution of the AEM space issues
- Coordinate faculty leaves to minimize impact on courses offered
- Provide coordination and administrative support for large proposals
- External research work is consistently strong, is commended by the Board
- New faculty hires and posted positions seem appropriate to balance the skill base
- Department should consider more proactive promotion of AEM objectives, needs and performance
- The connection between innovative research and applications should be established
- Change to new advising system that benefits both students and the department
- Connections by AEM faculty with outside researchers are excellent; industry relationships at the same level are encouraged

AEM Departmental Relationship with IT

- A strategic plan should be developed to engage the IT Development Office in additional AEM fund-raising activities
- In general, Dean Davis is supportive of AEM; however, he needs to define a short-term plan for solving AEM space problems
- AEM must provide supporting data to the Dean to justify additional space
- AEM should develop a strategic plan/vision

One of the most important recommendations was the development of a strategic plan for the Department. Development of a 5 year plan is in progress and will be posted for your comments on the Departmental Website

Student Commencement Speech-Spring 2003

Richard Johnson, May 9th 2003,BAEM

The year two-thousand and three marks the hundredth anniversary of flight as we know it today—heavier-than-air, powered, and piloted. The Wright brothers' endeavor is paralleled today in many engineering efforts. Our undertaking here at the University of Minnesota shares some commonalities with their pursuit of flight.

Orville and Wilber worked as a team. Communication is important in any team. They were bicycle builders that taught themselves to be engineers. They weren't the leading experts in any science, yet they accomplished one of the most noteworthy technological achievements in history. Some of the technologies they needed to get off the ground were around before the brothers set out to reach the skies. Other ideas—such as the control system—were truly their own. The integration of these two pieces of knowledge was essential. It was their task to collect these various technologies and create something that would change the world.

Here at the U, we set out on the same mission. We too often work in teams. However, we have the advantage of learning from experts in all of the sciences. We have the opportunity to explore countless existing technologies. We gather those ideas and will use them to support our aspirations—our careers.

An airplane is a balance of many things. Weight, stability, performance, cost, reliability, and safety must all be considered. The stringent requirements imposed by the physics of flight make the design of an aircraft a compromise of many things. There is more than one right answer. The path leading to any one of them is by no means trivial. As a result, the aviation industry has historically developed and incorporated cutting-edge technologies. The field of aerospace encompasses many of the disciplines that make-up the Institute of Technology.

Specialized materials, manufacturing techniques, hardware, and software all come together to form a modern aircraft. Complex computational tools are a crucial part of designing the machine. Concepts in mathematics, physics, material science, computer science, mechanical engineering, electrical engineering, chemistry, and biological engineering will serve as the enabling technologies of our professions.

I don't believe the Wright brothers could have imagined how far their efforts would go in the one hundred years after their famous flight. Over 30 years ago, the world saw the first jumbo jet take flight. That same year, humans first stepped foot on the moon. The Wright Flyer itself can easily fit inside modern cargo aircraft. Its first flight could be accomplished within the shadow of many of the air transports of the present day.

Aside from our fondness for the technologies themselves, the importance of our work is found in the effect the implementation has on people. The aerospace vehicles of today benefit from increased capabilities. Improvements in size, range, fuel consumption, speed, and all-weather capabilities allow people to better connect with one another around the world. This human need fuels the creation that drive the industry forward. With such a profound effect on the people, we have a responsibility to them. The aviation industry lives up to this responsibility with extremely high levels of safety.

The economic hardship that strains the current economy is most profound in the field of aerospace. Its effects constitute the worst downturn in aviation history. The only certainty in what the future will hold is that things will change. It is important for us to be able to anticipate that change and act accordingly. There are many ideas out there that await the development of technologies to convert them into reality. Like the Wright brothers, we will make this transformation happen.

Aviation will see this occur on many fronts. Airlines will offer nonstop service to anywhere in the world with twin-engine aircraft capable of economically, reliably, and safely flying half-way around the world with minimal effect on the environment. Aircraft design will carefully consider aspects and factors previously seen as uncontrolled consequences. The assumptions of optimum aircraft configuration will be challenged. The capabilities of UAVs will expand further than we can imagine. Private industry will venture into space. New space propulsion systems will be developed to assist in our journeys to the far reaches of our world.

An airplane represents a significant investment. Likewise, the degrees we earn today will signify the time, money, and effort we have put forth to earn the status of college graduate. As we depart the University, we will be flying into troubled skies. If we can climb through it, we are going to be alright. It will be a challenge, but that pressure will foster innovation. Follow your dreams, the technologies will be there to support them.

AEM Students Take Flight

Students participated for a third year in the NASA reduced gravity flight experiments March 13-22, 2003, at the NASA Johnson Space Center in Houston, Texas. NASA's KC-135 was used to train and perform the in-flight experiments of the students. The experience they gained was similar to that of what astronauts experience on a real shuttle flight doing experiments. The two experiments, which the students performed, are described below.

* * *

Solids Team

*Topic Area: Material Science
*Team Name: The Space Balls
*Team Members: Lynn Gravatt, Daniel Lehman, Jake Thrift, Ryan Nordell, Eve Skoog, and Jason Bryan
*Faculty Advisor: Professor Thomas Shield

Left to Right: Front row— Daniel Lehman, Jake Thrift. Second row:— Jason Bryan, Eve Skoog, Lynn Gravatt, Ryan Nordell.

Effects of Microgravity on Random Close Paking Arrangements – Part II

The purpose of this project is to provide accurate data concerning the random packing of spheres. It is believed by many scientists that the random closed packing of a collection of spheres is a universal quantity. By packing a collection of spheres in a box we can model the packing of particles of composite material.

Conducting this experiment in a zero gravity environment will allow us to measure the state of the system without the biasing influence of Earth's gravitational field. The spheres will be packed at multiple speeds which will allow us to determine the relationship between wall speed and average packing volume ratio at the systemís maximally jammed state.

Thus far, most of the research done on this topic has been through theoretical mathematics and computational methods. This is most likely due to the fact that gravitational effects of earth on the randomizing of the spheres make physical experiments difficult. The data we collect will be compared to data collected from computational models, which require zero gravity, and data collected from last years experiment.

* * *

Fluids Team

*Topic Area: Fluid Dynamics
*Team Name: Zero G and the Funky Bunch
*Team Members: Nicholas Schellpfeffer, *Maria Bigwood, Richard Johnson, Nathan Koelln, Matthew Stegmeir, and Kimberly Lay
*Faculty Advisor: Professor Ellen Longmire

Left to Right: Richard Johnson, Nathan Koelln, Prof. Ellen Longmire, Kimberly Lay, Maria Bigwood, Nick Schellpfeffer, Matthew Stegmeir

Study of Droplet Coalescence Criteria of a Liquid/Liquid Interface in Micro- and Macro-Gravity Conditions

The criteria for coalescence of two droplets colliding in a liquid-liquid interface will be studied in micro- and macro-gravity conditions.

Previous experiments in this subject have used droplet sizes with diameters on the order of microns to justify the assumption that buoyancy forces were negligible.

For this experiment the ability to perform the collisions in a zero gravity environment creates a unique opportunity to analyze the criteria for coalescence on a macroscopic scale.

