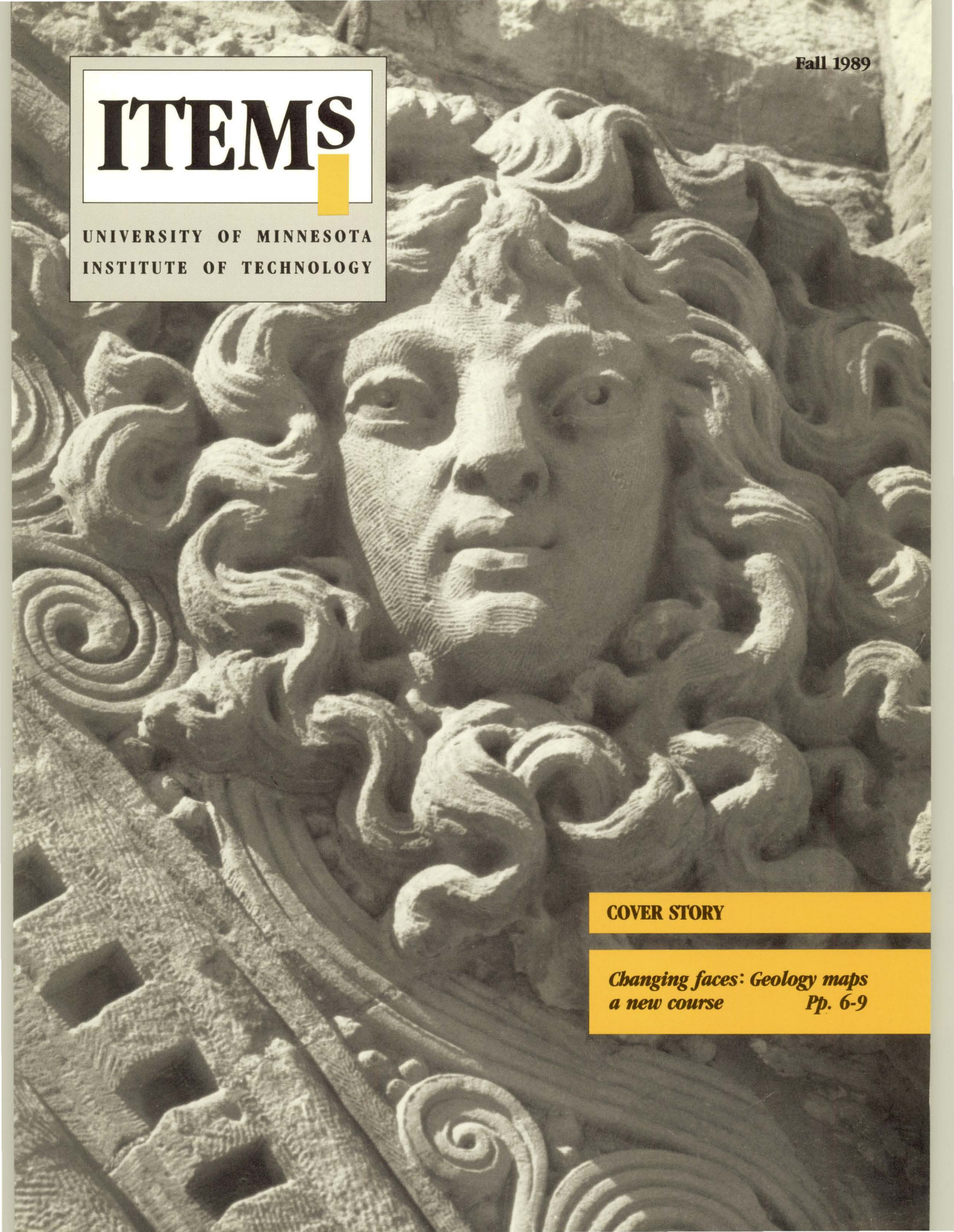
Fall 1989

ITEMS

UNIVERSITY OF MINNESOTA
INSTITUTE OF TECHNOLOGY



COVER STORY

Changing faces: Geology maps a new course ***Pp. 6-9***

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Institute of Technology

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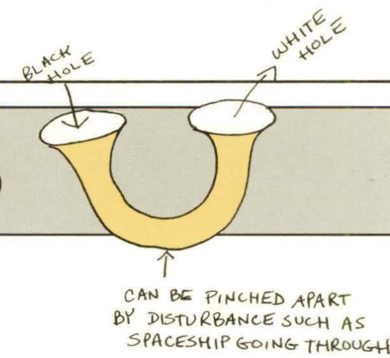
Cover photograph by Tom Foley

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.

This issue was prepared with the assistance of University Relations.

About the cover: Photographer Tom Foley captured the kindly face that guards one of Pillsbury Hall's archways. The second oldest building on campus, Pillsbury grew up with geology under its wings. Now geology needs a new place to do modern research, hopefully one with Pillsbury's inherent character.

NEWS



An imaginary time was had by all

The next time you look up at a sky full of twinkling stars, think about some of the things out there you *can't* see—black holes, from which nothing can escape; singularities, where time and space come to an end; and wormholes that let particles travel into other universes.

They sound like science fiction, but observable evidence points to all these phenomena, which, in turn, provide clues in the search for one theory explaining everything in the universe. Stephen Hawking, regarded as one of the most brilliant theoretical physicists since Einstein, spoke about his search for this one unified theory to a full house in Northrop Auditorium May 16. Hawking is Cambridge University's Lucasian Professor of Mathematics, the post once held by Isaac Newton. His lecture, "Imaginary Time," was the 10th Agibail and John Van Vleck Lecture.

A nearly 25-year struggle with Lou Gehrig's disease has left Hawking almost completely paralyzed and unable to speak because of a hole cut in his windpipe to restore his breathing. He addressed the crowd with a speech synthesizer, which, he explains, "varies the intonation and gives me a voice that sounds almost human instead of like a Dalek [an evil, monotonic space robot in the television series, *Dr. Who*]."

Hawking is a positivist—he regards a scientific theory as "just a mathematical model that describes what we observe." Using this approach, he traces perceptions about the nature of time through different mathematical models of the universe on the way to the ultimate understanding of time that can explain why the universe is the way it is and how it got that way.

The first complete mathematical model of the universe was Newton's, which views time as a straight line from creation to the apocalypse. In Einstein's theory of relativity, each observer measures time differently: An astronaut, for example, could go off in a spaceship and return to Earth only a few years older while his stay-at-home twin would have become an old man.

Relativity opens up interesting possibilities for time, says Hawking: Gravity can distort space-time and create black holes; black holes contain singularities (places of infinite gravity where time and space come to an end and the laws of physics no longer apply) and may allow time travel. Still, Einstein's theory treats time as essentially a line, he says. "Although relativity combines time and space into space-time, it doesn't fully unify time with space."

Quantum theory might be the key to this unification, helping scientists finally "get away from this one-dimensional, line-like behavior of time." Invented in the 1920s, quantum theory describes the behavior of infinitesimally small systems—such as atoms. There's no predicting events precisely in quantum theory—you can only predict the probability that an event will occur, involving an element of uncertainty or randomness.

"Einstein objected strongly to this randomness, saying that, 'God does not play dice,' " says Hawking. "But all the evidence points to God being an inveterate gambler and throwing the dice to determine the outcome of every observation.

"Great new possibilities open up," Hawking says, "if one combines the concept of imaginary time, coming from quantum theory, with the idea of the theory of relativity that space and time are joined together in space-time."

The elegance of imaginary time becomes clear when you plug it into the sum over histories, a mathematical model that describes the uncertainty in quantum theory. Using ordinary time in this model results in a wildly fluctuating answer, while using imaginary time results in a well-defined answer.

Hawking and a colleague took this concept a step—or, rather, a quantum leap—further in 1983 when they proposed applying the sum over histories with imaginary time to the idea that our universe is finite, but has no boundaries or singularities (sort of like the Earth, which is a finite size but has no edges for people to fall off). In this case, the laws of physics completely determine everything in the universe—in other words, God would have no choice in the state of the universe.

If this no-boundary proposal is correct, then particles can't end in singularities, but instead must pass through imaginary-time wormholes, thin tubes in space that don't contain singularities and that would allow particles to travel back and forth between universes. Elegantly enough, wormholes explain why the cosmological constant—Einstein's mathematical device to give the universe an inbuilt tendency to expand—is observed to be nearly zero when quantum theory would point to a much larger number.

If this sounds too theoretical and unlikely, Hawking points out that, "if one adopts a positivist viewpoint, as I do,... it is meaningless to talk about an underlying reality. How could one determine what reality was? Instead, one can just build mathematical models of the universe, and the best model is one that accurately describes the observations and is as elegant as possible." I

By Nancy Schwalenstocker

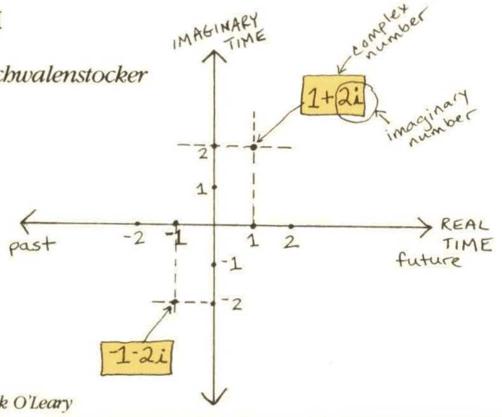


Photo by Patrick O'Leary

Some of the new building's principal planning and construction representatives display their framed copies of the commemorative "Thanks Minnesota" poster. From left to right, they are: Tony Kromrey, Larry Anderson, Terry Margo, Prisod Atluri, Don Hau, and Jamie Sipes.

Far from the madding crowd

What was once the main engineering library in Lind Hall became the Mr. and Mrs. George W. Taylor Undergraduate Academic Center with the room's dedication May 19. The new center, staffed by junior and senior IT honor students, will give undergraduates a place to go for help with any IT discipline.

A $300,000 pledge by Mrs. Taylor financed the room's renovation, which, under project architect Bernard Jacob, changed the dark, dusty room into a sunny, pleasant tutoring and advisement space in less than a year.

Linda McCracken-Hunt, senior architect for the University's physical planning office and project manager for the renovation, names the addition of a second staircase as a key change. With only the narrow, steep stairs at the back of the room, a second staircase was needed for fire and safety reasons. Designed to look like it had always been there, the grand, new staircase creates a focal point for the room.

The replacement of high, dark bookcases between the windows with lower, lighter tutoring stations—designed for acoustical privacy—helps make the room look larger and more pleasant. Other changes include new lighting and electrical wiring, air conditioning, refinishing of the original woodwork, and new tables in the style of the old woodwork.

Unveiled at the dedication, portraits of Mr. and Mrs. Taylor and plaques honoring their generosity will be a permanent part of the center. I

Top: **refinishing the old woodwork creates a splendid study space.** *Bottom:* **the grand staircase.**

Photos by Patrick O'Leary

Champagne and hot dogs

Chains of multicolored balloons against the brick of the new Electrical Engineering and Computer Science Building lent some brightness to the gray skies at the new building's April 28 dedication. More than 600 people gathered on the building's plaza, where IT Dean Ettore Infante, President Nils Hasselmo, and Lyndon Carlson, chair of the Minnesota Legislature's House Education Division, spoke to the crowd.

