



# AEM Update



Department of Aerospace Engineering and Mechanics 2005-2006

## Chairman's Corner

*Colleagues and Friends of the Department,*

It is an honor and a privilege to serve as the new Aerospace Engineering and Mechanics Department Head. My predecessors have built an excellent department that truly values both teaching and scholarship.

In taking stock of our Department, I am excited to work with an outstanding faculty, staff, and student body. The University of Minnesota is involved in a strategic planning process which aims to place the University among the top three public research universities in the world. Being recognized as one of the top-ranked Aerospace Engineering and Mechanics department in the world is part of this vision. My goals over the next five years are to:

- Continue to hire and support the best and brightest faculty members who have a passion for research, teaching, service and a strong desire for the department to be outstanding.
- Improve the undergraduate and graduate educational experience.
- Establish closer ties to our alumni.
- Increase the visibility of the department within the Institute of Technology, University, locally, nationally, and internationally.
- Significantly increase the amount of fellowships and scholarships offered to undergrad-



uate and graduate students, as well as increase endowments for professorships.

I look forward to working with you to build on the success of my predecessor, Professor Bill Garrard, toward being a top aerospace engineering and mechanics department nationwide and abroad. I want to take this opportunity to thank and acknowledge Bill for the many contributions and dedicated years of service in this role.

In coming months and years, the AEM department will focus on actively engaging alumni, a goal set by the AEM advisory board. You can help us accomplish this goal by helping us update our Alumni Network database, available at [http://www.aem.umn.edu/alumni/alumni\\_network.shtml](http://www.aem.umn.edu/alumni/alumni_network.shtml). Please take a few moments and visit the site. As an alumnus, if you have any suggestions on how we can keep you better informed about the events in the department, please let us know at [dept@aem.umn.edu](mailto:dept@aem.umn.edu).

Students continue to do exciting things in the field of aerospace engineering and mechanics. Students of the Solar Vehicle Project ([www.svp.umn.edu](http://www.svp.umn.edu)) finished fourth in the World Solar Rally. In spring of 2007, the Minnesat project will see its fruition – final selection of winning designs will occur. Twenty students from vari-

*More from Department Head Gary Balas on Page 5*

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**AEM is offering new content on our website aimed at keeping our constituents updated on the latest in aerospace and departmental news, but we need your help. Send in news, tips, or even just photographs of recent events and look for them on our site!**

## Academics: Where are we now?

### *AEM Undergraduate Program*

There seems to be a general increase in student interest in aerospace programs across the country. Of the 830 high school students admitted to the Institute of Technology in the fall of 2006 (transfers from other schools are another 273), 60 indicated they intended to major in AEM compared to 120 for ME, which is the most popular choice in IT (undecided is second at 102). We have seen a steady increase in our junior class size from about 50 six years ago to almost 80 for the current semester. Because of this, we have recently raised the BAEM upper division entrance GPA to 2.3 from 2.0 (out of 4) to control the number of students in our program. University policy dictates that this requirement can only be used to control numbers and not quality of the students entering our program, but our increased popularity does mean we can be (and have to be due to limited resources) more selective in the students we accept.

Next fall a group of reviewers from ABET will visit and review our program and the other engineering programs in the Institute of Technology. This spring we will be writing our report to ABET on the past 6 years of changes to and evaluation of the BAEM program. I would like to thank all of you that have completed the numerous surveys about your educational experience. This information is a key part of the evaluation process for our program and without it we would not be able to maintain our accreditation, something we have held continuously since it began for aeronautical programs in 1938. It is also a great help that Professor Garrard

has just finished his term as the ABET Commissioner for AIAA. Commissioners lead the evaluation team for an entire school. Professor Leo has also been doing ABET evaluations of other aerospace programs. Thus we have first-hand knowledge of the process and what is required for a successful review.

Student projects continue to be an important and popular part of our program. The Solar Vehicle Project ([www.svp.umn.edu](http://www.svp.umn.edu)) is now managed out of

the AEM Department and Jeff Hammer, our Industrial Professor, is the team advisor. They just returned from racing their car through the busy streets of Taiwan to 4<sup>th</sup> place as part of the World Solar Rally. This year we have one team involved in NASA's microgravity program and they just submitted their proposal to fly their experiment on the C-9 "Vomit Comet" next spring. They have proposed to study cavitation around a propeller when the cavities formed are not buoyant.

The students involved in the Nanosat-4 project ([www.aem.umn.edu/proj-prog/nanosat/](http://www.aem.umn.edu/proj-prog/nanosat/)) have successfully completed their critical design review and now are working hard to get their satellite built by the June 2007 deadline. They will then compete with ten other schools for the chance to have their design, which will attempt to use GPS for attitude determination, launched into space.

*Tom Shield*  
*Director of Undergraduate Studies*

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# INSTITUTE OF TECHNOLOGY

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## CSDy Graduate program update

The CSDy Interdepartmental Ph.D. Program provides an opportunity for interdisciplinary research in control science and dynamical system theory. The 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 Balas (AEM) and Prof. Tryphon Georgiou (ECE), and Prof. Balas serves as CSDy's Director of Graduate Studies. There were 8 students pursuing their Ph.D.s during the 2005-2006 academic year, with one student graduating.

The Program featured several seminars this year which included: *Suboptimal model order reduction via classical*

*relaxations of quadratic programming* by Professor Alexandre Megretski, MIT; *The error variance of the optimal linear smoother is the harmonic mean of the power spectral density* by Professor Tryphon Georgiou, University of MN; *Approximation of large-scale dynamical systems* by Professor Thanos Antoulas, Rice University; *The interaction between communication and control* by Professor Sekhar Tatikonda, Electrical Engineering, Yale University; *A semidefinite programming approach for control of systems along trajectories* by Dr. Mazen Farhood, Mechanical and Industrial Engineering, University of Illinois at Urbana-Champaign.

Gary Balas  
Director of Graduate Studies  
CSDy Program

## AEM Graduate program update

The AEM graduate program had another successful year. At the start of summer 2006, there were 72 graduate students in the department, 43 working towards their Ph.D. and 29 for M.S. degrees. Several of our students received special awards. Two of our graduate students, Xiaofeng Yang and Yucheng Hou, were honored with Graduate School Doctoral Dissertation Fellowships for 2006-2007. These awards provide full financial aid for one year. A former Ph.D. student, Jing Wang (Ph.D. 2005), received the prestigious "Best Dissertation Award" for Physical Sciences and Engineering. His thesis was titled "Topics in Multiphase Flow". Dr. Wang received a \$1,000 cash prize and a special certificate at a Graduate School lunch ceremony in June.

During the nine-month 2005-2006 academic year, 15 students received graduate degrees in AEM. We congratulate all of them, as listed in the awards and degrees section of this newsletter. One of these graduates received a Ph.D., while 13 received M.S. degrees and one received a Masters of Aerospace Engineering Degree. Of the M.S. graduates, 7 continued on in the Ph.D. program.

Graduate school applications for the AEM programs for the 2005-2006 academic year remained at approximately the same level as in 2004-2005. A total of 105 applications were received. Of the reviewed applicants, 52 were admitted.

Financial aid was offered to 27 of the admitted students in the form of teaching and research assistantships, with 10 of those applicants coming from the US, 10 from India, 4 from China, and one each from Canada, Korea, and Vietnam. Twelve of these offers were accepted and those students were enrolled in our graduate program in Fall 2005. Ten additional students enrolled in Fall 2005 with no financial aid from the department.

Ivan Marusic  
Director of Graduate Studies

## 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 below:

Number of Surveys: 41

The percentage of students who checked either a 4 or 5 “strongly agree” and is shown in parentheses.

### Preparation

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

- apply knowledge of math, science and engineering fundamentals (90.2 percent)
- design and conduct experiments and to analyze and interpret data (83 percent)
- design a system, component or process to meet desired needs (80.5 percent)
- identify, formulate and solve engineering problems (87.8 percent)
- have the fundamentals for continued learning throughout life (80.5 percent)
- with a good understanding of professional and ethical responsibilities: (73.2 percent)

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:

- communicate effectively in both oral and written form: (60.9 percent)
- to use modern tools (e.g., CAD) necessary for engineering practice (61 percent)
- with an understanding of the impact of technology on society (60.9 percent)

Students had the following response to questions about their Lower Division and Liberal Education coursework:

### Advising

Of all students surveyed, 31.7 percent agreed that lower division academic advising was good, 36.6 percent remained neutral and 31.7 percent strongly disagreed to the question of whether lower division

advising prepared them well for upper division. Sixty one percent of the students felt that their liberal education courses gave them an appreciation of the societal context in which engineering is practiced. Students felt that the science components (70.7 percent) and math components (70.8 percent) had prepared them well for their major courses.

### Experience

Students were more satisfied regarding:

- whether computational facilities were available for their use (62.5 percent with 27.5 percent remaining neutral)
- whether instructors were available to discuss course

related issues outside of class (72.5 percent); and

- whether their courses included active learning experiences, such as discussion and team work (90.3 percent)
- Students were positive about their Upper Division experience, with 48.8 percent who thought the upper division

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***Students were positive about their Upper Division experience. 48.8 percent of the students felt that the upper division academic advising was good, with 22 percent remaining neutral.***

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academic advising was good, and 22 percent remaining neutral. The majority of the students felt that their education provided them with:

- a good understanding of engineering materials (78.1 percent)
- a good understanding of aerodynamics (87.8 percent)
- a good understanding of aerospace structures (80.5 percent)
- a good understanding of aerospace propulsion systems (82.5 percent)
- a good understanding of atmospheric flight mechanics (82.9 percent)
- a good understanding of orbital mechanics and space flight (78 percent)
- a good understanding of flight dynamics and control (75.6 percent)

And the rest...

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

- a. whether they felt the design experiences provided throughout the BAEM curriculum: 67.5 percent re-

More on graduating senior exit surveys on Page 35

## Chairman's Corner from page 1

ous IT departments make up the Minnesat program, and have been working on the project since fall 2005. Students once again participated in the Reduced Gravity experiment, where students conduct tests aboard NASA's "Weightless Wonder" and experience about 30 seconds of freefall. Due to NASA changing its training aircraft for astronauts, students selected for the Fluid Mechanics experiment in 2004-2005 were delayed one year and participated alongside the 2005-2006 team. Photographs and a participant's take on the experience are on Page 10.

We were pleased to award three exceptional alumni - John Michael Jordan, Richard DeLeo, and Thomas Lundgren - with "Outstanding Achievement" awards.

AEM saw longtime professor and friend Gordon Beavers retire at the end of the 2005-2006 academic year. While we were sad to see Professor Beavers go, AEM was pleased to welcome two new faculty members, Assistant Professor Bernard Mettler and Professor Ellad Tadmor. Professor Mettler's research interests lie mainly in aerospace systems. Professor Tadmor is internationally known for his quasi-continuum method in solid mechanics. He has strong research connections with faculty members in our department, that of Mathematics, the Institute for Mathematics and its Applications, Chemical Engineering, and Materials Science and Civil Engineering.

Several of our faculty were honored or distinguished with awards this past year. To highlight a few, Professor Demoz Gebre-Egziabher received a University McKnight Land-Grant Professorship, Professor William Garrard received the ASME/AIAA John Leland Atwood Award, Professor Fosdick was awarded a Laurea Specialistica Honoris Causa in Ingegneria Meccanica from the Politecnico di Bari, Italy, Professor Lundgren was awarded the APS Fluid Dynamics Prize, Professor Ashley James received a Presidential Early Career Award for Scientists and Engineers, and Professor Richard James received an Alexander von Humboldt Senior Research Award from the German Government. You can read more about these in the Faculty News section on page 23.

Research in the department is thriving. The National Hypersonics Research Center, which was initiated in 2004 with funding from the Air Force, continues to expand and attract new sources of support. Center researchers are working on projects related to the Air Force Fundamental Research in Hypersonics flight test program, the DARPA/Air Force FALCON program, the Boeing/Air Force X-51A Scramjet Engine Demonstrator, the NASA/JPL Mars Science Laboratory,

and the NASA Crew Exploration Vehicle - Orion. Computational methods developed at the Center are playing a central role in the Air Force Stability and Transition Analysis for Re-entry (STAR) program.

