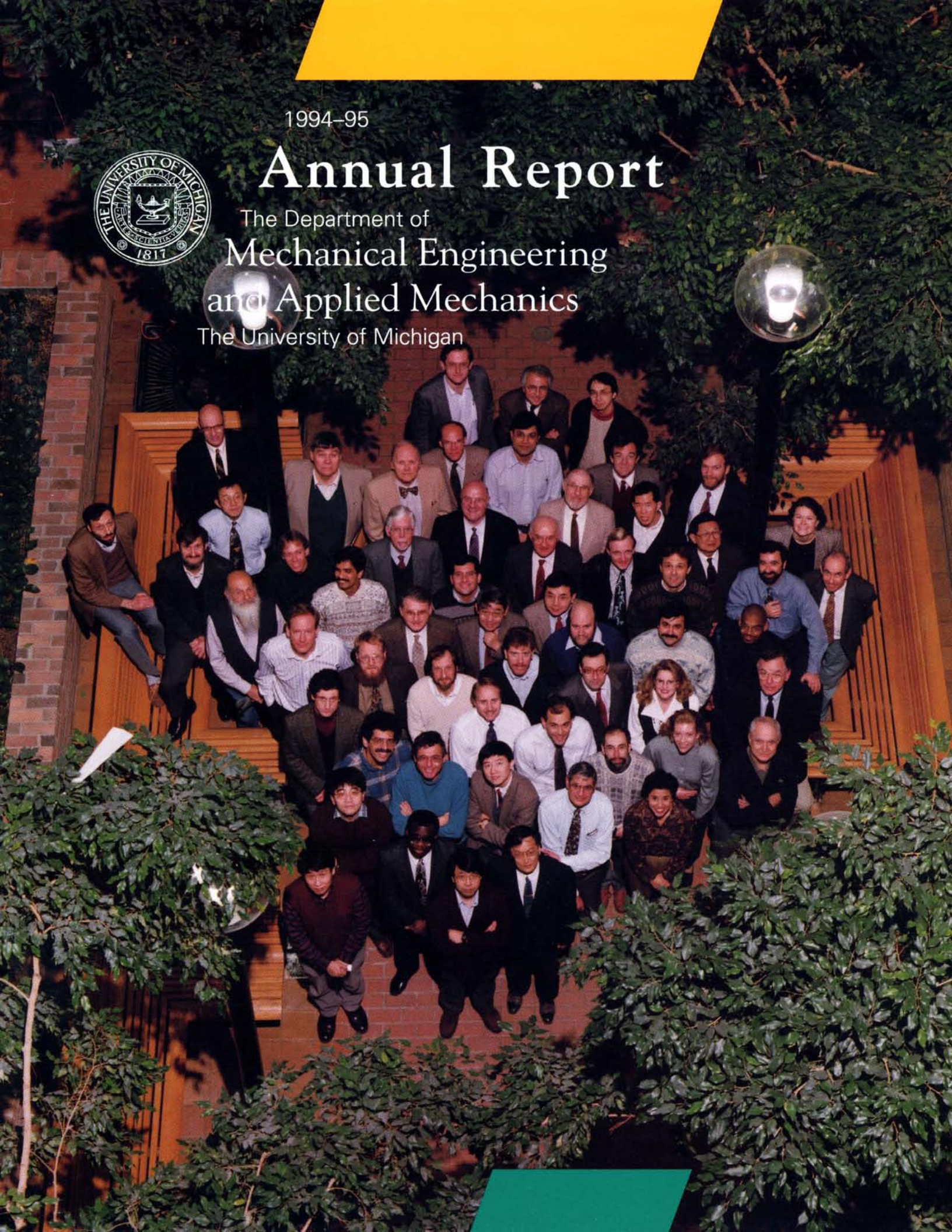
1994–95

Annual Report

The Department of
Mechanical Engineering
and Applied Mechanics
The University of Michigan



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In this year's message as representative of all the people of mechanical engineering and applied mechanics at the University of Michigan I would like to ask your indulgence as I reflect on some personal thoughts.

This past year, after concluding my three-year term as Department Chair, I agreed to serve an additional three-year term not without much deliberation. We academics have an instinctive suspicion towards administration and its tools, stemming from our greatly cherished individual freedom to pursue the intellectual challenges that attract us to the classroom or the laboratory. Yet, we also know, perhaps deep inside us, that the public and the world we presume to serve with our technology have its own expectations of us—that we do not always meet. This has been particularly true in the very recent past. University administrations across the country have been working hard to show how the Academy does serve the public interest while also protecting the valuable freedom that breeds intellectual breakthroughs.

Against this backdrop our Department at the University of Michigan has gone through an extraordinary period of change and adjustment. Change has touched the gamut of our enterprise: core curriculum, laboratories, elective courses, professional degrees, student relations, research programs, management structures, links with our alumni, industry and government relations; and most of all, faculty composition. An academic institution is really defined by its faculty. Everything else follows—from the students that come to us, to the research that we conduct and the reputation we have. In this spirit the annual report showcases our new faculty and the outstanding talent they bring to us.

My direct involvement in the recruitment of almost half of our faculty and my desire to see them build, along with our other colleagues, a great future for our Department is what convinced me to continue my service as Department Chair, in spite of the backbreaking balancing acts that I am frequently expected to perform. The enthusiasm of our student representatives, the hard work of our staff, and the leadership of our external advisory board were the clinchers. In the end, it is really a privilege and a great personal opportunity to serve this Department.

With a great sense of pride and expectation I invite you to learn more about us and to participate in our achievements of today and of the years to come.

With best regards,

Panos Y. Papalambros
Professor and Chair

New Faculty
A Focus on Present Need, Future Growth

Energetic and enterprising, new faculty bring new ideas, new skills to MEAM

The Department of Mechanical Engineering and Applied Mechanics has undergone enormous change over the last several years. Nowhere is this more evident than in the area of faculty development. Historically, the department has averaged about 55 faculty; but by 1989, retirement, professional advancement, and other factors had reduced this number to 41. Recognizing the need to infuse new blood and new disciplines into its faculty mix, the department began a wide-ranging talent search. The results have been nothing short of remarkable.

Biomechanics

Arthur Kuo
Steven Goldstein
Scott Hollister
Albert Schultz
Louis Soslowski

Design

Diann Brei
Debasish Dutta
Rida Farouki
Donald Geister
Sridhar Kota
Panos Papalambros
Allen Ward

Combustion & Heat Transfer

Dennis Assanis
Arvind Atreya
Michael Chen
Vedat Arpaci
Massoud Kaviany
Herman Merte
Gene Smith
Richard Sonntag
Wen-Jei Yang

Dynamics

Karl Grosh
Gregory Hulbert
Bruce Karnopp
Noel Perkins
Christophe Pierre
Richard Scott

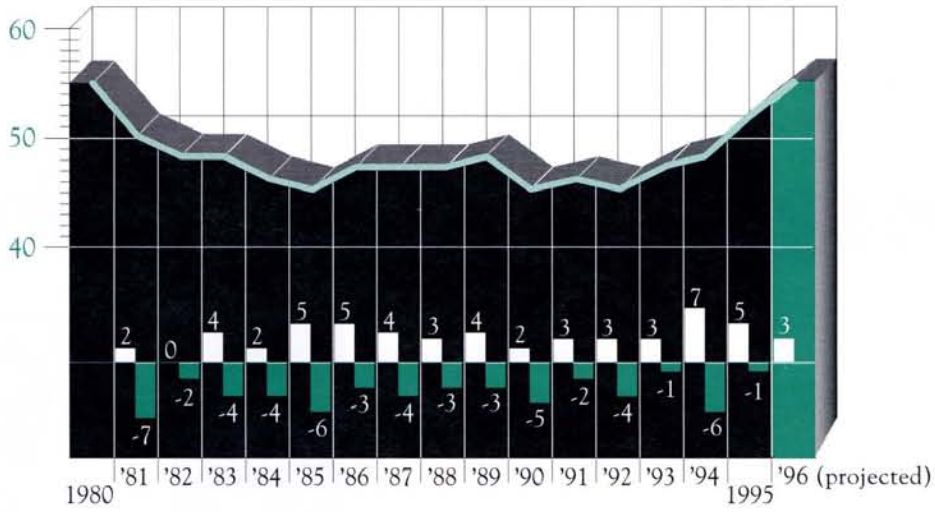
Since 1990, the Department has added 20 new faculty members—18 within the last three years alone. With the beginning of the 1995–1996 academic year, the number of MEAM faculty is once again at its historical level of full complement.

Through a fortuitous convergence of diligence, aggressive recruiting, and plain good luck, the department has been able to re-staff itself with an outstanding assemblage of world-class educator/researchers who have a wide spectrum of experiences and fast-growing research programs. As is evident from the profiles on the following pages, they come from a variety of backgrounds, representing cross-over academic disciplines as divergent as astrophysics, chemical engineering, computer science, materials design and engineering, naval architecture, electrical engineering, precision manufacturing, process control—and virtually every traditional mechanical engineering discipline as well.

Similarly, their research investigations encompass microelectrical mechanical systems, metallurgy, computer software design, automotive design and engineering, machining processes, biomedical engineering and many others.

Yet, as diverse as our new faculty are, it can be said that they share several critical traits, among them: a history of exemplary personal achievement; a proven aptitude for innovation, creative thinking and risk-taking; a knack for transforming leading-edge research into commercial applications; and the capacity to either lead or collaborate on research teams, including projects outside their own disciplines. They are an excellent complement to our existing strengths in core MEAM curricula.

Faculty Numbers and Replacement



Fluid Mechanics

David Dowling
David Mead
Rayhaneh Akhavan
Claus Borgnakke
Steve Ceccio
Walter Debler
William Schultz
Grétar Tryggvason

Solid Mechanics and Materials

Ellen Arruda
Mehrdad Haghi
Ann Marie Sastry
Michael Thouless
James Barber
Maria Comninou
David Felbeck
John Holmes
Noboru Kikuchi
Kenneth Ludema
Jwo Pan
Alan Wineman
Wei-Hsuin Yang

Manufacturing

William Endres
Shixin (Jack) Hu
Jun Ni
Elijah Kannatey-Asibu

Systems and Controls

Michael Bridges
Huei Peng
Dawn Tilbury
Robert Keller
Yoram Koren
Jeffrey Stein
Galip Ulsoy

Equally important, they bring to the Department a demonstrated commitment to teaching—the type of commitment that generates a lifelong passion for learning and intellectual achievement. These are precisely the qualities we want to nurture in every MEAM student because they are necessary for leadership in the worlds of higher education, research and industry.

In keeping with one of the Department's expressed strategic goals, namely to be recognized as the undisputed leader in automotive and manufacturing engineering across all engineering disciplines, nearly one-fourth of our new faculty were recruited specifically for their strengths in the fields of automotive dynamics and control systems, design, manufacturing processes, machining systems and thermal fluid applications related to materials processing. But in fact, every one of our new faculty is involved in landmark research, and has amassed advanced academic training in areas that can be tapped to strengthen our already strong presence in the automotive and manufacturing sector.

The synergy and cross-fertilization of ideas generated by such a unique collection of intelligent, multitalented individuals will keep MEAM at the forefront of engineering education, and greatly enhance the Department's value as a leading research and applications resource in all areas of scientific endeavor including, but certainly not limited to, the automotive and related manufacturing industries.

The fact that MEAM has been able to attract such extraordinary talent is a tribute to the tenacity and vision of our veteran faculty members who carried out the search process. It is also a credit to the Department's reputation as a magnet organization where excellence is recognized, where initiative is given free rein, and where opportunities for personal and professional growth are almost unlimited.

Get to Know the New Faculty

The Department of Mechanical Engineering


Arruda


Assanis


Atreya


Brei

MEAM is well-positioned to meet the challenges it faces as a world-recognized leader in engineering education. The reason for our confidence can best be summarized in the biographical sketches of the new faculty profiled in this section. These are the individuals who will shape and build this department well into the next century.

Ellen M. Arruda, Assistant Professor MEAM (1992) and Macromolecular Science and Engineering (1992). Received her Ph.D. (1992) in Mechanical Engineering from MIT, her M.S. in Mech. Engr. (1988), and B.S. in Engr. Science (1983) from Penn State. At U-M her work is in characterizing the large deformation response in elastomeric networks and in uncrosslinking amorphous and semi-crystalline polymers. Her interdisciplinary investigations in this area have led to a greater understanding of the role of birefringence as an *in situ* measurement of orientation, and have been funded by both NSF and Ford. She has introduced new, application-intensive courses at both the graduate and undergraduate levels, and has been a key participant in curriculum revisions. Primary research interests: Structure/processing/ property relationships in polymeric materials and glasses, and constitutive modeling of polymers.

Dionissios (Dennis) N. Assanis, Professor (1994). Received his Ph.D. in Power and Propulsion (1985), and M.S. degrees in Mechanical Engineering (1982) and Management (1986) from MIT. He earned his B.S. in Marine Engineering (1980) and M.S. in Naval Architecture and Marine Engineering (1982) from Newcastle University, England. Prior to joining the MEAM faculty, he was associate professor of mechanical engineering, head of a thermal sciences/systems division, associate professor of supercomputing applications, and NCSA research scientist at the University of Illinois. Assanis designed and directs MEAM's new Masters of Automotive Engineering degree program. He has been a consultant to GM and NASA, and is a recipient of numerous professional, science, and teaching awards. Primary research interests: Thermal and fluid sciences and their applications to automotive systems design, internal combustion engine processes and systems.

Arvind Atreya, Associate Professor (1993). Received his Ph.D. (1983) and S.M. (1978) in Engineering Sciences from Harvard University, and his B.Tech. (1975) in Mechanical Engineering from the Indian Institute of Technology, New Delhi. Since joining MEAM, he has focused on revamping the course sequence on combustion, and on establishing a leading research program in the area of fire and combustion. He is a recipient of the NSF Presidential Young Investigator Award, and of the Philip Thomas Medal of Excellence for his research on ignition and growth of fires. Primary research interests: Ignition, growth and suppression of fires; flame radiation; combustion generated pollutants; engine combustion; and industrial energy utilization.

Diann E. Brei, Assistant Professor (1994). Received her Ph.D. (1993) in Mechanical Engineering and her B.S. (1988) in Computer Systems Engineering from Arizona State University. For her doctoral thesis, she developed a new microelectromechanical actuator building block that can be used to create larger, more functional piezoelectric actuators. At the U-M she has extended her research to include design and development of other novel smart materials and devices and is part of a cross-disciplinary university team investigating new manufacturing processes and applications for these devices, ranging in size from the micro to mesoscale. Brei has worked as a consultant to Ford, and is an emerging national presence in the field of smart materials and structures. Primary research interests: Smart materials and structures, sensor/actuator design; microelectromechanical systems (MEMS) and design.