Electrical engineering students Bob Marvin and Jack Judy, and computer science student Lance Visser, loaded the new building's time capsule with artifacts including 1988-89 issues of the *Minnesota Technolog* and *Items,* a copy of IT's Master Facilities Plan, and the UNIX 4.2 operating system on a floppy diskette.

Infante likened the new building to "a ship that is going to allow students to explore many wonderful ports of knowledge." After Hasselmo broke a champagne bottle on the building, the crowd picked up hot dogs, beans, and coffee and went inside to enjoy the warmth and tour the building.

Dedication to p. 4

from p. 3

One of the stops on the building tour was a new workstation in the Main Computer Science Instructional Laboratory that brings new meaning to the term, "user-friendly."

Specially designed to be totally accessible for people with visual and motor disabilities, the computer station is available to all disabled members of the University community. Adaptive equipment and software, added by the Office for Students with Disabilities and the computer science department, accommodate almost any degree of disability.

For example, the visually impaired can use an embosser that prints in Braille or a speech synthesizer that reads the screen. A closed-circuit television system magnifies printed matter, while a huge monitor displays enlarged onscreen characters and a dot-matrix printer prints large letters for better readability.

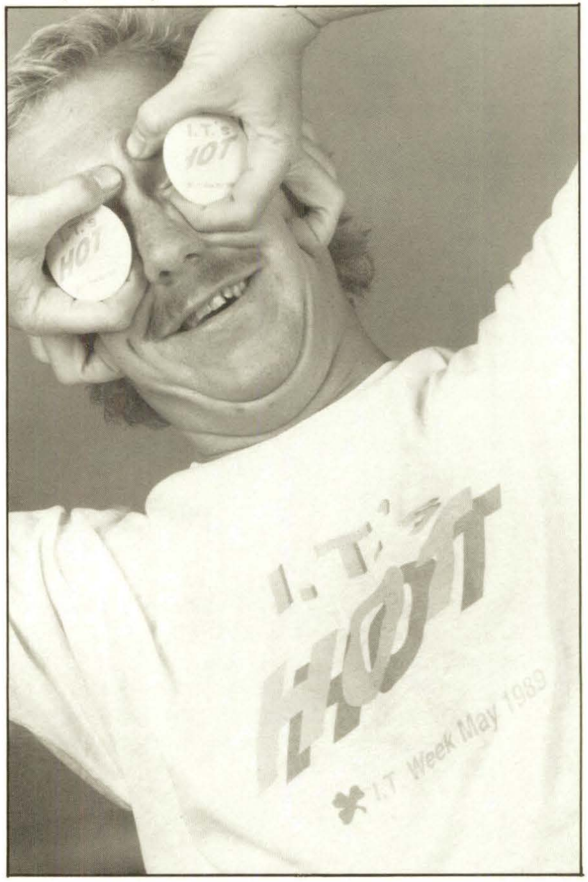
Choices for motor-impaired users include a tiny customized keyboard that aids people with a limited range of motion and good motor control, with the most frequently used keys in the center. A giant keyboard helps people with less refined movement and a greater range of motion. The keys require little or no pressure and can be redefined.

For those with extremely limited motion, single-switch devices allow "scanning"—where the computer presents groups of choices (for example, letters) at the bottom of the screen, and the user chooses one by activating the switch, whether by blinking an eye or twitching a muscle.

A grant from the IBM/University of Minnesota Woksape project funds the workstation, and a Project Woksape teaching assistant trains users and works with them to set up individual equipment configurations. The rest of the Electrical Engineering and Computer Science Building is user-friendly, too, with complete handicapped accessibility and classrooms and laboratories furnished to accommodate disabilities. I

By Nancy Schwalenstocker

Photo by Tom Foley



Buttons, T-shirts, pie-throwing contests, bed races, calculator tosses—May brought IT Week fever. Aerospace engineering senior Greg Hilliard displays some paraphernalia that swept the campus.

Service above and beyond...

Their service is more than civil

1988-89 IT Outstanding Service Awards went to 18 civil service staff members March 17. The winners, nominated by their department heads, are:

Carol Anderson, *executive secretary,* civil and mineral engineering
Herbert Ballman, *electromechanical systems specialist,* physics and astronomy
Frank Bell, *principal research shop foreman,* mechanical engineering
Arlene Bennett, *administrator,* civil and mineral engineering
Austris Cers, *scientist,* aerospace engineering and mechanics
Roberta Eich, *executive secretary,* physics and astronomy
William Fowler, *supply supervisor,* physics and astronomy
Connie Galt, *administrative secretary,* chemical engineering and materials science
Linda Goertzen, *executive assistant,* external relations
Beverly Harren, *principal accountant,* chemical engineering and materials science
Edmund Larka, *scientist,* chemistry
Mary Jane Lewis, *executive secretary,* chemistry
James McDonald, *junior user services specialist,* chemical engineering and materials science
Robert Nelson, *senior research shop foreman,* civil and mineral engineering
Kathy Ohler, *associate administrator,* geology and geophysics
Susan Page, *principal student personnel worker,* chemistry
Kathleen Ross, *administrative secretary,* chemistry
Jeanne Sitzmann, *office supervisor,* mechanical engineering
David Southwick, *senior scientist and associate chief geologist,* Minnesota Geological Survey
Robin Toy, *executive secretary,* computer science

She's a starr

Stephanie Miller, office specialist in the chemistry department, won a Minnesota Student Association 1989 Gordon L. Starr Award for her contributions to student life.

Retirees honored

A dinner at the Minneapolis Club June 9 honored IT retirees, including five civil service staff members. They are:

Frank Bell, *principal research shop foreman,* mechanical engineering
Warren Dahlin, *scientist,* St. Anthony Falls Hydraulic Laboratory
Vernon Petersen, *laboratory services coordinator,* chemistry
Gaylord Peterson, *senior research shop foreman,* chemistry
Donald Swadner, *senior research shop foreman,* chemical engineering and materials science I

Architecture designs new college

The School of Architecture and Landscape Architecture (SALA) became an independent professional school July 1 in a friendly split from IT. The move followed a recommendation in Academic Priorities, the University's 1988 plan specifying ways to improve research and undergraduate education.

Architecture's historic strong ties to landscape architecture are one reason for the Academic Priorities recommendation. Once a program jointly administered by architecture and horticulture, landscape architecture is now a department within the new College of Architecture and Landscape Architecture.

Academic Priorities also cites differences between architecture and other IT fields as a motivation for the split. Architecture has strong roots in arts, humanities, and the social sciences, with its location in the science and engineering sector hindering recognition and development of these other areas of architecture, says Harrison Fraker, professor and SALA head. While the split intends to help reinforce these areas, architecture's connections to IT won't be diminished—IT will still participate in teaching required architecture courses like math, engineering, and physics.

The new college also houses the Design Center for the American Urban Landscape, endowed by the Dayton-Hudson Foundation. I

Noted

More than 1,100 students received baccalaureate degrees at IT's graduation ceremony June 2 in Northrop Auditorium. ■ The Society of Women Engineers received an outstanding community service award from the University in May for its high school outreach program. ■ *Minnesota Technolog,* IT's undergraduate magazine, won first place for best all-around magazine at the Engineering College Magazines Associated (ECMA) annual convention in Washington, D.C., in April. ■ Unisys Corp. recently signed on as the sixth participating corporation of the Institute for Mathematics and its Applications (IMA). ■ IMA's 1989-90 program is dynamical systems. ■ Jeremy R. Knowles, Harvard University's Amory Houghton Professor of Chemistry and Biochemistry, held the spring quarter Kolthoff Lectureship in Chemistry. ■ Mihalis Yannakakis of AT&T Bell Laboratories was the Cray Endowed Lecturer in Computer Science, and Roman Polyak of the IBM Thomas J. Watson Research Center was a Computer Science Distinguished Lecturer, during spring quarter. ■ Robert Ervin, acting director of the University of Michigan Transportation Research Institute, spoke on developing a national program of intelligent vehicle-highway systems at a luncheon sponsored by the Center for Transportation Studies in May. ■ The Underground Space Center hosted three spring seminars for Japanese groups studying underground space use. ■ Geo engineering graduate student Marc Loken received the 1989 American Society of Civil Engineers (ASCE) Research Fellowship. ■ The steel bridge team of the University's ASCE student chapter won first place for aesthetics and first place for speed of construction in ASCE's regional competition at Michigan Technological University. The chapter's concrete canoe team took first place overall in the regional competition at the University of Wisconsin-Platteville. ■ Minnesota Department of Transportation Commissioner Lance Levine spoke to current and prospective civil and mineral engineering students in April. ■ Civil engineering

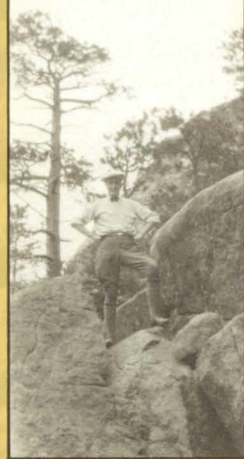
News to p. 18

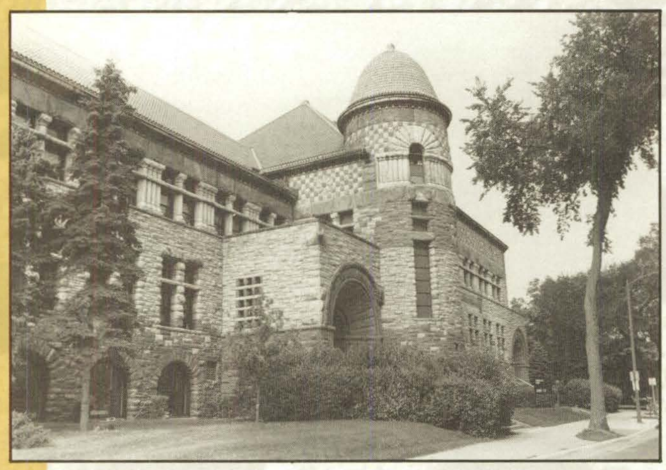
REUNIONS

Photos by Patrick O'Leary

Class of 1939 celebrates golden anniversary

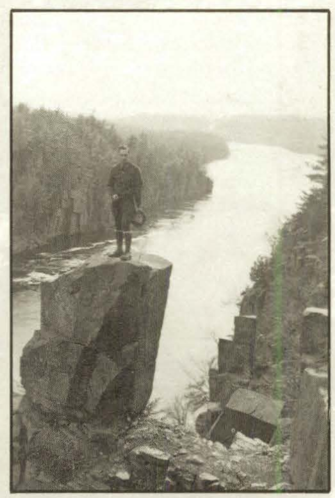
Alumni from a variety of IT departments gathered in May to mark the 50 years since their graduation from the University. *Top row:* **chemical engineering/ chemistry.** *Second row:* **civil engineering.** *Third row:* **mechanical engineering.** *Bottom row left:* **mines and metallurgy;** *Bottom row right:* **aerospace.**



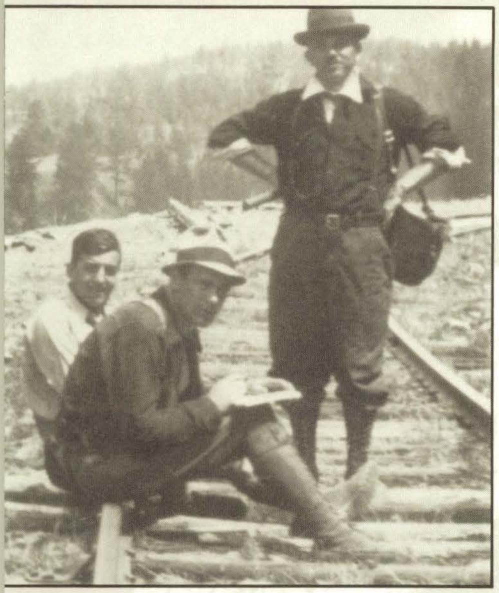


Finding New Digs

Geology excavates its past and maps its future



By Chuck Benda



Though moving day won't come at least until 1993, the appropriation of planning money for a new building for the Newton Horace Winchell School of Earth Sciences set the windows to rattling in Pillsbury Hall. When you've called the same building home for 100 years, the tiniest tremor seems like an earthquake.

