UNIVERSITY OF DELAWARE

mechanical engineering NEWS

Spring 2001

Managing Editor
Nathan Cloud
Copy Editor & Contributing Writer
Diane S. Kukich

The Chair's Corner

by Dr. Tsu Wei-Chou

You may recall that in the Winter 2000 ME News, I mentioned the preparation for a strategic planning meeting by the faculty. I am pleased to inform you that the meeting was held during the Winter Session earlier this year, and there was an intensive exchange of ideas among the faculty and a critical examination of our vision and goals for the future of the department. Now I would like to update you on some of our recent activities in undergraduate education, graduate education, and alumni relations.

Undergraduate Education

This has been a very active year for the undergraduate curriculum! This spring, we are graduating the first class of the ME 2000 program—this included our first time through a single fall-semester, six-credit version of Senior Design. Although there were some rough moments, the students and the project sponsors would basically agree it was very successful: two teams with potentials for patent applications and one team continuing this spring with a design-development follow-on effort. We merged the ASME dinner meeting honoring the seniors and their senior-design efforts with the February Engineer's Week activities. Remember to look for that next year as well! We've also started to announce, during the spring pre-registration, a tentative list of the ME technical electives for the entire academic year (not just for the next immediate semester) giving the undergraduates and their advisors a better ability to plan. I would also like to take this opportunity to inform you that Professor Michael Keefe is now serving as the Associate Chair of Mechanical Engineering for Undergraduate Education. This appointment not only recognizes the outstanding effort Dr.

Keefe has been making but also further strengthens our commitment to improving undergraduate education.

The Honors Day celebration at the University this year was on May 4. We are very proud of the fact that over 130 students, or 14 percent of the student body in the College of Engineering, are recipients of Honors Day awards. Engineering students make up about 8% of the undergraduate population, yet they received 25% of the Honors Day awards of the University. Our senior, Jennifer Buckley, who is active in varsity athletics and a 4.0 student, received the W. Francis Lindell Award for the Distinguished Senior. Alex Kelly, who will have enough credits upon receiving his BME degree to also be awarded a Master of Engineering degree, received the W. Francis Lindell Award as well as the Mary and George Nowinski Award for Excellence in Undergraduate Research.

However, we are not sitting still! Based on inputs during freshman advisement and watching the patterns since the new curriculum, we've made some adjustments to the Math/Calculus sequence—making five of the six undergraduate programs in the College identical in their calculus sequence. Another major effort will involve our continued accreditation and the new ABET criteria. Though we aren't scheduled for review until 2005, we're piloting a more comprehensive evaluation/assessment program that will involve inputs from current students, industry (employers of our graduates), and—of course—alumni!

I am also pleased to announce that Professor Dick Wilkins has been appointed by the Dean as the Associate Dean of Engineering College for ABET for an additional five-year term. We are very fortunate to have his capable and dedicated service to all engineering departments in this important task.

Graduate Education

We have continued to improve our graduate program over the past few years. During the past two years, we saw an increase in the quality of the incoming graduate students. We attribute this to a higher admission standard as well as high-quality and diverse research programs led by the faculty of Mechanical Engineering. We are committed to continue our effort in improving the diversity of our graduate student body.

Our new Graduate Curriculum is intended to educate students with broad knowledge in traditional and emerging areas of mechanical engineering. The degree program also facilitates the students in carrying out their dissertation research at a very early stage of study. With the expansion of department research in up and coming areas like biomedical engineering and nanotechnology, our students are increasingly exposed to and trained in interdisciplinary and cutting-edge research.

I would also like to share with you a concerted effort being made by the faculty in graduate recruitment, which is vital to the success of our graduate program.

In order to expose the prospective students to the research activities of the department, Professor Suresh Advani has organized a Power Point presentation that highlights the research programs in the department. This presentation is on the ME homepage and is available to faculty members for recruitment activities during their travel. Several faculty members visited local universities and made recruitment presentations this semester to expose the juniors to the research work in the department, and to motivate good students to apply to Delaware. Also, a new program called SUPREME (Summer Undergraduate Personal Research Experience in Mechanical Engineering) was also initiated to attract undergraduates from other universities to spend a summer at Delaware. Our plan is to continue to present seminars at four-year colleges and universities in the neighboring states to generate interest in graduate studies. We will also be requesting help from our alumni in recruitment activities.

I am pleased to mention that our graduate student, Jingbo Wang, is this year's winner of the Laird Fellowship for $18,000. The Laird Fellowship is given not only in recognition of outstanding scholarship, but is awarded to an individual who also has a variety of interests and talents. Jingbo received his undergraduate degree in mechanical engineering from Tsinghua University in China, and is pursuing a Ph.D. degree.

Alumni Relations

Along with the steering committee (Professors Jack Vinson, Mike Greenberg, and Suresh Advani) input, Nate Cloud, Coordinator for Alumni Relations, has started the process of re-establishing contact with the 2700 living alumni of Mechanical Engineering. The goal is to have an electronic and snail mail address for all ME alumni so that we can keep them informed about the department on a regular basis. We are also forming a core alumni group with class representatives who can meet and develop social and professional activities for alumni. In addition, there is a plan to invite all alumni to the homecoming football game in October. We will reserve a block of tickets and plan a luncheon before the game.

I hope the above summary gives you a glimpse of the various activities and events in the department as well as the challenges and opportunities facing us. I would particularly appreciate your thoughts and feedback on these issues. I will work closely with the faculty in the coming months for resource development, which will be devoted to undergraduate research scholarship, undergraduate teaching laboratory facilities, and scholarship for domestic graduate students.

Finally, I again urge you to continue to be an active member of the department's alumni community. Please keep us apprised of your own activities-see Alumni Association Section or log on to http://www.udel.edu/alumni/ and click "alumni sign-up form" and then select "sign-up" or update to update your contact information. Finally, on behalf of the students and faculty of Mechanical Engineering, I want to express our sincere appreciation of the support and encouragement from our many alumni during the past year and wish you an enjoyable spring and summer season.