Bridges


Ceccio


Chen


Dowling


Endres


Farouki

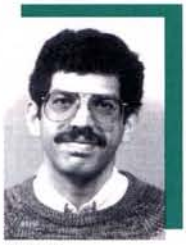
Michael M. Bridges, Assistant Professor (1994). Received his Ph.D. in Electrical Engineering and Robotics from Clemson University (1994) and his B.S. in Electrical Engineering (1989) from the U-M. His research in the field of electromechanical systems has led to the development of advanced nonlinear controllers for robot manipulators. A regular contributor to trade and academic publications, Bridges recently co-authored the book *Nonlinear Control of Robotic Systems for Environmental Waste and Restoration*, part of the Prentice Hall series on Environmental and Intelligent Manufacturing Systems. Primary research interests: Nonlinear control of electromechanical systems specializing in the areas of robotics, mechatronics, and manufacturing.

Steven L. Ceccio, Assistant Professor (1990). Received his Ph.D. (1990) and M.S. (1986) in Mechanical Engineering from CalTech and his B.S. (1985) in Mechanical Engineering from the U-M. Since returning to Michigan, he has been instrumental in reengineering the laboratory portions of the undergraduate curriculum. He also has introduced a new graduate-level course on multiphase flow. Ceccio's investigations extend from hydrodynamics of multiphase fluids to net-shape manufacturing of materials. He has conducted extensive research on cavitation for the U.S. Navy, and is designing and building the electrical hardware for a device that Sandia National Laboratory will use to study multiphase flows in chemical reactors. Primary research interests: Basic and applied fluid dynamics and heat transfer, experimental methods.

Michael M.Chen, Professor (1991). Received his Ph.D. (1961) and S.M. (1957) from MIT. He is a recipient of the ASME Heat Transfer Memorial Award and a former director of the NSF Thermal Transport and Thermal Processing Program. Chen has authored or co-authored more than 120 journal articles, book chapters, and other publications. His investigations have focused on transport phenomena fundamentals in engineering and biological systems. Since leaving NSF, his research has extended to laser welding, spray forming and coating. He was a featured speaker at the 1994 IMECE "Materials Technologies for the 21st Century" symposium, and keynote speaker at the 1995 joint ASME/(Japan)SME conference on thermal engineering. Primary research interests: Heat transfer and fluid mechanics, especially problems pertinent to manufacturing and materials processing.

David R. Dowling, Assistant Professor (1992). Received his Ph.D. (1988) and M.S. (1983) in Aeronautics from CalTech. Before coming to Michigan he was a scientist in the Applied Physics Lab at the University of Washington where he studied phase-conjugate acoustic systems. He also was an engineer with Boeing Aerospace and Electronics, Laser Technology Section, where, among other things, he developed heat transfer models, flow systems, and experiments for pulse chemical lasers. Dowling is a primary investigator with the Automotive Research Center, and has introduced both undergraduate and graduate-level coursees in engineering acoustics. Primary research interests: Acoustics, turbulent mixing and combustion, atmospheric and oceanic fluid mechanics, wave propagation in fluids, injection molding.


Grosh


Haghi


Hu


Kuo


Mead


Ni

William J. Endres, Assistant Professor (1994). Received his Ph.D. (1992), M.S. (1990), and B.S. (1988) in Mechanical Engineering from the University of Illinois, Urbana-Champaign. During graduate school, he was an independent contractor with Process Design and Control, Champaign. Prior to joining U-M, Endress was a Visiting Assistant Professor at UIUC. Since coming to MEAM, Endres has introduced an undergraduate elective course in machining processes, and helped revamp the first of a two-part undergraduate sequence in mechanical design. Endres has co-developed a new approach to modeling machining forces for cutting tools used in practice. Primary research interests: Cutting mechanics, machining process dynamics, mechanistic modeling techniques.

Rida T. Farouki, Professor (1994). Received his Ph.D. (1983) and M.S. (1981) in Astrophysics from Cornell University, and his B.A. (1978) and an honorary M.A. (1982) in Engr. Science from Oxford University. He brings to MEAM 11 years of distinguished service as a research scientist with GE and IBM, and is widely acknowledged for his contributions to the field of computer-aided geometric design. A frequently featured speaker at international conferences, Farouki is also the author of more than 60 articles ranging from CAD-related topics to computational physics. He is faculty leader of both the Design Laboratory Group and the Design and Manufacturing instructional area. Farouki is associate editor of the journal *Computer-Aided Geometric Design*, and has authored CAD software now in commercial use. Primary research interests: All aspects of design, with a special interest in computer-aided geometric design.

Karl Grosh, Assistant Professor (1994). Received his Ph.D. (1994) in Mechanical Engineering from Stanford University and his M.S. (1988) and B.S. (1985) in Engineering Mechanics from Penn State University. A former research scientist with the Naval Research Laboratory/SFA in Washington, D.C., Grosh has amassed significant experience using GGLS finite element formulations to predict the effects of vibrations on beams, plates, shells, and fluid-loaded structures. He is a member of the Dynamics Lab and has created a course in wave propagation and co-developed a course in acoustics. Primary research interests: Structural acoustics and vibration, finite element methods, biomechanics, smart materials.

Mehrdad Haghi, Assistant Professor (1992). Received his Ph.D. (1991) and S.M. (1986) in Mechanical Engineering from MIT, and his B.S. in Applied Physics from CalTech (1984). A leading proponent of undergraduate research activities and action learning, Haghi is faculty advisor on the UM/SAE Hybrid Electric Car team. He has revised the content of several graduate courses to reflect recent developments in plasticity theory, and applied numerical methods in metal forming. His recent research investigations into material deformation and failure have been underwritten by Whirlpool and NSF. Primary research interests: Metal forming and assembly, FEM and computational mechanics, fracture mechanics and fatigue, plasticity.

Shixin (Jack) Hu, Assistant Professor (1995). Received his Ph.D. in Mechanical Engineering from the U-M (1990). He is technical director of the NIST ATP sponsored "2mm Program," a research and development joint venture comprised of the Auto Body Consortium, Chrysler, GM, U-M, and Wayne State University. Hu is a frequent guest lecturer and contributing writer on the topics of statisical process control and assembly. He is a recipient of the SME Outstanding Young Manufacturing Engineer Award. Primary research interests: Design and control of manufacturing processes, including statistical approach to the design and control, with special interest in assembly and materials joining processes.

Arthur D. Kuo, Assistant Professor (1994). Received his Ph.D. (1993) and M.S. (1989) in Mechanical Engineering from Stanford University, and his B.S. in Electrical Engineering (1987) from the University of Illinois, Champaign-Urbana. His far-ranging investigations in the field of biomechanics have been funded by the Whitaker Foundation, NSF, NIH, and the R.S. Dow Neurological Institute, among others. One product of his research has been the development of a control systems model of human balance which has clinical applications in diagnosing and ameliorating balance deficits in the diseased and elderly. Kuo is a recipient of the Young Investigator Award presented during the 13th Annual International Congress on Biomechanics. Primary research interests: Dynamics and control of human movement, multi-body dynamics.


Peng


Sastry


Thouless


Tilbury

David W. Mead, Associate Professor (1995). Received his Ph.D. in Chemical Engineering (1988) from Trinity College, Cambridge University, and his M.S. (1979) and B.S. degrees in Chemistry and Chemical Engineering (1979) from MIT. His post-doctoral studies were performed at AT&T Bell Labs where he worked on liquid crystal polymer rheology; and at the University of California, Santa Barbara, where he investigated the rheology of linear flexible polymers. His expertise includes rheo-optical methods of studying material flow. Mead's considerable industrial experience includes tenures with DuPont and Shell. His research on wide-ranging polymer related issues are supported by DuPont, Exxon, British Petroleum and Hewlett-Packard. Primary research interests: Rheology, polymers and polymer processing.

Jun Ni, Associate Professor (1993). Received his Ph.D. (1987) and M.S. (1984) in Mechanical Engineering from the University of Wisconsin-Madison. He is a 1994 recipient of the prestigious NSF Presidential Faculty Fellow Award and current director of the NSF-sponsored Industry/University Cooperative Research Center for Dimensional Measurement and Control in Manufacturing. Ni also is director of the S.M. Wu Manufacturing Research Center. Under the sponsorship of various government agencies (NSF, ARPA, NIST, ONR, AFOSR) and industries, Ni has investigated the fundamental issues in error compensation techniques for machine tools, coordinate measuring methods, drills and drilling processes, and machine chatter prevention. Primary research interests: Manufacturing science and engineering, especially precision engineering; machining technology; automotive manufacturing quality improvement.

Huei Peng, Assistant Professor (1993). Received his Ph.D. (1992) in Mechanical Engineering from the UC-Berkeley and his M.S. (1988) from Penn State University. Prior to his MEAM appointment, he was a research engineer at the California PATH program. Peng teaches a variety of control systems courses at both the graduate and undergraduate levels. His predominant interest is in the automotive/truck sector, and he is one of a group of faculty now working with industry to establish a vehicle dynamics and control curriculum which will offer both solid theoretical and hands-on experience. Primary research interests: Control systems, electromechanical systems, modeling, vehicle dynamics.

Ann Marie Sastry, Assistant Professor (1995). Received her Ph.D. (1994) in Mechanical Engineering from Cornell University. She received many awards for outstanding scholarship and teaching in graduate school, including three Best Student Paper awards at international conferences, and the DuPont Teaching Award. Her current research in the application of micromechanics to material optimization includes damage progression modeling in composites, optimization of battery electrode materials for automotive applications, and modeling of processing-induced micromechanical behavior. She joined the faculty after holding the position of senior member of technical staff at Sandia National Laboratories. Primary research interests: Behavior of porous composites, damage progression analysis and processing of polymeric composites.

Michael D. Thouless, Associate Professor (1995). Received his Ph.D. (1982) and M.S. in Materials Science from UC-Berkeley. After earning his doctorate, he was an assistant research engineer at UC-Berkeley and then in the Materials Department at UC-Santa Barbara. He moved to IBM in 1986 where he worked on a variety of interdisciplinary projects including interfacial fracture mechanics, mechanical properties of thin films and the reliability of micro-electronics. Prior to arriving at Michigan, he was a visiting professor at Tsinghua University, Beijing. Thouless is the author or co-author of more than 50 papers in the areas of mechanics and materials science, and is an associate editor of the *Journal of the American Ceramic Society*. Primary research interests: Micromechanics modeling of materials, interfacial fracture mechanics and adhesion, mechanical properties of thin films and coatings.

Dawn M. Tilbury, Assistant Professor (1995). Received her Ph.D. (1994) in Electrical Engineering and Computer Sciences from the UC-Berkeley. As a graduate student she held visiting scholar appointments at LAAS-Toulouse; and LSS-Paris, France; LIDS (MIT) and at Harvard University. At UC-Berkeley, she received an AT&T Ph.D. Fellowship and the Eliahu Jury Award for excellence in systems research. She is one of a small group of researchers applying the theory of exterior differential systems to problems in control theory and robotic motion planning. Since her arrival at MEAM, Tilbury has introduced several curriculum innovations, among them, a Matlab tutorial for ME461 students accessible through the World Wide Web, which won an award from the U.S. Dept. of Energy. Primary research interests: Nonlinear control, hybrid control systems, motion planning for robotics.

Instructional Improvements Focus on Laboratory and Design Sequence

Changes emphasize continuity, hands-on experience, teamwork, and communications skills

By almost any measure, the U-M College of Engineering and its Department of Mechanical Engineering and Applied Mechanics rank among the best in the world. Maintaining this high level of achievement requires constant self-appraisal, a strong sense of mission, endless fine-tuning, and on occasion, fundamental restructuring. It was precisely in this spirit of self-improvement that the Department initiated a review of its undergraduate curriculum over three years ago.

One of the main goals of this review was to create consistent, long-term value for MEAM shareholders: our students and the companies that recruit them. After consultation with alumni, industry representatives, and faculty and student groups, several curriculum improvement areas were targeted.

What follows are summaries of the changes that have already taken place, and a glimpse at some that are still in the formative stages.

Restructuring Undergraduate Laboratories

For many years, laboratory modules have been attached to every basic course in the MEAM undergraduate curriculum, generally as add-ons to lectures. Typically, the instructor would lecture about a physical law or principle, and then demonstrate the point in the laboratory. Students, working relatively independently, then submitted a brief writeup of what they had seen, and the lecture/demonstration cycle would progress to the next step in the course outline.

This approach to undergraduate laboratories has been replaced by a more encompassing one offered as a pair of mandatory, three-credit-hour courses: Thermal-Fluid Science Laboratory (ME 395) and Mechanical Science Laboratory (ME 396).

The new courses: (1) consolidate all the material formerly offered as smaller modules into longer, sequentially linked labs; (2) cover both lecture and additional, stand-alone material; (3) expand opportunity for individual analysis of problems, and; (4) place a greater emphasis on teamwork and technical communications.

ME 395 topics include measurements of quantities and fundamental systems analysis as applied to devices involving thermodynamics, fluid mechanics, and heat transfer. ME 396 topics encompass measurements of fundamental quantities and systems analysis as applied to solid mechanics, strength of materials, dynamics and controls.

In place of demonstrations, students taking ME 395 and ME 396 now are taught the physical principles behind various engineering devices, and how professional engineers actually use these devices to solve problems. Students also receive hands-on instruction in their operation, and then apply what they have learned in lecture and laboratory sessions to solve engineering problems of varying difficulty. Some experiments, most notably the final exam project, are open-ended problem-solving projects (e.g., analyzing an air conditioning system) which may require weeks to complete.

To simulate real-world work experience, laboratory students are randomly assigned to project teams. As team members, they must, on their own initiative, hold regular meetings, delegate responsibility, gather data, synthesize and edit their findings, and then submit a group report for a shared grade. The real-life simulation model also places a greater emphasis on written presentation skills.

Students taking ME395 (opposite, below) and ME396 (left and above) are taught the physical principles behind various engineering devices, and how professional engineers actually use these devices to solve problems.

Grétar Tryggvason, chair of the curriculum committee, says the decision to emphasize teamwork and technical communications emerged from department consultation with alumni and recruiting firms. Both groups felt that MEAM students received excellent technical education, but could greatly enhance their career growth opportunities if they received additional training in "interactive skills."

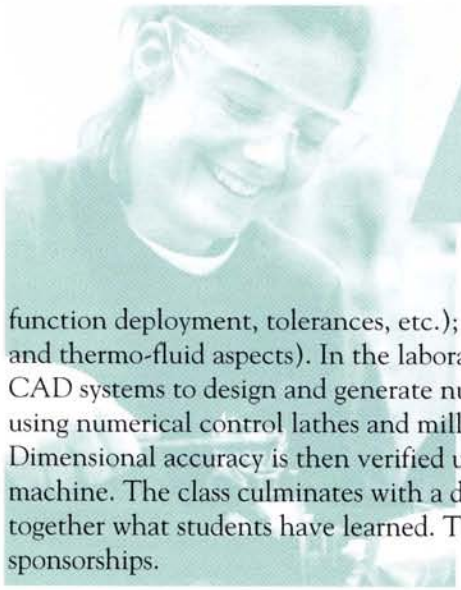
The process of lab revision and changeover is the intermediate step in a phase-in process that will culminate in the winter of 1997. At that point, the Fluid Science Laboratory and Mechanical Science Laboratory will be combined and restructured into a junior-level and a senior-level course. The junior-level course will span all lecture material covered through the first two years of instruction; and the senior-level course will encompass material covered over the first three years.

