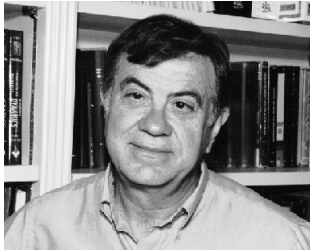


# THE AEM UPDATE

Department of Aerospace  
Engineering and Mechanics

UNIVERSITY OF MINNESOTA

## CHAIRMAN'S CORNER



This has been a very good year for the University of Minnesota Community. Our new President, Mark Yudof, has provided a huge boost for morale of students, faculty, and staff. He was an enormous success with

the legislature and governor. As a result, several major building projects in the Institute of Technology are or will be underway soon. These include a new building for Mechanical Engineering, reconstruction of Walter Library to house the Digital Technology Center, and an addition to Amundson Hall which houses the Chemical Engineering and Materials Science Department. Unfortunately Akerman Hall will not benefit a great deal from this new construction, and although we have made incremental improvements in the building over the last 10 years, the AEM Department is the only engineering department which has not received a new building or major renovations to an existing building. We hope that much needed improvements, such as new energy efficient windows, central air conditioning, and improved heating, will not be too long in coming.

The job market for our graduates is excellent and enrollments are increasing. In terms of Bachelors Degrees/faculty member we are still the lowest of the engineering departments, however due to our heavy service course responsibilities, the student credit hours/faculty member is the highest of all the engineering departments and our Ph.D. awarded/faculty members is only exceeded by Chemical Engineering and Materials Science. Our faculty members have been extraordinarily successful in obtaining research funding from external sources and we have increased our annual research expenditures per faculty member from \$183,656 in 1995-96 to \$254,830 in 1996-97. This is substantially above all engineering departments except Chemical Engineering and Material Science (the average for all engineering departments was \$165,326). Total external support for AEM in FY97 was over four million dollars. These funds came from Federal sources such as NSF, DoD, and NASA as well as private foundations

and industry.

This year Professor Dick James was selected as a Distinguished McKnight University Professor. Only six of these awards were given and this is the second consecutive year that a faculty member in our Department received one of these Professorships. The McKnight Professorships are designed to "honor the University's finest mid-career faculty scholars." Dick is a leading researcher in the field of smart materials and is internationally known for his work in mathematical modeling of materials. He and Professor Graham Candler were recently awarded a five million dollar grant to study the application of smart materials to nano technology including microscopic aircraft.

We are very happy to welcome a new member of our faculty, Dr. Ivan Marusic, who comes to us from the University of Melbourne in Australia. Dr. Marusic is an expert in

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turbulence and will teach both undergraduate and graduate courses in fluid mechanics. This year we will be searching for an new faculty member in the dynamics and control area.

During the past year, we reconstituted our Industrial Advisory Board and had a very successful meeting in May. In addition, our Graduate Program was reviewed very favorably by an external panel of distinguished scholars. Details of both of these events are described in this newsletter.

Next fall is the last year in which the University of Minnesota will operate on the quarter system. We have all been very busy in planning for the transition to semesters which will occur in the fall of 1999. Professors Perry Leo and Tom Shield have worked especially hard on this project.

Although state support for the University has increased, support for the departmental infrastructure - equipment, maintenance, and supplies - is still not adequate and we depend on gifts as an important method for supplementing state funds. For example, funds contributed by the Class of 1943 are being used to replace the old electric motor on our large horizontal return wind tunnel with a modern solid state controlled motor which will give us much more precise speed control. I would like to take this opportunity to thank the Class of '43 and all of our supporters.

As I stated last year, 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 at donna@aem.umn.edu or by fax at (612) 626-1558. Also visit the Departmental web site at <http://www.aem.umn.edu>.

## ACADEMICS: WHERE ARE WE NOW?

### AEM UNDERGRADUATE PROGRAM

Forty-six (46) students were cleared for their BAEM degree during the 1997-1998 school year. Also, 34 new juniors entered the AEM upper division program in the Fall of 1997. Our enrollment numbers look very strong in Lower Division as well, and we expect to continue with classes of forty or so for the next several years. In addition, we have been attracting top notch Honors students into the program, and we hope for that trend to continue.

The job market remains strong both in aerospace and in local industry, and students have had good success in finding jobs. This year, many of our graduates went on to top Graduate Schools such as Minnesota, Illinois and Stanford. In addition, several of our new seniors participated in summer internships at Boeing and at NASA.

The biggest news in the undergraduate program remains the change to semesters in Fall 1999. This past spring, we had extensive advising sessions designed to get students through the change as painlessly as possible. We also put together a manual for students addressing the changes that will occur

under semesters. The change to semesters has enabled us to strengthen the curriculum, by adding more spaceflight to the program, by introducing a junior year laboratory course and by increasing the role of the capstone senior design course.

### AEM GRADUATE PROGRAM

Last fall, the Department welcomed 16 new students into the Aerospace Engineering and Mechanics graduate programs. Four of the students were from the U.S., and the others came from Canada, China, India, Iran, Korea, Trinidad, Turkey and Venezuela.

Over the past year, the Department awarded 8 Ph.D. degrees and 9 M.S. degrees (5 Ph.D.s in Aerospace Engineering, and 3 Ph.D.s in Mechanics; 5 M.S. in Aerospace Engineering and 4 M.S. in Mechanics.) The job market continues to be very strong, and the graduates moved on to positions in industry (aerospace as well as other fields) national laboratories, and in academia. Several master's graduates moved on to further studies within the Department and at least one Ph.D. graduate accepted a position in the Department.

Wendy Cronese served as the departmental representative and as an officer on the Council of Graduate Students. Faezeh Mojtahed organized a workshop on interviewing skills. A number of AEM students helped out with recruiting, organized social activities, and led and participated in service activities for grade school students.

## AEM ADVISORY BOARD

This year, we reinstated the AEM Advisory Board. The new Advisory Board is composed of the following: Dave Selvig, Chief Engineer, Configurations and Engineering Analysis, Boeing Commercial Airplane Group; Thomas B. Cunningham, Director of Research, Systems and Research Center, Honeywell Inc.; Carl W. Peterson, Unsteady and Reactive Fluid Mechanics Dept., Sandia National Laboratories; Bill Wilson, Vice President, Technology, Alliant Techsystems; Karl Drutowski, Structural Analyst/Manager, Aero and Eng Analysis, BF Goodrich Aerospace, Aircraft Sensors Division, Rosemount Aerospace, Inc.; and Wendell Maddox, President and CEO, ION Corporation. The Board met with faculty, students, and staff on May 8, 1998. They were asked to address these questions:

- Do our undergraduate and graduate programs meet the current needs of our constituents?
- What is your opinion of our current research enterprise? What areas should receive more or less emphasis in the future and what new areas should we consider?
- How might we improve the diversity of our student body?
- What do you think of our current mix of faculty in terms of areas?
- How might we better interact with industry, government and national labs?
- Should the Advisory Board be expanded and if so who should be included?
- How might we improve our recruitment of outstanding students at both the undergraduate and graduate levels?
- Are there significant trends in aerospace engineering that we should be involved in?

The Board interviewed both graduate and undergraduates. The students were very positive about the Department and felt that the faculty was available and approachable. Students were concerned about the limited number of electives available and believed that the new liberal education requirements were too complex and restrictive.

The Board felt that the Departmental emphasis on fundamentals was the correct approach, but believed that AEM labs should be introduced earlier in the program (there will be a junior lab in the new semester based program). There was praise for the capstone design class, particularly the team approach. It was suggested that more emphasis be placed on economics, manufacturing and maintenance.

A graduate level design sequence was suggested by the Board and the desirability of increased contact between students and faculty and industry was emphasized. The necessity of developing good oral and written communication skill in students was also a topic which the Board discussed. Finally the Board emphasized the importance of more endowed chairs for our outstanding faculty.

## AEM GRADUATE PROGRAM REVIEWED

The graduate program of the department was reviewed this past fall in November. Reviewers were: Fluid Mechanics: Professor Theodore Y. Wu, Department of Engineering Science, Caltech; Solid Mechanics: Dean Michael M. Carroll, Rice University; Dynamics and Controls: Professor Arthur E. Bryson, Department of Aeronautics and Astronautics and Department of Mechanical Engineering, Stanford University.

Primary program review outcomes:

- The AEM program should be maintained and strengthened as a department
- The faculty should be rebuilt to its previous level of 21 faculty
- Experimental and computational facilities should be upgraded
- Stronger interactions with industry should be developed
- More recognition programs for senior faculty such as endowed chairs should be instituted
- Deteriorating physical facilities in Akerman Hall should be renovated

## CONTROL SCIENCE AND DYNAMICAL SYSTEMS (CSDy)

### Interdepartmental Ph.D. Program

The CSDy Interdepartmental Ph.D. Program provides an opportunity for interdisciplinary research in control science and dynamical system theory. The CSDy program coordinates scholarly and scientific activity of these areas within IT and the University and coordinates its activities with industrial firms in the Minnesota region. CSDy faculty are drawn from the Departments of Aerospace Engineering and Mechanics (AEM), Chemical Engineering, Electrical Engineering (EE) 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 in the fields of behavioral and societal systems. The Co-Directors of the CSDy Center are Professor Gary J. Balas (AEM) and Professor Tryphon Georgiou (EE).

