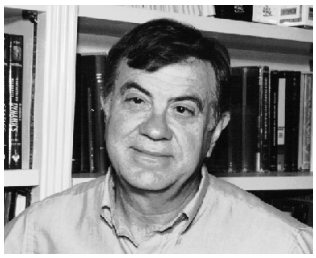
THE AEM UPDATE

Department of Aerospace Engineering and Mechanics

University of Minnesota

Chairman's Corner



This has been a year of great turmoil at the University. There have been budget cuts, proposals for major revisions in the tenure code, a planned shift from quarters to semesters in 1999, administrative changes and many other events which have served to foster a pessimistic attitude among the University community. In my 28 years at the University I have seen many crises, but this has been the most difficult year I have experienced and I have never seen faculty and staff morale so low. I am very concerned for the future of higher education in Minnesota. I think that we still have an outstanding Department and College. In 1995, the National Research Council's first comprehensive study of doctoral program quality in 13 years ranked the Department of Aerospace Engineering and Mechanics as twelfth in the nation (eighth in public universities). All of the engineering departments at Minnesota were ranked in the top 20 with Chemical Engineering ranked as number one and Mechanical Engineering as number eight. The U.S. News and World Report ranked the overall graduate program in engineering at Minnesota as twelfth in the nation (seventh in public universities). The details of these rankings are given on page 8 of this newsletter. Our faculty members serve in various editorial capacities for 21 journals (total number of faculty is 18). This is another indication that our faculty are considered to be leaders in their various fields. Our annual research expenditures from externally funded grants and contracts have increased from $1, 260, 571 in 1991-92 to $2,502,609 in 1994-95 (the last year for which we have data). This amounts to $125,130 per faculty member per year and means that for each dollar in faculty salary from state funds, we generate almost two dollars in external research funding. Contrary to what many believe, faculty members are not paid extra out of grants and contracts and most of this money is used to buy equipment and pay undergraduate and graduate students, post docs and others who assist with research. Our faculty play active roles in many of the Research Centers in the Institute of Technology, most notably the Army High Performance Computing Research Center and The Institute for Mathematics and Its Applications funded by the National Science Foundation. Regents' and Russell Penrose Professor Dan Joseph will receive the American Institute of Chemical Engineers' Thomas Baron Award in Fluid Particle Systems and Professor Yiyuan Zhao received the George Taylor Career Development Award for his exceptional contributions to teaching. All five of our Assistant Professors who we proposed for promotion to Associate Professor with tenure were indeed promoted.

Our student enrollments are down, but the employment situation for our new graduates has improved dramatically this year. We have a new Dean, H. Ted Davis. Ted has been a faculty member at the University for over 30 years. He's a member of the National Academy of Engineering and before becoming Dean, Ted was Head of our top rated Department of Chemical Engineering and Material Science for 15 years. We all have a great deal of confidence in Ted's leadership.

Despite all of the positives listed above, there is a general

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sense of discouragement at the University. Budget cuts continue. This year we suffered another 3.5% cut which will mean that we will lose another faculty position, as well as a clerical position. Our supplies budget was also cut again, and we now receive only about one third to one half of the funds required to maintain the infrastructure of the Department. We depend on gifts from alumni and friends to help us cover this shortfall. Last year, giving was up somewhat and I would like to thank everyone for the support that they have given the Department. I think that we have spent the money that you have entrusted to us wisely and I hope that we can depend on your support in the future.

A major source of our budgetary weakness is due to the fact that the percentage of support the University receives from the State has declined substantially during the past several years. State support has decreased from nearly 50% of the University budget in 1990 to 38.7% in 1995. Federal, private and other suport comprised 45.6%, and tuition 15.7% of the total University budget of 496.7 million dollars. Our new Provost for Arts, Sciences and Engineering, Phil Shively, has analyzed this decline and I will summarize his findings as follows. Minnesota is a small State with a relatively small tax base. In the 1950's and 1960's most of the State expenditures for higher education went to the University. Now there are 63 different public higher education institutions in the State. Many of these are community colleges or state universities located in smaller cities. State representatives from these districts often will champion their particular institution at the expense of the University. On the other hand, our location in a large metropolitan area hurts us because the benefits of the University are diffused across a large number of districts and the representative of any one of these districts does not see the University as a special project for his or her district. I think that most of our graduates would agree that a strong University is essential for the economic wellfare of our state. In addition to your financial support, we need you to support the University through your elected representatives and the media. It has taken us a long time to build a good University, but the University is fragile and all of our work could be destroyed very quickly without adequate support from our alumni and friends.

I would like to end on a more cheerful note. We are planning on expanding our section on Alumni News in this newsletter, but we need your help. Please let us know of significant events in your life, promotions, job changes, etc. Your can do this by e-mail by contacting Donna Rosenthal, donna@aem.umn.edu or by fax at (612) 626-1558. By the time of the next newsletter, we hope to have a much expanded Alumni News section.

Academics: Where are We Now?

AEM Undergraduate Program

There were 41 BAEM students cleared for graduation in the 95-96 school year. Beginning with winter quarter 1996, the students' programs were tallied through the use of the Academic Progress Audit System (APAS), a centralized auditing system which makes it easier to identify whether the student has met all the requirements for the degree. The report is also made available to both student and advisor and thus becomes a very helpful tool for planning the student's undergraduate degree program structures.

AEM Graduate Program

Last fall, the Department welcomed 13 new graduate students into the M.S. and Ph.D. programs in Mechanics and Aerospace Engineering. Seven of these students were U.S. citizens and 6 were foreign students, 1 each from Turkey, China, Russia, India, Canada and Greece. Two of the U.S. citizens, 1 male and 1 female were African-Americans, the first in the Department for more than 30 years.

The Department awarded a total of 16 graduate degrees through March of 1996, including 4 M.S. in Aerospace Engineering, 5 M.S. in Mechanics, 4 Ph.D.'s in Aerospace Engineering and 3 Ph.D.'s in Mechanics.

Professor Ellen Longmire will assume the role of Director of Graduate Studies starting in Fall of l996.

Control Science and Dynamical Systems (CSDy)

The Control Science and Dynamical Systems (CSDy) Program is involved in fundamental and applied research in general methods of analysis and design of complex uncertain nonlinear systems. The faculty and graduate students develop new mathematical theories and do all the necessary work to make these theories useful in the solution of a variety of industrial problems.

There have been truly striking developments in the last two decades in robust multivariable control, nonlinear dynamical systems, and all aspects of computation, from computational complexity theory to CAD software for control design. The faculty and students in the CSDy Program have been involved in these developments. During 1995, Professor Balas, a Co-Director of the CSDy program, teamed with the Control Science and Dynamical Systems Department at Caltech, and was awarded an AFOSR Partnership for Research Excellence and Transition grant for "Robust nonlinear control theory with applications to aerospace vehicles." This was 1 of 2 five year grants awarded for $2,500,000.

The focus of the AFOSR Partnership for Research Excellence and Transition grant is fundamental research in general methods of analysis and design of complex uncertain nonlinear systems. The researchers involved in this center will create new mathematical theory, as well as do all the necessary work to make that theory help engineers solve a variety of real industrial problems. Researchers from Caltech's Control and Dynamical Systems Department, Professor Balas and the industrial collaborators led by Honeywell, 3M, Hughes and GM, will work in unison to advance the state-of-the-art of robust nonlinear control theory to solve real world, aero-space control problems.

Three Ph.D. degrees were awarded this year by the CSDy program. Dr. Jim Buffington received his Ph.D. degree for his thesis entitled Control Design and Analysis for Systems with Redundant Limited Controls. Dr. Buffington was a member of the Air Force Palace Knight program. He is currently a research engineer in the Control Area at Wright-Patterson Air Force Base in Dayton, Ohio. Dr. Buffington's advisor was Dr. Dale Enns, an adjunct faculty member of the Department of Aerospace Engineering and Mechanics.