With buoyancy forces not present, the properties

Continued top of next page

of droplet collision and coalescence are defined only by their size, relative velocity and position at impact. Variations of these parameters will be studied to determine when coalescence occurs.
More information can be found at: http://www.aem.umn.edu/proj-prog/sfo/fluids-2003/

The microgravity projects, including travel expenses, were supported from funds from the Richard and Shirley DeLeo Scholarship and Engineering Fund, AEM Program Support, University of Minnesota UndergraduateResearch Opportunities, and the Department of Aerospace Engineering and Mechanics.

Minnesota Space Grant Consortium

The Minnesota Space Grant Consortium (MnSPC) is part of the NASA Funded National Space Grant College and Fellowship Program established by Congress in 1988. Nationally, Space Grant is a network of 52 university-based statewide consortia (all 50 states, the District of Columbia, and Puerto Rico) with 820 affiliates. Space Grant provides state-based pre-college education, higher educational research opportunities for faculty and students, and public service activities related to aerospace science and engineering.

The mission of the MnSGC is to provide a driving force for aerospace education in Minnesota. Program goals and objectives include diversity, competitiveness coupled with accessibility, ties with centers and NASA enterprises, and relationships with industry and state government. The MnSGC supports a variety of projects including pre-college activities in math and science, student research, program development, and fellowships and scholarships for students at its 14 academic affiliate institutions of higher learning and public outreach. Between 1997 and 2002, the MnSGC awarded 575 scholarships to college students in Minnesota and has supported numerous projects and programs involving students at all levels, from K-12 through graduate school. On our website you will find information on fellowships, internships, academic programs, links to NASA and to the other state Space Grant Consortia, and a variety of other information. We welcome your questions and comments. For more information contact the MnSGC Office at 612-626-9295 or mnsgc@aem.umn.edu
One of the major projects undertaken by the MnSGC this year was the development of a high altitude balloon project. The objective of this program is to develop a launch and recovery system which will allow students to fly small scientific pay loads into the upper atmosphere and recover these payloads with the data collected. AEM graduate student Kevin Sweeney and senior Stephanie Soffa are working with Lab Coordinator Greg Nelson and Professor William L. Garrard on this project.

The Iowa Space Grant at Iowa State University has had similar project for several years and has provided invaluable assistance. The system consists of a helium filled weather balloon from which a parachute and payload are suspended. The payload has GPS and radio transmission capability so that it can be tracked in flight. When the desired maximum altitude is reached, a signal is sent to cut loose the parachute and payload which then descends and is recovered. So far a tethered launch has been successfully achieved and the next step will be to do a free flight. For progress on this project see the web siteat: http://ww.aem.umn.edu/msgc/BSAT/ Some other highlights of the MnSGC include:

The Sverdrup Lectureship by Dr. Maria Zuber, Professor of Geophysics and Planetary Sciences at MIT on, "Expedition to an Astroid: the Near Earth Asteroid Rendezvous (NEAR) Mission"on April 8, 2003, at Augsburg College. She studies the evolution of the Earth and terrestrial planets.

The Space Science Across the Curriculum Conference was held March 15, 2003 at Science Museum of Minnesota and featured The Centennial of Flight in celebration of 100 years of powered flight. The keynote speaker was Betty Wall, a W.A.S.P or Women Air force Service Pilot who spoke on her experience as a pilot in WWII. Dr. Sanjay Limae, Director of the Office of Space Science Education at the University of Wisconsin, Madison also spoke on the "Weather on Planets" In addition, he gave a brief overview of the curriculum and resources their program has to offer to support the teaching of space science in the classroom.

The University of Minnesota supports the renewed efforts of Science CentrUM to connect research scientists at the University with K-12 educators in the Twin

Continued on pg 19

Control Science and Dynamical Systems (CSDy) Center
http://www.csdy.umn.edu/ -- Interdepartmental Ph.D. Program

The CSDy Interdepartmental Ph.D. Program provides an opportunity for interdisciplinary research in control science and dynamical system theory. The CSDy program coordinates scholarly and scientific activity of these areas within IT and the University and coordinates its activities with industrial firms in the Minnesota region. CSDy faculty are drawn from the Departments of Aerospace Engineering and Mechanics, Chemical Engineering, Electrical Engineering and Mechanical Engineering, as well as from the Departments of Computer Science, Mathematics and Statistics, all in IT, and from the Departments of Economics and Political Science. The Co-Directors of the CSDy Center are Prof. Gary J. Balas (AEM) and Prof. Tryphon Georgiou (ECE), and Prof. Balas serves as CSDy's Director of Graduate Studies. There are 8 students pursuing their Ph.D.s. in the program. The Program featured several seminars this year which included: Discrete Time Constrained Optimal Control, Dr. Francesco Borrelli, Swiss Federal Institute of Technology, Automatic Control Laboratory; The Impact of Automation in the Form of Feedback Control on Biomedical Systems, Professor B. Wayne Bequette, The Howard P. Isermann Department of Chemical Engineering Rensselaer Polytechnic Institute; In-Car GPS Route Guidance: Current Reality and Continuing Challenges, Professor Alain Kornhauser, Department of Operations Research & Financial Engineering Co-Director, Center for NJ TIDE (Transportation Information & Decision Engineering) Director, Transportation Program, Princeton University; The Future of Nuclear Power and Technology, Professor Andy Klein, Department of Nuclear Engineering and Radiation Health Physics, Director, Radiation Center, Oregon State University; How the Regulator Saturation and Model-Mismatch Influence Performance and Robustness Measures Controlling Time-Delay Plants, Dr. Csilla Banyasz & Dr. Laszlo Keviczky, Systems Control Laboratory, Computer and Automation Research Institute of the Hungarian Academy of Sciences; Robust Predictive Control of Vehicles, Arthur Richards, MIT Space Systems Laboratory, Department of Aeronautics and Astronautics Department MIT.

Current CSDy seminar schedules can be found at: "http://www.csdy.umn.edu/csdy_seminars"

Sethna Lectureships

Professor Arthur Bryson from the Department of Aeronautics and Astronautics, Stanford University gave the fall semester Sethna Lecture on November 15, 2002. He is the author of the famous minimum time climb trajectory theory. His talk covered different aspects of optimal control some of the unusual applications of optimal control over the last 30 years. He included information surrounding professional software packages like MATLAB that can be used to calculate and display optimal control data. His presentation also covered computer-animated movies of controlled plants like bicycles, unicycles, trucks with trailers, and (of course) spacecraft and aircraft. In addition, he pitched the need for using neighboring optimal control as a promising technique for controlling nonlinear systems with feedback.

The spring semester Sethna Lecture was given by Professor Stuart Antman on March 28, 2003. He is a Distinguished Professor in the Department of Mathematics, University of Maryland. He is also one of our former students. His talk addressed the Viscosity in Solids and the 50 years of effort about the growing consensus on the kinds of constitutive restrictions that are suitable for describing the nonlinear elastic behavior of solids. He reviewed the nature of the simplest dissipative mechanism for solids, that of (nonlinear) viscosity. His lecture looked at several surprising aspects of viscosity in solids, which have characters very different from the viscosity in fluids. These included its roles in (i) preventing total compression, (ii) justifying stability analyses, (iii) justifying asymptotic methods for dynamical problems, and (iv) formulating invariant numerical schemes for mollifying shocks.

Baseball Flight Trajectories

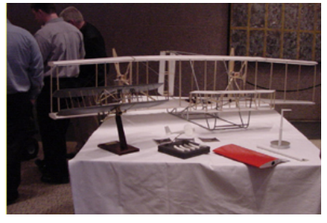
A course titled "Baseball Flight Trajectories" was offered in Spring Semester 2003 by Professor Ivan Marusic. The course was motivated by a Star Tribune (see full story article at: http://www.startribune.com/stories/509/4008558.html), investigation into the alleged effect the Metrodome ventilation fan duct flows can have on the distance a baseball can travel.

