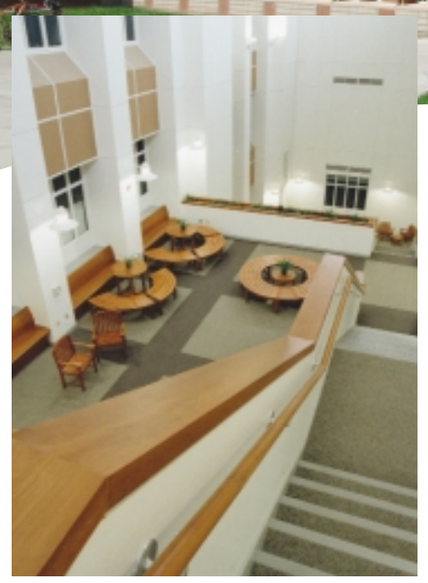
Breaking Ground

Science and mathematics get a new (and improved) home at NMU

The New Science Facility from the Academic Mall.



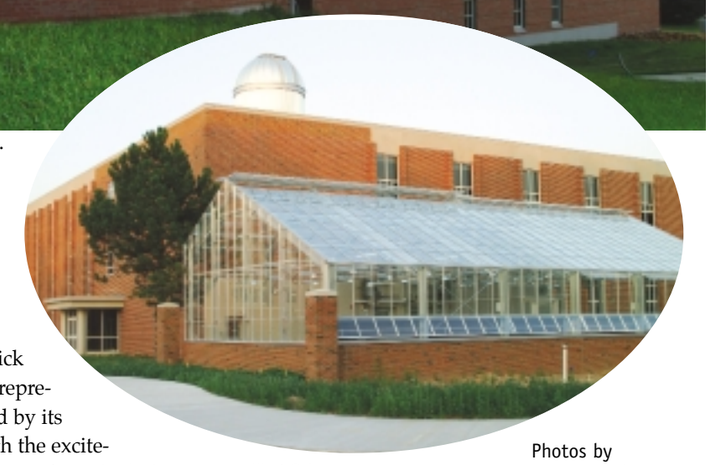
Atrium of New Science.

Profiles by CINDY PAAVOLA '84 BA, BRANDIE SHEETS, and KRISTI EVANS

Thirty-five years ago, Northern dedicated a new science building in honor of science scholar and biology department head Luther S. West. Sixteen years ago, Nobel laureate and Ishpeming native Glenn T. Seaborg lent his name to the newly established NMU center for improving the quality of elementary and secondary science and mathematics education. On October 5, both men — and their vision — were honored at the dedication of a new science complex.

The Seaborg Science Complex is comprised of two buildings: the New Science Facility and the renovated Luther S. West Science building. The complex features the best instructional equipment and technology and houses all science and mathematics departments under one roof: biology, chemistry, geography, and mathematics and computer science reside in New Science; physics, nursing, practical nursing, and The Glenn T. Seaborg Center for Teaching and Learning Science and Mathematics are housed in West Science.

While the complex represents the largest brick and mortar project in the university's history, it represents more than that. It embodies a vision shared by its two namesakes. These men believed that through the excitement of learning, we can motivate and encourage students in their pursuit of higher education, research, and discovery.



West Science greenhouse.

Photos by Kim Marsh '80 BS and Bill Sampson.

The Glenn T. Seaborg Center for Teaching and Learning Science and Mathematics

The mission of The Glenn T. Seaborg Center for Teaching and Learning Science and Mathematics is to enrich the knowledge and understanding of the general public in the areas of science and mathematics — particularly that of students and teachers from preschool through college. It is one of 25 designated mathematics/science centers in the state of Michigan and maintains a resource facility that includes publications, activity kits, and videos that teachers, students, and faculty may borrow for use in a classroom. It is also a regional NASA Educator Resource Center.

The Center strives to reflect the spirit and warmth of Glenn T. Seaborg, who epitomized the quest for science knowledge as a way of life. It reflects his belief that, in today's world, each citizen must have a solid understanding of and appreciation for scientific concepts and the technology to use them for the betterment of humankind.

The Seaborg Center has a unique opportunity to use its location and background to demonstrate that persons from diverse geographic regions can excel in science and mathematics and can contribute to the scientific future of our country and the world.

Entrance to Seaborg Center and walkway to Jamrich Hall.

Jeong-Chang Seong — Geography

Northern geography professor Jeong-Chang Seong helps his students see the world from different views — literally. They look at it from satellite images, aerial photos, 3-D maps, interactive and animated maps, and . . . well . . . any kind of map that can be computerized.