Known to University physical planning people simply as Building No. 2 (the second oldest building on campus behind Eddy Hall), Pillsbury Hall stands out as one of the most distinctive buildings at the University of Minnesota. From its completion in 1887, it has housed the state's premier geologists. In fact, the birth of the department only predates the construction of Pillsbury Hall by 13 years. The red stone, the tile roof, the singular, unmistakable profile—it's a building not easily forgotten.

The steps leading up to Pillsbury's twin arches are deeply worn, as if the first students walked the stairs before the stone had hardened and somehow marked it with their collective footprints. Herbert E. Wright, Jr., Regents' Professor Emeritus of Geology and Geophysics and director of the Limnological Research Center, can lay claim to a good deal of that wear and tear—as well as to many of the recent achievements of the School of Earth Sciences. Since 1947 when he joined the faculty, he has climbed those stairs thousands and thousands of times; his office in Pillsbury Hall has become a second home.

Despite its charm as a building, Pillsbury no longer offers the necessities for modern geologic research. Recognizing the need for a new home, the 1989 state Legislature appropriated a little more than $1 million in planning money—the first step leading to the construction of the new Earth Sciences and Materials Engineering Building. If all goes smoothly and the rest of the planning and construction money follows on schedule, the new building could be completed in 1993, and thus the Legislature will once again—as it did more than 100 years ago—drastically reshape the future of the Newton Horace Winchell School of Earth Sciences.

In the beginning

Like the curious owner of a mysterious steamer trunk recently inherited from a shirt-tail relative, the first Minnesota Legislature sat down in 1858, and among (one would assume) a few other matters, decided it wanted to know what was "out there" in the hinterlands of this Minnesota, the newest of the United States.

Perhaps there was gold, or copper, or precious gems. Or coal or iron. Fur traders and other explorers knew something of the land and the timber, and a few simple geologic studies had been conducted, but no one had attempted a systematic survey of the state's resources.

There was much to be done, but money was tight in 1858. Unable to afford geologic charting, the Legislature ordered the reprinting and binding of a smattering of earlier geologic reports, but it quickly saw the importance of a systematic geological survey. Other states were already busy charting and mapping the resources within their boundaries.

In 1860, the Legislature again attempted to organize a regular geologic survey, but Governor Alexander Ramsey rejected their entreaties. Again, too expensive. Finally, in 1864, the Legislature authorized the governor to appoint a state geologist who, presumably, would begin a geological survey. Unfortunately, the governor then in office, Stephen Miller, didn't do a great job of assessing the credentials of a state geologist.

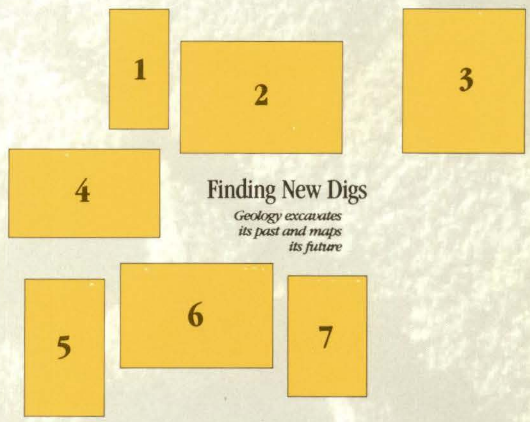
In 1864, Miller appointed A.H. Hanchett as state geologist. Many of the details of Hanchett's reign are lost to posterity, but apparently Hanchett was neither especially good at geology nor particularly dedicated. The Legislature dismissed him a year later. Governor Miller then appointed H.H. Eames as state geologist.

Eames "believed" there were vast ore deposits (including gold) in northern Minnesota—and apparently never bothered to investigate his beliefs before delivering reports describing those deposits. When the gold rush went bust, Eames' employment ended, along with the position of state geologist.

Although the Legislature continued to support geological work in the state, including a couple of exploratory surveys in search of copper and coal, it didn't come up with a solution to the dismal performance of Minnesota's early governors in picking state geologists until 1872. That year, legislators gave the job to the University of Minnesota.

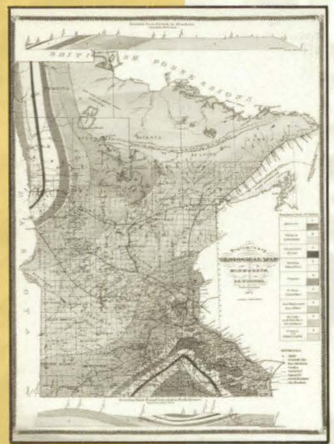
Believing the development of sound scientific information about the state's resources would lead to economic development, the Legislature empowered the University to create and administer a Geological and Natural History Survey and endowed it with the princely sum of $1,000 annually. The University hired Newton Horace Winchell, the younger brother of the then-famous geologist, Alexander Winchell, to head the survey.

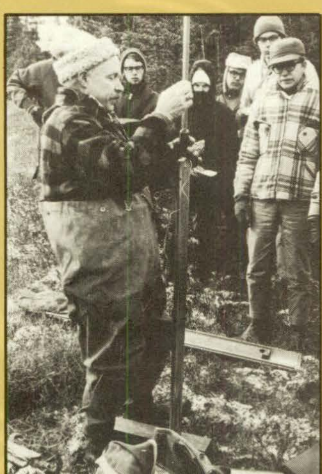
Winchell soon demonstrated that the University—unlike the state's first governors—could adeptly judge geologists. He immediately began the laborious task of mapping the state's geological features, often traveling by train while conducting a general survey along the railroad rights-of-way. By the end of the year, he completed a preliminary geologic map of the state, a summary of past geological work, and a brief report on Minnesota's natural history.

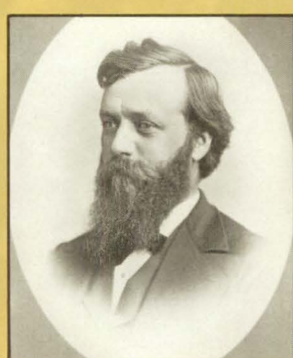


1. **George Thiel takes a break from climbing rocks.** *2.* **Pillsbury Hall's 1985 cleaning revealed patterns in pastel-red and buff sandstone.** *3.* **J.W. Gruner (standing) and crew in the Black Hills.** *4.* **George Schwartz relaxes after a hard day in the field.** *5.* **Field trips weren't all business.** *6.* **A well-preserved architectural detail near Pillsbury Hall's main entrance.** *7.* **A rock outcropping at Taylor's Falls, Minn., presented a great photo opportunity.**

Historical photos courtesy of the Department of Geology and Geophysics. Building photos by Tom Foley.







In 1874, as part of a general reorganization, the University established a department of geology and mineralogy, with Winchell as the new department's chairman and only faculty member for the next four years.

Winchell was not only an extremely competent geologist and administrator, he was also skilled at gathering good people around him. He quickly developed the survey into one of the premier geologic and natural history organizations in the country. During the 28 years of his tenure, Winchell wrote more than 115 survey reports. He developed a comprehensive geologic map that remained in service, relatively unchanged, until 1970. Among other features, he and other survey geologists identified and defined the Vermilion and Mesabi iron ranges in northern Minnesota. Perhaps most importantly, the work of Winchell and his colleague, U.S. Grant, laid the groundwork for what geology professor G.B. Morey, currently associate director of the Minnesota Geological Survey, describes as "one of the great triumphs of classic geology: unraveling the Precambrian stratigraphic succession in the Lake Superior region and, ultimately, in all of the Canadian Shield." The first to decipher that geologic history, they paved the way to understanding Minnesota's resources.

In his closing remarks at the dedication ceremony when the School of Earth Sciences was renamed for Winchell in 1988, Morey said, "It is only right that we honor him today for his contributions—it is wrong that we took so long to do it."

Building a reputation

The department grew slowly after Winchell's retirement in 1900—at least in terms of faculty members. When Herb Wright joined the faculty in 1947, there were still only seven members. But the people there were strong geologists, and they made good use of the work Winchell and his cohorts had begun.

"Four of the seven faculty members had been there 25 years, more or less," Wright says. "The department was dominated by these old-timers."

The original Minnesota Geological and Natural History Survey had been relatively inactive from the time Winchell retired in 1900 until 1911 when W.H. Emmons became director, according to Wright. Emmons revived the survey, minus its natural history component, and with the addition of three young faculty members—the "old-timers" Wright encountered when he came on board—the geology department began its rise to national prominence. This triumvirate—G.M. Schwartz in economic geology, J.W. Gruner in mineralogy, and G.A. Thiel in sedimentary geology—solved the mysteries of the Precambrian (Canadian) Shield that underlies northern Minnesota and most of central Canada. For Gruner, Schwartz, and Thiel, a canoe and backpack were part of the tools of their trade. Their work vaulted the department to a position of international prominence.

"Their work was very painstaking," Wright says. "Every summer they'd go into the north woods, take a compass bearing, and follow a straight line. They'd map every rock outcrop and identify every feature."

The big three retired almost simultaneously around 1960, and the department entered an era of expansion and reorganization. In 1961, the University established the Limnological Research Center (LRC). In 1962, the Minnesota Geological Survey, LRC, and the geology department officially became part of the Institute of Technology. The department was renamed the Department of Geology and Geophysics and joined the survey and LRC as part of the newly created School of Earth Sciences.

Growing pains

The faculty roughly doubled in size during the early 1960s, reaching its current level of 20 faculty members. The reputation established by the work of Gruner, Thiel, and Schwartz gradually faded as the natural growth of the science led the focus of geological research elsewhere. Today the school is ranked 24th in the nation among institutions that grant Ph.D.'s in geology.

"This is a very critical period for us right now," says Peter Hudleston, head of the school. "We're not where we'd like to be in terms of rankings, but we've got some good opportunities to bolster our position in the near future."

The school has developed new strengths to anchor its renewed push toward excellence. Herb Wright, LRC director since 1963, has helped turn LRC into one of the premier centers for limnological research in the nation. Wright, who formally retired in 1988 but will continue as acting LRC director until the school hires a suitable replacement, has been a pioneer in the study of paleolimnology. Through the study of lake sediments, Wright has simulated climates from thousands of years ago. Others associated with LRC have charted successions of forest fires and other paleo-events through the study of sediments.

