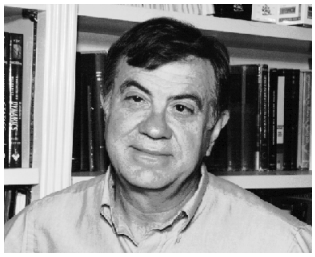
THE AEM UPDATE

Department of Aerospace Engineering and Mechanics
University of Minnesota

Chairman's Corner



Overall this has been a good, but busy year for the Department. The Department and Aerospace Engineering in general had a large presence at the IT Graduation Ceremonies on June 4. In addition to graduating 27 students with the BAEM Degree, the Commencement Speaker was Col. Robert Cabana, Astronaut and Chief of the Astronaut Office. Col. Cabana is a native of Minneapolis. Professor Gordon Beavers was named IT Distinguished Professor. The IT Professorships recognize distinguished faculty members within the Institute of Technology who are judged exceptional through unusual efforts in, and contributions to teaching, a reputation in scholarly research, and a genuine commitment to the Institute of Technology and its activities. It would be difficult to find another faculty member in IT who satisfies these criteria as well as Gordon Beavers. In addition two of our graduating seniors were honored at Commencement, Dorothea Czernik received the Paul A. Cartwright IT Alumni Award for Outstanding Service and Joe Mueller gave the student commencement address (the text of Joe's speech is given later in this news letter). Both Dorothea and Joe will remain in the Department for graduate studies.

External support for research and other activities per faculty member continued to rise for the seventh straight year. This year we were highest of any Department in IT with $277,754 per faculty (the average for the engineering departments was $171,873). In 1991-92 we were lowest of all of the engineering departments with external expenditures of only $63,029 per faculty member. This annualized increase of 48.7% is phenomenal and indicates the quality and dedication of our faculty.

Our undergraduate enrollments have increased slightly and the job market still appears to be good for our graduates. We are continuing our recruitment efforts for both graduate and undergraduate students. This summer will mark the end of the quarter system at the University of Minnesota. After a considerable amount of work, we have our new curriculum in place and are confident that we will make the transition without too many glitches. Every six years our program is evaluated by ABET (the Accreditation Board for Engineering and Technology). Our next accreditation is coming up in 2001. The new accreditation procedure, ABET 2000, is much more outcomes based than in the past. We will be surveying constituents - current and former students, employers, advisory board members, and other Universities regarding our program and its outcomes. If you are a recent graduate of the Department, you will be receiving a survey soon. Please fill it out and return it. I will share the results of this survey and how we will use these results to improve our program in the next AEM Update.

We have had some changes in the Department since the last newsletter. Professor Tayfun Tezduyar, Distinguished McKnight Professor and Director of the Army

Inside

High Performance Computing Research Center, left the University of Minnesota to assume the James F. Barbour Professorship in Engineering and Chairmanship of the Mechanical Engineering and Materials Science Department at Rice University in Houston. We will be searching for a faculty member in computational fluid mechanics this year. Dr. Ivan Marusic, previously of the University of Melbourne in Australia, joined our faculty in October of 1998 as a tenure-track Assistant Professor. Dr. Marusic is a fluid mechanist who specializes in turbulence modeling. Dr. Mehran Mesbahi will join the Department this fall as a tenure track Assistant Professor. Dr. Mesbahi comes to us from the Jet Propulsion Lab where he has been working on formation flying of satellites. He received his BS in Engineering from California State University in Northridge, an MS in Electrical Engineering and in Math from USC, and a Ph.D. in Electrical Engineering also from USC. Dr. Mesbahi will enhance Aerospace Systems in the Department. This is an area where student demand is high and our faculty is small. Graham Candler was promoted to Full Professor. Professor Candler is a leader in computational hypersonics and is one of the youngest Full Professors at the University.

Next year will see some administrative changes. Professor Ted Wilson has decided to step down as Associate Department Head and Professor Perry Leo will become our new Associate Head. Professor Ellen Longmire will resume her job as Director of Graduate Studies after returning from sabbatical leave and Professor Tom Shield will be our Director of Undergraduate Studies. As many of you know the age distribution of our faculty members is bimodal and all of the above individuals are from the younger mode. As older faculty members retire, we will undoubtedly see some changes in the focus of the Department. There will be opportunities to maintain and enhance the quality of our Department and expand into new areas. We are currently working on a plan for future hiring. Your suggestions on the future of the Department are welcome. The best way to contact me is via e-mail, garrard@aem.umn.edu.

One project that is consuming a great deal of time and resources is a major rehabilitation of our lab facilities. We are the only engineering department that has not had a new building or a major renovation of an existing building, so we are having to do the best with what we have. With the construction of the new Mechanical Engineering Building, the electrical service to our building will be increased substantially. We currently have some experimental facilities such as wind tunnels and the arc furnace which cannot be operated simultaneously due to lack of power. We are now looking toward some major renovations in the basement of Akerman including a new computer lab and wind tunnel facility.

State support for these infrastructure improvements is still not adequate and we depend on gifts as an important method for supplementing state funds. The support of our alumni and friends is critical to us in maintaining excellence in our programs.

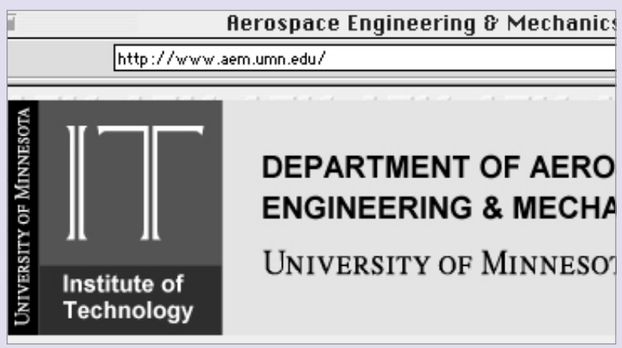
As I have stated before, one of our goals is to keep in better contact with our graduates. Please keep in touch by providing us with items for our Alumni news. You can do that by contacting Donna Rosenthal by e-mail. Her address is donna@aem.umn.edu. Alternatively, Donna's fax number is (612) 626-1558. Also visit the Departmental web site at http//www.aem.umn.edu.

Visit the AEM

homepage at:

http: //www.aem.umn.edu/

For Info on:
- Faculty
- Faculty Research
- AEM Programs



Academics: Where are We Now?

AEM Undergraduate Program

During the 1998-99 school year, 27 students received the BAEM degree through the undergraduate program in Aerospace Engineering and Mechanics. In the fall of 1998, 19 new juniors were admitted to the upper division program.

The job market continues to be very strong and our graduates have had good success in locating jobs, locally and across the nation. There were also graduates who will continue their studies at top graduate schools in the country, including 4 who remained in Minnesota to enroll in the graduate programs in Aerospace Engineering and Mechanics.

Early registration this spring brought about a new era for students at the University of Minnesota. They were registering to take classes in fall of 1999, the beginning of the new semester system. AEM students had to first meet with their assigned advisors to plan a program of study covering at least their first year under semesters. Some students planned out a four-year program. Students were able to register on-line with the (also new), university-wide computer system using the PeopleSoft software. Under the semester system, students will be taking more classes which are assigned fewer credits than under the quarter system, however, the amount of time a student spends per credit earned remains about the same (see related article on following pages).

AEM Graduate Program

Last year, the Department enrolled 20 new students into the Aerospace Engineering and Mechanics graduate program. Six of these students were from the United States, four of whom were graduates of our own BAEM program. Two were from China, two from Spain and two from Venezuela. The others were one each from Germany, Greece, India, Ireland, Malaysia, Russia, Sri Lanka and Turkey.

During the past year the Department awarded 9 Masters (six in Aerospace Engineering and 3 in Mechanics) and 5 Ph.D. degrees (one in Aerospace Engineering and 4 in Mechanics). Our graduates continue to secure lucrative and satisfying employment, some in industry and others teaching in higher education institutions. Several of our M.S. graduates last year continued on in the PhD. program here in Minnesota and one went on for a PhD. elsewhere.

The past year also saw a number of our graduate students participating in service activities with elementary schools along with conducting tours of our facilities and other activities with elementary school children during their visits to the Department.

BAEM Converts to Semesters

The University was mandated by the State to change over to the semester system starting with the Fall term of 1999. Thus the BAEM degree had to be converted to semesters. This process took a couple of years and this year we will start to find out how well the new program works. The new program is shown in the accompanying table and it is different from the quarter BAEM program in several respects. The first two years are fairly standard for a four year engineering program. The biology course with a lab is a University wide requirement and we have changed to requiring C/C++ as a programming language instead of FORTRAN.

The junior and senior years had to be significantly reworked to convert to the semester system. However, there are still the three main topic areas of Fluids, Structures and Aerospace Systems, which are brought together in the laboratory and design sequences. The Fluids sequence, which includes propulsion, repackages the five quarter courses into three semester courses. The thermodynamics and heat transfer courses given by the ME department have been combined into a single course. The Structures courses are essentially unchanged, the required solids technical elective is still a choice of several courses. Our Composites course, which is now a required course for Material Science majors, will most likely remain the most popular selection. The Aerospace Systems topics have been combined into three courses starting in the second semester of the sophomore year. Additional emphasis has been placed on Space by converting the Astrodynamics elective course into the

required Spaceflight Dynamics course. The laboratory courses have been completely redesigned (see the article on the Instrumentation Laboratory Course elsewhere in this issue). The required senior design sequence, which was two quarters, is now a full year. This should give the students much needed additional time to complete their projects , RC models and other hands-on aspects of their designs in the spring.

There is no longer a separate technical writing course. The University wide requirements have changed and, now require that advanced writing be integrated into technical courses. Four writing intensive courses are required, which will be met by the two freshman physics courses, our senior laboratory course and the second semester of the design sequence. The AEM courses already involved significant writing, thus making them writing intensive did not require major changes, but an additional credit was added to the laboratory and design courses to indicate the increased workload. Finally, there are two technical electives (in addition to the solids elective) that the students may choose from the advanced courses given by the AEM and other engineering departments.

Additional information on the BAEM program under semesters, including a listing of all AEM courses, is available over the Internet at:

http://www.aem.umn.edu/teaching/semesters/

AEM Semester Curriculum, Semester by Semester

Fall Semester		Spring Semester	
Freshman year:			
MATH 1271 — Calculus I	4	MATH 1272 — Calculus II	4
PHYS 1301 — Introductory Physics I*	4	PHYS 1302 — Introductory Physics II*	4
CHEM 1021 — Chemical Principles I	4	BIOL 1001 — Introductory Biology I: Evolutionary and Ecological Perspectives	4
ENGC 1011/2/3/4 — University Writing and Critical Reading	4	CSCI 1113 — Introduction to C/C++ Programming for Scientists and Engineers	4
Sophomore year:			
MATH 2263 — Multivariable Calculus	4	MATH 2243 — Linear Algebra and Differential Equations	4
PHYS 2303 — Introductory Physics III	4	AEM2012 — Dynamics	3
AEM2011 — Statics	3	AEM2301 — Mechanics of Flight	3
MATS 2001 — Introduction to the Science of Engineering Materials	3	Liberal Education Elective	3
Liberal Education Elective	3		
Junior year:			
AEM4201 — Fluid Mechanics	4	AEM4202 — Aerodynamics	4
AEM3031 — Deformable Body Mechanics	3	AEM4501 — Aerospace Structures	3
AEM4301 — Spaceflight Dynamics	3	AEM4303 — Flight Dynamics and Control	3
EE 3005 — Fundamentals of Electrical Engineering	4	AEM4601 — Instrumentation Laboratory	3
EE 3006 — Fundamentals of Electrical Engineering Laboratory	1	Liberal Education Elective	3
Senior year:			
ME 3324 — Introduction to Thermal Science	4	AEM4203 — Aerospace Propulsion	4
AEM4331 — Aerospace Vehicle Design I	3	AEM4332 — Aerospace Vehicle Design II*	4
AEM4602 — Aeromechanics Laboratory*	4	Technical Elective	3
Liberal Education Elective	3	Solids Technical Elective	3
Technical Elective	3	Liberal Education Elective	3

Total Credits : 127
* indicates writing intensive course.