This has been an exciting year for the CSDy Program. An alumni of the CSDy Program, Dr. Kris Burhardt, was named the new vice president of the Honeywell Technology Center. Professor Bruce Lee of CSDy and Electrical Engineering was his advisor. Dr. Burhardt was formerly a 3M executive and the vice president and chief technology officer at Imation prior to his new position. Dr. Burhardt received his Ph.D. degree in Control Science and Dynamical Systems in 1968 after coming from Poland. Dr. Burhardt looks forward to establishing closer ties with his former department.

In the Spring Quarter, we had the honor of a seminar by Professor Laszlo Keviczky on "Dialectics of Identification and Control for an Optimal Two Degree of Freedom Controller." Professor Keviczky is the current Secretary General of the Hungarian Academy of Sciences. This is

a government position in Hungary and is equivalent to a Presidential cabinet member in the United States. The Hungarian Academy of Sciences and the CSDy Program have long ties that date back to 1976 when an exchange program was initiated between the two groups. Professor Pat Kumar, currently Associate Dean of the Institute of Technology and member of the CSDy and Electrical Engineering faculty, and Professor Keviczky were instrumental in the establishment of this program. Professor Keviczky was a visiting scholar at the University of Minnesota in 1978. In fact, during his stay at the University of Minnesota Laszlo consulted with Dr. Kris Burhardt, who was then at 3M, on the application of adaptive control methods in manufacturing. Professor Balas has worked over the past 4 years to reestablish our strong relationship with the Hungarian Academy of Sciences. He has visited Hungary twice since 1994 and will be in Hungary again in November of 1998 as a member of the program committee for the 6th Mini Conference on Vehicle System Dynamics, Identification and Anomalies.

Currently, the CSDy Program has 9 students pursuing the Ph.D. The majority of these students are Research Assistants working with their advisors on various research projects. Professor Balas serves as CSDy Director of Graduate Studies.

For more information regarding the Control Science and Dynamical Systems Program call (612) 625-3364 (email:csdy@aem.umn.edu) or see the CSDy web page, at <http://www.aem.umn.edu/other/CSDy.html>.

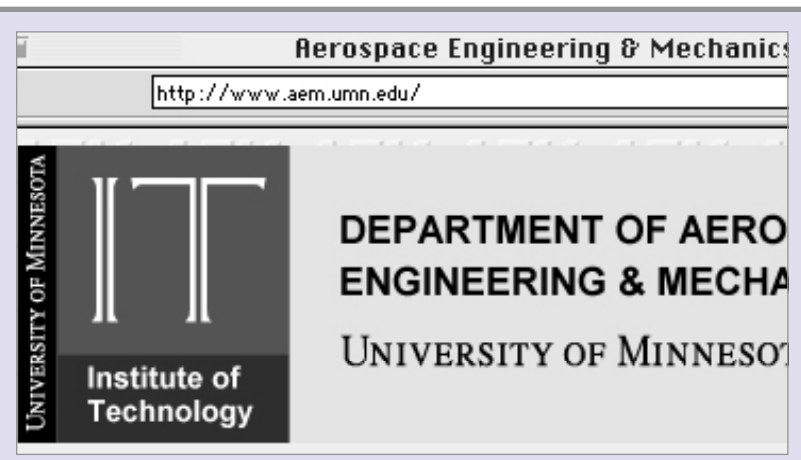
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For Info on:

- Faculty
- Faculty Research
- AEM Programs



## NEWS ABOUT OUR FACULTY

Professor Amy Alving has been a White House Fellow as a Special Assistant under Deputy Commerce Secretary Robert L. Mallett this past year. She was one of 15 appointed by President Bill Clinton and the Commission on White House Fellowships for one year. The Program is designed to encourage national leadership via exposure to the workings of the federal government at the highest levels. The White House Fellowship Program includes: senior-level work assignment involving private meetings with the political, business, and cultural leadership of the country; substantial domestic, military, and foreign travel as an official White House delegation, with trips to Seattle, Boston, Los Angeles, New York City, Baltimore; an aircraft carrier, Camp Lejeune; Greece, Cyprus, Turkey. Her work assignment at Commerce has included: critical infrastructure protection; space commercialization; Partnership for a New Generation of Vehicles; Advanced Technology Program; Y2K problem; and Decennial Census.

Professor Gary Balas co-organized and taught a new short course entitled, Theory and Application of Linear Parameter Varying Control. It was the most popular short course at the American Controls Conference in Albuquerque, NM, with over 50 attendees from throughout the world. He offered the same short course at NASA Langley Research Center in September 1997. Professor Balas has given invited seminars at NASA Langley, NASA Lewis, NASA Dryden, Duke University, University of Houston, and the University of Maryland. He continues to serve on the Technical Program Committee for the SPIE Conference on Smart Structures and Materials Mathematics, Modeling and Control and is a member of the International Programme Committee for the 2<sup>nd</sup> IFAC Symposium on Robust Control Design and the International Programme Committee for the 6<sup>th</sup> Mini-Conference on Vehicle System Dynamics, Identification and Anomalies.

Professor Graham Candler gave the following invited lectures and papers, Detailed Simulation on  $N_2$  Dissociation in Shock Waves, at the 32<sup>nd</sup> AIAA Thermophysics Conference, Atlanta, GA, June 1997; Detailed Simulation of Nitrogen Dissociation in Hypersonic Flow," AEM Department, University of Minnesota, May 1998; Simulation of TMD Interceptor Flowfields," Hypersonic Interceptor Form, Huntsville, AL, September 1997; Parallel Implicit Finite-Volume Methods for the Simulation of High-Speed Flows," Army Research Lab, Aberdeen, MD, December 1997; and "High Enthalpy Flow Simulation Challenges," plenary talk at the 29<sup>th</sup> AIAA Plasmadynamics and Lasers Conference, Albuquerque, NM, June 1998.

Professor Roger Fosdick gave invited talks at the University of Texas, Houston, and at the Second Euroconference and International Symposium on Material Instabilities in Deformation and Fracture, Polytechnic School of Aristotle University of Thessaloniki, Greece. A joint paper was presented at the Northwestern University meeting of the Society for Engineering Science. He continued as a member of the Board of Editors of the SIAM Journal on Applied Mathematics and he was appointed Editor-in-Chief of the Journal of Elasticity. He is a member of the Scientific Development and Visualization Laboratory Committee at the Minnesota Supercomputer Institute.

Professor William Garrard was nominated as an alternate delegate for the Aerospace States Association by Lt. Governor Joanne Benson. He was also elected an alternate by the AIAA for the Engineering Accreditation Council of the Accreditation Board for Engineering and Technology. Professor Garrard is also serving as Technical Committee Chair for the AIAA Aerodynamic Decelerator Systems Technology Conference to be held in Toulouse France in June of 1999. He gave a lecture on dynamics and control of tailless aircraft at CERT/ONERA in Toulouse in July, 1998.

Professor Richard James was awarded a MURI grant on Computational Tools for the Atomic/Continuum Interface: Nanometer to Millimeter Scale Aircraft for \$5M over the next five years starting in June of 1998. This research, on the development of concepts for flight at small scales with applications to atmospheric flight and biomedicine, is at the forefront of science and engineering. He was also named a Distinguished

McKnight University Professor, and a Fellow of the American Academy of Mechanics. He was named to the Editorial Board of the Journal *Interfaces and Free Boundaries*.

Professor James gave the Bell Lecture at Johns Hopkins University, and invited lecturers at the Departments of Mathematics and of Applied Mechanics and Engineering Science at the University of Arizona; the Department of Mathematics at Carnegie Mellon University; the Max-Planck Institut for Mathematics in the Sciences, Leipzig; the Department of Materials Science and Mechanics at Michigan State University; the Mathematics Institute at the University of Oxford, and 3M. He participated in German-American Frontiers of Science and the MartWerks Workshop on the Theory of Martensite.

Professor Perry Leo gave invited lecturers at the Department of Aerospace Engineering and Mechanics, University of Minnesota, Winter 1997; Department of Materials Science and Engineering, University of California at Los Angeles, Winter 1997; Department of Materials Science and Engineering, Northwestern University, Winter 1997, SIAM meeting on Mathematics in Materials Science, Philadelphia, PA, Spring 1997; ASM/TMS Fall meeting; Indianapolis, IN, Fall 1997; Department of Mechanical Engineering, University of Miami, March 1998 and the ASM/TMS Fall Meeting, Chicago, IL, Fall, 1998.

Professor Leo received a Bush Sabbatical Fellowship to study at the Max Planck Institute at Leipzig, Germany and at the California Institute of Technology in Pasadena, CA for his sabbatical in 1998-99.