Dr. Ian Fialho received his Ph.D. degree for his thesis entitled "Worst-Case Analysis and Design of Nonlinear Feedback Systems." Dr. Fialho is currently a temporary Assistant Professor in the Department of Aerospace Engineering and Mechanics and is working with Professor Balas on the application of linear-parameter varying gain-scheduled control design techniques to flight control. Dr. Fialho's thesis advisor was Professor Tryphon Georgiou of the Electrical Engineering Department here at the University.

Dr. Weizhong Lu received his Ph.D. degree for his thesis entitled "An Optimal Control Approach to Hankel Norm Computation and Linear Quadratic Performance with Worst-Case Disturbance Rejection." Dr. Lu is currently employed in the process control industry supporting 3M engineers. Professor Balas was Dr. Lu's advisor.

Interesting Fact...

The University of Minnesota was one of 10 original aero programs accredited in 1936 when national accreditation of engineering programs began. The others were Caltech, Georgia Tech, MIT, University of Alabama, University of Cincinnati, University of Detroit, University of Michigan, University of Washington, and NYU.

Professor Joseph Distinguished with Thomas Baron Award in Fluid-Particle Systems

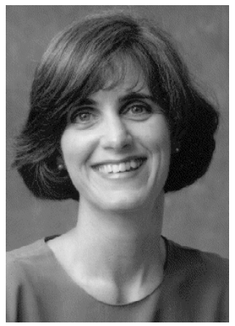
Professor Daniel D. Joseph is a recipient of the American Institute of Chemical Engineers Thomas Baron Award in Fluid-Particle Systems. He is recognized for his innovative contributions in research and education in multiphase flow theory, experiments and practice. The award will be presented on November 12, 1996, at the Particle Technology Honors Dinner during the 1996 AIChE Annual meeting in Chicago. An invited plenary lecture will be offered by Professor Joseph at the same meeting. Professor Joseph has published over 230 papers, written five books, received five patents, and held visiting positions at nine institutions in six countries. He is one of the few people who is a member of the National Academy of Sciences, the National Academy of Engineering and the American Academy of Arts and Sciences.

The Thomas Baron award was given to Dr. Joseph for identifying the consequences of wakes and turning couples on long and broad bodies in determining the microstructural properties of spherical bodies in fluidized suspensions. Professor Joseph showed that inertia which cause long bodies to turn broadside on in Newtonian fluids cause spherical bodies to draft, kiss and tumble into arrays across the stream; normal stresses on bodies moving slowly in viscoelastic fluids are compressive and proportional to the square of the shear rate causing long bodies to turn into instead of across the stream and spherical bodies to draft and chain into long chains along rather than across the stream. He showed that when the settling velocity is faster than signals that propagate before the falling body by diffusion and the propagation of shear waves, the particles will again be dominated by inertia with across the stream microstructure.

Ollie Kaldahl Honored with Crown Circle Award

Oliver (Ollie) Kaldahl was honored at the 29th National Congress on Aviation and Space Education as one of five to receive the Crown Circle for Aerospace Education Leadership Award for his outstanding leadership and commitment to aerospace education. This award was established in 1979 by the National Congress. Induction into the Congress's Crown Circle is one of the highest honors bestowed worldwide in the field of aerospace education. Ollie has been a long-term aerospace educator, workshop director and active NCR-AEA member. He is the founder and initial instructor for the first aeronautics summer school program in Minnesota. Since l972, he has taught a summer aerospace workshop for teachers in the Department. During the 23 years Ollie has taught this course, he has introduced hundreds of educators to aerospace curriculum activities, providing "hands-on" activities for both elementary and secondary teachers. He has dedicated himself to the task of providing aviation and space education both to young people and to their teachers. His efforts have been recognized by the Department of Transportation, Division of Aeronautics; the Federal Aviation Administration; the World Aerospace Education Association; and the Aircraft Owners and Pilots Association.

News About Our Faculty



Prof. Amy Alving

Prof. Tom Shield

Prof. Ellen Longmire

Professors Amy Alving, Gary Balas, Ellen Longmire, Tom Shield and Yiyuan Zhao were all promoted from Assistant to Associate Professor with tenure this year. These promotions are effective for fall of 1996. Professor Alving, who received her Ph.D. from Princeton, is an experimental fluid mechanician who works primarily in boundary layers. Professor Balas, who received his Ph.D. from Caltech, specializes in automatic control theory with applications to aerospace systems. Professor Longmire received her Ph.D. from Stanford and does experimental studies in particle laden flows and turbulence. Professor Shield received his Ph.D. from the University of California at Berkeley and is a solid mechanician who uses optical methods to study a variety of phenomena in mechanics of materials. Professor Zhao received his Ph.D. from Stanford and does research in guidance and control of aerospace systems.

Prof. Gary Balas

Prof. Yiyuan Zhao

News About Faculty, Continued

Professor Alving is an associate editor for the Journal of Experimental Thermal and Fluid Science. She was also appointed by the Assistant Secretary of the Army to the position of consultant to the Army Science Board, which is the senior scientific advisory group to the Army. She presented and participated in the American Physical Society's 49th Annual Meeting of Fluid Dynamics in November of l995. In addition, she gave invited lectures at the Stanford University and the IBM Lectureship at Notre Dame University.

Professor Balas gave an invited talk at the Old Dominion University and at NASA Langley Research Center in Hampton, VA, in February 1996.

Professor Beavers gave invited talks at the Nihon University l7th International Symposium: Life and Earth in the 21st Century and was the keynote speaker for the Global Environment and Human Living sessions in Tokyo in March 1996. In addition, he gave an invited lecture at the College of Science and Technology, Nihon University in Tokyo in March 1996.

Professor Candler presented an invited paper at the 27th AIAA Fluid Dynamics meeting in New Orleans, June l996.

Professor Garrard was appointed as a member of the AIAA Technical Committee on Aerodynamic Decelerator Systems for the next three years.

Professor Fosdick gave invited lectures at the University of Illinois, Champaign-Urbana in the Department of Theoretical and Applied Mechanics and at the ASME Mechanics and Materials Conference at Johns Hopkins University, Baltimore, Maryland. In addition, he was granted a single quarter leave for the Spring of 1997. He will spend part of this time at the Universita di Pisa, Italy, where he will be involved with research on the thermomechanics and mechanics of solids and nonlinear constitutive theory.

Professor James was the scientific organizer and chair of the Mathematics in Materials Science, Institute of Mathematics and Its Applications, University of Minnesota for the 1995-96 academic year. He joined the editorial board for the Journal of Elasticity. He also gave a principal lecture on "Applications of Young Measures in Materials Science" at the 90th Birthday Celebration for L.C. Young. In addition, he was a plenary lecturer at the International Conference on Industrial and Applied Mathematics, ICIAM 95 in Hamburg, Germany, and gave colloquia at Stanford, the University of Nebraska, Los Alamos, University of Paris XIII, the University of Maryland, Caltech and MIT.

Professor Joseph was the Croco Lecturer at Princeton University's Mechanical Engineering Department, October l995.

Professor Leo gave an invited lecture and was also co-organizer of the Thin Films Workshop in the Institute for Mathematics and Its Applications at the University of Minnesota, Winter 1996. In addition, he gave invited lectures at the Department of Civil Engineering, Mechanics and Metallurgy at the University of Illinois at Chicago; the Department of Material Science and Engineering, Virginia Polytechnic Institute and State University, Spring 1996; ASM/TMS meeting in Cincinnati, OH, Fall 1996; and MRS Winter meeting in Boston, MA, Fall 1996.

Professor Longmire gave invited presentations at Johns Hopkins University and the University of Maryland. She was an invited participant at the first National Academy of Engineering Symposium on Frontiers of Engineering in Irvine, CA.

Professor Ketema received the 1995-96 Best Instructor Award for our Department.