Eleven students were accepted in the course, including 5 seniors and 6 juniors. The students were required to design and build a baseball launching device capable of launching a baseball a distance of over 500ft with high repeatability. Two devices were built including a trebuchet and an air-pressurized canon. The air canon proved to be superior, and was used on two days of testing in the Metrodome. Among other things, the students conducted wind tunnel experiments to parameterize the duct flow characteristics, and wrote computer programs to simulate the flight of baseballs interacting with turbulent jet flows.

Senior Capstone Design Class-Academic Year 02-03

Project 1: Several students approached Professor Vano during the summer of 2002 and asked that the SAE Aero Design East competition be one of their project options for the coming academic year. In this competition, students are required to design a heavy-lift radio controlled (RC) airplane with three primary design criteria:1) the wingspan shall be no more than six feet, 2) the airplane will use an OS 60 engine, and 3) the payload will be non-structural and contained in a 200 cubic inch volume bounded on all sides with a rectangular surface. The fly-off was scheduled for May 24, 2003 at the Air Force Museum in Dayton, Ohio. This project seemed to fit the criteria for Design Class projects so it became the first project option on the list.

Project 2: December 17, 2003 will celebrate the 100th anniversary of the Wright Brothers first powered flight. During these first one-hundred years, humans have progressed from a marginally controlled flight of a few hundred feet to transglobal airlines, hypersonic flight, footsteps on the moon, and robotic explorations to most of our solar system planets and their moons; two spacecraft are on their way into inter-stellar space. We thought it would be fun to have a project to celebrate this anniversary so our second design project for the class was to design and construct a near-scale RC model of the Wright brothers Flyer with the following features: it will be electric powered, have a wingspan of no more than 10 feet, be easily transported and assembled, and have a flight control system with which a relatively inexperienced RC pilot can safely control the airplane.



Project 3: The Experimental Aircraft Association (EAA) is famous for its AirVenture Oshkosh air show, fly-in and aircraft exhibition where hundreds of thousands of aviation enthusiasts gather each summer. Amateur Built airplane kits are a popular part of the exhibition and have become a means by which thousands of people can afford to build/own/operate a small aircraft of their own creation. The third project option for the design class was to prepare the design of Amateur Built aircraft in one of the following categories: Personal Transportation Vehicle, Four-Place Cruiser, Racer or Aerobatic Airplane.

Project 4: Recent years have shown increased international interest in human exploration of space. The Chinese have announced plans to go to the moon. The early 1990ís interest in Mars is recurring. NASA has funded the Nuclear Systems Initiative ($1billion for 2 years) to develop/demonstrate nuclear power generation and propulsion – a necessary infrastructure for human missions. The spacecraft design option for the academic year was the conceptual design of a Solar System Cruiser: a vehicle to provide for extensive human exploration of the planets and their moons.

The Solar System Cruiser will be an international effort and will utilize technology and infrastructure expected to be available by approximately 2025.

The Design Class was formatted in the same way it has been presented for the past several years: complete a Conceptual Design Review (CDR) during Fall Semester and build/test models during Spring Semester.

The class had 57 students. Prior experience has shown that teams with approximately 12 students each works best in the design class environment.

The students selected their projects and were assigned to five teams for the above four projects, with the SAE Aero Design East competition having two independent teams.

Continued on next pg

SAE Team #1 at Dayton: Back row left to right: Prof.Vano, Micah Langseth, Dave Smith. Middle row left to right: Tom Langer, Jake Thrift, Phil Swenson. Front row left to right: Brian Naslund, Nick Schellpfeffer, Charles Knealing, and Neil Gorham

Two field trips were available to interested students this year: Cirrus Design in Duluth and Whipaire in South St. Paul. Both facility tours were excellent and showed the students some of the complex interactions involved between engineering, manufacturing and quality control in producing airplanes and aircraft floats. Special presenters were brought into the classroom to give the students a better real-world perspective and highlight the importance of professional ethics. Terry Johnson from Pemstar spoke about project management and ISO 9000. James Chiles, author of "Inviting Disaster: Lessons from the Edge of Technology", spoke to the class about some of the man-machine disasters detailed in his book.

Steve Cook, a former AEM student and Design Class Teaching Assistant, and now Deputy Director for Advanced Space Transportation Systems at NASA Marshall Space Flight Center came to the class during Fall Semester to talk to the students (especially the Spacecraft Solar System Cruiser Design Team) about future NASA programs. The Spacecraft team also viewed the IMAX movie "Space station" to give them a sense of the challenges of living in space for long periods of time. This inspired part of the team to do a special study on Crew Resources Management (CRM) during Spring Semester. Dick Jesse, the CRM instructor at Northwest Airlines NATCO facility talked to the class and worked with the students on this project.

The Amateur Built team selected to design an unlimited Reno racer airplane. Solid Works was used as the common CAD program to help the students physically integrate their designs. It was a very busy model building year with several wind tunnel models and four RC airplanes. Dave Hultman, Aero Shop manager, helped the students with their more complex CNC machining problems.

The AEM department's purchase of a Rapid Prototyping machine this academic year provided the students with a state-of-the-art facility to build many of the more complex parts of their wind tunnel and RC models. Greg Nelson, AEM Department Lab Coordinator, also brought his RC modeling experience on-line to help the students build professional class models.

The highlight of the year for the SAE Aero East heavy-lift competition teams was the trip to Dayton May 1-4. Professor Vano, Greg Nelson and Teaching Assistant Chris Regan took 18 students in two university vans to the three day event.

The competition was very fast-paced with lots of flying on one of the old (closed) Wright-Patterson AFB runways. Two social events also highlighted the competition: pizza at the Wright Brothers Bicycle Shop and a formal dinner amongst the airplanes at the Air Force Museum. This was the first time the design class entered a fly-off competition. Although we did not place, the experience was a very real motivator to our students and something they would like to see as part of the class every year.

Andrew Vano
Akerman Professor of Design

Students Venture Out to Participate in SAE Flying Competition

SAE Aerodesign East-Dayton, Ohio

This year about twenty students in the senior design class competed in SAE's Aero Design competition in Dayton, Ohio. The goal of the competition was to put classroom theory to practice by designing a radio-controlled, heavy-liftairplane. Competition rules specified the engine to be used as well as a maximum wingspan of six feet. Both teams spent the fall semester doing a conceptual design that included calculating performance specifications, performing stability and control calculations, airfoil selection, building wind tunnel and water channel models, and beginning a detailed design. Winter break saw us testing the models in the wind tunnel and water channel. Based on this analysis, we were able to refine our design to give us a better lift to drag ratio, which increased our payload lifting capability. With the design finished, we began constructing the model. Both models featured components not usually seen on radio-controlled models such as Fowler flaps, slats, custom made winglets, and construction materials such as titanium and carbon fiber. While the model was being constructed, we began working on our written report and detailed Solid Works plans, both of which would also be scored in the competition.