Professor Ellen Longmire gave invited lectures at the Universite Joseph Fourier in Grenoble, and IMF Toulouse in June 1998. She also chaired sessions and gave presentations at the American Physical Society Division of Fluid Dynamics meeting in San Francisco (November, 1997) and the International Conference on Multiphase Flows in Lyon, France (June, 1998). Professor Longmire received a Bush Foundation Fellowship for her 1998-99 sabbatical to work at the University of California/Berkeley developing expertise in a new research area - microscale fluid mechanics. In October and November, 1998, she will hold the TEPCO Chair as a visiting professor at Keio University in Yokohama, Japan.

Professor Tom Lundgren gave a conference lecture at the American Physical Society Fluid Dynamics Division meeting in San Francisco, November 1997 and an invited lecture at the Mechanics Department at the University of Illinois, Champaign/Urbana, in December 1997. His student Ram Rao was awarded the Ph. D. degree in December 1997, for his work on Numerical Simulation of Turbulent Flow in a Supersonic Jet.

Professor Ivan Marusic will be joining the faculty fall 1998 as an Assistant Professor. Professor Marusic's main research interest is on the experimental and theoretical study of turbulent boundary layers. He has focused on hot-wire anemometry, data acquisition and experimental automation techniques, including the development of a flying hot-wire system to make high accuracy measurements in regions of high turbulence intensity in flows with varying streamwise pressure gradient. Other research has concentrated on the extension of the attached eddy hypothesis into a physical model describing wall turbulence in arbitrary pressure gradients.

Professor Tom Shield lectured at the ASME Winter Annual Meeting, Dallas, November 1997; and the ASME AMD, ASCE EM, SES summer meeting, Chicago, July 1997. He has worked extensively on coordinating the semester conversion program for the Department. Professor Shield will be the Acting Director of Undergraduate Studies for the academic year 1998-99 while Professor Leo is on sabbatical leave.

Professor Tayfun Tezduyar was named to the editorial boards of the international journals *Computer Methods in Applied Mechanics and Engineering* and *Journal of Visualization*. Professor Tezduyar gave the opening lectures of the High Performance Computing on Multiphase Flows session at the Japan Society of Mechanical Engineers Centennial Grand Congress, Tokyo, Japan; Workshop on Parallel Computing in Applied

Fluid Mechanics, Scuola Normale Superiore, Pisa, Italy; and the Fourth Japan-US Symposium on Finite Element Methods in Large-Scale Computational Fluid Dynamics, Nihon University, Tokyo, Japan. Professor Tezduyar gave the Plenary Lecture of the Computational Mechanics Division at the Japan Society of Mechanical Engineers Centennial Grand Congress, Tokyo, Japan; and the plenary lectures at the High Performance Computing Workshop, Cetraro, Italy, and Multi-disciplinary Applications and Interoperable Computing, Wright-Patterson Air Force Base, Ohio.

Professor Tezduyar gave a keynote lecture at the 4th World Congress on Computational Mechanics, Buenos Aires, Argentina, and invited lectures at the Institute of Industrial Science, Department of Quantum Engineering and Systems Science (2 lectures), and Department of Earth and Planetary Physics at University of Tokyo, Tokyo, Japan. Professor Tezduyar gave invited lectures also at the Mini-Workshop on High Performance Computing, Cetraro, Italy; University of Calabria, Cosenza, Italy (3 lectures); Hitachi Mechanical Engineering Research Laboratory, Tsuchiura, Japan; Chuo University, Tokyo, Japan; 4th World Congress on Computational Mechanics, Buenos Aires, Argentina; Joint ASME/ASCE/SES Summer Meeting, Evanston, Illinois (2 lectures); 4th National Congress on Computational Mechanics, San Francisco, California; Workshop on Unstructured Mesh Generation and Partitioning, Army HPC Research Center, Minneapolis, Minnesota; University of Nebraska Lincoln, Lincoln, Nebraska; Tenth International Conference on Finite Elements in Fluids, Tucson, Arizona; Purdue University, Lafayette, Indiana; Cray Research, Eagan, Minnesota; and University of California at Davis, Davis, California.

The Army HPC Research Center, of which Professor Tezduyar is the Director and Principal Investigator, was awarded an additional \$20,000,000 from the United States Army for the purpose of upgrading the Center's computing equipment in Minneapolis and at four other partner universities.

Professor Lev Truskinovsky was on sabbatical furlough from January of 1997 to December of 1997. During this time, he held positions of Visiting Professor of Mechanics at Caltech, Pasadena; Institute Galilee, Universite Paris Nord, France and Department of Applied Mathematics, University of Padova, Italy. He also won the RIP Fellowship and spent three weeks at the Mathematical Institute, Mathematisches Forschungsinstitut Oberwolfach, Germany.

During this period Prof. Truskinovsky gave invited lectures at Ecole Superieure de Physique et Chimie, Paris; Ecole Polytechnique in Palaiseau; Laboratoire de Modelisation en Mecanique, University Paris 6; Mathematical Institute, Oxford; Department of Mathematics, Heriot-Watt University, Edinburgh, Instituto di Ingegneria, Universita' di Ferrara, Italy; Ecole Normale Superieure in Leon; Conference "Mathematical Thermodynamics" in Trento, Italy; International Institute of Advanced Studies (SISSA), Trieste, Italy; Istituto di Meccanica Teorica ed Applicata, Universita Di Udine, Italy; ASME Meeting "Mechanics and Materials", Chicago; International Conference "Nonlinear waves in inhomogenous media", Bari, Italy; Department of Mathematics, University of Mannheim, Germany; Department of Mathematics, Penn State.

Professor Yiyuan Zhao gave invited lecturers on Air Traffic Control at Iowa State University, October 1997; Boeing Commercial Aircraft Group, December 1997, and Stanford University, January 1998. In addition, he gave invited lecturers on rotocraft research at Boeing Rotocraft, Philadelphia, November 1997 and Princeton University, November 1997.

### HONORS, AWARDS, AND PRESENTATIONS

Professor Tayfun Tezduyar, Distinguished McKnight University Professor and Director and PI of the Army HPC Research Center, has received the 1997 Computational Mechanics Award from the Japan Society of Mechanical Engineers (JSME). The Award was given at a ceremony on July 17, 1997 at the JSME Centennial Grand Congress in Tokyo. This award was established in 1990. Professor Tezduyar is the 5th winner of the Award from the United States; the four winners of the earlier years are all members of the National Academy of Engineering. The JSME has approximately 50,000 members. During his visit to Japan, Professor Tezduyar gave six invited lectures at the University of Tokyo and the JSME Centennial Grand Congress, including a general, plenary lecture of the JSME

Computational Mechanics Division, immediately preceding the Award Ceremony. Professor Tezduyar has also received the 1997 Computational Fluid Dynamics Award from the US Association of Computational Mechanics. The Award was given at a ceremony on August 7, 1997 at the 4th US National Congress on Computational Mechanics in San Francisco. This is the first time this award was given, and it is "in recognition of outstanding and sustained contributions to the broad field of Computational Fluid Dynamics".

### ALUMNI HIGHLIGHTS

Rodney Lund (BAEM, 1991) is currently working at The Toro Company in Bloomington, MN. He is a design engineer for the consumer division, working on sound reduction for the hand-held electrical products. He is also working on his MBA at the College of St. Thomas in St. Paul, MN.

Mike Schwartz (Ph.D., 1993) is Assistant Professor, Department of Orthopaedic Surgery, and Director of Bioengineering Research, at Gillette Children's Specialty Healthcare in St. Paul, MN.

Steven Anderson (Ph.D., 1997) is currently the Midwest Regional Sales Manager for TSI, Inc. in Shoreview, MN. Steve Lonnes (BAEM, 1991 and M.S. in Aerospace Engineering, 1993) completed his PhD in Mechanical Engineering and accepted a position with Exxon in Houston, Texas.

### NEW DEPARTMENTAL POSTDOCS AND OTHER ACAMEDICIANS

Ram Rao, a recent Ph.D. in Mechanics from the Department is working as a Research Associate under the direction of Professor Graham Candler on the analysis of rocket motor plume flows. Dr. Rao's experience includes computational fluid dynamics methods, high performance computing, and compressible flows. His dissertation was entitled: "Direct Numerical Simulation of Turbulent Supersonic Jets" and his academic advisor was Professor Thomas Lundgren.

Ahsanul Karim began work as a Postdoctoral Associate under the direction of Professor Amy Alving in September of 1997. He earned his Ph.D. in Mechanical and Aerospace Engineering from the Illinois Institute of Technology. His thesis was entitled: "Experimental Investigation of the Three-Dimensional Unsteady Flow Over a Pitching Backward Swept Wing." The research Dr. Karim has been involved in for Professor Alving is in the area of experimental fluid mechanics in the general area of turbulent boundary layers, and recent projects include the study of inner/outer interactions, the effect of riblets on lifting surfaces, and the role of thin liquid films in the transition process.

Raffaella Rizzoni, a Ph.D. student from Italy, visited the Department as a Research Specialist at the end of Fall Quarter, 1997. Under the direction of Professor Richard James, she studied and engaged in research in the area of phase transformations.