Other strengths are evolving within the school, according to Hudleston. Subir Banerjee has established "one of the best, if not *the* best, laboratories in the country for looking at magnetic properties of rocks," says Hudleston. Because rocks maintain their magnetic properties, magnetism can act as a tracer that helps explain ocean floors' formation and movement of the continents.

"We've just hired a young person in isotope geochemistry—Larry Edwards—who has developed a technique of measuring extremely accurately the ages of corals," says Hudleston. "His technique covers a window of time that cannot be measured accurately by any other means. Radiocarbon dating goes back approximately 50,000 years, but Edwards' technique can go back several hundreds of thousands of years."

Despite its charm as a building, Pillsbury no longer offers the necessities for modern geologic research.

With increasing concern about water resources, hydrogeology offers a "hot" area of research, according to Hudleston. Thanks to a gift from George and Orpha Gibson, the school now has an endowed chair in hydrogeology, which it hopes will attract a prominent hydrogeologist who will establish a stronghold in that field.

"There's more potential now for things to happen than there has been for some time," Hudleston says. "And it's exciting because of these new people coming in, and the prospect of new facilities."

Hudleston sees the new building as key to a resurgence of the Newton Horace Winchell School of Earth Sciences. With the rapid growth of the school during the early 1960s, and the ever-increasing sophistication of the laboratory facilities needed for geological research, the school has long since outgrown Pillsbury Hall. Currently, several buildings across campus house different parts of the school, and the Minnesota Geological Survey operates out of rented off-campus quarters. The new building would bring the three divisions of the school under one roof and provide them with the necessary laboratory and classroom space. The athletic fields by Cooke Hall just north of the Harvard Street Parking Ramp are the site for the new building, which also would house Materials Science Engineering, the Center for the Development of Technological Leadership, and the Institute of Technology Dean's Office. The move would free space in Pillsbury Hall needed for other programs. Tentative plans call for remodeling of Pillsbury, with journalism as a possible new tenant.

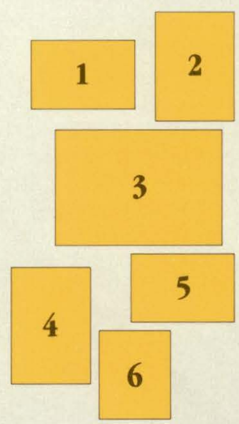
"This building [Pillsbury Hall] is now 102 years old," says Hudleston. "It's a great building. It's got lots of character, but for modern geological science, it's just impossible."

The school sends two advisors to planning committee meetings to ensure that the new building meets its needs. The current plan calls for 150,000 square feet of assignable space, with development of more details to follow. Although Wright agrees with Hudleston about the need for a new building and shares his hope that it will provide the means for revitalizing the school, he'd like the architects to incorporate some of Pillsbury Hall's character.

"We need an efficient, modern building for the type of research we're doing," Wright says, "but Pillsbury Hall, with its large hallways and close quarters, has always provided for a great deal of interchange between faculty and students. People are always moving around and running into each other in the hallways. I hope the architects can come up with a design that will foster that same sort of exchange."

In other words, Wright wants the new building to be what Pillsbury Hall has been for more than a century—a *home* to the students and faculty of the Newton Horace Winchell School of Earth Sciences. ▮

Chuck Benda, former editor of Minnesota *magazine, is a free-lance writer.*



1. **A curly maned lion adds to Pillsbury's mystique.** *2.* **Winchell's 1872 preliminary geological map of Minnesota was amazingly accurate.** *3.* **Two stony faces decorate a corner of the building.** *4.* **Herb Wright demonstrates coring for a group of students in northern Minnesota in the '60s.** *5.* **A group of geologists in the Black Hills find themselves up to their knees in snow on May 18, 1934.** *6.* **Newton Horace Winchell.**

Winchell photo courtesy of University Archives.

Mr. Clean Meets His Match

Talk about clean. Wipe your feet and hold on to your hat. A visit to the Microelectronic and Information Sciences Center's new clean-room laboratory reveals a whole new perspective on dirt. Located in the lower level of the new Electrical Engineering and Computer Science Building, the clean room really earns its name.

If you walked into the clean room in street shoes—which is strictly forbidden—and if you accidentally kicked loose from your soles, say, seven particles of dust, two specks of pepper, and a dandelion seed, you would increase by tenfold the level of airborne contaminants in the cubic foot of air surrounding your feet. Fortunately, within eight seconds—the amount of time it takes for the entire volume of air within the 4,000-square-foot laboratory to be exchanged and passed through the filter system—all of your dirty work would be undone.

While not a bad idea for parents of messy children, applied to everyday life such extraordinary fastidiousness might seem to border on the neurotic. But in the world of microelectronics, clean is sacrosanct. The infinitesimally small dimensions of modern microelectronic devices such as computer chips demand it. A single speck of dust, barely visible to the naked eye, could drop across several lines of a microcircuit, shorting it out and rendering the device useless. In the realm of microelectronics research, where scientists try to stretch the current limits of miniaturization, cleanliness *is* godliness.

Thus, NO ONE is allowed into the laboratory in street clothes. In fact, the scene that unfolds daily is totally unlike anything any of us encounter on the street. Costumed scientists—clad in white paper bunny suits with elasticized wrist and ankle cuffs and elasticized hoods, white paper slippers and masks, and rubber gloves—shuffle about in the yellow light and hunch over million-dollar machines with names to match: Varian Electron Beam Pattern Generator, Riber Gas Source Molecular Beam Epitaxy System.

Although it evokes science-fiction images, the clean room provides an environment in which even more amazing scientific facts may be created in the near future. And it offers the Microelectronic and Information Sciences Center (MEIS, pronounced "mice") an opportunity to plunge into the thick of world-class microelectronics research.

"Our clean rooms are Class-1, which is the most advanced cleanliness level for clean rooms anywhere in the world," says Stephen Gilbert, laboratory manager. The classification numbers refer to the number of particles a half-micron or larger contained in a cubic foot of clean-room air. In other words, a Class-1 clean room has just one such particle per cubic foot of air, while a Class-100 clean room has 100 such particles per cubic foot of air.

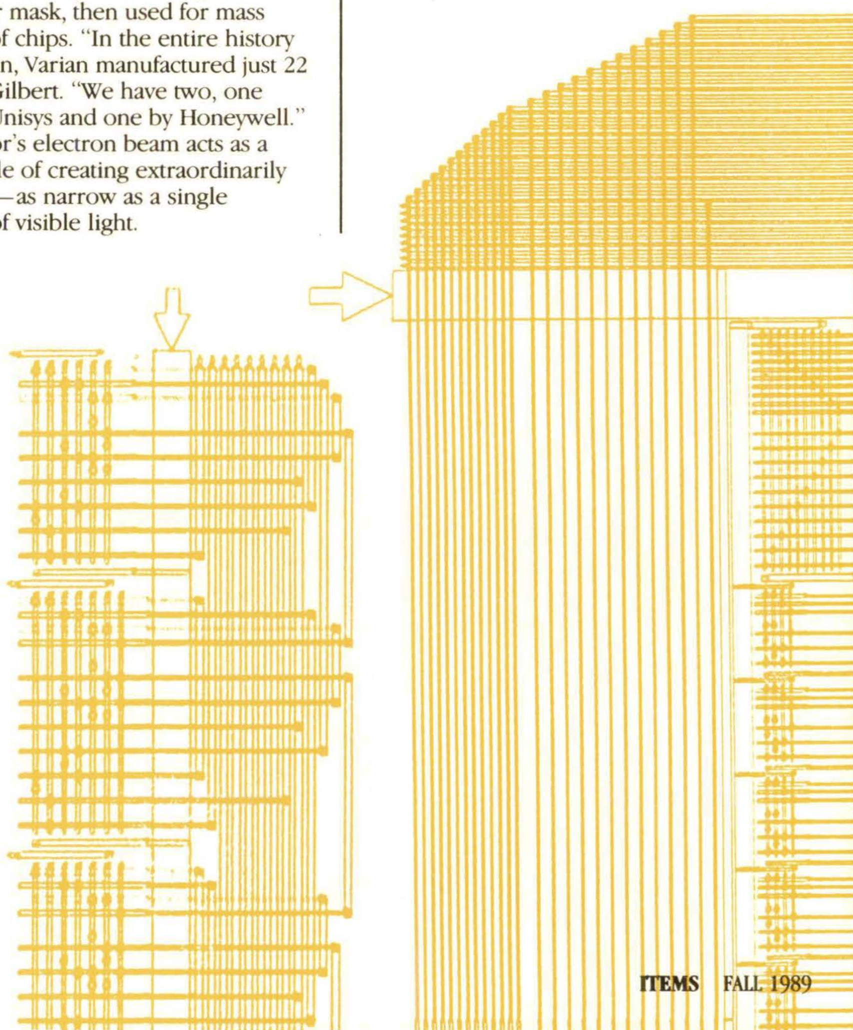
"Most manufacturing clean rooms are Class-100," says Gilbert. "A cubic foot of ordinary outside air would have from one to two million particles a half-micron or larger."

Clean-room equipment includes the Riber Gas Source Molecular Beam Epitaxy System (MBE), probably one of five or six such machines in the world, Gilbert says. Researchers use the MBE to make III-V semiconductors such as gallium arsenide and related compounds, building-block materials for the fastest computer chips and microelectronic devices.

Another rare instrument, the Varian Electron Beam Pattern Generator allows scientists to "draw" a microcircuit directly onto a computer chip or onto a glass "negative" or mask, then used for mass production of chips. "In the entire history of the division, Varian manufactured just 22 units," says Gilbert. "We have two, one donated by Unisys and one by Honeywell." The generator's electron beam acts as a pencil capable of creating extraordinarily fine circuits—as narrow as a single wavelength of visible light.

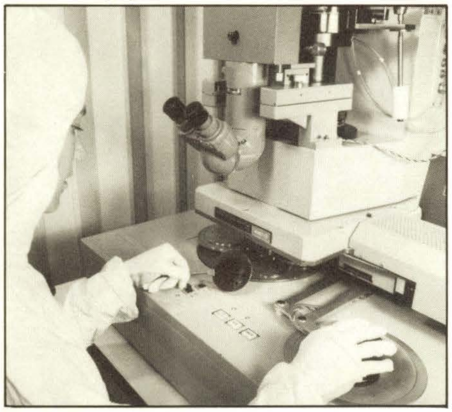
MEIS recently installed a third major piece of equipment—a bank of diffusion furnaces. Researchers use the diffusion furnaces either to "grow" semiconductor materials—various nitrides and oxides—or to diffuse impurities into semiconductor materials, thus altering their physical properties.

According to Gilbert, the combination of the clean room itself and those three pieces of equipment place the University of Minnesota among the top 10 universities in the world in terms of facilities and equipment available to scientists doing research in microelectronics. Until now, MEIS' only clean-room space was overcrowded Class-100 space in the old Electrical Engineering Building. The new clean room represents a major shift in focus for MEIS.



A sparkling environment for microelectronics research

Photo courtesy of MEIS.