The BAEM program has seen some changes during the year. In part due to an increased interest in our program (just more than 7 percent of incoming high school students into IT expressed interest in the BAEM), we have elected to raise minimum requirements for upper division BAEM classes from a 2.0 GPA to 2.3 GPA.

The AEM graduate program saw 15 students graduate and several students earn awards and fellowships; details are in this issue.

We have begun a new initiative to redesign the AEM main office and create two lounge areas for undergraduate and graduate students. The main office redesign will allow the staff to better serve our students and visitors while creating additional office space. The new office space comes at the expense of reducing by half the size of the department head office. The student lounges will serve both as a relaxation area and a working space. In addition to spending their free time in the lounge, students can hold study groups, discussions, and meetings in the lounge. These spaces would include several computer stations to help facilitate the preparation of materials for these study groups. Our goal is to create an overall environment within Akerman Hall that will be conducive to student-initiated academic study beyond the scope of coursework. We hope to have funding in place to realize this vision and initiate these renovations by early 2007.

I am excited to be part of Aerospace Engineering and Mechanics' future. I look forward to working with you to achieve our dreams and aspirations.

Best Regards,



Gary J. Balas  
Department Head  
balas@aem.umn.edu

## Accreditation Underway

### Educational Objectives: How are we doing?

As part of the accreditation process, every engineering program must have educational objectives which are “broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.” Our objectives were formulated in 1998 in consultation with our constituents: faculty, students, employers, and alumni. Each year we evaluate how well we achieve these objectives by consulting with our Professional Advisory Board, Faculty, and Graduating Seniors. In addition, we request comments from the readers of the AEM Update and receive limited input from this source. This year we decided to conduct a formal survey of employers to see how well they think that we are achieving our objectives, and if our current objectives are appropriate. Seventeen total responses were received: 13 from private industry, 2 from governmental agencies, and 2 from other entities. In fall of 2005, the IT Dean’s Office conducted a survey of graduates from the Class of 2002. This survey incorporated some questions specific to each engineering program and we included questions on our objectives in this survey (the Dean’s survey did not include questions on the appropriateness of the each objective; there were only 9 responses). Due to the small number of responses, we are planning another survey of our own which will cover classes from the past five years.

The objectives, questions and survey results are given below:

#### Objective 1

**To produce graduates with a broad background in aerospace engineering and mechanics, including fluid mechanics, structural mechanics and aerospace systems.**

Recent graduates/interns I have known achieve this objective extremely well. Rate this statement from 1-5 with 1 being strongly disagree and 5 being strong agree.

Employers 4.75  
Alumni 4.11

This educational objective is appropriate for the AEM program at the University of Minnesota.

Rate this statement from 1-5 with 1 being strongly disagree and 5 being strong agree.

Employers 4.76  
Alumni NA

#### Objective 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.**

Recent graduates/interns I have known achieve this objective extremely well. Rate this statement from 1-5 with 1 being strongly disagree and 5 being strongly agree.

Employers 4.41  
Alumni 3.25

This educational objective is appropriate for the AEM program at the University of Minnesota.

Rate this statement from 1-5 with 1 being strongly disagree and 5 being strongly agree.

Employers 4.65  
Alumni NA

## Objective 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.

Recent graduates/interns I have known achieve this objective extremely well. Rate this statement from 1-5 with 1 being strongly disagree and 5 being strong agree.

Employers 4.35  
Alumni 3.38

This educational objective is appropriate for the AEM program at the University of Minnesota.

Rate this statement from 1-5 with 1 being strongly disagree and 5 being strongly agree.

Employers 4.56  
Alumni NA

## Objective 4

To produce graduates with the ability to both seek out assistance when needed and to learn new skills throughout their careers.

Recent graduates/interns I have known achieve this objective extremely well. Rate his statement from 1-5 with 1 being strongly disagree and 5 being strong agree.

Employers 4.41  
Alumni 3.78

This educational objective is appropriate for the AEM program at the University of Minnesota.

Rate this statement from 1-5 with 1 being strongly disagree and 5 being strongly agree.

Employers 4.70  
Alumni NA

## Objective 5

To produce graduates with the oral and written communication skills needed to successfully work in a modern multidisciplinary environment.

Recent graduates/interns I have known achieve this objective extremely well. Rate this statement from 1-5 with 1 being strongly disagree and 5 being strong agree.

Employers 4.17  
Alumni 4.00

This educational objective is appropriate for the AEM program at the University of Minnesota.

Rate this statement from 1-5 with 1 being strongly disagree and 5 being strongly agree.

Employers 4.70  
Alumni NA

## Objective 6

To produce graduates who can be successful in graduate level work in engineering, as well as in other professional schools.

Recent graduates/interns I have known achieve this objective extremely well. Rate this statement from 1-5 with 1 being strongly disagree and 5 being strong agree.

Employers 4.17  
Alumni 3.38

Rate this statement from 1-5 with 1 being strongly disagree and 5 being strongly agree.

Employers 4.47  
Alumni NA

The responses by Employers are very good; however, it does appear that there is some concern about communications. Our alumni from the class of 2002 rate the achievement of their objectives less well than employers. However the number of respondents was low and therefore we believe that more data are needed. Therefore, during fall 2006 we are conducting another alumni survey only on objectives. If you are a recent graduate, we would appreciate your comments on how well you believe that your education prepared you to achieve the objectives listed above and whether you believe that these objectives are appropriate for the AEM program at the University of Minnesota. The more specific you can be in your comments, the more helpful your response will be to us. Please e-mail Bill Garrard at [wgarrard@aem.umn.edu](mailto:wgarrard@aem.umn.edu).

## Recommendations of the AEM Advisory Board for 2005-2006

The advisory board focused on plans to engage alumni

**RECOMMENDATION: Complete development of strategic plan**

Action: Work on strategic plan postponed until appointment of new Department Head and Definition of new University Priorities (to be completed 2006-2007)

**RECOMMENDATION: Need to more actively engage alumni**

A. Could be used to address student concerns about getting Freshman involved earlier, by sponsoring 2-3 "Aerospace 101" seminars with the AIAA student/local section (industry and research speakers)

Action: Development of Introduction to Engineering at IT level, participation by AEM Faculty.

Development of Freshman Course at Dept. Level still under consideration.

B. Guest lecturers on specific topics (e.g., spacecraft design) / technical review (e.g., capstone course)

Action: Alumni involved in CDR's and Guest Lectures in Capstone Design Courses

C. Mentors for students / exit interviews

Action: Alumni visitor to evaluate undergraduate program

D. Advocacy for department programs

Action: Worked to get Aero. Representation on Dean's Advisory Committee

E. Contributions (in-kind and \$) – e.g., graduate fellowships

Action: Event involving Lt. Col. (ret.) Duane Carey, Astronaut, and Student Nanosat Project

F. Department needs to establish a web-based "alumni network" database with up-to-date contact info, skills, etc.

Action: We have a department database [http://www.aem.umn.edu/alumni/alumni\\_network.shtml](http://www.aem.umn.edu/alumni/alumni_network.shtml). We did add link to it on our main menu, "Alumni Registration", after last meeting.

G. Board is willing to be more engaged (more than one meeting per year) to help on above topics

Action: Engagement of Board in Develop-

ing Questionnaire on Educational Objectives

**RECOMMENDATION: Review and give formal feedback to Undergrad Student Advisory Board**

Action: Done

**RECOMMENDATION: Continue to look for opportunities to expose principles of systems engineering into existing coursework (as early as possible in the sequence)**

Action: In preliminary stages of developing a course to replace EE with Systems Course at junior level

**RECOMMENDATION: Continue to support the growth of the Hypersonic Research Center**

Action: Significant new funding including funds from IT/Dept for Facilities Renovation

**RECOMMENDATION: Report out on status of recommendations at each following meeting**

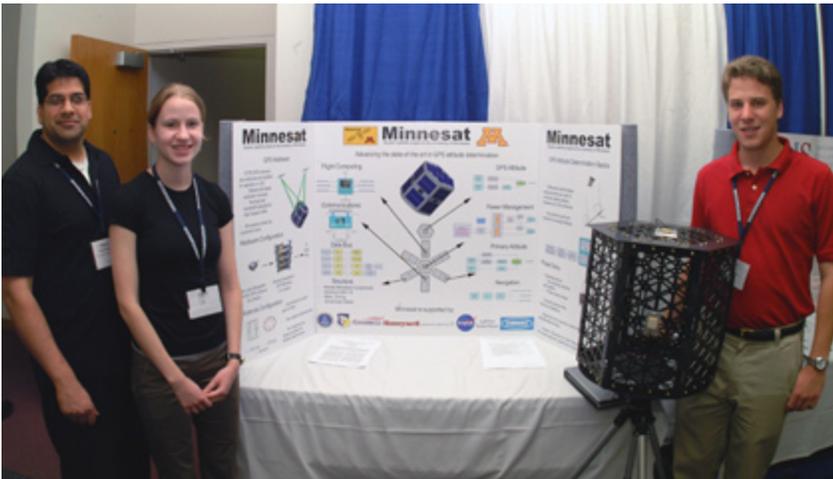
Action: Done

# What is



The US Air Force (USAF) University Nanosat Program is a joint program run by the Air Force Research Laboratory's Space Vehicle Directorate (AFRL/VS), the Air Force Office of Scientific Research (AFOSR), the American Institute of Aeronautics and Astronautics (AIAA) and the National Aeronautics and Space Administration (NASA). The major objective of the program is to educate and train the future

attitude determination where signals from the Global Positioning System (GPS) satellites are used like a radio interferometer. Making such radio interferometers work on miniature satellites such as Minnesat requires, in part, developing methods for precise calibration of GPS antenna gain patterns.



workforce that will be responsible for the design and operation of miniature satellites. A secondary objective of the program is to explore satellite research problems that are of current interest to the US Air Force and NASA.

The program achieves these dual goals by a national student satellite design and fabrication competition. The competition involves eleven universities where each university team must design a space-worthy nano-satellite (or nanosat for short) to perform a science experiment which addresses a problem of current interest to the USAF and NASA. At the end of the competition, a single winner is selected by a panel of experts. The winning nanosat design is launched by the USAF and the winning team gets to conduct their experiment on orbit.

Minnesat is the University of Minnesota's entry into the USAF University Nanosat Program and its science mission is to explore a novel method of orientation (or attitude) determination for miniature satellites. Minnesat will be exploring a technique of

Minnesat is a hexagonal-shaped satellite. For its science mission it will carry eight GPS antenna/receiver pairs which form the interferometer. One antenna is located on each face of the satellite. The satellite also has various other systems such as a thermal management system, a flight computer system, and a communications system which are there to support the science experiment.

The Minnesat team consists of 20 students (both undergraduate and graduate from various departments in IT) and 3 faculty members from the Aerospace and Electrical Engineering Departments. Design and analysis of most of the satellite's systems have been completed and the team has commenced prototyping and building the actual space qualified hardware. Final selection of the winning design will occur in March 2007.

Thanks for all the sponsors of the Minnesat Project: AFOSR, AFRL, Goodrich, Honeywell, Lockheed Martin, NASA, Tennant, the Digital Technology Center, Richard DeLeo, Torpedo Specialty Wire, Inc., EMJ Metals, and other AEM Alumni Sponsors.

**For more information about the Minnesat project contact Prof. Gebre-Egziabher ([gebre@aem.umn.edu](mailto:gebre@aem.umn.edu)) or the student program manager, Jason Mintz ([mint0023@umn.edu](mailto:mint0023@umn.edu))**

## A student experience

### AEM student Mike Mattson reflects on the Reduced Gravity experiment

This opportunity has been a great experience as students to use our engineering skills for an exciting and unique research experience. Academically, I was drawn to the freedom and challenge of creating, designing, building, testing, and evaluating a new experiment to be tested in a “weightless” or “zero-g” environment. The rest of me just wanted a ride on the “Weightless Wonder!”

In our experiment, we investigated acoustic control of boiling in micro-gravity. On Earth, heat transfer from boiling is usually taken for granted as a good source of heat dissipation. The bubbles that form on a hot surface are able to escape due to their buoyancy, which is due to gravity because the bubbles weigh less than the liquid. In microgravity environments, such as the International Space Station (ISS), there bubbles do not “weigh” less than the fluid and do not float away from the hot surface, which can result in overheating. As a solution to this problem, we proposed using high-frequency sound waves to push the bubbles off the hot surface to dissipate the heat.

