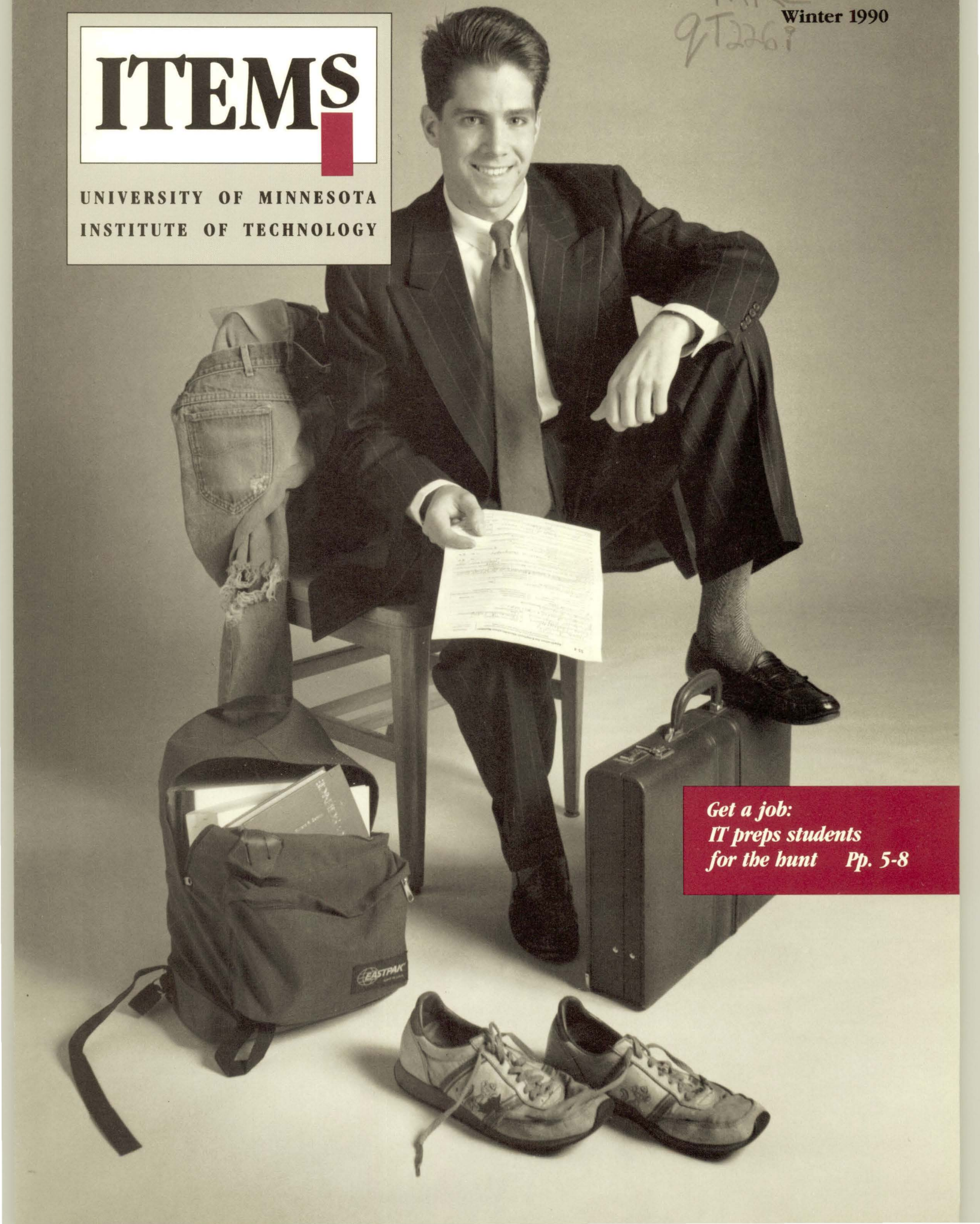
Winter 1990

ITEMS

UNIVERSITY OF MINNESOTA
INSTITUTE OF TECHNOLOGY



Get a job: IT preps students for the hunt ***Pp. 5-8***

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ITEMS

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Cover photograph by Tom Foley

Items is published three times a year to inform Institute of Technology alumni and friends about news, interesting alumni and faculty, and relevant issues. Letters to the editor, requests to receive *Items*, and notices of address changes should be sent to the Office of External Relations, Institute of Technology, 107 Walter Library, 117 Pleasant St. S.E., University of Minnesota, Minneapolis, MN 55455. *Items* welcomes letters and ideas from all readers.

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About the cover: Starting a job search demands a big change in wardrobe for most IT students. Working in his Minneapolis studio, photographer Tom Foley captured this image of the transformation that takes place when students head out on a job search.

NEWS

The "shaky" story behind Ford's success

Science and Technology Day has evolved into a multipurpose event for Institute of Technology Alumni Society (ITAS) members. Both an annual meeting and a fundraiser, the event also provides an opportunity for members to socialize and renew old acquaintances. However, the 1989 edition, held November 2 at International Market Square in Minneapolis, provided attendees with a new twist. The 700-odd students, alumni, and friends of the Institute got an insider's account of how Ford Motor Co. executives managed, in just three years, to take the company from the brink of financial ruin to a state of fiscal health most American executives would find enviable.

The remarks of keynote speaker Allan D. Gilmour, executive vice president for Ford, may have come as a surprise, considering Ford's recent success. With roughly $20 billion in earnings during the past six years, Ford Motor Co. is riding high among the Big Three—Chrysler Corp., Ford, and General Motors—in the American automotive industry. As recently as 1982, however, Ford was losing dollars by the millions. In 1981, Ford lost $1 billion and, in 1980, at the nadir of the downturn, $1.5 billion.

"Our tower of success was on very shaky ground," said Gilmour, in a deft stroke of understatement. "It was leaning badly."

The troubles for the automotive industry started with the Iranian revolution, according to Gilmour. Crude oil prices soared, interest rates rose to record levels, and a recession set in. The cost of car ownership jumped 64 percent in a four-year span. Chrysler's woes were well publicized as the company teetered on the brink of financial ruin. Perhaps less well known was the fact

Allan Gilmour, Ford Motor Co. executive vice president, told the audience at Science and Technology Day the inside story behind Ford's financial turnaround in the early 1980s.

that Ford was not far behind. The cumulative losses of 1980-82, more than $2.6 billion, got Ford executives thinking "survival."

Management decided that if the company was to survive, they would have to get back to basics, Gilmour said. They recognized that management skills had been allowed to erode and the Ford product had suffered. At the top of the list of changes was a new emphasis on quality.

"We learned there's no market for lousy cars—because we tested it," Gilmour said. "Quality doesn't cost, it pays."

Along with the emphasis on quality, Ford reexamined some of the other "basics" and implemented numerous changes, some of which were drastic. More effort was poured into design to improve the desirability of Ford products. They closed plants and reduced their work force by 70,000. Efforts were made to establish better relationships with dealers and suppliers. One of the most effective changes, however, was what Gilmour called a turn to more "participative management." Assembly-line workers were given access to the controls to stop the assembly line when problems arose—a function previously performed only by supervisors. That simple policy change created a 97 percent drop in quality adjustments and drastically reduced union grievances.

"We told employees, 'We need you and your best efforts and ideas,'" Gilmour said.

With a little boost from a revived economy, the return to basics moved Ford into the black in 1983 "with a vengeance," and has kept them there since.

"There's no room for complacency or inaction," Gilmour said. "We're enjoying a level of success, but we can't afford to sit back and take a breather. In the case of the tower of success, it ain't over until it's upright."

Although Gilmour's speech was the highlight of the evening, the audience also heard remarks from Institute of Technology dean Ettore F. Infante and Steven Goldstein, president of the Minnesota Alumni Association. ITAS awarded five scholarships to undergraduate students. Mary Arsenault, a computer science freshman, and Michael Collins, a freshman in astrophysics, were named Undergraduate Assistant Scholars. Nathan Belk, a senior in physics, Kristine Gordon, a junior in chemical engineering, and Brian Olson, a senior in aerospace engineering, were awarded Mary G. Childs Endowment Scholarships.

At the end of the Science and Technology Day activities, outgoing ITAS president Russ Susag turned the gavel over to Tom Rusch, 1990 ITAS president. Rusch, a product manager for surface analysis and ultra-high vacuum components at Perkin-Elmer in Eden Prairie, received bachelor's, master's, and Ph.D. degrees in electrical engineering from the University. I

Chair donors honored

University supporters who helped establish two of the University's newly endowed chairs were honored in ceremonies fall quarter. In September, William Norris, former chair of Control Data Corp. (CDC), was honored for his efforts to establish a chair in supercomputing—the William C. Norris Land-Grant Chair in Large-scale Computing. Funds for the endowment were raised during a ten-year period with help from CDC (a major contributor) and the St. Paul Chamber of Commerce. Norris was presented with a chair sporting an inscribed plaque that cites Norris as "an inspiration to entrepreneurs for his insight and accomplishments in the computing and information processing industry."

In October, major donors to the ERA Land-Grant Chair in the History of Technology—Adelle and Erwin Tomash, Mildred and Willis Drake, and Patricia and Frank Mullaney—were honored at the Charles Babbage Foundation Annual Dinner held at the Minneapolis Institute of Arts. The Tomashes and the Drakes were presented with inscribed chairs citing them for their generosity and dedication to the University. The Mullaneys received an inscribed sterling silver medallion also citing them for their contribution. I

Photos by Patrick O'Leary

Top: **Left to right, Arthur L. Norberg, Charles Babbage Institute director, Leonard V. Kuhi, senior vice president for academic affairs, Adelle Tomash, IT dean Ettore F. Infante. Seated: Erwin Tomash.** ***Middle:*** **Infante, Patricia Mullaney, Frank Mullaney, Kuhi.** ***Bottom:*** **Kuhi, Mildred Drake, Infante. Seated: Willis K. Drake.**

Missed a lecture? No Sweatt

If you missed hearing Lester Thurow's theories of technology leadership or Lewis Branscomb's opinions on dual-use technology, don't worry. The Center for the Development of Technological Leadership (CDTL) now offers monographs and videotapes of the Distinguished Honeywell W.R. Sweatt Lectures in Technology Leadership.

The lecture series began in 1988 with four lectures per year. Monographs of each lecture are free for the first copy, $3.00 each for between two and 10 copies, and $2.50 each for more than 10 copies. Videotapes can be rented for $30.00 per tape (VHS format). For ordering information, rental policy, and a list of lecture titles, write to CDTL, University of Minnesota, 107 Lind Hall, 207 Church Street S.E., Minneapolis, MN 55455. I

Noted

The Center for Transportation Studies is sponsoring and hosting a Transportation Research Conference May 2-3, 1990, at the Saint Paul Hotel, St. Paul. The inaugural conference is to be a multidisciplinary transportation conference for state, regional, and local agencies; private sector consultants, shippers, carriers, and providers. The conference is open to all University faculty and staff members and students.