The MEIS clean room offers the basic necessities: a place with no dust but with equipment to conduct world-class microelectronics research.

By Chuck Benda

Founded in 1981, MEIS works to strengthen the computer science and electrical engineering programs at the University and to establish strong ties between the University and local industry—the sort of ties that exist in places such as the Massachusetts Institute of Technology and Stanford, which are typically thought of as the strongholds of microelectronics research in this country.

"When I first came here, in October of 1985, MEIS was primarily in the business of funding research at the University," says Wallace Lindemann, director of MEIS. "We had four major research programs going, and we had several small grants programs. We were trying to get some interdepartmental research going, and we also funded individual professors to do research. We conducted lots of seminars to try to keep the lines of communication open to local industry."

In the early years, however, according to Lindemann, MEIS was not very successful in establishing the kinds of ties that he thinks are essential to develop a world-class research program in microelectronics. Also, the interdepartmental research projects never got going the way Lindemann would have liked. The tenure system, which Lindemann believes encourages individual productivity rather than cooperative research efforts, didn't help MEIS' efforts, he says. "The system wasn't working," Lindemann says, "so we gradually phased out of that mode."

The phase-out of the old system took place during construction of the new Computer Science and Electrical Engineering Building.

"I suggested to the dean of IT and to the board of directors of MEIS that perhaps a state-of-the-art microelectronics laboratory would be the place to focus MEIS' efforts," Lindemann says. "Because, in trying to establish solid ties between the University and industry, if you don't have a solid base—a place for people to come and do work with you—people don't come. People from industry aren't going to come over here to use a second-rate laboratory. If you really are interested in establishing working relationships between University professors and industrial scientists, you have to get some day-to-day contact between them."

The dean and the board of directors saw merit in Lindemann's ideas, and MEIS began to direct money and efforts at establishing a clean-room laboratory that was second to none. To that end, they enlisted Gilbert to design the sort of clean room that could be the linchpin of a revitalized MEIS.

Gilbert previously worked as a research scientist for IBM, RCA, and Sperry-Unisys. He designed half-a-dozen clean rooms for industry while working as a consultant, but he had never attempted something as ambitious as the MEIS clean room.

"Industrial clean rooms are generally set up for a single purpose—like manufacturing computer chips," he says. "This is an ubiquitous clean room. In designing it, I tried to anticipate research needs for at least 10 years into the future."

Gilbert considered the size of future devices as one key area. Currently, scientists make devices with components as small as

1,000 angstroms in size, roughly 1/750th of the thickness of a human hair. In designing the MEIS clean room, Gilbert predicted that in 10 years, scientists would be making even tinier devices—only 100 angstroms in size, which would require a laboratory environment carefully controlled in several different areas: cleanliness, humidity, temperature, and vibration. When working in such microscopic dimensions, the vibration caused by a passing bus, for example, could destroy painstaking research efforts.

So, working literally from the bedrock up, Gilbert called on all of his predictive powers to design a clean room that would satisfy the needs of its users for years to come. Underneath the clean room lie vibration isolation pads—three-foot-thick concrete pads that rest on six concrete pillars, much like a giant table. The concrete pads do not come in contact with the building foundation or the rest of the floor. Each pillar, or leg of the table, is anchored in bedrock and surrounded by an air space maintained by concrete tubes that keep soil from touching the pillars. When technicians first tested the vibration isolation pads, they thought their equipment malfunctioned—the sensors gave no indication of any vibration whatsoever.

The entire clean-room area uses positive air pressure, which prevents leaking of airborne contaminants. If you stand outside the door to the antechamber, you can feel air escaping through spaces in the door jamb. There is a constant breeze within the clean room, and you can hear the air rumbling through the duct work. The entire volume of air within the 4,000 square feet of clean room turns over every eight seconds and passes through a filtration system that removes close to 100 percent (99.9995) of the airborne particles.

Equipment carefully controls the temperature and humidity throughout the laboratory. There are 27 different zones, and the temperature can be regulated to within one-tenth of a degree Fahrenheit in each of those zones. Centralized smoke, fire, and toxic-air monitoring systems—with alarms designed to go off before such hazards reach a dangerous level—safeguard the clean-room occupants.

"We designed the clean room to get the most bang for bucks," says Gilbert. "As it turned out, our cost was a little less than half what commercial clean-room space typically costs.

"Our service chambers are 10 feet wide, and were designed so they can be used as research areas, too. They are Class-50 clean rooms, which is better than any other research area on campus. The wall systems are metal-clad, enamel-coated panels that can be reconfigured to fit our needs. Equipment can be mounted both in the service chambers and in the clean room. All the piping on the walls is mounted above seven feet so that equipment can be moved around without having to change the piping."

Although the temperature, humidity, vibration, and filtration systems are highly elaborate, the technology is fairly basic and straightforward.

"There's nothing magical about it," says Gilbert. "You might say it's all there just to keep the dirt off the chips and other devices. From a low-tech point of view, it's a machine shop on a microscale. In it you can modify materials—almost any type of material—using suitable reagents, and create patterns or structures that are in a microscale."

Using the MBE, researchers can grow their own gallium arsenide (or other III-V semiconductor compound) wafers. These wafers can then be changed by carefully implanting impurities into them in an ion implanter. The impurities alter the conductivity of the wafers. Circuits—designed on a very large scale at a computerized design station across the hall from the clean room and recorded on a magnetic tape—can then be imprinted onto the wafers by the electron beam pattern generator.

The clean room and the equipment in it are simply the tools for an endless array of research possibilities. Although the clean room is barely up and running, it has already hosted a wide range of research efforts. Currently, researchers use one of the service chambers to study the flow patterns of airborne particles.

"It's an interdisciplinary center," says Gilbert. "Anybody at the University who has research requirements that fit the facility can use it. We interact with people from neurophysiology, environmental pathology, from the chemistry department, chemical engineering, electrical engineering, and mechanical engineering. We even have some people from forestry and agriculture."

The mood of the people most closely involved with MEIS can best described as guardedly optimistic. Gilbert is obviously proud of the clean room and excited about the potential, but, beyond the three major pieces, much of the equipment remains in storage. Neither the manpower nor the funds exist to complete installation. And although there is a smattering of research projects from across disciplines, no major contracts have yet been awarded.

"We're just in the beginning stages," says Lindemann. "Everything is kind of coming together. Nobody can guarantee anything, but if we use the lab to its fullest extent, in five years we should be developing a reputation."

Lindemann is counting on another unique resource to develop that reputation.

"We need another push from the faculty; from people who are really looking ahead and saying, 'What can we do for the reputation of this University?' " Lindemann says. "We have a fine facility, better than we've ever had. We ought to use that to leverage our way into something really great. And I think our guys will do that, but it has to be faculty-driven, because that's what this University is: the faculty.

"No major university, especially the electrical engineering department, can compete in this world without being strong in microelectronics. Everything in electrical engineering is based on microelectronics now, one way or another. The laboratory can be the base for that strength.

"I think there is a hell of a potential here. We're really excited. But for that potential to fully blossom, there will have to be a great deal of cooperation among the faculty. If we reach that potential and develop a reputation, then people will be coming to us to get things done." **I**

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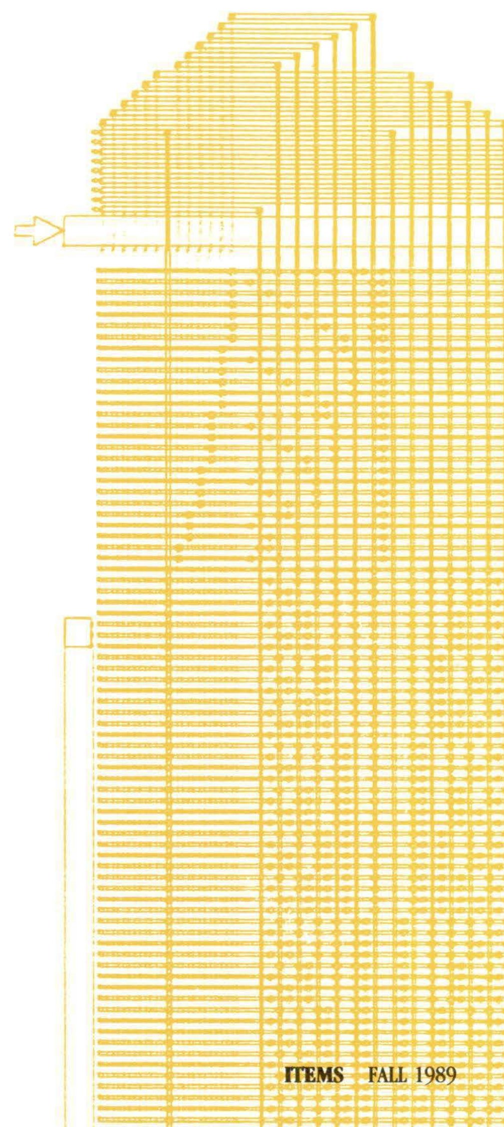
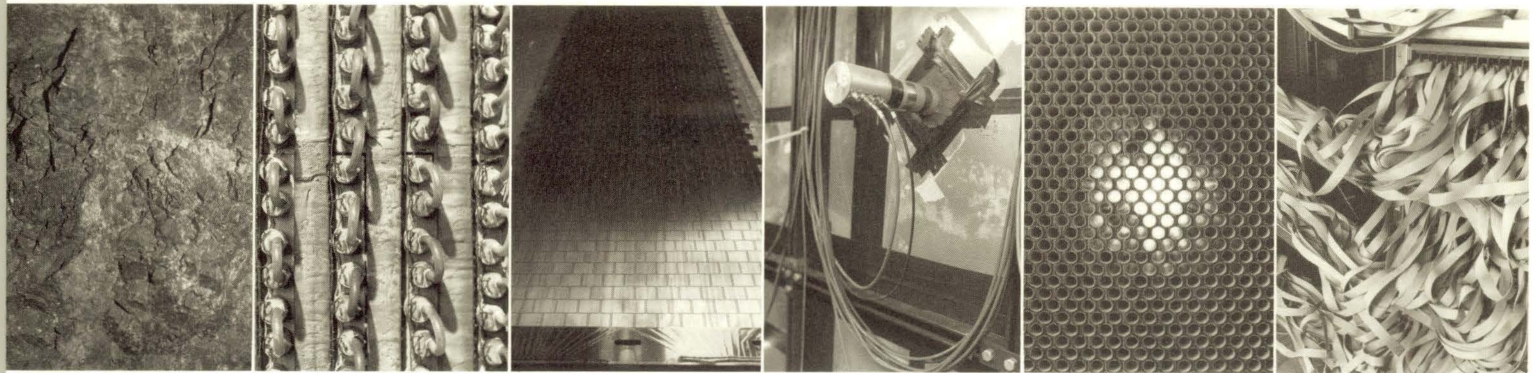


Photos by Tom Foley



Voyage to the Bottom of the Mine

The search for evidence of a dying universe goes underground

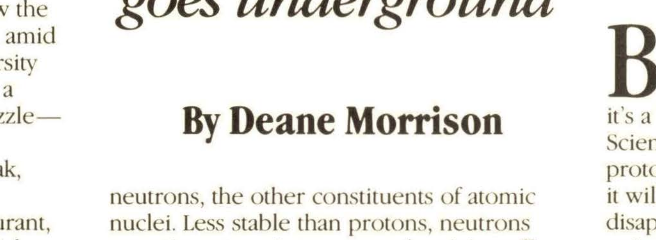
By Deane Morrison

The modern quest for the origins of the universe took a strange turn several years ago. It headed straight down an old mine shaft, to a cavern deep below the northern Minnesota landscape. There, amid solitude and the flitting of bats, University physicists began an intense search for a major missing piece in the cosmic puzzle—decaying protons.