We built a small setup consisting of a tank containing Fluorinert FC-72, which is a liquid with a low boiling point, a heating element, an ultrasonic transducer for sound, and various electronics to power the experiment and to record visual data. This setup was loaded into the “Weightless Wonder,” NASA’s aircraft that would fly our experiment and our crew on a series of parabolas to experience weightlessness.

We flew to NASA’s airfield in Houston, Texas for our flight training and to perform our experiment. Much like the astronauts, we underwent basic training such as an exercise in NASA’s high-altitude chamber in which we were “flown” up to 25,000 ft and breathed low-oxygen air to train us to feel and identify the symptoms of a low



*Austin Murch (L) and Mike Mattson (R) watch their experimental setup as they fly on NASA’s Weightless Wonder.*

oxygen environment.

On flight day, we donned our flight suits and readied our experiment. My first experience with weightless was nothing like I had ever felt before; a big smile came to my face as I floated off the cabin floor, without the restriction of gravity! Once the experiments were completed, the adventurous performed zero-gravity twirls and somersaults. In no other program could I get the educational and physical experiences as I did in the RGFOP, and I encourage other students to take advantage of the program.

Our team would like to thank Ellen Longmire for advising us, Dave Hultman and Mario Costello for helping build our experiment, the Aerospace Engineering and Mechanics Dept., Richard DeLeo, and the University Research Opportunities Program (UROP) for financial support, and the people of NASA’s Reduced Gravity Student Flight Opportunities Program (RGFOP) that provided this opportunity. Each contribution is greatly appreciated.

*Mike Mattson, Fluids team member*



## Reduced Gravity

### Fluids Team 05-06

#### Faculty Supervisor

Professor Ellen Longmire

#### Students:

Ross Wagnild (team lead), Nick Schramper, Matt Otterstatter, Brandon Huelman, and Matt Bartkowicz



(From left) Matt Bartkowicz, Nick Schramper, Ross Wagnild, Brandon Huelman, and Matt Otterstatter examine their experiment

### Microgravity Study of Gas Vortex Rings in a Liquid

#### Experiment Abstract

Vortices are very important to fluid dynamics and engineering because of their presence in many kinds of flows including jets and flow over airfoils. Vortex rings are generated when a slug, a volume of fluid in a cylinder, is given momentum to be injected into a tank of ambient fluid. In most experiments the slug and ambient fluid have similar densities to avoid buoyancy effects. Rarely is a gas/liquid experiment done because the buoyant force on the gas is so large relative to the mass of the gas slug that it dominates all other phenomena one might attempt to observe. In microgravity, this buoyant force becomes very small and it would be possible to observe a non-buoyant gas vortex ring. Also, we must consider the effects of

surface tension because we are using a gas in a liquid. This would be a factor in our analysis because it could inhibit the formation of the Vortex Ring. It is under these conditions that we will test the slug model of vortex rings. This will be done using a piston/cylinder assembly to drive the slug of air into a tank of water. To measure the necessary quantities of the vortex ring, we will record each test run with 2 video cameras placed at different angles. We expect to see minor, but measurable differences to the slug model based on the added effect of surface tension and the different fluid properties. In conjunction with the experiment, we will begin an outreach program to explain our project to the general public and to inspire the scientists of tomorrow.

### Fluids Team 04-05

#### Faculty Supervisor

Professor Ellen Longmire

#### Students:

Rayna DeMaster (team lead), Craig Lewandowski, Michael Mattson, Stephanie Mma, and Austin Murch

### Acoustic Control of Boiling

#### Experiment Abstract

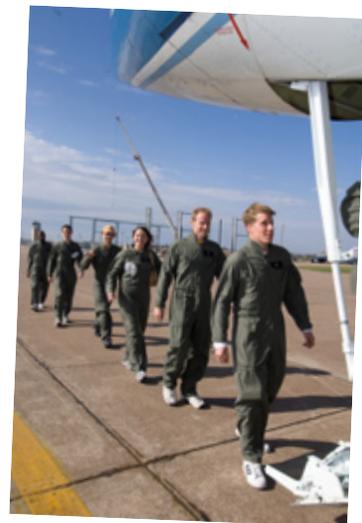
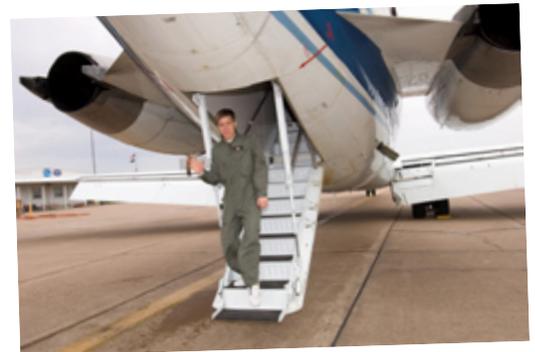
Boiling is an effective method of heat transfer from heat source to fluid in normal gravity. A buoyancy force on the produced vapor bubbles pull them away from the heat source, inducing fluid convection and increasing heat transfer. In microgravity, however, buoyancy forces are nonexistent, and heat transfer decreases without bubble separation from the heat source. Bubbles can possibly detach due to development of Marangoni forces; however, it is unclear how quickly they will detach or whether they will continue to move away from the surface. Because of this, other

methods must be developed to remove vapor bubbles from heating surfaces in order to increase heat transfer. Acoustic control of vapor bubbles in reduced gravity has been studied in drop towers for short periods of time (approx. 1-3 seconds) (Sitter, et. al., 1998), but further testing under extended periods should be performed in order to confirm previous work. We believe that testing acoustic control under gradient gravity fields would confirm this as an effective method to provide efficient heat transfer from heat source to coolant fluid. Also, we will study the results of acoustic control of boiling in terrestrial gravity as an effective method for bubble manipulation and heat transfer.

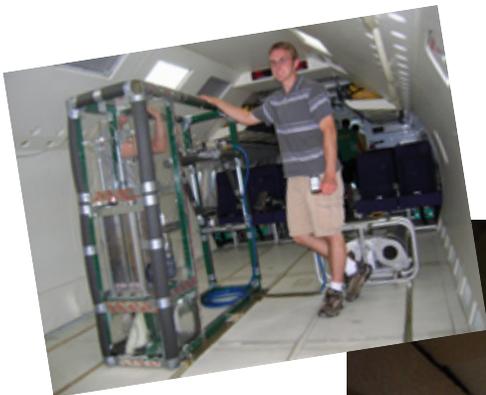
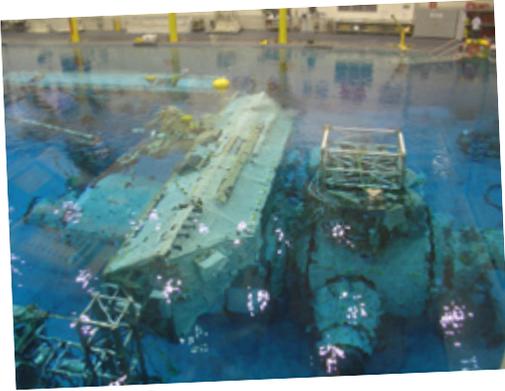
*Due to NASA's changing the training aircraft for astronauts, the 2004-2005 team flew in the spring of 2006 alongside the 05-06 team.*

# AEM Update

## Fluids Team - (2004-2005)



# Fluids Team - (2005-2006)



## AEM4331 – Senior Design I

There were 60 students in the class. We offered them a choice of 11 design projects. The students selected their top three choices and there was enough interest in 7 of the 11 offerings to go forward. The other 4 offerings did not have enough people interested to reach critical mass so they were dropped. The surviving projects (in no special order) were:

### PERPETUAL HEAVIER THAN AIR – LOCKHEED MARTIN SPONSORED

The goal of this design is a heavier than air UAV powered by solar energy (solar cells) which can stay aloft indefinitely recharging its batteries every day with sufficient energy to stay aloft over night. The vehicle must be capable of carrying a useful payload (camera or communications gear). The team's job was to conduct a feasibility study to see if a totally autonomous airplane can be designed to fly without a human "expert" pilot to exploit thermal updrafts.

In the spring, the team fabricated a "proof of concept" plane and tested it. Lockheed Martin provided consulting help and flight hardware for the proof of concept test in the spring of 2006.

### PERPETUAL LIGHTER THAN AIR

The goal of this design is a lighter than air (i.e. airship) UAV powered by solar energy (solar cells) which can stay aloft indefinitely recharging its batteries every day with sufficient energy to stay aloft over night.

This team fitted a gondola to this blimp with three propellers and a video camera. They demonstrated controlled flight in the gymnasium in the ROTC building. They also demonstrated they could take and stream back live video images from the gondola to a laptop screen using radio frequency communication. This was a joint Aero and Electrical Engineering senior design project.

### SCRAMJET MISSILE – ALLIANT TECHSYSTEMS (ATK) SPONSORED

In this project, the team designed a hypersonic missile system to cruise at over Mach 5 covering over 300 miles in under 3 minutes. The students designed the missile, including engine flowpath, fuel system sizing, warhead selection, aerodynamic performance, structural analysis, and subsystem packaging. In addition, the team selected an appropriate booster for the missile and analyzed the trajectory flown by this vehicle. GASL (wholly owned subsidiary of ATK) supported this project with expert consulting and coaching. The GASL sponsor for this project put together the X43A (world-record



*The Homebuilt team with RC experts from the TriValley RC club.*

holder hypersonic vehicle) and are part of the FALCON program. Dr. Candler in our department also worked with the team. This was a very difficult analytical design effort that was a huge learning experience for the team. They did well. The opportunity to work with pioneering members of the hypersonics community was priceless for the students.

### HOMEBUILT – LIGHT SPORT AIRCRAFT (LSA) CLASS PLANE

This was not a sponsored project. A small team designed a single place LSA plane to FAA regulations, analyzed it in the AAA software design tool (DARcorporation commercial program based on the work of Roscam). Then they built and tested a wind tunnel model, and made a scratch build RC model for flight test in the spring.

The flight test for this plane was conducted at the TriValley RC plane club field in Rosemont. The plane the students built was tail-heavy and the pilot (to the left holding transmitter) was barely able to land it safely. Then the experienced RC plane builders from TriValley helped the students add lead shot ballast to the nose of the plane and made a second flight. On the second flight, it performed beautifully with aileron rolls and many passes over the field. It passed a stall recovery test and the pilot said it had good flying qualities.

### SKY SPIRIT – LOCKHEED MARTIN UAV PROJECT

The Lockheed Martin Corporation, based in Eagan, Minn., supported this design class project to characterize the aerodynamic performance of the Sky Spirit UAV they have developed. The primary mission of this airplane is to fly a surveillance camera. Smooth

[More on the Senior Design I on Page 34](#)

# AEM4332 – Senior Design II

The second required design course AEM 4332, Space Vehicle Design, had three projects. These were design of a new MER-class Mars Rover, Design of a Mars Precision Landing System, and Design of elements of the University of Minnesota Student Nano-Satellite, Minnesat.

## MER vehicle

Launching in 2016, the specific goals of this vehicle, called Pollux, include site excavation using shaped charges, and demonstrating soil-gathering techniques. The team was broken down into subsystem design teams which then concentrated on a specific aspect of the rover design. These subsystems included:

**Science:** Defined the science objectives and requirements.

**Payload:** Responsible for determining the payload (science instruments) based on the science objectives.

**Surface Operations:** Day-to-day operations of the rovers, including specification of instrument operation, driving time, and charging time.

**Structures:** Responsible for instrument placement and robotic arm design, as well as other aspects of the structural design.

**Power:** Responsible for the power management system, including power distribution among systems.

**Thermal:** Responsible for the thermal management system, including insulation and heat dissipation.

**Communications:** Defines the communication systems for each rover, including equipment and communications windows.

**Command and Data Handling:** Signal routing from the Earth-based command to each system on the rovers, as well as between systems on the rover, including data storage and transfer.

## Precision Mars Landing

NASA is very interested in landing vehicles on Mars at a pre-determined point with an error of about 100 meters as opposed to an error of 1 to 2 kilometers currently achievable. The system should be able to achieve a soft landing without the use of airbags which are seen as a potential point of failure and which add substantially to the weight of the vehicle. This project required the following groups.