Student Viewpoint: Interview with Senior G. Paul Ledebur

By Diane Kukich

Recent years may have witnessed a downward trend in ME enrollment, but there doesn't seem to be a lack of jobs for ME graduates—at least not if you ask Paul Ledebur ('01 BME). Ledebur, who has accepted a position with W. L. Gore and Associates as a process engineer, turned down several other offers. "I chose Gore because I liked their style, and I think the atmosphere there is compatible with how I work," he says. At Gore, I know I'll have the opportunity to do whatever I want to do."

As for the reported downward trend in ME's, Ledebur predicts a reversal in the next few years. "Electrical and computer engineering have been very popular for the past 10 or 15 years," he says, "which led to a lot of new devices. But now industry needs people who can make all those things that have been invented, and that's where ME is going to make a comeback."

For Ledebur, ME was always his first choice. As a student in a technical high school, he had a better idea than most kids his age of what he wanted to do for a career. "I learned drafting," he says, "and when I thought about possible careers that would let me apply this skill, I eliminated architecture right away because nothing moved. Mechanical engineering was a logical choice."

It's been a straight path forward for the Maryland native ever since. He doesn't settle for just getting something done—he wants it done right. When he learned that enrollment in the student chapter of the National Society of Professional Engineers (NSPE) was way down compared to a few years ago, he got involved. He served as co-president during his junior year and president as a senior.

"We made it our goal to promote professionalism in engineering," he says. "A lot of students don't really know what that means or what career opportunities are available, so we brought in speakers from the field to educate the students and enable them to make intelligent decisions about whether engineering is something they really want to do." Ledebur points out how important it is for students to really know what they want—too many choose engineering because they have an aptitude for math and science and because they have heard that it's a lucrative field. "That's not enough," Ledebur says. "You have to be good at problem solving to be a good engineer."

Students also have to be prepared for the rigors of what can be a very tough curriculum. For Ledebur, teamwork was key in getting through the program. "You need people to share ideas with," he says, "so that you learn from their experiences as well as from your own. Teamwork not only gets you through school but also is very important in interviews with industry. I found that the companies I talked to were impressed with how effective Delaware is in teaching students how to work in teams and how to handle design."

How could the transition be made better for students? "Outreach to high school students would help," says Ledebur, "and participation in programs like Odyssey of the Mind are great—that's problem solving in a nutshell." Once students get to the university level, Ledebur recommends a common first semester for all engineering majors who are unsure of the direction they want to take.

With graduation looming as this issue of ME News went to press, Paul Ledebur was eager to get started at Gore. "I initially thought I wanted to go directly into design," he says, "and then I ended up accepting a position as a process engineer. But I realized that I didn't want to sit in front of a computer all day, so this is really the best of both worlds. Process engineering can lead to design when something doesn't work right. Fixing things is design at its best because it involves problem solving."

And that's what good mechanical engineers are for….

Frosh Matchbox Cars

by Jerry Rhodes, reprinted with permission from UD *UpDate*

Early Introduction to Design Principles. But will it go straight?

While they may not represent the cutting edge of automobile technology, mousetrap cars provide more than enough challenges for their student creators, who must design a vehicle to travel as far as possible on spring power. In early December, 18 teams, composed primarily of freshman mechanical engineering students, brought their creations to the Pearson Hall gymnasium for the MEEG 101 (Introduction to Mechanical Engineering) Celebration and Mousetrap Car Contest.

Not only were they required to build a mousetrap-powered device, but students also had to predict how far the vehicles would travel each time the device was engaged.

Prof. Dick Wilkins said that while professors provide the mousetraps, students must build the cars, which cannot exceed 12 inches in any dimension and must provide a receptacle to hold a soda can positioned vertically. "The wheels are actually CDs," Wilkins said. "The soda cans are partially filled with sand, and the amount is varied with each heat or race."

The cars, with ticket prices coming in at under $5, must be self-contained and travel at least one meter. The real challenge for the students is being able to predict accurately how far each unit will travel with changing payloads.

Matt Reber a mechanical engineering freshman, with his mousetrap car

After the performance trials, the distance traveled by each car gets recorded on a data collection sheet, and a complicated formula determines the MPI, or Mousetrap Performance Index, with the top 10 teams qualifying for further rounds until an eventual winner emerges.

While this group of freshman ME students was putting their distance estimating skills to the test, students in MEEG 401 Senior Design 2000 were putting the finishing touches on design presentations for the six-credit course required for all mechanical engineering seniors.

These final presentations, held Friday, December 8, in the Composites Center Presentation Room, represented the final stage in a course designed to give mechanical engineering students the freedom to pursue general and technical electives during the spring semester of their senior year.

The course includes the development of system designs, benchmark test practices and the design, fabrication, assembly, testing, and improvement of actual prototype models.

"This year all the design processes were industrially sponsored, and the semester-long time frame is comparable with industry practices in the real workplace," Wilkins said. "This has been an excellent learning experience for the teams."

The class permitted seniors to show their expertise with such projects as a shower rod sleeve assembly, high viscosity dispersion system, child-resistant bottle closure, roll gap adjustment system, pinstripe applicator system, adhesive testing system, handling placement system and a print sleeve cut off system.

"This was the first year that two groups of mechanical engineering students gave final presentations so close to each other," Wilkins said. "By doing so, it gives people a chance to see what students are doing at the beginning of their academic careers and how they finish up."

Team members and their Mousetrap Car Project are, from left Michaelena Borreggine, Jennifer Pahnke, Matt Reber and Dan Fitzpatrick

MPI = Mousetrap Car Performance Index

$$MPI = \frac{10^{5}(D_p - D)^2 C}{PD^2}$$

P = payload, g
D = distance traveled (m)
$\mathbf{D_p}$ = predicted distance traveled (m)
C = cost of device, $

Try it yourself; or with a son or daughter who might be interested in engineering as a career! Just build a device for less than $5.00 that will fit within a 1 ft. cube; powered by a common mousetrap that can carry a payload (e.g.; soda can - your choice) at least 1 meter on a hard surface. The rest is up to you! Winner is minimum MPI. Best student scores were around MPI = 1.0 ….actually one team got zero which caused the professor to re-think the algorithm for next year—a good lesson in course design!

Focus On Senior Design

by Nate Cloud

Seniors Conquer Single Semester Format—
"But it was pretty intense!"