The team includes Marvin Marshak, head of the School of Physics and Astronomy, fellow physicists Hans Courant, Ken Heller, Earl Peterson, Keith Ruddick, Pete Border, and Ken Johns, plus several graduate students and technicians and researchers from Argonne National Laboratory, Tufts University, and England's Oxford University and Rutherford-Appleton Laboratory. The mine project's annual budget approaches $2 million—almost $1 million from the Department of Energy, distributed through the University, and the rest from the other institutions—and its funding has just been renewed for a second five-year period. It employs nine people in the Tower, Minn., area and involves more than 50 physicists, engineers, students, and technicians.

With such a big group looking, it may seem that decaying protons could never slip by unnoticed. But nature doesn't yield her secrets so easily. For all anyone knows, she could have blessed protons with immortality. If not, then protons must decay, probably by falling apart and leaving nothing but energy behind. However, the quest reaches beyond protons to neutrons, the other constituents of atomic nuclei. Less stable than protons, neutrons sometimes turn into protons by giving off an electron and a neutrino. Like their proton pals, neutrons might also decay into energy.

"The project really should be called nucleon decay, because we're looking for decay of either protons or neutrons," Courant says. If they find decay, it means the two particles that form atomic nuclei will disappear someday, and so too will matter, the universe, and everything.



The marker for the Tower-Soudan mine doesn't tell the tale of its new underground mission: discovering universal mysteries. Above: some extraordinary evidence of a scientific project.

But not to worry. Even though the detection of proton decay would sound the death knell of the universe, it's a little early to plan the funeral. Scientists estimate an average life span for protons of at least 10^{31} years, which means it will take that long for half of them to disappear, Marshak says. Meanwhile, the universe itself is only on the order of 10^{10} years old.

Still, even if it takes an eternity, proton decay must occur to confirm physicists' current understanding of the four fundamental forces of nature. Those forces stack up as follows: The "strong" force holds the atomic nucleus together; the "weak" force governs the breakup of neutrons in the nucleus with the subsequent release of radiation; the electromagnetic force causes the phenomena of electricity and magnetism; and the gravitational force causes one to fall downstairs but not up. Physicists have been diligently trying to unify these forces in terms of particles that mediate attractions and repulsions between other particles or, in the case of gravity, large bodies such as stars and planets. They have succeeded in unifying the theories of electromagnetism and the weak force, but the stickiest challenge—bringing gravity into the fold—continues to stymie them. The efforts to develop a "theory of everything," however, has spun off some interesting ideas, among them the concept that protons decay.

"In trying to understand the fundamental forces in nature, one is led to the hypothesis that protons are unstable and will decay over a very long period of time," Marshak says. "It's not enough to make up theories. They must apply to our universe. They're not physics unless they do. This experiment is a test of the fundamental interactions of nature."

It may end up a test of endurance, too. If protons last forever, then the team is looking for a will o' the wisp. If protons decay, but less frequently than thought, the team will likely miss it and will have to decide whether to step up the search. And, of course, since no one has ever seen proton decay, it could be hard to recognize in the best-designed experiment.

None of this daunts the team members. They all know it's a gamble and are willing to stake a lot of effort on the chance that something will show up.

The search began in 1981, in a small space 1,900 feet down in the Tower-Soudan mine near Ely, Minn., with a proton-decay detector now called Soudan-1. It embodied the elegantly simple idea that one detects proton decay by keeping tabs on as many protons as possible—that is, by monitoring a very heavy mass of material. Accordingly, Soudan-1 comprised an orderly, 31-ton pile of concrete reinforced with taconite ("We were the first people in the world to carry iron ore down into an iron mine," Courant quips) and honeycombed with detection devices and wires leading to computers to try to catch decaying protons in the act. The thick layers of rock above the detector shielded it from cosmic rays that could swamp out a signal from a decaying proton.

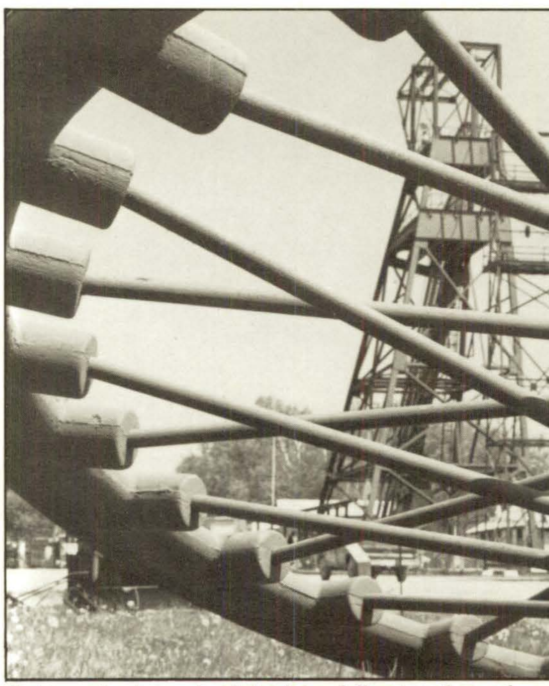
Soudan-1 has now been retired from the proton-decay business and its place taken by the new Soudan-2 detector at 2,341 feet below ground. Soudan-2 is already up and running at one-quarter capacity, with the rest of the detector scheduled for completion in 1992. In sharp contrast to the cramped quarters of Soudan-1, the new detector lies in a spacious excavation dug especially for the experiment. When finished, it will monitor protons in about 1,100 tons of steel rods arranged in 256 sections called detection cells. That amount of steel contains roughly 10^{33} nucleons, or enough to produce 60 decays per year if the life span is 10^{31} years. A double layer of aluminum sheets shields the detector, catching stray cosmic rays that slip through the overlying rock and sealing it off from the rest of the room to protect it from dust.

The discovery of protons kicking the bucket would shed light not only on the universe's fate, but on its beginning in the big bang.

"One explanation for why there's so little antimatter in the universe is a differential decay rate for matter and antimatter during the big bang," says Marshak. "If proton decay occurs, it would have happened fast in the big bang. We don't know a way to re-create the conditions of the big bang, which were very hot and dense. But a reaction that goes quickly when it's very hot will still go, but slowly, when it's cold. We're studying the big bang in sort of a perverse way."

When researchers convert energy to matter in the laboratory, they produce equal amounts of antimatter. So why did the big bang create more matter than antimatter? The asymmetry can be explained by a concept known as the CP (charge conjugation parity) violation, which left more protons than antiprotons, Marshak says. According to this theory, protons and antiprotons were created in equal numbers during the big bang, and both decayed rapidly. As the universe cooled, however, decay slowed way down, and the main losses occurred when protons and antiprotons collided and annihilated each other. The annihilations continued until only the excess protons were left.

"If that's true, then the universe we know today is composed of the surviving matter," Marshak says. "We don't have a lot of protons—the ratio of matter to radiation in the universe seems low. There ought to be more matter."



The Tower-Soudan project helps bring dollars into the northern Minnesota town and employs nine local residents.

While Soudan-2 looks for clues to the life and death of the universe, Soudan-1 investigates a phenomenon that turned up when it was on proton-decay duty: a mysterious, rhythmic burst of subatomic particles called muons coming from the direction of the constellation Cygnus, the swan. They seem to originate at or near an object, possibly a binary star, called Cygnus X-3, the third major source of X-rays in the Milky Way. Those X-rays arrive in cycles, with a peak every 4.8-hour period.

The arrival of Cygnus muons also reflects this 4.8-hour period, although the signal doesn't come through very loudly or clearly. The detector picks up the muons only when Cygnus appears in the sky, and then only a few hundred a year. Some days none arrive at all.

Since muons lack the stability to travel the 30,000 light-years from Cygnus, the particles streaming in must produce the muon showers when they hit the Earth or the atmosphere. The particles also must carry a neutral charge, or they would be deflected by various and sundry electric and magnetic fields and could not be traced to their source. Also, they must all move at light speed to give a good sharp signal.

Only neutrinos, photons, and ultrahigh-energy neutrons fit these criteria, but none could be responsible. Tiny neutrinos pass through planets as easily as through space and so would not die away when Cygnus dropped below the horizon. Photons don't produce enough muon showers to account for all those picked up by the detector, and neutrons, like muons, couldn't survive the journey intact.

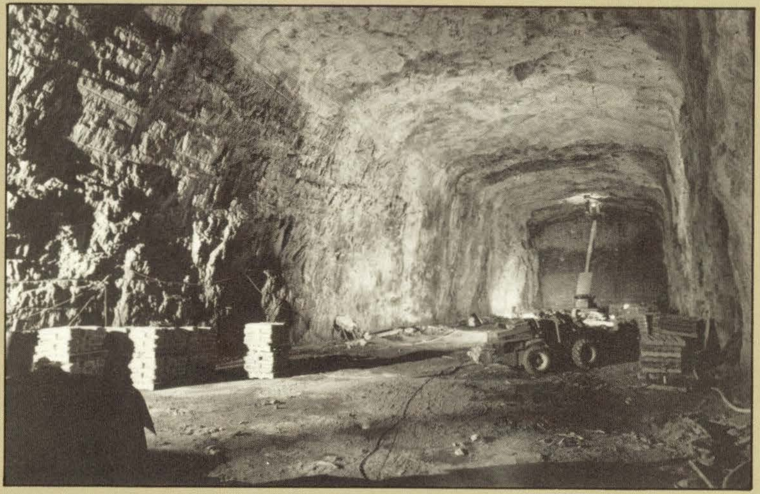
Whatever is raining down from Cygnus must be something out of the ordinary—an intriguing idea, but one that hasn't garnered much support from other physicists.

"No one else believes it's a new phenomenon," Marshak says. "That doesn't worry me—if what we've been saying is right, it will come out. I'm counting on living long enough to see the answer."

The physics team is also keeping an eye out for magnetic monopoles: tiny particles that, if they exist, would behave like magnets with only one pole. Either detector could pick up evidence of them. In fact, says Marshak, all kinds of particle-detection experiments can be done in the shelter of the mine as spin-offs of the proton-decay experiment. Whether one will hit the scientific jackpot remains to be seen. I

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

Dropping in on the Batcave



No one should have to go to work at 8 a.m. on a Saturday, but that's when I needed to meet Earl Peterson and his gang at the entrance to the Tower-Soudan mine. If I missed the 8 o'clock run I might have to wait till 10:30, and that's a long wait in a town with not a whole lot to do in two-and-a-half hours except sit in the bakery and scarf donuts. So to make sure I'd be there on time, I checked out the location the night before. The mine head was actually easy to find, even though, to avoid the entrance fee, I took the circuitous back way into the state park that houses the mine. Pulling up at the gate near the head, I got out of my car and walked to the shaft, just past a small building reassuringly labeled "Mine Rescue Room." Next to the shaft, a cold draft seeped up and swirled around my feet.