1. Mission planning, systems integration
2. Entry phase design
3. Descent phase design
4. Final landing phase design
5. Navigation, guidance system design

## The University Nanosat-4 Program

The UN-4 Program is a student design competition run by the Air Force Office of Scientific Research (AFOSR), Air

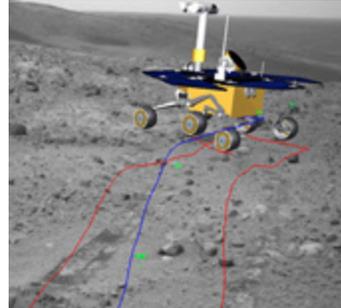
Force Research Labs (AFRL), the American Institute of Aeronautics and Astronautics (AIAA) and the National Aeronautics and Space Administration (NASA). It is the fourth in a series of student satellite design competitions. The objectives of the program are future workforce training and small satellite technology development. The program consists of entries from eleven universities across the country, each of which will design a satellite to perform a mission of their choice. The winning school will build a flight satellite, which will then be launched into orbit to perform its mission. Minnesat is the University of Minnesota's entry into the UN-4 competition

The mission of Minnesat is to develop, fabricate, test, and fly a short baseline Global Positioning Satellite (GPS) attitude determination system in low Earth orbit. The system will consist of several GPS antennas and receivers positioned on the spacecraft. Using the differences in the signals received by the different antennas, we can compute the spacecraft's attitude. Because the antennas are located close to one another, the problem is very complex and difficult.

The spacecraft is designed solely to accommodate the GPS attitude determination system in low Earth orbit. Minnesat consists of six systems, each serving a specific function vital to the mission. All systems exist either to support the GPS mission or to meet UN-4 program requirements. The following subsystems were designed

### 1) Flight Computing

The flight computing system is responsible for all computing on board the spacecraft. The system consists of two PC-104 computer boards. Each computer will perform all of the computations necessary to compute the attitude and navigation solutions, control the spacecraft, communicate with the ground station, and troubleshoot any problems on board. In the event



## ***Hypersonics Center on its way toward being a national leader***

Since its opening in 2004, the Hypersonics Research Center at the University of Minnesota has developed into one of the leading academic programs in hypersonics research. Center researchers are developing advanced simulation methods to support the design of future hypersonic aircraft and planetary entry spacecraft. These methods are being validated in the nation's premiere hypersonic test facility located at CUBRC Inc. The Center is supported by the Air Force Office of Scientific Research (AFOSR), Sandia National Laboratories, and NASA. During the past year, there have been a number of significant research accomplishments at the Center.

A critical issue in hypersonic vehicle design is predicting transition to turbulence. Center researchers, lead by Dr. Heath Johnson, have been developing a set of computational methods to predict the growth of instabilities and their breakdown to turbulence in hypersonic flows. Extensive work is being conducted to validate this tool. In recent work, we have used this code to predict the location of transition to turbulence on a blunted cone at Mach 7 and 10 conditions. Comparisons with the CUBRC wind tunnel measurements are very encouraging, with the simulations predicting transition much more accurately than widely used empirical correlations. The results of this study are being used to design a sounding rocket flight experiment as part of the joint U.S. – Australia HIFiRE (Hypersonic International Flight Research Experimentation) program. This set of transition prediction codes is being used at national laboratories, universities, and in the aerospace industry for the analysis of hypersonic aircraft and spacecraft.

Center researchers have been working on the design of inward-turning hypersonic inlets for scramjet engines for the past several years. Recently, Travis Drayna, a graduate research assistant at the Center, has developed the capability to optimize the performance of these inlets. He uses a third-party multidisciplinary design optimization tool and the advanced flow field simulation methods developed at the Center to

iteratively compute the optimal inlet shape. This approach has led to improved inlet designs, and more importantly, it has illustrated how the flow physics can be manipulated to improve inlet performance. This approach will be applied to a number of optimization problems, including the design of a new inlet for a wind tunnel being developed at CUBRC.

Center graduate student research assistants David Peterson, Pramod Subbareddy, and Ryuta Suzuki

have been developing advanced approaches for simulating injection and mixing inside scramjet engines. This approach resolves the key large-scale turbulent motion, resulting in a more accurate representation of the turbulent mixing process. A critical aspect of this work is the development of high-quality numerical methods to

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***Since its opening in 2004, the Hypersonics Research Center at the University of Minnesota has developed into one of the leading academic programs in hypersonics research.***

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reduce the artificial dissipation in the simulations. The interaction between shock waves, turbulence, and turbulent combustion is the focus of Center graduate student researchers, Yucheng Hou and Jeff Doom. They, and Center postdoctoral researcher, Dr. Noma Park, have developed highly accurate simulation methods and unsteady turbulence models, that will be applied to scramjet flows.

During the past six months, there has been an interesting off-shoot from the hypersonic aerodynamics work being done at the Center. The Mars Science Laboratory (MSL) will be launched in 2009, and will land a large rover on the surface of Mars. This will require the use of a very large parachute that will open at high altitude and supersonic speed. The Jet Propulsion Laboratory is concerned that the parachute will be unstable and will not produce the required drag. Center researchers, along with AEM Prof. William Garrard, are developing methods to predict the parachute dynamics including the interaction of the capsule wake with the canopy.

*Graham Candler  
Krishnan Mahesh*

# MnSGC program update

The Minnesota Space Grant Consortium (MnSGC) is a NASA-funded group of affiliated organizations with the mission of promoting teaching, research, educational outreach, and public service in Minnesota in the fields of engineering, science, and mathematics that support NASA's Mission. The University of Minnesota is the lead institution for the MnSGC. Professor William Garrard remains the Director and Professor James Flaten is now the Associate Director, having replaced long-time Associate Director Dr. Randi Quanbeck-Lundell who stepped down in the fall of 2005.

In addition to the thirteen higher education affiliates around the state, the MnSGC is affiliated with the Minnesota Department of Transportation Office of Aeronautics, as well as five informal industrial affiliate members: Goodrich Aerospace Inc., Boeing, Honeywell Inc., Lockheed-Martin, and AlliantTech Systems. The Science Museum of Minnesota is also an affiliate for informal education programming.

During the 2005-2006 grant cycle, the MnSGC provided \$140,000 in 79 scholarships and fellowships to support students attending MnSGC higher education affiliate institutions who are interested in pursuing careers in Science, Technology, Engineering, and Mathematics (STEM) fields. The following is a sampling of some of the funded programs at the higher education affiliates of the MnSGC.

**Concordia College** - Dr. Heidi Manning operates a hypervelocity dust particle accelerator on campus at Concordia to study impacts similar to those experienced by spacecraft.

**Fond du Lac Tribal and Community College** - Dr. John Gustafson and Ms. Connie Wappes are developing courses in Native American Mathematics and Native American Science, Technology, and Engineering Heritage for use at FDLTCC and for dissemination to other tribal colleges.

**University of St. Thomas** - Seven faculty members at UST in the Physics and Geology departments have used MnSGC funds to support summer undergraduate research assistants, whose research projects include developing simulations of the Martian atmosphere, searching for dust in galaxy clusters, and analyzing the effect of climatic change on Minnesota lakes.

#### **Southwest Minnesota State University**

Dr. Ken Murphy continues his planetarium outreach to schools and the general public in southwestern Minnesota.

#### **University of Minnesota –Twin Cities**

As the lead institution of the MnSGC, the UMTC coordinates statewide scholarship and internship opportunities and prepares annual Space Grant proposals and budget reports. Students in the AEM department are familiarized with the challenges of spaceflight especially through the two-semester Senior Design course and through individual faculty research programs. Students and faculty at the UMTC are also participating in the Nanosat-4 design competition with an entry called "Minnesat" to demonstrate shortband GPS attitude determination and control of nanosatellites.

**Bethel University** - The physics department at Bethel uses MnSGC funds for scholarships and to hire undergraduates to participate in research, such as stroboscopic holographic imaging.

**College of St. Catherine** - Dr. Terry Flower is developing an aerospace class to serve as the capstone course for the new STEM minor for Elementary Education majors at the College of St. Catherine.

**University of Minnesota – Duluth** - Funds are used by Dr. Alec Habig at UMD to support students to work with him on high-energy particle physics research at the underground laboratory deep in the Soudan mine in northern Minnesota.

**Bemidji State University** - Professor Jason Dahl coordinates the course sequence for the successful interdisciplinary Earth Science and Space Science minor and is involved with recruitment of students for the program and faculty to staff it.

**Augsburg College** - Dr. Jeanine Gregoire delivers professional development workshops to in-service public school teachers on robotics, mathematics, and physics.

**Macalester College** - Dr. Ray Rogers of Macalester's Geology Department coordinates the use of MnSGC funds to support student summer internships helping faculty study numerous geology topics.

**More online: [www.aem.umn.edu/msgc](http://www.aem.umn.edu/msgc)**

## Research Focus:

A recent competitive grant won by AEM's own Demoz Gebre-Egziabher could create a new function for the already- and increasingly-popular unmanned vehicles sector. The grant-funded research seeks to create a novel way for unmanned vehicles to interact and will explore ways to dynamically increase precision and accuracy in aircraft landing systems.

By using the military's next-generation navigation and guidance technology, known as the Joint Precision Approach and Landing System (JPALS), the research will explore methods of increasing the effectiveness of navigations systems that are used on Unmanned Aerial Vehicles. JPALS is being developed by the U.S. Department of Defense as a replacement for older aircraft navigation and guidance systems currently used by the military. It is expected to provide an unprecedented level of accuracy and flexibility for navigation and guidance of aircraft.

The research conducted by the University will also explore how to use specially-equipped vehicles as mobile data sources, broadcasting information that would enhance navigation and guidance performance of JPALS-equipped vehicles.

While JPALS technology is first and foremost a military program, research in this area could also have a great effect in coming years in the area of commercial flight.

"This could have broad implications for future global positioning system-based navigation and precision landing systems that will be used in civilian aviation applications," Gebre-Egziabher said. "Many of the



Products derived from Gebgre-Egziabher's research could be mounted to UAVs, like Lockheed Martin's SkySpirit

## Grant-funded research seeks to update uses of Unmanned Aerial Vehicles

challenges that have to be addressed by JPALS will be the same, if not more challenging, than ones that have to be addressed by civilian systems."



Lockheed Martin's \$50,000 grant is one of several that have supported and kept the University at the forefront of JPALS-related research.

"Lockheed Martin is excited to be working with the University of Minnesota in the discovery of advanced technologies that will provide innovative solutions to further the development of future unmanned systems," said Rick Udicious, vice president and general manager of Lockheed Martin's Eagan, MN-based Tactical Systems business.

In addition to novel applications in flight, Gebre-Egziabher's research is one in a new direction for aerospace engineering and mechanics. While classical research in aerospace engineering has dealt with the physics of complicated single systems, new research is trending more and more toward integrating various sources of information from complex systems, according to Department Head Gary Balas.

"Research is becoming more about information and the role information plays in both the design and safety of complex systems," he said. "It is using information in a more intelligent way and blending information that is available from multiple sources to get a better perspective of the situation and the environment one is in."

## Research Focus:

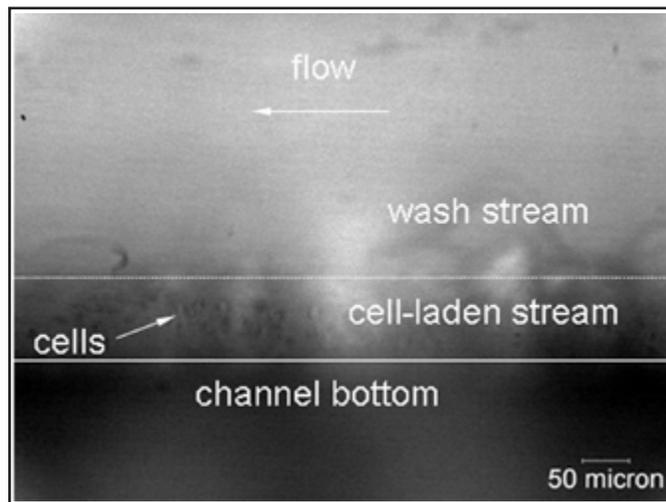
Over the past two years, Professor Ellen Longmire and Professor Allison Hubel (ME), an expert in cell cryopreservation, have been developing methods for processing suspensions of blood cells needed for transplantation after receiving grants from the National Blood Foundation and the National Institutes of Health. The transplantation of blood-derived stem cells has been used for decades to treat a variety of diseases and disorders including leukemia, malignant tumors, and immunodeficiencies, and the list of possible uses for these cells is growing continuously. Historically, the cells have been collected from adult donors, but the use of cells from umbilical cord blood is rapidly increasing. Cord blood is easy to collect (with no risk to the donors), and requires less-strict matching between the donor and recipient. This blood is also rich in stem cells. Adult and cord blood sources are cryopreserved (frozen) and stored until they are needed.