CONTROL SCIENCE AND DYNAMICAL SYSTEMS (CSDY)

Interdepartmental Ph.D. Program

The CSDy Indepartmental Ph.D. Program provides an opportunity for interdisciplinary research in control science and dynamical system theory. The CSDy program coordinates scholarly and scientific activity of these areas within IT and the University and coordinates its activities with industrial firms in the Minnesota region.

CSDy faculty are drawn from the Departments of Aerospace Engineering and Mechanics, Chemical Engineering, Electrical Engineering and Mechanical Engineering, as well as from the Departments of Computer Science, Mathematics and Statistics, all in IT, and from the Departments of Economics and Political Science. The Co-Directors of the CSDy Center are Professor Gary J. Balas (AEM) and Professor Tryphon Georgiou (EE). Professor Balas serves as CSDy Director of Graduate Studies.

This has been an exciting year for the CSDy Program. The CSDy seminar series focussed on Air Traffic Management. In the Fall, Professor James K. Kuchar of the Massachusetts Institute of Technology lectured on "Managing Uncertainty in Aerospace Decision Aiding and Alerting Systems." Professor Claire Tomlin from Stanford University gave a seminar in Winter on "Hybrid Dynamical Systems with Application to Air Traffic Management" and Dr. Christine Haissig of the Honeywell Technology Center lectured on the ongoing work at Honeywell related to "Designing an Airborne Alerting System for Closely Spaced Parallel Approaches."

Three students, Dr. Ali Jhemi, Dr. John Pliam and Dr. Wayne Lu graduated with the Ph.D. degree in CSDy during the 1998-1999 academic year. Dr. Jhemi's thesis was entitled "Optimal Flight of a Helicopter in Engine Failure." Dr. Jhemi's advisor was Professor Yiyuan Zhao (AEM). He is currently employed at the Aerospace Corporation in Los Angeles as a member of their technical staff. Dr. Pliam's thesis was entitled "The Algebraic Properties of Cryptographic Protocols in their Formal Analysis." His advisor was Professor E.B. Lee (EE). Dr. Lu's thesis was entitled "Norms and Optimal Control with Worst Case Disturbance Rejection." He was co-advised by Professor Gary Balas (AEM) and Professor E.B. Lee (EE). The CSDy Program has 7 students pursuing the Ph.D and all are Research Assistants working on various research projects related to the control and dynamics of systems.

For more information regarding the Control Science and Dynamical Systems Program contact Kristal Belisle at (612) 625-3364 (email:kristal@aem.umn.edu).

NEWS ABOUT OUR FACULTY

Professor Gary Balas gave invited talks at NASA Lewis Research Center, Boeing in Houston, TX, NASA Johnson Space Center, University of Budapest, Hungary, and the University of Stuttgart, Germany. He taught a three-day short course at 3M this past spring on, "Frequency Domain Process Analysis and Control, for engineers and researchers. In addition, he co-organized and taught a short course on, "LFT-Based Methods for Integrated Modeling of Nonlinear Systems," at the 1999 American Control Conference in San Diego, CA, in June.

During the past year, Professor Graham Candler and his post-docs and graduate students presented papers at: the 51st APS Division of Fluid Dynamics Meeting, Philadelphia, PA, November 1998; 37th AIAA Aerospace Sciences Meeting, Reno, NV, January 1999; 2nd AFOSR International Conference on DNS and LES, New Brunswick, NJ, June 1999; 35th AIAA/ASME/SAE/ASEE Joint Propulsion Conference, Los Angeles, CA, June 1999; 30th AIAA Plasmadynamics and Lasers Conference, Norfolk, VA, June 1999; 33rd AIAA Thermophysics Conference, Norfolk, VA, June 1999; 30th AIAA Fluid Dynamics Conference, Norfolk, VA, June 1999; and the 3rd ASME/JSME Joint Fluids Engineering Conference, San Francisco, CA, July 1999. He was also promoted to full professor in the Department.

Professor Roger Fosdick was elected Chairman of the Society for Natural Philosophy in March, 1999 for the second time in the history of the society, which began in 1962. He

gave invited lectures at the 1st Canadian Conference on Nonlinear Solid Mechanics, Victoria, British Columbia, Canada, June 1999 and at the symposium on Finite Thermoelasticity: ASME Winter Annual Meeting, Nashville, TN, November 1999. In addition, he was honored for his past research contributions at the 1999 ASME Mechanics and Materials Conference in Blacksburg, VA, June 1999 with a symposium in his behalf titled "Advances in the Continuum Mechanics and Thermodynamics of Material Behavior". There were 37 talks presented by friends and colleagues over a 3-day period capped by an enjoyable celebration dinner.

Professor William Garrard served as a Technical Co-chair for the AIAA/CEAS 15th Aerodynamic Decelerator Seminar and Technology Conference in Toulouse France in June 1999 and presented a paper at the conference. He also organized the 8th Decelerator Systems Short Course which was held in Minneapolis in October 1998. There were 46 practicing engineers including an astronaut participating in the five-day course.

Professor Richard James was named (together with John Ball from Oxford University) Chief Editor of the Archive for Rational Mechanics and Analysis. The Archive is a premier journal in the field of mechanics and analysis, that counted as early members of the editorial board, among others, Chandrasekhar, Einstein, Green, Hadamard, Hamel, E. Hopf, Kac, Leray, Rellich, Rivlin, Schlichting, Signorini, Sternberg, and von Neumann. The predecessor for the Archive, the Journal for Rational Mechanics and Analysis was launched by Clifford Truesdell in 1952.

Professor James and Manfred Wuttig (University of Maryland) received the best paper award for their paper "Magnetostriction of Martensite" at the ASME/SPIE Smart Structures and Materials conference, March, 1999. In 1999, James gave invited lectures at Brown University (PDE Seminar), The National High Magnetic Field Laboratory and Florida State University, Harvard University (Applied Mechanics and Condensed Matter Physics Seminar), Oxford University (Mathematics Colloquium). He also gave a "Riverside Chat" (Mississippi River) to McKnight University Professors on Smart Materials. With S. Müller (MPI Leipzig), G. Friesecke (Oxford) and E. Salje (Cambridge), James organized a conference at Castle Ringberg (Tegernsee, Bavaria) on the Passage from Atomic to Continuum Scales; incidentally, he also enjoyed the mountain climbing there. James participated in a DARPA conference on Biologically Inspired Flight, and enjoyed the ASME Applied Mechanics conference in Blacksburg, Virginia in honor of Roger Fosdick.

Professor Daniel Joseph gave the 1999 L.S.G. Kovasznay Distinguished Lecture on "Lubricated Transport of Viscous Materials," at the University of Houston, April 1999.

Professor Yohannes Ketema received the 1999 IT Student Board Best Instructor Award.

Professor Perry Leo gave invited lectures at the Department of Engineering Mechanics at the University of Darmstadt in Germany, January 1999; the Department of Mathematics at the University of Bonn in Germany, December 1998; Max-Planck-Institute for Mathematics in the Sciences, October 1998; and the FMS Fall Meeting at the Symposium in Honor of J.W. Cahn on his 70th Birthday, October 1998.

Professor Ellen Longmire held the TEPCO Chair at Keio University, Yokohama, Japan during October and November 1998. During her stay in Japan, she gave invited lectures at Tokyo Electric Power Company, Keio University, Tokyo University, Science University of Tokyo, Osaka University, Kyoto Institute of Technology, and the Japanese Agency of Industry, Science, and Technology. For the rest of the academic year, she worked at the University of California/Berkeley on microscale fluid flows. She also gave invited lectures at Stanford University and the ASME/JSME Fluids Engineering Conference in San Francisco.

In 1999, Professor Thomas Lundgren gave two invited lectures while visiting the Issac Newton Institute, Cambridge, U.K., during the winter, and one at the Department of Aeronautics, at the California Institute of Technology in April. During the summer, he was a visiting Professor at Stanford.

Professor Ivan Marusic gave an invited lecture at IIT, Chicago, IL, March 1999. He also gave a talk at the APS meeting in Philadelphia, November 1998 and attended the AIAA meeting in Norfolk, VA, June 1999 where he coauthored two papers that were presented by his colleagues.

Professor Thomas Shield was appointed the new Director of Undergraduate Studies.

Professor Ted Wilson stepped down at the end of this year as Associate Head of the Department.

Professor Yiyuan Zhao gave invited lectures at the University of Washington and NASA Ames Research Center 1999.

New AEM Faculty Member

Professor Ivan Marusic is a new Assistant Professor in the Department of Aerospace Engineering and Mechanics this year. He received his Ph.D. in Mechanical Engineering from the University of Melbourne, Australia, 1992. He was very instrumental in revitalizing aspects of our senior lab course and is presently setting up a new research wind tunnel facility. Professor Marusic's main research interest is on the experimental and theoretical study of turbulent boundary layers and high Reynolds number turbulence. This work involves laboratory measurements as well as measurements in atmospheric boundary layers on the Great Salt Lake Desert flats of Utah. Professor Marusic is also collaborating on new visualization and data mining tools applied to multi-gigabyte turbulence data sets generated from simulation and experiment.

Professor Ivan Marusic

Honors, Awards, and Presentations

Professor Beavers was appointed as an Institute of Technology Distinguished Professor. This Professorship recognizes distinguished faculty members in the Institute who are recognized as exceptional through outstanding efforts in, and contributions to teaching, a reputation in the scholarly field, and a genuine commitment to the Institute of Technology and its activities. It carries a one-time unrestricted fund of $15,000 for use in the professional development of the faculty member's research. He was honored at the IT Graduation Ceremony on June 4th.

Pictured above from left to right: Professor Beavers presented with his award by Mrs. George Taylor and Dean Davis

Professor Daniel Joseph was selected to receive the 1999 Professional Achievement Citation from the Alumni Associate Board of Governors at the University of Chicago.

Professor Joseph also received the 1999 Fluid Dynamics Prize from the American Physical Society. This Award recognizes and encourages outstanding achievement in fluid dynamic research. Professor Joseph is being acknowledged for his contributions to the stability and bifurcation of fluid flows, rheological fluid mechanics, and fluid mechanics of problems involving solid-liquid boundaries. He will be presented with the Award at the fall 1999 meeting of APA.

Professor Yiyuan Zhao received the Boeing–A.D. Welliver Faculty Summer Fellowship as one of 10 that were selected for the 1999 program. He is participating in the 1999 summer program that runs from June to August at the Boeing Commercial Airplane Group. The objective of the Boeing–A. D. Welliver Faculty Summer Fellowship Program is to influence the content of engineering education in ways that will better prepare tomorrow's graduates for the practice of engineering in a world-class industrial environment. It exposes a small number of competitively selected Faculty Fellows to the key elements of industrial competitiveness and to

the practice of engineering by enabling them to "look over the shoulder" of working engineers at several levels of the technical and management career paths. When they have completed the program, they will have a network of contacts within Boeing and among their Faculty Fellow peers that can form the basis of long-term relationships.