■ Philip M. Gresho was the George T. Piercy Distinguished Professor fall quarter in the chemical engineering department. Gresho is with the Lawrence Livermore National Laboratory, Atmospheric and Geophysical Sciences Division, Department of Physics. He is renowned for his work in computational fluid dynamics and the finite element method. ■ A dedication ceremony noting the completion of the remodel-

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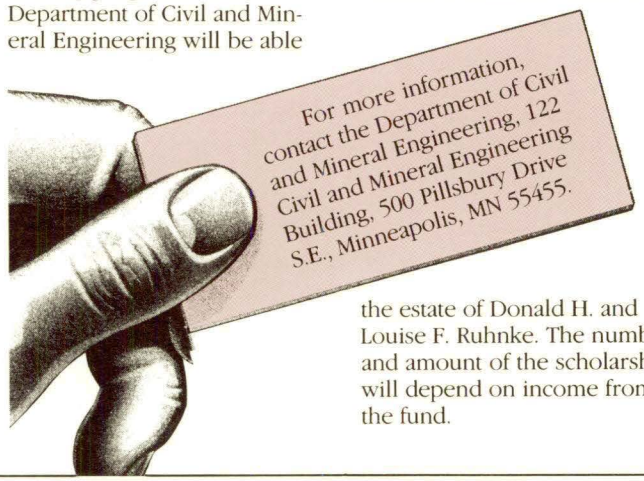
ing of Amundson Hall was held October 13, 1989. ■ Electrical Engineering's Center for Micromagnetics and Information Technologies received an IBM Departmental Grant of $25,000 for "it's excellent research work in areas of interest to storage technology, primarily in the study of thin film materials." ■ Dennis M. Cavanaugh, recently retired president and chief executive officer of Soo Line Corp., has been named a research fellow for the Logistics Management Research Center and Center for Transportation Studies. ■ The Minnesota Geological Survey is conducting an aerial survey of Earth's magnetic field over much of southeastern Minnesota. The survey will gather data regarding variations in the magnetic field caused by variations in the bedrock geology. The data will help exploration companies locate areas likely to contain mineral deposits. ■ The Institute for Mathematics and its Applications (IMA) has announced that it is seeking to fill four one- to two-year postdoctoral positions in Industrial Mathematics. The positions are supported by funding from the National Science Foundation, Honeywell, Inc., and 3M. Contact IMA for more information. ■ The Minnesota Supercomputer Institute awarded 19 Visiting Research Scholarships for 1989-90. ■ The Local Road Research Board awarded $200,000 to support development of the Minnesota Road Research Project (MRRP). MRRP is a joint project between the Minnesota Department of Transportation and the University to develop pavement design and management strategies for a cold climate. ■ Hou Xuxuan, head of the Department of Geotechnical Engineering at Tongji University in Shanghai was a guest lecturer in the Department of Civil and Mineral Engineering during a two-week visit fall quarter. I

New scholarship opportunity

University students in the mineral and geological engineering programs of the Department of Civil and Mineral Engineering will be able to apply for a new scholarship beginning spring quarter, thanks to an endowment from the estate of Donald H. and Louise F. Ruhnke. The number and amount of the scholarships will depend on income from the fund.



Donald Ruhnke, deceased, graduated from the University with a bachelor's degree in metallurgical engineering in 1925 and master's degree in 1933. Louise Steiner Ruhnke graduated from Winona State Teachers College.

The Ruhnkes' niece, Susan Steiner, described her uncle as "a very disciplined, conservative, and kind man. His family was poor and his college education was a struggle. He was an inveterate reader and held education in high regard. In this gift to the University, he desired to help others on the path to an education." I

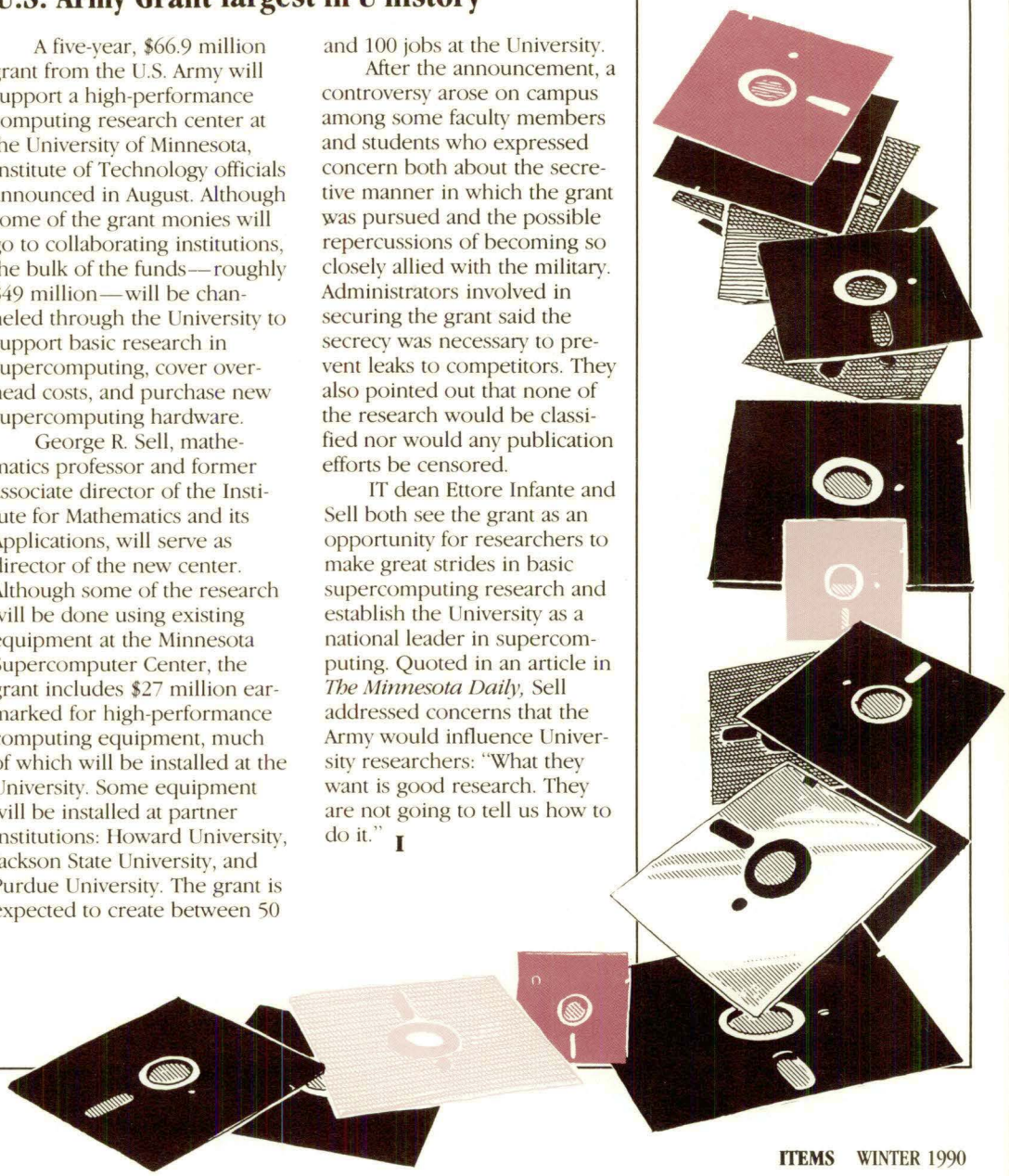
U.S. Army Grant largest in U history

A five-year, $66.9 million grant from the U.S. Army will support a high-performance computing research center at the University of Minnesota, Institute of Technology officials announced in August. Although some of the grant monies will go to collaborating institutions, the bulk of the funds—roughly $49 million—will be channeled through the University to support basic research in supercomputing, cover overhead costs, and purchase new supercomputing hardware.

George R. Sell, mathematics professor and former associate director of the Institute for Mathematics and its Applications, will serve as director of the new center. Although some of the research will be done using existing equipment at the Minnesota Supercomputer Center, the grant includes $27 million earmarked for high-performance computing equipment, much of which will be installed at the University. Some equipment will be installed at partner institutions: Howard University, Jackson State University, and Purdue University. The grant is expected to create between 50 and 100 jobs at the University.

After the announcement, a controversy arose on campus among some faculty members and students who expressed concern both about the secretive manner in which the grant was pursued and the possible repercussions of becoming so closely allied with the military. Administrators involved in securing the grant said the secrecy was necessary to prevent leaks to competitors. They also pointed out that none of the research would be classified nor would any publication efforts be censored.

IT dean Ettore Infante and Sell both see the grant as an opportunity for researchers to make great strides in basic supercomputing research and establish the University as a national leader in supercomputing. Quoted in an article in *The Minnesota Daily,* Sell addressed concerns that the Army would influence University researchers: "What they want is good research. They are not going to tell us how to do it." I



Get a job!

IT spruces up its placement services

Herbert Harmison is pretty blunt when he speaks about the history of IT's placement office. "It long has been an orphan," he says, shuttled around and isolated, lacking a budget of its own, decent quarters, or any interest on the part of the Institute's deans.

Dean Ettore Infante is even more blunt when talk turns to the placement office. "When I first came here five years ago, I looked at the placement office and thought, 'Oh my God.' It was probably the worst placement office of the hundred universities I had visited in my life."

That was then. Today, the IT placement office has come into its own. No longer isolated in a remote corner of campus, it has been reborn near the hub of IT activity in Lind Hall. Everything about it is new. It is housed in a stylish suite of rooms outfitted with the helping hand of a decorator. It is run with a new, computerized registration system. And, for the first time, it has a full-time director.

After a national search for just the right person, IT found Herbert Harmison, a 20-year veteran of placement services who was ready for a new challenge after having built a model program at Iowa State University. Harmison, who stands 6'5" and admits to being fifty something, commutes to work on a secondhand, blue Schwinn bicycle. One glimpse of him at work in his office, and it's easy to see he's a no-nonsense kind of guy with a penchant for computers. With his desk top and bookshelves loaded with boxes of computer discs, he swivels his desk chair between the IBM and Macintosh that he keeps in constant use. Harmison has a strong sense of his ability to do the job. "I could even find jobs for English majors," he boasts.

Such self-assurance will be a definite asset as he tackles the job he started last July. After years of neglect, there's a lot that has to be accomplished before the placement office is in true working order, he says. When his mission is accomplished, Harmison hopes that the University will have an IT placement office that ranks among the best in the country.

His plans include doubling the number of recruiters who visit campus and establishing an endowed chair in placement. He believes an endowed chair would guarantee an independent budget for the office and ensure that it never again reverts to its orphan status. Harmison will consider his tenure in the job extremely successful if, when he leaves, IT placement has the funds to hire the best placement director available and to provide services and facilities unsurpassed in the country.

The new placement headquarters, as well as a newly refurbished tutoring room one floor above the placement office, are part and parcel of dean Infante's plan to create an appealing environment for students. "When I came here five years ago, the undergraduate experience at IT reminded me of the kind of experience one has at the Port Authority (bus terminal in New York City)," Infante says. "It's effective

Photos by Tom Foley

By Miriam Feldman

and efficient. You get your transportation. But it sure gives you the creeps."

Kathy Clinton, the assistant director of placement, agrees that the old offices were terrible. Recruiters interviewed students in tiny cubicles, which offered little privacy and no escape from the surrounding noise. The new placement office has 16 private interview rooms, each decorated in soothing pale blue and dusty rose tones and art that was hand-picked by Clinton and a decorator. Recruiters are impressed with the space, Clinton says. Harmison calls them the best interview rooms in the country.

Dean Infante saw that there was a need to fix up the placement office, and he went ahead and did it, Harmison says. "He's a student-oriented dean, and that's reflected in his willingness to fix up the placement office and the national search for a director."