Professor Tezduyar was named a Managing Editor of the international journal Computational Mechanics. He gave invited lectures at Ecole Polytechnique Federale de Lausanne, Lausanne, Switzerland; Workshop on Computational Methods for Oceanic and Atmospheric Flows, Laboratorio Nacional de Computacao Cientifica, Rio de Janeiro, Brazil; Ninth International Conference on Finite Elements in Fluids, Venice, Italy; Institute of Space and Astronautical Science, Kanagawa, Japan; Lectures on Finite Element Simulation of Flow Problems, Tokyo, Japan (two lectures); Symposium on High Performance Computing, Royal Institute of Technology, Stockholm, Sweden; International Workshop on Computational

News About Faculty, Continued

Science and Technology, Tokyo, Japan; International Conference on HPCN Challenges in Telecomp and Telecom: Parallel Simulation of Complex Systems and Large-Scale Applications, Delft, The Netherlands (Panel Session), Technical University of Delft, Delft, The Netherlands; and the NATO Advanced Research Workshop on High Performance Computing Technology and Applications, Cetraro, Calabria, Italy.

In addition, Professor Tezduyar gave invited lectures at the Department of Defense Senior Technologists Conference, National Academy of Science, Washington, D.C.; Third U.S. National Congress on Computational Mechanics, Dallas, Texas; High Performance Computing in Science and Engineering, International Conference on Computational Engineering Science, Hawaii, Smart Algorithms in Computational Fluid Dynamics, International Conference on Computational Engineering Science, Hawaii; 6th International Symposium on CFD, Lake Tahoe, Nevada; Fourth Conference on Current Trends in Computational Chemistry, Vicksburg, Mississippi (Banquet Speaker); Sandia National Laboratories, Albuquerque, New Mexico; Third U.S. Japan Symposium on Finite Element Methods in Large-Scale Computational Fluid Dynamics, Army HPC Research Center, Minneapolis, MN; Rensselaer Polytechnic Institute, Troy, New York, and Recent Advances in Computational Structural Dynamics and High Performance Computing, Vicksburg, Mississippi (Panel Speaker), Northwestern University, Evanston, Illinois.

Professor Truskinovsky was invited to give the following lectures: ASME Mechanics and Materials Conference and Ericksen's Symposium on Recent Developments in Elasticity at John Hopkins University; Thermodynamische Materialtheoren, Oberwolfach, Germany; Symposium on Trends in Application of Mathematics to Mechanics, Warsaw Poland; Dynamics of Crystal Surfaces and Interfaces, Traverse City, MI; and Applied Mathematics Workshop for Materials Studies and Industrial Applications, Penn State.

Professor Yiyuan Zhao received the Institute of Technology's George Taylor Career Development Award for his exceptional contributions to teaching by a tenure-track Assistant Professor.

FACULTY HELD PROFESSIONAL EDITORSHIPS

Professor Alving, associate editor for the Journal of Experimental Thermal and Fluid Science and editor for the fluids on the North American continent.

Professor Balas, associate editor for the AIAA Journal of Guidance, Dynamics and Control.

Professor Candler, associate editor for the AIAA Journal of Themophysics and Heat Transfer.

Professor Fosdick, editorial board for the Journal of Elasticity.

Professor James, editorial boards for the Journal of Elasticity, Archive for Rational Mechanics and Analysis; Journal of Intelligent Materials and Structures; Continuum Mechanics and Thermodynamics.

Professor Joseph, associate editor for the Bifurcation and Chaos in Applied Sciences and Engineering; the Journal of Non-Newtonian Fluid Mechanics; Theoretical and Computational Fluid Mechanics; Video Journal of Engineering Research; International Journal of Multiphase Flow; and PanAmerican Mathematical Journal and editorial board, Interdisciplinary Applied Mechanics; and International Advisory Board, European Journal of Mechanics B/Fluids.

Professor Tezduyar, managing editor Computational Mechanics, CFD editor; and editorial boards for Computational Science and Engineering, International Video Journal of Engineering Research, and International Journal for Numerical Methods in Fluids.

Professor Wilson, editorial board for the Journal of Applied Physiology.

OTHER NEWS...

SYMPOSIUM IN HONOR OF PROFESSOR J.L. ERICKSEN

A symposium, "Recent Developments in Elasticity" was held at the ASME meeting in Baltimore, Maryland, to celebrate the 70th birthday of J.L. Ericksen, Professor Emeritus of the Department of Aerospace Engineering and Mechanics. The symposium was extremely well attended with talks threading through the full range of Professor Ericksen's past and current interests: liquid crystals, fundamental continuum mechanics, nonlinear elasticity, rods and shells, soil mechanics, phase transformations, thermodynamics, mathematical analysis, crystallography, magnetism, thin films, viscoelasticity and dynamics. C. Truesdell gave a brief summary of Ericksen's career. A banquet was held in Shriver Hall on the Johns Hopkins University campus, followed by a minimal after dinner talk, respecting Ericksen's widely appreciated distaste for long-winded post dinner speeches. Professors Fosdick, James and Truskinovsky attended and gave lectures.

Professor Alving did a segment for Newton's Apple explaining how water-skis work. Newton's Apple is a science show on the Public Broadcasting System.

America's Best Graduate Schools:

The Top 25 Engineering Schools, as ranked by U.S. News & World Report*

1. Massachusetts Institute of Technology
2. Stanford University
3. University of CA., Berkeley
4. University of Illinois as Urbana-Champaign
5. University of Michigan at Ann Arbor
6. Carnegie Mellon University (Pa.)
7. Cornell University (N.Y.)
8. California Institute of Technology
9. Georgia Institute of Technology
10. Purdue University at West Lafayette (Ind.)
11. University of Texas at Austin
12. University of Minnesota, Twin Cities
13. Northwestern University (Ill.)
14. Princeton University
15. University of California at L.A.
16. University of Wisconsin at Madison
17. Texas A&M University at College Station
18. Penn State University at University Park
19. University of Southern California
20. Ohio State University
21. Harvard University
22. University of Washington
23. Johns Hopkins University (Md.)
24. Columbia University (N.Y.)
25. Rensselaer Polytechnic Institute (N.Y.)

*Source: U.S. News, Online. Based on U.S. News & World Report's rankings that appear in the 1996 America's Best Graduate Schools guide.

Relative Rankings: Research-Doctorate Programs in Aerospace Engineering

1. California Institute of Technology
2. Massachusetts Institute of Technology
3. Stanford University
4. Princeton University
5. University of Michigan
6. Cornell University
7. Purdue University
8. University of Texas at Austin
9. Georgia Institute of Technology
10. University of California - San Diego
11. University of California - Los Angeles
12. University of Minnesota
13. University of Colorado
14. U of Illinois at Urbana - Champaign
15. Virginia Polytech Institute & State U
16. North Carolina State University
17. Texas A&M University
18. Pennsylvania State University
19. University of Washington
20. University of Maryland College Park
21. Iowa State University
22. Rensselaer Polytechnic Institute
23. University of Cincinnati
24. Ohio State University
25. University of Notre Dame
26. University of Kansas
27. University of Florida
28. Air Force Institute of Technology
29. State University of New York - Buffalo
30. Naval Postgraduate School

Today's Technology for Tomorrow's Engineering Designs

An aircraft streaks across the sky. A button is pressed and a spacecraft roars up into the atmosphere. How would you like to be the person who designs that aircraft or space vehicle? You can be if you are one of our students; however, you will be working on a small scale model or a computer-generated design.

Our Senior Capstone Design Course

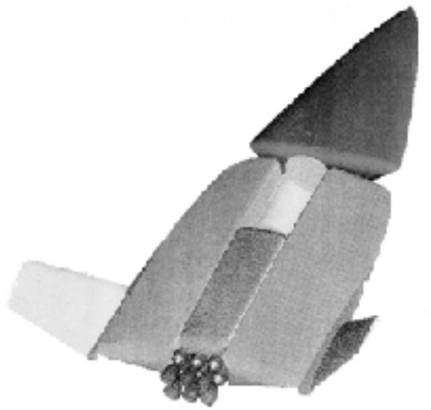
The design class continues to provide real world design challenges giving students a chance to apply their knowledge and skills in conjunction with departmental resources to solve problems in design of aerospace vehicles and systems.