In conventional cryopreservation methods, dimethyl sulfoxide (DMSO) is added to the blood suspension to prevent cell loss from shrinkage during freezing. However, DMSO is a toxic compound that causes significant adverse reactions in patients. Therefore, it must be removed from the cell suspension before patient infusion. DMSO is currently removed from graft suspensions using centrifugation, typically resulting in a 25-30% cell loss. Since the available sample volume is often small at the start, this loss adversely affects the success of transplantations.

The current research focuses on developing a microfluidic device capable of removing DMSO from a cryopreserved cell suspension while minimizing cell losses. The device, an enclosed channel with depth ~500 microns, operates in a laminar regime permitting diffusion-based extraction of the DMSO from the cell suspension into a neighboring, parallel-flowing wash stream. The laminar flow prevents the cells from spreading into the wash stream and also precludes strong shearing and straining forces that occur in centrifuges. At the downstream end of the channel, the wash stream and DMSO-depleted cell stream exit through opposing outlets. Thus far, numerical simulations of model flows have been used to determine scaling effects and design experimental prototypes that are fabricated under the direction of

## Microfluidic processing of cryopreserved blood suspensions for infusion into patients

Dave Hultman. The simulations predict that a device incorporating two wash stages in series can match the DMSO-removal performance of centrifugation and that the stages can also be designed with reasonable but sufficient spanwise dimensions to process clinical volumes of cell suspensions in the required time frame. Preliminary experiments on DMSO solutions and DMSO-containing suspensions of Jurkat cells yield concentration results that match closely with those predicted numerically. Also, experiments on



prototypes have demonstrated a very high capture rate of viable cells (>90%) at device outlets. Ongoing research is aimed at determining parametric limits related to device performance and the physical causes of these limits, demonstrating device scale-up, and testing device performance on samples of umbilical cord blood. On an applied level, the development of methods to improve cell processing efficiency will directly facilitate the use of blood-related cell-based therapies for the treatment of disease.

Moreover, these studies are enhancing our fundamental understanding of cell flow through microfluidic devices. We expect that this understanding will lead to improved methods for controlling the motion of and processing of additional cell types.

## Adventures with the AIAA



**“Shoot for the moon. Even if you miss, you’ll still land among the stars.” Les Brown**

What a great year we had with AIAA over the last school year! It was a year for rebuilding, revamping, and restructuring – and the end result was phenomenal! Not only was a new constitution drafted and ratified, but general meetings were redone to be more organized and provide better and more direct feedback from students attending. We also tried to have a student or professor speaking at each one, along with the favorite draw of free pizza. Tons of other background documentation and paperwork was set up to help facilitate the group keep records and continue to grow.



Marc Granson, Theresa Krack and John Kostrzewski (left-to-right) relax after presenting at the Region V Conference in Iowa.

The year started off in the summer with a goal to get the office redone to be cleaner, more professional, and a more effective place for students to hang out and study. Thanks to the efforts of a great crew of people, we were able to get the walls repainted and a wicked cool blue stripe added for accent. We also got a brand new fridge as well as a newer couch and desk. Some of the old, lesser used items were cleaned out to provide more space.

With the new look in the office, we had started to put a new, more active face on the organization. We started the year off with a Welcome BBQ where we had free food for students of all sorts. The AEM department helped us out with getting this going and we hope that it will be an annual fall events to welcome aerospace students back to school.

Another big fall event that we had was a trip to the Eau Claire Planetarium and Hobbs Observatory. Through connections with the University of Eau

Claire, AIAA was able to travel and see a planetarium show, learn constellations, have dinner with the UWEC Society of Physics Students, and, of course, watch the classic *Men in Tights*. The evening would have included a trip to the Hobbs Observatory to see the real stars; however, the weather just did not want to cooperate. This is another event that AIAA hopes will occur on a yearly basis and hopefully the weather will cooperate next year.

Aside from the big events in fall, AIAA also started up a RC Plane Club division through the help of Prof. Hammer. This sub-club provided interested students with the chance to get some hands on experience with RC planes, both in terms of flying and building. One of the winter and spring projects that was started included having students design and build profile models that would be flown with the club equipment. On the plate for the future of the RC Plane Club is to get started on a SAE Heavy Lift vehicle over the summer and maybe actually get it entered into the contest for next year.

At the end of both fall and spring semester, AIAA hosted a shindig to honor active members and, of course, free food and tons of fun! The fall shindig was held at Gameworks in downtown Minneapolis and, along with active member certificates, gag awards were also handed out with appropriate stories and chuckle to go with them. Spring found AIAA wanting to host a students vs. staff softball game, but the weather did not want to cooperate, so the festivities were moved indoors. At the spring shindig, several professors attended and were able to witness both the ridiculous slide show of memories and the gag awards. At this shindig, recognition certificates were handed out to all officers and AEM staff and faculty that helped us get the group going again.

The Branch Report that was sent back to AIAA was 112 pages long and contained summaries and signs on more than 50 events held for the entire year. We had guest speakers, from somebody from Boeing to a graduate student out of Madison to even a Roger Launius, a distinguished lecturer. There was also informational events like a Matlab Information session and Prof. Hammer’s Industry Spiel. We even had a few bake sales to help raise funds. Regular events like movie nights or intramural softball may not have always been a big draw, but still offered the opportunity to hang out

More on the AIAA’s adventures on page 35

# Undergraduate graduation reception

May 5, 2006.  
The McNamara  
Alumni Center.

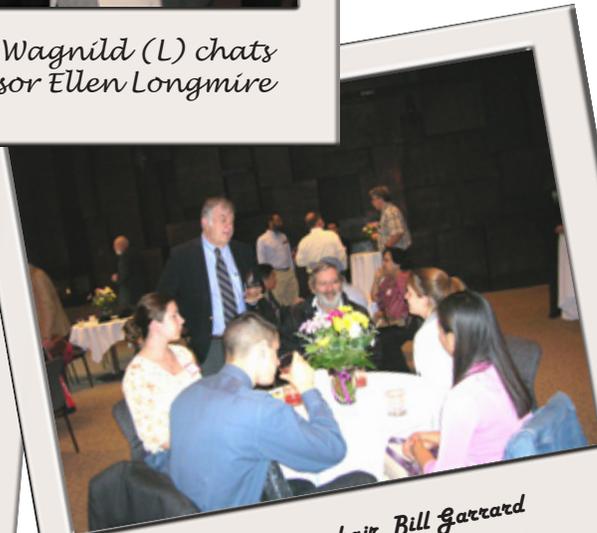
The graduation reception gave 2005-2006 graduates an opportunity to have their parents meet faculty and display their progress. Congratulations, graduates, and good luck in the future!



*Senior Ross Wagnild (L) chats with Professor Ellen Longmire*



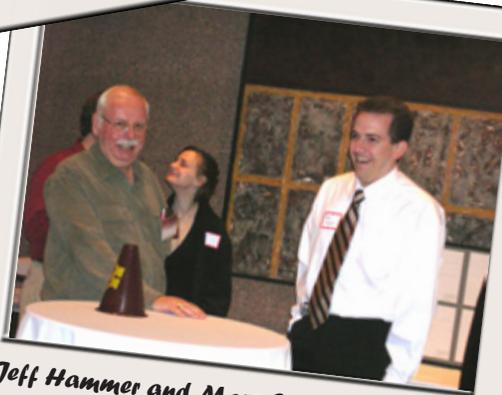
*Scott Miller (R), Professor Jeff Hammer (M), and Cory Rolfes (R)*



*Former department chair Bill Garrard (standing in back) mingles with students.*



*John Kostrzewski (L), Matt Mitchell (M), and Mark Granson (R)*



*Jeff Hammer and Marc Granson (R)*

## Outstanding Achievement Award Recipients 2005-2006

### Thomas Lundgren

#### CITATION:

- Distinguished Graduate of the University of Minnesota
- Retired professor of Aerospace Engineering and Mechanics, University of Minnesota
- Inspiring teacher, adviser and mentor for a generation of leading fluids mechanics researchers
- World leader in the theory of turbulence and theoretical fluid mechanics
- Internationally renowned research and developer of theoretical methods that are used extensively in the study of high Reynolds number turbulence, combustion and other applications

#### BIOGRAPHY:

Tom Lundgren is one of the most important figures in fluid mechanics in the past 40 years. He has made major contributions to turbulence, magneto-hydrodynamics, free molecular flow, shock structure, rotating fluids, vortex dynamics, drop dynamics, and solid-liquid flows. His work is characterized by mathematical rigor and attention to detail.

Tom spent his entire career at the University of

Minnesota.

He received a B.S. in 1954, a M.S. 1956 and a Ph.D. in 1960. He joined the faculty in the Department of Aeronautical Engineering (now Aero-



Thomas Lundgren

space Engineering and Mechanics) as an Assistant Professor and, after being quickly promoted, served as full Professor from 1966 to 2000. Tom has about 70 publications to-date.

Recently, Tom derived Kolmogorov's Laws from the Navier-Stokes equations without recourse to the many assumptions and hypotheses used by Kolmogorov himself; this will lead to a new wave of research. In addition to his own research Tom has been a mentor and teacher to many well-known researchers in fluid mechanics.

### Richard DeLeo

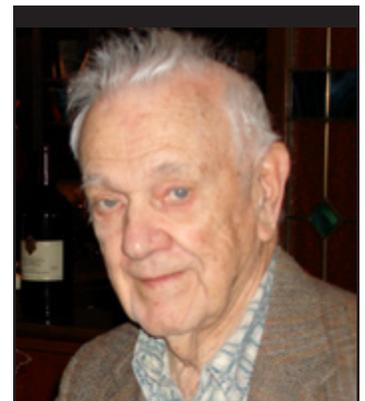
#### CITATION:

- Distinguished Graduate of the University of Minnesota
- Vice President for Aeronautical Research, Rosemount Aerospace, now retired
- Pioneer in the design of pitot-static probes for aircraft
- Innovative engineer whose inventions have improved the performance and safety of aircraft
- Visionary executive responsible for development of a new high-technology industry in Minnesota
- Dedicated mentor and benefactor who influenced many generations of engineers

#### BIOGRAPHY:

Dick DeLeo is a pioneer in the development of air data sensors for aerospace vehicles. In the mid-1950's,

engineers, including Dick, who worked at the Rosemount Aeronautical Laboratory at the University of Minnesota, developed an air data sensor called the total temperature sensor. This sensor provided means for measuring the speed, Mach number and dynamic pressure for high speed aircraft. The developers of this sensor formed a company called Rosemount Engineering to produce the total temperature sensor for use on aircraft for the U.S. Navy. The customer base for this sensor grew



Dick DeLeo

rapidly and Rosemount developed other products. Soon there was not a high performance aerospace vehicle produced in the non-Soviet world which did not have at least one Rosemount sensor. This included launch vehicles such as the Space Shuttle as well as more conventional aircraft. Dick DeLeo was a major contributor to the development of Rosemount products.

In addition to his technical leadership, Dick was a mentor to many generations of engineers and recently has provided support for many programs at his alma mater, the Department of Aerospace Engineering and Mechanics at the University of Minnesota.