Miguel Charlotte, a Ph.D. student from France, is spending an eight-month stay in the Department under the supervision of Professor Lev Truskinovsky. He is a visiting Research Specialist whose research interests are in the area of the mechanics of solids.

Oliver Bauche is visiting the Department on an End-Of-Study Project as a trainee from the Ecole Nationale Supérieure De L'Aéronautique Et De L'Espace in Toulouse, France. He is being hosted by Dr. William Garrard. In his research, Mr. Bauche is developing computer simulations of aircraft dynamics and designing and evaluating control systems using these simulations.

Joachim Plaettner-Hochwach is visiting the Department as a trainee from the Institute for Flight Mechanics of the University of Stuttgart. He is studying control of tailless aircraft under the direction of Prof. William Garrard. He has also been admitted as a graduate student in the Department beginning Fall, 1998.

### STUDENT NOTES

AIAA Student Paper Conference was held at the USAF Academy in Colorado Springs, CO. There were eight people in attendance (first time in 4 years) Gerald Brenden, Gunnar Einarsson, Kasey Roskopf, Sara Brandenburg, Abbey Eichman, Nina Tortosa, Lisa Parkin, and James Chase. Four papers were presented, two at the undergraduate level and two at the graduate level.

#### 1997-98 AIAA Officers

President	Gerald Brenden
Vice President	Sara Brandenburg
Treasurer	Karrie Breit and Lisa Parkin
Secretary	Kasey Roskopf

Abbey Eichman, Undergraduate, "The influence of viscosity on the aerodynamic breakup of Newtonian liquids exposed to high-speed flows"

James Chase, Undergraduate, "The potential of Northwest Airlines in the satellite launch market"

Gerald Brenden, Graduate Student, "A comparison of the aerodynamic breakup process of Newtonian and viscoelastic liquids in a high-speed flow"

Gunnar Einarsson, Graduate Student "The evaluation of thermochemical models for simulations of aerocapture re-entries"

Gunnar Einarsson placed first in the Graduate division and Gerald Brenden placed third. Because of his first place finish, Gunnar Einarsson has been invited to attend the AIAA National Student Conference in Reno, Nevada on January 11, 1999, with airfare and lodging paid for by the AIAA.

Gerald Brenden participated in the Mentorship program for the second year, his mentee was Kyle Gudmunson from Washburn High School. His project was on the effect of viscosity on the aerodynamic breakup process of Newtonian liquids.

Gerald Brenden also participated in an outreach for kids at the Minneapolis Convention Center. It was the annual MN Dot Aviation Conference. He helped kids make egg cartons for an egg drop and effervescent rockets (rockets fueled with antacid and water).

Naomi Daire and Karrie Breit did an extra outreach for middle/high school girls with the Society of Women Engineers. This included a tour of the aerospace department wind tunnel and BD-5B wing test facilities.

Wendy Crone and Professor Tom Shield hosted a student from St. Paul Central High School for a week in the WISE Science Research Camp for Girls in August, 1997. The student helped to design and construct a Portable table-top testing machine to be used for AEM outreach in solid mechanics.

Wendy Crone presented an outreach program for physically challenged grade school girls with Project Gold in General College.

Derek Gefroh (BAEM '98) will enter the M.S. program in the Department of Aerospace Engineering at the University of Illinois in September, 1998. He will receive full support for his studies as a Research Assistant.

Alexandra Naughton (M.S. '98) accepted a job with Guidant Corp. in Arden Hills, MN.

Wendy Crone will start a tenure-track position as an Assistant Professor in the Department of Engineering Physics at the University of Wisconsin at Madison in January, 1999.

Konstantinos Hennighausen ("Kosti") talked to preschoolers at the Lab Preschool at the Institute for Child Development, about space exploration, the space shuttle, and rockets and aerodynamics in general. Professor Vano brought models of landers, satellites, and rockets. They also brought a hair dryer and some ping-pong balls to illustrate aerodynamic forces. Kosti talked to 7th and 8th graders at a school in Roseville about career opportunities. He also spoke with juniors and seniors at Roseville High School about courses to take in high school to prepare them for programs in the sciences in college. These were kids who felt they had already decided what they wanted to do (at least in broad terms), but wanted to know more about how to go about preparing for a given career.

On Saturday, April 18th, the AEM Department participated in Looking Toward the Future for middle school girls and boys. The intent was to get them interested in math and science by giving them an opportunity to perform some hands-on experiments. Our department hosted four groups that did a balsa wood composites experiment. Those who participated from the department were: Kevin Hane, Faezeh Mojtahed, Ali Naughton, Galyna Vasko, Greg Weirs, Wendy Crone, and Professor Perry Leo.

### PARACHUTE SYSTEMS TECHNOLOGY SHORT COURSE

The AEM Department will sponsor, in cooperation with the Minnesota Space Grant Consortium and the AIAA Aerodynamic Decelerator Systems Committee, a Parachute Systems Technology Short Course. The Course will be offered October 25-29, 1998 at the Radisson Hotel Metrodome in Minneapolis. Topics will include canopy design, case studies, computer simulation, construction methods, definitions and nomenclature, deployment processes, design project, drag area control, flight mechanics, gliding parachutes, parachute materials, parachute types and applications, steady and unsteady aerodynamics, and supersonic parachutes. Faculty for the course are Drs. Vance Behr and Dean Wolf of Sandia Labs, Dr. Karl-Fr. Doherr of the DLR in Germany, Dr. Stephen Lingard of Martin Baker Aircraft in England, and Dr. William L. Garrard of the AEM Department. This is the seventh time this very successful Short Course has been offered. For further information contact Dr. Randi Quanbeck in the AEM Department at (612) 626-9295, fax (612) 626-1558, or e-mail [quanbeck@aem.umn.edu](mailto:quanbeck@aem.umn.edu).

### SOLAR VEHICLE PROJECT: ON THE ROAD AGAIN



Photo Courtesy of the University of Minnesota  
Solar Vehicle Project

This past year students from AEM and other departments continue their work on the solar car, Aurora. This summer, Aurora3 competed in the 1998 World Solarcar Rally in Akita, Japan, on a 31.25km closed course called the Ogata-Mura Solar Sports Line. They finished first in class and seventh overall among 91 entries. For the 1998-99 year, they have planned two races. The first one will be the Sunrayce 99, an 11-day race from Washington, DC to Epcot Center in Orlando, Florida. They will be competing against 40 other college teams. The second race will be at the World Solar Challenge in Australia's outback. Here they will compete against multinational corporations, high school and college teams. To keep posted, see their Web page at:

<http://www.umn.edu/umnsvp/overview.html>

### KIDS PROGRAM '98

Faezeh Mojtahed, an AEM graduate student, worked this summer with the Kids '98 program that is offered by the Academic Programs for Excellence in Engineering & Science. The kids vary in age from 9-13 years old. The intent of the program is to get kids interested in science and engineering at an early age. Students constructed and launched a simple bottle rocket made from 2-liter soft drink bottles and other materials. This gives students perspectives on physical science relating to the position and motion of objects; abilities in technological design; science processing skills for measuring and making models; and in standards for mathematical connections, geometry and measurement. Dave Hultman, Steve Nunnally and Andy Geppert from our Shop assisted Faezeh. Aviation Education publications distributed to the participating kids were provided by the Office of Aeronautics, Minnesota Department of Transportation.



(left to right, background) Dave Hultman, Andy Geppert, and Steve Nunnally supervise as three young rocket scientists prepare for launch.



Blastoff! Students in the "Kids '98" program launch their bottle rockets.



Lt. Colonel Susan Helms (USAF), NASA Astronaut, gave a special seminar on, "Space Flight: One Engineer's Perspective," that was open to all students at the University on January 23, 1998. She became an astronaut on July 1<sup>st</sup> of 1991. Col. Helms is currently assigned to a six-month space station flight, commencing in the Summer of 1999. A veteran of three shuttle flights, Helms has orbited the Earth 544 times, traveled over 14 million miles, and has logged a total of 33 days, 20 hours, 17 minutes and 17 seconds in space. On her first mission, Helms flew on the crew of STS-54 in January of 1993 that deployed a \$200 million NASA Tracking and Data Relay Satellite (TDRS-F). In September of 1994, she was the flight engineer for orbiter operations and the primary RMS operator aboard Space Shuttle Discovery. In June and July of 1996, Helms was the payload commander and flight engineer aboard Columbia, on the longest Space Shuttle mission to date.

### ASTRONAUT SPEAKS SPACE TO STUDENTS

THE FOLLOWING ARTICLE BY DAVID HYLAND APPEARED IN THE MN DAILY ON JANUARY 26, 1998, AND IS EXCERPTED HERE WITH PERMISSION.

WHEN ASTRONAUT SUSAN HELMS FIRST WENT INTO SPACE, SHE DIDN'T REALIZE THE HEIGHT TO WHICH SHE HAD GONE.