Likewise, the process for using services offered by the placement office has also been revamped. Last year, 172 companies from around the country came to Minnesota. It used to be that getting an interview with a company representative was an ordeal for IT students. The sign-up process was on a first-come, first-served basis, which meant students often had to stand in long lines. If they weren't quick enough, they often failed to get the interviews they wanted. That's changed. Now a new computerized system allows students to register anytime during a two-day period for up to four interviews per week. When recruiters visit the campus during the fall and winter each year, students have a fair chance at getting the interviews they want.

Kathy Clinton, assistant director of placement, sees a mixed market ahead for IT graduates.

Given Harmison's fondness for computers, it's not surprising that most of the office's services are computerized. From the moment the students walk in the door, they begin interfacing with a computer. Students register with the placement office by purchasing a $2 floppy disc that contains the format for entering everything an employer might want to know. Once completed, it is turned over to Harmison, who copies it and, within seconds, returns it to the student for future revision. The 1,000 students who are currently registered can expect to have their resumes sent to a prospective employer at any time, either via the placement office or the Human Resources Information Network (HRIN)—a national job search database in Indianapolis. Minnesota is one of 20 schools that provide information to HRIN.

With the information tucked away in his computer, Harmison is now ready to start serving his other constituency—employers. When a call comes in from the plastics division of Ford Motor Co. for electrical and mechanical engineers, for example, Harmison can automatically extract a list of appropriate candidates who will be graduating in the coming months. The information, which fits on one disc, is sent to the company later that same day.

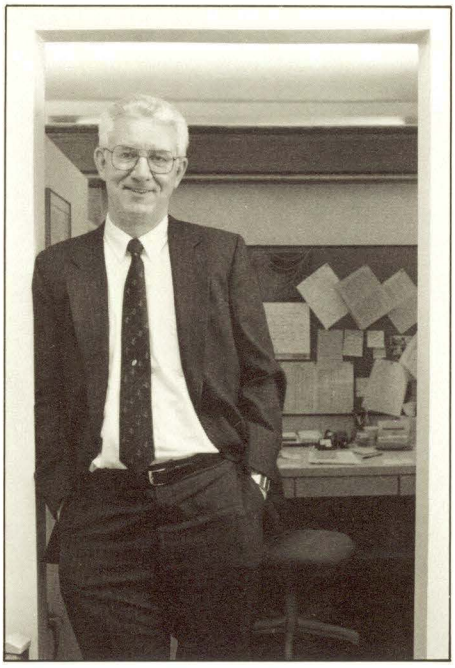
Clinton estimates that 33 to 40 percent of those registered with the placement office manage to land jobs through the service, although it's difficult to calculate since students are not required to inform the placement office once they accept a position.

But helping students find jobs is not the sole function of the placement office. It also counsels students, holds resume and letter-writing seminars, works with alumni (see "Alumni welcome at IT Placement Office, too"), and networks.

Networking is by far the most intangible service a placement office can provide, but it may be the most important. It's something Harmison does well. "When you've been in the business 20 years, you know a lot of people, and a lot know you," he says. Calls from recruiters are not simply a random occurrence.

When he came to Minnesota, Harmison brought with him his membership in a group that meets periodically to discuss placement issues. The group, which is composed of about 15 employers from Fortune 100 companies and 15 placement officers from top universities, mulls over the gamut of placement issues, including drug-testing policies, written pre-employment testing, effective recruiting, interviewing policies, and immigration rules. Members also keep each other informed on recruiting forecasts.

When it comes to forecasts, Harmison is reluctant to predict the future, although he concedes that the current market for IT graduates is soft. A recruiter at a large auto company recently informed him that it had cut its initial hiring goal by two-thirds, he says. And recent events in Soviet Bloc countries, which seem to spell the end of the Cold War, mean the defense industry will be in a decline. The computer industry is also in a slump.



Herbert Harmison, director of placement.

Harmison is far from despairing, however. As he sees it, when one market goes soft, another one will rise in its place. "People no longer doing defense work will have to figure out something new to do," he says. "What they come up with will be a heck of a lot more productive and fun and improve our standard of living."

Clinton, who has been working in the placement office for the past six years, sees a mixed job market ahead that will be better for some majors than others. Mechanical and electrical engineers and computer science majors will be affected by the slump in the computer industry. But chemical engineering students will find a strong market, Clinton projects, because there are fewer of them, and hiring is up. Oil companies started recruiting again last year, and opportunities exist in food and pharmaceutical companies.

Although 56 percent of the students who responded to a placement office survey last year reported that they found work in Minnesota, a softer market in some fields may mean that more students will have to leave the state to find work, Clinton says. The ones who leave tend to go to California or Texas, although students typically find work in about 25 states.

Honeywell Inc. is always a top local employer of IT graduates, as is Rosemount Inc. Several smaller local companies have shown an interest in IT graduates, including Braun Engineering, Data Card Corp., and USE Inc., Clinton says.

If Harmison is correct, the current crop of students can expect "a very dynamic career pattern." No longer will an IT graduate take one job and settle down for

life or even remain in one field of work throughout his or her career. Today's students must be flexible and realize they might have multiple changes in their careers throughout their lives. For example, a chemical engineer starting out in a chemical plant may end up in a marketing position, Harmison says. "The very prudent person in today's world will continue to learn broadly in their chosen field," he says, in order to maintain a competitive edge.

That's as far as Harmison will go in offering predictions. Just where the job market is headed, he refuses to say. "That's a very tough question to answer," he says. "What's the market for a given discipline? What's the market for experience versus inexperience? What's the market geographically? What's the market industry by industry? It gets tough to say anything definite."

But don't think he hasn't been asked. Parents often call Harmison, wondering what fields will lead to good jobs after graduation. But he digs in his heels and refuses to answer. With four children of his own—all grown and working, thank you—he advises parents to do what he did. "Let the kids decide what they want to do."

Harmison's motto could easily be "do what you like, and the money will follow," but he phrases it this way: "If you're good at it and enjoy doing it, someone's going to hire you." Enthusiasm is the best qualification for a job, he says.

At that, Harmison reaches over and pulls out a copy of Studs Terkel's book, *Working*. The book opens easily to a well-marked passage in which a factory owner is describing his attitude toward work. Harmison reads aloud: "Saturdays and Sundays are the worst days of the week. It's a long weekend because I'm not here. I bum around, see movies, go to somebody's house, but I'm always waiting for Monday."

Harmison wants you to know that he's like that factory owner—always itching to get back to work. And if he succeeds, plenty of IT students should find the kind of jobs that keep them waiting for Monday, too. I

Miriam Feldman is a free-lance writer who lives in the Twin Cities.

Alumni welcome at IT Placement Office, too

Shell shock. That's what it's like when a person gets laid off or quits a job, says IT's placement director, Herbert Harmison. "When people get laid off or quit, they go into a state of hibernation that lasts anywhere from two weeks to three months. They do nothing," he says.

That's when Harmison gets busy. He spends much of his time plugged into a computer, extracting information on job openings. And almost as much time listening to and advising students and alumni about their careers. With a new alumni placement service begun just this year, Harmison wants to get the word out that if IT alumni are looking for work, he's there, ready to help.

"I would encourage them to get in touch with us immediately. They need to understand that losing a job is a grieving process that they have to go through." But, at the same time, should also be going through an active job search, he advises.

Harmison knows that losing a job can be disorienting. "It's like being hit on the head with a baseball bat," he says. "But if you get with it and get going, you're going to survive more intact."

The idea to initiate a placement service for alumni came about one day when associate dean Russell Hobbie received a call from an IT graduate who wanted to relocate from Silicon Valley to the Midwest. The call followed on the heels of one from a local employer who mentioned how difficult it was to attract engineers with experience to the Midwest. "Something clicked," Hobbie says. The need to assist alumni with their career changes could be easily met through the placement office.

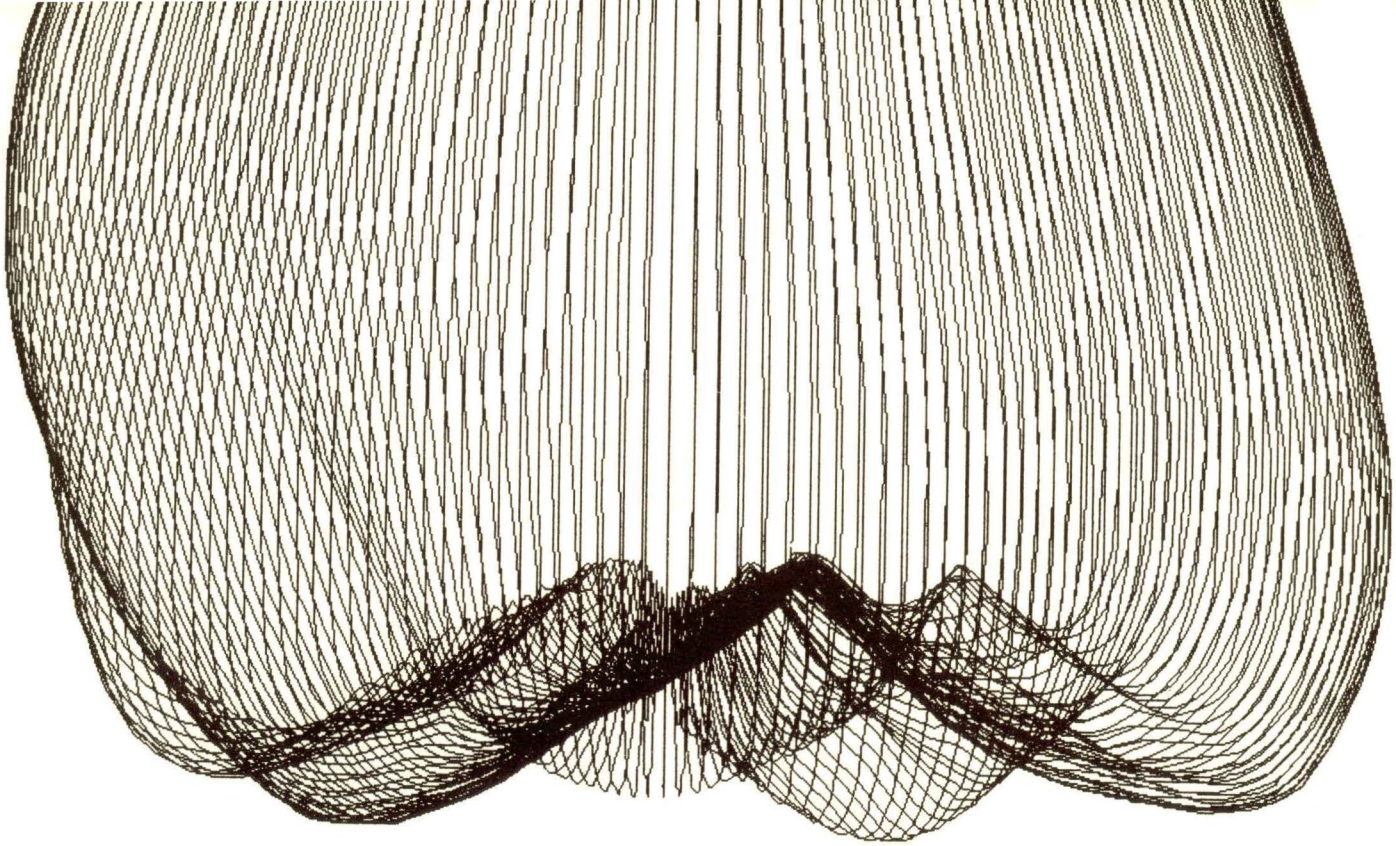
About 150 alumni are currently registered with the placement office and have their resumes logged onto floppy discs. When Harmison receives a call from an employer, he quickly scans his file and ferrets out the appropriate job candidates. At the same time, the registered alumni receive a weekly listing of job openings throughout the country as well as feedback on their resumes, if desired. All services are offered free of charge.