The program is named in honor of the late A.D. "Bert" Welliver, Corporate Senior Vice President of Engineering & Technology. Mr. Welliver was recognized throughout the aerospace industry for his vision and leadership in promoting a close working relationship between industry and academia and between engineering and manufacturing. He was also dedicated to exploiting advances from the world of science and technology for the benefit of aviation and space endeavors.

Parachute Systems Technology Short Course

The AIAA Aerodynamic Decelerator Systems Technical Committee, NASA/Minnesota Space Grant Consortium, and the Department of Aerospace Engineering and Mechanics at the University of Minnesota sponsored the 7th Parachute Systems Technology Short Course at the Radisson Metrodome in Minneapolis Minnesota, Oct. 26-30, 1998. Lecturers were Drs. Vance Behr and Dean Wolf of Sandia Labs, Dr. Karl-Frederick Doherr of the German DLR, Dr. William L. Garrard of the AEM Department, and Dr. Stephen Lingard of Martin-Baker in Great Britian. Forty-six students participated in the course. There were 12 NASA participants (including one astronaut), 4 from the Navy, 2 from the Army and one from the Air Force. There was one student from the University of Alaska and 10 of the students were from foreign industries and governments. The remainder of the students came from the U. S. Aerospace Industry including Lockheed Martin, AlliantTech Systems, Pioneer Recovery Systems, and Irvin Industries. Student evaluations of the course were very positive.

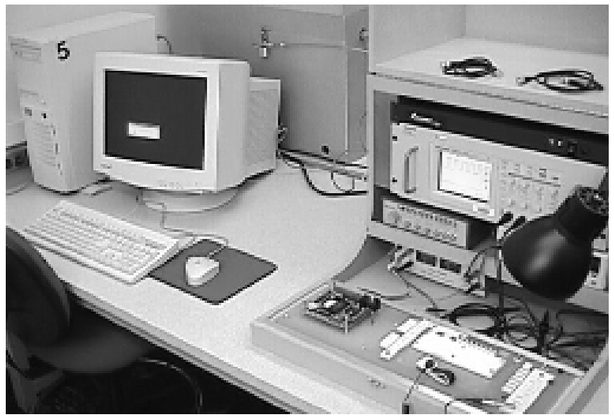
Per Capita Expenditures from External Sources by IT Department—FY98

Department	Number of Faculty	Research $ per Faculty	Total External Support $ per Faculty
Aerospace Engineering	16	$240,096	$277,754
Astronomy	10	254,733	260,021
Chemical Engineering and Material Science	31	214,576	256,228
Chemistry	39	178,692	185,774
Civil and Mineral Engineering*	32	78,828	90,164
Civil and Mineral Engineering**	32	126,085	157,570
Computer Science and Engineering	25	151,846	159,428
Electrical and Computer Engineering	42	166,020	183,853
Geology	24	115,838	127,681
Mathematics	68	17,245	23,961
Mechanical Engineering	44	110,517	121,929
Physics	45	133,942	144,055

*without St. Anthony Falls Lab
**with St. Anthony Falls Lab

New Instrumentation Lab Course Part of BAEM Semester Requirements

As part of the conversion of the BAEM program to semesters, a significant change was made to the laboratory courses. Under quarters there were three laboratory courses, one each with experiments in the areas of Fluids, Solid Mechanics, and Dynamics and Controls. Students were required to take two of these three courses. To solve the problem of how to convert these three quarter courses into two semester courses and to address the need for more instruction on the instrumentation and computers used in the laboratories, it was decided to devote the first laboratory course to instrumentation and computer data acquisition and the second laboratory course to the areas of fluids, solids and dynamics. Advanced control experiments are now part of an elective course.



One of the six new laboratory stations for the BAEM required Instrumentation Laboratory Course.

The goal of the Instrumentation Laboratory Course, as the first required laboratory course for the BAEM degree under semesters is called, is to give the students a fundamental understanding of the measurement of a physical quantity using a sensor, instrumentation amplifier and analog to digital converter and finally a computer to record the measured value. In addition, this course introduces the students to statistical and uncertainty analysis of experimental data. In order to expose the details of the operation of the hardware to the students, a very low level approach was used. The computer the students use for this lab is a single board computer based on an 8-bit microprocessor. Computers of this type, usually called embedded controllers, are very common in industrial applications, for example the Boeing 777 uses over 1200 microprocessors distributed throughout the aircraft and most modern automobiles contain several microprocessors. Thus the instrumentation lab course has the added advantage of introducing the students to embedded controllers, which account for the largest number of microprocessors used in the world.

A new facility was required for the Instrumentation Laboratory Course. This lab is situated in room 301 of Akerman Hall. The Institute of Technology provided the funds to equip this room with 6 identical lab stations as well as a TA station with a printer. A typical lab station is shown in the accompanying photograph. A lab station consists of an instrument rack which contains a dual trace digital storage oscilloscope, digital voltmeter, function generator, power supply, single board computer and bread board area. The various input and output connections to the single board computer are brought out to solderless connector strips around the edge of the bread board area to allow the students to connect the circuits they construct on their bread boards to the computer. The oscilloscope, meter and function generator allow the students to test and exercise the circuits they construct. These circuits include digital to analog and analog to digital converters and instrumentation amplifiers. By the end of the term, the students have the knowledge to construct a circuit that connects a sensor, such as a strain gage, to a digital input port on the computer. The lab station also includes a Windows NT Workstation. This computer runs the Integrated Development Environment that is used to program the single board computer. So while the students only have to figure out how to access the hardware of the small single board computer from their program, they get to operate in a familiar computing environment. Many of the course materials for the Instrumentation Lab are available over the Internet. The URL for the course's home page is

http://www.aem.umn.edu/courses/aem4601/

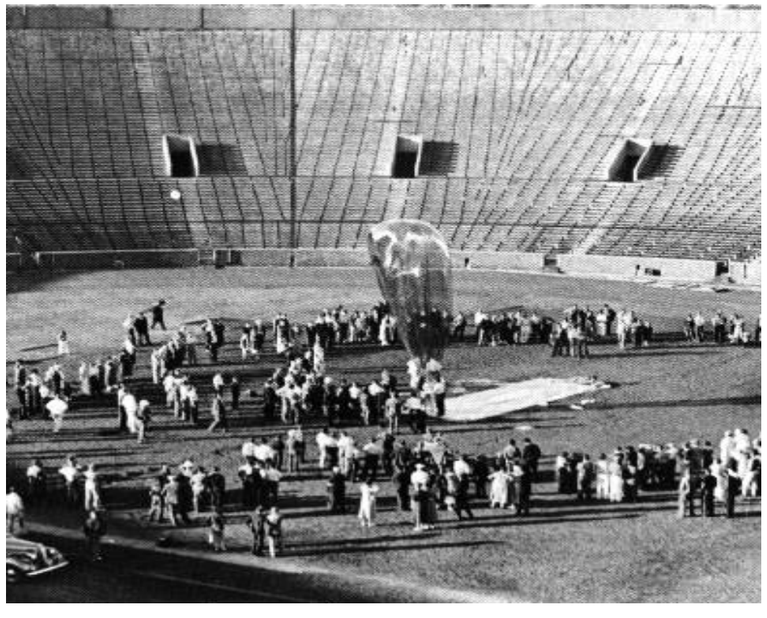
The students are encouraged as part of this course to use the Internet as a resource, for example, data sheets for most electronic parts are now available over the Internet.

Looking Back...

Paul Sorenson
Director of Communications
Institute of Technology

On a cool, clear Michigan morning in October 1934, Jean and Jeanette Piccard stepped inside the pressurized, air tight gondola of a balloon named Century of Progress and launched themselves into history, soaring to a record atitude of 57,979 feet.

The flight, piloted by Jeannette Piccard, proved that humans could tolerate ascents into the frigid stratosphere with gondolas and balloons designed to withstand the low pressures of the atmosphere's isothermal layer. The technology, developed by Jean and his twin brother, Auguste, laid the groundwork for manned space flights decades later.



One of Dr. Jean Piccard's first projects at the University was constructing an unmanned hydrogen-filled transparent cellophane balloon for ascents 10 to 14 miles into the stratosphere. The balloon was successfully flown on June 24, 1936.

Jean Piccard joined the University of Minnesota faculty in 1936. He taught courses in stratospheric flight problems while doing research and conducting many pioneering balloon flights. One of his first projects at the University was the construction of an unmanned hydrogen-filled transparent cellophane balloon designed for ascents 10 to 14 miles into the stratosphere. (The balloon's panels were held together by a revolutionary product — adhesive-coated cellophane strips called Scotch transparent tape.) The balloon was launched from Memorial Stadium in 1936. It rose more than 50,000 feet and traveled nearly 600 miles, landing in a field in Arkansas. He later devised the multiple-balloon concept and in 1937 made the first manned ascent utilizing multiple balloons.

Although Auguste remained in Switzerland, he and Jean continued to collaborate throughout their careers. Their work led to the development of a frost-resistant window for high-altitude balloon gondolas and an electronic system for emptying ballast bags. Jean also experimented with plastic balloons and helped design the high-altitude polyethylene balloons that the United States Air Force used for manned flights of up to 100,000 feet.

Jeannette Piccard was at her husband's side through it all. In a 1966 interview, she described how she became involved in the pioneering research. "My husband needed a balloon pilot, so I went out and learned how to pilot a balloon. I didn't have to be convinced. I don't know if it was his idea or my idea or just spontaneous combustion. It was something that was obvious, that's all."

With that, she became the first licensed female balloonist in the world and the first woman to ascend into the stratosphere. She continued to collaborate with her husband until his death in 1963, after which she became a consultant to NASA's manned spacecraft division. A decade later, in 1974, she gained notoriety as one of the first women ordained as an Episcopalian priest. She died in 1981.

J.F. Piccard preparing for a balloon launch

This summer, Jean and Jeannette Piccard were posthumously inducted into the International Space Hall of Fame in Alamagordo, New Mexico, in recognition of their lifetime achievements in aeronautics. Earlier this year, their son, Donald, was recognized by the National Aeronautic Association for his work in establishing hot-air ballooning as a serious sport in the 1960s.

Donald Piccard rode alongside his mother during several flights in the 1930s. In 1966 she described those flights and the wonder and awe with which she and Jean approached their work: "When you fly a balloon you don't file a flight plan; you go where the wind goes. You feel like part of the air. You almost feel like part of eternity, and you just float along."

— Paul Sorenson

Special Note: Bertrand Piccard, who is the great nephew of Dr. Jean F. Piccard, successfully circled the world in a balloon this past March, along with his co-pilot Brian Jones. He had tried this in 1997 and 1998, but his balloons fell short of their destination. He is a third-generation adventurer. Bertrand Piccard's grandfather was Auguste Piccard, who was the twin brother to Jean Piccard. Bertrand's father Jacques was a noted undersea explorer.

Exchange Visitor Program

This program is sponsored by the University of Minnesota to provide courses of study, learning, and research opportunities, in the various fields of instruction and research conducted by the University of Minnesota for qualified foreign students, professors, research scholars and short-term scholars to promote the general interest of international educational and cultural exchange.

Visitors in '98–99 were:

Miguel Charlotte, a Ph.D. student from France, returned to the Department for the second phase of his research in the Mechanics of Solids under the direction of Professor Lev Truskinovsky. He expects to be in this phase, which began on March 1, 1999 thru September 30, 1999.

Dr. Antonio Francisco Fortes, is from the University of Brasilia in Brazil. He was appointed by Professor Dan Joseph as a Senior Research Associate in the Department while on leave from his University. He has been engaged in collaborative research with Professor Joseph on topics related to solid-liquid flows and cavitation.