One of the fastest changing segments of the design experience is the computing resources available to students. With the increase in processor speeds, and the availability of powerful new software packages, students are able to model and analyze their projects with greater speed, accuracy and realism then ever before. As these technologies evolve, employers are eager to hire people with computer-aided design skills, and our state-of-the-art hardware and software helps our students maintain a competitive edge in today's job market. That is why even with continual budget cuts, it is imperative that we maintain our commitment to these exciting new innovations, and provide our students with the tools that will help get them jobs.

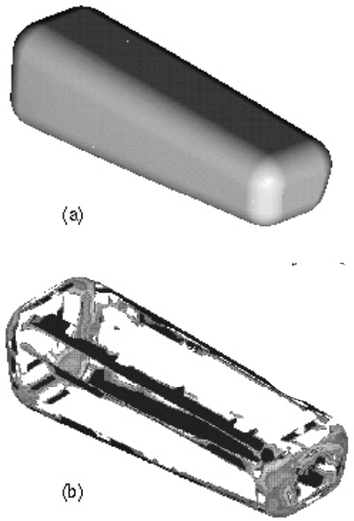
Spacecraft Design RLV

Reusable Launch Vehicle (RLV) and X-33 continue to be a major NASA focus. This academic year's Spacecraft Team design project revisited RLV design requirements and designed a commercially viable RLV vehicle. The team used last academic year's lifting-body RLV design (see AEM update 1994-95) as a baseline and made significant improvements in the following areas: improved aerodynamic shape to reduce local leading edge heating, improved subsonic and hypersonic performance and stability/control, and developed integral fuel tanks to reduce vehicle empty weight. It is interesting to note that NASA has recently selected the lifting-body concept for the X-33 demonstrator; this concept is very similar to the RLV lifting-body our students have designed.

STRUCTURES: SCOTT SKROK AND JEFF SWENSON

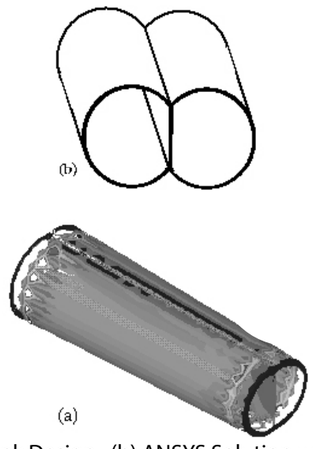


Tank Assembly



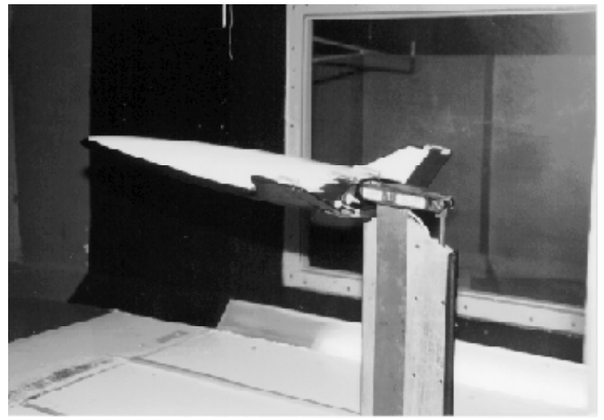
(a) Fall Quarter Liquid Oxygen Tank (b) ANSYS Solution with 0.1 Inch Skin Thickness

ANSYS Solution of Fall Quarter Liquid Oxygen Tank with 1.0 Inch Skin Thickness

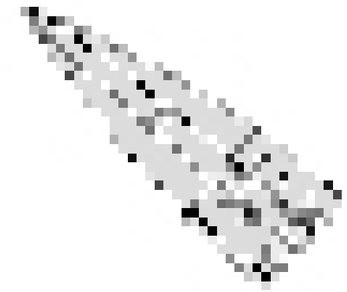


(a) Pillow Tank Design (b) ANSYS Solution with 0.1 Inch Skin Thickness

The structures group was responsible for the thrust structure, and fuel tank design. Using Pro/Engineer, a geometric configuration of each tank was determined, and appropriate material properties assigned. The Pro/Engineer model was then converted to a finite element grid for ANSYS, a structural analysis program. Stresses and deformations were determined for selected pressure loading conditions. A 30 inch long scale model tank was fabricated, and instrumented with strain gages so the experimental data could be compared to the calculations.



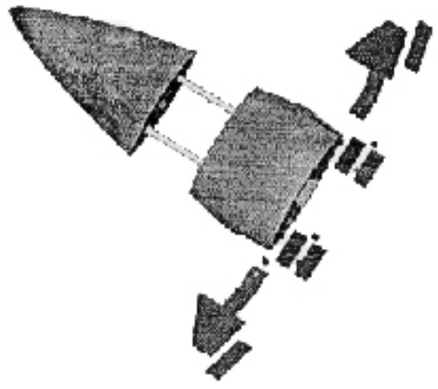
Model in Departmental 100 hp Wind Tunnel



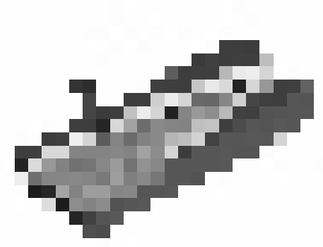
Pro/Engineer Wireframe Model of RLV

WIND TUNNEL TESTING: JERRY BRENDEN, CHAD HERMAN, MATT REETZ, FRED MOELLER, AND SCOTT DOUDRICK

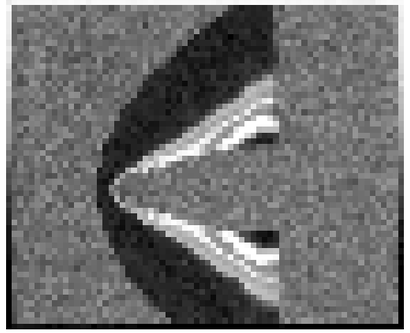
Aerodynamic stability is a major concern during re-entry and landing. The aerodynamics group wanted to assess the effects of different control surface sizes on aerodynamic stability. Data on lift, drag, and stability were calculated using a computational fluid dynamics (CFD) program called Overflow. Calculations were then reduced and plotted using FAST, a data reduction program. A twenty inch long model of the RLV was CNC machined using Pro/Manufacture to generate the toolpaths from Pro/Engineer geometry. The model was tested, using a six component balance in the Department's recirculating wind tunnel. The data obtained were compared to the CFD calculations.



Exploded View of Complete Wind Tunnel Model

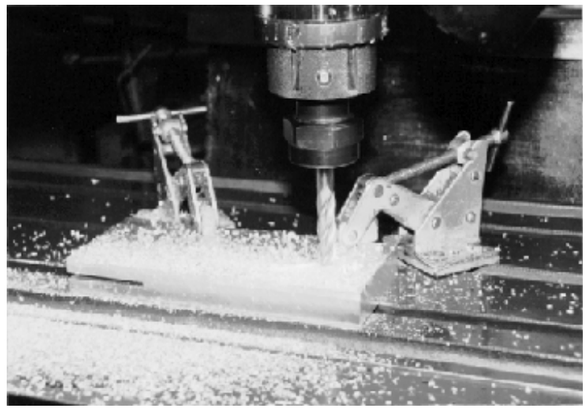


Pro/Manufacture Generated Tool Path of the RLV Surface

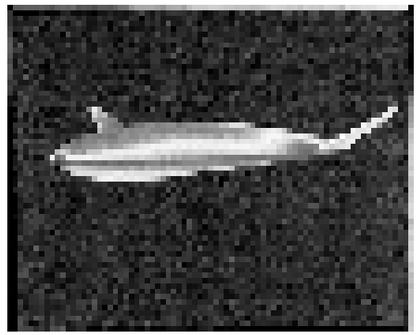


RLV Pressure Contour

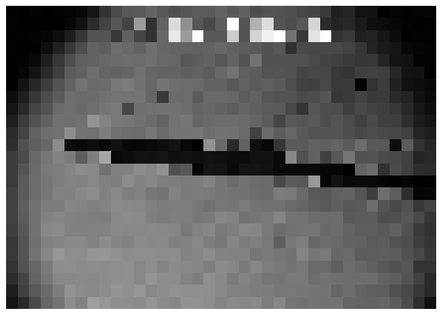
A second model was built, and tested in NASA's Trisonic wind tunnel at Marshall Space Flight Center in Huntsville, AL. This tunnel is capable of Mach 5, providing force and moment coefficients for different angles of attack, and Schlieren video for shock wave position. This data was then compared to CFD calculations obtained using Hypersonic Arbitrary Program (HABP), a hypersonic analysis program.