In fact, Seong, who serves as director of NMU's geographical information systems (GIS) certificate programs, has dynamic news for people who still have road maps from the 1970s stuffed in their car glove compartments: The U.S. Geological Survey is in the process of digitizing every United States map it manages, putting them on-line, and updating them almost in real-time.

"The goal of this is to have no map of any part of the country that is more than 30 days old," said Seong. "For instance, say a road is re-routed because of construction of a building somewhere — a map showing those changes will be available to the public within days of the building going up and the road being re-routed."

Eugene Wickenheiser — Chemistry

Department Head Eugene Wickenheiser and other chemistry professors are using technology and the new facilities within the Seaborg Science Complex to help students become better prepared for a job after their college education.

Instead of collecting data points by hand, students are using new computer software loaded onto their NMU issued laptop computers to collect data.

"The computer can collect thousands of data entries in an hour," Wickenheiser said. "If students were to collect the data by hand, they could only collect a fraction of that. By collecting more information, students can perform more accurate experiments."

The new chemistry facilities give students the room and equipment necessary to use their computers when conducting experiments.

"What we are using now is a better match to what students can expect to encounter in the industry," said Wickenheiser.

The new software plots data points in graphs as the information is collected. So now, instead of spending time collecting data, students are able to focus on what is happening and interpret the data as it is collected.

Lucille Contois — Clinical Laboratory Science

"Who is doing your medical lab work or that of someone you love?" asked Lucille Contois, director of Northern's clinical laboratory science program. "Does it matter to you if hospital labs are severely understaffed? Of course it does!"

According to Contois, hospitals around the United States cannot fill 20 percent of their laboratory positions due to a lack of qualified job candidates.

Northern's clinical laboratory science program is addressing that need by offering bachelor's degrees for diagnostic genetics, clinical lab scientist, clinical lab science in microbiology, cytotechnologist, histotechnologist, science technologist, and clinical system analyst; associate degrees for clinical lab technician, histotechnician, and science technician; and certificates for clinical assistant and phlebotomy.

The programs combine three main areas of study: biology, chemistry, and clinical laboratory science. Some baccalaureate students also have the opportunity to do a six-month internship at the world-renowned Mayo Clinic in Rochester, Minnesota.

"The partnership with Mayo Clinic provides the type of hands-on laboratory experience that will make our students qualified to work in any lab in the world following graduation," said Contois.

"But the partnership has also been important to Mayo Clinic because it, too, has a critical need for lab technicians," she added. "The people at Mayo have said they are impressed with the work ethic and strong educational foundation of Northern students."

Jackie Bird — Biology

When the large animals she was working with as a veterinarian started to physically get the best of her, Jackie Bird turned her interest to something smaller — studying parasites.

"As a veterinarian in a large animal practice, I became very intrigued by the questions of parasite control," said Bird, an NMU biology professor.

Two and a half years ago, one of Bird's students got her involved in a study of the tick that carries spirochete, the bacteria that causes Lyme disease. Today, she and professors Ned Walker of Michigan State University and Mark Wilson of the University of Michigan, and their collective group of student assistants are trying to answer the question of how, or if, ecology plays a role in where populations of this tick can be found.

"We're looking for something that will answer why a tick is found in a particular area, but not in another," said Bird.

Bird said she and her students are out in the field looking for ticks every week between May and September.

West Science from the Academic Mall.

Dave Lucas — Physics

Whether it is researching particles and fields theory with Neil Russell or creating lenses that mimic the gravity that bends light around planets with Mark Jacobs, students in the physics department are sure to be exposed to faculty research projects on a daily basis.

According to Department Head Dave Lucas, each physics professor is involved in a research project, and almost all of them have at least one student taking part. For example, students working with Jacobs on his research of gravitational effects on light help make lenses, record data, and assist in many other ways.

"If students want to be involved, chances are we can find something for them to do whether they are physics majors or minors or not," Lucas said.

The department also strives to get students excited about physics at an early age by doing demonstrations at area elementary and middle schools.

Ron Sundell — Environmental Science

The environmental science program has a new research facility at its disposal, but it's not housed in the Seaborg Science Complex — or anywhere on Northern's campus. It's located at Marquette's upper harbor near Presque Isle Park. The program has obtained a research vessel to assist in ecological studies on Lake Superior and the near-shore environment.

Ron Sundell, director of the program, developed a long-term lease agreement between NMU and the boat's owner, Argonne National Laboratory near Chicago.