## John Michael Jordan

### CITATION:

- Distinguished Graduate of the University of Minnesota
- Aerospace Engineer US Army Research, Development and Engineering Command, Huntsville, Alabama
- Pioneer and chief architect in the development of high-fidelity, hardware-in-the-loop simulations for air defense systems
- Innovative engineer whose expertise has resulted in the success of major air defense systems for the US Army
- Contributor to world peace by enhancing the defensive capabilities of the United States and its allies
- Mentor and leader to a generation of engineers

### BIOGRAPHY:

John M. Jordan began his professional career at the US Army Missile Research, Development and Engineering Center in 1976 as an officer in the US Army. He was instrumental in the development of the Improved HAWK air defense system hardware-in-the-loop simulation which resulted in his receiving the US Army Missile Research and Development Command Scientific and Engineering Award.

In the upcoming decades, John would play key roles in the development of:

The Low Altitude Simultaneous HAWK Engagement capability - for which he received the US Army Missile Command Scientific and Engineering Award.

The performance evaluation tool for the PA-

TRIBUT system.

The PATRIOT Electromagnetic Radiation test bed.

The Millimeterwave Simulation System 2, a state-of-the-art hardware-in-the-loop test facility uniquely capable of exercising and evaluating the most critical PATRIOT seeker operations.

The Virtual Engagement Simulation Tool, the Army's part in the first phase of the Joint Cruise Missile Defense Advanced Concept Technology Demonstration.

In 2004

John was selected to co-chair the Medium Extended Air Defense System Sensor Assessment Panel. The panel consisted of respected radar and guidance and control experts from both the Department of Defense and the defense community. The panel uncovered several technical problems of such import that stakeholders have called for system design modifications.



John M. Jordan

## Longtime professor retires

**Gordon Beavers, a distinguished faculty member, retired at the end of the 2005-2006 academic year.**

Gordon Beavers was born and grew up in northern England. After receiving a BA degree in engineering from Cambridge University he attended Harvard Uni-



versity as a Gordon McKay Fellow, obtaining an M.S. degree in applied mathematics. He returned to Cambridge to do research on axial flow compressors, earning a Ph.D. in 1963.

Immediately afterwards he was appointed as an assistant professor in the University of Minnesota's Department of Aeronautics and Engineering Mechanics (which was renamed Aerospace Engineering and Mechanics a few years later).

Gordon has spent his whole academic career at the University of Minnesota. He was promoted to full professor in 1974 and appointed as an Institute of Technology Distinguished Professor in 1999. He was a visiting professor at Cambridge University in the spring quarter 1979, and a Distinguished Visiting Professor at Nihon University in January 1995.

When starting as a faculty member Gordon expanded his research interests from gas turbine engines to general experimental fluid mechanics, and throughout his career his research has covered a broad spectrum of fluid mechanics from high speed compressible flows to slow viscous flows

In the early 1970's Gordon and Dan Joseph established a new laboratory for research on the fluid mechanics of viscoelastic liquids which generated many novel and interesting results. In the final decade of his career Gordon's interests in high speed flows and viscoelastic liquids were brought together

in a program to study the aerodynamic breakup of viscoelastic liquids under high Mach number conditions. This work was carried out in a dedicated shock tube facility using very high speed cinematography, and produced the first detailed movies of the first few milliseconds of the breakup process.

Gordon has always been an enthusiastic and popular teacher with undergraduates. He was a five-time recipient of the AIAA Outstanding Faculty Adviser Award, he received the George Taylor/I.T. Alumni Society Distinguished Teacher Award in 1979, and the Institute of Technology Student Board Best Instructor Award in 1998 and 2003.

Since 1972 Gordon has served in several administrative positions. He was associate head of the Aerospace Engineering and Mechanics Department from 1972 to 1983, associate dean for academic affairs of I.T. from 1983 to 1991, including a concurrent position as joint acting head of the Computer Science Department for the year 1990-1991, and acting dean from 1991 to 1993. He was also the equal opportunity officer for I.T. from 1983 to 1990, for which in 1986 he was the first recipient of the Lillian Williams Award for Contributions to Equal Opportunity and Affirmative Action. He has served on numerous University and I.T. committees, including the University Senate, the University Sexual Harassment Board, co-chair of the executive planning committee for the EE/CS building, chair of the committee to write the I.T. constitution, and the I.T. consultative committee. Gordon received the George Taylor Distinguished Service Award in 1994.

Gordon claims that probably his most exciting project was as co-director of the "Building a New World" event which involved over 10,000 schoolchildren from across Minnesota working throughout the academic year 1992-1993 to make their small part of the "New World", and culminated with over 8,000 of them coming to Northrop Mall on May 4, 1993 to build a 42-foot-diameter globe in front of Northrop Auditorium. The Board of Regents presented Gordon with a Certificate of Appreciation for this project.

## Faculty News

Prof. Ashley James was granted a Presidential Early Career Award for Scientists and Engineers (PECASE) by President Bush in a ceremony at the White House.

Prof. Gary Balas and his Ph.D. student Dr. Tomas Keviczky were awarded 2006 American Automatic Control Council's O. Hugo Schuck Award for Practice for the paper entitled, "Flight Test of a Receding Horizon Controller for Autonomous UAV Guidance." presented at the 2005 Automatic Control Conference (ACC). This is a very prestigious award which will be given to Gary and Tomas at the 2006 ACC in June of this year in Minneapolis.

Professor Roger Fosdick was awarded a Laurea Specialistica Honoris Causa in Ingegneria Meccanica from the Politecnico di Bari, Italy. This is the highest Honorary Degree granted in the engineering profession in Italy and involved the approval of both the Ministry of Education and the Ministry of Foreign Affairs.

Prof. Demoz Gebre-Egziabher was selected as one of the 2006-08 University McKnight Land-Grant Professors. He received his Ph.D. from Stanford University and his research interests center on the design and operation of miniature aerospace vehicles.

Prof. William Garrard was elected for a two year term as the Chair of the National Council of Space Grant Directors which represents 52 NASA Space Grant Consortia in the 50 states, Puerto Rico, and the District of Columbia. As Chair Garrard will be the primary point of contact between NASA Headquarters and the Space Grant Consortia.

Prof. William Garrard received the John Leland Atwood Award from the Aerospace Division of the American Society of Engineering Education (ASEE)

and the American Institute of Aeronautics and Astronautics (AIAA) "for the lasting influence of his recent contributions to aerospace engineering education." Garrard received the award at the ASEE Meeting in Chicago in June, 2006. He will also be honored at the AIAA Aerospace Sciences Meeting in Reno in January of 2007.

Prof. Richard James received an Alexander von Humboldt Senior Research Award from the German government.

Prof. Richard James held the John von Neumann Visiting Chair, TU Munich, for two months this summer. He gave a course on "Lessons on Structure from the Structure of Viruses", summarizing research he carried out earlier under the Russell J. Penrose Professorship. He gave a lecture series in Rome on related topics, two keynote lectures at US National Congress on Theoretical and Applied Mechanics in Boulder, and

the "Crocco Colloquium" at Princeton. He was invited to give two popular lectures on his work: one for the Student Chapter of the Materials Research Society and the other for the Space Grant Executive Committee. For the latter he spoke on, "New Materials, Real and Imagined".

A paper Prof. Longmire co-authored with Mubassar Ali and Susan Mantell of Mechanical Engineering, "Reliability of microcantilevers in

liquid environments," was awarded 'Best Paper' of 35 presented in the reliability category at SPIE MOEMS-MEMS Conference V in San Jose, California.

Prof. Emeritus Thomas Lundgren received the Outstanding Achievement Award from the University of Minnesota and was awarded the Fluid Dynamics Prize at the November APS meeting in Tampa Bay.

Prof. Yiyuan Zhao received the Best Instructor Award as the top professor in the Department from The Institute of Technology Student Board. The Student Body chose him for his commitment to the furthering of higher education and to promoting excellence in teaching at the University of Minnesota.

### On-line AEM Alumni Database

Keep in touch and let us know your current contact information. You can also search for old classmates through our AEM Alumni Network Web page at:

[http://www.aem.umn.edu/alumni/alumni\\_network.shtml](http://www.aem.umn.edu/alumni/alumni_network.shtml)

## Faculty research

### **Air Force Office of Scientific Research**

Center for Excellence in Hypersonics Research

*Graham Candler, Krishnan Mahesh*

CFD Code Validation Experiments for Hypersonic High-Enthalpy Flows

*Graham Candler*

Direct Numerical Simulation of the Influence of Plasmas on Turbulent Flows

*Krishnan Mahesh*

Shear Stress Sensor Using Shape Memory Films

*Richard James, Ivan Marusic, Chris Palmstrom, Thomas Shield*

*Dominca (AFOSR Prime)*

Fundamental Physics and Practical Applications of Electromagnetic Flow Control in High Speed Flows

*Graham Candler*

*Rutgers University (AFOSR Prime)*

Design, Performance, and Operation of Efficient Ramjet/Scram combined-cycle Hypersonic Propulsion

*Graham Candler*

*California Institute of Technology (AFOSR Prime)*

Development of Analysis Tools for Certification of Flight Control Laws

*Gary Balas*

*(UC-Berkeley)(AFOSR Prime))*

Energy Delivery System in a Multi-Stage Railgun

*Graham Candler*

*(Uof Texas-AS (AFOSR Prime))*

University Nanosat Program: An Integrated Design Methodology for Nanosat Navigation Guidance and Controls Systems

*Demoz Gebre-Egziabher*

*William Garrard*

### **Army High Performance Computing Research Center**

High Performance Computation of Compressible Flows, Turbulent Flows

*Graham Candler*

Multiscale Methods for Active Materials

*Richard James*

### **Department of Energy**

Large-eddy Simulation of Gas-turbine Combustors

*Krishnan Mahesh*

*Stanford University (DOE Prime)*

Nonequilibrium and Structural Effects on Models of Interfacial Motion in Multicomponent Alloys

*Perry Leo*

Multiscale Design of Advanced Materials Based on Hybrid Ab-Initio and Quasicontinuum methods

*Richard James, Mitchell Luskin (Math), Ellad Tadmor*

### **National Aeronautics and Space Administration (NASA)**

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

*Gary Balas*

Development of Aeroshell Technologies for Aerocapture Missions to the Outer Planets

*Graham Candler*

The Minnesota Space Grant College Consortium

*William Garrard*

Mars Science Laboratory Parachute CDF Modeling

*Graham Candler*

*William Garrard*

### **National Science Foundation**

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

*Krishnan Mahesh*

Development of Long Distance Microscope Velocimetry Systems for Bridging Macro and Microscales

*Ellen Longmire, Ivan Marusic*

ITR: Dynamic Methods for Identifying, Visualizing, and Tracking Eddy Evolution in Experimental Turbulent Flows

*Ivan Marusic, Ellen Longmire, Victoria Interrate (C.Sci. Eng)*

NIRT: Nanoscale Shape Memory Actuators and Swimming Bugs - Theory, Computing and MBE Synthesis

*Mitchell Luskin (Math), Richard James*

SGER: Nanoparticle Tubeless Siphons

*Daniel Joseph*

Studies of Viscous and Viscoelastic Potential Flows

*Daniel Joseph*

Three New Topics in Solid-Liquid Flows

*Daniel Joseph*

Fundamental Optimization Problems in Airborne Network Design and Applications

*Yiyuan Zhao*

Wind-Generated Electrical Energy Using Flexible Piezoelectricity

*Ivan Marusic, William Robbins (ECE)*

The Effect of Surfactant on Topological Transitions in Interfacial flows

*Ashley James*

### **Office of Naval Research**

Large-Eddy Simulation of Propeller Crashback

*Krishnan Mahesh*

Multiferroic Materials in Smart Structures and Devices

*Richard James & Thomas Shield*

Compositions and Processing for Improved High Temperature Shape Memory Alloys

*Richard James*

*Marlow Industries (ONR Prime)*

Stability and Control of Very High Speed Cavity-Running Bodies

*Gary Balas*

Muri: Structural Magnetostrictive Alloys: Revolutionary Materials

*Richard James*

*(University of Maryland (ONR Prime))*

**Center for Transportation Studies (MN DOT Prime)** RPV/UAV Surveillance for Transportation Management and Security

*Demoz Gebre-Egziabher*

**Sandia National Lab**

Mechanisms of Hypersonic Boundary-Layer Transitions on Re-Entry Vehicles

*Graham Candler*

**The David and Lucile Packard Foundation**

Packard Fellowship

*Ivan Marusic*

**American Chemistry Society Petroleum Research Fund**

Experiments on Drop Coalescence in Liquid/Liquid Systems

*Ellen Longmire*

**SRF Consulting Group**

Intelligent Transportation Systems (ITS)