"I GREW TWO INCHES TALLER IN SPACE," HELM SAID. "THAT I DID NOT EXPECT. THAT WAS BECAUSE THE SPINAL COLUMN ELONGATES WITHOUT THE EFFECT OF GRAVITY."

THIS WAS JUST ONE OF MANY STORIES AND EXPERIENCES HELM, A FORMER AIR FORCE ENGINEER, SHARED FRIDAY AT A LECTURE AT AKERMAN HALL. BEFORE AN AUDIENCE OF MORE THAN 100, HELM DISCUSSED HER NUMEROUS SPACE SHUTTLE MISSIONS AS WELL AS VARIOUS QUESTIONS ABOUT THE FUTURE AND DIRECTION OF NASA.

A LACK OF HIGH-PROFILE MISSIONS AND SHRINKING BUDGETS HAVE BROUGHT NASA UNDER FIRE IN RECENT YEARS. MANY FISCALLY CONSERVATIVE LAWMAKERS HAVE TAKEN SHOTS AT A SPACE PROGRAM THEY ARGUE IS UNFOCUSED.

WILLIAM GARRARD, WHO HEADS THE UNIVERSITY'S DEPARTMENT OF AEROSPACE ENGINEERING, DISAGREES. HE SAID NASA'S FOCUS IS TO CONDUCT MORE, LESS-EXPENSIVE MISSIONS, SIMILAR TO HOW IT OPERATED IN NASA'S EARLY DAYS.

"I THINK NASA HAS REALLY COME BACK TO WHAT IT WAS IN THE '60s," GARRARD SAID.

THE COST OF THE VIKING PROBES TO MARS IN THE MID-1970S COST \$3 BILLION IN EQUIVALENT VALUE TO 1997 DOLLARS; THIS SUMMER'S PATHFINDER MISSION COST \$250 MILLION, ACCORDING TO NASA ESTIMATES.

AN IMPORTANT DIFFERENCE NOW, HOWEVER, IS THE SPACE AGENCY'S CURRENT PROJECTS DON'T ENJOY THE SAME WIDESPREAD POPULARITY OF THE APOLLO PROGRAM IN THE 1960s.

HELM SAID THE DISINTEREST STEMS FROM THE PROGRAM'S EVOLVEMENT TO A POINT WHERE SPACE EXPLORATION IS COMMONPLACE.

"BACK THEN, THERE WAS ALL THIS CELEBRITY ATTACHED TO THE SPACE PROGRAM AND IN PARTICULAR THE ASTRONAUTS," HELM SAID. "WE DON'T FEEL THAT NOW; I NEVER GET RECOGNIZED. THOSE GUYS GOT RECOGNIZED LIKE THEY WERE MOVIE STARS."

DESPITE THE LOW PROFILE OF EACH MISSION, HELM SAID THE IMPORTANCE OF EACH IS CRUCIAL TO THE EVENTUAL ACCOMPLISHMENT OF MAJOR GOALS, LIKE THE PLANNED MISSION TO MARS.

"WHAT WE'RE REALLY TAKING ARE BABY STEPS TO GETTING MORE AND MORE ADEPT AT LIVING IN SPACE," HELM SAID. "BABY STEPS ARE HARD TO SEE."

ALTHOUGH HELM SAID SHE WOULD LIKE TO TRAVEL TO MARS, SHE MIGHT BE TOO OLD WHEN MANNED MISSIONS ARE SCHEDULED TO BEGIN.

DESPITE THE SLIM BUDGETS, THE UNIVERSITY STILL COOPERATES WITH NASA ON SOME PROJECTS. VANO, A FORMER AEROSPACE ENGINEER FOR NASA, AND HIS STUDENTS ARE DESIGNING A NEW SPACECRAFT -- A REUSABLE LAUNCH VEHICLE, WHICH THEY HOPE TO USE AND LAUNCH IN COLLABORATION WITH NORTHWEST AIRLINES.

"SPACE IS REALLY A DESTINY FOR MANKIND," VANO SAID, "WE'RE ON THE SHORES OF THIS HUGE OCEAN, AND WE'RE GOING TO EXPLORE IT."

### SENIOR CAPSTONE DESIGN CLASS



AEM Senior Chris Mitchel preparing Reusable Launch Vehicle model for testing in the wind tunnel.

#### DESIGN CLASS PROJECTS

The senior design class had 34 students enrolled at the beginning of the 1997-98 academic year. It has been departmental policy to provide students the opportunity to select a spacecraft or an aircraft design project. The choices for this academic year were: 1) design a Reusable Launch Vehicle (RLV) for Northwest Airlines (NWA), and 2) design an AeroCar.

#### SPACECRAFT DESIGN PROJECT

Dr. Daniel Goldin, NASA Administrator, has identified three NASA goals: "Global Civil Aviation", "Revolutionary Technology Leaps", and "Access to Space". On the third goal, "Access to Space", he states: "In the last 25 years, the US has developed one major launch vehicle and rocket engine. In the same timeframe, other nations have developed 27 rocket engines and many more launch vehicles. Our launchers, once preeminent, now supply only 30 percent of the worldwide commercial market. In the world's rapidly expanding launch business,

the US continues to lose market share. To realize the potential for research and commerce in space, America must achieve one imperative, overarching goal - affordable access to space. The space transportation industry can benefit significantly from the transfer of aviation technologies and flight operations to launch vehicles. High reliability and a rapid turn-around are the first steps to increase confidence in delivering payloads on time with fewer ground crew." The AEM department has had a special relationship with NWA during the past several years including our internship program, and special cooperative projects with faculty and graduate students. This relationship was used to support Dr. Goldin's "Access to Space" goal. The Design Class examined the NWA infrastructure, designed a vehicle fitting these specifications and provided NWA with a new marketplace.

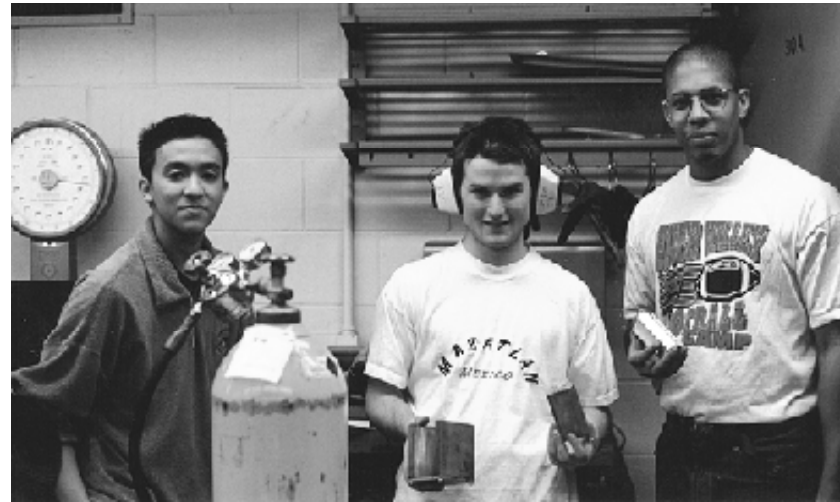
The academic year began by assigning students to the following disciplines based on their job application letters: Aerodynamics, Structures / TPS, Systems Layout / Weights, and Propulsion / Trajectory Analysis. The spacecraft design team was lead by two Project Managers: Derek Gefroh and Joe Mueller. The spacecraft design team's first task was to make a preliminary estimate of vehicle size. A brief market study showed that small satellites will be a major market for launch vehicles in the future. The decision was made to design a small RLV which would launch small satellites using a Boeing 747 (B747) as its first stage.

Captain Dwayne Edelman from Northwest Airlines came to talk to the spacecraft design students during Fall Quarter to give them NWA's perspective on the design project. Cpt Edelman emphasized that the vehicle must fit within the existing NWA infrastructure and not require major aircraft modification or disruption of fleet operations. The students selected an autonomously controlled, thin wave rider / lifting body design with high hypersonic L/D and large cross-range to give NWA maximum operational flexibility. They called their vehicle Aeolus. Initial sizing showed that it was possible to mount Aeolus under the B747 fuselage. This substantially reduced the B747 structural modifications (Aeolus's mounting hard points would be near existing aircraft landing gear hard points) and eliminate the need for a mating gantry. Several students took measuring tapes to NWA