Harmison is proud of the system. "It's about as slick as I can imagine," he says. "If you can tell me how to make it better, I'm all ears. But I don't think you can."

About three or four alumni call the office every day. "I've gotten a number of calls from alumni who have been laid off recently," says Kathy Clinton, assistant director of the placement office. "I think they feel good about having a place to call," she says. "It makes them feel good that they can come back."

For more information on how to register with the IT Placement Office, call, drop in, or write: IT Placement Office, 50 Lind Hall, 207 Church Street S.E., Minneapolis, MN 55455; (612) 624-4090. I

By Miriam Feldman



A crowning achievement

Taking the "bite" out of getting a dental crown

While skiing in Oregon a couple of years ago, Chris Rekow took a fall that sent his front teeth through his lip. The then 16-year-old Twin Cities resident went straight to a dentist. Reading his name on a form, the dentist said, "Rekow. Isn't that the name of somebody in Minnesota who has a new system to make teeth?"

"That's my mom!" said Chris, incredulous that an Oregon dentist should have heard of his mother.

"I think Chris just about fell over," laughs Dianne Rekow, a mechanical engineering graduate and School of Dentistry assistant professor. "I must say, it's nice when you can impress your son."

Not to mention the entire world of dentistry. But then, fame comes with the territory when you're putting together what may be the world's best hi-tech system for making dental crowns. Rekow heads one of three leading teams—along with one from France and one from Switzerland and Germany—each developing a computer-guided system to cut the time, money, fuss, and bother that go into molding a well-fitting crown.

Mechanical engineering professors Arthur Erdman and Don Riley, along with associate professor Barney Klamecki, are her main partners in the project. The four have formed a company called Digital Dental Systems (DDS) to market the system once fully developed. With the United States alone producing about 30 million crowns every year by Rekow's estimate, their work could have a staggering impact.

Currently, crowns are cast in molds in a process similar to the making of sculpture and jewelry. And like those processes, says Rekow, the creation of crowns is more art than science, with chances for error every step of the way. At the first visit, a dentist removes the decayed part of a tooth and cuts the remainder down to a peg. Next, he or she takes an impression of the entire mouth by putting a putty-like material in the patient's mouth that feels "like cold mashed potatoes," says Rekow.

The impression is then sent to a dental laboratory, where dental technicians make a plaster impression of the peg. Then, they create a wax pattern on the plaster cast of the peg, making sure it meshes properly with other teeth. Next, the wax pattern is put in a mold, and the mold is used to form the crown. This casting process sometimes fails due to cracks or bubbles that persist in the melted crown material as it cools in the mold. The whole process takes about a week, during which time the patient must wear a temporary crown, which may fit poorly and even come off. At the second visit, the dentist removes the temporary and seals the permanent crown to the tooth stump using an adhesive.

For a successful job, two factors are critical: (1) The outer surface of the crown must mesh with other teeth and allow proper chewing motions; and (2) the inner surface of the crown must fit against the tooth stump so closely that the dentist cannot feel any gap when running a fine probe along the border. This last requirement poses the toughest challenge. A gap can mean not only a poor fit, but an open door for bacteria and other microbes to invade the tooth stump.

By Deane Morrison

Thanks to skillful dentists and dental technicians, the process usually produces a reasonable facsimile of the original tooth. However, to a computer-aided design/manufacturing (CAD/CAM) researcher like Erdman, the possibilities for improvement were irresistible.

"I was working on robotics and vision systems in the late '70s," he says. "One day when I was in the shower, it struck me that instead of casting crowns and caps in molds, we could use imaging to locate all points of a tooth surface in space." In other words, it would be possible to take pictures of a tooth stump and neighboring teeth, feed the data into a computer, and let it figure out how to cut a crown to match those points. A great engineering problem, but one that could sure use some help from somebody trained in dentistry.

Enter Rekow, an engineer who, after working in several positions at FMC Corp. and Medtronic, decided around 1978 to leave industry to pursue dentistry. But in order to be accepted in the University's dental school, she needed courses in biology and chemistry, and figured she might as well get a master's in mechanical engineering while she was at it. Department head Richard Goldstein directed her to Erdman, and a dream team was born.

"It's been a fascinating challenge to put together areas I was interested in," says Rekow, whose work on this project contributed toward a Ph.D. degree in biomedical engineering in 1989. "I can see possibilities that a person with only a dental degree or an engineering background couldn't see."

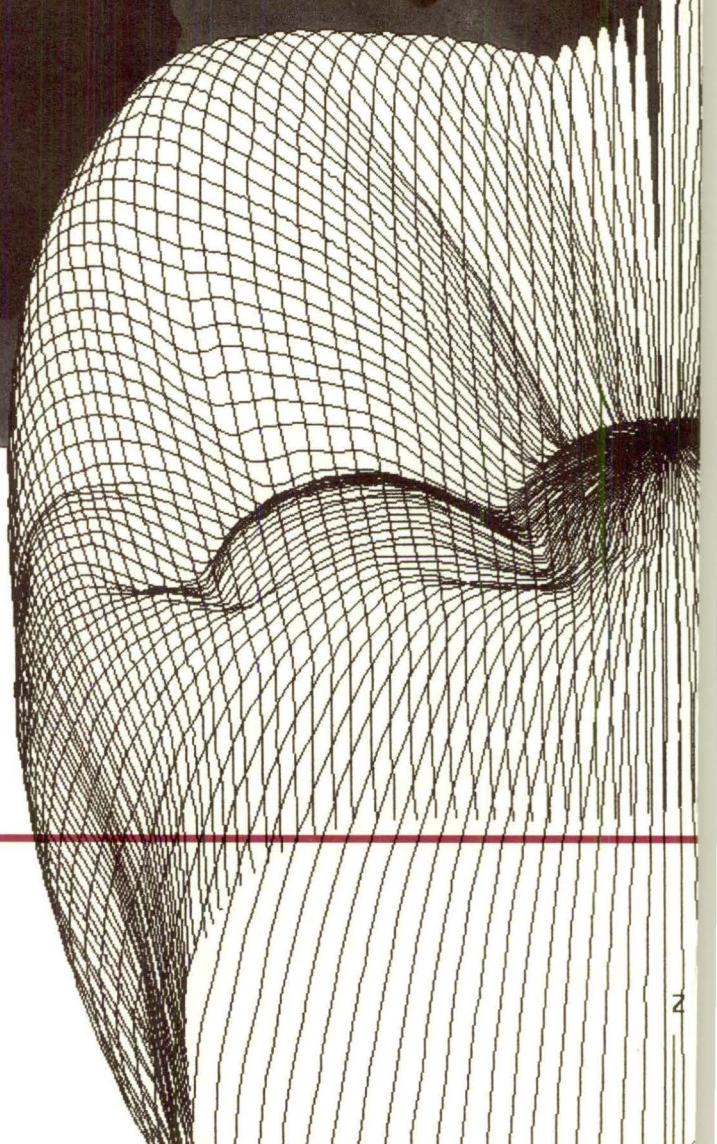
The system she and her colleagues developed takes Erdman's vision of imaging a tooth as a departure point. They aim to put more science into crown design to reduce the margin of error and to remove some of the worry associated with dental visits.

"We're proposing to eliminate impressions by using a special lens to photograph the tooth and surrounding area from at least two angles," Rekow says. "Then you can create models of the teeth with a computer. A CAD/CAM system can produce the pattern. The computer can then direct a milling machine to cut the block of crown material to the pattern.

"A milling machine has a cutting tool called a burr that moves up and down while the block underneath moves back and forth. One of the big challenges is to design a system that directs the burr in what we call the optimal tool path. That is, the burr should follow the shortest, most efficient path so that the crown can be cut as fast as possible without breaking the cutter or distorting the material.

Photo by Daniel Corrigan

These paper-mache tooth models, constructed by School of Dentistry emeritus professor Fred Noble, convey a sense of the complicated shapes crowns must match, but the research team does its modeling on a computer. Left to right, Dianne Rekow, Barney Klamecki, Arthur Erdman, Donald Riley.



"That changes a nine-hour process to a one-hour process, giving patients a same-day crown. It would mean people wouldn't have to summon their courage to go to the dentist twice."

"I envisioned something like Lens Crafters," says Erdman. "The type of thing where you could go to a dental clinic, perhaps in a shopping mall, and get a crown while you wait."

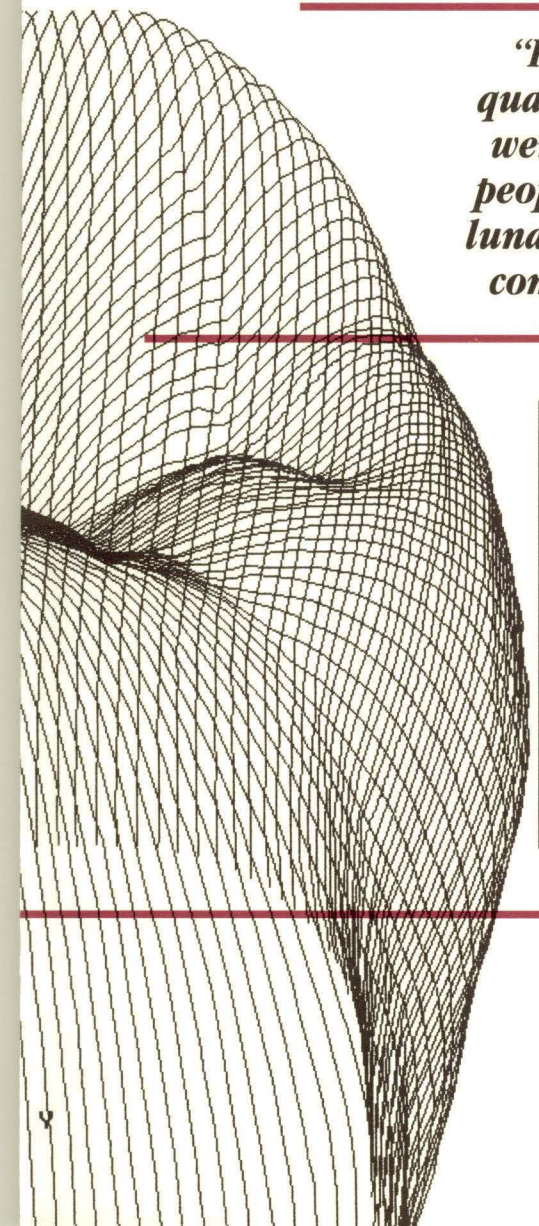
Computer-designed crowns command another advantage, at least from the engineer's perspective, say Rekow and Erdman: They pave the way for new and better materials. Now, crowns must be made from "castable" materials, such as gold, that can be melted down and reformed in a mold. But CAD/CAM crowns can be made from any substance that mimics real tooth material and can be milled.

Of course, the path to dental heaven has been fraught with earthly setbacks in the trial-and-error stage. For example, an early experiment tested a milling machine that used a diamond-edged cutter to carve the crown.