Design Sequence Extended to Sophomores

Another important change in the undergraduate curriculum has been the debut of Introduction to Design and Manufacturing (ME 250), a sophomore-level design course. Previously, design had been a two-course sequence (ME 350 and ME 450, see photos, below and next page) taken during students' junior and senior years. Over the past few years, both courses have increasingly emphasized the solution of real-world engineering problems. Indeed, the major thrust of ME 450 is for each student to solve a mechanical engineering design problem, often provided by, and carried out in conjunction with, industry sponsors.

Extending the design sequence to the sophomore year is a boon to both students and their project sponsors. Students benefit because they are farther along the design/manufacturing learning curve by the time they reach their junior and senior years, and thus can derive more benefit from their advanced-level design courses. Sponsors gain because they have greater flexibility in the types of projects they can assign, and receive a superior product.

ME 250 is designed to provide students a broad exposure to various aspects of design and manufacturing. Its goals are to have students: (1) think [and communicate] in 3D, (2) relate engineering design to manufacturing processes and (3) build mechanical artifacts using state of the art CAD/CAM facilities. Course time is almost evenly split between lecture and laboratories. In the lectures, basics of mechanical design (visual thinking, engineering drawing, conceptual design, quality



function deployment, tolerances, etc.); and manufacturing (processes, materials, and thermo-fluid aspects). In the laboratories, students learn the use of 3D CAD systems to design and generate numerical control cutter paths. Then using numerical control lathes and mills, the designed parts are fabricated. Dimensional accuracy is then verified using a co-ordinate measurement machine. The class culminates with a design/manufacturing project that ties together what students have learned. The course is supported by corporate sponsorships.

Pending Curriculum Improvements:

Repackaging MEAM course material into fewer classes of uniform value.

For various reasons, a significant majority of engineering students at the U-M, and elsewhere, now take longer than four years to complete an undergraduate degree. One contributing factor at U-M is that because many College of Engineering courses are less than four credit hours in value, MEAM students generally need to take five or more courses per term to earn the necessary 128 credit hours in eight terms. The workload can be overwhelming, given the fact that these courses are both intellectually demanding and homework intensive.

One proposed solution is to repackage course material into fewer classes of four credit hours each. While the amount of work per credit hour would stay the same, consolidation would reduce both the number of different homework sets and the number of midterms. Students would benefit from a more cohesive and integrated curriculum and could focus greater attention on each individual course. In addition, more students could matriculate sooner, and at less cost, than is currently the case. This proposal has generated interest at the College level where a comprehensive review of the undergraduate curriculum is now taking place.

Increasing access to course material on the World Wide Web (WWW.)

Individual instructors already offer WWW services to students. However, the department, under the leadership of Professors Richard Scott and Dawn Tilbury, is working to extend this option to all instructors. The department launched a pilot project with the College library this past fall to provide course material on the Web. The knowledge gained from this experience will be incorporated into future efforts to use the ever expanding graphical and software links of the Web as a means of teaching engineering, carrying out scientific inquiry and doing business.

ME 250 students were presented with a design problem (in this case a consumer-grade camera) as an actual commercial effort. Teams of up to three students had to consider both the marketability and manufacturability of their designs with a high degree of detail. Prototypes could then be milled directly on CNC equipment or cast from CNC created molds.
This project was sponsored by Applicon.

Camera Designs: top—M. Ackerman, R. Murua, J. Utton; top right—K. Seeger, R. Castro, E. Hill; second right—B. Ellsworth, C. LeMovne, M. Memmer; third right—M. Roelle, L. Butzlaff, J. Janbekar; bottom right—G. Baker, C.L. Chiang, M. Sacks.

Finding the Right Match

A discussion on faculty recruiting with CHRISTOPHE PIERRE

Associate Professor Christophe Pierre, faculty search committee chair, says that the recruiting process is equal parts science and art. Just how difficult is it to find faculty whose professional attributes fit the needs of MEAM?

"Very," says Associate Professor Christophe Pierre, whose committee recruited 12 new faculty members. "MEAM tends to be a self-limiting department in that we set our selection criteria so high."

"We are constantly on the lookout for people who can bring something new to the Department; people with cross-disciplinary skills who can be both stars in the laboratory and in the classroom, especially in areas like design where interactive teaching is very important. We want people whose intellectual breadth will enable them to branch into other fields as the need or opportunity arises. Finally, we want people who will be good citizens of the Department: who will serve on committees, take on outside projects, and generally do the various administrative tasks required in a large and dynamic department such as ours."

Finding such individuals is equal part science and art, Pierre says. By way of illustration, he notes that during his chairmanship of the search committee, the department ran a "positions available" advertisement in a prominent national trade journal. About 1,900 applications poured in. Of those, less than 20 percent made the first cut; and of that number the Department eventually hired just five. The remaining faculty were found by making personal inquiries among respected colleagues at corporations and other top engineering schools, and by pursuing specific individuals who fit the department's strategic needs. To give itself even more of an edge in the competition for the best talent, the Department extended its efforts beyond the traditional January to May faculty recruiting cycle.

"We started our recruiting in August, and that gave us a tremendous advantage–at least the first year," Pierre says. "By the time our competitors were just beginning to get their acts together, we had already hired five people. In the recruiting arena, a college or a department's reputation is everything," Pierre says.

"The U-M College of Engineering and MEAM are always ranked among the best in North America. That helps a lot," he observes. "So does the level of our research funding. All the other indicators of quality are here as well: top faculty, top students, quality publications, leading-edge research. People know about us; that we're strong and getting stronger. That makes this a very attractive place for energetic, highly-motivated people who want to do big things, important things."

MEAM External Advisory Board

A Partnership for Continuing Excellence

Since its formation in 1993, the MEAM External Advisory Board has become an important contributor to department operations. With the exception of the Department chair, the board is comprised of business leaders representing a variety of industries, all of which have high interest or experience in MEAM disciplines. Among its responsibilities, the board provides ongoing advice and counsel on matters related to the needs of industry—one of the department's most important education and research partners. In turn, board members receive valuable information about Department activities which better enables them to serve as external spokespersons, and to champion departmental initiatives.

Kenneth K. Kohrs (MSE, ME '66), Ford Motor Co. vice president of the Rear Wheel Drive Car Vehicle Program Center, has been chair of the Advisory Board since its inception. A member of the College of Engineering National Advisory Committee, the Engineering Campaign Executive Committee, and Ford's designated U-M liaison since 1989, Kohrs has been instrumental in shaping Board/Department relations.

"I consider my involvement on the advisory board one way I can repay the U-M for the education I received," he says. "I'm willing to do everything I can to continue the tradition of educational excellence for new generations of U-M students."

There is also a professional dimension to his commitment. "Ford hires a lot of U-M graduates and we richly benefit from the steady supply of talent," Kohrs explains. "Over the last ten years, the relationship between Ford and the U-M has matured and become much stronger. As a board member, I can contribute to what has become a very productive partnership."

In the following interview, Kohrs shares his observations on the department as it continues to focus on its mission.

MISSION STATEMENT OF THE DEPARTMENT OF MECHANICAL ENGINEERING AND APPLIED MECHANICS

To serve society and all its members by:
(i) providing the highest quality benefits emanating from the discovery and communication of knowledge on mechanical engineering theory and practice;
(ii) developing leaders of high achievement in the global world of higher education, research, and industry.

Preparing Students for Tomorrow's Industry

An Interview with EAB Chair, KENNETH K. KOHRS

MEAM: What do you consider the major strengths of the department?

KOHRS: I'd say it's the quality of the graduates, and by inference, the underlying philosophy of focusing on the fundamentals of engineering education. At Ford, we've found that it takes about two years of additional Ford process-specific training after graduation before an engineer is able to make significant contributions. Obviously, the better prepared students are when they arrive, the quicker the payback. The MEAM students I see are well schooled in mechanical engineering and often in other engineering disciplines as well; especially, electrical engineering and computer science. They are confident in their ability to get the job done and great organizers. Not only are they willing to take on responsibility, they actually look for it. As a result, they tend to make contributions earlier in their career.

Another department strength is the intellectual reach of the faculty. This is reflected in the depth and diversity of the curriculum: biomechanics, design and manufacturing processes, applied mechanics, structural mechanics, cross-disciplinary research into fields as related as polymers and advanced mechanisms and systems—and the list goes on. The department has become a leader in tearing down old paradigms, in expanding the boundaries of mechanical engineering beyond strict, classical definitions. I see evidence of this in department efforts to combine ME and Business School degrees, and in its willingness to create bridges with other engineering disciplines to produce better students and better research. MEAM has a vision to be the best. To do that, you need a broad systems perspective. The department is working aggressively toward that end.

MEAM: What do you see as the major challenges facing MEAM?

KOHRS: The College and the department have built their national reputations on their commitment to educating students in the fundamentals. Without losing sight of that, MEAM needs to continue to fine-tune its curriculum, to keep it current with the changing demands of the marketplace. Recent faculty additions indicate the department's commitment to renew itself; and by recent, I mean the last ten years or so. New faculty infuse new enthusiasm, new disciplines, and new ways of thinking. That process of continuing improvement is important in any organization—whether its an engineering department, a corporation, or a governmental body. Future growth and development is built upon continuing investment in top young talent.

MEAM: You mention the changing demands of the marketplace. How are they changing in ways that affect engineering education?

KOHRS: Industry's expectations of engineers are changing, both in terms of the type of work they do, and in the way they do it. To succeed today, engineers have to bring a systems approach to problem solving. The type of engineer Ford looks for is one who can work effectively as a team member in a workplace that is increasingly multicultural, multiethnic and multidisciplinary. We want focused individuals who can adapt to changing conditions quickly and efficiently; who can see emerging opportunities and marshal the resources necessary to capitalize on them.

There will always be a need for engineers who choose to specialize in a particular aspect of mechanical engineering. They are the individuals who break through barriers with innovative developments. However, as technology, new tools and new interfaces rapidly change, even specialists must continue to broaden their perspective. Those who constantly add to their knowledge base, who combine current technical know-how with management skill, will always succeed in academics or industry.

Instilling this understanding in students and finding ways to incorporate this knowledge into course material is the challenge educators face. Industry desperately needs departments such as MEAM to succeed in its efforts. By partnering with them in various ways, companies such as Ford are attempting to contribute to their success, and our own.

Automotive Research Center

Joint venture taps combined research might of universities, private industry, and U.S. Government

In the fall of 1994, the U.S. Army Tank Automotive Command (TACOM) awarded MEAM a three-year, $7.5 million research grant to establish an Automotive Research Center (ARC) at the U-M. The university responded with an additional $800,000 commitment to the landmark undertaking which brings together five universities, many of the premier firms in the civilian and military ground vehicle industry, and the federal government.

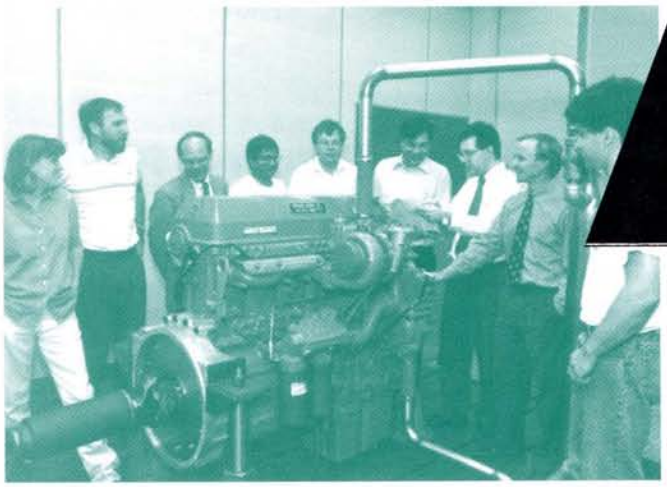
The overall goal of the center is to develop research-level computer simulations and mathematical tools that can be used to design vehicles ranging from tanks and heavy trucks to automobiles. The center also is developing human-machine interaction models for use in operator training and to provide new insights into how a driver reacts to a vehicle's performance. Center researchers project that the sophisticated simulations and models now being developed will make it possible for manufacturers to reduce costs and design cycle time, and even eliminate the need for hardware prototypes.

While many first year operations focused on pre-production activities—assembling project teams, defining analytical models, recruiting industry partners, and establishing production timelines—the center still managed to initiate over 30 individual projects directly related to ground vehicle design, development and manufacturing. Among the projects already up and running is a world-class engine test cell with adjacent control rooms capable of steady state and transient performance and emissions analysis of a 14-liter, 400 hp diesel engine.

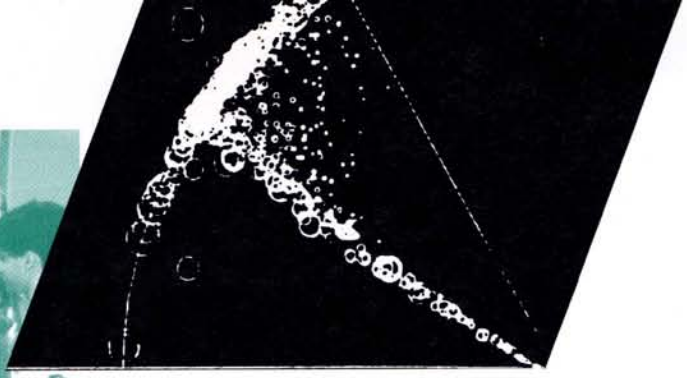
As part of its first year activities, the ARC, which is housed in the Walter E. Lay Automotive Laboratory, hosted a steady flow of visitors from U.S. industry. Several of these visits resulted in immediate research projects, including a few (e.g., spark ignition and gasoline fuel additive studies) that are complementary to the existing ARC projects. Many other projects are in various stages of negotiation.

Technology developed in the center is transferred to both the military and the private sector. To facilitate this, every research project team includes university faculty and students, industry and TACOM representatives. Similarly, ARC by-laws are designed to encourage technology transfer, including: (1) a non-exclusive, royalty-free license for internal use only; (2) a royalty-bearing license for purposes of commercialization; (3) options for the establishment of start-up companies; (4) consideration of equity in lieu of royalties; and (5) other options as appropriate.

The interior of Vehicle Hardware/Human Interface Simulator. Driving simulator research is being conducted at the University of Iowa.



This Detroit Diesel heavy equipment engine is part of the ARC combustion studies laboratory.