NMU will use the 26-foot vessel for faculty research and for faculty-supervised graduate and directed study projects. The university is working with the Central Lake Superior Watershed Partnership to examine aquatic flora and fauna habitats along the 14 rivers that flow from Marquette County into Lake Superior.

Sundell has forged two other cooperative agreements. NMU provided a location outside New Science for the National Weather Service to erect a 10-meter tower as the official reporting station for Marquette.

The university will also develop a native plants study area with guidance from the U.S. Forest Service. Student interns will assist the USFS in gathering native plant seeds for habitat restoration projects.

"These relationships give students hands-on experience that will prove beneficial as they pursue graduate school or employment," Sundell said.

What's happening up there?

Unlocking the secrets of the aurora borealis

BY KAREN WALLINGFORD

The ends of the land and sea are bound by an immense abyss, over which a narrow and dangerous pathway leads to the heavenly regions. The sky is a great dome of hard material arched over the Earth. There is a hole in it through which the spirits pass to the true heavens. Only the spirits of those who have died a voluntary or violent death, and the raven, have been over this pathway. The spirits who live there light their torches to guide the feet of new arrivals. This is the light of the aurora.

Ernest W. Hawkes, *The Labrador Eskimo*

Principal investigators Bill Ralph (left) and Dave Donovan check on Northern's all sky camera, on the roof of the Jacobetti Center. *Photo by Bill Sampson.*

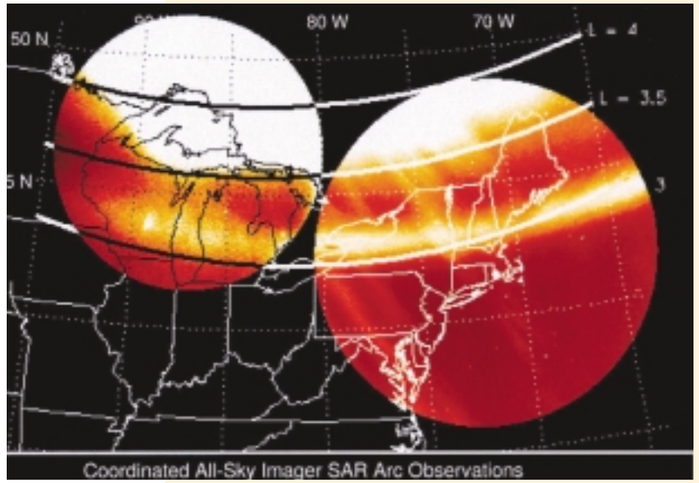
The eerie and mysterious beauty of the northern lights have fascinated people for centuries. Explanations for this fleeting phenomenon are as varied as the cultures that attempt to explain them. In ancient China, the aurora was believed to predict forthcoming births. The Mandan Indians of North Dakota, on the other hand, believed the northern lights were fires over which the great medicine men and warriors of northern nations simmered their dead enemies. Other theories about the aurora have a more scientific flair.

"I think the most entertaining explanation is that it's sunlight reflecting off the polar ice caps," said NMU Physics Professor, Dave Donovan.

Donovan can tell you all about the northern lights. As he delves into a super-charged explanation of the upper atmosphere and how auroras form, his enthusiasm is unmistakable. He talks quickly and emphatically as if he had been doing this for his entire career. But he hasn't. In fact, Donovan is relatively new to this area of research.

When he joined the physics department in 1992, Donovan's research focused on phase transition in metals. In particular, Donovan looked at what are known as shape memory alloys — alloys that remember and pop back into their original shape regardless of how they are deformed.

Now along with NMU Physics Professor emeritus, Bill Ralph, and Michael Kelley from Cornell University, Donovan is a principal investigator on a research grant project funded through the National Science Foundation. The purpose of the grant is to study aurora-related phenomena using an all-sky camera, which has been installed on the NMU campus. In addition to Cornell, NMU is collaborating with Boston University, the U.S. Air Force Research Labs, and MIT Haystack Observatories Incoherent Radar Scattering Group.



This image shows stable auroral red arcs as recorded by Northern's all-sky camera on the left and Boston University's all-sky camera on the right.

The pictures the all-sky camera takes of the aurora, however, are not what you'd expect to see. In fact, the pictures it takes cannot be seen by the human eye alone. It looks through filters and takes a horizon-to-horizon picture of the sky using an extremely long exposure.