Nick Schellpfeffer, Neil Gorham, and Phil Swenson

With the model complete, we headed off for Dayton, where we unfortunately crashed the airplane during the qualifying round, damaging it beyond repair. While our flight performance was disappointing, both teams managed to make a respectable showing with our written and oral reports. We also learned valuable information about how the competition is conducted, which will be passed on to future teams from the University of Minnesota that wish to compete at this event. The biggest highlight of the trip other than the competition was being able to tour the U.S. Air Force Museum, which was located adjacent to where the competition was held. Here they have one copy of every airplane that the Air Force has ever flown from the Wright Brothers Military Flyer to the F-22 Raptor.
Also on display are several research airplanes including the X-15, YF-12, XB-70 Valkyrie, and X-29, as well as several modern military airplanes such as the Predator and Global Hawk UAV's, and the F-117.
This trip was a very valuable experience to all who were involved, and we'd like to thank all of those who made it possible.

On the return trip from SAE East in Dayton, a handful of us decided to modify our design slightly and enter it in the West Coast version of the competition. With the registration deadline being the same day that we returned from Dayton, the written report being due in California three days later, final projects due for our classes, and the competition (with a plane that we had to build from scratch) taking place in less than a month, we had a lot of work to get done. The actual construction of the plane was finished in eight days, the last two of which we worked straight through.

SAE Aerodesign West-Palmdale, CA

Team Phoenix on a typical day in Palmdale – sunny and 105 degrees. Left to right: Neil Gorman, Josh Sharpe-Stirewalt, Phil Swenson, and Tom Langer

Dayton paid off, with our team posting written and oral scores in the top 15 against a very competitive, international pack. Our flight performance also improved, with our team successfully qualifying. In the first round of the competition, however, we made a hard landing while carrying about twelve pounds of payload, which destroyed the fuselage, cracked the wing, and bent the axles.

Having driven all the way to California for the competition, we werenít going to give up without putting forth our best effort. So on a cool desert night under a full moon in the parking lot of the Antelope Valley Inn in Lancaster, California, we spent the night rebuilding our

Continued top of next page

airplane. The next day, we had the plane ready for the final round of the competition. With only one round remaining, we decided to ëgo for broke and lift a payload that would put us in contention for the overall title.

During this run, due to the damage that the wheels had received the day before, our plane was unable to lift off in the 200 foot takeoff zone, and we were out of the race. Although the ending was a heartbreaker, everybody who participated in this project had an absolutely wonderful time doing it, and hopefully our experience will be able to be used by next year's team.

Highlights of this trip centered on Lockheed Martin and included a banquet featuring Lockheed engineer Steve Justice, who gave a very inspirational technical presentation on the A-12 (the predecessor of the SR-71 Blackbird). Other noteworthy activities included touring Blackbird Park in Palmdale, which had several aircraft on display including an SR-71, A-12, D-21 (the Mach 4, ramjet powered drone that was initially launched off of an A-12), and an F-104.

The trip itself was also an adventure that took us through eight states in nine days.

We'd like to thank all of those who made both of these trips possible – the AEM department who provided the facilities as well as financial support. The shop guys - Dave Hultman, Steve Nunnally, and Greg Nelson, who gave not only their craftsmanship skills, but also their much needed advice and encouragement. Other students – Sordy Muor and Jeff Martin, who were not officially part of the team, but whose technical help and craftsmanship was much appreciated. And last, but certainly not least, Professor Andy Vano for his openness to new ideas, and his unwavering support for our project. ■

Reported by Neil Gorham
AEM Undergraduate Student

Student participation support came from funds from the AEM Program Support Fund and the Department of Aerospace Engineering and Mechanics.

News About Our Faculty - Honors, Awards, and Presentations

Professor Gary Balas received the Institute of Technology George Taylor Distinguished Research Award. He will be a Semi-Plenary Speaker at the 2003 European Control Conference being held in Cambridge, England in September. His talk is entitled "Flight Control Law Design: An Industry Perspective."Professor Balas was also selected as an Associate Fellow of the AIAA and a Senior Member of the IEEE in 2002.

Professor Graham Candler was also selected as an Associate Fellow of the AIAA in 2002.

Professor William Garrard received an award from the American Institute of Aeronautics and Astronautics Aerodynamics Decelerator Systems Technical Committee in recognition for his many years of organizing, coordinating, and conducting the H.G. Heinrich Parachute Systems Short Course and for the large number of parachute engineers it has produced, May 21, 2003.

Professor Roger Fosdick has given recent invited talks at the University of Illinois (March, 2003) and at the University of Parma and the University of Bari (Polytechic Institute) in Italy during June and July, 2003. The area of these presentations was "Self-interpenetration in Elasticity","Thermoelastic Behavior of Coexistent Phases" and "Critical Point Analysis in Elastic Solids". Additional invited 1-hour talks concerning joint work of Fosdick and Professor Gianni Royer of Parma, Italy were presented by Royer in Bari on July 4 and 5. These presentations were concerned with "Multiple Natural States for an Elastic Material with Polyconvex Energy" and "Lagrange Multipliers in Incompressible Multipolar Elasticity: A Penalty Interpretation".

Professor Ashley James received the 3M Nontenured Faculty Award which is designed to support new faculty. This award carries $15,000 in support for her research and is funded by the 3M Contributions Program.

Professor Richard James was appointed to the Board of Governors of the Institute for Mathematics and its Applications at the University of Minnesota. He spent the fall quarter at Cornell University where he held the Mary Upson Chair; as part of his duties he gave three institute wide lectures in the College of Engineering. He gave invited lectures at the "Summer School on Multiscale Problems in Nonlinear Analysis" at Carnegie Mellon University and at the conference on "Frontiers of Solid Mechanics", a meeting that served also to honor the memory of Prof. Dan Drucker, who had numerous connections to the AEM department; also, he lectured at the SPIE meeting in San Diego, the Conference on Nanomechanics (AHPCRC), General Motors Research and Seagate. With Professor Leo, he organized the US-EU conference on Phase Transformations in Crystalline Solids.

Professor Ellen Longmire was promoted to Full Professor with tenure. She was appointed Associate Editor of Experiments in Fluids and Multiphase Science and Technology. In November, Professor Longmire was elected to serve a three-year term on the Executive Committee of the American Physical Society Division of Fluid Dynamics. In March, she gave an invited lecture at Imperial College of Science and Technology, London.

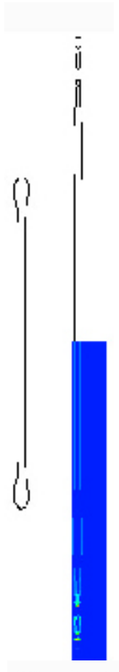
Professor Krishnan Mahesh was awarded the McKnight Land Grant Professorship in 2003 by the University of Minnesota.
He gave invited presentations at the Johns Hopkins University, Sandia National Laboratories, St. Anthony Falls Laboratory, University of Minnesota and at a symposium honoring Dr. Charles Speziale at the 4th ASME-JSME Fluids Engineering Conference.

Research Focus

Each year we will be reporting on some of the current research of our faculty members

Professor Ashley James: Fluid Dynamics

Professor Ashley James' fascination with interfacial fluid dynamics began when she performed the following experiment as a child. First, sprinkle pepper on the surface of a bowl of water. Then stick a bar of soap into the middle of the bowl. The pepper suddenly moves outward on the surface of the water to the edge of the bowl. Years later, Prof. James figured out that this happens because soap is a surfactant. Surfactants are substances that have a chemical preference to reside at the boundary between a liquid and a gas, such as water and air, or between two liquids that donít mix, such as oil and water. The soap dissolves in the water, but collects on the water surface because of its chemical preference. Surface tension forces make the layer of soap on the surface expand, pushing the pepper outward. This happens so rapidly that the pepper seems to move to the bowl edges instantly.