"The ten-dollar diamond chips were held onto the cutter by silver solder," Rekow says. "The diamonds were fine, but we didn't realize what would happen if things went too fast and heated up. After two revolutions of the cutter, the silver melted and the rest is history. But then, knowing what doesn't work is always valuable."

Another early bugaboo was identifying a place to publish their findings—promising or otherwise. Neither engineering nor dental literature offered a good niche for such a highly interdisciplinary subject, Rekow says. But even more than that, support from colleagues in engineering and dentistry fell short of universal. "For the first three-quarters of the time we were working on this people thought we were lunatics," she laughs. "Then they did a complete about-face. Now, I take between two and four trips a month to give talks and presentations about the system."

"For the first three-quarters of the time we were working on this, people thought we were lunatics. Then they did a complete about face."



The automated manufacture of dental crowns, such as one represented by this computer-generated image, may require digitizing as many as 80,000 data points to create an optimal crown shape and fit.

Secure in their colleagues' esteem, the team can settle back and worry about more down-to-earth problems, such as how many points on the tooth stump's surface must be specified for the computer to get an accurate picture. They have studied the effects of specifying different densities of data points, Erdman says, and found that the density needed varies with individual teeth and with different areas on the tooth. For example, denser clusters of data must be taken around the base of the stump, where the crown will lie. Neither Rekow nor Erdman will venture even a ballpark guess as to how many data points must be specified, but Erdman says they will all fit on a floppy disk. The researchers are now looking into data compression—namely, how much data can be thrown out without compromising accuracy. If this sounds hard, it is.

"A dental crown is probably the most complicated surface you can try to replicate—it's small and irregular and has to fit in with other small and irregular surfaces," Erdman says.

"A traditional CAD/CAM system starts with simple, straight lines to create curves, such as those used in designing a house or car," Rekow says. "There's nothing like that in a tooth because each is unique to the patient. The tough part is translating the procedure for carving wax patterns into computer rules. However, we do have a database of ideal tooth forms, and the computer automatically modifies them for each new crown. One really exciting aspect of all this is that if we ever achieve excellent quality with the computer system, we can reproduce that quality every time."

Such quality control would be a godsend to dentists, even the best of whom have trouble with some crowns, she says. For example, a patient who's unable to open his or her mouth very wide may come in with a back tooth that's badly decayed and bleeding. Faced with poor access to the tooth, the dentist can either do a "good enough" crown that will last four to 10 years and save the tooth, or, if the decay has reached nearly to the bone, simply pull it. If the patient is 60, "good enough" is probably good enough, Rekow says. But if the patient is 12, it's not.

"Good enough" likely means the gap between the tooth and the crown wouldn't pass muster on a dental board certification exam, she says. Ideally, it should be undetectably narrow, which translates to about three microns or less on an easy-to-reach tooth surface. But, in real life, it often exceeds 60 microns, Rekow says. Hence, the longing for a computer system to eliminate errors that can multiply throughout every step of the process, particularly with difficult patients.

The need for a better way has hit home to just about everybody he has talked to, Erdman says. Much of the financial, equipment, and human resources to develop the system have come from the mechanical engineering department's Productivity Center, the School of Dentistry, and the National Institutes of Health (NIH). Help also arrived from electrical engineering professor Steve Case's Cyberoptics Co., which built a digitizer to turn points on a tooth surface into data; and a machine built by Laser Design of Bloomington, which bounces a laser off a tooth impression, to get a complete picture.

As the system nears the homestretch, the researchers say it might be best to ease into the crown-making business by using the system first to make crowns from

impressions rather than to start off at the beginning with camera imaging of patients' mouths. The system will probably be placed first in dental labs, where camera imaging would be performed on cast impressions. The computer would then direct the milling of the crown. If this setup works well, shopping mall clinics where dentists image real teeth in the same place (and hour) as crowns are made could become a reality, just as Erdman dreamed long ago.

"It's an awful lot of work, but it's exciting to think about the possibility of changing your profession. That's extremely satisfying."

Of course, cost will dictate how the system is used. Rekow estimates a camera system would cost a few thousand dollars, and so might one day be installed in private dental offices, but the whole system could go for $100,000, which would limit its use to central dental labs or large clinics involving many dentists.

Before it is marketed, however, clinical trials must be done. The researchers have already used the system to produce crowns from casts, but none of these crowns have yet been placed in a patient. Rekow says the group is now applying to NIH for funds to conduct clinical trials, which she hopes will begin later this year. They would probably involve dentists taking impressions, from which crowns would be made by both the traditional method and the new system. The dentists could then choose whichever type worked better. Rekow has always maintained that dentists have an ethical duty to choose whatever method yields the best results for their patients, and that if casting works better than CAD/CAM, then they should cast.

The stiffest competition, however, will likely come not from traditional casting but from the Swiss/German and French teams developing similar systems. So far the Cerec/Siemens system, developed by Swiss researchers and licensed to a West German firm, is the only one approved by the federal Food and Drug Administration. But, say Rekow and Erdman, it has a drawback: It doesn't include design of the surface that abuts other teeth.

The French team, whose system is named for team leader Francois Duret, has marketed a few prototypes in the United States but hasn't made a big splash yet, and Rekow and Erdman remain confident that it won't. Both say that their system will yield more accurate fits and save dentists more decisions, especially some that dental school doesn't prepare them to make. Further, the Duret system requires dentists to perform time-consuming functions on a computer to adjust the fit, for example, and most dentists would balk at that.

Assuming it beats the competition, the Minnesota system has only one hurdle left: the business part. Finding money to commercialize their process is the biggest problem now, Rekow says. "Research dollars from the University won't do it," she says. "The University gave us permission to form Digital Dental Systems and commercialize it, but we must raise private money. Also, many faculty don't realize the difference between the processes of research and commercialization. Commercialization requires fewer inventions and more roll-up-the-sleeves workers, whose job is to reduce inventions to practice. In other words, it takes more effort than bright ideas."

Slogging through the business/commercialization morass may go a little more smoothly with Rekow on the team. In addition to her five degrees in engineering and dentistry from the University, she has an M.B.A. from the College of St. Thomas. Still, no one should underestimate the complexities of setting up a company based on new technology.

"Last May we submitted four patent applications that cover the whole process," says Erdman. "The patents will be assignable to the University. Also, the University licenses the technology to DDS to use and build on. DDS has raised money for equipment and development to allow this to happen. The next phase is to expand DDS to the point where it can have a facility to build, design, modify, and sell the system. We need about $2 million to get to the point of installing systems. When it all starts paying off, the University will receive the royalties.

"One somewhat tangential frustration is just setting up a company and figuring out the politics in the University and the real world and talking to lawyers. Also, the success of Duret puts pressure on us to move faster than technology can move."

Rekow, too, feels the pressure, but seems to thrive on life on the cutting edge. "If anybody had told me how much fun it would be to combine engineering and dentistry, I wouldn't have believed them," she says. "It's an awful lot of work, but it's exciting to think about the possibility of changing your profession. To have a big enough impact to change dentistry—that's extremely satisfying." I

Quietly Making Waves

It doesn't appear on any map, but the Productivity Center is quickly becoming a major exporter of new products for seemingly unlimited markets. Its products? New knowledge in computer-aided design and manufacturing (CAD/CAM), robotics, manufacturing processes, and applications of artificial intelligence, to name a few.

Headed by mechanical engineering professor Subbiah Ramalingam, the center is a nucleus of interdisciplinary research, composed of faculty members primarily from mechanical engineering, as well as chemical engineering and materials science, electrical engineering, computer science, and civil and mineral engineering. Founded under its present name in 1981, the center focuses on applied research in collaboration with industry, continuing education for people in technical careers, and technology transfer.

"We try not to do just basic research or mainstream teaching," says Don Riley, associate director and professor of mechanical engineering. "For example, in 1979 or 1980, before the IBM personal computer came out, we developed a 3-D drafting package for microcomputers. We called it Minn/Draft, and it was put to use in 22 technical colleges in Minnesota. It was the first statewide computer-aided drafting program in the country. Another example is LINCAGES-4, an interactive software package we produced for computer-aided design of mechanical linkages. Engineers can use it to design linkages in all kinds of systems, from typewriter key mechanisms to office equipment, packaging equipment, and automotive and aerospace mechanisms. About 40 companies and 35 universities have purchased it."

Currently, Riley and his mechanical engineering colleagues Arthur Erdman and Barney Klamecki are working with Dianne Rekow of the School of Dentistry to develop a new technique to make dental crowns using a CAD/CAM system. To commercialize the results of this research and get the technology out where it benefits society, the researchers formed a company called Digital Dental Systems, which has a formal license agreement with the University. This project, says Riley, illustrates how research initially supported in part by the Productivity Center can lead to the transfer of new technology to the private sector. If the venture is successful, the University will also reap some of the rewards in the way of royalties.

The center runs on a total annual budget of about $2 million, including a "state special appropriation" of $350,000, Riley says. The investment has paid off handsomely, as illustrated by one of Ramalingam's projects. He headed the

development of a now-patented process that uses high-temperature plasmas to deposit microscopically thin coatings on a variety of surfaces.

"That process, which was licensed to a company in Europe, returned several hundred thousand dollars in royalties to the University," Riley says. "LINCAGES-4 has brought in more than $150,000 and Minn/Draft about $100,000. Since 1981, I'd estimate research at the Center has returned about $500,000 in all."

Companies working closely with the center come in all shapes and sizes. Among them is the Computer-Integrated Manufacturing Consortium, a small group of high-tech firms that stand to benefit from research at the center. Companies also come singly; Toro, Control Data, Honeywell, Graco, 3M, General Motors, Alcoa, and others all send engineers to check out the latest research. In addition, grants from the Greater Minnesota Corp. (GMC) have enabled center scientists to work with two Minnesota companies, Mar Engineering and Laser Design. While Mar projects involve super-precision machining, especially in microelectronics, the Laser Design research projects are aimed at getting good three-dimensional data on objects, Riley says.

In addition to helping organizations create new ideas, the center has also helped create new organizations. Center faculty members helped secure the initial state and subsequent GMC funding for the Minnesota Advanced Manufacturing Technology Centers Inc. (MAMTC). MAMTC is a one-and-a-half-year-old nonprofit organization that, with help from the center, currently works to define statewide programs and services for smaller companies. Riley, a member of MAMTC's board of directors, describes the organization's mission as "helping small companies modernize and cope with advancing technologies so they can compete in the global marketplace." But keeping up can be difficult, as many senior managers of even the best companies have had to deal with technological handicaps.