That night I found that my worries about not getting to the mine on time were groundless. Seems that whenever the bathroom lights in my motel were turned on, so, too, were the bathroom fans, which made a noise like a 747 engine warming up. Lots of fellow travelers couldn't resist this novel technology, even at 5 a.m., which helped immeasurably in not oversleeping.

At the mine head I met Peterson, graduate student Sue Schubert, the University's self-proclaimed "guys Friday"—actually technicians—Bill Miller and Brian Dahlin, and several Tufts University researchers. A little brown bat flew out of the shaft as we donned hard hats and boarded the two elevator cages that would carry us into the bowels of the earth. I insisted on standing by the door so I could get the scenic view of the rock wall hurtling by at 10 miles per hour. The cages, pitch black and cramped, rattled during the three-minute descent, contributing to the general atmosphere of a trip down a mine and not down the IDS Tower. About halfway down, Peterson assured me that even if the cables snapped and the hoistman controlling our descent went to sleep at the switch, the cages would brake themselves. At the 27th level we disembarked and headed up a short tunnel littered with dead bats to the Soudan-2 cavern. The cavern lies 689 feet below sea level, a depth at which "if the lake finds a leak into here, we're in big trouble," as Peterson puts it.

Walking into the cavern I was struck by its immense size and bright lights—not your typical iron mine. I also noted the tall, wood-sided work shed with the "Tornado Shelter" sign. Bats flew around the room or hung from the walls, some of the latter perhaps dead but not yet fallen. Attracted by Soudan-2's heat, the little blighters face a daily 2,340-foot ascent to the surface to feed; eventually the energy drain will do them in. A shame, since the high-tech atmosphere of Soudan-2 evokes visions of Batman's batcave, and what's a batcave without bats?

Dahlin led me on an impromptu tour of the place while the rest of the crew busied themselves assembling and checking out the detector, which is being built from the back of the cavern forward. About one-quarter is finished and taking data already. It measures 18 feet high by 13.5 on a side; the complete detector will cover a floor area of 65 by 27 feet.

Speaking of the floor, what are all those teeth painted on it?

"Those aren't teeth, they're dinosaur tracks. You're looking at them upside-down," Dahlin said. "They lead to the air-intake tunnel, which is where we're supposed to go if there's a fire down here."

At the other end of the cavern, opposite the detector, an open staircase wound up to two levels of offices, including one lined with computers—a deck area dubbed "the bridge" that commands a great view of the chamber. Sitting on the bridge with me, Peterson explained that the iron rods sticking into the ceiling a few feet above our heads help stabilize the rock. "They guarantee that if a chunk of rock falls on you, it'll be at least 20 tons," he said. Behind us a kitchen offered almost all the comforts of home, except that no one drank the tap water, a.k.a. condensate from the air conditioner. On the kitchen table lay a box of goodies from the Tower bakery, something to make the work go more easily.

The heart of the whole operation lies in five-ton detection cells known as "cans," which will number 256 when the detector is complete. Each can, Dahlin explained, comprises a corrugated sheet of steel with a 10,000-volt electric field running from the center to the edges, about 19 inches. Stacked in the folds of the steel sheet are plastic tubes; across their open ends run horizontal cathode boards and vertical anode wires. If a charged particle—say, one resulting from proton decay—goes through the cell, it sets up a cascade of electrons, which leaves a wake of positive charges. A computer takes note of which anode wire gets hit by the electrons and which cathode board gets hit by the positive cloud, and thereby can pinpoint the location of the event.

Peterson called up a few records on the computer and pointed out a couple of dark squiggles signifying muon hits. The surrounding rock filters out most muons, essentially huge electrons with a half-life of about two microseconds, but a few do make it down to the detector. So far, no dead protons, though.

Underneath the floor of the detector, Tufts guys lay in a crawlspace about four feet high and aimed flashlights on voltmeters connected to the steel sheets, trying to tell whether the voltages were there or not. Closer to the center of the cavern, I climbed an open metal staircase almost to the ceiling. Way below, a Ping-Pong table looked the size of a playing card, and the people were unrecognizable. The cavern is *tall.*

The lack of dying protons hasn't dampened any spirits; in fact, the project has raised a few spirits in the area by employing nine local residents. A few weeks before my visit, Soudan-2 held an open house and hosted about 200 visitors.

Leaving the cavern I sensed I had just dropped in on a project that could go down in history as a big risk that paid off. Maybe like the Wright brothers. Talk about risk, what kind of deal is this anyway, spending millions just to figure out whether protons decay? But then, what if no one cared, and *Wheel of Fortune* represented the furthest frontier of human intellectual exploration? In that case I think the whole world would look as bleak as the rest of the Tower-Soudan mine. I

By Deane Morrison

Paul Gassman

Gassman wins Triple Crown

Professor Paul Gassman always teaches his students to ask two questions before starting a research project. One, if this works out, will it change the way people think about organic chemistry? And two, will it change the way people do organic chemistry? "If the answer to either of these is no, the project is not worth doing," Gassman says. "If the answer to both questions is yes, you've got a world-beater."

Gassman, 54, knows a lot about world-beaters. His contributions as an organic chemist include nearly 300 journal articles, 30 chemical patents, and recognized research in the areas of carbocation chemistry, nitrenium chemistry, strained-ring chemistry, and bond distortion. He has also been an activist, chairing the Council for Chemical Research for a year and working hard for the American Chemical Society (ACS).

This year, the fruits of these labors paid off in a big way for Gassman. Like a Triple Crown winner, Gassman recently was elected president of ACS, named a Regents' Professor of Chemistry, and elected a member of the prestigious National Academy of Sciences.

"It's been a very nice year in terms of honors," Gassman reflected, during an interview in his office arranged between trips to Buffalo, N.Y., and Washington, D.C. (Frequent travel is nothing unusual for a man who currently holds invitations to speak in England, Taiwan, Hong Kong, and Japan.) "There were people who knew that all three things were in the mill who would have laid a very heavy wager that not all three things would come to happen at the very same time, but coincidentally they did."

Coincidence had very little to do with Gassman's sweep of honors. "I've never seen anyone with that drive to accomplish," says Louis Pignolet, chair of the chemistry department. Pignolet speculates that if Gassman worked in industry, he would reach the very top. "Paul Gassman has an enormous energy and drive, and we have now only begun to see what he can accomplish."

Energy and drive barely begin to describe a man who spends 70 to 80 hours a week working, but who doesn't call it work, and who won't call himself a workaholic. "I don't look at what I do as a job. I enjoy what I do. I have fun doing what I do," he says. "It's a great life to be paid to do something you really like to do."

His drive and energy set him apart from others, but at times they can be a source of frustration for both him and his colleagues. It is well known that he pushes people and will tell them if he thinks they are not working hard enough. He takes on his colleagues in a talk he has given a number of times on one of his pet subjects—the shortage of qualified chemistry students and the supply of adequate faculty. "Overall, I feel that the work ethic of the faculty has significantly decreased over the years. At the same time, it is difficult to persuade students that they should work harder than their mentors," he has said in his prepared talk, "Graduate Education in Chemistry: Where Have We Been and Where are We Going?"

"That gets me in a lot of trouble. It rankles faculty. It rankles students," Gassman admits. But he says it anyway, because, as he puts it: "I'd like to see more desire for success and the willingness to give up things to accomplish success."

"He's the most high-pressured person I've ever worked with," says his secretary, Chris Lundby. But Lundby enjoys the challenge: "He's always demanded excellence of everyone he comes in contact with."

Gassman's reputation, which is worldwide, isn't built on any particular project. He calls himself "very broad based," with interests ranging from "almost classic synthetic organic chemistry, on one extreme, to very physical, almost inorganic chemistry, on the other extreme." At this point in his career, Gassman does no hands-on work in the lab—his students do that. But he generates the ideas, and he says those ideas result from a finely honed intuition. "If I think about something, and I'm convinced it will work, we have a very good success rate."

"He has a strong sense of how he feels things should be done," says graduate student Dave Gorman. That combination of intuition and conviction led to Gassman's discovery that nitrenium ions exist, even though, in 1913, another chemist had said they did not. Nobody thought to challenge that assumption, until Gassman did as an assistant professor at Ohio State University. His discovery turned out to be an important one. "It was purely esoteric chemistry," says Gassman, but it became instrumental in the way people think about carcinogenesis, or how things cause cancer.

Gassman's generally upbeat mood takes a sober turn when he talks about scientific illiteracy in this country and the shortage of scientists, issues he plans to address as ACS president. "We know, plus or minus 50, how many Ph.D. chemists will graduate each year to the year 2000," he says. "There's not enough of them. We won't graduate enough to make up for attrition." Gassman also sees shortages in elementary and secondary science education. "We're in a frightening situation.... that will take a generation to two generations to change. That really constituted the reason that I agreed to run for ACS. I wanted a soap box."

Gassman will have that soap box, and there's a good chance that people will listen. As Pignolet sees it, "he's really trying to move that organization. If he can't do that, nobody can." I

By Miriam Feldman

IT yields PYI winners

Four IT faculty members received Presidential Young Investigator (PYI) awards from the National Science Foundation (NSF) in April. NSF awarded the five-year PYI grants to associate professor Frank Bates and assistant professor Robert T. Tranquillo from chemical engineering, assistant professor Steven Campbell from electrical engineering, and associate professor Greg Anderson from mathematics. They could receive up to $100,000 each in research funding per year. NSF provides $25,000 per year and will match up to an additional $37,500 per year raised by a winner's department. The five-year awards aim to help keep promising young scientists in academia. I

Aerospace Engineering

Scott Abrahamson and ***Gary Balas***, assistant professors, joined the department fall quarter. Abrahamson specializes in experimental fluid mechanics, and Balas focuses on structural dynamics and control with applications to large-space structures. Professor ***C. Arthur Harvey***, who specializes in aerospace systems, joined the department part time in spring 1989. Professor ***Daniel D. Joseph*** was elected delegate-at-large to the National Academy of Sciences theoretical and applied mechanics committee. Joseph also was honored on his 60th birthday by a jubilee meeting at l'Université Paris-Sud, May 17-18, featuring 13 guest speakers. ***Anastasios Lyrintzis*** and ***Thomas Posbergh***, assistant professors, joined the department this fall. Lyrintzis researches aerodynamics and aeroacoustics, and Posbergh's work deals with structural dynamics and control with applications to large-space structures. ***Eugene Stolarik***, associate professor, retired in June after 42 years with the department. Visiting professor ***Yiyuan Zhao*** received the Best Professor Award from the department's undergraduate students.

Agricultural Engineering

Jonathan Chaplin and ***Ian Moore*** were promoted to associate professors. ***Chang Ho Park***, assistant professor, joined the department in April. Park specializes in bioprocessing of biological materials. ***William F. Wilcke***, assistant professor, joined the department in July. Wilcke's research looks at the storage, handling, ventilating, and processing of grains, vegetables, and other crops.

Architecture

Professor ***John S. Myers*** retired in June after 33 years with the school.