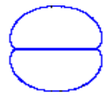


Shape of a drop during stretching with and without surfactant (Contours show concentration level).

The research of Professor James and her group is aimed at understanding such multi-fluid phenomena using numerical simulations. These simulations are challenging because the location of the deformable boundary between the fluids must be tracked, in addition to solving the equations of fluid motion. The evolution of the flow field and the boundary are coupled because of surface tension. Surfactant poses additional challenges because its motion must also be tracked and its presence alters the surface tension.

One application in which the motion of surfactant-laden drops is important is petroleum production. Oil occurs naturally in the form of drops suspended in water in porous rock. Surfactant injected into oil wells can keep the oil drops from sticking in small constrictions by lowering the surface tension. Additionally, a drop may break up as it moves through a constriction. Simulations of the motion of a surfactant-laden drop through a constriction are being performed (with S. Williams) to determine the conditions under which sticking and break up occur. Surfactant accumulates at the ends of the drop, lowering the surface tension and allowing the ends of the drop to become pointed. Thus, the secondary drops that break off from the ends are extremely small, which can be desirable.

The merging of two drops is important in a wide array of applications ranging from raindrop formation to the separation of suspensions. When two drops are propelled together it isn't known definitively whether they'll merge or bounce apart. As the drops approach each other they flatten so that a thin layer of gas separates them. Current efforts (with J. Jiang) are focused on understanding the balance of forces that try to either push the gas film out, leading to coalescence, or maintain the gas film between the drops, leading to bouncing.



Two drops at the instant they merge.

Professor Demoz Gebre-Egziabher: Global Positioning Systems

Dr. Demoz Gebre-Egziabher joined the AEM faculty in October 2002. Prior to joining the faculty at the University of Minnesota, from 1990-1996 he served as a systems engineer in the US Navy's nuclear propulsion program. In this capacity, he worked at the Naval Seas Systems Command Division of Naval Reactor in Washington, D. C. where he supported projects such as the refueling of the reactor plants on aircraft carriers and the decommissioning and disposal of nuclear powered cruisers and destroyers. He subsequently joined the Global Positioning System (GPS) laboratory at Stanford University where he worked on research aimed at developing inexpensive multi-sensor navigation and guidance systems. He was also involved with developing high performance GPS based precision landing systems.

At the University of Minnesota, Dr.Gebre-Egziabher has continued to work on GPS based precision landing systems. Currently, he and his graduate students are working to develop navigation and fault detection algorithms for the US Navy's Shipboard-Relative GPS (SRGPS) system. SRGPS is being developed to provide high accuracy and high integrity navigation for automatic shipboard landings. The required navigation system vertical accuracy is currently envisioned to be approximately 30 cm with an associated probability of undetected system faults on the order of 1 in 10,000,000 (or 10-7). Providing high quality navigation performance like this requires developing high fidelity models for system and sensor errors. It also requires developing novel algorithms for fusing the information from multiple system and sensors in real time. One such sensor fusion algorithm called Carrier Loop Doppler Aiding is being investigated by one of his graduate students (A. Razavi). The results of this work are expected to make GPS more robust to faults. A similar project that he working on is sponsored by the US Army/ARINC and is aimed at developing land based variant of SRGPS. This system, known as Local Differential GPS (LDGPS), has similar performance requirements and is expected to rely on multi-sensor systems to achieve its design goals. One graduate student working on this project (Y. Shao) is exploring multi-sensor fault detection algorithms in support of LDGPS.

Other projects Professor Gebre-Egziabher and his students are working on are related to exploring issues associated with designing inexpensive multi-sensor navigation, guidance and control systems. For example, one of the research projects currently in progress involves designing compact and accurate navigation systems for

Continued top of next page

use on Uninhabited Aerial Vehicles (UAVs). This work has been performed in conjunction with Professor Balas' research group and has led to the construction of a prototype for a miniaturized light-weight navigation system.

Professor Richard James & Others: Nanotechnology

Professors Chris Palmstrom (Chemical Engineering), Mitch Luskin (Mathematics) and Richard James (Aerospace Engineering & Mechanics) received a NIRT grant from the National Science Foundation in the area nanotechnology for their project on Nanoscale shape memory actuators and swimming bugs - theory, computing, and MBE synthesis.

The investigators will undertake a program of research on the development of shape memory and emerging ferromagnetic shape memory materials for the production of motion at small scales. These materials spontaneously undergo a martensitic (diffusionless, structural) phase transformation with a change of shape. In the ferromagnetic shape memory materials, the shape change can be triggered by a remotely applied magnetic field. Because of their exceptionally high work output per unit volume,
and the unusually large shape changes that are predicted to be possible in single crystal thin films, these materials are good candidates for nanoscale motors. The investigators will develop theoretical models and computational predictions for nanoscale motors that move, place, orient, actuate, and propel.

A program of molecular beam epitaxial growth of NiTi films will be initiated, and the predicted designs will be put into practice on single crystal thin films of NiTi and Ni_2MnGa. The research includes a fundamental theoretical/computational/experimental study of the behavior of phase transformation and the shape memory effect at small scales, resting on the study of the martensitic phase transformation in a sequence of specimens of smaller and smaller size. Emerging multiscale mathematical methods, expanded to atomic scale, will play a key role in guiding nanoactuator design.

The production of well-defined movements of objects at the nanoscale is a critical component of the emerging field of nanotechnology. This underlies the development of nano-robots, plays a crucial role in optical devices and the placement and orientation of sensors, and is an enabling component of devices that foster the interaction between the physical world and the fundamental processes of biology. The production of well-defined motions and forces at small scales is particularly hampered by the dominance of interfacial and viscous forces at these scales, and the destabilizing effects of random Brownian motions. The shape memory materials proposed by the investigators for use at these scales promise to overcome these impediments to well-defined small scale motion. As a underlying technology for several emerging fields, the research directly supports US strategic goals in materials science, nanotechnology and national security.

A Means of Connection: Preparing the Youth of Today with Science and Engineering

Reach for the Sky is a three-year outreach math and science program funded by the Toyota USA Foundation, the Institute of Technology (IT) at the University of Minnesota, NASA and 4-H. For three days each month, three IT students, and a math student, travel to the White Earth Reservation to teach hands-on physics and engineering projects to Reservation high school youth at the Circle of Life School. Two staff members from 4-H also take part. The school is an alternative school where many students are considered to be at risk because of poverty. All receive a free school lunch. In 2002, the program included aerospace activities. This year human powered vehicles were built, and the 2003-04 school year small engines will be introduced. The goals of Reach for the Sky are to:

1. Improve test scores in math and science, school attendance and graduation
2. Make science culturally relevant,
3. Disseminate the model to other Ojibwe reservations.

During the school year, Circle of Life students made traditional human powered vehicles (Ojibwe snow shoes, moccasins, and a birch bark canoe), and they learned to fix and build modern vehicles such as bicycles, and tricycles that were raced.

White Earth elders taught the cultural aspects of science. Faculty from IT involved in Reach for the Sky include Professor Len Kuhi, Department of Astronomy, who was the principal investigator for a year of aerospace programming. Professor Ashley James, Department of Aerospace Engineering and Mechanics, developed the technical curriculum. Dave Hultman, Managing Research Engineer, Department of Aerospace Engineering and Mechanics, taught University student teachers and Circle of Life youth how to use shop tools.