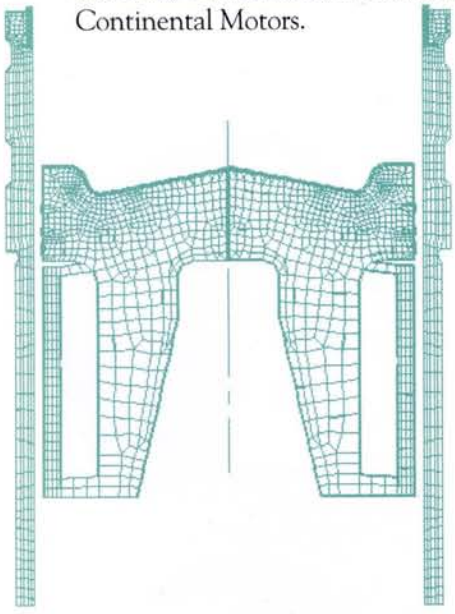
Fuel spray trajectory and dropsize visualization based on assumed dropsize and spray angle.

ARC research efforts fall into four broad categories: Vehicle Hardware/Human Interface Simulation (Leader: Edward Haug, University of Iowa); Modeling and Simulation of Vehicle Structures (Leader: Christophe Pierre, MEAM); Advanced Propulsion Simulation (Leader: Naeim Henein, Wayne State University); and System Integration: Issues and Design (Leader: Greg Hulbert, MEAM).

MEAM Chair, Panos Papalambros, is director of the ARC. Professor Dionissios (Dennis) Assanis served as the center's acting director during Papalambros' 1995 Fall term Sabbatical.

Any U.S. company that manufactures ground vehicles or related components, materials, or software is eligible for ARC membership. There is no membership fee for industrial participants. The sole cost of participation is an agreement to make in-kind contributions of manpower, equipment, software, or services to center projects in which participants are involved or interested. In addition to receiving preferential access to center intellectual property, ARC industry members have direct input into the content and direction of the research program.

MEAM's academic associates include Howard University, the University of Iowa, Wayne State University, and the University of Wisconsin-Madison. The center also is working with many of the world's most prominent land vehicle development companies, among them: AM General Corp., Allied Signal, Applied Dynamics, Argonne National Laboratory, CADSI, Caterpillar, Chrysler Corp., Cummins Engine Co., Detroit Diesel, FMC (United Defense L.P.), Ford Motor Co., General Dynamics, General Motors Corp., Johnson Controls, Martin Marietta, Masco Tech, Mechanical Dynamics, TRW and Teledyne Continental Motors.



A finite element mesh of a Diesel engine piston and cylinder liner generated for heat transfer studies.

MEAM faculty
attached to ARC activities:

Panos Papalambros, Professor and Director
Dennis Assanis, Professor
Arvind Atreya, Associate Professor
James Barber, Professor
Claus Borgnakke, Associate Professor
David Dowling, Assistant Professor
Gregory Hulbert, Associate Professor
Noboru Kikuchi, Professor
Donald Patterson, Professor Emeritus
Huei Peng, Assistant Professor
Noel Perkins, Associate Professor
Christophe Pierre, Associate Professor
Jeffrey Stein, Associate Professor
Galip Ulsoy, Professor

Faculty from the Departments of Electrical Engineering and Computer Science, and Aerospace Engineering also participate.

MEAM Launches Master's Degree Program in Automotive Engineering

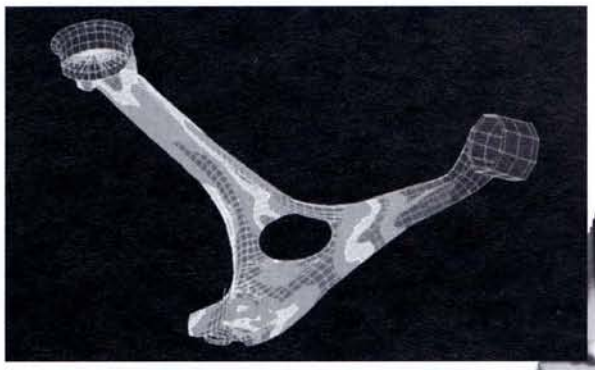
Course content focuses on meeting industry's demand for a new breed of manager/engineer

To be a leader in today's highly competitive automotive industry, top engineering professionals must have command of their own engineering specialty, and be knowledgeable about a wide range of other engineering disciplines as well. They also must be able to lead teams, think strategically, and manage finite human and financial resources while producing optimal outcomes.

In the fall of 1995, MEAM launched a new advanced degree program—a Master of Engineering in Automotive Engineering (MEngAE)—which will produce just such leaders. In September of its inaugural year, ten students had enrolled in the program. MEngAE Program Director, Dennis Assanis, projects an enrollment of 30 students by Fall 1996; and possibly 60–100 or more students within two years, as word of this innovative program spreads to U.S. and overseas automotive companies.

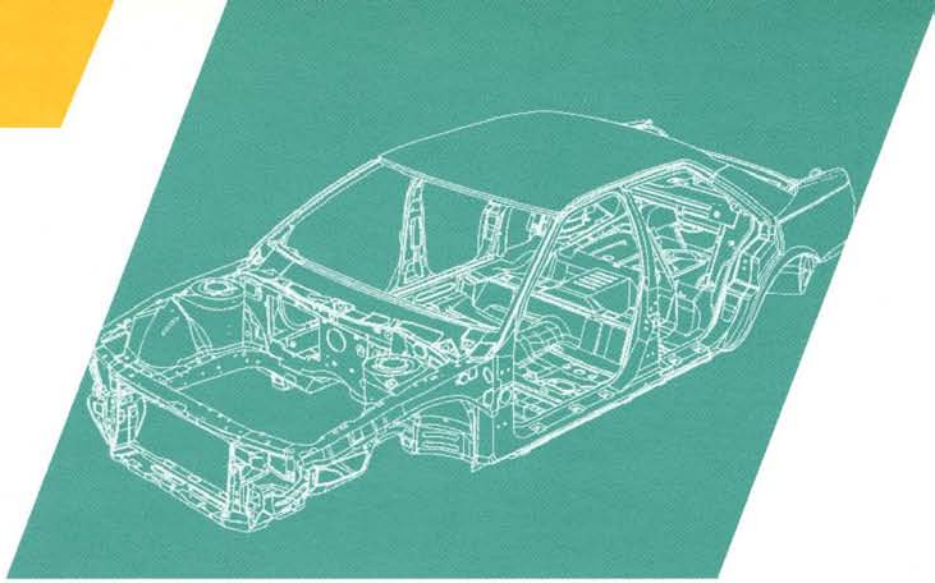
The MEngAE program focuses on contemporary engineering practice, balancing technical aspects with a strong emphasis on executive skill development. The program also has been structured to accommodate the needs of working engineers who want to acquire graduate-level experience and credentials, but cannot be away from work full time.

According to Assanis, the MEngAE program is a direct outgrowth of the department's close working relationship with its corporate partners in the automotive industry. This is reflected in the program's objectives, which are to: (1) strengthen technical competence and depth by teaching advanced skills in automotive engineering; (2) broaden personal technical horizons through exposure to a wide spectrum of interdisciplinary engineering activities; (3) enhance understanding of management and human-factor issues related to the design and marketing of automotive systems; and (4) provide practical experience in team building, interdisciplinary team membership, and team project management.



Finite element model of a lower control arm in an automotive front suspension.

Passenger car gasoline engine on the laboratory test stand instrumented for combustion and emissions studies.



To earn their MEngAE, students must complete 30 credit hours in the following categories:

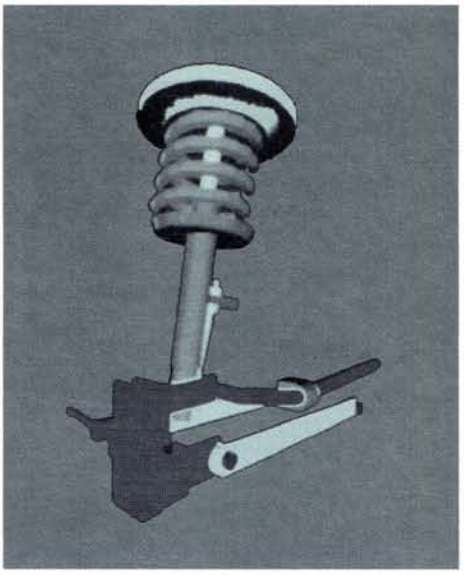
- *Engineering Core (9 credits, graded).* One course taken from *three* of the four following areas: power and propulsion, dynamics and controls, aerodynamics and structural dynamics, electronics.

- *Systems Engineering (6 credits, graded).* Two, student-choice courses selected from any engineering discipline, such as: design and manufacturing, materials science engineering, quality engineering, intelligent transport systems, etc.

- *Management and Human Factors (9 credits, graded).* Three courses selected from among the management and human factors curricula offered by MEAM, the Department of Industrial Operations Engineering, or the U-M Business School. Course selections may include business and management, ergonomics and human factors, law and professional ethics, operations research, or other electives.

- *Automotive Engineering Seminar and Project (6 credits, pass/fail).* An interrelated series of seminars spanning a broad spectrum of automotive engineering activities. The course culminates with a project requiring students to synthesize their knowledge and then apply it to solve an industrially relevant problem.

MEngAE admission requirements include: a bachelor's degree in engineering with course work related to automotive engineering, and the equivalent of two years of full-time work experience in automotive engineering.



This finite element analysis of a piston/cylinder wall interface was used to evaluate the effect of ceramic insulation on component thermal loads.

A Multi-body dynamics (MBD) model of a quarter-suspension system.

Professional Service

James A. Ashton-Miller: Board of Editors, *J. Orthopaedic Research*; *European J. Musculoskeletal Research*; *Clinical Biomechanics*.

James R. Barber: Editorial Board, *J. Thermal Stresses*.

Diann E. Brei: Session Chair, *SPIE 1995 North American Congress on Smart Materials and Structures*, San Diego; *International Mech. Engr. Congress and Exposition*, San Francisco, 1995; *ASME Symposium on Adaptive Structures and Material Systems*, San Francisco; MEAM Curriculum Review Committee.

David E. Cole: Advanced Powerplant Committee, SAE; Awards and Recognition Committee, SAE; Standards Board, SAE; Advisor, US Army National Automotive Center; Board of Directors, Automotive Hall of Fame; Assistant Chair, Ann Arbor Hands-On Museum; Organizer, *U-M Automotive Management Briefing Seminars*, SAE; Organizer, *Symposium on Organizational Change in the Automotive Industry*, French Trade Commission; Board of Trustees, Hope College.

Debasish Dutta: Chair, Foreign Papers Review Committee, Design Automation Conference, ASME; Associate Editor, *J. Mechanical Design*, ASME Transactions.

William J. Endres: Co-Chair Session on Sensor Issues, *North American Manufacturing Research Conference*; Faculty Co-advisor for the *Society of Manufacturing Engineers (SME) Student Chapter*.

Rida Farouki: Associate Editor, *Computer Aided Geometric Design*; Organizing Committee, *3rd SIAM Conference on Geometric Design*, Nashville, 1995; Vice Chair, SIAM Activity Group on Geometric Design.

S. Jack Hu: Co-organizer, *Second Annual "Body-in-White and Stamping" Conference*, Warren, Michigan, 1995; Organizer, *IMECE Symposium "Dimensional Measurement and Control in Sheet Metal Forming and Assembly,"* San Francisco, 1995.

Gregory M. Hulbert: Secretary, Computer Technology Committee, Pressure Vessels and Piping Div., ASME; Secretary, Committee on Computing in Applied Mechanics (CONCAM), ASME; Junior Awards Committee, Applied Mechanics Div., ASME; Editor, *Pressure Vessels and Piping Division Newsletter*, ASME; Editorial Board, *Finite Elements in Analysis and Design*; Organizer, *Symposium "Recent Trends in Computational Mechanics,"* ASME/JSME Pressure Vessels and Piping Conference, Honolulu.

Elijah Kannatey-Asibu: Executive Committee, Progr. Chair, Manufacturing Engineering, ASME; Associate Editor, *J. Manufacturing Science and Engineering*, ASME; Fellow, American Society of Mechanical Engineers.

Massoud Kaviany: Chair, Committee on Theory and Fundamental Research, Heat Transfer Div., ASME; Editor (Guest), *Advances in Water Resources*; Co-Chair, *5th Symposium on "Multiphase Transport in Porous Media,"* ASME,1995, IMEC&E.

Kenneth C. Ludema: Organizing Committee, *Wear of Materials Conference*, Boston, 1994; Editor, North American Region, *J. Wear*.

Jun Ni: Curriculum Committee, Focus: HOPE; Board of Directors, (representing U-M,) Machine Tool—Agile Manufacturing Research Inst.; Proposal Review Committee, National Science Foundation, Division of Manufacturing Processes and Machinery; Organizing Committee Member, First S.M. Wu Symposium for Manufacturing Sciences (*US venue*) at Northwestern University, 1994; Chair, Organizing Committee, First S.M. Wu Symposium for Manufacturing Sciences (*Far East venue*,) Beijing, China, 1994; Co-organizer and session chair, First Annual Stamping and Body-in-White Conference, Troy, 1994; Co-organizer, Agile Manufacturing Research Institute Workshop on Machine Tool Technology, Ann Arbor, 1994; Associate Editor, *J. of Manufacturing Systems*.

Panos. Y. Papalambros: Editorial Boards, *J. Integrated Computer Aided Engineering*, *J. Artificial Intelligence in Design and Manufacturing*, *Int. J. Engineering Design*, *J. Global Optimization*, *J. Engineering Optimization*, *J. Japan Soc Mechanical Engineers*; Board of Directors, R & B Machine Tool Co.; Board of Directors, Fraunhofer Resource Center-Michigan.

Huei Peng: Organizer, Vehicle Control Session, American Control Conference, 1995; Organizer, Vehicle Control Session, *International Mechanical Engineering Conference and Exposition*, 1995.

Noel C. Perkins: Technical Committee, Vibration and Sound, Design Division, ASME; Chair, Election Committee, ASME; Editorial Board, *J. Vibration and Control*; International Scientific Committee, *International Symposium on Cable Dynamics*, Liege, Belgium, 1995.

Christophe Pierre: Associate Editor, ASME, *J. Vibration and Acoustics*; Advisory Board, Nonlinear Dynamics; Committee on Vibration and Sound, ASME; Structures and Dynamics Committee, International Gas Turbine Institute, ASME.

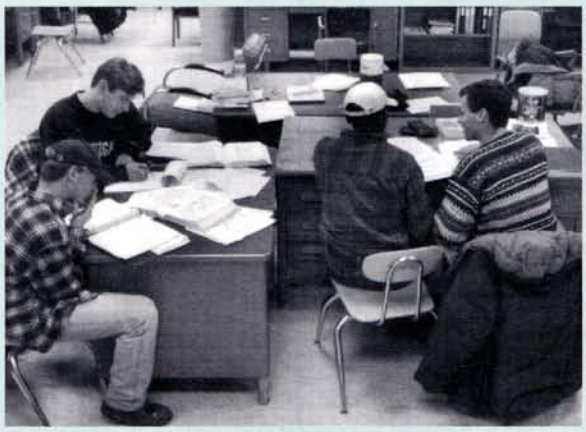
Albert B. Schultz: Editorial Advisory Board, *J. Orthopaedic Research*; Editorial Board, *J. Biomechanics*.