The "Fall 2000" session of Senior Design was successfully concluded in December. This was the inaugural for a single semester format—still six credits, but in half the time. Many students thought that the pace was very intense, but when the dust settled, the Senior Design Staff Team (Dick Wilkins, Mike Keefe, Jim Glancey, and Nate Cloud) felt very good about the effort that the student teams had put forth.
Many improvements are in the planning stages to make this key student learning experience even better in Fall 2001. These include streamlining the integration of teaching/learning the design process with the production of tangible results for industrial sponsors of the projects. Upgrades in resources that support the student teams in their efforts to rapidly convert their ideas to reality (i.e., proof-of-concept prototypes) are also being planned.

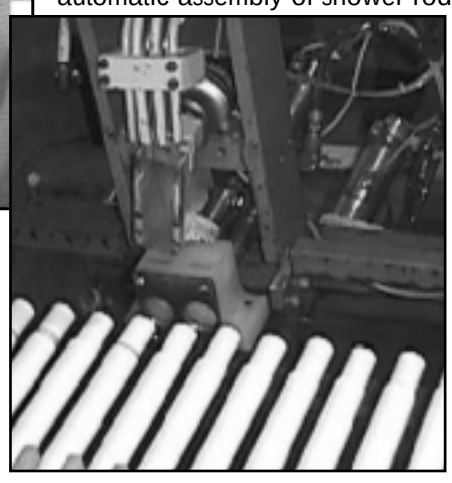
Fall 2000 project sponsors were AstroPower, DuPont Flooring Systems, W.L.Gore & Associates, Harley Davidson, Johnson Controls, New Holland-Case, PolySeal, Xymid, and Zenith Corp. Representatives from these companies kept the nine student teams focused on their project goals and helped the students learn design project subtleties, including value-based tradeoffs, timely communications, and contingency planning.

The ME Design Team Staff kept busy acting as advisors to the students, helping them learn the design process as they iterated through initial concept generation, feasibility modeling, and proof-of-concept prototyping. During each of these phases, teams defined customer requirements, benchmarked applicable technology, and defined, analyzed, and tested their design solutions. Teams gave written and oral reports to sponsors and advisors following each phase. At the end of the semester, teams delivered project results to sponsors and worked with them on "hand off" and future development plans.

In addition to preparing students for the fast-paced "new product development" world, the single-semester format enables students to continue working on next-step development of projects if there is sponsor interest and faculty advisor availability. Students may take this step for academic credit as an independent design study or as a research project.

If your business is interested in sponsoring a project for Fall 2001, please contact Nate Cloud at 302-778-4567 or cloud@me.udel.edu. You may also submit your project idea at http://me.udel.edu/events/news-events.msql. Click on "Senior Design – Call for Projects" and then "here" in the "Next Step" paragraph.

One of the teams in action, testing a prototype of their project solution "on the line" at the Zenith Products Corporation while advisor Jim Glancey and sponsor Bill Caron look on.



Close-up of student's project-automatic assembly of shower rods

Spring Follow-up Projects Wrapping-up

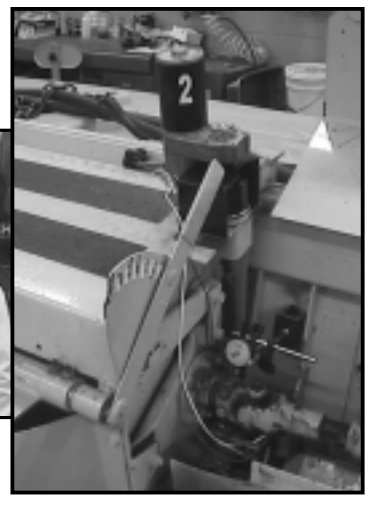
After completion of Senior Design in the fall, two student teams chose to continue working with their industrial sponsors in the spring to further develop their prototype solutions. Both Harley Davidson of York, Pa., and Case-New Holland, Inc. (CNH) of New Holland, Pa. agreed to continue sponsoring the teams during the spring semester. The result is a win-win situation for both the students and companies.

"It's real-world design experience," said Jeff Gordon, CNH Team, when asked why he wanted to continue this spring. Matt Dunson, also on the CNH Team added, "It's nice to continue a project we had started last semester and look at some things we didn't have time to investigate before."

The companies are also gaining value from the teams' efforts. "So far, the design reviews with the companies have been very positive," said Jim Glancey, advisor for the projects. "In fact, the final handoff for the CNH team has been expanded to included a presentation and demonstration to the Marketing Group and the Global Product Manager at CNH."

Final presentations and solution handoffs to the companies were scheduled for mid-May as this issue of ME News is going to press.

The CNH student team and project test set-up



Focus on Faculty

by Nate Cloud

Hai Wang, Assistant Professor of Mechanical Engineering

Dr. Hai Wang has a very long and varied professional history for someone who can give an old alumni visitor the impression that he is perhaps a graduate student. A lively gait and a smile always greet the unintroduced in the halls of Spencer Lab!

Wang's educational background is as diverse as his approach to his work at the University of Delaware (more on that later). Wang came to the U.S. from ShangWang, China, in 1984, where he had received his Bachelor's degree in Polymer Materials Science and Engineering. He then earned a Master of Science in Chemical Engineering from Michigan Technological University. His Ph.D. (1992) in Fuel Science from Penn State was the result of six years of study and research focused on the science of combustion. Following this, Wang continued to focus his study and research on fuel/combustion science, in particular that which occurs in automotive and aircraft engines. His early materials and chemical engineering background was supplemented by a shift to mechanical engineering, which has provided an extremely broad interdisciplinary foundation for this current work in the combustion arena.

Wang provides the interviewer with an exciting glimpse of the future and a certain confidence that, while his work is fundamental in nature, he manages to keep commercial and societal relevance in view. Wang's research is sponsored by government agencies—including NSF, DOE, NASA, and AFOSR—linked with leading industrial companies such as Toyota and Caterpiller, all of which have a high stake in developing more fuel-efficient, cleaner engines.