"Our eyes refresh at roughly a sixtieth of a second," Donovan said. "We can let this camera collect light for up to two hundred seconds. A lot more becomes apparent when you let the camera collect light for that long."

Kelley, who has been researching the aurora for nearly 30 years, approached Bill Ralph with the idea of installing an all-sky imager on Northern's campus in 1994. Kelley has all-sky imagers installed in other parts of the country and felt that Northern's location would be ideal for an additional camera. Not only is it in a location where there hadn't been an imager before, Northern's camera overlaps with an all-sky imager run by Boston University at the Millstone Hill Research Facility in Westford, Mass.

"Alone, BU sees a certain part of the sky," Donovan said. "With the addition of our camera, we now see almost twice as much of the sky."

Northern's camera is adding optical data to an existing array of data collected by other all-sky imagers around the country. NMU's data will eventually be joined with data from the other cameras and compared against data taken by other instruments such as satellite data taken by the Air Force and radar data taken by MIT. Together the data should provide a more complete picture of what is going on in the upper atmosphere.

"What's going on in the upper atmosphere is not well understood at this point, so we are trying to find out what's happening up there," Donovan said. "When we see light, it's an indication of plasma densities. We're look-

ing at why these plasmas take the shape they do, why they move the way they do, how often they move, and how they are evolving."

Adding to this body of research has far-reaching implications — affecting such modern conveniences as cellular phones, pagers, digital television, and airline travel.

"Right now, the U.S. economy is extremely near-space dependent," Donovan said. "Most of our satellites are just above or partially in our atmosphere. All of this is very interconnected with the sun. If the sun does something energetic, all of these things are affected. We need to know this."

Donovan was brought in on the project in the grant stage in 1996, after Ralph decided to retire. Ralph remains an active member of the research team, but the university needed an active faculty member to help with the research and manage the grant. While aurora research is quite a departure from Donovan's area of expertise, his background as an experimentalist — coupled with his experience using complex computer equipment — made him an ideal addition to the project.

In 1998, the camera was installed on the roof of West Science, and Donovan and Ralph spent the next year learning how to operate it and make the proper adjustments in order to get good, usable data. However, they weren't getting good results from the first pictures they took. When the West Science renovation began, the camera was moved to the roof of the Jacobetti Center, and they soon discovered that the lights outside of West Science had been effectively washing out the night sky, making it very difficult to capture any aurora activity.

"Now it's a much better view. We can see the stars and the Milky Way. We're not planning to move back."

Donovan and Ralph are now skilled all-sky photographers, but the process of data gathering is slow and limited by a number of external conditions. While the auroral rings are always present, it's too bright to see them during the day, so data gathering is restricted to night. And because one of the goals of the research is to expand on the images captured by the BU camera, Donovan looks for nights when images can be captured both in Marquette and in Boston.

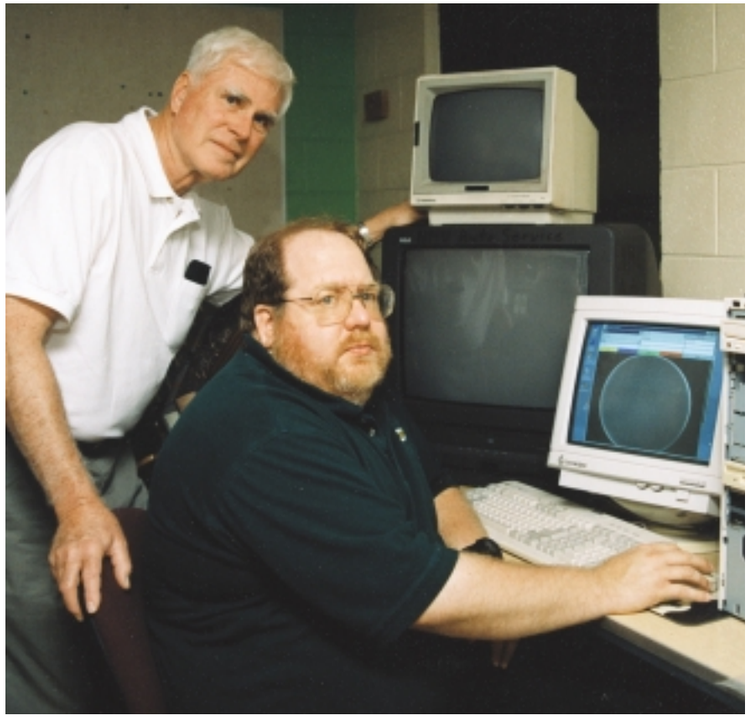
"Getting usable data isn't as easy as simply taking pictures on a clear night," he said. "The night sky needs to be clear both here and in Boston. Not as easy as it might sound."