### DESIGN CLASS: REUSABLE LAUNCH VEHICLE, CONT.

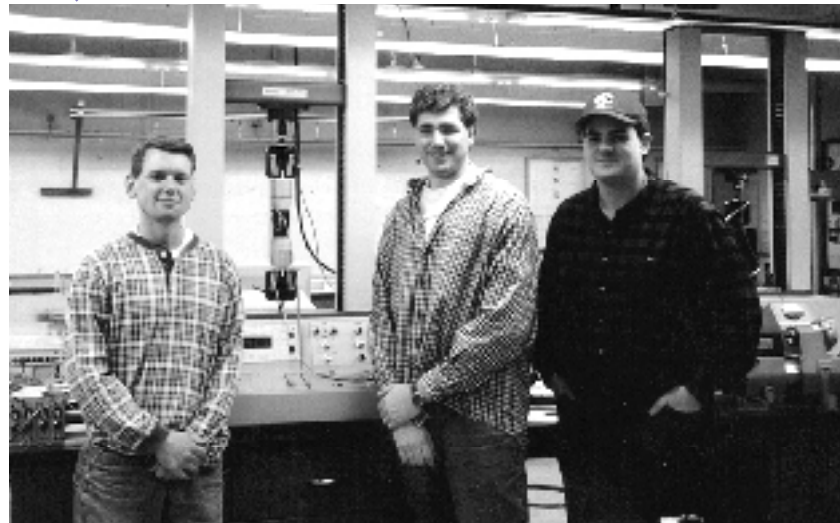
Maintenance to get accurate B747 dimensions. The final vehicle size was 2.4 meters high, 20.0 meters wide and 23.5 meters long; the vehicle weighed 61,235 kg at launch and 7,467 kg at landing. A typical launch/recovery involves the customer installing their satellite in a launch interface module and delivering it to the nearest airport served by NWA. NWA then transports and installs the satellite/module in the Aeolus after it is turned around following its previous flight. Aeolus is then rolled under and mounted to a NWA 747 freighter. The NWA 747 freighter crew flies to a preselected (orbital inclination) and environmentally acceptable launch-point. Launch is conducted autonomously by a launch team located at NWA Operations in Minneapolis. This method is selected to minimize B747 crew training and eliminate the need for extensive special equipment on-board the launch aircraft. The Aeolus then carries the satellite to orbits ranging from polar orbit (186 kg payload) to equatorial orbit (1050 kg payload). Aeolus is autonomously recovered at a NWA served airport consistent with its next launch.

Students spent Winter Quarter testing their design. The aerodynamics discipline fabricated a subsonic wind tunnel model and tested it in the department's recirculating wind tunnel. The propulsion group fabricated a small model of the linear aerospace engine and tested it using 2000 psi air. The structures group measured the characteristics of composite materials used in their analysis of the primary tank and airframe structure. A special group was organized to look at launch and recovery trajectories by developing related simulations on the department's computers. Unfortunately, the class size was too small to continue the project through Spring Quarter. One student, Jim Chase, is continuing parts of the study as a part of a Undergraduate Research Opportunities Program.



**RLV Aerospike Propulsion Test**  
(left to right) Ahmad Mohamed, Tom Jones, Ray Kaiser

**RLV Structural Test of Composites**  
(from left) Blake Leonard, Jim Chase, Dan Madsen



### DESIGN CLASS: RLV WIND- TUNNEL TESTING



Derek Gefroh

Clockwise from left: Joe Mueller, Shahab Matin, Derek Gefroh, Craig Wightman, Nina Tortosa-Boonacker



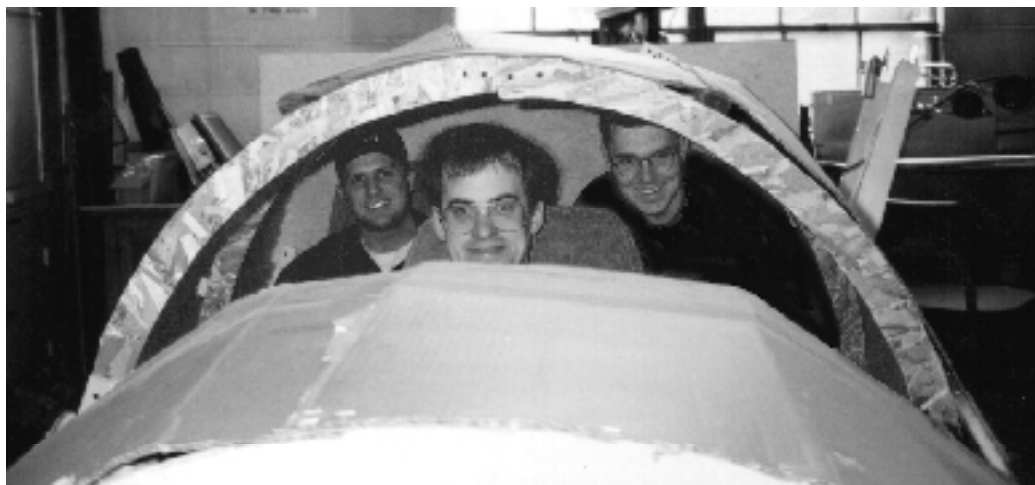
Mark Wibben (left) and Chris Mitchel (right)

Nina Tortosa-Boonacker





### AEROCAR AIRCRAFT DESIGN PROJECT



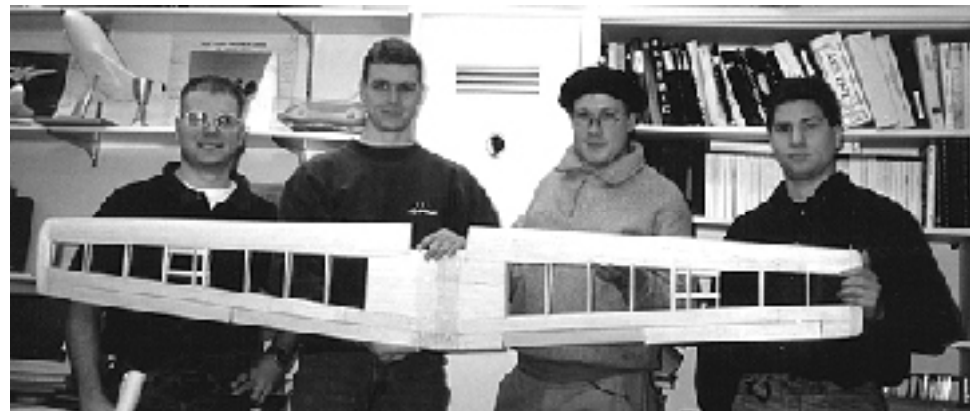
From left: Mark Ledermann, Ben Roberts, Mark Dmytryszyn sit in a mock-up of the cabin of the AeroCar, this year's Aircraft Design Project

Dr. Goldin's second goal, "Revolutionary Technology Leaps," addresses the revitalization of General Aviation. He states: "The general aviation segment of air travel, which includes privately owned aircraft, has tremendous potential for growth if a number of technical issues are solved. At its peak in 1978, the US general aviation industry delivered 17,811 aircraft. In 1996, the number of aircraft delivered had fallen to 1,132. Along with critical tort reform in 1994, the technology innovations anticipated for general aviation will revitalize this industry." NASA, FAA and the USAF Research Laboratory are sponsoring an annual General Aviation Design Competition for students at US aeronautical and engineering universities. Our students elected to enter this competition.

Students for this project were assigned to the following disciplines based on their job application letters: System Layout / Weights, Aerodynamics, Structures, Systems and Equipment, and Powerplant Installation. Dave Skalicky and Nate Rice were selected as Project Managers. Students were given a project statement: Design a two-place AeroCar which will cruise at 250 knots 7500 ft altitude with 800 NM range (IFR reserves). The AeroCar was to fit into a standard automobile garage, and transition from ground-to-flight and flight-to-ground without stopping and/or elaborate set-up, meeting FAR Part 23 and US Highway Standard requirements. The AeroCar purchase and operating costs were competitive with current and anticipated 2005 production aircraft.

The students began their project by contacting several businesses to determine market interest and received a very enthusiastic response. The students determined that if they changed the vehicle to a three-place AeroCar and gave it STOL capability, they would have a unique market niche. Several weeks were spent looking at airplane configuration. The big challenge: where do you put the wing in auto mode? The solution: a canard

Aerocar RC Model Wing (from left) Cory Beose, Dave Skalicky, Jeff Lotterman, Dennis Zeigeweid



which swings aft to stow under the fuselage and a three-panel folding wing which stows on the side of the fuselage. This configuration had major problems generating lift on take-off (STOL) and its stability/control characteristics were marginal. Many difficult decisions were made by the AeroCar team in the last weeks of Fall Quarter, and the Conceptual Design Review was held as scheduled December 1.

Students spent Winter Quarter testing their design. The aerodynamics discipline fabricated a wind tunnel model and tested it in the departments recirculating wind tunnel; the tests verified that aircraft CG location is critical and its stability/control characteristics are marginal. The structures group fabricated a wing panel and tested it in our BD-5 wing test fixture. One group of students built a full size cabin mock-up using seats from Professor Vanos van to evaluate seating comfort.

The Design Class size trickled to eight enthusiastic students for Spring Quarter. They spent many late hours fabricating a radio controlled (RC) model of their design. Cory Bose, an experienced RC pilot, was chosen to be the test pilot. Flight testing confirmed the previous analysis and wind tunnel testing: the design had marginal stability/control characteristics. Although each of the three flight tests ended dramatically (repairable damage to the airplane), flying an actual airplane gave special meaning to the theoretical equations used to determine the airplanes characteristics.