Professor Toshio Funada was a visiting researcher from March-June, 1999. He was sponsored by the Ministry of Education, Science and Culture in Japan who provided travel grants and maintenance for his research travels. During his visit here he was hosted by Professor Dan Joseph and engaged in joint research with Joseph's research group in projects related to solid-liquid flows and other multiphase flow projects.

DEPARTMENT NOTES

Professor Thomas Shield and John Tucker, AEM Scientist, gave departmental tours and demonstrated the wind tunnel for 45 eighth graders from the Benjamin Banneker School in Minneapolis. This event was sponsored by the APEXES Program in IT.

New Departmental Postdocs and Other Academicians

Dr. Leonard Imas began work as a Research Associate under the direction of Professor Graham Candler in March of 1999. Dr. Imas earned his Ph.D. in Hydrodynamics from the Department of Ocean Engineering at the Massachusetts Institute of Technology and his M.Eng. in Aeronautical Engineering from the Department of Mechanical and Aeronautical Engineering at Rensselaer Polytechnic Institute. He has been working on a research project that involves the modification of a large computational fluid dynamics code to include a new implicit algorithm.

Dr. Xiao-Yen Wang was an Adjunct Assistant Professor in the Department this year. She taught our AEM 5250 in the fall and conducted research with Dr. Candler the rest of the year on a project using a new computational fluid dynamics code that has very low dissipation properties, making it ideal for aero-acoustics applications.

Dr. Gary Chapman was a Visiting Professor in the Department for Spring Quarter. He taught AEM 5244, Hypersonic Aerodynamics, and conducted research with Dr. Candler on transition to turbulence in hypersonic reacting flows. He came to us from University of California, Berkeley, where he is an Adjunct Professor. Dr. Chapman received his bachelors degree from our department in 1957. Previously, Dr. Chapman had a long and distinguished career with NASA Ames Research Center from which he retired.

Student Notes

Abbey Eichman is spending her summer at the 1999 NASA Academy in Aeronautics at NASA Dyrden Flight Research Center.

Dorothea Czernik worked with fourth through eighth grade girls as part of "Looking Towards the Future (formally Opportunities Day for Girls)" on April 24, 1999, organized by the IT Program for Women. She did a water channel and wind tunnel demonstration as part of their activities in the Department.

Jenny Cordina and Dorothea Czernik did wind tunnel demonstrations for 56 sixth grade girls from Rosemount, Scott Highlands, and Dakota Hills Middle Schools for Science Exploration Day on May 15, 1999. John Tucker, our AEM scientist, assisted them.

During the summer of 1998, two of our undergraduate students did internships at Boeing in Seattle. Dorothea Czernik worked with the Weight Engineering Department of the Boeing Commerical Airplane Group and participated in product development for large airplaces including derivatives of the 747 airplanes. Jenny Cordina worked in the Aerodynamics Engineering Department of the Boeing Commercial Airplane Group and participated in product development and airplane performance for the 777 airplane.

Professor Andy Vano and the following AEM students: Dorothea Czernik, Matt Gast, Erick Hokenson, Brad Kelley, Mariann Jansen, Todd Colten, Michael Olson, Carlos Mostek, Carl Roos, Brad Herzberg, Alfred Leano, Erick Edgar, Reagan Woolf, Jenny Cordina, Doug Muerle, Sukjoo Choi and Masato Ishii,and the two design TAs, Jake Hageman and Jim McDonald, all assisted with giving tours of the AEM Department for IT Week's Open House. Sixty high school students participated in this event. The tours included a wind tunnel demonstration using the Design Class "Thunder" airplane design, a BD-5 wing structural test demonstration, and a computer demonstration featuring the Design Class Spacecraft

design project, "Mission to Comet Temple–1." They also had a display featuring the Design Class RC model.

Jake Hageman and Jim McDonald, design class TAs participated in the Exploratory Scouts in Engineering Day in the Department that was held October 15, 1998. They did a wind tunnel demonstration that featured a BD-5 model, fabricated by students in our senior design class that was installed in our 54 x 38 inch recirculating wind tunnel and showed how lift and drag are measured at different angles of attack and speed. They also gave a brief description of the department and explained how and why wind tunnels are used.

Jeff Barker and Kostantinos Hennighausen, both AEM graduate students, served as resource persons and participated in other activities for systemic science reform effort: ScienceWorks, the Science Education Program in the Minneapolis Public Schools (MPS), which is sponsored by a NSF grant through Science CentrUM and College of the Schools, University College, under the direction of Susan Henderson. The goals of the NSF project are first, to prepare all K-8 teachers to teach state-of-the arts science curriculum and second, develop the support and structures that will sustain an excellent K-8 science program in the MPS beyond the life of the grant.

ALUMNI HIGHLIGHTS

Christopher J. Armstrong (BAEM 1986), is President of Topher AeroCAD, a 2D and 3D CAD service based in Osceola, WI. Current clients include Powersport Aviation, manufacturers of the Powersport 200 and Superlight Rotary Aircraft Engines; Ratech Machine, Inc, a CNC machine shop with clients ranging from accoustic ceiling tile manufacturers to Wipaire Inc., a St. Paul based manufacturer of amphibious floats for a broad range of aircraft.

Jimmy Jingtao Feng (Ph.D.Mechanics 1995) is an Associate Professor at Levich Institute, City College of CUNY, New York, NY.

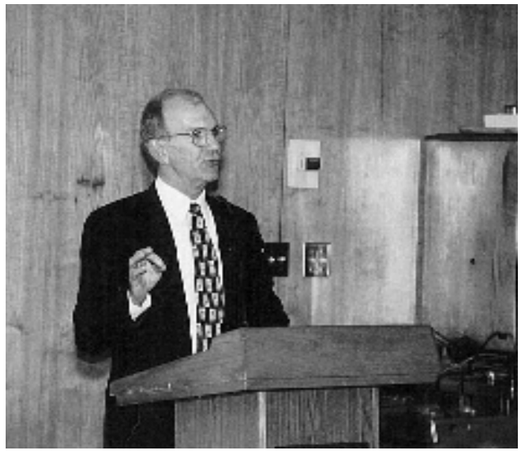
Thomas Konicke (M.S. Aero.Eng. 1981) is a Lt. Col. in the U.S. Air Force

AIAA HOSTED REGION V STUDENT CONFERENCE

The AIAA Student Branch and the Twin Cities Section of AIAA hosted the Region V Student Conference April 28-30, 1999, at the University of Minnesota. Participating schools from the Midwest Region V were Iowa State University, Colorado State University, University of Colorado, U.S. Air Force Academy from Colorado, University of Missouri–Columbia, University of Missouri–Rolla, Parks College of St. Louis, Washington University of St. Louis, University of Kansas, Kansas State University, Wichita State University and the University of Minnesota. A total of 74 students and 8 faculty attended the paper conference from 7 of the universities in Region V. There were 24 undergraduate and 10 graduate papers presented. Officials from AIAA Headquarters also attended the conference.

Pictured above some of the awardees from the Conference along with Dave Myren on the left and Kasey Roskopf and Sara Brandenburg on far right.

The conference began with registration and a reception on Wednesday, April 28th. Paper presentations were given at both the undergraduate and graduate levels on Thursday and Friday. Thursday afternoon also included a tour of the Northwest Airlines and dinner at Planet Hollywood and other special activities at the Mall of America. The conference concluded on Friday night with an awards banquet at the Campus Club at the University of Minnesota. The guest speaker was Mr. R. Gale Schluter, Vice President and General Manager of Expendable Launch Systems for Boeing in Huntington Beach, CA.



Pictured above: Mr. R. Gale Schluter speaking at awards banquet.

The winners of the Student Paper Conference were:

Undergraduate Division

1st Place: Jonathan Dowty—U.S. Air Force Academy with his paper entitled, "A Wind Tunnel Investigation to Reduce the Drag Associated with External Protuberances on the AC-130H Gunship."

2nd Place: Charles Cain and Daniel Kaercher—U.S. Air Force Academy with their paper entitled, "Periodic Blowing and Suction for Delta Wing Vortex Control in a Water Tunnel."

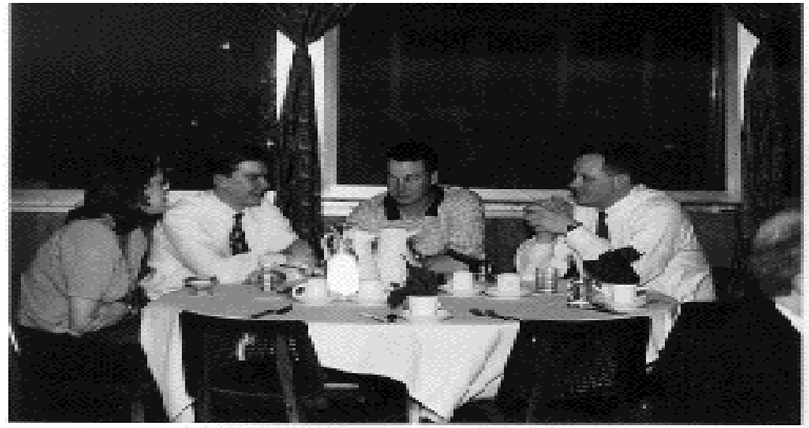
3rd Place: Keith Gray—University of Missouri-Rolla with his paper entitled, "Computational Study of Unsteady Separated Flowfields Surrounding a Flapping Airfoil at Very Low Reynolds Numbers."

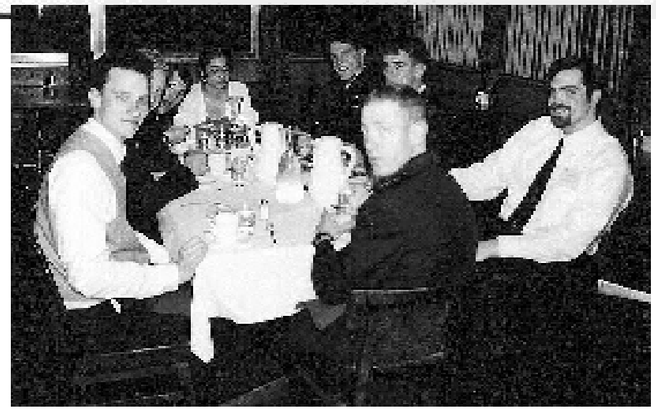
Graduate Division

1st Place: Michael Murdin and Scott Foster — Wichita State University with their paper entitled, "Inexpensive Quantitative Flow Visualization."

2nd Place: Vacant due to a disqualification.

3rd Place: Manohari Ramish—Iowa State University with her paper entitled, "Correlations to Predict Streamwise Influence Regions of 2-Dimensional Turbulent Shock Separted Flows."