*Demoz Gebre-Egziabher*

**US Department of Defense Army**

Design of Active Materials: new Transforming Materials with Unprecedented Physical and Mechanics Properties

*Richard James*

**National Institute of Health**

Cell Graft Engineering Using Microfluids

*Ellen Longmire, Allison Hubel (ME), David McKenna*

Tissue-Engineered Valve from Cell Remodeled Biopolymer

*Ellen Longmire, Robert Tranquillo (Biomed Eng), Catherine Verfaillie (Medicine)*

## Faculty and staff in 2005-2006

### INSTRUCTORS/CONTRACT FACULTY

Jeff Hammer , Teaching Specialist

Yohannes Ketema , Associate Professor

Todd Hesla , Assistant Professor

James Flaten , Assistant Professor & Associate Director, MnSGC

Joseph Mueller , Instructor

Ellad Tadmor , Visiting Associate Professor

### POST DOCS/RESEARCH ASSOCIATES

Jing Wang, Post Doc

Noma Park, Post Doc

Nicholas Hutchins, Post Doc

Tamas Keviczky, Post Doc

Ioannis Nompelis, Post Doc

Runyuan Bai, Research Associate

Heath Johnson, Research Associate

### FACULTY

Gary Balas, Professor

Gordon Beavers, Professor

Graham Candler, Professor

Ryan Elliott, Assistant Professor

Roger Fosdick, Professor

William Garrard, Professor

Demoz Gebre-Egziabher, Assistant Professor

Ashley James, Assistant Professor

Richard James, Professor

Daniel Joseph, Professor

Perry Leo, Professor

Ellen Longmire, Professor

Krishnan Mahesh, Associate Professor

Ivan Marusic, Professor

Tom Shield, Professor

Yiyuan Zhao, Professor

### STAFF

Elizabeth Bodelson, Executive Office Specialist

Lisa Schouviller, Executive Accounts Specialist

Emily Peterson, Executive Office Specialist

Daniel Hegland, Principal Accountant

Donna Rosenthal, Senior Administrative Director

Ray Muno, Info Tech Professional

Molly Nelson, Executive Office Specialist

Greg Nelson, Lab Coordinator

## Alumnus wins prestigious award

### Company named Entrepreneurial Business of the Year

In late September of 2005, Ritalka Inc. was chosen as the Southwest Minnesota Entrepreneurial Business of the Year at the Annual Southwest Minnesota Workforce Summit. The award was presented to Kevin Wald for outstanding accomplishments as the president of engineering and manufacturing firm, SpecSys Inc.

neering design and manufacturing firm. With just under 150 experienced staff members on board, SpecSys is able to tackle a wide range of product developments and production, including follow-on support.

At the point of completing a documentation package, SpecSys is able to provide follow-on phases related to product development that other firms are unable to achieve. SpecSys has the ability to develop prototype builds, testing, fixture design and builds, and pilot unit production runs along with the flexibility, product experience capabilities, and capacity to offer full production if the client so desires.

In the fall of 2002 a new 110,000 ft<sup>2</sup> facility located in Granite Falls, MN was acquired. Not only did this new facility provide for a safe haven away from the flooding Minnesota River, but brought with it a much improved facility for the heavy steel industries now being supported by Spec-

Sys. The manufacturing move to Granite Falls began late 3<sup>rd</sup> quarter of 2002, and finalized mid 1<sup>st</sup> quarter of 2003. The next expansion was March 1, 2005, adding a 15,000 ft<sup>2</sup> welding facility located in Redwood Falls, MN. The most recent expansion includes the opening of an engineering office on July 1, 2005, located in Milwaukee, WI.



University alumnus Kevin Wald (seen here with Gov. Tim Pawlenty, founded SpecSys Inc., which won the 2005 award for Entrepreneurial Business of the Year.

The award, which was presented by the Southwest Minnesota Workforce Council and the Minnesota Department of Employment and Economic Development, honored Mr. Wald and the employees of SpecSys Inc. for the company's achievements in "willingness to assume risk, success in innovation, response to adversity, and community involvement." The award is given annually at the Southwest Minnesota Workforce Summit which is hosted by the Southwest Minnesota Workforce Council and the Central Minnesota Workforce Investment Board for the eighteen county area of southwestern Minnesota.

#### *About SpecSys, Inc.:*

Specialty Systems (SpecSys) specializes in design and development of machinery and mobile equipment for Original Equipment Manufacturer (OEM) clients across North America. SpecSys was founded in March of 1997 and has grown quickly to be a premiere engi-

## Alumnus elected honorary Fellow

Peter Torvik, a Minnesota native and alumnus who received his B.S. (Aeronautical Engineering), M.S. (Engineering Mechanics) and Ph.D. (Engineering Mechanics) at the University, was recently named an honorary Fellow by the Ohio Academy of Science.

“Election as an honorary Fellow is the highest form of recognition by peers offered by the Ohio Academy of Science,” said Lynn Elfner, the Academy’s Chief Executive Officer.

The Ohio Academy of Science is a membership-based, volunteer-driven, not-for-profit organization.

Dr. Torvik began his research career as an undergraduate at the University, working on Air Force sponsored studies of vibration damping in the experimental materials laboratories of University of Minnesota. As a graduate student, he held the positions of teaching assistant, research assistant, Fellow, and Instructor.

While a junior, Torvik married his wife, Patricia, and the couple had their first child while Dr. Torvik was a senior.

“In consequence of the outstanding financial support provided and enabled by the University of Minnesota, rather than leaving graduate school in heavy debt, I left with about \$3,000 1964-sized dollars in the bank,” he said. “The support also enabled my wife, who had also been a U of M student before we were married, to be a full-time mom from before our first son was born until both were well into their school years.”

All in all, the University provided and enabled support of approximately \$200,000 (in 2004 dollars), he said. Along with that financial support, Torvik remembers the University for its demands and rigor, opportunities in employment and for intellectual advancement, and quality of faculty and education – which, he said, was “clearly superior, by any standard.”

In 1964, Torvik started as an Assistant Professor at the Air Force Institute of Technology in the Department of Mechanics of the School of Engineering. He was promoted to Associate Professor in 1967, to Professor in 1973, and was selected to the Institute’s third senior research faculty position in 1975. He served as department head from 1980 until 1990, eventually

retiring in 1996 as a full-time faculty member. He now provides consulting support in technical areas and in the development of organizations for collaborative research and education.



Among other honors and awards, he is the 2002 recipient of the John Leland Atwood award and medal jointly given by the American Institute of Aeronautics and Astronautics and ASEE. He has been elected a Fellow of the AIAA and of the Ohio Academy of Science, a Life Fellow of the American Society of Mechanical Engineers, and has received Air Force Medal for Exceptional Civilian Service, the Air Force Medal for Meritorious Civilian Service, and the USAF Outstanding Civilian Career Service Award. His biography appears in Who’s Who in Engineering and Who’s Who in the Midwest.

Torvik now privately consults and enjoys living on seven hilly and wooded acres 25 miles from Dayton, Ohio. In addition to spending time with his “pet” 1948 Ferguson tractor, Torvik fishes, hunts and continues to be interested in music – he received a bachelor of arts in Music Theory and History from Wright State University in 1980.

**AEM is offering new content on our website aimed at keeping our constituents updated on the latest in aerospace and departmental news, but we need your help. Send in news, tips, or even just photographs of recent events and look for them on our site!**

## Donations 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:

[www.giving.umn.edu](http://www.giving.umn.edu)

If you have questions on donating, you can contact the University Foundation by phone at: 612-624-3333 or 800-775-2187 or 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 in which we encourage contributions are as follows:

**AEM Strategic Initiatives Fund:** Used as the main source of discretionary funds to support improvements in our Department. Fund No. 3739

**The John D. Akerman Memorial Fund:** Supports the Akerman Professor of Design of our year-long capstone senior capstone 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. 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 and many student-sponsored projects. Fund no. 5330

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](mailto: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/>



# The look of AEM is changing

## Initiatives will create study space for students

Two student lounges - one for graduate students and one for undergraduates - will soon come to be as part of new departmental initiatives.

The student lounge will serve both as a relaxation area and a working space. Apart from spending their free time in the lounge, students will also hold study groups, discussions, and meetings in the lounge. By providing computers to facilitate the preparation of materials for these study groups, an environment conducive to student-initiated academic study beyond the scope of coursework will be created on the department premises.

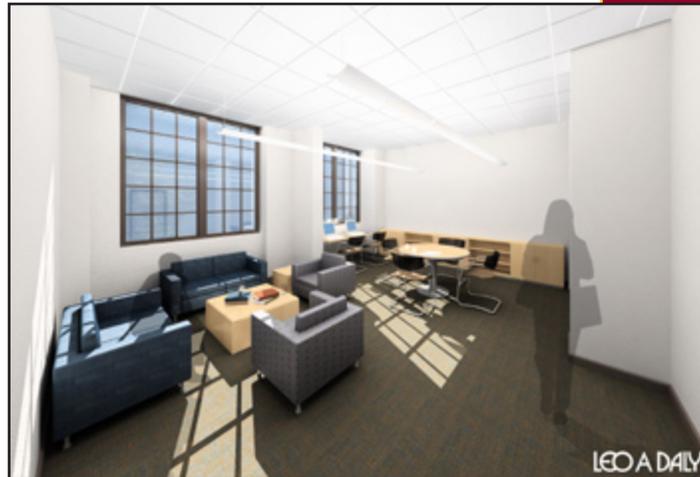
In addition to this, computers will be set up so as to meet field-specific needs of students in the department thereby facilitating their individual study and research.

The undergraduate lounge will also serve as a center point for the AIAA student chapter activities. Students at both the graduate and undergraduate program endorse or embrace these initiatives.

It is important that all, not just the faculty and staff but also students, have a feeling of belonging - and not just one of passing through.

Gary Balas

*Proposed Graduate Student Lounge*



*Proposed Undergraduate Student Lounge*



## MnSGC awards: 2005-2006

### NASA ACADEMY/INTERNSHIPS

*Rayna DeMaster*  
*Brandon Huelman*  
*Matt Otterstatter*  
*Michael Busch*  
*Kelly Stephani*  
*Chris Alba*  
*Kristin Fristad*  
*Craig Lewandowski*  
*Aaron Westman*  
*Christopher Olson*  
*Bryce Engen*

### UMTC GRADUATE FELLOWSHIPS

*Karl Isensee*  
*Erin Ryan*  
*Johannes Hubmayr*  
*Paul Edmon*

### UMTC STUDENT SATELLITES (MINNESAT)

*Moehnke, Nathan*  
*Field, Ella*  
*Anderson, Jason*  
*Pogemiller, Jim*  
*Moehnke, Nathan*  
*Anderson, Jason*  
*Mintz, Jason*

### UMTC UNDERGRADUATE

*Andres Abin-Fuentes*  
*Ibrahaim Alade-Lambo*  
*Hassan Hassan*  
*Alexander Kado*  
*Chris Nwaiwu*  
*Sergio Perez*  
*Crystal Pitts*  
*Joseph Shelerud*  
*Meagan Thompson*  
*Nick Turner*  
*Oluwatoyin T Alowonle*

### CONSORTIUM-WIDE AWARDS

*Vigeland, Sarah – Carleton College*  
*Andreason, Molly – University of St. Thomas*  
*Berg, Karissa – Augsburg College*  
*Harell, Chelsi – University of St. Thomas*  
*Lytte, Christian – University of St. Thomas*  
*Miller, Jason – Concordia College*  
*Mintz, Jason – University of MN Twin Cities*  
*Schwendther, David – Augsburg College*  
*Nguyen, Long – University of MN Twin Cities*

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## Scholarships, awards and fellowships

### 2005-2006 BOEING COMPANY STUDENT SCHOLARSHIP

*Angela Reesman*  
*Rachel Winters*  
*Cecilia Sickler*  
*Samuel Zarovy*  
*Jonah White*  
*Jillian Schmidt*