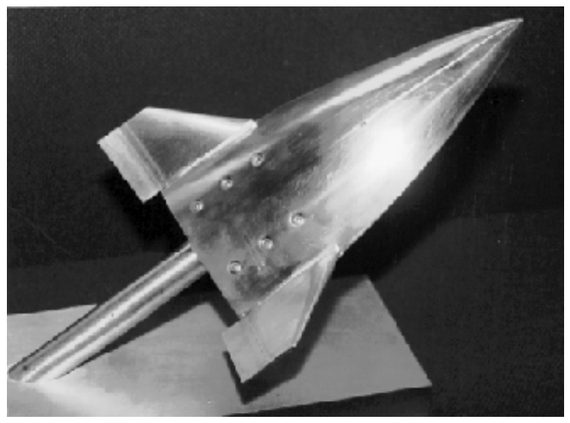
CNC Machining of Trisonic Model



RLV Temperature Profile



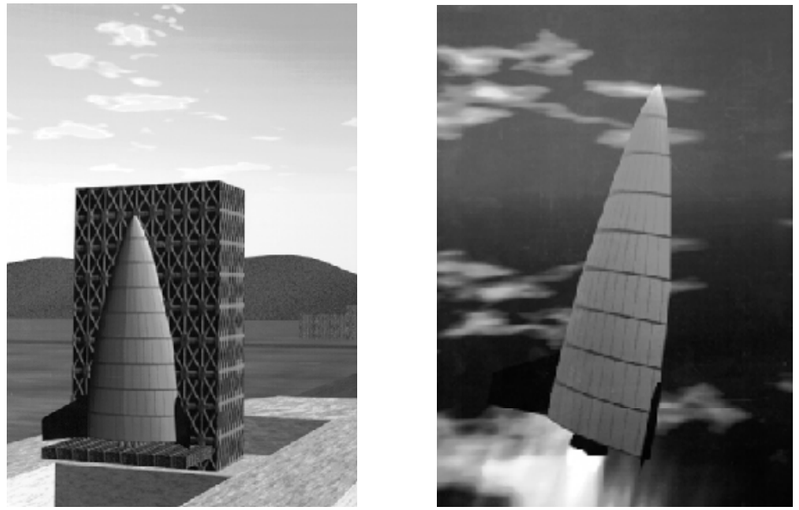
Schlieren Picture in Trisonic Wind Tunnel at Mach 3.48



Finished Trisonic Model

Animation: Anthony Gilbert and Terese Oconer

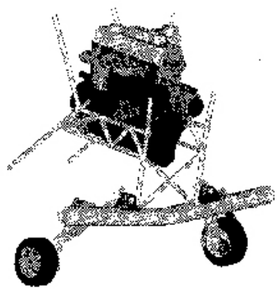
Animations were created from Pro/Engineer geometry, using Alias Studio, a program that allows the rendering of models and scenes using a variety of surface materials and textures. Alias provides photo realistic images that can be used for prints or transferred to video. By creating an animation, potential problems such as accessibility for vehicle maintenance and loading of payloads can be predicted and solved before the actual vehicle is built. Animation is also important for communicating complex ideas, concepts and designs quickly and effectively.



Still Frame Samples of Animations which were Created Using Alias

BD5 Engine Installation:

Jereme Beaudin, Derek Langseth, Jonas Paulen, Matthew Oliverius, and Scott Cocchiarella



Pro/Engineer Model of Honda Civic Engine

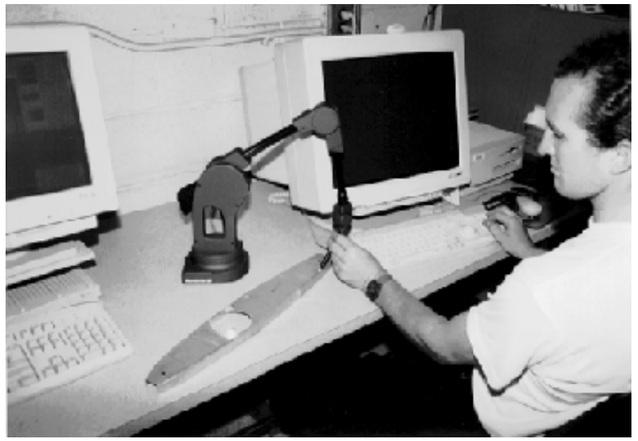
A second BD5, which is a small single-passenger, high performance aircraft, was donated to the department this year, providing more opportunities for testing, and modification. The first of two projects was the power plant installation, however, before

the engine could be installed the students had to complete several tasks. They had to assemble the nose wheel landing gear, attach the wing spar, and finish up some loose body panels. Once this was completed, they chose a Honda Civic engine, which was donated, based on cost, weight, and power output. The engine, and engine compartments were digitized using the Departments newly acquired 3-D digitizing arm, which allows 3-D points to be taken in space and imported to the computer. With these points they created computer models using Pro/Engineer that allowed them to determine clearances and placement. They designed a tubular engine mount, and performed structural analysis using ANSYS, a finite element modeling program, on their computer model. After the design parameters were satisfied, the engine mount was fabricated and the engine was installed.

BD5 Wing Test: Derek Gefroh, Shahab Matin, William Sheridan, and Tracy Vetruba

The second project was testing of the wing. Each wing rib was digitized, and a pattern was printed and used as a guide for cutting out wooden blocks. These blocks clamped around the aluminum ribs, and provided an attachment point for loading the wing with a hydraulic wiffle tree test fixture. The wing was instrumented with strain gages, and strain and deflection were measured with the wing loaded to over 2,000 lbs. This load was determined by the planes gross weight, with a load factor of 3.8 Gs, and a safety factor of 1.5.

Load Testing of Wing



Digitized Airfoil Rib Section

At the end of spring quarter, both the spacecraft RLV and the aircraft design BD5 teams had accomplished their goals within the defined timetables set for the course and projects. The spacecraft RLV team successfully created a conceptual design for a commercially viable RLV, bringing large scale access to space within easy economic reach for thousands or possibly millions of customers. The aircraft design team successfully designed, manufactured and installed a complete engine mount design and preformed a static test of a wing. Having students work on these team projects moves them exactly in the directions needed to undertake some of their most challenging future endeavors.

New Departmental Postdocs & Other Academicians

Maurizio Angelillo is a Visiting Associate Professor working with Professor Wilson on the biomechanics of the diaphragm. He is from the University of Salerno in Italy.

Runyuan Bai, Postdoctoral Associate, received his Ph.D. in Mechanics and Aerospace Engineering from the University of Minnesota. He is working on Professor Joseph's research on lubricated pipelining of bitumen froth.

Antonio Bannwart is a Visiting Associate Professor from the University of Estadual de Campinas in Brazil, working with Professor Joseph.

Dominique Eyheramendy, Research Fellow, received his Ph.D. from the Swiss Federal Institute of Technology in Switzerland in Applied Mechanics. He is currently doing research with Professor Tezduyar in the area of computational methods.

Gustovo Gioia, Postdoctoral Associate, received his Ph.D. in Engineering from Brown University. He is currently working with Professor James on thin films of martensitic and magnetic materials.

Yadong Huang, Postdoctoral Associate, received his Ph.D. in Mechanics from the University of Minnesota. He conducted research with Professor Joseph on two-fluid phase pipe flow.

Kimiya Komurasaki is a Visiting Assistant Professor from Nagoya University in Japan. He is working with Professor Candler on computational fluid dynamics.