Aerocar Wing Structural Test Clockwise from left: Naomi Diare, Bill Sheridan (hidden), Tom Bragg, Bohdan Stepchuk, Karrie Breit



Getting AeroCar Model Ready for Flight (right to left) Mark Ledermann, Jason Chirco



Installing Aerocar in Wind Tunnel, Travis Smieja



AeroCar RC Model Taxiing Out for Take-Off (left to right) Craig Wightman, Dennis Zieglweid, Cory Boese, and Dave Skalicky. Inset: AeroCar Model in flight.

## MN SPACE GRANT CONSORTIUM

### Seminar: NASA Astronaut Pamela Ann Melroy

Major (U.S. Air Force) Pamela Ann Melroy, NASA Astronaut, gave a special seminar on February 20, 1998, on "Training to Fly in Space". Major Melroy was selected as an astronaut candidate by NASA in December 1994 and reported to the Johnson Space Center in March 1995. She completed a year of training and evaluation and is currently qualified for assignment as a shuttle pilot. Presently, she is assigned to astronaut support duties for launch and landing while awaiting for her first flight assignment. During her visit here, she also participated in the Space Science Across the Curriculum Conference for K-12 teachers that was sponsored by the Minnesota Space Grant Consortium and the Science Museum of Minnesota.



Joseph Mueller (left) with three other students at the Summer Academy.

### NASA Summer Academy Program by Joseph Mueller

If you gave me one word to describe my experience last summer at Dryden, it would be a toss up between "incredible" and "super-duper-awesome." It was truly the most valuable opportunity I have yet had in my 21 years. As one of the seven academy participants, I had fun all the time, enjoyed my work, and learned constantly.

Dryden, located at Edwards Airforce Base in the dry heat of the Mojave Desert of Central California, is home to astronauts and test-pilots Gordon Fullerton and Bill Dana, as well as to Marta Bohn-Meyer, the national aerobatics champion and the only woman to ever fly the SR-71 Blackbird. It is also the site where Chuck Yeager broke the sound barrier in 1947. Working at Dryden was both a learning experience and a history lesson each and every day.

My job at Dryden was to work with Dr. Joseph W. Pahle on Validating Linear Models of the F-18 HARV. The HARV stands for High Angle Research Vehicle and is a test vehicle for examining flight control effects associated with thrust vectoring. Creating a linear model from a non-linear system was challenging work. My specific task was to apply linear models that were modeled at conditions other than the actual flight conditions.

The Academy was not all work! Our Dean, Dr. Dominick Andrasani of Purdue University, kept us in touch with the larger world of aeronautics. We spent five days in Washington D.C. where we met and stayed with the Goddard Academy. We had a tour of their NASA Center and a seminar/Q&A session with Bob Whitehead, Wilbur Trafton, Spence Armstrong, and Dan Goldin himself. On another trip, we met Peter Diamandis (CEO of X-Prize Foundation) who said he would love for us to take the X-Prize design project idea back to our respective schools. I would LOVE to do this and show everybody how good our aerospace program is at the U of M!

The NASA Academy gave me the gift of discovery and excitement in my field. I hope that it will continue to provide others with the same opportunity to learn and grow as it has provided me.

The University of Minnesota has been fortunate to have at least one student participate in this program since its inception. James Chase will participate in the 1998 Goddard NASA Academy Program at the Goddard Space Flight Center in Greenbelt, Maryland. Emily Eelkema will participate in the 1998 NASA Academy in Aeronautics at NASA Dryden Flight Research Center at Edwards Air Force Base in California.

## AEROSPACE ENGINEERING INTERNSHIP PROGRAM

The Aerospace Engineering Internship Program provides AEM students the opportunity to work in a professional engineering setting during their junior and senior years. Students apply for the program during Spring Quarter of their sophomore year; accepted students are required to have a good lower-division academic record. Specific Internship opportunities are posted in Akerman Hall so that students may prepare an employer specific cover letter and resume. This information is then forwarded to the company representative who uses it to select students for interview. The employer hires the student and together they negotiate the student's work schedule. Students receive academic technical elective credit by registering for four two-credit "Industrial Assignment" courses or two one-to-four credit "Summer Employment" courses. Course grades are based on a technical report describing the work experience.

Students participating in the AEM Internship Program gain considerable insight into their future roles as Aerospace Engineers. Most students mature considerably during their work experiences and become very career focused. Many students identify their area of technical speciality based on their work experiences and select their upper-division technical elective courses to match.

Companies participating in the AEM Internship Program also benefit. Our academic program provides our students with a solid background in the engineering fundamentals. Our students make good workers, they are competent, honest, dedicated and enthusiastic. Many employers use the program as a primary source of selecting student graduates for permanent professional positions. During the past few years, our students have worked at companies such as Boeing, Cirrus Design, Engineering Laboratory Design, Lockheed/Martin, NASA, Northwest Airlines, Phoenix Solutions, and Rosemount Aerospace. These companies assign our students to interesting and significant engineering projects under the direction of experienced engineers. Examples of such projects are the following: preparing technical data to enable a small general-aviation airplane manufacturer put a new product into production, develop methodology for and write computer code to solve a company specific problem, help study STS TPS tile for high velocity impact damage, analyzing airline fleet data to determine fuel-burn parameters, conduct wind tunnel tests and calibrations on air-data probes.

If your company has an Internship Program and/or is interested in setting up a program with us, please provide us with information about your company (including company contact person) at any of the following addresses.

Andrew Vano, Director AEM Intern Program Dept of Aerospace Engineering and Mechanics University of Minnesota 107 Akerman Hall, 110 Union Street SE Minneapolis, MN 55455 Contact Dr. Vano via e-mail Telephone: 612/625-3867 On-Campus Office 320/846-1661 Off-Campus Office

## RECIPIENTS OF UNDERGRADUATE STUDENT AWARDS 1997-98

1997-98 Rose Minkin  
Scholarship Awardees  
Erick O. Swanson  
Johan C. Bakken

1997-98 Chester Gaskell  
Aeronautical Engineering  
Scholarship Awardee  
Erick A. Euteneuer

1997-98 Boeing Scholarships  
Awardee  
Dorothea Czernik  
Jenny Cordina



Gaskell Scholarship: Erick A. Euteneuer with Dr. Garrard.



Boeing & Minkin Scholarships: Jenny Cordina, Dr. Gordon Beavers, Dorothea Czernik, Dr. Perry Leo; Johan C. Bakken

## RECIPIENTS OF GRADUATE STUDENT AWARDS FOR 1997-98

Graduate School Fellowship  
Wenjuan Wang

Engineering Dissertation Fellowship  
Wendy Grebner, American Association of University  
Women

Undergraduate Minnesota Space Grant  
Consortium Fellowships  
Jenny Cordina  
Emily Eelkema  
Thomas Jones

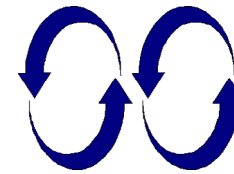
Control Science and Dynamical Systems  
Fellowships  
Saroj Saimek  
Jong-Yeob Shin

## JOB POSTINGS ON THE WEB

Job postings that have been sent to the AEM Department have been put online. The URL is

<http://www.aem.umn.edu/aero/jobs.txt>

We encourage you to take advantage of this website if you are looking for a job, or if you are an employer who has job openings that you would like to post.

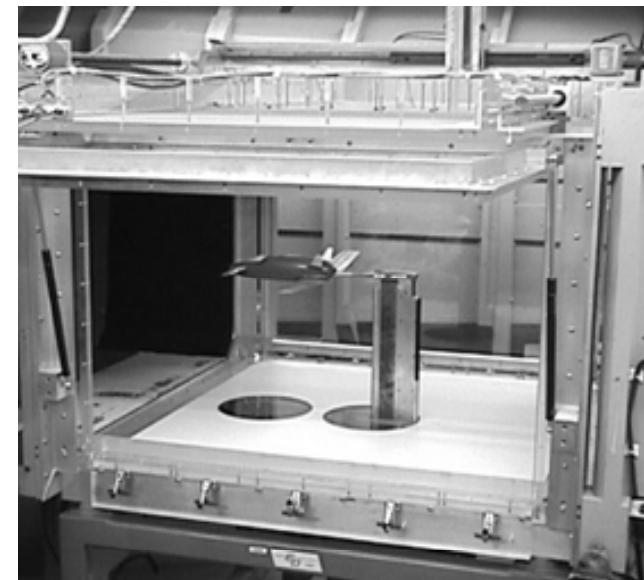


## ALUMNI

We'd like to hear what you're doing, where you are, etc. You can either send the information to: Donna Rosenthal, Aero-space Engineering and Mechanics,

University of Minnesota, 110 Union St. SE, Minneapolis, MN 55455; e-mail to [donna@aem.umn.edu](mailto:donna@aem.umn.edu), or fax to (612)-626-1558. We'll make sure that it gets in our next

## WIND TUNNEL CLASS OF '43



The past year we installed two new test sections in the large 100 horsepower recirculating wind tunnel. One of the sections is fitted with a three-axis-traverse. This allows a probe to traverse the entire cross section of the test section for pressure and velocity measurements. The other test section will be used with the department's NK six component force balance. Having the two test sections will accommodate multiple setups, and allow access without dismantling complicated setups.