Chemical Engineering and Materials Science

The IT Student Board recently named regents' professor ***Rutherford Aris*** the best chemical engineering professor. ***Frank Bates***, associate professor, received the American Physical Society's Dillon Medal in March for outstanding polymer physics research. ***H. Ted Davis***, professor and department head, received the 1988-89 George Taylor Distinguished Service Award at the June 2 IT graduation. Professor ***Richard A. Oriani*** retired in June. Professor ***L.E. Scriven*** was named a regents' professor by the University's Board of Regents in May. Regents' professorships, the highest honor conferred by the University on its faculty, carry an annual $10,000 stipend. Scriven also received the Distinguished Contribution to the Advancement of Science and Technology award from the Science Museum of Minnesota in April. Professor ***Matthew Tirrell*** is the editor of the journal, *Chemical Engineering Science*.

Chemistry

Margaret Etter, associate professor, was the Helen Homans Gilbert Prize Lecturer at Harvard University's chemistry department in April. Regents' professor ***Paul Gassman*** was elected to the National Academy of Sciences, the nation's most prestigious scientific honorary society. John Carroll University in Cleveland, Ohio, awarded Gassman an honorary doctor of science degree at its commencement May 28. The executive committee of the Chicago Community Trust named ***Scott D. Rychnovsky***, assistant professor, a 1989 Searle Scholar in March. The awards, which include three-year research grants, go to outstanding newly appointed assistant professors doing research in the biological sciences. Professor ***Archie Wilson*** retired in June after 18 years with the department.

Civil and Mineral Engineering

Matthew J. Huber, associate professor, received the 1988-89 Bonestroo, Rosene, Anderlik and Associates Undergraduate Faculty Award in May, recognizing his contributions to undergraduate students. Huber retired in June after 21 years with the department. Professor ***Ioannis Vardoulakis*** was appointed to a National Research Council panel reviewing U.S. progress in rock mechanics-borehole stability.

Computer Science

Gerald P. Dineen, retired corporate vice president for science and technology of Honeywell Inc., joined the department as a Senior Fellow. Professor ***Kai Hwang*** of the University of Southern California was the Control Data Corp. Visiting Professor of Computer Science spring quarter. Professors ***J. Ben Rosen*** and ***Marvin L. Stein*** and associate to the dean ***Peter Zetterberg*** received achievement awards from the department in March.

Electrical Engineering

Professor ***Raymond M. Warner*** retired after 19 years with the department.

Mechanical Engineering

Professor ***Arthur G. Erdman*** won the 1989 Machine Design Award from the American Society of Mechanical Engineers (ASME). ***Richard J. Goldstein***, professor and department head, was named senior vice president and chair of ASME's Council on Engineering. Professor ***Warren Ibele*** was elected chair of the University's Faculty Consultative Committee for 1989-90. ***Thomas Kuehn***, associate professor, and professor ***James Ramsey***, along with research associate Hwataik Han and research assistants Mark Perkovich and Sadek Youssef, won the Award of Excellence for a Technical Paper at the International Appliance Technical Conference at Purdue University in May. Professor ***Thomas E. Murphy*** retired after 48 years with the department. Professor ***E.M. Sparrow*** received the Senior Research Award, the highest research recognition accorded by the American Society for Engineering Education, in June.

Faculty to p. 18

ALUMNI

1969

Cliff Moulton *(Mechanical)* was promoted to vice president and general manager of Honeywell's skinner valve division, New Britain, Conn.

Jeffrey E. Schiebe *(Electrical)* was appointed president and chief operating officer of NSI Logic Inc., Marlboro, Mass., in February. He will be responsible for the general management of the company, which develops proprietary application-specific integrated circuits to enhance PC graphics capabilities. Before joining NSI Logic, Schiebe was vice president of international operations at MASSCOMP, a developer of real-time systems.

1973

Curtis L. Page *(Civil and Mineral)* was promoted to the Office of Engineering and Program Development in Washington, D.C., as a highway engineer with the U.S. Department of Transportation, Federal Highway Administration. He works with the Bureau of Indian Affairs to develop a certification program for road construction in Indian reservations.

1979

Roger W. Johnson *(Mathematics)* is an assistant professor in the mathematics and computer science department of Carleton College, Northfield, Minn.

Douglas A. Lauffenburger *(Chemical, Ph.D.),* head of the chemical engineering department at the University of Pennsylvania, will be the O.A. Hougen Visiting Professor at the University of Wisconsin's chemical engineering department during his sabbatical from September 1989 to May 1990.

Daniel B. Lovegren *(Civil and Mineral)* was appointed by the California Legislature to serve as consumer representative on a high-speed rail corridor study group. Lovegren is an associate transportation engineer with the California Department of Transportation in Sacramento.

1982

Thomas J. Barth *(Aerospace)* is program manager of several advanced armament programs at the armament laboratory of Eglin Air Force Base, Fla.

1984

David B. Morris *(Architecture, Civil and Mineral)* passed the state exam and is now registered as a professional engineer. A consulting structural engineer for Meyer Borgman and Johnson Inc., Minneapolis, he is rehabilitating his turn-of-the-century home.

Gregory R. Reuter *(Civil and Mineral),* a geotechnical engineer with GME Consultants Inc., Plymouth, Minn., received his master's degree in civil engineering from the University of Illinois at Chicago in 1988.

Theodore N. Rydell *(Aerospace),* an engineer for McDonnell Douglas, lives in Mesa, Ariz.

Lyn Zastrow *(Electrical)* is a lead engineer for Texas Instruments defense systems division, Dallas, Texas.

1986

Jong-Kai Lin *(Chemical, Ph.D.),* a staff scientist in the area of microelectronic thin film technology for Motorola Inc., lives in Chandler, Ariz.

1988

David J. Dykes *(Mechanical)* is an engineer in the manufacturing professional development program of Westinghouse Electric Corp., St. Louis, Mo.

Mark Litecky *(Electrical)* is an applications engineer for Rosemount Inc., Eden Prairie, Minn.

T. Kyle Vanderlick *(Chemical, Ph.D.)* received a 1989 Presidential Young Investigator award from the National Science Foundation (NSF). NSF awards the five-year, $25,000-per-year awards to help attract the nation's most promising young doctoral scientists to academic careers. Vanderlick joined the University of Pennsylvania's chemical engineering department as an assistant professor in fall 1989, after completing her postdoctoral fellowship at Johannes Gutenberg Universität, West Germany. I

NEWS
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undergraduate Brian Weikle was a member of the University's four-person College Bowl team, which won the national championship in spring 1989. ■ The 1987-88 IT Annual Report won a Northern Lights Award of Merit in the annual/biennial report category from the Minnesota Association of Government Communicators. I

FACULTY
from p. 17

Physics

Professor ***J. Morris Blair*** retired after 39 years with the department. Professor ***Kenneth J. Heller*** received the George Taylor Distinguished Research Award at IT's June 2 graduation. ***Robert L. Lysak,*** associate professor, received the George Taylor/IT Alumni Society Distinguished Teaching Award at the IT graduation ceremony in June. Professor ***Walter Weyhmann*** is chair of the University's Senate Finance Committee for 1989-90. I

DEATHS

Tilney W. Erhardt ***(School of Mines 1936), 81, June 18, in Bozeman, Mont.***

Harold J. Westin *(Civil and Mineral 1943),* 69, owner of Harold J. Westin Architects and Engineers and Harold J. Westin Constructors Inc., both of St. Paul. A St. Paul native, he served in the Navy during World War II and earned a law degree from the St. Paul College of Law in 1950. He wrote textbooks on engineering and construction law and taught a contracts and specifications course through University Continuing Education and Extension for 25 years. I

ITAS

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Institute of Technology Alumni Society • University of Minnesota

Thursday, November 2, 1989
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7:00 p.m. Dinner/Program
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Keynote Speaker: Allan D. Gilmour
Executive Vice President Ford Motor Company

"The Leaning Tower of Success"

Tables and individual seats available. For ticket information, call Cynthia Killmer (612) 624-1030

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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

Alumni achievement honored

The University's Board of Regents awarded two IT alumni the Outstanding Achievement Award (OAA) for unusual distinction in their fields at IT's June 2 graduation. Robert A. Henle (Electrical 1949, M.S. 1951), former director of the IBM Advanced Semiconductor Technology Laboratory, Yorktown Heights, N.Y., was given the award posthumously. Erick A. Schonstedt (Mechanical and Business Administration 1941), founder and president of Schonstedt Instrument Co., Reston, Va., also received the award, the highest conferred on University alumni.

Henle, who died early this year, laid the foundation for the development of the first solid-state computing system. The holder of 48 computer-technology patents, he pioneered the application of semiconductor devices to computer memories.

Schonstedt, a Minneapolis native, leads the development, design, and manufacture of high-quality magnetometers—instruments that detect and measure magnetic fields. Scientists and others use his magnetometers to study planetary magnetic fields, to conduct geological surveys, and to detect metals. I

Service saluted

James R. Sutherland (Agricultural 1961), president of SPECROTECH International Inc., received the Alumni Service Award from the University of Minnesota Alumni Association (MAA) at IT's June graduation.

A board member of the Institute of Technology Alumni Society (ITAS) for eight years, Sutherland was society president in 1985-86. An elected member of the MAA National Board of Directors, he is volunteer chair of the MAA's Constituent Society Advisory Committee. He also served on the College of Agriculture Alumni Association's Reorganization Task Force.

Sutherland's contributions to Minnesota agriculture rival his contributions to University alumni societies. His company, SPECROTECH, offers consulting services on specialty-crop technology and development. During his 12 years as a market development specialist with the University's Extension Service, he helped develop the edible-dry-bean industry in central Minnesota and North Dakota. He also headed several projects for the Governor's Council on Rural Development for Minnesota and serves on the advisory committee to the University's agricultural engineering department. I

IT helps alumni job-seekers

Looking for a change of jobs? Want some information about the marketplace? IT alumni may now use several new services offered by the IT Placement Office, including free listing and referral to prospective employers. Alumni also may receive a weekly listing of jobs from more than 50 major U.S. newspapers, says Herb Harmison, newly appointed placement director. The office hopes to provide alumni with quarterly issues of *Career Opportunity Update*.

Employers seeking IT alumni may contact the IT Placement Office and receive listings by college major and other selection factors. In case of urgent need, the office can fax alumni information.

For more information, write the IT Placement Office, 50 Lind Hall, 207 Church St. S.E., University of Minnesota, Minneapolis, MN 55455, or call 612/624-4090. I

Noted

About 150 alumni, students, and parents gathered to hear IT Dean Ettore Infante and recognize outstanding IT seniors at the Institute of Technology Alumni Society (ITAS) Annual Dean's Reception and Student Recognition Program. The program, held May 2 at the Radisson University Hotel, honored 20 seniors for their involvement and accomplishments in IT student organizations and activities. ■ The 1988-89 Paul A. Cartwright/IT Alumni Society Outstanding Student Service Award went to Susan Hobbs, a senior in the chemical engineering and materials science department, at IT graduation June 2. ■ Civil and mineral engineering undergraduates Brett Phillips, Shawn Schottler, and John Siekmeier received 1988-89 Simon and Claire Benson Awards from the department in May. ■ Irma B. Hill donated $5,000 to the civil and mineral engineering department for the William Crawford Hill Graduate Fellowship, commemorating her late husband, a 1932 graduate in civil engineering. I

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