### 2005-2006 ROSE MINKIN SCHOLARSHIP

*Daniel Poniatowski*

### 2005-2006 RICHARD AND SHIRLEY DELEO SCHOLARSHIP

*Jason Anderson*

### 2005-2006 CHESTER GASKELL SCHOLARSHIP

*Daniel Van Lith*  
*Erik Axdahl*

### AEM PROGRAM INITIATIVES --STUDENT STUDY ABROAD SCHOLARSHIPS

*Nicholas Buystedt Taiwan and Hong Kong*  
*Daniel Van Lith Poland and Czech Republic*

### 2006 PAUL A. CARTWRIGHT AND I.T. ALUMNI SOCIETY AWARD FOR OUTSTANDING SERVICE IN STUDENT ACTIVITIES AND/OR COMMUNITY PROJECTS

*Theresa Krack*

### GRADUATE STUDENT FELLOWSHIPS

*Vladimir Gidzak*  
*John and Jane Dunning Copper Fellowship*  
*Hyunchul Jang*  
*John and Jane Dunning Copper Fellowship*

# Congratulations Graduates!

## MASTERS OF AEROSPACE ENGINEERING

Andrew Carl Poppe

## MASTERS OF SCIENCE

### AEROSPACE ENGINEERING AND MECHANICS

Bhuiyan Aizaz

Pradeep Chandra Babu Salapakkam

Michael Daniel Barnhardt

Nenad Bjelogrić

Sidharth Saktan Chiravarambath

*Thesis: Indentation of Articular Cartilage*

Jeffrey Joseph Doom

Mikhail Alexeevich Egorov

*Thesis: Robust Stabilization of Relative Equilibria with Application to the Heavy Top*

Shankar Ghosh

Juan Carlos Padrino Inciarte

Ana Florencia Rasetti Pacios

*Thesis: Electromigration Effect on Morphological Stability*

Neelakantan Saikrishnan

Justin Joseph Syrstad

*Thesis: Experimental Investigation of Wedge Shaped Fin and Supercavity Interaction*

Kerry Agnes Trumble

## DOCTORATE OF PHILOSOPHY

### AEROSPACE ENGINEERING AND MECHANICS

Weston Daniel Clarence Heuer

*Thesis: Fluctuating Wall Shear Stress Measurements in the Atmospheric Surface Layer*

## DOCTORATE OF CONTROL SCIENCE AND DYNAMICAL SYSTEMS

Tamas Keviczky

*Thesis/Project Title: Decentralized Receding Horizon Control of Large Scale Dynamically Decoupled Systems.*

## BACHELOR OF SCIENCE

### AEROSPACE ENGINEERING AND MECHANICS

Aaron Alexander Boysen, *Fall 2005*

Rachel Ann Busch, *Fall 2005*

Ryan Ardin Jelle, *Fall 2005*

Richard Lee Martin III, *Fall 2005*

Michael L Petersen, *Fall 2005*

Reid Vincent Plumbo, *Fall 2005*

Nicholas Schroeder, *Fall 2005*

Matthew James Scott, *Fall 2005*

Christopher Jacob Skwarek, *Fall 2005*

Christopher Robert Alba, *Spring 2006*

John Michael Arazny, *Spring 2006*

Matthew David Bartkowicz, *Summa Cum Laude, Spring 2006*

Kyle Peter Boe, *Spring 2006*

Minsuk Cha, *Spring 2006*

MacKenzie Jeanne Collatz, *Spring 2006*

Christopher R Cook, *Spring 2006*

Joseph Coraggio, *Spring 2006*

Adam Franklin Czerwonka, *Spring 2006*

Jennifer Joan Dague, *Spring 2006*

Atul Danny Dhuria, *Spring 2006*

Chase Robert Dullinger, *Spring 2006*

Brian Jacob Erickson, *Spring 2006*

Geoffrey Miyake Fischer, *Spring 2006*

Marc Thomas Granson, *Spring 2006*

Neal Arthur Hario, *Spring 2006*

Timothy James Hoffman, *Spring 2006*

Brandon Nicholas Huelman *Summa Cum Laude, Spring 2006*

Kristoffer Ramirez Jonson, *Spring 2006*

John Brooks Kostrzewski, *Spring 2006*

Jacob J Kowalski, *Spring 2006*

Theresa Michelle Krack, *Spring 2006*

Craig Michael Lewandowski *Summa Cum Laude, Spring 2006*

Garrison Jay Lindholm, *Spring 2006*

Jen-Chia Liu, *Spring 2006*

Kyle James Lundequam, *Spring 2006*

Gregory Steven Maki, *Spring 2006*

Scott Andrew Miller, *Spring 2006*

Matthew Allen Mitchell, *Spring 2006*

Todd Otto Novak, *Spring 2006*

Dustin Cassidy Otis, *Spring 2006*

Matthew Robert Otterstatter, *Spring 2006*

Aaron Justus Pederson, *Spring 2006*

David Ryan Pfister, *Spring 2006*

Jeff M Porwoll, *Spring 2006*

Jason Craig Roble, *Spring 2006*

Corey Adam Rolfes, *Spring 2006*

Shaun William Roycraft, *Spring 2006*

Scott J Schollmeyer, *Spring 2006*

Nicholas Ryan Schramper, *Spring 2006*

Aniekan Daniel Udoh, *Spring 2006*

Ross Martin Wagnild, *Summa Cum Laude, Spring 2006*

## Senior Design I from page 14

flight under wind gust disturbance is a primary concern for this design. The goal of this work is to tune the autopilot to provide smoother flight.

This airplane has two versions, the baseline and Extended Range (ER) version. The end product of this project is a set of autopilot gains for both versions of this airplane, which will insure smooth controlled flight under autopilot control. These gains will be determined by simulation methods. This effort is primarily analytical in nature, but it uses real flight test data, and culminates in a flight of the Sky Spirit using the gains selected by the student team. This team built and tested a wind tunnel model and participated in flight tests of the UAV.

LARGE COMMERCIAL JET TRANSPORT DESIGN  
– BOEING SPONSORED

This is an analytic design trade of study starting with mission requirements supplied by Boeing. A dedicated air freighter airplane (DAF) designed exclusively as a freighter has never been done (designed and put into service) by any airplane company. Freighter planes have in the past always been derived from passenger planes, modified for freighter service. This compromises the design for its freighter role. In this design study the team had to understand the unique requirements of the air freight business and design a complete system to address that market. The team addressed issues put forth to them by Boeing and produced a credible CDR attended by Hammer and Boeing. Boeing had high

praise for the results and two of the students on the team are now employed at Boeing.

ENGINE TEST STAND – LEGACY LOCKHEED MARTIN SPONSORED PROJECT

This project continued the engine test stand built and tested (unsuccessfully) in spring 2005. At the start of the project mechanical structure was built, load cells were installed, but the mechanical structure was unreliable. The instrumentation system developed the previous year left much to be desired.

To correct all these design flaws we formed up a joint Aero and EE team. This team refined the mechanical design, the electronic design and interface software. Lockheed loaned us superb computer hardware and instrumentation electronics to put the system together. The students learned to overcome mechanical, electrical and real time software measurement problems making this system work.

KINETIC ENERGY UAV – TWO TEAMS

The mission of this UAV is surveillance over nearby hills, obstructions or in dense urban environments. The user is a team of Special Forces soldiers scouting for enemy forces of much greater strength. Two teams signed up for this project and did the project as a design competition. The winning team got to build and flight test the device in the spring of 2006. It flew successfully and landed three times in a very short time with no repairs.

*Jeff Hammer*

## Senior Design II from page 15

that one computer fails, the second will take over immediately, allowing Minnesat to continue its mission.

### 2) Power

The power system is responsible for providing electrical power to every system on board the spacecraft. It consists of solar cells for collecting energy, rechargeable batteries for providing power during eclipse and during periods of peak power draw, regulators and busses to distribute power to the other systems, and a power management microcontroller to oversee the battery charging and maintain the system health.

### 3) Communications

The communications system is responsible for maintaining contact with the ground. It will consist of two transceivers using amateur radio frequencies (435 MHz) for uplink and downlink, and several antennas.

### 4) Attitude Determination, Navigation, and Control

The attitude determination, navigation, and control system consists of two subsystems, the GPS subsystem and the truth attitude subsystem. The GPS

subsystem is the science mission of Minnesat, and will find the attitude of Minnesat using several GPS receivers working together. The truth attitude subsystem will determine Minnesat's attitude using conventional sensors proven to work in space. This will provide a baseline to compare the GPS attitude system with, in order to determine how well it works.

### 5) Structure

The structure system integrates every system together. It is responsible for ensuring the survival and integrity of the spacecraft throughout the launch and on orbit. It will consist mainly of an aluminum structure, with component boxes to house other systems.

### 6) Thermal Management

The thermal control system is responsible for maintaining all components within their operating temperature range. The system consists of sensors to determine if a component requires heat, resistive heaters for heating, logic to control the heaters, and other passive heating or cooling elements such as heat sinks or conductive finishes.

*Bill Garrard*

## Exit Survey from page 4

sponded positively while 12.5 percent were neutral.

b. whether the intern and/or experience enhanced their education; forty percent responded positively while 57.1 percent remained neutral.

c. whether the quality of facilities provided were good; 38.5 percent responded positively while 33.3 percent remained neutral.

d. whether the quality of the computational facilities provided were good: 43.6 percent responded positively and 35.9 percent remained neutral.

e. whether the senior design courses improved their ability to work as part of a team: 67.5 percent responded positively, while 17.5 percent 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: 67.5 percent responded positively.

Although the majority of the graduating seniors were generally satisfied with their educational experiences in the BAEM program, 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](http://www.aem.umn.edu/teaching/undergraduate/BAEM_prog_assessment.shtml)*

## AIAA from page 20

with fellow aerospace majors and meet new people. Some events took a lot of planning and fell through due to circumstances beyond our control – like the Imax projector breaking down or lack of professors showing up to the rescheduled softball game. Don't worry, next year we *will* be challenging the professors, faculty and staff to a game and, so far, the students are technically undefeated.

Looking back on the year, we accomplished something that was absolutely phenomenal. We set our aim high and, though we may not have hit the moon, we definitely landed among the stars. Kudos for a job well done go out to the out-going officer crew. They worked as a team to ensure that there would be activities of all sorts for the students that were interested. As for the incoming officers, they have a lot to live up to but they are ready and willing to take the mantle that has been passed on. The next crew of officers is enthusiastic to keep the group alive and growing – they definitely will do a great job with AIAA.

*Theresa Krack, President 05-06*

## Wife of former faculty member passes away

Luise Heinrich, wife of former faculty member Helmut Heinrich, died in early October of 2006. From her obituary :

Luise Heinrich (92) of Whitefish, MT, formerly of Minneapolis, born March 1, 1914 in Alsace, Germany, died October 9, 2006. She was preceded in death by her husband, Dr. Helmut G. Heinrich; daughter, Hildegard Crowley; and granddaughter, Kristin Schutz. Survived by daughter Eva (Paul) Lane; son Klaus (Joaquenia) Heinrich; son in law Tom (Erica) Crowley; grandchildren, Jennifer Jah; Christopher (Jennifer) Crowley; Devin (Karin) Crowley; and great grandchildren, Ryan and Alyssa Jah; Casey and Ryan Crowley; and Kiran Crowley. Luise immigrated to the United States with her husband and children in 1947 as part of "Project Paperclip", which brought German scientists to the US after WW II. She loved nature, gardening and music and incorporated those passions into her own art. She will be remembered as a spunky lady with an unforgettable smile.

Luise's husband, Dr. Helmut G. Heinrich, joined the University of Minnesota faculty in 1956; he left Germany after the war as part of Project Paperclip. Professor Heinrich taught courses and conducted pioneering work on deployable aerodynamic deceleration devices, primarily parachutes. A number of undergraduate and graduate students worked on government contracts and grants under the direction of Dr. Heinrich. He invented the guide-surface parachute and several related devices that significantly improved parachute construction and performance. Heinrich developed supersonic parachutes that were considered for use in the Apollo program and his contributions to parachute systems were used for soft-landing scientific probes on Venus and Mars. Helmut Heinrich died of a heart attack on March 7, 1979 in Houston where he had just received the first AIAA Aerodynamic Deceleration Systems Award. He was a fellow of the AIAA, a Fellow of the RAES, and a charter member of the AIAA Committee on Aerodynamic Deceleration Systems formed in 1965.

# AEM Update

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