Jian Li, Postdoctoral Associate, received his Ph.D. from the University of Illinois at Urbana-Champaign. He is currently working for Professor James on his research project on the development of magneto-memory materials.

Jinhui Liu, Postdoctoral Associate, received her Ph.D. from the University of Maryland at College Park in Mechanical Engineering. She is currently working for Professor Candler on his research project on the numerical simulation of compressible turbulent flows.

Gianni Royer from the Universita di Piza visited and worked with Professor Fosdick in the area of fundamental continuum mechanics during the summer of 1996.

Donald Webster is a Temporary Assistant Professor in the Department. He received his Ph.D. from the University of California, Berkeley. He is working with Professor Longmire on two research projects. In one project, he is performing experiments on the effects of three-dimensional trailing edge geometry on jet stability and mixing, and in the other, he is studying perturbed vortex rings. He also taught our AEM 3200 class last winter.

Job Postings on the Web

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

hhtp://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.

WWW Homepage

The department of Aerospace Engineering and Mechanics at the University of Minnesota has its own homepage on the World Wide Web. The URL is

hhtp: //www.aem.umn.edu

You'll find information about our faculty and their research as well as information about our programs.

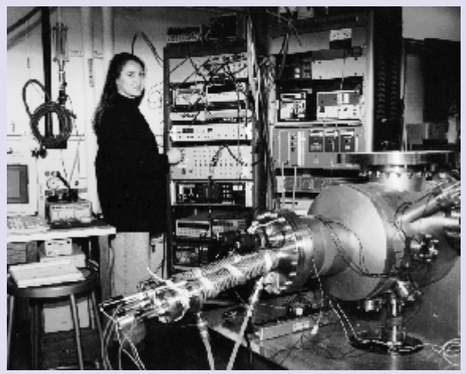
Minnesota Space Grant Consortium

The Minnesota Space Grant Consortium (MnSGC) is one of 52 consortia, located in each of the 50 states, the District of Columbia and Puerto Rico, sponsored by the NASA Space Grant College and Fellowship Program. The lead institution of the MnSGC is the University of Minnesota-Twin Cities, which is responsible for administering the $205,000/year grant for a total of ten academic affiliates in Minnesota. The $205,000 is matched by contributions from the affiliates. The Consortium is housed in the Department of Aerospace Engineering and Mechanics under the directorship of William L. Garrard, who is also the Head of AEM Department. The ten academic affiliates of the Consortium are Augsburg College, Bemidji State University, Bethel College, College of St. Catherine, Fond du Lac Community College, Macalester College, Normandale Community College, University of Minnesota-Duluth, University of Minnesota-Twin Cities, and the University of St. Thomas. MnSGC's industrial affiliates are Honeywell Inc. and Rosemount Inc. The state government affiliate is the Minnesota Department of Transportation, Office of Aeronautics.

The purposes of the Space Grant are to promote education, research and public service in the space sciences and aerospace engineering. To these ends, the MnSGC has a fellowship and scholarship program, provides limited funds for research initiation, supports teacher enhancement programs, develops higher education programs, and supports programs to encourage women and minorities to pursue careers in science and engineering. Some examples of our programs include the development of Space Studies and Space Science Minors, the development of laboratory experiments for college physics classes, presentation of a course on use of the internet for K-12 teachers, support of students ranging from freshmen to Ph.D. candidates, and a summer science camp for girls. Further information on the Space Grant is available on the world-wide-web page at http:/www.aem.umn.edu/other/MNSG.html; call (612) 626-9295 or send an e-mail message to mnsgc@aem.umn.edu to request a newsletter.

Affiliates

Augsburg College
Bemidji State University
Bethel College
College of St. Catherine
Fond du Lac Community College
Macalester College
Normandale Community College
University of MN - Duluth
University of MN - Twin Cities
University of St. Thomas



The space grant supports the work of researchers like Gloria Martinez-Arizala (pictured, left) who is working with Professor Allen Goldman (U of MN, Physics and Astronomy Department) on a project called "Large electric field effects of ultrathin films of Bi/a Ge grown on a single crystal SrTi03 substrates". A large electric field effect was observed in ultrathin films of Bi/a Ge, quench condensed at liquid helium temperatures onto single crystal SrTi03 substrates. A Pt gate electrode was pre-evaporated on the back of the substrate. Insulating films exhibited a symmetric response to the gate voltage, with a maximum increase in conductivity of about 50% for the most insulating film. The symmetric effect disappeared as the superconductor insulator (SI) transition was approached. In the superconducting (metallic) state, the response was small and antisymmetric in the gate voltage. The variation of this effect with temperature, film thickness, and its relationship to the SI transition will be reported. The possible origins of this phenomena, including electron hole symmetry and electrostriction in SrTi03 will be discussed.

Alumni News

Dale Enns and Tim Beckwith, both 1979 graduates of the Department, received the H.W. Sweatt Engineer-Scientist Award from Honeywell. This is Honeywell's highest award given to recognize outstanding engineering and technical achievement and to encourage vital technical creativity.

Dale Enns is a senior research fellow at Honeywell Technology Center in Minneapolis. He received the award for designing and developing a nonlinear control law methodology that spans a wide range of applications, including flight control for atmospheric vehicles. This control solution is distinctly superior in both cost and capability to competing techniques and enhances Honeywell's position as the leader in avionics controls.

Since starting work as a student intern at Honeywell in 1979, Dale has worked on modeling, guidance, and control of aerospace vehicles. Ten years ago his control laws were successfully flight tested on the AH-64A attack helicopter. He has worked with a team from NATO countries to develop a guidance and control system for an Autonomous Precision Guided Munition and led a group of McDonnell Douglas and Honeywell engineers in developing guidance and controls for the National Aerospace Plane program. Subsequently, he codeveloped nonlinear control laws for the F-18 High Angle of Attack Research Vehicle. These control laws, called MACH, can be re-used for many different applications.

As an adjunct professor, Dale has taught juniors, seniors and graduate students at the University of Minnesota since 1984, after receiving a Ph.D. in Aeronautics and Astronautics from Stanford University.

Timothy Beckwith is a principal design engineer at Military Avionics in Minneapolis and received an award for developing a production screening process that measures gyro random walk during an early step of the production process. The method does not require installation of a dither motor or readout sensors, thus allowing measurement immediately after the assembly is built. Tim's device proved vital to random walk improvement, that led to dramatically improved gyro performance. The direct cost reduction because of performance is significant—$12 million in two years.

Tim joined Honeywell in 1979 after earning a B.S. in aerospace engineering and mechanics from the University of Minnesota. Since then, he has focused on ring laser gyros, developing many processes, fixtures, and mechanical devices. His efforts have yielded three patents, four trade secrets and several other patents pending.

Peter Nagel, who received his M.S. degree, from here two years ago has been distinguished with receiving a Fulbright fellowship to study in Delft in the Netherlands. He is one of only 22 Fulbright fellowships awarded this year. He is currently a Ph.D. student studying astrodynamics at the University of Texas, Austin.

Duane Carey, who is a major and a pilot in the USAF, was selected by NASA for the Astronaut Class of 1996. He is one of thirty-five astronaut candidates that will begin training in August of 1996 at the Johnson Space Center for one year and then will be sent on a technical assignment within the Astronaut Office for advanced preparation for future Shuttle flight assignments. He was selected from more than 2,400 applicants. The class composition will be 10 pilots and 25 mission specialists. This class is the largest class selected since the first class of Shuttle astronauts, which also numbered 35, was named in 1978. Major Carey received both his undergraduate and graduate degrees in Aerospace Engineering and Mechanics from the University of Minnesota. He is currently a System Safety Officer/Experimental Test Pilot, 416th Flight Test Squadron, Edwards AFB in California.

Ed Abramson who received his masters degree in Aeronautical Engineering from the University of Minnesota passed away. He was a Lieutenant and Navigator in the 452nd B-17 Bomber Group of the 8th Air Force. In addition, he was chairman of the board and cofounder of Research Inc. in Eden Prairie, MN, and also a board member of Washington Scientific Industries; community board member of Norwest Banks and cofounder of the Upper Minnetonka Yacht Club.