William W. Schultz: Fluids Committee, Applied Mechanics Div., ASME; Organizing Committee, *5th International Congress in Applied Mechanics*, Cairo, Egypt.

ΠΤΣ

(Pi Tau Sigma)

Membership in Pi Tau Sigma (ΠΤΣ), the national mechanical engineering student honor society, is restricted to those who rank in the top 25 percent of their junior class, or in the top 33 percent of their senior class. Originally an undergraduate-only organization, Michigan's Pi Rho chapter of ΠΤΣ now includes graduate students. In addition to sponsoring MEAM's annual Design Competition, ΠΤΣ participates in numerous service activities including peer counseling, tutoring, and a Big Brother/Big Sister mentorship program which pairs society members with incoming students. Each term, members prepare and serve meals for the Ann Arbor Hunger Coalition. During the winter and spring terms, the society hosts a banquet at which it presents the coveted Professor of the Term Award. Current membership: 81. Officers 1994-95: Theo Moreno/Stacey Segowski, president; Norm Peralta/Matt Mathias, vice president; Amy Donaldson/Jennifer Roush, secretary of affairs; Stacey Segowski/Mark Stock, corresponding secretary; Clay Hunt/Jason Weidman, treasurer; and 24 committee chairpersons.



SAE

(Society of Automotive Engineers)

Through a combination of educational programs, technical competitions and leadership challenges, SAE provides many opportunities for students to amass and then apply knowledge to real-life engineering problems. The focus of the College's SAE chapter extends to all forms of land, sea, and air transportation. Not only is it the world's largest student branch, but the College's SAE group is one of the best, as evidenced by its 1994–95 outstanding student branch designation: an honor conferred by the SAE International Committee. During 1995, U-M SAE student teams finished first overall in the Mini-Baja Midwest race; took another first in the Coopers & Lybrand sponsored Time-Based Manufacturing competition; and in Formula SAE competition captured top honors in the dynamics events and placed fifth overall. Also in 1995, Michigan's SAE team finished sixth in its first-ever entry in the highly competitive national hybrid electric vehicle competition. Current membership: 230. Officers 1994–95: Brian Bishop, president; Laura Sebesta, secretary; John Okasinski, treasurer.

UMME

(Underrepresented Minority Mechanical Engineers)

UMME was founded in the fall of 1995 in direct response to President James Duderstadt's call for students to create "community excellence while preserving and respecting difference." Established with the support of MEAM and the MEPO office, the goals of the organization are to: (1) ensure that minority students take full advantage of MEAM resources; (2) promote the interaction of different cultures within the College and the department; and (3) help first and second year minority students make the adjustment to college life. Among the services UMME offers its members are tutoring, peer counseling, study groups and job placement and annually sponsors a discussion forum. Current membership: 36.

Research Interests
MEAM FACULTY

	Biomechanics				Control & Measurement						Dynamics						Design				
	Structural Analysis	Biomechanical Models	Movement Analysis & Control	Prosthetics	Automated Modeling / CAE	Control Systems	Microelectromechanical Sys.	Modeling & Identification	Robotics	Sensing, Signal Processing	Structural Dynamics	Multi-body Dynamics	Nonlinear Dynamics	Vehicle Dynamics & Control	Acoustics & Vibration	Kinematics	AI & Design Methodology	CAD / CAE Geometric Mod.	Design Optimization	Innovative Systems	Tribology
Akhavan, Rayhaneh																					
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Arruda, Ellen M.																					
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Kaviany, Massoud																					
Keller, Robert B.						•	•														
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Sastry, Ann Marie																					
Schultz, Albert B.	•	•	•								◊				◊	◊					
Schultz, William W.													◊		•						•
Scott, Richard A.											•		•		•						
Smith, Gene E.																					
Sonntag, Richard E.																					
Soslowsky, Louis J.	•	•	◊													◊					
Stein, Jeffrey L.					•	•	•	•		•	•	•		•			◊			•	
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Ulsoy, A. Galip						•		•	◊		◊			•	•						
Ward, Allen C.																	•		•	•	
Wineman, Alan S.	•	•						•	•												
Yang, Wei-Hsuin																					
Yang, Wen-Jei		•						◊													

• Active in the field, conducts research, teaches courses, contributes papers, ◊ Interest in the field, small research grants, sometimes teaches courses

Research Interests
MEAM FACULTY
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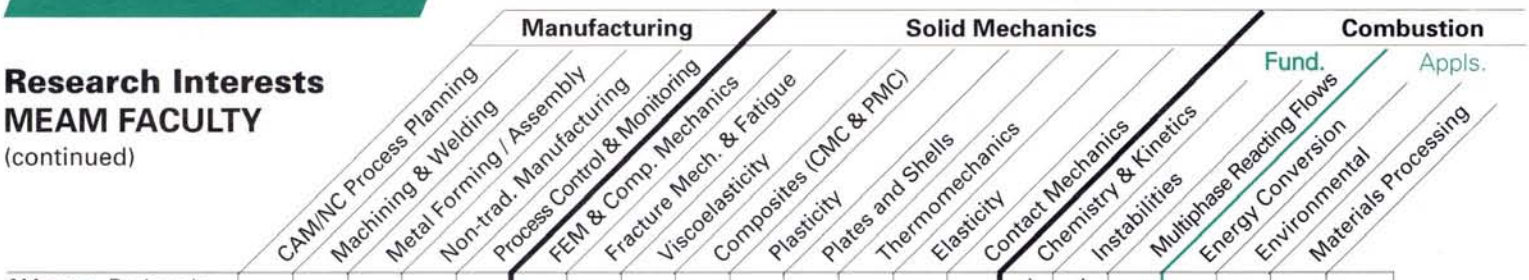

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Perkins, Noel C.						•							•	•							
Pierre, Christophe						•															
Sastry, Ann Marie				•		•	•		•	◊	◊	◊	•								
Schultz, Albert B.																					
Schultz, William W.		◊		•				•										•			
Scott, Richard A.						•															
Smith, Gene E.																		•	•		
Sonntag, Richard E.																					
Soslowsky, Louis J.								•	•				◊	◊							
Stein, Jeffrey L.					•										◊			◊			
Taylor, John E.						•			•		•		◊	◊							
Tilbury, Dawn																					
Thouless, Michael				•				•	•			•									
Tryggvason, Grétar																					
Ulsoy, A. Galip	◊	◊			•																
Ward, Allen C.																					
Wineman, Alan S.				•	•			•	•			•	•								
Yang, Wei-Hsuin		•	•			•				•											
Yang, Wen-Jei		•																			

• Active in the field, conducts research, teaches courses, contributes papers, ◊ Interest in the field, small research grants, sometimes teaches courses

Research Interests
MEAM FACULTY
(continued)

	Combust. (cont.) Appls.							Fluid Dynamics Fundamentals				Fluid Dynamics Applications				Heat Transfer Fundamentals				Heat Transfer Applications		
	Microgravity	Transportation	Complex Fluids	Multiphase	Numerical Techniques	Turbulence	Waves & Instabilities	Biomedical	Cavitation	Matls. Process. & Manf.	Transportation	Convection	Molecl. & Small Scales	Phase Chg. & Multiphase	Radiation	Energy Conversion	Environmental	Matls. Process. & Manf.	Microgravity	Transportation
Akhavan, Rayhaneh			•	•	•	•	•	◊		•		•	•				◊			
Arpaci, Vedat S.	•			•		•	•					•	•	•	•		◊		•		
Arruda, Ellen M.									•									•			
Assanis, Dennis		•		•	•	◊				•						•	•			•	
Atreya, Arvind	•	•				◊						•	◊	◊	•	•	•	◊	◊	◊	◊
Barber, James R.																					
Borgnakke, Claus		◊		◊	•	•				•		•		•		•	◊	•			
Brei, Diann E.																					
Bridges, Michael M.																					
Ceccio, Steven L.			•	•	•			•	•	•	•			•				•	•		
Chen, Michael M.			◊	•	◊					•		•	◊	•	◊			•			
Cole, David E.																					
Comninou, Maria A.																					
Debler, Walter R.			•	◊		◊	•		◊												
Dowling, David R.		◊	•			•	•			•	•										
Dutta, Debasish																					
Endres, William J.																		•			
Farouki, Rida T.																					
Felbeck, David K.																					
Goldstein, Steven A.	◊						•														
Grosh, Karl																					
Haghi, Mehrdad																					
Hollister, Scott J.																					
Holmes, John W.																					
Hu, Shixin (Jack)																					
Hulbert, Gregory M.																					
Kannatey-Asibu, Elijah																					
Karnopp, Bruce H.																					
Kaviany, Massoud										•	◊	•	◊				•		•		
Keller, Robert B.																					
Kikuchi, Noboru					•				◊	•								◊			
Koren, Yoram																					
Kota, Sridhar																					
Kuo, Arthur D.																					
Ludema, Kenneth C.																					
Mead, David			•	•	•		•			•								•			
Merte, Herman													•						•		
Ni, Jun																					
Pan,Jwo																					
Papalambros, Panos Y.																					
Peng, Huei																					
Perkins, Noel C.																					
Pierre, Christophe																					
Sastry, Ann Marie					◊					•								•			
Schultz, Albert B.																					
Schultz, William W.			•	•	•		•	◊		•		◊		•				•			
Scott, Richard A.																					
Smith, Gene E.		•			◊											•				•	
Sonntag, Richard E.												◊	◊			•	•			◊	
Soslowsky, Louis J.																					
Stein, Jeffrey L.																					
Taylor, John E.																					
Tilbury, Dawn																					
Thouless, Michael																					
Tryggvason, Grétar			•	•	•		•		•	•	•			•			•	•	•		
Ulsoy, A. Galip																					
Ward, Allen C.																					
Wineman, Alan S.			•	•					•												
Yang, Wei-Hsuin																					
Yang, Wen-Jei				•	•	◊		•	◊	•		•	◊	•	•	•	◊	•	•	•	

• Active in the field, conducts research, teaches courses, contributes papers, ◊ Interest in the field, small research grants, sometimes teaches courses

Research Interests
RESEARCH SCIENTISTS

	Biomechanics									Control & Measurement					Dynamics					Design				
	Structural Analysis	Biomechanical Models	Movement Analysis & Control	Prosthetics	Automated Modeling / CAE	Control Systems	Electromechanical Sys.	Modeling & Identification	Robotics	Sensing, Signal Processing	Structural Dynamics	Nonlinear Dynamics	Vehicle Dynamics & Control	Acoustics & Vibration	Kinematics	AI & Design Methodology	CAD / CAE Geometric Mod.	Microelectromech. Sys.	Design Optimization	Innovative Systems
Ashton-Miller, James	•	•	•			◊		◊			◊				◊									
Borenstein, Johann							•		•	•			◊											
Ervin, Robert D.					◊	•	•	•		•			•								•			
Geister, Donald E.																•	•							
Ma, Zheng-Dong					◊			•	•		•	◊	•	•		◊				•				
Selamet, Ahmet																								
Shi, Jianjun						•		•		•														
Wu, Xin																								
Yuan, Jingxia							◊																	

	Manufacturing										Solid Mechanics						Combustion					
																	Fund.			Appls.		
	Automotive Assembly	Statistical Process Control	CAM/NC Process Planning	Machining & Welding	Metal Forming	Non-trad. Manufacturing	Process Control & Monitoring	FEM & Comp. Mechanics	Fatigue	Fracture Mechanics	Non-trad. Materials	Plasticity	Elasticity	Contact Mechanics	Chemistry & Kinetics	Instabilities	Multiphase Reacting Flows	Energy Conversion	Environmental	Materials Processing		
Ashton-Miller, James																						
Borenstein, Johann																						
Ervin, Robert D.																						
Geister, Donald E.			•																			
Ma, Zheng-Dong							◊					•	◊									
Selamet, Ahmet														•	◊	◊	•	•				
Shi, Jianjun	◊			◊	•		•															
Wu, Xin				•	•	•			•		•											
Yuan, Jingxia				•			•															

	Combustion (cont.)							Fluid Dynamics									Heat Transfer					
	Appls.							Fundamentals					Applications				Fundamentals				Applications	
	Microgravity	Transportation	Complex Fluids	Multiphase	Numerical Techn.	Turbulence	Waves & Instabilities	Biomedical	Cavitation	Matls. Process. & Manf.	Transportation	Convection	Molecl. & Small Scales	Phase Chg. & Multiphase	Radiation	Energy Conversion	Environmental	Matls. Process. & Manf.	Microgravity	Transportation		
Ashton-Miller, James																						
Borenstein, Johann																						
Ervin, Robert D.		•																				
Geister, Donald E.																						
Ma, Zheng-Dong																						
Selamet, Ahmet		•			•	◊	•	◊			•	◊	◊		•	•					•	
Shi, Jianjun																						
Wu, Xin																						
Yuan, Jingxia																						

• Active in the field, conducts research, teaches courses, contributes papers
◊ Interest in the field, small research grants, sometimes teaches courses

MEAM Student News

Student Societies

Christina Avila	President, Society of Minority Engineering Students
Jennifer Cook	President, Tau Beta Pi
Andre Dsouza	President, Volunteer Computing Corps
Arun D'souza	President, American Society of Mechanical Engineers
Stephanie Halloran	President, Epeians
Suzanne Sarafa	President, Senior Class Officers
Stacey Segowski	President, Pi Tau Sigma
Lauren Somershoe	President, Society of Automotive Engineers
Amber Thweitt	President, Students for the Exploration and Development of Space

Student Awards

Honors Committee
Christina DeGnore

Distinguished Achievement—Undergraduate
David Miller

Distinguished Achievement—Graduate
Heidi Morano
Laila Guessous

Outstanding Student Leaders—Undergraduate
Mark Ardayfio
Kyle Chenet
Stephanie Fisher
Stephanie Halloran
James Samra

Tau Beta Pi Award
Jennifer Cook

Mildred and Steele Bailey Prize
Jennifer Cook

J.A. Bursley Prize
Clay Hunt

Cooley Writing Prize
Karl Iagnemma
Sarah Middleton

Roger M. Jones Poetry Prize
Sarah Middleton

George M. Landes Prize
David Goodman

Marian Sarah Parker Prize
Mira Sahney

Henry Ford II Prize
Nataliya Pukhlik

Student Scholarships–Undergraduate

Amoco
Norman Peralta
Theo Moreno

Babcock-Wilcox
Patrick Fahey
David Miller

John Deere Foundation
Nataliya Pukhlik

Student Fellowships–Graduate

AT&T
Daniel Apley

Benton
Craig Scholar

Robert M. Caddell Memorial
Adrian Adamson

Robert Vlasic
Michael Sanko

Rollin Gerstacker
Thomas Bress

Lucile B. Conger
Hwei Che

DeVlieg
Nicole Breniser
Andrew Filip
Mark Wu

GEM (Graduate Degrees for Minorities in Engineering and Science)
Charles Hoffler
Ron Johnson
Jaime Pagan
Timothy Sanabria
Morris White
James Wooten