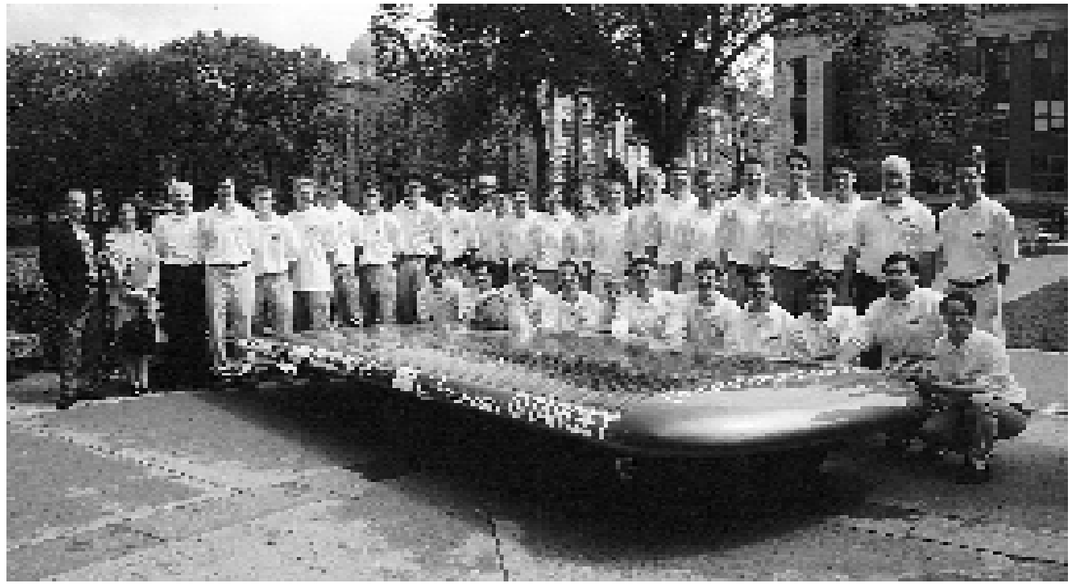


Pictured above and at right are students at the AIAA Conference Banquet

Kasey Roskopf and Sara Brandenburg of the University of Minnesota AIAA Student Chapter were the Conference Co-Chairpersons. With the assistance of David Myren from the AIAA Twin Cities Professional Section and other AIAA students, they planned and coordinated the events of the conference. Special thanks to the Aerospace Engineering and Mechanics faculty, staff, graduate and undergraduate students and the many industry contributors and volunteers who assisted with a number of conference events. The conference was sponsored by the AIAA Student Branch, the Twin Cities Professional Section, and the Department of Aerospace Engineering and Mechanics at the University of Minnesota.

1998-99 AIAA Officers	
Co-President	Sara J. Brandenburg
Co-President	Kasey S. Roskopf
Secretary	Lisa Parkin
Treasurer	Brad Herzberg

Solar Vehicle Project



Pictured above is the Solar Car Team for this year.

University of Minnesota Institute of Technology students designed and constructed their fourth generation solar vehicle, the Aurora 4. The 38 team members spent two years improving the key aspects of the design and manufacturing of the car. The Solar Car Team's two premier solar car races include: Sunrayce 99, a 10-day race in June 1999 spanning over 1300 miles starting in Washington, D.C. and ending at Epcot Center in Orlando, Florida where they came in fourth out of 29 college teams; the World Solar Challenge in October 1999 where they will compete against teams from multinational corporations, high schools and colleges across 1,880 miles of Australia's outback. This program maximizes's students learning by participating in a challenging environmental project, developing professional-level work skills enhancing their leadership and teamwork skills, educating the public and having fun. Aurora 4 has over 1999 solar cells, a top speed of 80 mph, and at 55 mph, it only uses the power of a 1600 watt hair drier. More information can be found at:

http://www1.umn.edu/umnsvp/aurora4/index.html

The AEM Department is one of many sponsors that provides financial support for this project.

Kids Program '99

Nina Tortosa and Dorothea Czernik worked with our Kids Program '99 this summer. Both Nina and Dorothea received their undergraduate (BAEM) degrees here at Minnesota, and are now graduate students in the Department. The students ages were 9-15 years old and were here on various dates from June to August. They made bottle rockets, Estes rockets and whitewing airplanes. They learned basic concepts of gravity, thrust, lift, and drag of space and aircraft. Everyone had a blast!

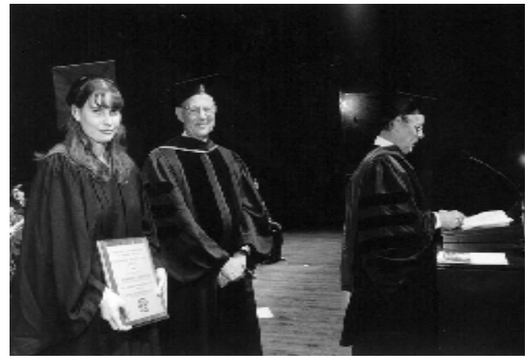
NASA Astronaut IT Commencement Speaker

Colonel Robert Cabana was the featured speaker at the Institute of Technology graduation ceremony on June 4th. His most recent spaceflight, the STS-88 Endeavour (December 4-15, 1998), was the first International Space Station assembly mission. During the 12-day mission, Unity, the U.S. built node, was mated with Zarya, the

Pictured above from left to right are Jan Beavers, Gordon Beavers and Col. Robert Cabana.

Russian built Functional Cargo Block (FGB). Two crew members performed three space walks to connect umbilicals and attach tools/hardware in the assembly and outfitting of the station. Additionally, the crew performed the initial activation and first ingress of the International Space Station preparing it for future assembly missions and full time occupation. The crew also performed IMAX Cargo Bay Camera (ICBC) operations, and deployed two satellites, Mighty Sat 1 built by the USAF Phillips Laboratory and SAC-A the first successful launch of an Argentine satellite. Selected by NASA in June 1985, Cabana completed initial astronaut training in July 1986, qualifying for assignment as a pilot on future Space Shuttle flight crews. His initial assignment was the Astronaut Office Space Shuttle flight software coordinator until November 1986. At that time he was assigned as the Deputy Chief of Aircraft Operations for the Johnson Space Center where he served for 2-1/2 years. He then served as the lead astronaut in the Shuttle Avionics Integration Laboratory (SAIL) where the Orbiter's flight software is tested prior to flight. Cabana has served as a spacecraft communicator (CAPCOM) in Mission Control during Space Shuttle missions, and as Chief of Astronaut Appearances. Prior to his assignment to command STS-88, Cabana served three years as Chief of the Astronaut Office. A veteran of four space flights, Cabana has logged over 1,010 hours in space. He served as pilot on STS-41 (October 6-10, 1990) and STS-53 (December 2-9, 1992), and was mission commander on STS-65 (July 8-23, 1994). Colonel Cabana is originally from Minneapolis, Minnesota and graduated from Washburn High School in Minneapolis. During his visit here, he had lunch and met with several AEM faculty, students and industry representatives.

Dorothea Czernik, AEM Undergraduate, was selected



Pictured above from lef to right Dorothea Czernik being presented with the Cartwright award by Dick Hedger and Dean Davis

to receive the 1999 Paul A. Cartwright and IT Alumni Society Award for Outstanding Service in student activities and/or community projects and was honored at the June 4th IT Commencement Ceremony.

Joseph B. Mueller, AEM Undergraduate, was honored to be the Student Speaker at the Institute of Technology's graduation ceremony on June 4th. Joe's speech follows on the next page.

1999 IT Commencement Speech

by Joseph B. Mueller

Good evening everyone. A few weeks ago, when I excitedly told a few of my close friends that I would get to speak at graduation, they all had the same reaction: "Wow… Why on earth would you want to do that?!" I will be honest—their response made me think. Let me assure you, though, that I feel very privileged and am extremely thankful to be here tonight. I want to extend a sincere thank you to the faculty members on the selection committee for giving me this opportunity to say a few words. But the question remains: Why on earth do I want to do this? And that is a very good question. In fact, I think it is safe to say that "Why?" is a pretty important question for all of us to consider right now.

Why are we all here tonight? Why have we decided to have this ceremony? Well, this certainly isn't the first time that hundreds of IT students gathered together in a dark room, wearing dark robes and funny hats—Star Wars Episode I opened just a few weeks ago. But I think the reason we are holding this ceremony is because this is a time to reflect, a chance to look back on the past four, five, yes some of us six, years of our college experience, and to let it all sink in. This is a time of transition, an opportunity for each of us to evaluate both what we have done, and what we are about to do. We all draw from our own unique experiences, but for me, it has been these times of transition and change that have allowed me to learn the most about myself.

I'm sure most of you would agree with me when I say that one of the best facets about attending the University of Minnesota is its great diversity of people. In my time here, I've studied with and made friends with people from Sri Lanka, the Netherlands, India, Germany, Brazil, and yes, Wisconsin. What a rich pool of resources we have to draw from in each other. Myself, I don't come from anywhere too terribly exotic—just the small yet unique little town of Ironton, Missouri. It was your typical small town. We had more people on our high school football team than we had enrolled in the high school. Children growing up in Ironton would pass their time by trying to find it on the map. After going back to visit recently, I found there was only one place that hadn't gone out of business—the unemployment office. Despite all of its excitement, though, I did not stay in Ironton for very long… at the young age of 14, I experienced the first of a few significant transitions. I found myself moving to Hibbing, MN. You may have heard of it… Hometown to Bob Dylan and Kevin McHale, and just two short hours from the Canadian border.

So what is it like moving from Missouri to Minnesota, you may ask? Couldn't be that difficult, right? Well, there certainly are a lot bigger challenges that one may experience in life—but allow me to paint a picture for you. Imagine Christmas-time in St. Louis. It's a mild 35 degrees (above zero). My family and I board an airplane. Three hours later, we're in Minnesota, where the wind chill has brought it down to 75 degrees below zero, and the doors of our rental car are conveniently frozen shut. The moving trucks containing everything we owned are stuck in a snowstorm in Iowa, forcing us to live out of our suitcases for two weeks. Even after we got settled in, it was strange being the only family on the block that didn't own a snowplow. That was a transition I will never forget!

Most of my friends from Hibbing still give me a hard time, claiming that I never learned how to be a true Minnesotan. Since my move north, I haven't learned how to ice-skate, I've failed to learn how to ski (three or four times), and I definitely have not learned how to play or even understand the game of hockey. However, the experience of the transition did teach me quite a bit about some other important things. I discovered that a little bit of hardship is the best way to better yourself; that change should not be resisted, but rather embraced; and that we can never know what blessings await us in life, or in what mysterious form they may come.

Can you remember what it was like when you first arrived here? First, you get dropped off in the middle of the city, with some clothes, a few crates full of toiletries, a microwave, a backpack, and a lava lamp. When you find your dorm room, it reminds you of your closet back home, and then you meet the other person that will

Joe Mueller

be living there with you. I think at this point, we all asked ourselves "why? But here we all are. Finally graduating.

For most of us, the move to college was accompanied by a movement of our identity. How could it not be? In a sudden surge of independence, we are surrounded by a thousand new minds who share the common desire to learn. Over the period of a few short years, we trade innocence for experience, immaturity is lost to responsibility, and we start to realize what our priorities are. A poet by the name of Robert Frost once said that: "The world is full of willing people; some willing to work, others willing to let them." Well, let me say that, having earned this cap and gown no differently than any of you did, I am fairly certain that we must be the ones willing to work! The challenge of making it through the rigors of the Institute of Technology has not been the only source of our education, though. So much of what college offers is the, unknown, limitless, exuberant element of the people we encounter everyday.

Now, when I hear the words unknown, limitless, and exuberant, my college roommate and best friend, Patrick Duffy, immediately comes to mind. A recent graduate from the U, and currently a history teacher at Hopkins Junior High, he always seems to have some remarkable fact to inform me of. You see, an IT grad living with a CLA grad makes for an interesting arrangement: He provides me with free history lessons, while I program the VCR for him. Well, he mentioned something in one of these lessons one day that I felt needed to be shared with all of you. In a recent study, over 1,000 terminally ill people from all over this country were interviewed. They were asked one simple question: If they had the chance to go back and to improve on some aspect of their lives, what would it be? Nearly everyone replied with the same three answers, now known as the three R's of happiness: Relationships, Risk, and Reflection.