He also created prototypes for three-wheeled bikes, soap box cars, and water bikes. This year he will oversee the development of a work shop at the school. Professor William Garrard headed the science advisory board. A long term goal of the project is to provide youth with the skills to enter a technical work force, and to bring industry to the Reservation where people want to live and work. Program results for this year have been positive. Student scores on The Department of Defense Education Activity Terra Nova 2002 test improved during the school year by 20% in math, and 14% in science. The Circle of Life School principal also reported that average daily attendance improved from 80% in the 2001-2002 school year to 87% in 2002-2003. Attendance was also up for

Continued on pg 19

Research Projects of AEM Professors for 2002-2003

Air Force Office of Scientific Research

Computational Tools for the Atomic/Continuum Interface: Nanometer to Millimeter Scale Aircraft
Richard James, Graham Candler, Mitchell Luskin (Math), & Chris Palmstrom (CEMS)

Continuum and Particle Computations of Hypersonic Shock Interaction Flows
Graham Candler

Large-eddy Simulation of Turbulent Hydrosonic Flows
Graham Candler

Localized Flow Control in High Speed Flows Using Laser Energy Deposition
Rutgers University(AFOSR Prime)
Graham Candler

An Integrated, Multi-Layer Approach to Software-Enabled Control: Mission Planning to Vehicle Control
Gary Balas & Yiyuan Zhao

Scaled Up Nonequilibrium Air Plasmas
Stanford University (AFOSR Prime)
Graham Candler

Army High Performance Computing Research Center

High Performance Computation of Compressible Flows,Turbulent Flows
Graham Candler

Army Research Office

Advanced Methods for Interceptor Flow Simulations
Graham Candler

Enhanced Reentry Vehicle Performance Through Power Extraction and Plasma Control Enabled by Multifunctional Materials and Structures
Princeton University (Army Prime)
Graham Candler

Integrity Monitoring and Fault Detection Methodologies for Local Differential GPS
(with Army, ARINC/Stanford University)
Demoz Gebre-Egziabher

Department of Energy

Large-eddy Simulation of Gas-turbine Combustors
Krishnan Mahesh

Multiphase Pipeling
Daniel Joseph

Nonequilibrium and Structural Effects on Models of Interfacial Motion in Multi-component Alloys
Perry Leo

Topological Transitions in Liquid/Liquid Flows
John Lowengrub(Math) & Ellen Longmire

Honeywell

Coordination and Control of Multiple Autonomous Vehicles
Gary Balas

National Aeronautics and Space Administration (NASA)

Application of Linear Parameter-Varying Techniques to Safety Critical Aircraft Flight Systems: Phase II
Gary Balas

Advanced Models for High Enthalpy Flow Simulations
Graham Candler

Development of Aeroshell Technologies for Aerocapture Missions to the Outer Planets
Graham Candler

Comprehensive Computer Simulation of Air Traffic Systems
Yiyuan Zhao

The Minnesota Space Grant College Consortium (Headquarters)
William Garrard

Real-time Motion Path Planning for Autonomous Rotocraft
Yiyuan Zhao

National Science Foundation

A Novel Approach for Large Eddy Simulation on Unstructured Grids Applied to Turbulent Jets in Cross-Flow
Krishnan Mahesh

A Physical Modeling Approach to Wall Turbulence and Enhancing the Educational Experience through the Beauty of Fluid Motion
Ivan Marusic

Comparative Theoretical and Experimental Studies of Breakup, Outgassing and Stress Induce Polymerically Thickened Liquid
Daniel Joseph and Gordon Beavers

Dynamic Feature Extraction and Data Mining for the Analysis of Turbulent Flows
Ivan Marusic, Ellen Longmire, Graham Candler, Victoria Interrante(CS&E), George Karypis(CS&E), Sean Garrick (ME), Vipin Kumar(CS&E)

Dynamic Performance of MEMS in Liquid Environments
Ellen Longmire & Sue Mantell (ME)

Continued top of next page

Fundamental Fracture Mechanisms in Ductile Single Crystals
Thomas Shield

GOALI: Direct Numerical Simulation of Slurry Transport Focusing on Engineering Correlations
Daniel Joseph

KDI: Direct Numerical Simulation and Modeling of Solid-Liquid Flows
Daniel Joseph

Mathematical Theory and Numerical Methods for Microscale Biomedical Devices
Richard James & Mitchell Luskin (Math)

Mathematical Models of Materials with Multi-Stability at the Micro-Level
Roger Fosdick

Numerical Methods for Very Large, Sparse Dynamical Systems
Daniel Boley (CS&E) & Gary Balas

Studies of Viscous & Viscoelastic Potential Flows
Daniel Joseph

Office of Naval Research

Hybrid INS/GPS Integrity Monitoring Concepts for Shipboard Relative GPS
(with ONR/Stanford University)
Demoz Gebre-Egziabher

Large-Eddy Simulation of Propeller Crashback
Krishnan Mahesh

Multiferroic Materials in Smart Structures and Device (University of Maryland (ONR Prime))
Richard James & Thomas Shield

The David and Lucile Packard Foundation

Packard Fellowship
Ivan Marusic

Industry Research Gifts & Other Industry Awards

3M Nontenured Faculty Award designed to support new faculty members by the 3M Contributions Program in the amount of $15,000. A.James

Honeywell Technology Center Research Gift. A gift in the amount of $30,000 to support Aerospace Systems faculty research activities and sponsor a joint University of Minnesota – Honeywell guidance, navigation, and control seminar series. Gary Balas, Demoz Gebre-Egziabher, and Yiyuan Zhao ■

New Departmental Postdocs and Other Academicians

Giuseppe Fadda was hired as a research associate by Professor Richard James to work with him on a research project on multiscale methods applied to martensitic phase transformations. Dr. Fadda will also analysis data and supervise a graduate research assistant along with participating in the preparation and presentation of results to collaborators and grant technical monitors. Dr. Fadda received a graduate degree in Civil engineering from the Ecole Suerieure des Travaux Publics in Paris, France (1990) and, a Ph.D. in Mechanics from the University of Paris, France (1997).

Francesco Borrelli was hired as a postdoctoral associate by Professor Gary Balas to work on his research project on the development of on-line receding horizon control, trajectory generation and sensor fusion algorithms for autonomous aerospace vehicles. Dr. Borrelli has a Masters in Computer Engineering from the University of Napoli (1998) and a Ph.D. from the Automatic Control Laboratory at the Swiss Institute of Technology (2002).

Nicholas Hutchins was hired as a research fellow by Professor Ivan Marusic to work on his research project concerning turbulent shear flows using hot-wire anemometry and particle image velocimetry. He will interact and help train graduate students, participate in preparation and presentation of data and collaborating in other areas related to the project. Mr. Hutchins has a MS in aeronautical engineering from the University of Manchester (1994) and is presently working to complete his Ph.D. from the University of Nottingham.

Heath Johnson was hired as a postdoctoral associate by Professor Graham Cander to work on his research project on the development of numerical methods to predict transition to turbulence in hypersonic flows. Dr. Johnson received a B.A.E.M. (1994), a M.S. (1998) and a Ph. D. (2000) all from the University of Minnesota. His specialties are in computational fluid dynamics for high-enthalpy reacting flows; the development and application of linear and parabolized stability codes for the analysis of hypersonic boundary layers; the development and interactive Perl/CGI programs for command-line driven or web-based applications and, the development of Perl/Tk program interfaces and applications.