NSF
Laila Guessous
Paris VonLockette

NSF Traineeship
Adrian Adamson
Andrew Filip
Larry Kuang
Tamar Liebermann
Elizabeth Smith
Mark Wu

Rackham Merit
Fautimah Amin
Eric Brown
Nigel Hyatt
Christopher Orr
Michael Sullivan

Rackham Pre-Doctoral
Nallan Suresh
Timothy VanDyke

U-M Regents
Andrew Moskalik

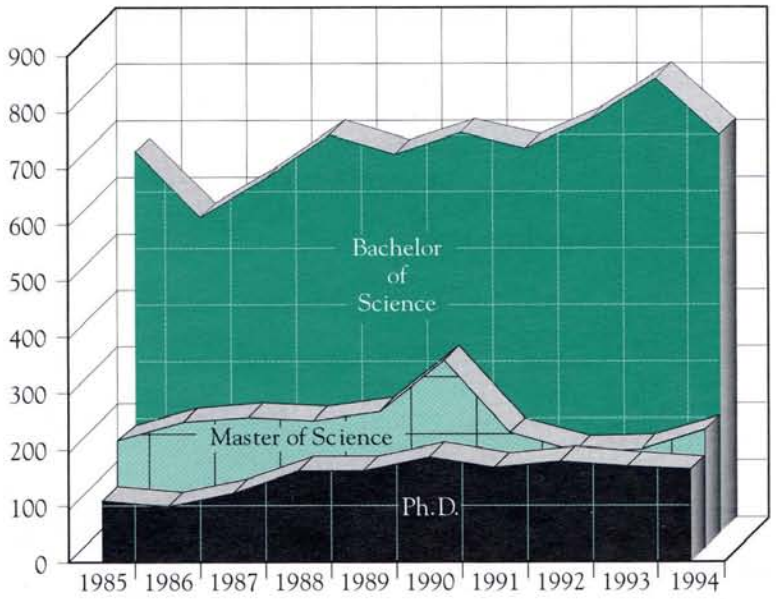
Whirlpool
Jason Schmidt

Whitaker
Laura Wojcik

Enrollment and Degrees Granted

Enrollment, Fall 1994
- Doctor of Philosophy 162
- Master of Science in Engineering. . . 202
- Bachelor of Science 701
- Total 1065

Degrees Awarded 1994
- Doctor of Philosophy 31
- Master of Science in Engineering. . . . 75
- Bachelor of Science 275
- Total 381



Doctoral Degrees Conferred

Fall, 1994

G.K. Ananthasuresh A New Design Paradigm for Micro-Electro-Mechanical Systems & Investigations on the Compliant Mechanism Synthesis—Chair: S. Kota

David Bell Modeling Human Behavior for Adaptation in Human-Machine Systems
Co-Chairs: Y. Koren & P. Levine

Shean-Juinn Chiou Conceptual Design of Mechanisms Using Kinematic Building Blocks—A Computational Approach
Chair: S. Kota

Kyu-Jung Kim Biomechanical Analysis of Female Stress Urinary Incontinence
Co-Chairs: A. Schultz & J. Ashton-Miller

Cheng-Tang Lee On the Nonlinear Dynamics of Centrigugal Pendulum Vibration Absorbers—Chair: S. Shaw

Rong-Shine Lin Real-Time Surface Interpolators for Multi-Axis CNC Machine Tools—Chair: Y. Koren

Norberto Mangiavacchi Dynamics of a Turbulent Jet Interacting with a Free Surface—Chair: R. Akhavan

Hsien-Chung Meng Wear modeling: Evaluation and Categorization of Wear Models—Chair: K. Ludema

Lakshmi Srinivas Cyclides in Engineering Design: Algorithmic and Computational Aspects—Chair: D. Dutta

Irfan Ullah Optimal Synthesis of Adjustable Mechanisms for Generating Multiple Continuous Paths
Chair: S. Kota

Winter 1995

Herchang Ay Heat Transfer and Life of Cutting Tool in Turning—Chair: W.J. Yang

Asghar Esmaeeli-Koos Numerical Simulations of Bubbly Flows—Chair: G. Tryggvason

Shenhou Liu Variation Simulation for Deformable Sheet Metal Assembly—Co-Chairs: S. Hu & T. Woo

Yu-Ning Liu Thermal Analysis of Multiple-Beam Laser Welding—Chair: E. Kannatey-Asibu

Ata Mugan Non-Reflecting Boundary Conditions for Finite Element Methods Based Upon Off Surface Boundry Integral Equations—Chair: G. Hulbert

Gregory Ohl Dynamic Analyses of Methanol to Hydrogen Steam Reformer for Transportation Applications
Co-Chairs: J. Stein & G. Smith

Youn K. Park Extensions of Optimal Layout Design Using the Homogenization Method—Chair: N. Kikuchi

Gai-Wai Yang Micro and Macro Phenomena in Nucleate Pool Boiling on Grapite-Copper Composite Materials—Chair: W.J. Yang

Summer 1995

Matthew J. Brusstar Relative Effects of Flow and Orientation on the Critical Heat Flux in Subcooled Forced Convection Boiling—Chair: H. Merte

Matthew P. Castanier Dynamic Analysis and Modeling of Multi-Coupled Nearly Periodic Structures—Chair: C. Pierre

Chenggang Che Multi-Axis, Structured-Light, Three-Dimensional Laser Scanning System: Modeling, Calibration, and Measurement Uncertainty Assessment—Co-Chairs: J. Ni & E. Kannatey-Asibu

Zhejun Fan Modeling and Control of Autonomous Tracked Vehicles—Co-Chairs: Y. Koren & D. Wehe

Robert E. Guldberg Mechanical Adaptation of Trabecular Bone Formation *in vivo*
Co-Chairs: S. Goldstein & S. Hollister

Neiyuan Hai Machine Tool Accuracy Enhancement by Inverse Kinematic Analysis and Real Time Error Compensation—Co-Chairs: S. Wu & J. Ni

Summer, 1995 (cont.)

Hisashi Heguri	Modeling and Numerical Analysis of Geometrically Nonlinear Composites with Incompressibility Constraint—Chair: N. Kikuchi
Geesern Hsu	Stochastic Modeling and Identification of Lubricated Polymer Friction Dynamics Co-Chairs: K. Ludema & A. Yagle
Jaehong Kim	Turbulence Effects on the Early Flame Development of Propane-Air Mixtures—Chair: V. Arpaci
Chiu-Feng Lin	Lane Sensing and Path Prediction for Preventing Vehicle Road-Departure Accidents Chair: A.G. Ulsoy
Je-Hong Min	Dilatation Enhanced Stress Relaxation Effects in the Nonlinear Viscoelastic Solid Polymeric Structures—Chair: A. Wineman
Faical Tounsi	Numerical Simulations of the Interactions of Vortices and Drops with a Density Interface—Chair: G. Tryggvason
Timothy J. VanDyke	Weekly Nonlinear Oscillations Superimposed on Finite Circumferential Shear of a Compressible, Nonlinearly Elastic, Isotropic Material—Chair: A. Wineman

Faculty and Staff Honors

Sandra K. Ackerman	Award of Merit, SE Michigan Chapter, Society for Technical Communication for ***Mechanica.***
James A. Ashton-Miller	University of Michigan, College of Engineering, Outstanding Research Scientist Award, 1994.
Diann E. Brei	Pi Tau Sigma, Professor of the Term, MEAM, Winter 1995.
Rodney L. Hill	Best of Show & Distinguished Technical Communication Award, SE Michigan Chapter, Society for Technical Communication for ***125 Years of Mechanical Engineering at theUniversity of Michigan, 1992/93 Annual Report.***
Margaret L. Hostetler	Award of Merit, SE Michigan Chapter, Society for Technical Communication for ***Mechanica,*** Best of Show & Distinguished Technical Communication Award, SE Michigan Chapter, Society for Technical Communication for ***125 Years of Mechanical Engineering at the University of Michigan, 1992/93 Annual Report.***
Kenneth C. Ludema	Mayo D. Hersey Award of ASME, ASME/STLE Tribology Conference, Orlando, FL, 1995, the highest national award for contributions to the advancement of lubrication science and engineering.
Albert B. Schultz	1994 Distinguished Faculty Achievement Award, U-M; 1995 Distinguished Lecturer in Biomechanical Engineering, Stanford University, California.
Dawn Tilbury	Undergraduate Computational Science Education Award from the Undergraduate Computational Engineering and Science Project of Ames Laboratory, Ames, Iowa, recognized for her paper, "An Introduction to Using Matlab for Control System Design."
A. Galip Ulsoy	Invited Lecturer, Southwest Mechanics Lecture Series, 1995; Best Presentation Award (with Tom Pilutti), 1995 American Control Conference, Seattle.
Wen-Jei Yang	Keynote Lecturer, 7th International Conference on Computational Methods and Experimental Measurements, Capri, Italy, 1995; Plenary Lecturer, 6th Asian Congress of Fluid Mechanics, Singapore, 1995; Honorary Invited Member, Heat Transfer Society of Japan, 1995.

Departmental Awards

Excellence in Teaching

Ellen M. Arruda, for her work in launching the new course ME 396.

Mehrdad Haghi, for his work in launching the new course ME 396.

Sridhar Kota, for making ME450 one of the CoE's showcase educational activities.

Allen C. Ward, for making ME450 one of the CoE's showcase educational activities.

Excellence in Research Award

Kenneth C. Ludema, for his international recognition as a leading authority in tribology.

Jun Ni, for his national recognition as a leading young researcher, exemplified by his selection as Presidential Faculty Fellow, the only one at U-M.

Excellence in Service Award

James R. Barber, for his continuing efforts to strengthen the position and quality of our graduate program.

Christophe Pierre, for the highly successful faculty recruiment effort he conducted as Chair of the Faculty Search Committee.

Staff Excellence Award

Pat Ferullo, for outstanding service to the department.

Rosalind Harden, for outstanding service to the department.

Marcy Nautsch, for outstanding service to the department.

Fun, Competition, Learning and Leadership:

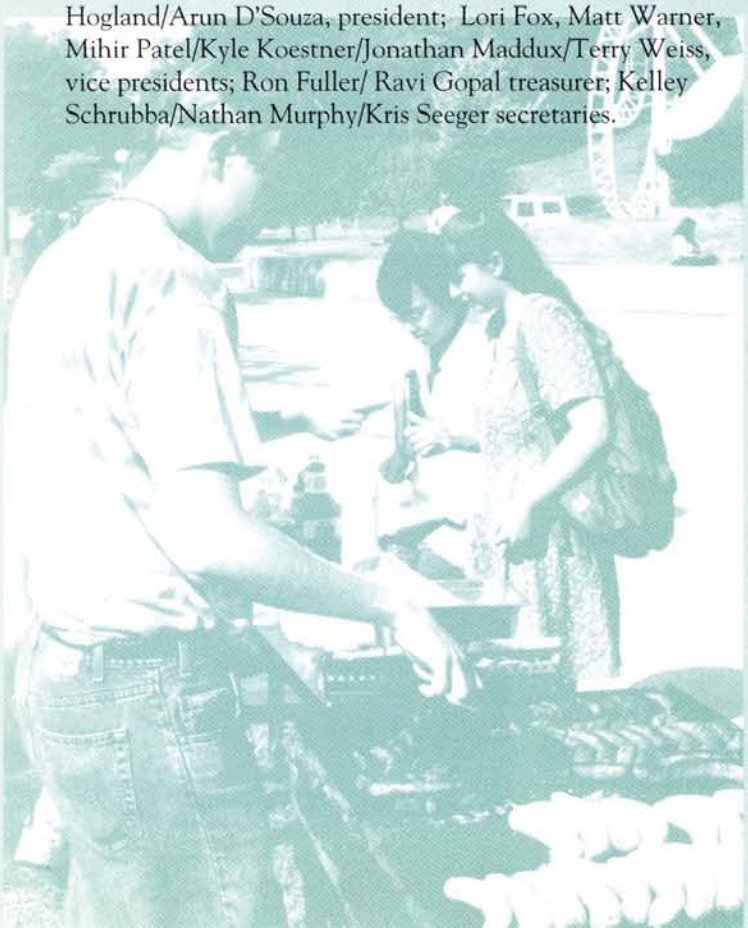
Student Societies in MEAM

Although they vary in size and scope, student societies play an important role in the department's overall educational process. In fact, many students are active in more than one. Most of the student societies provide opportunities for personal and professional growth through a variety of leadership and team-focused activities. All offer at least some degree of social outlet from the intense, career-focused learning experiences that define a MEAM student's life.

ASME

(American Society of Mechanical Engineers)

The expressed purpose of ASME is to advance and disseminate the theory and practice of mechanical engineering and related fields. As part of its educational function, the society coordinates student attendance at various regional and international ASME conferences, competitions and other activities. It also hosts weekly luncheon meetings featuring a range of speakers from industry and academia. These meetings are open to faculty and staff, as well as ASME members and non-members alike. ASME groups have participated in Habitat for Humanity projects, and the ASME-sponsored Slide Rule Ball is a highlight of the department's annual social calendar. Current membership: ~150. Officers 1994-95: Derek Hogland/Arun D'Souza, president; Lori Fox, Matt Warner, Mihir Patel/Kyle Koestner/Jonathan Maddux/Terry Weiss, vice presidents; Ron Fuller/ Ravi Gopal treasurer; Kelley Schrubba/Nathan Murphy/Kris Seeger secretaries.



GRIME

(Graduates in Mechanical Engineering)

As a counterpoint to the highly-focused cerebral activity of graduate studies, GRIME exists largely for fun. Since its founding in 1994, the association's events have grown to include graduate student orientation, bi-weekly happy hours, and such intramural sports as broomball and softball. GRIME also hosts group expeditions to Cedar Point, bowling forays, and an annual trip to the North American International Auto Show. The group has a serious side as well. Extending beyond its original commitment to helping graduate students prepare for their qualifying exams, GRIME has recently taken a leadership role in reshaping the qualifying process. GRIME also disseminates information to all graduate members, sponsors a support group for MEAM women, and its members volunteer for various *Focus: HOPE* activities. Current membership: ~400.

MESLB

(Mechanical Engineering Student Leader Board)

This new board is comprised of the presidents of the five officially sanctioned student societies (ASME, GRIME, Pi Tau Sigma, SAE and UMME), three at-large members who are active in student activities, the administrative associate, and one or more faculty members. As a consensus-forming body, the board exists to improve the educational experience of all MEAM students; to facilitate better communications between MEAM students, faculty and administration; and to foster a greater sense of community and cooperation among various student groups. First year efforts have centered on building closer student/faculty relations, and on resolving a variety of curriculum issues.