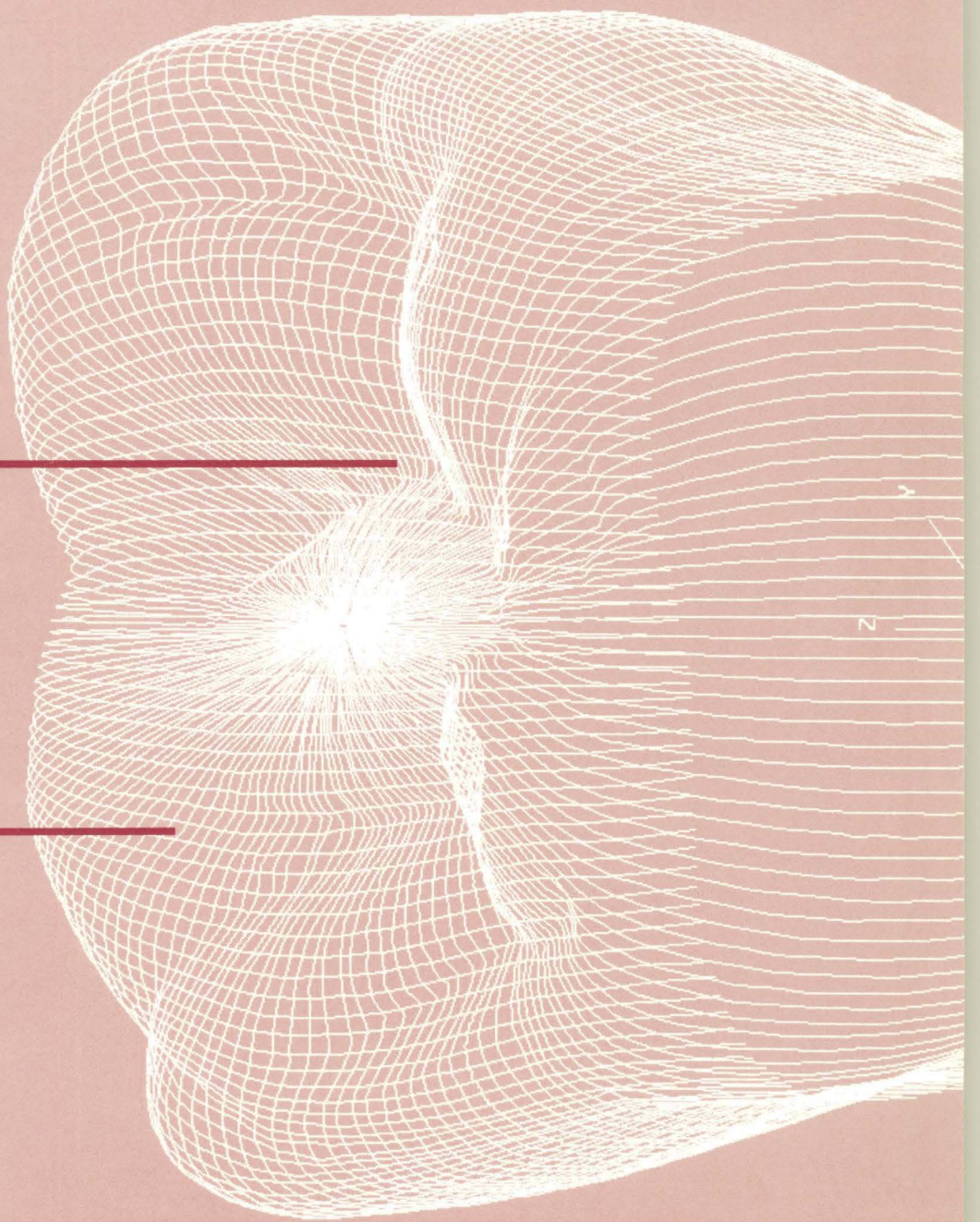
"Computers didn't get into the college curriculum until the early 1960s," says Riley. "Engineers, managers, technicians, or other professionals in these companies who are now over the age of 42 didn't get computers in school. Word processing didn't catch on until the late 1970s. That means many of these high-ranking people have had to play catch-up with computers, and we're trying to help fill in those gaps."

The Productivity Center may not be a household word, even on campus, but it seems to be making waves in the waters that count.

"In any endeavor, the real litmus test should be whether there's a market for what you're doing," Riley says. "We'd like the Productivity Center to be judged by the graduate students and the technologies that come out of it. Our graduate students are in high demand—they are recruited from all over the country. And our patents in hardware, copyrights in software, and licensing royalties all make for a very good record.

"I think people sometimes look at the University and think 'ivory tower,' but we're anything but that. We've helped fill real needs." I

Deane Morrison covers science and technology issues for the University News Service.



"In any endeavor, the real litmus test should be whether there's a market for what you're doing. Productivity Center graduate students are in high demand."

Many happy returns

A small investment in a bright young student pays off in a big way

When Raghu Sharma came to the United States in 1963, an enviable dilemma confronted him. Some of the best universities in the country had accepted him into their graduate schools. For a man without substantial resources, the dilemma was quickly resolved when Minnesota offered him almost twice the scholarship offered by the other schools. If it hadn't, Sharma might have built his $50-million company, Multi-Tech Systems Inc., in Massachusetts instead of Minnesota. But that's getting ahead of the story.

As far back as the early 1960s, Sharma wanted to own a company. But at that time, the government in Sharma's native India required company owners to be licensed. Neither Sharma nor anyone in his family had a license, and as the son of a civilian worker in Indian Army Headquarters, he didn't have the means to bribe the right people to get one. Sharma decided the best way to fulfill his dream was to go to America.

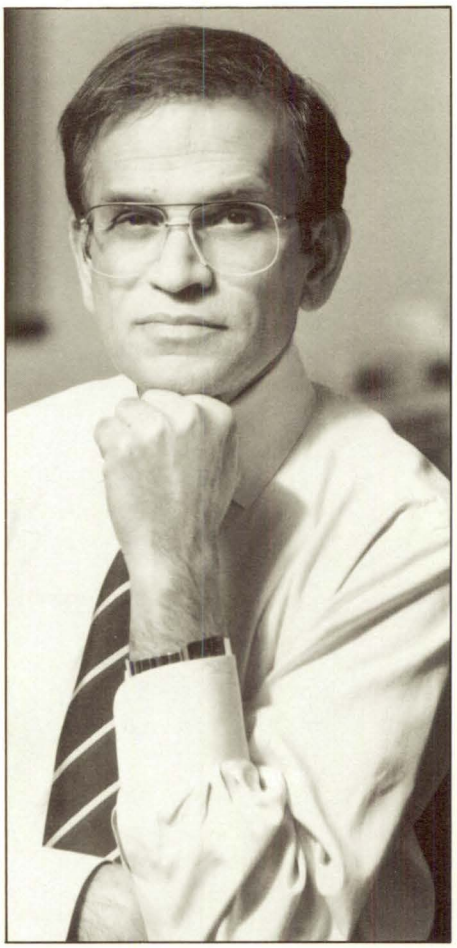
Although at that time Sharma already had a bachelor's degree in physics from Delhi University and bachelor's and master's degrees in electrical engineering from the India Institute of Science in Bangalore, he decided that the first step toward his dream was to get a Ph.D. degree from an American university. He was accepted at Johns Hopkins University, the University of Wisconsin, Massachusetts Institute of Technology, and Harvard University, which offered him $1,200 a year. But when the University of Minnesota offered him $3,600 a year, with the promise of a $4,000 teaching assistant job later, his decision was easy.

On September 13, 1963, the slight, soft-spoken, 24-year-old Sharma stepped off an Air France jet and onto the tarmac at the Twin Cities airport with $300 in his pocket, his one-way plane ticket spent, and a naiveté about Minnesota winters.

Those were heady days at the University of Minnesota for Sharma. "The friends around me were pretty helpful," Sharma recalls. "I got good grades in advanced math classes, and my advisor, Carl van Vliet, was very encouraging in my academics. But he had no idea that I was thinking of starting my own business."

His fellow graduate students knew just what Sharma had in mind, however, because they spent many hours tossing business ideas around over beer and pizza on the third floor of the electrical engineering building. (Actually, Sharma, a vegetarian, avoided the pizza.)

Photos by Patrick O'Leary



Raghu Sharma, president and founder, Multi-Tech Systems.

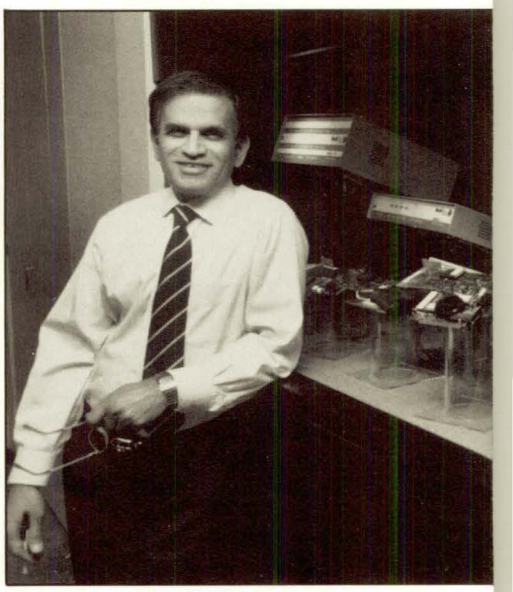
Between 1963 and 1969, Sharma completed a Ph.D. degree in electrical engineering and, at the University of Minnesota's request, repeated some of his master's work, which stretched his program two years longer than he had hoped. At about that time, two events took place—one that confirmed his goal of owning a company and another that set the direction.

First, he saw that many of his friends who had been hired by California's aerospace companies had been laid off. "I wanted to start my own business, partly because I had the desire, and partly because I was afraid the same thing could happen to me," he says.

At about the same time, the U.S. Supreme Court ruled that American Telephone & Telegraph (AT&T) did not have exclusive control over equipment used to tap into telephone lines. The ruling had dramatic implications for the computer industry in general and Sharma in particular.

Although he knew nothing about modems, Sharma knew circuitry, and he knew a market opportunity when he saw one. He withdrew $300 from his savings account, bought a box of amplifier chips, and headed for the University student workshop, where he fashioned the mold for an acoustic coupler, a device that cradles the handset of a telephone in rubber cups. When he sold his first acoustic coupler to University of Minnesota Professor Emeritus Otto Schmidt for $300 and realized a profit of $200, Sharma knew he had the makings of a company.

The next several years were a whirlwind of 18-hour working days—the earliest of them spent in a $68-a-month office in the basement of Snyder Bros. Drug Store in Minneapolis near University Avenue and Bedford Street. Slowly, Multi-Tech Systems, the name Sharma chose for his company, won orders for acoustic couplers from Northern States Power, the Minnesota Education Computing



By Judith Yates Borger

Consortium, and other companies.

By the late 1970s, the world of data communications was changing fast. AT&T required that computers hooking into its lines use a data-access arrangement box to protect the system from voltage changes. The circuitry on the box was simple, and soon manufacturers of acoustic couplers were incorporating it into their devices. At the same time, manufacturers began to realize that they could bypass the telephone handset altogether by plugging telephone wires directly into a box called a modulator-demodulator, or a modem. Because Multi-Tech already had an excellent acoustic coupler, the transition to manufacturing modems was easy.

With markets in 62 countries and sales reaching $50 million in 1989, Multi-Tech is tied for third place in direct-dial modem sales worldwide. The company, which projects 1990 sales at $75 million, makes virtually every type of modem currently in use, including multiplexers, which increase efficiency considerably by allowing data from more than one source to be transferred along one leased computer line.

Just two years ago, Sharma put the final touches on his boyhood dream when he, his brothers, and a friend opened Multi-Tech Computers in New Delhi. The business is doing very well; sales, which reached $500,000 during just the first year, are expected to quadruple this year.

As he has always known, doing business in India is not easy. It took one person two years, working full-time, to wade through the paperwork to open the company. "But we did it without bribing anybody," says Sharma. I

Multi-Tech Systems, which manufactures every type of modem currently in use, tied for third place for 1989 worldwide sales of direct-dial modems.

More a night owl than an early bird, Sharma seldom leaves his home and family for the office until 9:30 or 10:00 a.m.—but his work day often extends into the evening hours. Front to back, Matthew, Janel, Patricia, Adrienne, and Sharma.