Wang easily moves across the enigmatic space of researcher "pigeon holes." After patiently explaining his zest for seeing real application results from his work, he declares that "he likes to operate with few constraints." Wang's reflections have led him to realize that today there is a "missing dimension" in the ability to analytically model the formation and dynamics of soot particles, which is necessary in the study of combustion. The missing dimension is in a region between particles a few nanometers in several tens of a nanometer. A basic understanding of physics and chemistry is not well defined in this space, and it has been identified as a key gap in our ultimate ability to improve commercial value and environmental conditions. The challenge is great, but one has a sense of confidence that as soon as Wang sees that a model works, he "looks for application collaborators"!

In addition to Wang's dedication to his research, he is very much in touch with his responsibility to teach young engineers and scientists. Wang quickly points out that today's students are not well prepared in math skills, but while disappointed in this trend, he is challenged to make the needed corrections. He likes to help his students prepare to be more competitive in today's world. He asks them to look up and look for "what new things are out there"…and "be prepared for change." He is also very keen on helping students understand the practical application relevance of classical topics such as differential equations.

Wang was asked to reflect on the apparent downward trend in the numbers of mechanical engineering students (see "Downward Enrollment Trend Reversing?" Alumni Association Section). His feeling is that the trend may be temporary, and perhaps due in part to an ongoing transition from "classical" mechanical engineering to more interdisciplinary mechanical engineering (ergo Wang's background). Also, new mechanical engineering arenas, such as biomechanics and nanotechnologies, are continually being defined and bringing an exciting newness and relevance to the pursuit of mechanical engineering.

Wang's broad scientific knowledge of our world is no doubt extended by virtue of his marriage to Jasna Tomic, who does research in Marine science. The couple have a four-year old son, Neven.

Tom Buchanan, Associate Professor of Mechanical Engineering

Dr. Thomas S. Buchanan is eager to define the field of biomechanics to those who are interested but aren't aware of the many dimensions of this relatively new area of mechanical engineering and the issues associated with it. An accomplished teacher and researcher, Buchanan is Director of the Biomechanics & Movement Science Program (BMSP) and the Center for Biomedical Engineering Research (CBER) at UD. He clearly articulates how mechanical engineering, biology, and other areas of medical science are integrated in exciting new ways to provide an understanding of how we use our bodies and lead to improvements in how we care for them. Buchanan finds an eager audience in one who has practiced mechanical engineering for about 40 years, but who is feeling the consequences of overly aggressive use of the old body in recent years—I only hope that the commercial application of Tom's work will be accelerated….

Buchanan began his work at the University of Delaware as Associate Professor of Mechanical Engineering and Biomechanics & Movement Science. He came to Delaware from Chicago, where he was an Assistant Professor of Physical Medicine & Rehabilitation and Biomedical Engineering at Northwestern University. His long- term dedication and commitment to the field of study is seen in his education and professional history, having begun 22 years ago as a Research Assistant in the Biochemistry Department at the Scripps Clinic and Research Foundation in San Diego. He has held a number of research positions in areas such as Brain and Cognitive Sciences (at MIT) and Rehabilitation Medicine (at the Rehabilitation Institute of Chicago) after progressing through his education, obtaining a B.S. (1980) in Bioengineering from the University of California, San Diego and a Master of Science in Biomedical Engineering from Northwestern University (1982), where he also received his PhD in Theoretical and Applied Mechanics (1986).

Buchanan explains the difference in approaches to developing an understanding of neural control of musculoskeletal movement. Historically, researchers have taken the "top down" approach—i.e., by conducting "electrode in brain" studies to determine how the brain gets the body to move. In an innovative deviation from the traditional approach, Buchanan and his colleagues start at the other end by looking at the point where the body contacts the world. There they know F=ma. From this they can calculate forces and torques at the joints, thus working their way inside the body. Then, with knowledge of the geometry of the muscles and their force generating capacity, they can estimate muscle forces. They can then examine what command the brain is giving the muscles to produce the observed muscle forces. They hope that this way of approaching the problem will lead to new therapies and a better understanding of neuromuscular problems such as strokes and Parkinson's Disease.

Applying this research to sport and recreation, Buchanan hopes to contribute to our capability to return quickly from injury to health. For example, studies are underway to determine why some people who suffer torn anterior cruciate ligaments (ACL) require surgery to reconnect or replace the ligament ("non-copers"), while others ("copers") return to normal function with no surgery at all! This latter work is being done in conjunction with the University's world-renowned Physical Therapy Department, centered in McKinley Hall, neighboring Spencer Lab.

Readers can learn more about this exciting new field in Mechanical Engineering by visiting our web site at http://www.me.udel.edu/ and following the "click path": Research, Research Areas, Biomechanics.

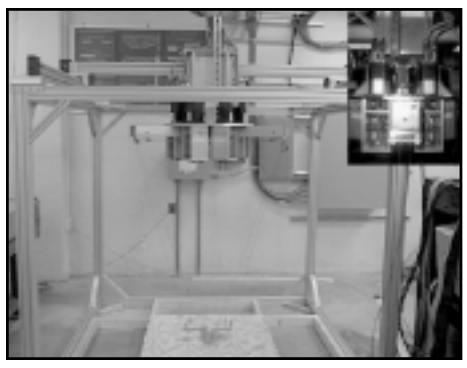
A New Cable Robot

by Dr Sunil Agrawal

The robotics group has recently fabricated a new robot for research aimed at long-reach manipulation tasks to impact automation in shipyards and airplane hangars. In these applications, the workspace requirements are three to four orders of magnitude larger than what is typically given by conventional series or parallel robots. This research is currently being performed in cooperation with National Institute of Standards and Technology (NIST).

The device, designed in-house and fabricated by a group of students working in the Mechanical Systems Laboratory, consists of a six degrees-of-freedom cable robot mounted on a two degrees-of-freedom gantry. A photograph of this experimental facility, along with details of the drive actuation, is shown. The cable robot has three concentric guide rails 120 degrees apart with a moving shuttle on each guide rail. When a crank is turned, each shuttle can slide radially. Through each shuttle, two ropes are connected to a triangular end-effector plate. Each vertex of the triangular end-effector plate has two ropes connected to it. Six direct-drive servomotors from Kollmorgen, fitted with encoders, drive the six cables. The data acquisition and control of the system is through a dSpace 1103 board with MATLAB Simulink and Real-time Workshop as the front-end interface. This robot was designed and built by a student group that includes Jason Pusey, Abdullah Basar Alp, Gregory Pease, and Stephen Pledgie, under the supervision of Prof. Sunil Agrawal and visiting Professor Himanshu Pota from Australia.