Hector Rotstein was hired as a research associate by Professor Balas to work on his research project on the development of on-line receding horizon control, trajectory generation, fault detection and isolation and sensor fusion algorithms for autonomous aerospace vehicles. He will also assist with writing papers and proposals and give technical presentations related to this work. Dr. Rotstein's has a M.Sc. in electrical engineering (1990) and a Ph.D. in electrical engineering (1993), both from the California Institute of Technology. Dr. Rotstein has published extensively in his field and has also taught graduate and undergraduate courses in robust and optimal control, design of multivariable control systems, advanced control techniques and vision and control. ■

Alumni News

Many IT Alumni in the Houston and surrounding areas turned out for the Burgers and Baseball event hosted by H. Ted Davis at the Astros Stadium, May 3, 2003. Among the over 100 alumni in attendance were Aerospace Engineering and Mechanics alumni Michele Brekke ('75, '77), Chuck Campbell ('90), Tim Hall ('95, '99), Pete Halvorson ('89), David Khemakhem ('91, '93), Stephen Rossenbaum ('00), and Walter Wang ('97).

Pictured here in front at the Astros stadium enjoying the games is David Khemakhem who served as host for the event for the department.

Lee Coggins ('89) is pictured here inside the flight simulator at NASA. Lee currently works for United States

AIAA

Student Group Activities

The AIAA student group hosted a fall and spring barbeque for faculty, students and staff. Both events had a great turnout.

Region V Student Conference

The Department of Aerospace Engineering and Mechanics will be hosting the AIAA Region V Student Conference in April 2004. Conference activities as they are planned will be posted to this web site: http://www.aem.umn.edu/AIAA/student_conference/AIAA_student_conf.shtml Volunteers are needed to assist with activities if you are interested send an e-mail to Dave Myren dmyren@aerosysengr.com or Yohannes Ketema ketema@aem.umn.edu

AIAA Officers 2002-2003
President – Neil Gorham
Vice President – Mike Holtz
Treasurer – Phillip Boigenzhan
Secretary – Maria Bigwood & Kim Lay
Faculty Advisor – William Garrard

Alumni Dollars at Work

AEM Program Support Fund provided matching travel funds with the IT Students Affairs Office for two aerospace engineering undergraduate students to participate in Global Seminars in the study abroad program during the May Term, 2003. Zachary Kahly went to Italy for a global seminar on modern physics and Andrew Nguyen to United Kingdom for a global seminar on the history of technology. This fund also provided support for some model expenses for the senior design course. In addition, it covered expenses for two student teams to participate in the SAE competitions.

The microgravity student groups were supported from funds from the Richard & Shirley De Leo Scholarship and Engineering Program, AEM Program Support Funds, the Undergraduate Research Opportunities and the Department of Aerospace Engineering and Mechanics.

Tim Jackson, AEM Graduate Student received a stipend from the Alumni Program Support Fund for Spring Semester 2003. Tim has been one of students who has been a recipient of the Astronaut Scholarship from the Astronaut Scholarship Foundation, created by the Mercury 7 Astronauts. He completed his MS degree in Aerospace Engineering, May 2003 on, Performance of Thermally Actuated MEMS Shuttle Plates in Liquids.

Solar Vehicle Project

The Department of Aerospace Engineering and Mechanics was one of many financial sponsors for the Solar Vehicle Project for the 2002-2003 academic year. The 2003 vehicle, Borealis II, was built upon the potential shown in Borealis by refining its shape, component layout and construction methods, and further developing the solar array, the custom motor and electronic systems. Students entered the vehicle in the American Solar Challenge race that ran on "Route 66" in July 2003 and came in second place. More information can be found on their web site at: http://160.94.213.33/

Student Committees

Undergraduate Student Advisory Board Member 2002-2003: Mark Arend (Chair), Nicholas Schellpfeffer, Jason Graham, Muhammad Malik, Daniel Lehman, Kristen Gerzina, Steve Harkman, Vladimyr Gidzak. John Wildey, Nathan Koelln, Neil Gorham, Jacob Thrift, Thomas Langer, Ryan Nordell.

Donations: You Can Make A Difference

Donations can be made anytime during the year and sent to the University of Minnesota Foundation, McNamara Alumni Center, University of Minnesota Gateway Center, 200 Oak Street SE, Suite 500, Minneapolis, MN 55455. Just designate the fund you wish to support. Checks should be made payable to the University of Minnesota. You can also donate on-line — see this web site: http://www.giving.umn.edu/. If you have questions on donating, you can contact the University Foundation at: 612-624-3333 or 800-775-2187 fax: 612-625-4305. There are many ways to give to the Department of Aerospace Engineering and Mechanics at the University of Minnesota to help create excellence in addition to contributing to your own personal and financial goals. More information on types of gifts (Outright Gifts, Planned Gifts, or Corporate & Foundation Gifts) can be found at the Foundation web site listed above.

The funds to which you can contribute are as follows:

AEM Program Support: Used as the main source of discretionary funds to support all funds. Fund No. 3739

Aeronautical Class of 1943 Wind Tunnel Fund: Created by the Class of 1943 to defray costs of a new wind tunnel and instrumentation Fund No. 3585

The Chester Gaskell Aeronautical Engineering Scholarship Fund: Used for undergraduate scholarships for outstanding first-year aerospace students. Fund No. 2898

The John D. Akerman Memorial Fund:
Supports the Akerman Professor of Design of our year-long capstone senior design course. Fund No. 3191

The AEM Laboratory Equipment Fund:
Used to purchase instructional and research equipment. Fund No. 2500

The AEM Excellence Fund: Used to sponsor lectureships by distinguished individuals in aerospace engineering and mechanics. Please note that this fund also supports the Sethna Lecture. Fund No. 2281

The B.J. Lazan Fund: Supports activities that promote faculty/student interactions and educational activities.

John A. & Jane Dunning Copper Fellowship in Aerospace Engineering & Mechanics:
Provides fellowships for AEM graduate students. Fund no. 5330

Lawrence E. Goodman Scholarship in Theoretical & Applied Mechanics: Provides a prize to a graduating student with a baccalaureate degree from AEM who is deemed by the faculty to have achieved the best record in the field of theoretical and applied mechanics. Fund No. 5594.

Richard & Shirley De Leo Scholarship & Engineering Fund: Provides undergraduate scholarships to Aerospace Engineering students and provides discretionary funds to the Department of Aerospace Eng. & Mechanics. Fund no. 5470.

Robert H. & Marjorie F. Jewett Fund:
Provides supports program support to the Department of Aerospace Engineering and Mechanics. Fund No. 4810.

If you would like information about establishing a Unitrust with the University of Minnesota Foundation, contact the Institute of Technology Development Officer for Aerospace Engineering and Mechanics, David Hoffman, at 612-625-6035 or e-mail at: dhoffman@mail.itdean.umn.edu
You can also find out about giving options and make pledges online at the following University of Minnesota Foundation web site: http://www.giving.umn.edu/

White Earth Continued from pg 15

Reach for the Sky days. This is the first year that most high school graduates have plans to continue their education beyond high school.

Two major factors are contributing to the success of Reach for the Sky:

- Formal evaluations show that the involvement of University faculty and students has helped
- The University students are also positive role models who have shown youth that there is a world outside the Reservation.