In addition, there are two weeks a month when Donovan cannot run the camera because the moon is in the sky and it's too bright to capture images. And then there's the weather.

"Earlier this year we went through two straight weeks of clouds," Donovan said. "On March 31, the world saw a huge aurora. It went as far south as Richmond, Virginia, and San Diego, California, but we didn't see a bit of it here."

Adding to these limiting factors is the variability of the aurora. Oftentimes, the activity simply isn't worth recording. Although data gathering is slow, Donovan does not seem fazed by the pace of the research.

"You can't predict when you're going to get results. This kind of research isn't like other research. You have to wait for things to happen."



While both Bill Ralph and Dave Donovan have the capability of operating the camera from their homes, this control room in the Jacobetti Center allows them to see the images much more quickly.

Nor does he seem fazed by the fact that he may not see definitive results during his career. According to Donovan, it isn't uncommon for researchers to reanalyze data as much as thirty years old and uncover new findings. He is more concerned with collecting good data. And now is the best time to do it.

"We're trying to get as much data as we can right now because the sun is in solar max — the eleven year sun spot cycle — which increases the amount of aurora activity. In two to three years, the sun will quiet down some, and there will not be as much aurora," Donovan said.

Once solar max is over, Donovan and crew will be able to spend more time analyzing the data while they wait for sun spot activity to pick up again.

After roughly a year and a half of taking images, Donovan and Ralph now have enough good data sets to begin joining it with data from BU's camera and the Air Force's satellites. Although they don't currently have any nights in common with MIT, they continue to look for nights when conditions will be favorable in both locations so they can begin additional collaborations.

"We have some preliminary results," Donovan said. "We have some more questions, and now we have to start refining things. We have to start doing some more data analysis."

One of the questions raised by their preliminary analysis resulted when they began joining data with Boston. They saw something unexpected involving a phenomenon called stable auroral red arcs, or SAR Arcs, and Donovan is currently focusing data analysis on this occurrence.

"It has always been believed that these arcs form in the main aurora and drift south, but they do so horizon to horizon. We may have some evidence here that they don't."

Donovan is currently focusing his data analysis on what are called stable auroral red arcs.

"It has always been believed that these arcs form in the main aurora and drift south, but they do so horizon to horizon. We may have some evidence here that they don't."

Donovan uses images captured from both locations to illustrate the discovery. There are two nights in which Northern's and Boston's camera have both clearly imaged an SAR Arc, but on a third night, Northern's camera imaged an SAR Arc, while Boston's did not.

"Here's a day where we join up. The interesting thing is we see this arc and they [BU] don't. And no one is exactly sure why. So right now, this is one of the key questions we're looking at. What's going on with these arcs? How are they forming? Why do we see them sometimes and BU doesn't?"

Although Donovan admits that this could simply be an instance of losing part of the image due to varying resolutions between the two cameras, he is not willing to dismiss it as a mere fluke. And neither is Kelley.

"Mike Kelley at Cornell thinks if we look hard enough, we might actually see some structure — you know wiggles and things that are reproducible," he said.

Donovan would like to see the University of Calgary join the project because they have a camera that overlaps Northern's western edge, adding yet another piece to what has become quite a puzzle. He went on sabbatical last semester to continue building collaborations with other universities and research institutions.

He likes the project because it has been productive and because the grant has allowed for a good deal of student involvement. Donovan has taken four students to academic conferences, where they have been able to meet aurora researchers from all over the world.

While the grant will end next spring, Donovan said he sees this project going on long after the grant runs out. In fact, he hopes to be able to get additional instrumentation to enhance Northern's research capabilities.

"The camera doesn't go away. As we take more pictures and see more things, the picture becomes clearer. The results we have now may totally reverse in ten years depending on the data. Who knows." ■

MARC KNEPPER
BAY AREA BIOTECH

By KRISTI EVANS

How does one simplify the concept of recombinant DNA — the core of modern biotechnology — for a writer who once scorched her bangs over a Bunsen burner in a botched high school experiment? **Marc Knepper '96 MA** faced this daunting challenge during a recent interview at a Starbucks in San Francisco.