From a scientific point of view, cables have the unique property that they carry loads only in tension but not in compression. Due to this feature, the well-known results in robotics for design, workspace, trajectory planning, and feedback control must be suitably modified to reflect the constraints of positive cable tensions.



A photograph of the cable suspended robot along with details of its drive mechanism. (The robot is in Spencer 134)

Faculty Highlight Briefs

Dr. Michael D. Greenberg, Professor, recently had a book published, Differential Equations and Linear Algebra, by Prentice Hall (2001).

Dr. Suresh G. Advani, Professor, and **Dr. Michael H. Santare**, Associate Professor, filed a patent for a novel design of hip prosthesis. Their analysis shows that this implant causes less stress shielding and has the potential to last longer in younger patients. Professor Advani's paper "Simulations for Control of Liquid Composite Molding Processes" was selected as the TOP (The Outstanding Paper) at the Society of Manufacturing Engineers conference last year.

Professor Santare was awarded a Distinguished Fulbright Fellowship to lecture and conduct research at the Universidade do Porto in Portugal. While on sabbatical from U.D., he is spending the spring term there collaborating with engineers and scientists on several projects involving fracture of nonhomogeneous materials and orthopedic biomechanics.

Dr. Lian-Ping Wang, assistant Professor, with his student **Dr. Yong Zhou** and **Dr. Anthony S. Wexler**, recently published two papers in the Journal of Fluid Mechanics on the modeling of particle coagulation in turbulent flow; other significant publications include a paper in *International Journal of Multiphase Flow* and another in a recent AIAA meeting, with graduate student **Mr. James DeSpirito**, on simulation and modeling of particle-laden jet flow. Dr. Wang currently collaborates with colleagues at the Bartol Research Institute and the Institute of Energy Conversion on scalable parallel computing and thermal modeling of source nozzle in thin-film fabrication.

Dr. Michael Keefe, Professor, is working on a project with **Dr. Tsu-Wei Chou**, Department Chairperson, to investigate the mechanical response of the seams used by ILC Dover in their inflated structures. Undergraduate researchers are involved in developing an experimental database for design and simulations, and a graduate researcher is working on an analytical model to predict seam strength.

Dr Sunil Agrawal, Associate Professor, has currently taken up three new editorial positions and is serving as an Associate Technical Editor for the following three journals: *Journal of Mechanical Design* (Transactions of the ASME), *IEEE Transactions on Robotics and Automation*, and *IEEE Transactions on Control Systems Technology*. In 2000, Dr Agrawal received several new research grants, including awards from the National Science Foundation and the Air Force Research Laboratory on cooperative control of unmanned vehicle systems.

Self-Healing Polymers Go Mainstream

by Diane Kukich

When Nancy Sottos, 86BME, 91PhDME, and her colleagues at the University of Illinois–Urbana Champaign submitted an article on their innovative polymer research to *Nature*, they weren't thinking about mainstream publicity or future commercialization. Their goal was simply to publish their work. However, the day before the Feb. 15 publication of *Nature*, the story of the "self-healing polymers" developed by the UI research team made the front page of *The Washington Post*.

Within days, press coverage had expanded to include more than 75 print, radio and television media, including *The Associated Press*, *The New York Times*, *National Public Radio*, *MSNBC*, *The BBC* and *The Discovery Channel* in Toronto. Sottos was getting calls from relatives who had heard her on the radio in Singapore and from students whose parents had spotted her on their local cable TV affiliates.

The materials that are getting so much attention are composites that can repair themselves when they crack or break. In this particular application of the self-repair concept, the materials are made up of a healing agent encapsulated in a pill-type form along with a catalyst embedded in the matrix of a structural composite. When the material cracks, the capsule ruptures and releases the healing agent, which then comes into contact with the catalyst, initiating polymerization and formation of a bond to seal over the crack. In this way, microcracks can be fixed before they turn into structurally threatening macrocracks.

According to Scott White, professor of aeronautical and astronautical engineering at UI and head of the research team that developed these novel materials, "Once cracks have formed within typical polymeric materials, the integrity of the structure is significantly compromised [because] these cracks often occur deep within the structure where detection is difficult and repair is virtually impossible. This technology could increase the lifetime of structural components, perhaps by as much as two or three times."

Sottos, associate professor of theoretical and applied mechanics at UI, contributed to the project by characterizing the micromechanical behavior of the embedded capsules and performing fracture tests to assess healing efficiency. Other team members included faculty from chemistry and aerospace engineering. "This was a truly multidisciplinary project," says Sottos. "I was well prepared for this approach to research from my experience as a graduate student at the University of Delaware in the Composites Center."

Sottos's graduate co-advisor, professor of chemical engineering Roy. L. McCullough, was not at all surprised to hear about his protégé's most recent success. "I was always impressed with Nancy's creativity and initiative," he says. "She has a good imagination and knows how to identify key issues. It was a real pleasure for me to work with her."

In an interesting twist, Richard Wool, professor of chemical engineering at UD, was invited to review the technology in the news and views section of *Nature*. Formerly on the UI faculty, Wool has no connection to the project or to Sottos; his opinion was sought based on his expertise in the area of polymer healing. Wool refers to the new material system as "ingenious" and says it has "far-reaching consequences for improving product safety and reliability." Wool was quoted along with White in the front-page *Washington Post* story.