Beyond the bottom line

Raghu Sharma is a gentle man who hates bureaucracy, believes in conservative business management, and functions much better around midnight than before 10:00 in the morning. Although he was a top-notch soccer player in college, an errant kick from a huge Nigerian cost him a kidney and ended his soccer playing. He stopped smoking—cold turkey—after a mild heart attack a few years ago and took up daily walks. Today, at 52, he lives in Arden Hills with his wife, whom he married after his company was well established in 1981, and his three children.

Although he denies it, Sharma has a special empathy toward other immigrants. Consider, for example, his association with Hoang Tran, an American immigrant from Vietnam, who began work at Multi-Tech part-time in 1979 at the age of 18. Within months, Tran began taking home Multi-Tech piece work. Every evening, 11 members of Tran's family worked in his Lauderdale basement assembling chassis and working with cable.

In 1984, Tran opened his own shop in Roseville assembling electronic components. Multi-Tech is the largest of his 11 customers. In 1988, Tran Electronics and its 50 employees moved to the 20,000-square-foot space that had been vacated by Multi-Tech in New Brighton. When the bank refused to give Tran a loan, Sharma gave him a contract for deed.

Sharma says he helped Tran only because it was good business, but there's no escaping the fact that Sharma knows what it feels like to be a stranger in a strange land.

"I look different and I talk different," says Sharma, whose English is halting but precise. "When I was in graduate school, I was the last to get a fellowship. Other people always got more money than I did. Later, when I tried to make a sale, people distrusted me. They thought I might pack up and go back to India. Finally, I figured that the only one who could treat me fairly was me."

And yet, Sharma is convinced that Minnesotans have treated him more fairly than other Americans might have. "I couldn't have done this in California or New York," he says.

He's also convinced that his success has been predicated on his personal traits: tenacity, a willingness to work long hours, confidence in his destiny, and conservative risk- taking. It has all brought him a good life in America.

What about India?

"I like to go there for a short while, maybe a week," says Sharma, who makes a yearly three-week trek around the world to visit with his distributors. "It's a tough place to live. I'm always ready to go back to America."

Meanwhile, Sharma looks on Multi-Tech more as his hobby than his work. He says he has a file two inches thick with requests from people who would like to buy his company. So far, he's turned them all down.

"It's risky not selling the company when things are going well," he says. "But why would I want to sell? I could make a whole lot of money, but there's no dearth of money now. If I sold out, I'd have to retire. Why would I want to do that?" I

Judith Yates Borger is editor of MINNESOTA BIOMED ALERT, *a newsletter covering Minnesota's health care industries for subscribers in the United States, Canada, and overseas.*

FACULTY

In Liu of dust

The dust never settles in the world of Professor Benjamin Y.H. Liu. As professor and director of the Particle Technology Laboratory and Environmental Division in mechanical engineering, the applications of his research on dust, or airborne particles, have been far reaching—from coal mines to industrial clean rooms, from the yellow cloud suspended over the Los Angeles urban area to wildlife refuges in the depths of the Grand Canyon.

The apparatus for one of Liu's most recent projects was launched into outer space aboard the space shuttle Columbia last January. The project began in 1987 when NASA called him to help resolve a rather "messy" problem. Astronauts had reported dusty air in the cabin, and some had experienced minor respiratory problems upon their return to earth, possibly due to the buildup of airborne particles throughout the voyage. In an environment without gravity—where particles remain suspended in air and accumulate over time—it is easy to understand their concern. According to Liu, the human body alone emits about half a million particles each minute. Other visible particles floating about the cabin include everything from clothing fibers to skin flakes to strands of human hair. Although there are air cleaners aboard the shuttle, they have been designed to protect the electronic equipment more than the people.

After recommending acceptable levels to NASA based on known limits in nuclear submarines and other available data on health effects of airborne dust, Liu and his colleagues (Kenneth Rubow, Peter H. McMurry, and Tom Kotz) designed two devices to measure, sample, and monitor airborne particles in the shuttle. The first device included an electrical sensor and small computer that recorded maximum, minimum, and average readings of dust levels within the cabin. The second device gathered and separated dust particles by size into four filters. These data will allow Liu and his colleagues to analyze the sources of particles and their chemical composition.

Data from Columbia's January flight have not yet been fully analyzed; however, based on preliminary indications, Liu suspects that current dust levels in the cabin may not be high enough to be of concern. "We will be taking further measurements on the future flights before giving our recommendations to NASA, but it appears that the problem of airborne particles in the shuttle may be one of nuisance dust—that is, dust that looks bad but doesn't cause any harmful health effects," he says.

Although Liu's recent work on the space-shuttle project has garnered a fair bit of publicity, his other research probably has had a wider impact. The particle measuring and sampling devices Liu has developed throughout his career have not only set the stage for rational policy formulation on important environmental issues, they also have helped prevent health hazards and equipment damage in numerous industrial settings. A member of the prestigious National Academy of Engineering, Liu has also prepared many graduate students for top positions in both industry and educational institutions, organized a consortium of industries to sponsor research at the University, helped organize the first of several international aerosol conferences to promote international cooperation and goodwill, and initiated a publication titled *The Aerosol Science and Technology Journal.*

Liu's work, however, doesn't stop at the identification of what he calls "bad particles"—or pollutants. He and his colleagues also have developed instrumentation to produce particles for inventive engineering applications. The application of this research, both directly and indirectly, contributes roughly $15 million a year to local industries alone.

Photo by Patrick O'Leary

Benjamin Liu displays his space-shuttle devices.

"There are two things you can say about particles," says Liu. "Either they are bad or they are good. Bad particles are those that produce negative health effects over a period of time, such as automotive emissions, asbestos fibers, or coal dust. Because environmental regulations always affect a certain industry or segment of society, increasingly more importance is placed on pinpointing the sources of pollutants and the percentage emitted from each. With this information, you can determine how much improvement in air quality can be achieved through various regulations and make rational decisions about how to spend pollution-control dollars.

"Good particles are those that, because of their unique properties, can be used in producing new materials, such as titanium dioxide—a white pigment used in paint to provide better opacity—or carbon black which is used in tires to increase longevity. There are many valuable engineering materials that are either being made in the aerosol particle form or could be made in that form. Unfortunately, people haven't paid enough attention to particles in the past simply because they weren't sure what they were or where they came from."

In spite of a certain notoriety that accrues from research like the space-shuttle project, Liu's ambitions are very down-to-earth when it comes to his personal goals for the future. First, he wants to continue to improve his already internationally renowned laboratory in terms of its contributions to science and technology

in the areas of quality research and students. Second, he is hoping that the work performed in his laboratory will have an even greater economic impact on Minnesota than it already has.

It is this commitment to his students, laboratory, and the state of Minnesota that is the driving philosophy behind Liu's work. "There is a saying in Chinese," Liu says reflectively, "that states, 'in order to help humankind, first you need to prepare *yourself* well to be good; then your family; then your community.' Only after these things are accomplished can you begin thinking about the more grandiose notions of bettering the nation and saving humanity. The way to help the U.S. is to help the family and community in which you live. If everyone can do that, we will have a very strong United States. If every country can do that, we will have a very strong world." **I**

By Maggi Aitkens

Aerospace Engineering
Professor ***William L. Garrard*** will be coordinating a short course on parachute technology in Natick, Mass., during June 1990.

Agricultural Engineering
Associate professor ***Ian Moore*** has accepted the Jack Beale Chair of Water Resources with the Centre for Resource and Environmental Studies at the Australian National University, Canberra, Australia. ***Chang Ho Park,*** assistant professor, will co-chair two sessions at the American Institute of Chemical Engineers 1990 meeting in Chicago, November 11-16. The sessions are titled "Utilization of Food and Agricultural Residues" and "Food Fermentation."

Charles Babbage Institute
Institute director ***Arthur L. Norberg*** was appointed to the ERA Land-Grant Chair for the History of Technology. As chair holder, Norberg will be responsible for establishing Institute goals and will design and direct programs to achieve them. Norberg also recently received the National Science Foundation (NSF) Historical Monograph of Computing and Computer Science Award for his history of NSF's programs in computing and computer science and the impact these funding programs have had on basic research and the development of strong research and teaching programs.

Chemical Engineering
Regents' professor ***Rutherford "Gus" Aris*** was honored by the department with a 60th Birthday Academic Festival on October 13, 1989. The festival included a symposium during the day and a banquet at the Radisson University Hotel that evening. Professor ***Frank S. Bates*** was named the 1989 Young Chemical Engineer by the Twin Cities section of the American Institute of Chemical Engineers. Professor ***Chris W. Macosko*** will be at BASF Central Research, Ludwigshafen, West Germany, doing rheology research during his leave spring quarter 1990. Regents' professor ***L.E. Scriven*** received the 1990 E.V. Murphree Award in Industrial & Engineering Chemistry (sponsored by Exxon Research and Engineering Company and Exxon Chemical Company). The award will be presented at the 199th ACS national meeting, April 22-27, Boston, Mass. Professor ***Matthew Tirrell*** will be the O.A. Hougen Visiting Professor in the University of Wisconsin's chemical engineering department during his leave fall quarter 1990.

Chemistry
Regents' professor ***Paul G. Gassman*** received a 1990 Chemical Pioneer Award from the American Institute of Chemists. The award was presented to Gassman for his work in "establishing the existence and mechanistic significance of divalent positively charged nitrogen as reactive intermediates" and for being the "first to propose the existence of 'twist' bent carbon-carbon sigma bonds." Professor ***W. Ronald Gentry*** is the new chair of the chemistry department, replacing professor Louis Pignolet, whose term expired. Gentry's five-year term began fall quarter 1989. Professor ***Larry Miller*** received the Paul Flory Fellowship. The fellowship will support a six-month sabbatical leave at the IBM Almaden Research Laboratories. Associate professor ***Margaret C. Etter*** gave the Lucy Pickett Honorary Lecture at Mount Holyoke College, South Hadley, Mass., in October 1989.

Civil and Mineral Engineering
Professor ***Pat Brezonik*** was appointed to a National Academy of Sciences National Research Council committee to conduct a two-year review study of aquatic systems restorations. ***Steven L. Crouch,*** professor and head, received a Quality Service Award at the November meeting of the Minnesota Council for Quality. Assistant professor ***Catherine E. French*** received a 1989 Edmund Friedman Young Engineer Award for Professional Achievement. French's research has focused on reinforced and prestressed concrete structures. Professor ***Ted Galambos*** has been granted a sabbatical for spring and fall quarter 1990. He has accepted an appointment as the Distinguished Visiting Professor of Civil Engineering at the United States Military Academy in West Point. Associate professor ***John Gulliver*** was commended by the American Society of Civil Engineers Energy Division for his work on "Civil Engineering Guidelines for Planning and Designing Hydroelectric Developments." Gulliver also recently passed the Professional Engineer Examination and is now a registered engineer in Minnesota. ***Miles S. Kersten,*** professor emeritus of soil mechanics, is the first recipient of the Harold R. Peyton Award for Cold Regions Engineering. The national award, announced last month by the American Society of Civil Engineers, honors his contributions to cold regions engineering education and research in thermal properties of soils, subgrade moisture conditions, and their role in flexible pavement design and airport engineering. Professor ***K.J. Reid,*** Mineral Resources Research Center director, was appointed by Minnesota Governor Rudy Perpich to a blue ribbon commission on mining. The commission will study the economic costs and benefits to industry, affected counties, and the state resulting from the collection of the taconite production tax. Associate professor ***Karl A. Smith,*** Mineral Resources Research Center, gave the keynote address at the Lilly Endowment Teaching Fellows Program Conference in November 1989 in Indianapolis, Ind. Also in November, Smith and professor ***Tony Starfield*** presented a workshop on "Learning through Modeling" at the Bush Regional Faculty Development Conference, St. Paul. Associate professor ***Raymond Sterling,*** Underground Space Center, was invited to serve on the Energy Coordinating Committee of the Legislative Commission on Minnesota Resources. Sterling has also been elected to a two-year term as vice chair of the U.S. National Committee on Tunneling Technology, a committee of the National Research Council, National Academy of Sciences. ***Henryk Stolarski*** has joined the department as associate professor of structural mechanics, replacing professor ***Lawrence Goodman,*** who retired in 1989. Stolarski received his Ph.D. in civil engineering from the Polish Academy of Sciences, Warsaw, Poland.