Our 1980's graduates, Major Jeff Koss of the USAF at Eglin AFB and Terry Weber of McDonnell Douglas are members of the AIAA Flight Testing Technical Committee.

Faruk Said Abuzzahab, who received his B.S. in Aerospace Engineering and Mechanics from the University of MN Institute of Technology, has earned a Ph.D. at Marquette University. The doctorate in Biomedical Engineering with a specialization in Biomechanical/Biomaterials was awarded in May, 1996. The title of Dr. Abuzahab's dissertation is A Kinetic Biomechanical Model of the Foot and Ankle and Kinematic Study of Hallux Valgus.

We'd like to hear what you're doing, where you are, etc. You can either send the information to Donna Rosenthal, Aerospace Engineering and Mechanics, University of Minnesota, 110 Union St. SE, Minneapolis, MN 55455; e-mail to donna@aem.umn.edu, or fax to (612)-626-1558. We'll make sure that it gets in our next newsletter.

Alumni Notes

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.

Aeronautical Class of 1943 Wind Tunnel Fund: Created by the Class of 1943 to defray costs of a new wind tunnel and instrumentation.

The Chester Gaskell Aeronautical Engineering Scholarship Fund: Used for undergraduate scholarships for outstanding first-year aerospace students.

The John D. Akerman Memorial Fund: Supports the Akerman Professor of Design of our year-long capstone senior design course.

The AEM Laboratory Equipment Fund: Used to purchase instructional and research equipment.

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.

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

Donations: Your Dollar at Work

We have purchased a SIG Indy Presenter jointly with the Department of Mechanical Engineering at the University. This system consists of an SGI Indy R4400SC workstation, 200 Mhz, and an overhead display panel/projector. The unit is a stand-alone unit that is dedicated for classroom use and other presentations.

Wind tunnel update: We are in the process of upgrading our 100 h.p. closed-return wind tunnel. This tunnel is a great asset to the Department, and it could cost close to a half million dollars to replace. We began improvements one year ago by adding a flow straightening section, containing honeycomb and screens, for a cost of $10,000. This greatly improved the flow in the test sections. At the same time, we had the variable prop rebuilt and balanced at a cost of $2,000 and spent a lot of time chasing parts since the prop mechanism is World War II surplus from a P-38. Two new test sections have been ordered. One will be fitted with a 3-axis travers, and the other one will be fitted with our 6 component N.K. balance. Both test sections and traverse will cost $45,000. The next improvement will be to replace the motor and add a variable frequency converter. This would allow us to vary the motor speed, rather than feathering the prop, permitting quieter operation, reducing heat build up, and allowing more precise speed control. We do not have an estimate for this part of the project. Costs associated with this project have been supported in part from donations by the Class of 1943 and other Alumni.

The department acquired a 3-D digitizing arm. This device allows 3-D points to be taken in space, and imported to a computer. Once in the computer, the 3-D points can be used to generate surfaces, arcs, and planes. With the geometry in the computer, students can produce models used for analysis, and design.

Recipients of Undergraduate Student Awards 1995-96

AIAA 1995-96 Undergraduate Scholarship:
Sarah Braasch

Boeing Scholarship Awardees:
Mary Hayden and Bill Washabaugh

R. Minkin Aerospace Engineering Scholarship Awardees: Derek Gefroh, Ahmad Mohamed-Kassim and Joseph Mueller

Pictured above (left to right) Bill Washabaugh and Dr. Paul Rubbert from Boeing. Mary Hayden (Not shown).

Pictured above (left to right) Derek Gefroh, Professor Leo, and Joseph Mueller. Ahmad Mohamed-Kassim (Not shown).

Institute of Technology Undergraduate Assistantship/Chester Gaskell Aeronautical Engineering Scholarships
Jeremy Nelson

NASA Summer Academy Participant
Derek Gefroh

Other Undergraduate Notes

Sarah Braasch, AEM senior, spent spring quarter doing research in flight control at CERT (Centre d'Etudes et de Recherche de Toulouse) which is a decentralized establishment of ONERA (Office National d'Etudes et de Recherches Aerospatiale). CERT is the research center for one of the premier aerospace universities in France, Ecole Nationale Superieure de l'Aeronautique et de l'Espace, Sup Aero for short. We have had an informal exchange program with Sup Aero and last year a student from France spent spring and summer working with Professor Gary Balas on control of large space structures.

Our Undergraduate Graduates: Where are they now?

Troy Beyer, Lockheed Martin, Houston, TX
Heath Bowden, Nordic Track, Eden Prairie, MN
John Buch, Parametric Technology Corporation, Minneapolis, MN
Kim McLaughlin: Lockheed Martin, Houston, TX
Andrew Krolnik, Caterpillar, Peoria, IL

AIAA Student Officers
Jason Dick, President
Mark Oreshnick, Vice President
Dan Madsen, Secretary
Jerry Brenden, Treasurer

Matt Reetz has been awarded a teaching assistantship by the Mechanical Engineering Department at Stanford University where he will begin graduate studies in September.

Matt Litke will begin graduate studies at Stanford University in September.

Recipients of Graduate Student Awards for 1995-1996

NASA Graduate Fellowship
Andrew Wissink

Graduate School Fellowship
Ismail Guler
Janet Foster, CIC/GE Predoctoral Fellowship
Donald Johnson, National Graduate Feeder Ú&Ú&Ú&Ú&Ú&Ú Program Fellowship

Graduate School Doctoral Dissertation Fellowship
Joseph Olejniczak

Minnesota Space Grant Consortium Fellowships
Donald Johnson, Aerospace Engineering and Mechanics
Kim Marsh, Aerospace Engineering and Mechanics
Darren Mason, Aerospace Engineering and Mechanics
Gloria Martizez-Arizala, Physics

Control Science and Dynamical Systems Fellowships
Jin Hui
Sue-Woon Kim

Our Graduates Students: Where are they now?

Paolo Aquilar received his M.S. degree in Mechanics in December 1995 and is continuing in the Ph.D. program in the Department.

Abbas Alahyari received his Ph.D. in December of 1995 and is currently a research associate at Idaho National Engineering Labs. He gave a presentation on his Ph.D. research in November 1995 at the American Physical Society Meeting in Irvine, CA.

Ramon Cajina received his M.S. in June of 1995 and is currently employed at Flomerics in Westboro, MA.

Jennifer Hamelin received her M.S. in September of 1995 and now works for Lockheed Martin in Houston, TX.

Sadok Hogui received his Ph.D. in Aerospace Engineering in June 1996 as well as a Masters in Technological Management. He has returned to his position at Rafael in Israel.

Christine Jeseritz received her M.S. in December of 1995 and is currently employed at Lockheed Martin in Colorado Springs, CO.

Shad Jeseritz received his M.S. in December of 1995 and is an officer in the Air Force in Colorado Springs, CO. In his M.S., he designed a new shape memory composite that exhibits the two-way shape memory effect.

Sanjay Pahuja received his M.S. in September of 1995 and is currently a Ph.D. student in environmental engineering at MIT.

Narendra Simha received his Ph.D. in Mechanics in January of 1995 and is holding a two-year postdoctoral position at Caltech.

Wendy Grebner received the Amelia Earhart Fellowship for 1996-97 from the Zonta International Foundation. This will be her second year for receiving this award. The Award is given to women for graduate study in aerospace-related sciences and aerospace-related engineering. In addition, Wendy was nominated and participated in the NSF sponsored Engineering Education Scholars Program at Carnegie Melon University (July 21-26). This program is designed to give future Ph.D.'s a better view of an academic career.

Darren Mason finished his Ph.D. degree during the summer of 1996. His academic and thesis advisor was Professor Fosdick. Darren has accepted a postdoctoral position in the Department of Mathematics, Center for Nonlinear Analysis, at the Carnegie-Mellon University of Pittsburgh, Pennsylvania, for next year.