In his review, Wool mentions potential applications of the work, including remote space stations, prosthetic organs, and bridges. Sottos acknowledges that commercialization is feasible, but it's obvious that's not where her focus lies. She's waiting for the commotion to die down so she can get back to her research and her teaching. For additional information, checkout Nancy's website <http://ssm7.aae.uiuc.edu/self-healing/>

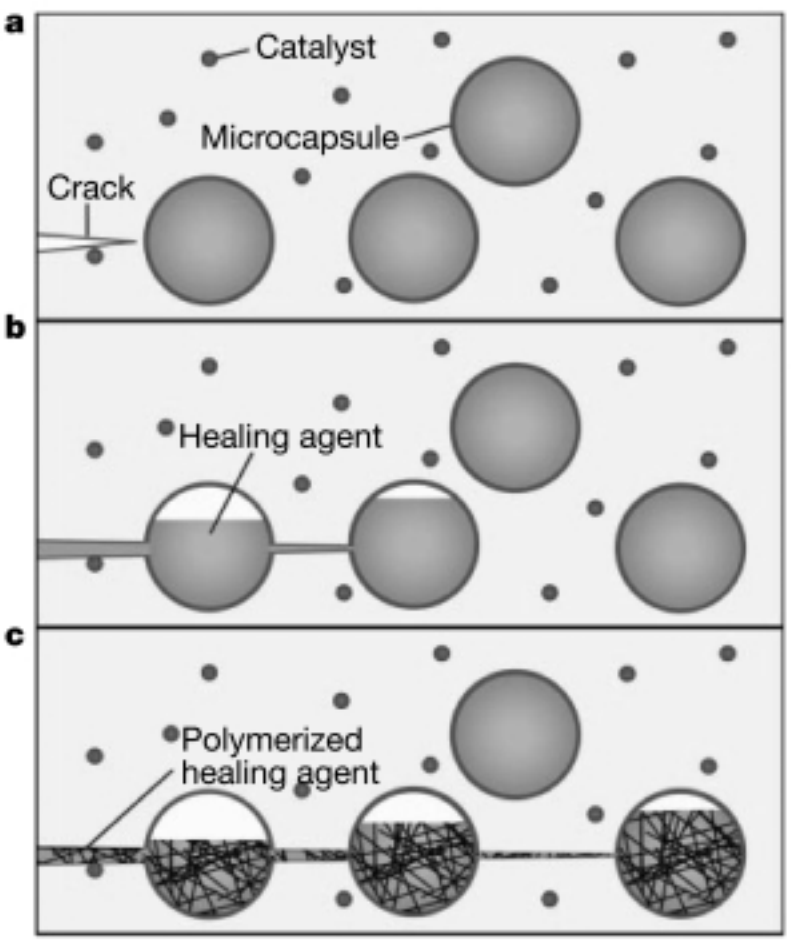
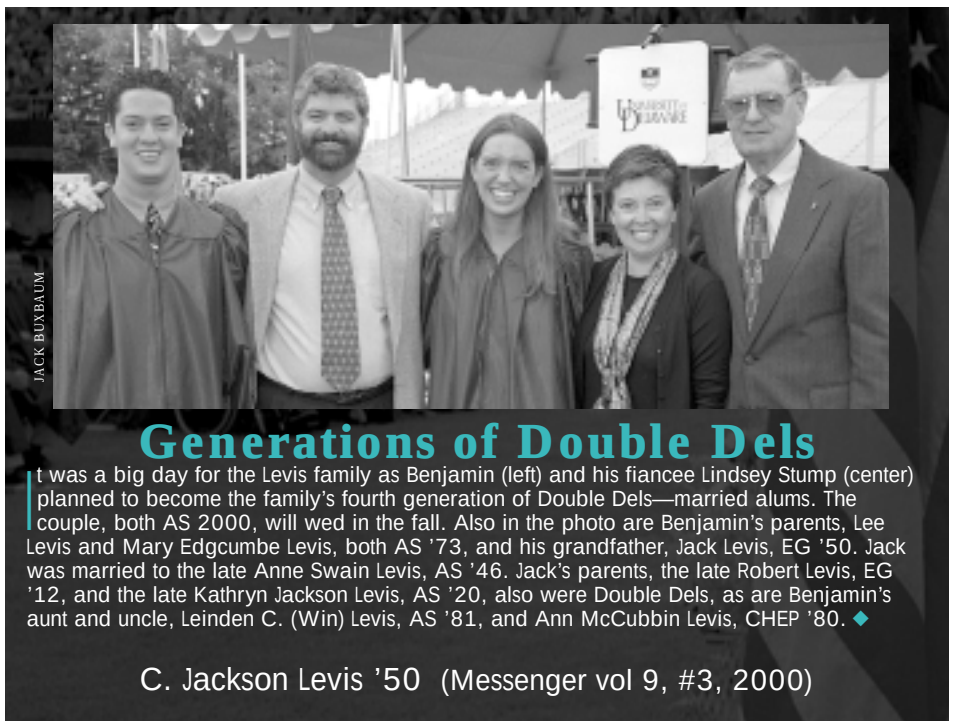


Figure from Autonomic Healing of composites · *Nature* http://ssm7.aae.uiuc.edu/self-healing/publications.html

The autonomic healing concept. A microencapsulated healing agent is embedded in a structural composite matrix containing a catalyst capable of polymerizing the healing agent. a, Cracks form in the matrix wherever damage occurs; b, the crack ruptures the microcapsules, releasing the healing agent into the crack plane through capillary action; c, the healing agent contacts the catalyst triggering polymerization that bonds the crack faces closed.



Generations of Double Dels

It was a big day for the Levis family as Benjamin (left) and his fiancee Lindsey Stump (center) planned to become the family's fourth generation of Double Dels—married alums. The couple, both AS 2000, will wed in the fall. Also in the photo are Benjamin's parents, Lee Levis and Mary Edgcumbe Levis, both AS '73, and his grandfather, Jack Levis, EG '50. Jack was married to the late Anne Swain Levis, AS '46. Jack's parents, the late Robert Levis, EG '12, and the late Kathryn Jackson Levis, AS '20, also were Double Dels, as are Benjamin's aunt and uncle, Leinden C. (Win) Levis, AS '81, and Ann McCubbin Levis, CHEP '80. ◆

C. Jackson Levis '50 (Messenger vol 9, #3, 2000)

John M. Pursell '49 – "It's All Relative"

by Nate Cloud

John Pursell wrote to us recently to ask if I would help find someone in the physics department who would be willing to review a short paper that he had developed on an aspect of relativity (the physics kind). I told John that I'd be happy to do this for him, and, as of this writing (4/27/2001), I am in the process of doing so. With John's permission, however, I thought I'd share part of his letter

Dear Nate,

I was very pleased to read in the Feedback column of the Winter 2000 issue of the Newsletter that you welcome information about alumni or articles to share. In addition to these, I have an unusual request to make of you.