Professional Service (continued)

Louis J. Soslowsky: Solid Mechanics Committee, Bioengineering Division, ASME; Review Committee, Student Paper Competition, Bioengineering Div., *ASME International Mechanical Engineering Congress and Exposition*; Review Committee, Orthopaedic Research and Education Foundation; Organizer, *Upper Extremity Mechanics Mini-Symposium, International Mechanical Engineering Congress and Exposition* (ASME/WAM), San Francisco; Calendar of Events Coordinator, *J. Biomechanical Engineering*, ASME; Invited Participant, 4th China-Japan-U.S.-Singapore Conference on Biomechanics.

Jeffrey L. Stein: Executive Committee-Secretary of the Division, Dynamic Systems and Control Div., ASME.

Michael Thouless: Associate Editor, *J. American Ceramic Society*.

A. Galip Ulsoy: Executive Committee, Dynamic Systems and Control Div., ASME; Honors Committee, Dynamic Systems and Control, Div., ASME; Editorial Board, *Mechanical Systems and Signal Processing*; Program Committee, *CIRP Seminar on Manufacturing Systems*, Ann Arbor, 1995; Program Chair, *American Control Conference*, Seattle, 1995; Organizing Committee, *International Conference, Recent Advances in Mechatronics*, Istanbul, Turkey, 1995; Executive Committee, Board of Directors, 2mm Program, Inc., National Institute of Standards and Technology, Advanced Technology Program; Steering Committee, Greenfield Coalition for New Manufacturing Education; External Proposal Review Committee, Manufacturing Research Center, Georgia Institute of Technology, 1995.

Allen C. Ward: Chair, Review Committee, *Design Theory and Methodology '95*, ASME; Board of Directors, Army Sciences and Technology, National Research Council.

Alan S. Wineman: Editorial Boards, *J. Mathematics and Mechanics of Solids, J. Stability and Applied Analysis of Continuous Media, Canadian Society of Mechanical Engineers Transactions*; Organizing Committee, *Institute for Mechanics and Materials Workshop on "Non Linear, Time-Dependent Constitution of Engineering Polymers,"* La Jolla, 1995

Wen-Jei Yang: K-10, K-17 Committees, Heat Transfer Div., ASME; Editor-in-Chief, *J. Flow Visualization and Image Processing*; Editor-in-Chief, *International J. of Rotating Machinery*; Chair, *5th International Symposium on Transport Phenomena and Dynamics of Rotating Machinery*, Kaanapali, Hawaii, 1994; Chair, *Symposium on Flow Visualization and Image Processing of Multiphase Systems*, Joint ASME/JSME Fluids Engineering Conference, on Laser Anemometry, Hilton Head, South Carolina, 1995.

Promotions

James A. Ashton-Miller	Associate Research Scientist to Research Scientist
Johann Borenstein	Assistant Research Scientist to Associate Research Scientist
Debasish Dutta	Assistant Professor to Associate Professor with tenure
Gregory M. Hulbert	Assistant Professor to Associate Professor with tenure
Ahmet Selamet	Assistant Research Scientist to Associate Research Scientist

Departures

Walter R. Debler, professor emeritus, retired in May of 1995. Professor **Robert B. Keller** began his retirement furlough December 31, 1995. **Giles Brereton** and **Robert Fijan**, both assistant professors, have left the Department. Brereton is currently at Michigan State University, and Fijan is now in private business.

In Memorial

Robert C. Juvinall, professor emeritus, died April 13, 1995, in Sarasota, Florida. Juvinall, who served on the faculty from 1957 to 1984, published two textbooks, *Engineering Considerations of Stress and Strength* and *Fundamentals of Machine Component Design*. He was 78.

Donna Pineau, administrative assistant, died July 11, 1995, at the age of 35. Donna joined the MEAM staff of the S.M. Wu Manufacturing Center in January, 1991. She is survived by her husband and two young children.

Faculty Publications 1994

Biomechanics
Contributing Faculty: James Ashton-Miller, Steven Goldstein, Scott Hollister, Noboru Kikuchi, Arthur Kuo, Albert Schultz, Lou Soslowsky, Wen-Jei Yang.

Journal Articles

Ateshian, G.A., Kwak, S.D., Soslowsky, L.J., Mow, V.C., "A Stereophotogrammetric Method for Determining *in situ* Contact Areas in Diarthrodial Joints, and a Comparison with Other Methods," *J. Biomechanics*, 27, 111–124, 1994.

Borodkin, J. L., Eadie, J.S., Choi, K., Hollister, S.J., Goldstein, S.A., "The Effect of Mechanical Stimuli on Bone Ingrowth into Porous Coated Implants," *Trans. Orthop. Res. Soc.*, 19, 2, 582, 1994.

Bylski-Austrow, D.I., Ciarelli, M.J., Kayner, D.C., Matthews, L.S., Goldstein, S.A., "Displacement of the Menisci Under Joint Load: An *in vitro* Study in Human Knees," *J. Biomechanics* 27, 4, 421–431, 1994.

Chen, H.C., Ashton-Miller, J.A., Alexander, N.B., Schultz, A.B., "Effects of Age and Available Response Time on Ability to Step Over an Obstacle," *J. Gerontol: Med. Sci., 49*, M227–M233, 1994.

Derwin, K.A., Soslowsky, L.J., Green, W.D.K., Elder, S.H., "A New Optical System for the Determination of Deformations and Strains: Calibration Characteristics and Experimental Results," *J. Biomechanics*, 27, 1277–1285, 1994.

Flatow, E.L., Ateshian, G.A., Soslowsky, L.J., Pawluk, R.J., Grelsamer, R.P., Mow, V.C., Bigliani, L.U., "Computer Simulation of Glenohumeral and Patellofemoral Subluxation: Estimating Pathological Articular Contact," *Clinical Orthopaedics and Related Research*, 306, 28–33, 1994.

Flatow, E.L., Soslowsky, L.J., Ticker, J.B., Hepler, M.D., Ark, J.W., Pawluk, R.J., Bigliani, L.U., Mow, V.C., "Excursion of the Rotator Cuff Under the Acromion: Patterns of Subacromial Contact," *American J. of Sports Medicine*, 22, 779–788, 1994.

Frankenburg, E.P., Goldstein, S.A., Harris, S.A., Toomajian, L.R., Pellizzon, G.G., Bakker, D.A., Bauer, T.W., "Evaluation of an *in situ*-Setting Calcium Phosphate Grout in an *in vivo* Canine Metaphyseal Defect Model," *Trans. Orthop. Res. Soc.*, 19, 1, 157, 1994.

Frankenburg, E.P., Goldstein, S.A., Harris, S.A., Toomajian, L.R., Pellizzon, G.G., Rouleau, J.P., "The Effects of Zeolite-A on Fracture Healing in a Rat Femoral Fracture Model," *Trans. Orthop. Res. Soc.*, 19, 2, 513, 1994.

Gilsing, M., VanDenBosch, C., Lee, S.C., Ashton-Miller, J.A., Alexander, N.B., Schultz, A.B., "Effects of Age on the Reliability of Detecting Ankle Inversion and Eversion," *Age & Aging , 24*, 58–66, 1994.

Glüer, C-C., Wu, C.Y., Jergas, M., Goldstein, S.A., Genant, H.K., "Three Quantitiative Ultrasound Parameters Reflect Bone Structure," *Calcified Tissue International*, 55, 46–52, 1994.

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Contributing Faculty: Ellen Arruda, William Endres, Shixin Hu, Elijah Kannaty-Asibu, Kenneth Ludema, Jun Ni, A. Galip Ulsoy, Shien-Ming Wu.

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Solid Mechanics and Materials

Contributing Faculty: James Barber, Mehrdad Haghi, John Holmes, Noboru Kikuchi, Jwo Pan, Ann Marie Sastry, Richard Scott, John Taylor, Michael Thouless, Alan Wineman.

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Research Funding and Expenditures

July 1, 1994–June 30, 1995

Agency	Researcher	PROJECT NAME	$ Funded	$ Expended
2mm Program, Inc.	Hu	The Development of Advanced Technologies & Systems for Controlling Dimensional Variation in Automobile Body Manufacturing		1,517,062
Air Force	Akhavan	Intermittent Fine Scale Structure of Vorticity and Dissipation		39,730
	Dutta	Numerical Control Machining of Cyclide Surfaces		37,745
	Dutta	Next Generaton Solid Modelers for Elect Prototyping		54,446
	Dutta	Algorithms for Geometric Comparisons in Solid Modelers for Electronic Prototyping	87,338	15,429
	Holmes	High Temperature Aerospace Structural Materials: The Mechanics and Mechanical Behavior of High Temperature Intermetallic Matrix Composites		1,496
	Holmes	Influence of Loading Frequency on the Fatigue Life and Frictional Heating of Fiber-Reinforced Ceramic Composites	84,446	11,949
Anderson	Koren	Electro Mechanical Research		5,764
Army	Chen	National Defense Science and Engineering Graduate Fellowship	104,226	29,837
	Pierre	Modal Analysis Techniques for Nonlinear Large-Scale Structural Systems	90,408	42,931
	Pierre	Normal Modes and Modal Analysis for Non-Linear Structural Systems		18,227
Army/TACOM	Kikuchi/Dutta/ Papalambros	Homogenization Design and Layered Manufacture of Mechanical Components in Project MAXWELL	334,329	117,696
	Papalambros	Automotive Research Center	3,500,000	1,132,105
	Ulsoy	Crewman's Associate for Path Control: An Automated Driving Function	113,157	159,127
ASCOM-IVHS	Stein	Active Safety Conflict Model	36,838	31,461
Battelle	Ward	Short Duration Aerial Reconnaissance Demonstration	11,762	11,940
Carnegie Mellon/USAF	Pierre	The Forced Response Consortium Initiative	9,449	121,475
Caterpillar, Inc.	Dutta	Process Planning Research for Mill-Turn Parts	25,164	17,567
Chevron Oronite Technology Center	Assanis	Engine Heat Transfer and Fuel/Engine Interactions	5,000	0
Chrysler	Hu	Development of Advanced Technologies		66,926
	Ni	Reduction of Variability of Hole Dimensions and Improvement in Tool Life	69,397	0
College of Enrg, U–M	Koren	Engineering Research Center	6,500	11,416
Cummins Engines	Ludema	Scuff Prevention of Fuel Injector Parts	56,959	46,000
DARPA	Holmes	Advanced Development of Fibrous Monolithic Ceramics		24,737
Detroit Deisel	Borgnakke	Performance of Methanol Blend in a Diesel		608
	Borgnakke	Performance of a Diesel with Ethanol		32,710
	Borgnakke	Heavy Duty Diesel Engine Research	2,000	226
DHHS-PHS	Kuo	New Diagnostic Measures of Balance Performance in Elderly	30,400	0
DoD	Kikuchi	High-Temperature Aerospace Structural Materials: The Mechanics and Mechanical Behavior of High-Temperature Intermetallic Matrix Composites		14,363
	Ward	Japan Technology Management Program		23,285
DoE	Atreya	The University of Michigan Energy Analysis and Diagnostic Center	120,450	107,649
Dupont	MEAM Chair	Dupont Fundamental Research	12,000	7,470
EPA	Brereton	Small Engine Test Facility		82,173
Federal Highway Administration	Ulosy	Adaptive Driver Modeling for Advanced Vehicle Control Systems		27,587
Ford	Arpaci	Modeling of In-Cylinder Heat Transfer and Fluid Mechanics and Modeling of the Ignition Process		1,619
	Arpaci	The Effects of Turbulence on Early Flame Development	50,000	43,081
	Arpaci	Part-Load Engine Performance Modeling	45,000	21,001
	Arruda	Testing, Modeling and Simulations of Crash-Worthiness of a Composite Elastromer/Polymer System	50,000	8,678
	Assanis	Engine Heat Rejection Studies	50,000	0

Agency	Researcher	PROJECT NAME	$ Funded	$ Expended
Ford (continued)	Assanis	Experimental Investigation of the Heat Rejection Characteristics of I-4 and V-6 Engine Designs	142,000	45,327
	Brereton	Improved Accuracy and Reliability in Coriolis Mass Flowmeters		27,556
	Brereton	Characterization of a Dynamometer Fuel Delivery System		31,337
	Clark, S.	Modeling of a Tire Traversing an Obstacle		2,639
	Dowling	Noise Abatement Strategies for Engine Plants		9,821
	Dowling/Grosh/ Perkins	Tuning Cable Technology for Large Scale Hydraulics	50,383	0
	Hulbert	Ford General Research	20,000	17,618
	Kaviany	Liquid Acquisition in Compact Condensers	116,174	102,513
	Kikuchi	A Study for the Crash Energy Absorption Optimization of Front Frame Rail Section		27,681
	Kota	A Framework for Selection of Engine Assembly Automation Concepts		5,147
	Kota	Ford General Research		80,000
	Ludema	Study of Rack and Pinion Steering Gear Seal Friction Dynamics	137,369	57,682
	Pan	Strain Rate Effect on the Formability of Aluminum Sheets	21,400	2,917
	Pan	Plastic Anisotropy and Failure Criteria		16,707
	Pan/Haghi/ Holmes/ Papalambros/ Wineman	Center for Automotive Structural Durability Simulation	700,000	529,095
	Papalambros	Design Management Strategies: An Application to Powertrain Design		26,951
	Papalambros	Large Scale Optimization for Automotive Components	13,000	0
	Perkins	Traction and Parasitic Loss in Automotive Accessory Drives		38,666
	Selamet	Research in Engine Performance Modeling	40,000	67,016
	Selamet	Integrated Muffler/Manifold Catalyst Exhaust System: An Innovative Approach		81,558
	Selamet	An Experimental and Theoretical Study of Exhaust System Elements for Engine Performance		65,150
	Selamet	Research in Engine Performance Modeling	75,000	54,485
	Selamet	Analysis and Improvement of the Bentler and Hitachi MCM Systems	90,165	228,729
	Selamet	A Computational Approach for Thermal Analysis of Disk Brake Rotors	30,000	35,208
	Selamet	Modeling and Design of Exhaust System Components for Improved Engine Performance and Noise Characteristics: Theory, Computations, and Experiments, Phase II, Part 2	150,000	15,050
	Selamet	Engine Performance Modeling	100,000	0
	Stein	Advanced Motor Control for Automotive Steering and Active Suspension Application	83,320	69,857
	Tryggvason	A Hierarchy of Reduced Models for Underhood Flows	51,514	0
	Ulsoy	Mathematical Modeling of Manufacturing Processes	100,000	16,155
	Ulsoy	Accessory Drive Belt Dynamics Design Program		456
	Ulsoy, Peng	Advanced Suspensions and Vehicle Dynamics and Control	40,000	0
	Ward	Automated Electromechanics System Configuration		9,015
	Ward	Design of Air Conditioning Components with Conceptual and Physical Robustness	64,975	41,345
	Yang, W. H.	Development of an Optimized CAE Tool for Safety Analysis	45,000	4,508
	Yang, W.J.	Visualization of Flows in Torque Converters	7,715	28,073
	Yang, W.J.	Temperature Measurements of Cutting Tools		40,096
G & L	Ni	The Development of an Adaptive Compensation Technique for Enhancing Coordinate MM Accuracy		106,420