Other News

Volkan Nalbantoglu was in Budapest during the Spring quarter of 1996 as part of a collaboration between the Department of Aerospace Engineering and Mechanics of the University of Minnesota and the Computer and Automation Institute of the Hungarian Academy of Sciences. He participated in some research activities in the field of System Identification and Robust Control.

Again this year, AEM participated in Opportunities Day for Girls sponsored by the Program for Women in the Institute of Technology on April 13th. The event brought fourth through eighth grade girls to campus for a half day of hands-on activities designed to show that physical sciences and engineering are interesting and fun. AEM graduate student presenters were: Wendy Grebner, Kim Marsh, Pam Schumacher, Janet Foster, Greg Weirs, Trevor Seipp, Deb Olejniczak, Heath Johnson and Vincent Kuo. Pam Schumacher, a staff scientist, also helped in the presentation. Kim Marsh and Wendy Grebner coordinated the event.

On May 31st, a class of 6th graders visited AEM from Oak Point Intermediate School in Eden Prairie. The students performed experiments using airfoils and composite materials. AEM Graduate student presenters were Wendy Grebner, Kim Marsh, Greg Weirs and Trevor Seipp. Scientist Pam Schumacher presented as well.

The AEM Mechanics of Materials Research Seminar continues to meet every Tuesday afternoon for approximately two hours during the academic year. It now has a tradition of almost 15 years of operation and is currently run through the efforts of Professors Fosdick, James, Leo, Shield, and Truskinovsky. It is designed to discuss current research issues in continuum mechanics and the modeling of material behavior. Graduate students attend and often give talks and updates on their M.S. and Ph.D. thesis projects. The environment is informal, interactive and stimulating to research for the faculty, the graduate students and visiting postdoctoral associates in mechanics of materials. Graduate students from our Department who have given talks recently on their current research work include Darren Mason, Wendy Grebner, and Rob Tickle. Besides talks given by Professors Fosdick, James, Leo, Shield, and Truskinovsky, others who have spoken about their current research interests include Professor M. Angelillo from the Department of Civil Engineering at the University of Salerno, Salerno, Italy; Professor L. Antanovskii, Department of Mathematics, The University of West Indies, St. Augustine, Trinidad, West Indies; Professor R. Aris, Department of Chemical Engineering and Materials Science, University of Minnesota; Professor O. Bruno, Department of Applied Math, California Institute of Technology; Professor I. Gargash of the Institute of Earth Physics, Russian Academy of Sciences, Moscow, Russia; Professor R. Rogers, Department of Mathematics, Virginia Polytechnic Institute; Professor C.S. Man, Department of Mathematics, University of Kentucky; Professor M. Ortiz, Department of Material Science, California Institute of Technology; Professor S. Spector, Department of Mathematics, University of Illinois at Carbondale; Professor V. Sverak, School of Mathematics, University of Minnesota; and Dr. G. Zanzotto of the Department of Mathematical Methods in Mechanics and Applied Sciences, University of Padova, Padova, Italy.

President's Distinguished Faculty Mentor Program

The President's Distinguished Faculty Mentor Program (PDFMP) links high-ability students of color with distinguished faculty member who serve as mentors for personal and professional growth and assists the scholars in meeting the intellectual challenges of an academic career at the University of Minnesota's Twin Cities. It provides a dynamic out of classroom learning experience that enhances the quality of academic life and humanizes and personalizes the University environment. Students sponsored this year, along with their mentors were:

Jeanne Cloud	Professor Garrard, Faculty Mentor
Jim Chase	Professor Garrard, Faculty Mentor
Mike Duran	Professor Leo, Faculty Mentor
Frank Aquair	Professor Leo, Faculty Mentor

Recent Research Projects of AEM Professors

Advanced Methods for Interceptor Flow Simulations
Army Research Office-AASERT
Graham Candler

Aeroacoustics in Turbulent High-Speed Jets
NASA - AMES
Thomas Lundgren

Aerodynamic Dissemination (Shock Tube)
Army Research Office
Daniel Joseph & Gordon Beavers

Analysis, Design, and Computation of Active Materials
USDOD - Air Force
Richard James
Mitchell Luskin

Army High Performance Computing Research Center (AHPCRC)
Army Research Laboratory (ARL)
Tayfun Tezduyar

Automated Route Planning and Optimizing Software
MN Department of Transportation
Maria Gini & Yiyuan Zhao

Basic Research on the Improvement of Magnetostrictive and Shape Memory Materials
Office of Naval Research
Richard James & Thomas Shield

Break-up of Viscoelastic Liquids in High-Speed Air Flow
Army Research Office—AASERT
Daniel Joseph

Cavitation in a Flowing Liquid
National Science Foundation,
Daniel Joseph

Computational Methods for Simulation of Hypersonic Re-Entry Flows
NASA Langley Research Center
Graham Candler

Direct Simulation of the Motion of Particles in Flowing Liquid
National Science Foundation
Daniel Joseph
Ahmed Sameh

Dynamics and Stability of Capsules in Pipeline Transportation
MnDOT (CTS)
Yiyuan Zhao & Daniel Joseph

Economic Analysis of a Mach 4 Transport
NASA
William Garrard & Andrew Vano

Engineering Research Equipment: Drum Camera and Holography
National Science Foundation,
Gordon Beavers
Daniel Joseph
Ellen Longmire

Experiments in Particle-Laden and Buoyancy Driven Flows
National Science Foundation - NYI Award
Ellen Longmire

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

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

Finite Element Simulations in Aerospace Engineering and Applied Fluid Mechanics
ARL - AHPCRC
Tayfun Tezduyar

High Performance Computation of Compressible Flows, Turbulent Flows
ARL - AHPCRC
Graham Candler

The Hoechst-Celanese Company
Daniel Joseph

Interfaces with Structure: Kinetics, Nucleation, Microstructures, Topological Transactions
National Science Foundation
Lev Truskinovsky

Large Scale Turbulent Structure in Supersonic Jets
NASA
Thomas Lundgren

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

Lubricated Pipeline of Bitumen Froth
Syncrude LTD of Canada
Daniel Joseph

Lubricated Transport of Viscous Materials
Department of Energy
Daniel Joseph

McKnight Land Grant Professorship
McKnight Foundation
Ellen Longmire

Measurements of Crack Tip and Microstructural Strains in Single Crystals
National Science Foundation - NYI Award
Thomas Shield

Measurement of Vibrational Nonequilibrium Reaction Rates
Subcontract with Caltech (USDOD-Air Force)
Graham Candler

The Minnesota Space Grant College Consortium
NASA
William Garrard

Modeling of Articular Cartilage
Center for Interfacial Engineering — Biomedical Interfacial
Perry H. Leo

Modeling of Disperse Multiphase Flows
National Science Foundation, Division of Chemical/Thermal Systems
Tayfun Tezduyar

New HPC Techniques for Finite Element Simulation of Large Ram Air Parachutes
Army Research Office—AASERT
Tayfun Tezduyar
William Garrard

Novel High Performance Magnetoferro-Elastic Actuators
Office of Naval Research
Richard James & Thomas Shield

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

Optimal Takeoff Procedures for Category A. Helicopters
NASA - Ames
Yiyuan Zhao

Packard Fellowship in Science and Engineering
Packard Fellowship
Amy Alving

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

Particle-Turbulence Interactions Near Walls
Electric Power Research Institute
Ellen Longmire

Respiratory Action of the Intercostal Muscles
National Heart, Lung, and Blood Institute (NIH)
Theodore Wilson

Research and Engineering Apprenticeship Program
Academy of Applied Science (ARO Prime)
Amy Alving

Respiratory System Mechanics
Baylor College of Medicine
Theodore Wilson

Rheology of Bread Dough
The Pillsbury Company
Daniel Joseph

Robust Structural Control for Hazard Mitigation Using Probable and Possible Models
National Science Foundation
Gary Balas
William Garrard

Robust System Identification and Validation for Control
NASA
Gary Balas

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

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