I graduated from the University of Delaware in 1949 with a B.S. degree in Mechanical Engineering. I worked for a year for DuPont in Philadelphia as a construction engineer helping to build a concrete laboratory on Gray's Ferry Avenue.

My father worked for DuPont during the years 1934–1955 in the Wilmington du Pont building, and participated in planning part of the Hanford/Richland atomic facilities in Washington State in the 1940's. I attended A.I. du Pont High School, and our family lived on DuPont Road in Lancaster Village near Elsmere.

I drove to Seattle in 1950 and began working for Boeing on their KC-97 air-refueling tanker aircraft. After several moves within the company, I joined the newly created Systems Analysis, Operations Analysis Group (eight strong) in 1953.

Boeing had recently received their first vacuum-tube, mainframe computer, the IBM 701 (14,000 operations per second!), and many of us were fortunate enough to obtain on-the-job-training in the use of that machine. It could add, subtract, multiply, divide, and shift registers—and that was it. We were required to mentally keep track of where the decimal point (the binary point) was and to write our own algorithms for square root, trigonometric, and other functions.

I remained in systems analysis for over 30 years, learning from extraordinarily talented people in the fields of aerodynamics, orbital mechanics, mission analysis, radar, computers….

It was a marvelous and wonderful work experience.

Several years ago, I began as a hobby to study special relativity in "relativity-for-the-layman" style of books, and have since acquired nearly two dozen of these.

The books are often similar in the sequence of their presentation of material, and very early in the text appears a discussion of "simultaneous events." The geometry and mathematics of such are extremely simple. The discussion is easy to follow. But from the start, I have been unable to understand the conclusion at which the various authors arrive. For a long time I thought that there was a subtle something that I was missing, but if there were, I was never able to find it. A number of months ago, I hesitantly decided that the conclusion the various authors were drawing from their presentations was wrong….

John

Sorry, now that I have piqued your curiosity I have to tell you that we don't have space in the newsletter to go further with John's theories, but if you are interested you can get in touch with John at 206-325-5624 or through John's friend at nash@serv.net

Alumni Association

Upcoming Activities - Homecoming

Homecoming this year is October 13th. The Alumni Association & Faculty are planning a special event for ME Alumni that will include a gathering for fellowship and lunch. There is a limited supply of free tickets to the homecoming football game with Hofstra (tickets will be in an ME block). Please let me know by returning the feedback section below if you think you would like to join us for this event so that we can do some advanced planning. We will be providing more details later.

E-mail campaign

Most of you should have received a postcard from us asking you to return the card with your e-mail address. We also decided to supplement this with a phone call campaign. Undergraduates have been making the calls and we hope this hasn't been too much of an intrusion in your busy days! Our goal has been to build an interactive community of alumni of the Mechanical Engineering Department. When we started in early April, the ME alumni data base had about 250 e-mail adresses out of about 2500 active alumni; and 50 alumni had signed up on our alumni web site (http://www.me.udel.edu/alumni/index.msql). To date, over 500 email addresses are logged into our database, and over 100 alumni have signed up on the web site. Just one of the possibilities in the future is to be able to send a version of this Newsletter directly to you via e-mail, as other Universities are doing. We will be exploring other ways of using this capability for mutual benefit, while endeavoring to avoid the "downside" aspects of e-mail – intrusiveness and information overload. We welcome your ideas on maximizing the value of this capability. If you haven't done so already, please add your e-mail address to the feedback section below.

Number of UDME Alumni in our world continues to grow but is the downward enrollment trend reversing?

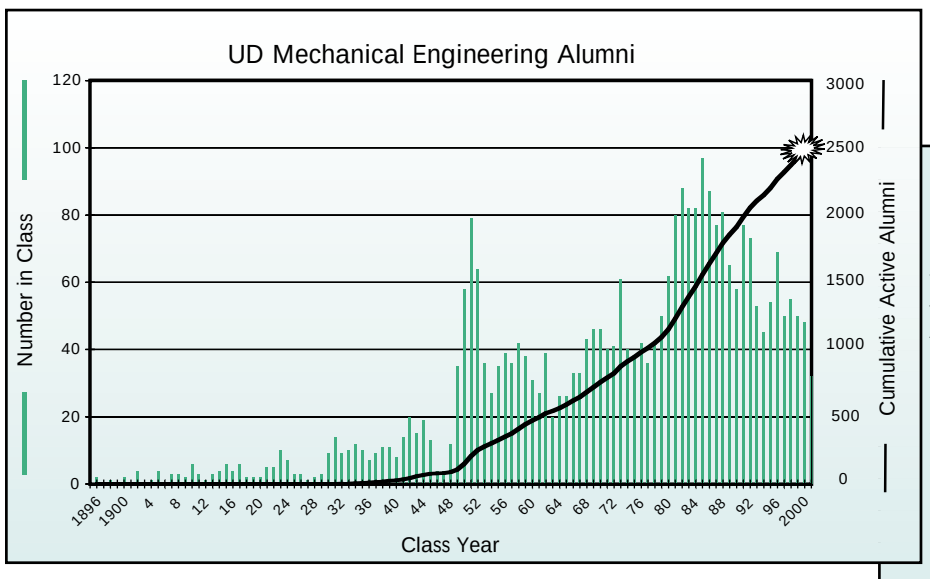
The graphic shown below is just one of the results of our recent efforts to better understand the demographics of our Mechanical Engineering Alumni community. The good news is that the number of active UD mechanical engineering alumni continue to grow—surpassing the 2,500 mark! In the process of looking over the alumni database it did, however, become apparent that there has been a downward trend in the graduate class size since the mid-eighties.