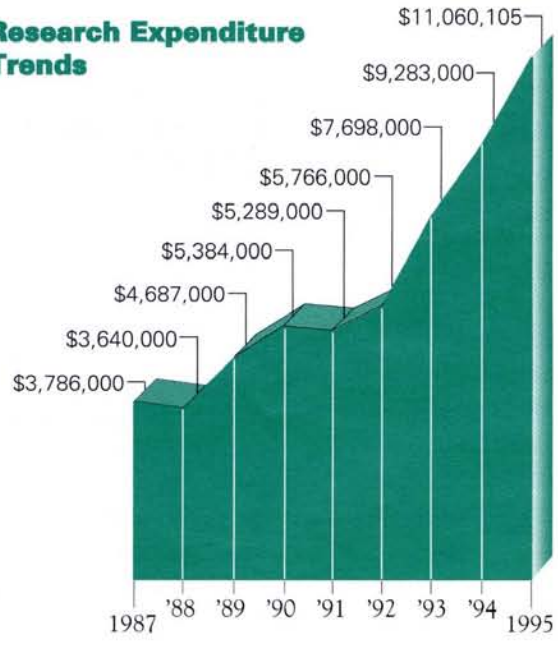
Agency	Researcher	PROJECT NAME	$ Funded	$ Expended
Gas Research Inst.	Atreya	Formation and Oxidation of Soot and Nox if Diffusion of Flames	20,000	219,846
GLCTTR	Hulbert	Proper Three-Dimensional Tire Models	14,121	12,432
	Peng	Worst-Case Evaluation Method for Trucks	27,554	22,819
	Stein	A High Efficiency Powerplant for Heavy Trucks and Buses: A Feasibility Study	27,000	23,676
GM	Hu	Variability Characterization and Tolerance Budget Analysis for Die Manufacturing	120,000	9,863
	Papalambros	Doctor of Philosophy in Mechanical Engineering	8,000	1,943
	Shi	Variation Reduction for Body-In-White Assembly at Lansing Car Assembly Plant	150,000	51,684
GM-2mm Program	Hu	The Development of Advanced Technologies and Systems for Controlling Dimensional Variation in Automobile Body Manufacturing		24,179
Goldstar Corporation	Kikuchi	Development of a Practical Design Optimization for Mechanical Structures	52,162	0
Greenfield Coalition	Kannatey-Asibu	Instructional Modules on Tool Wear/Tool Life and Non-Traditional Machining	20,000	13,556
NSF				
Hayes-Wheels	Yang, W.H.	Software Development for ARC-Welding Simulation and Optimization		72,252
John Deere Foundation	Kota	Synthesis, Simulation and Rapid Prototyping Using Motion Building Blocks		1,610
Legacy Good Samaritan Hospital & Medical Center	Kuo	Organization of Postural Control: Vestibular Processing	22,602	0
Modicon	Koren	A Sequencing Central Controller for Flexible Transfer Lines	70,044	8,626
NASA	Atreya	An Experimental and Theoretical Study of Radiative Extinction of Diffusion		40,503
	Holmes	Influence of Composite Microstructure on the Creep Behavior of Ceramic Matrix		41,183
	Merte	Graduate Student Researchers Program—Bouyancy Effects on the Forced Convection Critical Heat Flux	22,000	23,215
	Merte	Study of Pool Boiling in Microgravity—Rewetting Following Dryout	135,000	45,088
	Merte	Pool Boiling Experiment		67,038
	Tryggvason	Computational Studies of Drop Collision and Coalescence	59,000	49,371
	Tryggvason	Computational Studies of Boiling under Microgravity	22,000	18,424
	Tryggvason	Fundamentals of Mold-Free Casting: Experimental and Computational Studies	55,000	51,022
NASA-Lewis	Arpaci	Droplet Evaporation Under Microgravity	105,022	52,060
	Merte	A Study of Forced Convection Nucleate Boiling in Microgravity	65,788	41,269
NAVY	Ceccio	Experimental Study of Cavitation Transient and Boundary Layer Interactions		2,540
	Ceccio	HPIV Measurements in Cavitating Flows		59,216
	Kaviany	Computational Methods for Rapid Prototyping of Analytical Solid Models	132,519	0
	Perkins	The Dynamics of Slack Cable—Mass Systems	106,744	65,509
	Perkins	Propagating Structural Wave Phenomena in Elastic Cables		49,033
NIDR	Ashton-Miller	Regeneration and Transplantation of Skeletal Muscle		21,880
NIH	Ashton-Miller	Biomechanics of Female Stress Urinary Incontinence	242,908	214,748
	Ashton-Miller	Older American Independence Center—Intervention 3	93,913	65,868
	Schultz, A.	Biomechanics of Falls and Balance in Old Adults		151,907
	Schultz, A.	Older American Independence Center—Intervention 3	59,435	40,593
	Schultz, A.	Fundamental Aspects of Mobility in Old Adults	1,017,993	676,002
NIH-DSSH	Schultz, A.	Michigan Geriatrics Research and Training Center—Biomechanics Core		14,944
NIH-PHS	Kikuchi	Trabecular Architectural Effects on Material Properties		1,916
Nissan	Kikuchi	General Research Support for Computational Methods for Automotive Engineering		7,652
NIST	Atreya	Basic Research on Fire Suppression	46,695	58,643
NSF	Akhavan	Spectral Domain-Decomposition Methods for LES of Turbulence in Complex Geometries	46,200	2,273
	Arruda	Proof-of-Principle Study of the Use of Orientation Parameters Measured		9,362
	Arruda	Synthesis, Experimental Testing and Constitutive Modeling of Elastomeric Networks Having Statistically Well-Defined Structures and Defect Structures	89,977	19,923

Agency	Researcher	PROJECT NAME	$ Funded	$ Expended
NSF (continued)	Arruda	Non Isothermal Analytical and Experimental Study of Viscoelastic Fiber Drawing	94,478	55,276
	Barber	Thermoelastic Effects in the Solidification of Castings	62,740	48,018
	Barber	Frictionally-Exited Thermoelastic Instabilities in Automotive Disk		21,062
	Borenstein	Design and Control of Multi-Degree of Freedom Vehicles for Industrial Applications		72,757
	Dutta	Computer-Aided Process Planning for Parallel Numerical Control Machines		16,905
	Dutta	Engineering Research Equipment: Layered Manufacturing in Project MAXWELL	87,532	131,558
	Haghi	Knowledge-Guided 3-D Detection of Brain Tumor Volume		43,757
	Holmes	Young Investigator Award	62,500	58,375
	Kannatey-Asibu	Laser Beam Splitting and Materials Processing		17,415
	Kaviany	Thermomechanical Aspects of Multicomponent Binder Melting and Evaporation in Thermal Debinding	299,859	84,150
	Kikuchi/Dutta/ Papalambros	Optimal Design of Topology and Microstructure of Discrete Parts in Project MAXWELL	83,508	51,975
	Koren	A New Architecture of CNC Servo-Controllers		74,395
	Kota	A New Method of Synthesis for Micro-Electro-Mechanical Systems in a Single Phase: From Function to Fabrication		148,353
	Ni	NSF-Industry/University Cooperative Research Center for Dimensional Measurement and Control in Manufacturing	51,000	39,413
	Ni	The Development of a Science Base for Drills and Drill Grinding Processes		68,759
	Ni	Presidential Faculty Fellows Award	100,000	0
	Ni	Machine-Tool Chatter Prevention Through Spindle Speed Variation	50,000	0
	Pan	Stress Resultant Constitutive Laws For Sheet Metal Forming		2,485
	Stein	Well-Conditioned Observers for High-Performance, Low-Cost, Sensing Systems	62,548	52,829
	Ulsoy	Establishment of Graduate Research Traineeship Program		158,998
	Ulsoy	Hierarchical Controller for Real-Time Quality Control in Machining	145,678	137,258
	Ulsoy	Adaptive Repetitive Control of Nonlinear Discrete-Time Systems	53,060	13,957
	Ward	Stochastic Strategies for Distributed Decisions in Concurrent Engineering		41,570
Ohio State	Kikuchi	Application of Homogenization Method in Conjunction with Voronioi Cell Finite Elements for Finite Deformation Analysis of Real Composites	27,284	28,862
ONR	Akhavan	Direct Numerical Simulations of Free-Surface Turbulent Flows	20,512	87,068
	Ceccio	Experimental Study of Cavitation Transients and Boundary Layer Interaction		172,341
	Kikuchi/Dutta/ Papalambros	Research in Design Optimization and Computational Geometry in Project MAXWELL	163,830	199,687
	Schultz, W.	Task B5		68,701
	Schultz, W.	Short Wave and Surfactant Interactions	61,320	60,413
	Tryggvason	Wave Model by Vorticity Task B3		36,968
	Ward	Generalized Quantitative Inferences on Sets of Possibilities in Design and Plan		42,834
ONR-ASSERT	Dowling	Surfactant Dynamics	112,893	23,159
OVPR	Ashton-Miller	Effect of Age and Physical Activity on PFM Activity in Nulliparous Women		2,666
	Brei	Design and Feasibility Study on Piezoceramic C-Block Actuators	13,835	3,948
	Shaw	Optimal Design of Nonlinear Vibration Absorbers		3,825
Parke-Davis	Fijan	Intergration of Multi-Robot System for Automated Chemical Processes		5,630
Rackham	Arruda	Faculty Research Grant		5,106
	Bridges	Faculty Research Grant	7,990	0
	Ceccio	Faculty Research Grant		3,025
	Dowling	Faculty Research Grant		1,551
	Grosh	Faculty Research Grant	14,845	0
	Peng	Faculty Research Grant	14,685	0

Agency	Researcher	PROJECT NAME	$ Funded	$ Expended
Sandia Labs/DOE	Sastry	Structural Analysis and Design of Composite Parts Produced by RTM	24,400	0
SMS-ARPA	Ni	Advanced Compensation System for Quasi-static and Cutting Force-Induced Errors for Turning Centers	452,496	214,276
SNECMA	Pierre	Studies of the Dynamics of Dry Friction Damped Blade Assemblies	33,000	13,060
State of Michigan	Geister	Emissions from Alternate Fueled State of Michigan Vehicles		9,736
Suzuki	Kikuchi	Development of an Integrated Optimal Structural Design System for Vehicles		66,197
TAPPI	Perkins	The Mechanics and Modeling of Wet Paper Forming		22,715
Tecumseh Products	Patterson	Combustion Research in Internal Combustion Engines		7,387
Toyota	Kikuchi	Research and Educational Activities		42,278
Transitions Research Company	Borenstein	The Multi-Degree of Freedom Vehicles		123
Transportation Services	Haghi	Hybrid Electric Vehicle	75,000	24,846
TRW: Vehicle Safety Systems	Grosh/Perkins	Evaluation and Analysis of Rattle Noise	71,664	0
	Perkins	Vibration Analysis	25,496	30,968
Univ. of Illinois /NASA	Assanis	Direct Injection of Natural Gas: In-Cylinder CFD Computations Using KIVA-3	214,506	0
Univ. of Illinois /NSF	Ni	National Coalition for Machine Tool Technology	100,000	51,846
Various Research Sponsors	Ni	NSF/Industry University Cooperative Research Center for Dimensional Measurement and Control in Manufacturing - Corporate Sponsorship	503,697	346,381
Vennema Endowment	Schultz, A.	Vennema Endowment	50,000	13,402
Whirlpool	Dutta	Research in How Design Changes Affect the Manufacturing and Logistic Costs over the Product Life Cycle		5,103
	Haghi	Processing and Failure of Materials with Distributed Properties		214
Whitaker Foundation	Borenstein	The NavBelt: A Computerized Travel Aid for the Blind	179,815	2,646
	Kuo	An Age-Related Study of Sensorimotor Control of Human Balance	179,989	21
Yardney Technical Products	Sastry	Testing on Novel Battery Electrode Materials	7,000	0
			13,311,675	11,060,105

Research Expenditure

Research Expenditure Trends



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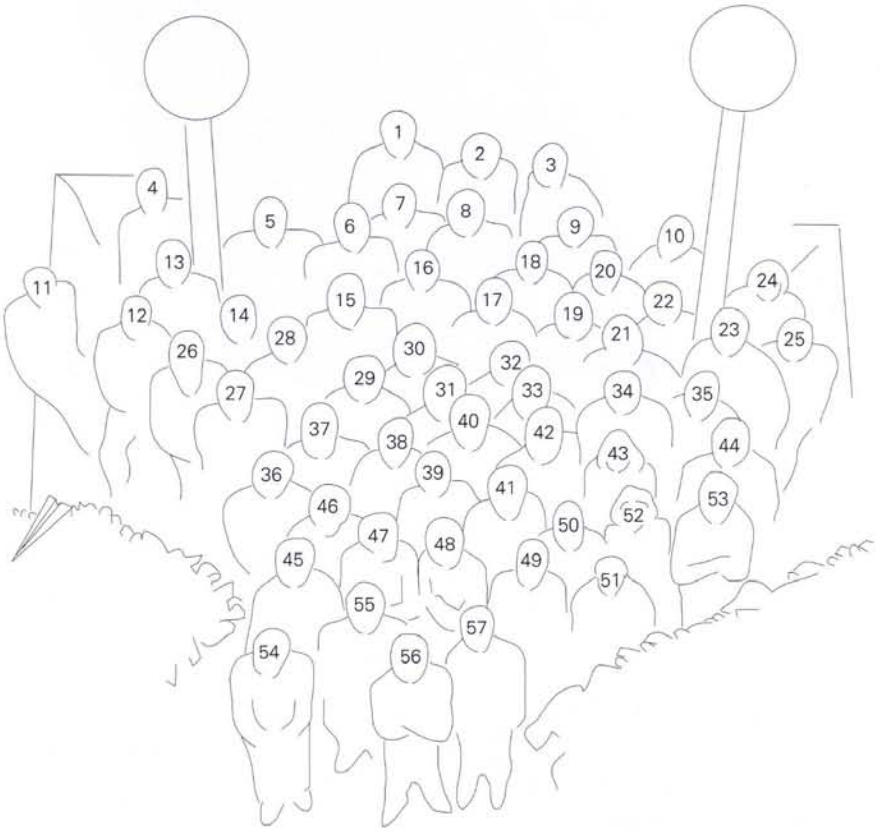

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1994-95

Annual Report

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