What a powerful discovery! Think about it: To know, while there is still life to be lived, what the most important parts are! To put it in academic terms: It's like having all of the answers in the back of the book—you have to take advantage of it! Tonight, as we think back on our college careers, we can be reminded of our own individual journeys. We can recall the risks taken, the relationships formed. Think about this: it has been those times when we have decided to take a risk, to walk the long way home, to say hello, to stay up late talking, to lend a kind word—it has been those times when we have grown more than ever.

Hopefully, the relationships and the risks have been taken care of over the past four or five years. Now is the time for reflection. Now is the perfect time to contemplate what you've done with the opportunities you've been given. Have you done enough? Are you happy with the decisions you've made and the path you've taken? Tonight, and tomorrow, and the day after, I encourage you to be proud of your accomplishments, and to be moved by your disappointments. So, everyone wearing caps and gowns, all of you who have pulled so many all-nighters and made so many little sacrifices for that diploma, I encourage you to take advantage of this time, to reflect, and to ask yourself "why?"

Why did I want to speak tonight? After taking some time to reflect a little myself, I finally figured out what to tell my astonished friends. I have learned the hard way a few different times in my life what it feels like to work hard chasing a dream, and then once realizing it, also realizing that I've been chasing in the wrong direction. I wanted to share this message with you, because of the opportunities and the decisions that you have ahead of you. I hope that I haven't thrown too much advice at you tonight. But more importantly, I sincerely hope that we all have the wisdom and the patience to spend some time reflecting on our lives, understanding our priorities. So… Congratulations IT grads! You did it! You made it out before semesters! You have earned the right and the ability to start chasing your dreams. Now is the time to decide what your dreams truly are.

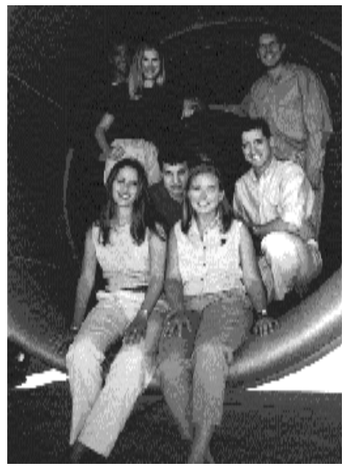
Minnesota Space Grant Consortium

Astronaut Heide Marie Stefanyshyn-Piper, NASA astronaut, was the keynote speaker at the second annual "Space Science Across the Curriculum" conference sponsored by the MnSGC and held at the Science Museum of Minnesota, March 13, 1999. Heide is a Lieutenant Commander in the US Navy and is assigned to the team that supports Space Shuttle launches and landings. The conference sponsored several master teachers who contributed their expertise in how to integrate space science content into existing K-12 curriculum. Walt Tremer of Muhlenberg College, PA, gave the closing remarks for the conference about his experience as astronaut in training with Christa McAuliffe for the ill fated Challenger Shuttle flight of 1986.

The MnSGC sponsored three NASA summer academy candidates in 1998. Emily Eelkema (Dryden), Jim Chase (Goddard), and Wendy Davis (Ames). All three candidates are U of M students that graduated this spring. Emily comments about her experience at Dryden follow:

> The NASA Academy in Aeronautics was a very unique experience. It is held at NASA's Dryden Flight Research Center in Edwards, CA. As a research associate, I worked with John Bosworth in the Controls and Dynamics Branch, studying the stability of the X-38's landing trajectory. The X-38 will be used as a 'lifeboat' on the International Space Station, and is designed to make a completely autonomous landing.
>
> The location of the academy is ideal for learning about the aerospace industy. Companies toured included Lockheed Martin Skunkworks, the Boeing Space Shuttle Facility, Northrup Grumman's B-2 plant, the Jet Propulsion Laboratory, the National Test Pilot School, Aerovironment, and Burt Rutan's Scaled Composites. We also had the chance to travel to Washington, DC to meet the Goddard Academy and visit NASA Headquarters. Later in the summer, we drove to NASA Ames to meet the Ames Academy.
>
> The summer's experience was extremely valuable. Not only did I gain research experience, but I also learned about the aerospace industry as a whole. It also helped me to decide what I wanted to do after graduation - in August I will start work as an associate engineer in the Flight Systems Section of the Jet Propulsion Laboratory.

The MnSGC has added three new affiliate members. Dr. Ken Murphy of the Physics Department and Director of the Planetarium at Southwest State University in Marshall, Minnesota represents SWSU in the consortium. Dr. Murphy was a visiting professor at the US Air Force Academy in Colorado Springs, CO where he collaborated in the Asteroid photometry research program using the USAF's 24" telescope. Boeing and Honeywell have also been added as industrial affiliates. The key to Honeywell's participation is its membership in the Minneapolis Operations Technical Council (MOTEC) that was established in 1978 to serve Honeywell's technical community. MOTEC sponsors several K-12 outreach programs that involve women and minorities in engineering. Boeing has been a long-time supporter of the AEM Department's outreach efforts and of the MnSGC.



1998 Dryden Academy in a 747 Engine. Standing: Kyle Snyder (director), Emily Eelkema (UofM), Nathan Palumbo. Sitting: Christie Bertels, Aaron Jacobovits, Heather Hillebrandt, Justin Garr.

The MnSGC continues to sponsor undergraduate scholarships and fellowships in addition to K-12 and general public outreach programs. This year, the annual Sverdrup lecture series hosted at Augsburg College featured Dr. John Freeman, Professor of Space Physics and Astronomy at Rice University in Houston, TX. Dr. Freeman's lecture was titled "Storms in Space" focusing on the need to understand, model, and even forecast the severity and occurrence of storms that rage high above the earth's atmosphere. Dr. Freeman is part of the scientific community examining the new field of space weather.

For questions and comments on MnSGC programs please see the website at http://www.aem.umn.edu/other/msgc.

DEGREES AWARDED 1998-99

Bachelor of Aerospace Engineering and Mechanics

December, 1998
Andres Mediavilla, magna cum laude

March, 1999
Cory Allen Boese, with distinction
Steven Lee Boysen
Thomas John Jones, with distinction
Mark Jerome Ledermann
Mishawn Rebecca Mielke
Joseph Bernard Mueller, with high distinction
David Michael Skalicky, with distinction
John Ryan Steffen
Troy Clinton Welker

June, 1999
Todd Colton
Jenny Cordina, with high distinction
Amy Cornielle
Dorothea Czernik
Mark Dmytryszyn
Eric Edgar
Emily Eelkema, with high distinction
Matthew Gast
Joseph Gresser
Masato Ishii
Douglas Muerle
Jesse O'Niell-Oine
Kevin Park
Spencer Rasmussen
Carl Roos, with distinction
Ryan Spice
Craig Wightman

Doctor of Philosophy

Eric B. Carlson, Mech., 7/99
Wendy Crone, Mech., 11/98
Timothy J. Hall, Mech., 7/99
Vincent Kuo, Aero.E., 4/99
Clara Mata, Mech., 11/98
Harry Vinagre, Aero.E., 10/98
Gregory Weirs, Aero.E., 12/98

Master of Science

Gerald Brenden, Aero.E., 3/99
Ling Jiang, Mech., 11/98
Hoilum Helen Lee, Aero.E., 6/99
James McDonald, Aero.E., 7/99
Faezeh Mojtahed, Mech., 12/98
George Platanitis, Aero.E., 6/99
Travis Smieja, Aero.E., 8/99
Nina Tortosa-Boonaker, Mech., 8/99

Senior Capstone Design Class

Project "Oasis": Sample Return Mission To Comet Temple-1

OASIS MISSION: Spacecraft Team

MISSION STATEMENT: The Oasis Mission is to rendevous with the comet Tempel 1, land on the comet's surface to scientifically test the comet's physical properties, map the comet, and return to Earth with two representative samples in the most economic and efficient manner possible.

Project Managers
- Kasey Roskopf
- Ryan Steffen

Transportation Systems
- Shea Peterson-Burch
- Jamison Roman
- Amy Cornielle
- Emily Eelkema

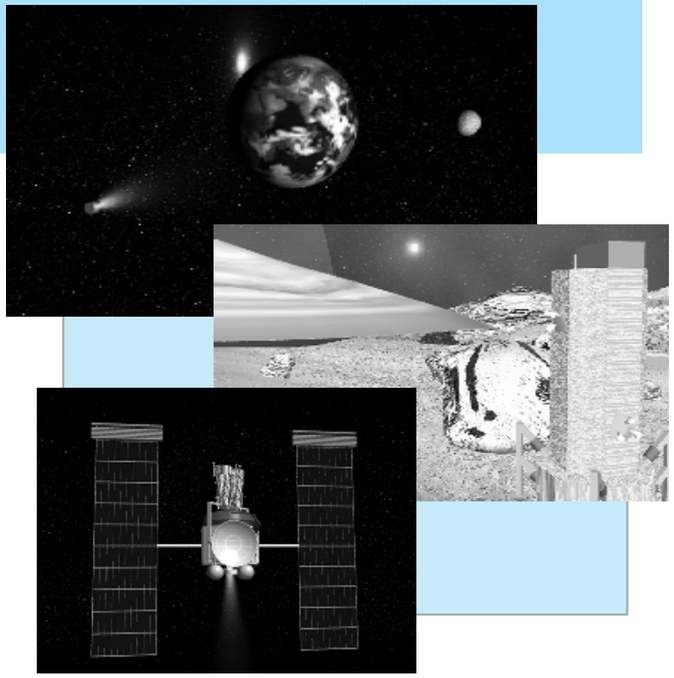
Lander/Return System
- Joe Gresser
- Scott Schuh
- Todd Colten
- Carlos Mostek

Systems and Equipment
- Scott Valminck
- Mike Olson
- Mark J. Effertz

Aeroshell (Earth Return)
- Klayton Ives
- Nathan Brusius

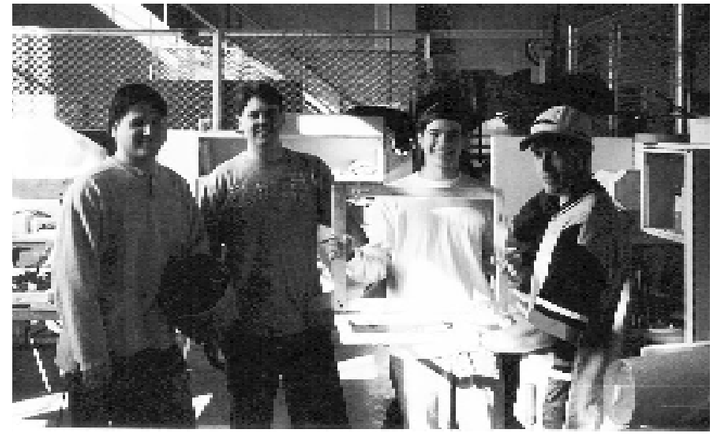
Structural Systems
- Brad Kelley
- Ryan Swanson
- Phil Peterson

Propulsion Systems
- Mishawn Mielke
- Erik Hokenson
- Carl Roos



Jet Propulsion Laboratories (JPL) has overseen exploration of the Solar System with robotic spacecraft during the past three and one half decades. We have all watched in amazement as Sojourner explored Ares Vallis or Galileo discovered intricate ice patterns on Jupiters moon Europa. Dr. Garrard thought it might be beneficial to our students if the design class would do a project which paralleled one of the many active JPL initiatives; he arranged an on-site visit for Prof Vano to explore the possibility. JPLs interest in our students and their willingness to share their experiences and perspective was outstanding. Prof Vano selected a sample/return mission to Comet Temple-1 as the 1998-99 spacecraft design project (see mission statement).