The next update will be a new motor, to replace the 50 year old 100 horsepower electric motor. The new motor will incorporate a frequency inverter. This will enable us to control the motor speed for more efficient wind tunnel operation.

## 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

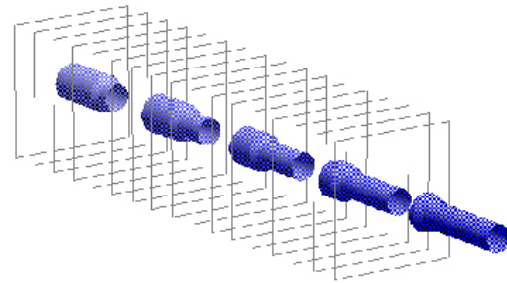
The AEM Excellence Fund: Used to sponsor lectureships by distinguished individuals in aerospace engineering and mechanics. Please note that this fund also supports the Sethna Lecture. Fund No. 2281

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 External relations, at 1-800-587-3884, and 1-612-624-5537.

## Announcement

## Computational Tools for the Atomic/Continuum Interface: Nanometer to Millimeter Scale Aircraft



Prospective Graduate Students and Postdoctoral Fellows from engineering, physics and mathematics with outstanding records are encouraged to apply for a highly interdisciplinary basic research program on the forefront of science and engineering. The research concerns the development of new concepts for flight at nanometer to millimeter scale, with applications to atmospheric flight and to the design of vehicles for microsurgery. The general framework for this research is the propulsion of small vehicles by the motion of active materials - ferroelectric, magnetostrictive and shape memory materials - configured as deformable tubes, flaps or flagella and powered by a remotely applied electromagnetic field. The research is based in scientific computation, with additional opportunities in mathematical modeling and laboratory research. Specific research areas include:

1. Fluid mechanics and aerodynamics at nanometer to millimeter scale
2. Phase transformations and the behavior of active materials at small scales
3. Computational methods for the passage from atomic to continuum scales
4. The synthesis of active materials by molecular beam epitaxy
5. The design of micro-electro-mechanical (MEMS) systems for small scale flight

The participants with a brief summary of their fields are listed below. Interested persons are encouraged to contact any of the participants by e-mail for further information and application materials. For general information on the project, contact R. D. James, james@aem.umn.edu.

Kaushik Bhattacharya, Applied Mechanics, California Institute of Technology, Shape memory materials, active thin films, continuum mechanics of materials. bhattacha@cco.caltech.edu

Iain D. Boyd, Mechanical and Aerospace Engineering, Cornell University, Computational Fluid Dynamics at the atomic continuum interface, Monte Carlo methods. boyd@mae.cornell.edu

Graham V. Candler, Aerospace Engineering and Mechanics, University of Minnesota, Computational Fluid Dynamics at the continuum/atomic interface aerodynamics. candler@aem.umn.edu

Richard D. James, Aerospace Engineering and Mechanics, University of Minnesota, Shape memory and magnetostrictive materials, active thin films, mathematical methods for change-of-scale. james@aem.umn.edu

Karin M. Rabe, Applied Physics and Physics, Yale University, Density Functional Theory predictions of atomic level structural properties of active materials, effective Hamiltonians for ferroelectrics and related materials. rabe@critical.eng.yale.edu

Facilities for the research include a dedicated multiprocessor machine for simulation, advanced molecular beam epitaxial system for the growth of thin films, clean room facilities for the analysis and patterning of thin films.

This research is supported by the Department of Defense Multidisciplinary Research Program (MURI), administered by the Air Force Office of Scientific Research

Visit Our Website: <http://www.multiscale.umn.edu/>

## RECENT RESEARCH PROJECTS OF AEM PROFESSORS

Advanced Research Projects Agency

Parallel Scalable Libraries for Large-Scale Applications  
A. Sameh, L. Petzold, Y. Saad & Tayfun Tezduyar

American Chemical Society Control of Particle-Laden Flows with Ceramic Actuators  
Ellen Longmire

Air Force Office of Scientific Research

Active Thin Films  
Richard James & Mitchell Luskin

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 Palmstrom

Numerical Simulation of Atmospheric Pressure Air Plasmas  
Graham Candler

Magnetostriction of Martensite  
Richard James

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

Active Thin Films  
Richard James & Mitchell Luskin

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

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

ARO, cont.

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

Simulation of Nonequilibrium AeroThermo Chemistry Using Continuum and Particle Methods  
Graham Candler

Simulation of Nonequilibrium Rocket Motor Plums  
Graham Candler

Simulation of TMD Flowfields  
Graham Candler

Three Problems in Fluid Dynamics  
Daniel Joseph

Two-Phase Flows of Rheologically Complex Fluids  
Daniel Joseph

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

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

Baylor College of Medicine

Respiratory System Mechanics Theodore Wilson	National Aeronautics and Space Administration (NASA)	NASA, cont. Robust System Identification and Validation for Control (Langley) Gary Balas
Boeing Defense and Space Group Shape Memory Alloys Consortium Richard James & Thomas Shield	Aircraft Scheduling and Conflict Resolution in Air Traffic Management (Ames) Yiyuan Zhao	Studies of Trajectory Synthesis Methods and Trajectory Sensitivity in Air Traffic Management (Ames) Yiyuan Zhao
Department of Energy	Effect of Swirl on Turbulent Structure in Supersonic Jets Thomas Lundgren	National Heart, Lung, and Blood Institute (NIH) Respiratory Action of the Intercostal Muscles Theodore Wilson
Lubricated Transport of Viscous Materials Daniel Joseph	Finite Element Computation of Compressible Flows with Particular Emphasis on Blunt Geometries, Wake Flows, and Unsteady Behavior (Johnson) Tayfun Tezduyar	National Science Foundation
Topological Transitions in Liquid/Liquid Flows John Lowengrub & Ellen Longmire	Large Scale Turbulent Structure in Supersonic Jets (Ames) Thomas Lundgren	Direct Simulation of the Motion of Particles in Flowing Liquid Daniel Joseph & Ahmed Sameh
The Hoechst-Celanese Company Study of Spinning Rod Interfacial Tensionometer used to Measure Polymer Bands Daniel Joseph	The Minnesota Space Grant College Consortium (NASA Headquarters) William Garrard	Experimental, Analytical and Computational Study of Nematic Optical Elastomers Richard James
Mayo Foundation Regional Mechanics of Injured Lungs Theodore Wilson	Nonlinear Feedback Control of Aircraft Propulsion Systems (Lewis) William Garrard & Gary Balas	Experiments in Particle-Laden and Buoyancy Driven Flows Ellen Longmire
Minnesota Department of Transportation	Numerical Simulation of Atmosphere Entry Flows Graham Candler	Fundamental Fracture Mechanisms in Ductile Single Crystals Thomas Shield
System Simulation and Optimization Yiyuan Zhao	Optimal Takeoff Procedures for Category A. Helicopters (Ames) Yiyuan Zhao	Interfaces with Structure: Kinetics, Nucleation, Microstructures, Topological Transactions Lev Truskinovsky
Light Weight Guideways Used for Personal Rapid Transit Systems William Garrard & Gary Balas	Parallel 3D Computation of Fluid Dynamics and Fluid-Structure Interactions of Ram-Air Parachutes (Johnson) Tayfun Tezduyar	Loss of Coherence and Formation of Incoherent Structures at Crystalline Interfaces Perry Leo

NSF, cont.	NSF, cont.
Measurements of Crack Tip and Microstructural Strains in Single Crystals Thomas Shield	Tayfun Tezduyar & D. Truhlar  Office of Naval Research
Modeling of Disperse Multiphase Flows Tayfun Tezduyar	Basic Research on the Improvement of Magnetostrictive and Shape Memory Alloys Richard James & Thomas Shield
Nonlinear Control of Systems with Relative Equilibria Thomas Posbergh	Novel High Performance Magnetoferro-Elastic Actuators (with DARPA) Richard James & Thomas Shield
Nonlocal Models in the Mechanics of Materials Roger Fosdick	Packard Fellowship Packard Fellowship in Science and Engineering Amy Alving
Numerical Methods for Very Large, Sparse Dynamical Systems Daniel Boley (CSCI) & Gary Balas	The Pillsbury Company Rheology of Bread Dough Daniel Joseph
Robust Structural Control for Hazard Mitigation Using Probable and Possible Models Gary Balas William Garrard	Syncrude LTD of Canada Pipeline Transportation of Bitumen-Froth in Core-Annular Flow Mode Daniel Joseph
Studies of Reservoir Stimulations, Drilling, Transportation, Emulsion Stability and Foaming Bubble Reactor Daniel Joseph & Gordon Beavers	
Studies of Two-Phase Flows of Solids and Liquids Daniel Joseph & Thomas Lundgren	
Transitions and Defects in Ordered Materials Richard James & Mitchell Luskin	
Undergraduate Internship in High Performance Computing in Fluid Dynamics	

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