MnSGC Continued from pg 9

Cities and surrounding area. Science CentrUM maintains a website informing teachers of workshops, programs, in internships, opportunities and special events at the University of Minnesota, with links to departments and programs sponsored by Science CentrUM Consortium Partners and district affiliates. Current programs include GLOBE; ESSEA; PKAL; Science Works!; COSTS; GENiE; REX, and additional related programs. Partners include the MnSGC, Earth Systems Science Education Alliance, the JASON Project, NASA/NOVA, GLOBE, and Minneapolis Public Schools' Math/Science Matters. See http://www.science.umn.edu for more information and to get involved.

Degrees Awarded 2002-2003

Bachelor of Aerospace Engineering and Mechanics

Summer Semester 2002
Jeremy D. Hill

Fall Semester 2002
Michael A. Becker
Andrew D. Henslin
Travis J. Ottenbacher
Shirin F. Salber with Distinction
Spring Semester 2003
Jayson R. Brouchoud, Summa Cum Laude
Jason O. Bryan
Aron J. Cooper, Summa Cum Laude
Rachel M. Davis
Matthew Gmach
Lynn Gravatt
Richard Johnson, Cum Laude
Nathan T. Koelln with Distinction
Micah W. Langseth
Kimberly A. Lay
Daniel A. Lehman
Peter G. Loegering
Peter H. Lommel, Summa Cum Laude
Craig M. Mueller
Brian B. Naslund, Summa Cum Laude
Beth E. Nollenberger with Distinction
Jason R. Platz
Andrew C. Poppe
Joshua D. Rubin
Makoto Sato
Nicholas G. Schellpfeffer
Michaels S. Schirmers
Matthew J. Stegmeir
Jaime M. Strandmark
Philip H. Swenson

Graduate Degrees

Master of Science

MS (Mechanics)
Shuwang Li
James A. Speck
Hong Yang
Yubao Zhen

MS (Aerospace Engineering)
Heather A. Banbury
Rayven J. Chinniah
Dorothea C. Czernik
Timothy R. Jackson
Travis J. Schauer
Feng Zou

Doctor of Philosophy

PhD(Aerospace Engineering)
Raktim Bhattacharya
Joachim K. Hochwarth
Stamatios Pothos

PhD(Mechanics)
Ron C.Anafi
Jun Cui
Olga M. Kresse
Igor Novak

Student Awards

2002-2003 John A. & Jane Dunning Copper Fellowships
Tian Wan
Xiaofeng Yang

2002-2003 Rose Minkin Aerospace Engineering
David T. Sellnow
Matthew J. Thomasson

2002-2003 Richard and Shirley De Leo Scholarship and Engineering Award
Mark R. Arend
Ryan P. Gahagan
Kristen L. Gerzina

2002-2003 Chester Gaskell Aeronautical Engineering Scholarship
Jonathan A. Boardman
Stephanie L. Soffa

2003-2004 Doctoral Dissertation Fellowship
Bharathram Ganapathi Subramani

2002-2003
University of Minnesota
Minnesota Space Grant Consortium
Undergraduate Students Scholarships
Brian Naslund, AEM
Eve Skoog, AEM
Kristopher Carver, AEM
Richard Johnson, AEM
Maria Bigwood, AEM

Graduate Student Fellowships
Rachelle Ennis. AEM
Christopher Regar, AEM
Matthew Arboe, Physics
Heather Banbury, AEM
Gaio Lakin, AEM
Sean Oneill, Astronomy
Jon Vermedahl, Astronomy
Scott Williams, AEM
Jay Kucera, AEM

MnSGC continued from pg 8

Student Honors

Cecilia Ortiz-Duenas, who received her undergraduate and masters degree from the Department, has been awarded a studentship (a fully-funded research position) to pursue a Ph.D. degree in the Whittle Laboratory of the EngineeringDepartment at Cambridge University, starting this October. She will be working with Professor Howard Hodson, Professor of Aerothermal Technology, who is well known for his work in transition, fluid dynamics, and heat transfer in turbomachery.

Hong "Iris" Yang who is one of our graduate students was awarded the Amelia Earhart
Fellowship for the academic year of 2003-2004 by the Zonta International Foundation. The award is granted annually to women who are pursuing a graduate degree in aerospace-related sciences and aerospace-related engineering. This award was established 63 years ago to honor Amelia Earhart, who was a member of Zonta International. More information on this award can be found at: http://www.Zonta.org/Our_Programs/Amelia_Earhart_Program/amelia_earhart_program.html

Ahmad Zulfaa Mohamed-Kassim received a supplemental grant from the University of Minnesota Graduate School for his participation in the 4th ASME/JSME Joint Fluids Engineering Conference in Honolulu, Hawaii, July 6-10, 2003.

2002-2003 AEM Personnel

Regular Faculty

Professors
Gary Balas, Director of Graduate Studies
Gordon S. Beavers, Director of Undergraduate Studies, IT Distinguished Professor
Graham V. Candler
Roger L. Fosdick
William L. Garrard, Department Head
Richard D. James, Russell J. Penrose Professor, Distinguished McKnight University Professor
Daniel D. Joseph, Regents Professor
Perry H. Leo, Associate Head
Associate Professors
Ellen K. Longmire
Ivan Marusic
Lev Truskinovsky
Thomas W. Shield
Yiyuan Zhao
Assistant Professors
Demoz Gebre Egziabher
Ashley James
Krishnan Mahesh
Akerman Professor of Design
Andrew Vano
Adjunct Associate Professor
Dale F. Enns

Other Faculty & Staff

Professor Emeritus
J.L. Ericksen
Philip G. Hodge, Jr.
C.C. Hsiao
Thomas S. Lundgren
Robert Plunkett
William H. Warner
Theodore A. Wilson
Associate Professor Emeritus
Eugene Stolarik

Contract Faculty
Yohannes Ketema
Part-time Contract Faculty
Jeff Hammer
Nilabh Naryan
Satish Ramadhyani

Part-time Instructor
Todd Hesla

Research Staff

Postdoctoral Associates
Runyuan Bai
Heath Johnson
Krishnendu Sinha

Research Associates
Maria Bicero
Jozsef Bokor
MichaelWright

Technical Staff
Dave Hultman, Managing Research Engineer
Ray Muno, Information Technology Professional
Steve Nunnally, Principal Lab Machinist
Greg Nelson, Lab Coordinator & Department Safety Officer

Administrative Staff

Kristal Belisle, Principal Secretary
Dan Hegland, Principal Accountant
Emily Peterson, Office Specialist
Ruth Robinson, Senior Office Supervisor
Donna Rosenthal, Senior Administrative Director
Lisa Schouviller, Principal Accounts Specialist
David Vogel, Jr. Applications Programmer

Minnesota Space Grant Consortium
William L. Garrard, Director
Randi Lundell, Associate Program Director

Aerospace Engineering
and Mechanics,
Institute of Technology,
University of Minnesota
107 Akerman Hall,
110 Union St SE
Minneapolis, MN 55455

Tel: 612-625-8000
Fax: 612-626-1558
dept@aem.umn.edu

Address Service Requested

Nonprofit Org.
US Postage
PAID
Minneapolis, MN
Permit No. 155

2002-2003 The AEM Update

This publication is available in alternative formats upon request. Please call or write to Donna Rosenthal in the Department of Aerospace Engineering and Mechanics, University of Minnesota, 107 Akerman Hall, 110 Union Street S.E., Minneapolis, MN 55455, (612) 625-3348, donna@aem.umn.edu.

The University of Minnesota is an equal opportunity educator and employer.