The Spacecraft Design Team was organized into six disciplines (see tabulation) at the beginning of Fall Quarter; two student Project Managers were chosen to lead the team and complete a conceptual design by the end of the quarter. The Transportation Systems discipline was responsible for the integration of the entire vehicle; Pro/ENGINEER was used as a tool to assemble the vehicle. The Lander/Return Systems discipline used comet models developed by JPL to design a method of anchoring the lander to the comet so that a core sample could be taken. The Structural Systems discipline was responsible for the primary structure of all vehicles. The Propulsion System discipline determined the most efficient trajectory between Earth launch and comet rendezvous; they selected an ion propulsion system following JPL's successful Deep Space 4 demonstration. The Systems and Equipment discipline determined what kind of avionics the mission would require for control, navigation and communication, and then determined the power requirements for all the systems on-board the spacecraft. The Aeroshell discipline investigated aerobraking to recover the samples to low earth orbit. Each discipline presented their primary design issues to the entire team at regularly scheduled team meetings. The Project Managers organized and conducted the meetings and helped the team resolve conflicting issues. The team successfully presented their design at a formal Conceptual Design Review at the end of Fall Quarter.



"Oasis" Model Construction. Left to right: Ryan Swanson, Erik Hokenson, Carlos Mostek, Jamison Roman

Comet Temple-1 Surface Models. First row, left to right Emily Eelkema, Amy Cornielle, Kasey Roskopf. Back row, left to right: Phil Peterson, Scott Schuh

The design team was reorganized at the beginning of Winter Quarter to include special project groups which addressed the following open issues: solar-array deployment, lander attachment, core sampling, primary structure design and mission trajectory. Each group designed and fabricated a working model of their design and used it to test their design concepts. An additional group prepared a video to document the teams efforts. The result of the Spacecraft Design Teams year-long effort is summarized in the Pro/ENGINEER graphics presented herein. The vehicle is called "Oasis". The assembled vehicle is approximately 6 meters long (with landers, not including the 2 X 7 meter solar arrays), 2 meters in diameter and has a mass of 1335 kg (including landers and solar arrays).

Senior Capstone Design Class

"Thunder" Aircraft Design

THUNDER MISSION: Aircraft DesignTeam

MISSION STATEMENT: Design a four-place airplane which will cruise at 225 knots TAS with 800 NM range plus IFR reserves. The airplane will meet FAR Part 23 requirements and will be designed to operate in the future ATC environment with cockpit systems which simplify pilot interface while enhancing safety and utility.

Project Managers
- John Callan
- Patrick Bergen

Systems Layout/Weights
- Eric Edgar
- Reagan Woolf
- Mariann Jansen

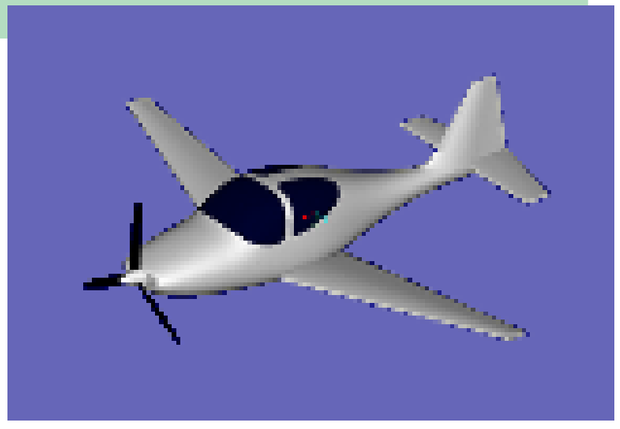
Aerodynamics
- Jenny Cordina
- Dorothea Czernik
- Matthew Gast
- Brad Herzberg

Structures
- Koichi Fujimoto
- Mulugeta Gerbremeskel
- Masato Ishii
- Jeff Johnson

Powerplant
- Doug Muerle
- Alfred Leano

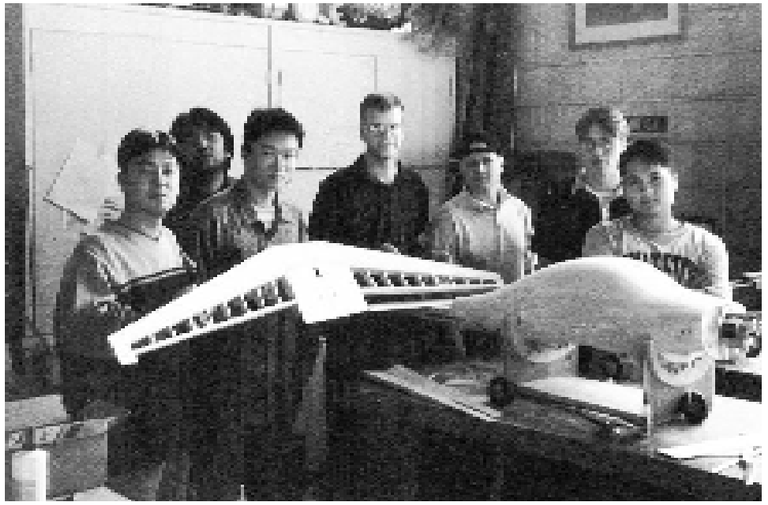
Cockpit Systems
- Jesse O'Neill-Oine
- Bill Klein
- Spencer Rasmussen

Mission Profile/Operating Infrastructure
- Ryan Spice
- Troy Welker



The Aircraft Team designed a four-place airplane (see Mission Statement) and was organized into six disciplines (see tabulation) led by two project managers. The Systems Layout/Weights discipline used Pro/ENGINEER to physically integrate all the airplanes components; several design changes were required to fit the cabin into the fuselage. They also used a weight-and-balance spreadsheet to locate components such that the final airplane weight-and-balance were within the Aerodynamics allowable weight-and-balance limits (3200 lbs maximum takeoff weight).

The Aerodynamics discipline determined allowable weight-and-balance limits by examining longitudinal static stability and control characteristics. Airplane configuration was also chosen to meet performance criteria. The airplane ended up with a 30.2 ft wingspan and 26 ft length. The Structures discipline generated a V-N diagram for the airplane per FAR Part 23 requirements and used it to size selected parts of the composite primary structure. The Powerplant discipline selected a scaled-up TCM General Aviation Propulsion (GAP) engine to meet the Aerodynamics discipline



Students holding wing section of Thunder Aircraft. Left to right: Masato Ishii, Koichi Fujimoto, Sukjoo Choi, Eric Edgar, Doug Muerle, Pat Bergin, Alfred Leano.

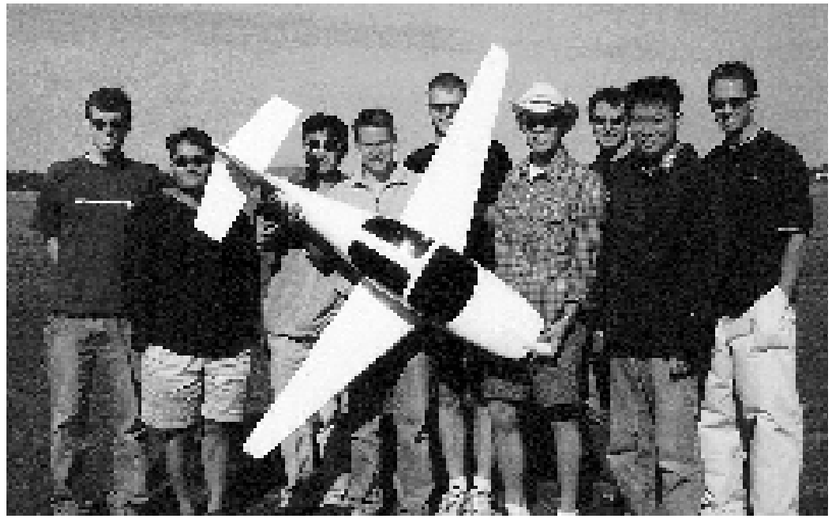
power requirement for 260 HP. The GAP engine is a next generation diesel engine (Jet A fuel is readily available and less expensive than gasoline) that is designed to be 50% less expensive than currently available engines; it also has a very favorable specific fuel consumption (0.36 lbs per HP hour).

The Cockpit Systems discipline was responsible for selecting and arranging the airplanes avionics, controls and other systems which require pilot interface. The Mission Profile/Operating Infrastructure discipline looked at future aircraft weather and traffic information systems. Together they conceptualized a glass-cockpit with two 15 inch displays which presented the pilot with properly prioritized and efficiently displayed airplane, traffic, and weather information. These information systems were interfaced to a fly-by-wire control system to make it possible for a nonprofessional pilot to safely operate the airplane in almost all weather conditions.

Each student was required to study selected design issues and make a presentation to the team for discussion and resolution. The Project Managers organized and conducted these meetings. The aircraft team successfully presented their design at a formal Conceptual Design Review at the end of fall quarter.

The Aircraft Design Team was also reorganized during winter quarter to address certain issues. A wind tunnel test group built a scale model and tested it in the AEM 38 X 54 inch recirculating wind tunnel. Pro/ENGINEER was used to NC machine the airplanes wings, horizontal stabilizer and a left/right side male molds of the fuselage (vacuum formed with hot plastic). The students determined that the airplane was longitudinally stable and controllable and directionally stable. Five students built a full scale mock-up of the airplanes cockpit and instrument panel (firewall to baggage compartment) to evaluate the human ergonomics. Professor Vano's van seats were used once again. The students conducted a survey and determined that several comfort-driven design changes were needed and the door frames required redesign to improve pilot visibility.

Perhaps the most ambitious project for the academic year was building a 1/5th scale radio controlled (RC) model. Nine students participated in this activity over winter and spring quarters. The students used Pro/ENGINEER and NC machining to fabricate parts for an otherwise conventional RC model construction (balsa wood with monocote covering). A data logger data acquisition system (DAS) was installed in the RC mod



Thunder RC Model Flight Test Team. Left to right: Reagan Woolf, Alfred Leano, Masato Ishii, Doug Muerle, Eric Edgar, Pat Bergen, Brad Herzberg, Sukjoo Choi and Jeff Johnson

el along with sensors to measure dynamic pressure, angle of attack, normal acceleration, elevator position and throttle position. Pat Bergen (an experienced RC airplane pilot) was selected to be the test pilot. A flight test program was prepared which included ground tests to evaluate DAS / airplane control system interface. The ground tests indicated that some RFI from the DAS was getting into the airplane control system. The problem was investigated and several modifications were incorporated into the airplane to separate the two systems. A decision was made to fly the first flight without the DAS because time was running-out (spring quarter week eight). The first flight lasted several minutes and was considered a great success. The pilot flew several maneuvers to evaluate performance and airplane handling qualities; the flight concluded with an impressive three-point landing. An engine failure (fouled glow plug) occurred during the second flight; the airplane was recovered without significant damage. A complete range check was conducted prior to the third flight to determine the extent to which the RFI problem would effect the control system. The test showed that although the DAS caused very slight control system oscillations, this should not effect airplane control. The pilot lost control of the airplane shortly after takeoff during the third and last flight. It appeared that the aileron and horizontal stabilizer servos were getting full-control spikes. The pilot was able to cut throttle and land the airplane with minimal damage. Is there a more exciting way to end ones academic experience?