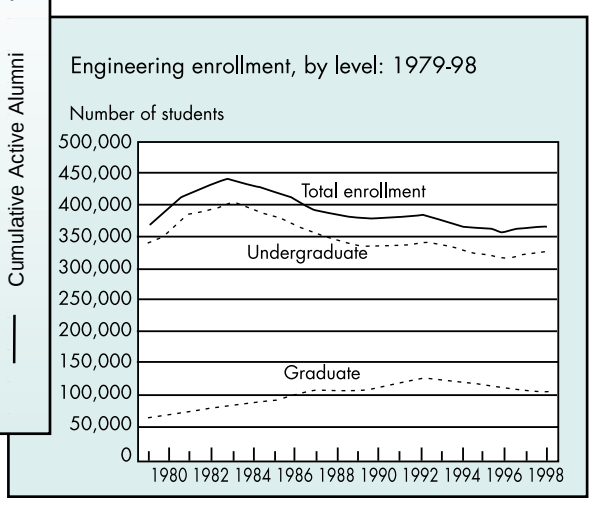
A brief search for some overall trends indicates that a downward trend has occurred for all engineering enrollment (about 20% in 15 years according to the American Association of Engineering Societies). AAES (http://www.aaes.org/) also presents data that indicates that mechanical has been the most popular engineering discipline based on the number of1999 bachelors degrees (~13,000 ME's vs. 2nd place, ~12,000 EE's).

The overall downtrend in engineering enrollment appears to be reversing in the past few years, however. In addition to the AAES data, Mechanical Engineering magazine (http://www.memagazine.org/), reports in a September 1999 editorial by John G. Falcioni that, "ME and engineering enrollment was trending upward."

We haven't researched this deeply enough to understand fully what has caused the downtrend since the 80s, but we would be very interested in your views on the subject— especially what you think will contribute to an upward direction at Delaware.

We also found it interesting to look back over the years and try to understand the reason for changes in the numbers of alumni in various class years. Some of the more senior folks on the faculty have suggested that some of the larger class sizes were due to Government programs following international conflicts—for example, the "GI bill" following WWII. What do you think about these trends? Please return the feedback section with your thoughts.





Graph from American Association of Engineering Sciences (AAES) - http://www.aaes.org

ALUMNI FEEDBACK - What's New With You?

Do you have any feedback (comments, questions)? Or let us know any current events or info not covered by the data sheet below.

_____

_____

_____

_____

_____

_____

❒ Yes, I'm planning to attend the homecoming event, on October 13 and would like to reserve _____ tickets to the football game. (tickets will be in an ME block)

INFORMATION FORM FOR THE DEPARTMENT'S RECORDS

Name _____
First Middle Last Maiden

Delaware Degree BME Date_____ MME Date_____ Ph.D. Date _____

Spouse's Name _____ DE Alum? _____

Mailing Address _____

Home Phone _____ E-mail _____

Company _____ Your Position _____

Mailing Address _____

Business Phone _____ Fax _____

E-mail_____ Web Address _____

Please identify if your company is an affiliate or subsidiary of a larger company _____

Return this form to: Nate Cloud, 126 Spencer Lab, University of Delaware, Newark DE 19716 and/or contact me anytime at cloud@me.udel.edu or 302-778-4567

Capital Campaign

by Wanda Mock, Director of Development, College of Engineering

The College of Engineering's rich academic tradition of excellence has been nurtured throughout its 90-year history by people who believed that the past and present are an integral part of the future. Now, one of the most important events in the history of the College is taking place: the College is working to reach a $45-million goal within the University's $225-million Campaign for Delaware. With the help of our alumni, we had nearly $30 million or 65 percent of our goal by the end of February, but we need your help.

The College's campaign steering committee recently held its third meeting. Representatives of the Mechanical Engineering Department serving the committee include Nate Cloud (64) and Jim Laser (69). Our dedicated volunteers invest hours of personal time, energy, and expertise in addition to their financial resources, and we are grateful for their participation. Currently, we have one open seat for another ME representative. If you would be interested in serving on this committee, please contact us.

And please consider joining our team in support of the college and the Department of Mechanical Engineering. Though you may never be aware of the impact you have on another's life, gifts of cash, appreciated securities, real estate, life insurance, annuities, trusts, and bequests all assist in the intellectual growth of our students. Simply put, your partnership in our common purpose will provide UD students with a better engineering education.

The future of the ME department begins with you. No gift is too small. In addition to the influence your gifts have on our students, your gifts also influence our national rankings and alumni satisfaction surveys. On behalf of the college, I thank you for your consideration and, again, ask for your support.

Honors Day Awards

SENIOR YEAR AWARDS

W. Francis Lindell Mechanical Engineering Award to the Distinguished Senior

J. Buckley
A. Kelly

Mary and George Nowinski Award for Excellence in Undergraduate Research

A. Kelly

Delaware Section of the American Society of Mechanical Engineers Senior Design Project

1st place (tie):
Team 1 = D.Cook, M. Dunson, J. Gordon, A. Yiournas
Team 9 = J. Buckley, M. H awley, C. Laboy, A. Martin
2nd place:
Team 8 = A. Cox, M. Petrova, D. Richard, W. Vilda

JUNIOR YEAR AWARDS

W. Francis Lindell Mechanical Engineering Award to the Distinguished Junior

S. Campbell

W. Francis Lindell Mechanical Engineering Achievement Award

M. O'Leary

Cordant Technologies Scholarship

D. Cintavey

SOPHOMORE YEAR AWARDS

W.J. Renton Award for Outstanding Sophomore

D. Forney

OTHER DEPARTMENT AWARDS

Delaware Section of The American Society of Mechanical Engineers Outstanding Student

F. Li

American Society of Mechanical Engineers Student Section

A. Kobetis

Robert T. Bosworth Scholarship

J. Rochester

Redden Scholarship

J. Feser

COLLEGE AWARDS

Bangalore T. Lakshman

A. Barkley

Conectiv Power and Light Scholarship

T. Shipman

Liston Houston Scholarship

D. Das

Panel of Distinguished Seniors

J. Buckley

RISE Corporate Friends Award

A. Barkley

George W. Laird Merit Fellowship

Jingbo Wang

NEWS
mechanical engineering

Department of Mechanical Engineering
University of Delaware
Newark, DE 19716-3140

NONPROFIT
ORGANIZATION
U.S. POSTAGE
PAID
NEWARK, DE
PERMIT NO. 26