Electrical Engineering
Kevin M. Buckley, assistant professor, received the John Gallen Memorial Award from Villanova University. The award, which is presented annually to a Villanova engineering alumnus, is for contributions in education and

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research. Professor *A. Gopinath,* director of the Center for Microelectronics and Information Sciences, was elected a fellow of the Institute of Electrical and Electronics Engineers for his work in analysis of microstrip discontinuities and contributions to microwave integrated circuits. Professor *Mostafa Kaveh* presented invited talks at Uppsala and Linköping Universities in Sweden during October 1989. Kaveh and Buckley were invited speakers at the Indo-U.S. Workshop on Spectrum Estimation in One or Two Dimensions, New Delhi, India, during November 1989. Professor *Larry L. Kinney* was appointed an associate editor for *IEEE Transactions on Computers.* Professor emeritus *Gottfried K. Wehner* was granted U.S. Patent #4834856, "Method and Apparatus for Sputtering a Superconductor onto a Substrate." Patent coverage is pending in the European Commonwealth countries, Japan, and Korea. *Keshab K. Parhi,* assistant professor, was presented with a National Science Foundation Research Initiation Award for his research proposal "VLSI Architecture Designs for High-Speed Signal and Image Processing." Associate professor *William P. Robbins* co-authored the recently published book, *Power Electronics: Converters, Applications, and Design. Ahmed H. Tewfik,* assistant professor, was appointed an associate editor for *IEEE Transactions on Acoustics, Speech, and Signal Processing.*

Mathematics
Professor and department head *Richard McGehee* announced that he will be resigning as department head in July 1990, one year before his term is up. McGehee will remain on the faculty and continue his teaching and research activities.

Mechanical Engineering
Professor *Arthur G. Erdman* received the Al S. Hall, Jr., Award at the 1989 Applied Mechanisms and Robotics Conference for his contributions to mechanism science and application. *Richard J. Goldstein,* James J. Ryan Professor and head, was elected a fellow of the American Physical Society, Division of Fluid Dynamics in November 1989 for significant contributions to knowledge of fluid mechanics through development of precision systems and their application to studies of important physical phenomena. *Subbiah Ramalingam,* professor and director of the Productivity Center, received the Outstanding Alumnus of Department Award from the Department of Mechanical and Industrial Engineering, University of Illinois at Urbana-Champaign. Three new faculty members joined the department during fall 1989: *Avram Bar-Cohen* and *Joachim V.R. Hberlein,* associate professors, and *Jeffrey H. Vogel,* assistant professor.

Physics
Professor *Roger Stuewer,* history of science and technology, received an American Association of Physics Teachers Distinguished Service Citation. I

DEATHS

William M. Becker *(Mechanical 1936),* 78, retired administrator of technical services for Babcock & Wilcox Co. Becker was born April 13, 1911 in Marquette, Mich. and attended Central High School in Minneapolis. He was a life member of the Minnesota Alumni Association and the American Society of Mechanical Engineers.

Charles James Clark *(Electrical 1929),* 82. Clark worked with Ingersol Rand in New York and Chicago, and then formed his own company selling Johns Mansville products.

Leslie P. Hanson *(Mechanical 1930),* 84, a heating and air conditioning expert. Hanson designed several new buildings and, during World War II, a Russian warship that was refitted at a U.S. shipyard. Hanson retired from the Barry Blower Co. in the mid-1970s but continued to work as a consultant for several years.

Calvin M. Nelson *(Mechanical 1950),* a retired engineering purchasing agent for 3M.

Charles E. Villars, a senior-citizen directed studies research registrant in the Chemistry Department for several years. Villars, who earned his Ph.D. in chemistry at Michigan State University worked in the chemical industry for many years and was doing research with a group in the University of Minnesota Chemistry Department.

Vernon Paul Wystrach *(Chemistry 1941),* 70, a former research chemist for American Cyanamid Co., Stamford, Conn. Wystrach was born in St. Paul. After graduating from the University of Minnesota, he earned his Ph.D. in organic chemistry from the University of Rochester. He was an emeritus member of the American Chemical Society. I

ALUMNI

1933

Roman Arnoldy *(Mechanical)* received a Community Recognition Award from the city of Savage. The award recognized Arnoldy for achievements including the founding of the Houston, Texas manufacturing firm Triten Corp., receiving an Outstanding Achievement Award from the University of Minnesota, and for being named Inventor of the Year in Houston in 1986.

1944

Donald H. Smith *(Electrical)* retired in 1987 from Bell Telephone Laboratories and is currently working as manager of string instruments for the Newark Community School of the Arts, Newark, N.J. Smith purchases, adjusts, and repairs the stringed instruments for the school's beginning music students.

1958

Bradford A. Lemberg *(Civil and Mineral)* has formed a new consulting firm, Independent Consulting Engineers Inc. (ICE). The St. Paul firm specializes in the design of both new and retrofitted ice arenas.

1965

Jacqueline (Lander) Jeffrey *(Mathematics)* was named director of marketing and management consulting services for Coopers & Lybrand, New York, N.Y. in July 1989.

1967

G. Ali Mansoori *(Chemical, M.S.)* is a professor of chemical engineering at the University of Illinois, Chicago.

1971

James Gilley *(Agricultural, Ph.D.)* is head of the Agricultural Engineering Department at Iowa State University.

1974

Tom Johnson *(Mechanical)* is marketing manager of ventila-

tion products for Snyder General Corp., Minneapolis.

1976

Sister Karen Conover *(Chemistry, M.S.)* is assistant principal and science instructor for St. Paul High School in San Francisco, Calif. St. Paul is an inner-city Catholic girls' school. Conover works with Hispanic, Filipino, and Black students and reports that St. Paul is "a great place to encourage women to believe in themselves and [consider themselves] as future scientists."

Richard W. Freeman *(Civil and Mineral)* is a process instrumentation and control resident engineer for 3M Co. in Hutchinson.

1977

Martin J. Hanson *(Civil and Mineral)* has joined Ayres Associates, an Eau Claire, Wisc., engineering and architecture firm, as a manager of their highway division.

1979

Roger W. Johnson *(Mathematics)* has accepted a position as assistant professor in the Mathematics and Computer Science Department at Carleton College, Northfield. Johnson was previously employed by the Naval Ocean Systems Center, San Diego, Calif.

1980

Tho Vu *(Electrical, M.S.)* is president of Top-Vu Technology Inc., Minneapolis. Top-Vu employs 12 engineers/scientists who research, develop, and manufacture microsystems.

1983

Kay A. Youngdahl *(Chemistry)* received her Ph.D. in chemistry from Texas A&M in 1987 and is currently employed as a research analyst in the materials and processes division of Boeing Aerospace and Electronics, Seattle, Wash.

1984

Scott Dacko *(Mechanical)* received his M.B.A. from the University of Minnesota in 1988 and is currently an engineer in the Naval Systems Division of FMC Corp., Minneapolis.

Keith A. Larson *(Electrical)* recently completed a three-year tour of duty in the United States Navy aboard the submarine "USS Stonewall Jackson." Larson is currently serving as an instructor at the Navy's Nuclear Power School, Orlando, Fla.

1986

Jon Berndt *(Aerospace)* is a design engineer for Lockheed Corp., Houston, Texas. Berndt is implementing changes to the space shuttle flight controls software on Lockheed's systems engineering simulator for test and evaluation.

Kathy (Hewitt) Giori *(Electrical)*, a research engineer in the electromagnetic sciences laboratory for SRI International, Menlo Park, Calif., married Nick Giori on June 24, 1989. Giori received her master's degree in electrical engineering from Stanford University in 1988.

Michael J. Sherman *(Mechanical)* is a project engineer for UFE Inc., Stillwater.

Grant D. Stevenson *(Mechanical)* is a plant engineer for Northern States Power Co. at the Sherburne County Plant.

1987

Ronald S. Indeck *(Electrical, Ph.D.)* has been chosen as a National Science Foundation Presidential Young Investigator. The award includes a five-year grant to support Indeck's research in applied magnetics and sensors. Indeck is a professor in the department of electrical engineering at Washington University, St. Louis, Mo. His research focuses on the magnetic recording process and recording transducers.

Richard S. Nelson *(Civil and Mineral)* is an aircraft maintenance officer for the United States Air Force, Seymour Johnson AFB, Goldsboro, N.C.

1988

Clare Haas *(Mechanical)* is a marketing engineer for Trane Co., Scranton, Penn.

1989

Amy Abouelenein *(Chemical)* is employed as an engineer at the pilot plant, General Mills Inc., Minneapolis.

Laura Randell *(Electrical)* is a design engineer in network facilities for U S West Communications, Minneapolis. I

News About You

Name

Address

City, State

Graduation Year/Degree/Department

Job

Employer/Location

Other News

Membership Information

The Institute of Technology and its alumni society need your support. Please join ITAS today. Your membership dues ($25 single; $35 couple) support Science and Technology Day, seminar and lecture programs, student publications and activities, and more.

☐ **Yes;** please send me Minnesota Alumni Association/ITAS membership materials as soon as possible.

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ALUMNI NEWS

Upcoming ITAS events

As part of its spring calendar, the Institute of Technology Alumni Society (ITAS) is sponsoring two events to update alumni on IT happenings. On March 22, ITAS is sponsoring "I.T. Speaks!"—a program during which department heads will meet with alumni and fill them in on the latest developments (and a few anecdotes) from their departments. On May 22, the annual Dean's Reception will honor outstanding IT seniors. Both events are open to all IT alumni.

ITAS, which is one of 24 constituent societies of the Minnesota Alumni Association, provides a means for IT alumni to maintain personal and professional contact with the University; support the students, faculty, and administration of IT; and work for the improvement of IT and the University.

ITAS activities include: financial contributions to student events and publications; funding student scholarships and awards; sponsoring lecture programs, networking activities, and social events; and Science and Technology Day. For more information on ITAS membership and activities, please contact the Minnesota Alumni Association at (612) 624-2323. I

The big FIVE-OH

Plans for the golden reunion of the IT class of 1940 are under way. Department volunteers and staff members in the Office of External Relations are organizing the reunion, which will be held July 26-28, 1990. If you are a member of the class of 1940 and have not yet received notification or if you would like to volunteer to help plan your 50th reunion, please write to Linda A. Goertzen, IT External Relations, 117 Pleasant Street S.E., #107, Minneapolis, MN 55455 or call (612) 624-1030. I

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