SPECIAL DEPARTMENT SPEAKER

Lieutenant Commander Heidemaria M. Stefanyshyn-Piper gave the lecture on, "So You Want To Be An Astronaut," as part of the regular departmental seminar series for faculty and students on March 12, 1999. She was selected as an astronaut candidate by NASA in April of 1996 and is currently a member of the Astronaut Support team at the Kennedy Space Center, supporting Space Shuttle launches and landings. While she was here, she participated in the Science Across the Curriculum conference at the Science Museum in St. Paul that is offered through the MN Space Grant Consortium. Lieutenant Commander Heidemarie M. Stefanyshyn-Piper graduated from Derham Hall High School, St. Paul, Minnesota, in 1980; received a bachelor of science degree in mechanical engineering from Massachusetts Institute of Technology in 1984, and a master of science degree in mechanical engineering from Massachusetts Institute of Technology in 1985.

Recipients of Undergraduate Student Awards 1998-99

Rose Minkin Scholarship Awardees

John W. Heidt

Travis J. Schauer

Richard G. Pennertz

Chester Gaskell Aeronautical Engineering Scholarship Awardees

Brandon Crook (joint scholarship — see also MN Space Grant Consortium)

Dorothea Czernik (joint scholarship — see also AEM Program Support Scholarship)

Boeing Scholarship Awardees

Abbey Eichman

Paul Hannah

MN Space Grant Consortium

Jenny Cordina

Brandon Crook (joint scholarship —see also Chester Gaskell Scholarship)

Joe Mueller

Richard G. Pennertz (joint scholarship—see also AEM Program Support Scholarship)

Carl Roos

April Rogoyski

Control Science and Dynamical Systems Fellowships

Jiecai Luo

Saroj Saimek

AEM Program Support

Richard G. Pennertz (joint scholarship—see also MN Space Grant Consortium)

Dorothea Czernik (joint scholarship — see also Chester Gaskell Aeronautical Engineering Scholarship)

Donations: You Can Make a Difference:

Donations can be made anytime during the year and sent to the University of Minnesota Foundation, 1300 S. 2nd St., Ste. 200, University of Minnesota, Minneapolis, MN 55455. Just designate the fund you wish to support. Checks should be made payable to the University of Minnesota. The funds to which you can contribute are as follows:

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

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

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

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

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

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

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

If you would like information about establishing a Unitrust with the University of Minnesota Foundation, contact Richard Hatfield, Director of Development and

ALUMNI DONATIONS

The department has just purchased a new motor to replace the 50-year old 100-horsepower electric motor in our wind tunnel. The new motor will incorporate a frequency inverter which will enable us to control the motor speed for more efficient wind tunnel operation. Using funds provided by the Class of '43, we continue to plan additional improvements to our wind tunnel facilities and are grateful to the Class of '43 and other donors who help to make this possible.

We would like to thank all of our donors for their generous contributions throughout the year.

Recent Research Projects of AEM Professors

American Chemical Society

Control of Particle-Laden Flows with Ceramic Actuators
Ellen Longmire

Air Force Office of Scientific Research

Analysis, Design, and Computation of Active Materials
Richard James & Mitchell Luskin

Application of Linear Parameter Varying Control Methods to Aerospace Systems (with CalTech)
Gary Balas

Computational Tools for the Atomic/Continuum Interface: Nanometer to Millimeter Scale Aircraft
Richard James, Graham Candler, Mitchell Luskin, & Chris Palmstrøm

Robust Nonlinear Control Theory as the Applications to Aerospace Vehicles (with CalTech)
Gary Balas

Simulation of Turbulent Hypersonic Flows
Graham Candler

Army Research Laboratory

Army High Performance Computing Research Center
Tayfun Tezduyar

Army High Performance Computing Research Center

Advanced Flow Simulation and Modeling
Tayfun Tezduyar

High Performance Computation of Compressible Flows, Turbulent Flows
Graham Candler

Army Research Office

Advanced Methods for Interceptor Flow Simulations
Graham Candler

Aerodynamic Breakup, Cavitation, & Rupture Fluids
Daniel Joseph

Aerodynamic Breakup of Liquids (with Battelle Memorial Institute)
Daniel Joseph & Gordon Beavers

Break-up of Viscoelastic Liquids in High-Speed Air Flow
Daniel Joseph

Design, Modeling and Computation of Active Thin Films
Richard James & Mitchell Luskin

Finite Element Computation of the Dynamics of Large Ram Air Parachutes
William Garrard & Tayfun Tezduyar

New HPC Techniques for Finite Element Simulation of Large Ram Air Parachutes
Tayfun Tezduyar & William Garrard

Numerical Simulation of Atmospheric Pressure Air Plasmas (with Stanford University)
Graham Candler

Shock Tube Simulations of High-Altitude Breakup of Thickened Simulants (with Battelle) Memorial Inst.
Daniel Joseph and Gordon Beavers

Simulation of Nonequilibrium Rocket Motor Plums
Graham Candler

Simulation of TMD Flowfields
Graham Candler

Two-Phase Flows of Rheologically Complex Fluids
Daniel Joseph

Virtual Fluid-Object Interaction Laboratory (Army/DURIP)
Tayfun Tezduyar and Andrew Johnson

Department of Energy

Lubricated Transport of Viscous Materials
Daniel Joseph

Topological Transitions in Liquid/Liquid Flows
John Lowengrub & Ellen Longmire

DiaSorin, Inc.

Flowcell Investigation
Daniel Joseph

The Hoechst-Celanese Company

Study of Spinning Rod Interfacial Tensionometer used to Measure Polymer Bands
Daniel Joseph

Minnesota Department of Transportation

System Simulation and Optimization
Yiyuan Zhao

Light Weight Guideways Used for Personal Rapid Transit Systems
William Garrard & Gary Balas

National Aeronautics and Space Administration (NASA)

Aircraft Scheduling and Conflict Resolution in Air Traffic Management (Ames)
Yiyuan Zhao

Analysis of the X-38 V132 Flight Control System (Dryden)
Gary Balas

Application of Gain-Scheduled Multivariable Control Techniques to the FIA-18 System Research (Dryden)
Gary Balas

Finite Element Computation of Compressible Flows with Particular Emphasis on Blunt Geometrics, Wake Flows, and Unsteady Behavior (Johnson)
Tayfun Tezduyar

Large Scale Turbulent Structure in Supersonic Jets (Ames)
Thomas Lundgren

The Minnesota Space Grant College Consortium (NASA Headquarters)
William Garrard

Nonlinear Feedback Control of Aircraft Propulsion Systems (Lewis)
William Garrard & Gary Balas

Numerical Simulation of Atmosphere Entry Flows
Graham Candler

Optimal Takeoff Procedures for Category A. Helicopters (Ames)
Yiyuan Zhao

Parallel 3D Computation of Fluid Dynamics and Fluid-Structure Interactions of Ram-Air Parachutes (Johnson)
Tayfun Tezduyar

Robust System Identification and Validation for Control (Langley)
Gary Balas

Studies of Trajectory Synthesis Methods and Trajectory Sensitivity in Air Traffic Management (Ames)
Yiyuan Zhao

National Heart, Lung, and Blood Institute (NIH)

Regional Mechanics of Injured Lungs (with Mayo Foundation)
Theodore Wilson

Respiratory Action of the Intercostal Muscles
Theodore Wilson

Respiratory System Mechanics (with Baylor College of Medicine)
Theodore Wilson

National Science Foundation

Direct Simulation of the Motion of Particles in Flowing Liquid
Daniel Joseph

Experimental, Analytical and Computational Study of Nematic Optical Elastomers
Richard James

Experiments in Particle-Laden and Buoyancy Driven Flows
Ellen Longmire

Fundamental Fracture Mechanisms in Ductile Single Crystals
Thomas Shield

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

Loss of Coherence and Formation of Incoherent Structures at Crystalline Interfaces
Perry Leo

Measurements of Crack Tip and Microstructural Strains in Single Crystals
Thomas Shield

Mechanics of Systems with Bi-Stable Elements
Lev Truskinovsky

Nonlinear Control of Systems with Relative Equilibria
Thomas Posbergh

Nonlocal Models in the Mechanics of Materials
Roger Fosdick

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

Studies of Reservoir Stimulations, Drilling, Transportation, Emulsion Stability and Foaming Bubble Reactor
Daniel Joseph & Gordon Beavers

Transitions and Defects in Ordered Materials
Richard James & Mitchell Luskin

Undergraduate Internship in High Performance Computing in Fluid Dynamics
Tayfun Tezduyar & D. Truhlar

Office of Naval Research

Basic Research on the Improvement of Magnetostrictive and Shape Memory Alloys
Richard James & Thomas Shield

Boeing Defense and Space Group Shape Memory Alloys Consortium
Richard James & Thomas Shield

DURIP-Magneto-Mechanical Testing Machine
Richard James & Thomas Shield

Packard Fellowship

Packard Fellowship in Science and Engineering
Amy Alving

Syncrude LTD of Canada

Pipeline Transportation of Bitumen-Froth in Core-Annular Flow Mode
Daniel Joseph

1998-99 FACULTY & STAFF

Regular Faculty

Professors
Gordon S. Beavers
Roger L. Fosdick
William L. Garrard
Richard D. James
Distinguished McKnight University Professor
Daniel D. Joseph,
Ú&Ú&Ú&Ú&Ú&Ú&Ú Russell J. Penrose Professor, Regents' Professor
Thomas S. Lundgren
Tayfun E. Tezduyar
Ú&Ú&Ú&Ú&Ú&Ú&Ú
Distinguished McKnight University Professor
Theodore A. Wilson
Associate Professors
Amy E. Alving
Gary J. Balas
Graham V. Candler
Perry H. Leo
Ellen K. Longmire
Lev Truskinovsky
Thomas W. Shield
Yiyuan Zhao

Asistant Professor
Ivan Marusic

Akerman Professor of Design
Andrew Vano

Adjunct Associate Professor
Dale F. Enns

Professor Emeritus
J. L. Ericksen
Philip G. Hodge, Jr.
C.C. Hsiao
Robert Plunkett
William H. Warner

Associate Professor Emeritus
Eugene Stolarik

Temporary Faculty

Assistant Professor
Marek Behr
Gary Chapman
Yohannes Ketema
Xiaoyen Wang

Research Staff

Postdoctoral Associates
Runyuan Bai
Hyung Gwon Choi
Kevin Hane
Yi Jian Huang
Qi Pan
Neelesh Patankar

Research Associates
Antonio Fortes
Yadong Huang
Leonard Imas
Thomas Posbergh
Ram Rao
Steven Ray
Michael Wright

Research Specialists
Miguel Charlotte
Giuseppe Puglisi
Raffaella Rizzoni
Cornelia Van Etten

Technical Staff

Jim Frame, Scientist
Dave Hultman, Managing Research Engineer
Ú&Ú&Ú&Ú&Ú&Ú&Ú
Ray Muno, Scientist
John Tucker, Scientist
Steve Nunnally, Principal Lab Machinist

Administrative Staff

Kristal Belisle,
Senior Secretary
Dan Hegland,
Principal Accountant
Randi Quanbeck,
Associate Program Director, MN Space Grant Consortium
Ruth Robinson,
Senior Office Supervisor
Donna Rosenthal,
Senior Administrative Director
Lisa Schouviller,
Accounts Specialist
Greg Swieringa and
David Vogel,
Application Programmers

Part-time Administrative Staff

Heide Burns,
Executive Assistant

Head
William L. Garrard

Associate Head
Theodore A. Wilson

Director of Undergraduate Studies
Thomas W. Shield

Director of Graduate Studies
Theodore A. Wilson

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

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

This brochure is printed on recycled paper containing 10% post-consumer waste.

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

Address Service Requested

Nonprofit Org.
U.S. Postage
PAID
Minneapolis, MN
Permit No. 155