"The technology takes chromosomes from the bacteria … ," he began. An anxious nosedive into the froth of my latte did little to disguise my clueless expression. Knepper opted for a visual aid. He picked up a crumpled drinking straw wrapper from the table, smoothed out the accordion-like folds, and formed it into a ring. "Imagine having a circle of DNA and taking a scissors to slice it open. Then you insert other DNA of your choice and attach it together." In other words, functioning lengths of DNA can be cut from one organism and pasted into the cells of another organism. Cut and paste. That's better.

Had he realized I was a Wisconsin native, Knepper might also have mentioned that biotechnology, in its earlier forms, was at the root of cheese making and beer brewing. It's not a revolutionary concept. The term reportedly was coined in 1919 to reflect all lines of work that made products from raw materials with the aid of living organisms. With the advent of gene splicing and recombinant DNA techniques about 25 years ago, its applications expanded to other commercial — and sometimes controversial — areas. Biotechnology is used in agriculture, pharmaceutical development, food processing, bioremediation, and energy production.

Knepper has established a career in biopharmaceuticals, an industry that spawned after a key event at the University of California at San Francisco. In 1978, a researcher constructed a synthetic version of the human insulin gene and inserted it into the Escherichia coli (E-coli) bacterium. "Up to that point, they had to slaughter pigs and purify their insulin before giving it to diabetics," Knepper said. "With DNA technology, you can take the human insulin gene, put it in the bacteria and the bacteria will make it for you. No pigs required."

As a research associate for two San Francisco biotech companies — Onyx Pharmaceuticals and Advanced Medicine — Knepper carried out in-vitro experiments. These cell-based assays were designed to show whether drug compounds demonstrated the desired effects.

At Onyx, he worked with Bayer Corp. to develop a small-molecule drug for certain types of cancer cells. "The standard treatments for cancer have been radiation therapy and chemotherapy, which is like using a shotgun to get a fly off your nose. You may kill the fly, but you also kill a lot of normal cells, and that makes patients sick. Therapeutics developed with the small-molecule approach actively target the tumor cells and destroy them, but leave normal cells alone. It's exciting, and I think we've only scratched the surface in this area."

Knepper enjoyed the cutting-edge nature of his field, but knew he couldn't be a research associate forever. In July, he accepted a position with SuperGen, also based in the Bay area. Rather than perform test tube experiments in a lab, he monitors human clinical trials of pharmaceuticals in the field.

"You have to be somewhat anal or detail-oriented to do this job because you have all of these FDA regulations and protocols to follow," Knepper explained. "If Marquette General Hospital was doing a trial, I would fly there to review the case reports for all patients involved and make sure they've been properly informed about the process. I would also make sure the site itself is in compliance with FDA regulations."

A similar process earlier this year led to FDA approval of Gleevec for chronic myelogenous leukemia. Knepper said nearly all CML patients who've taken the drug have improved or are in complete remission, with relatively few side effects.

Along with each major advance in biotechnology — from pharmaceuticals to modified foods to the human genome project — come the inevitable questions about the ethical and sociological implications of manipulating nature's course.

The hot-button topic of the moment is stem cell research. While it could hold the key to treatments and cures for a variety of diseases, some find it unsettling that the cells are drawn from excess embryos about to be discarded by fertility clinics.

They're even more concerned about reports that Virginia scientists created a human embryo for the sole purpose of harvesting stem cells.

"The line is very thin at times," Knepper said. "A character in the Jurassic Park movie said something like, 'You only thought about whether you can; you never thought about whether you should.' That's important. Some scientists see only fame and dollar signs with little regard for what it took to get there or what it will mean down the road. Others are in it for noble reasons like improving human health and the environment.

"I think it's worth developing pharmaceuticals for Alzheimer's and cancers, because I've seen their devastating effects. Is it important to find a cure for wrinkles? If we can clone human beings, does that mean we should? There are no easy answers. I thought biotechnology was a field I could make a difference in, especially because I realized there's potential for both good and bad."

Knepper has prior experience making a difference. While a graduate student at Northern, he successfully lobbied the Board of Control for a $1,500 laminar flow hood. The equipment allows researchers to work with cells in a clean environment and reduces the risk of contaminating them with bacteria.

"There were some hospital administrators on the board and they were pretty surprised we didn't have one. It ended up getting funded, and I was able to get the necessary training that helped me land my first job."

Knepper describes his overall NMU experience as very positive. "It helped that I had a great advisor in John Rebers. Northern seems to attract professors who want to teach and do research on the side. At some major universities, teaching is just a front for the research and they rely heavily on GTAs. John is very dedicated to what he does and to his students. He's teaching for the right reasons." ■

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