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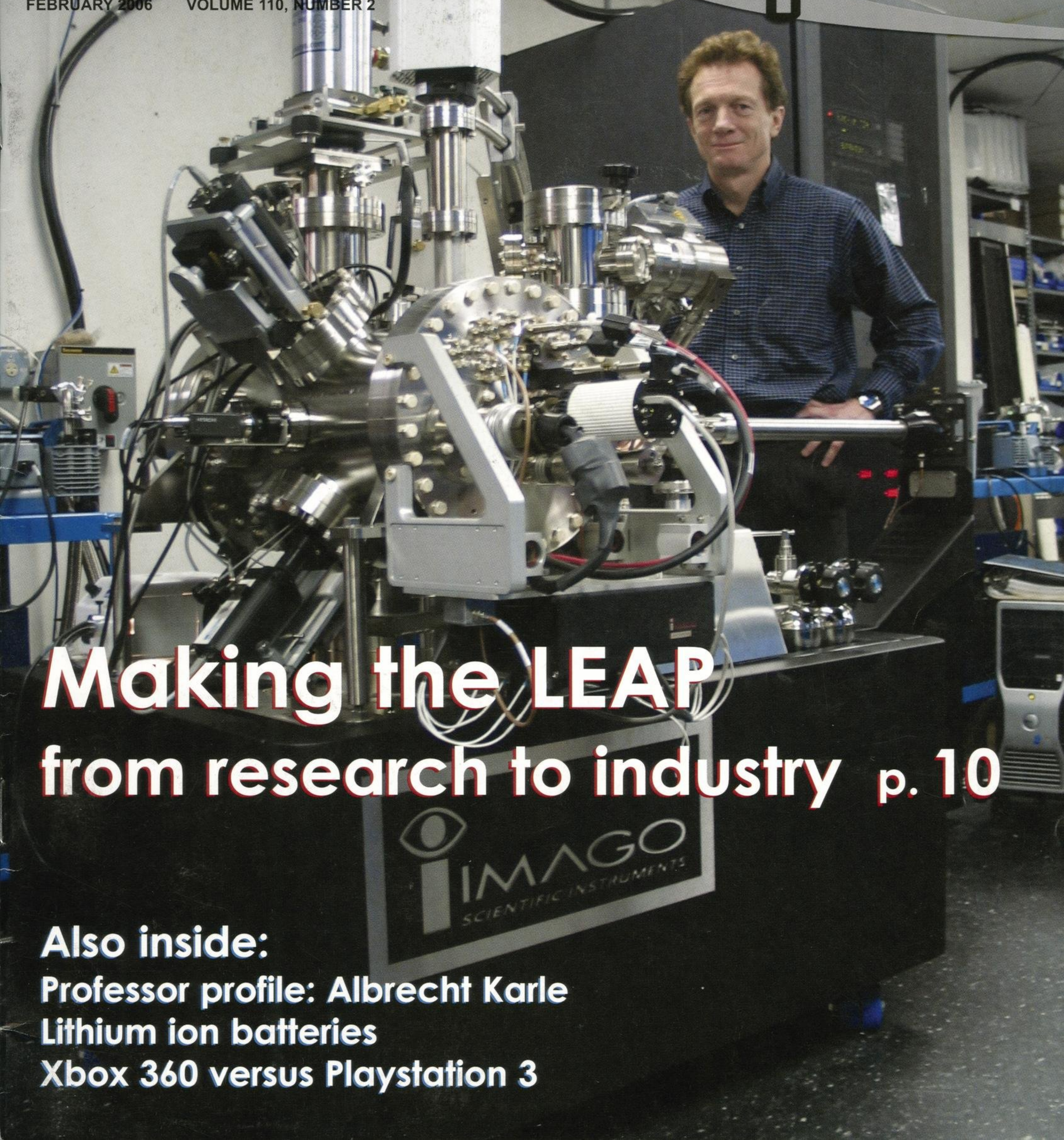

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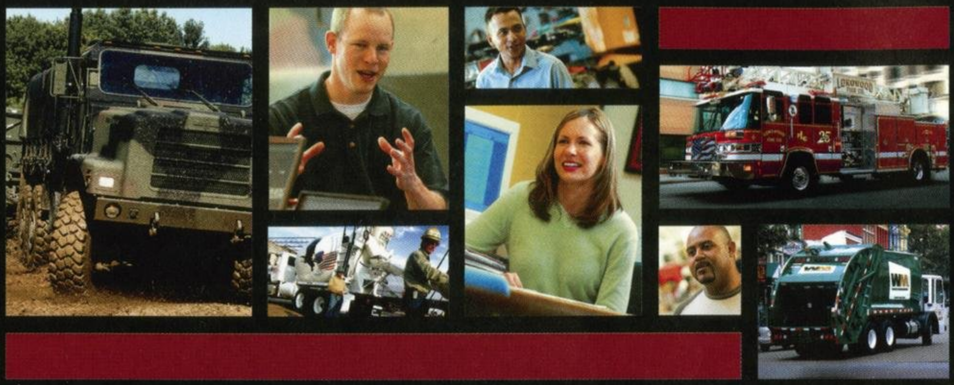

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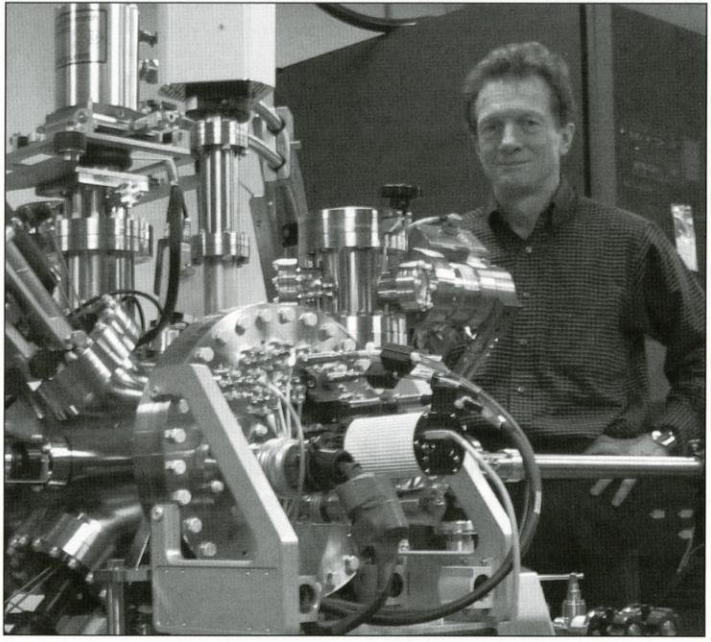
Cover photo by Aaron Arnold



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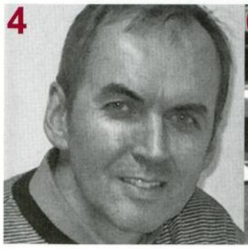

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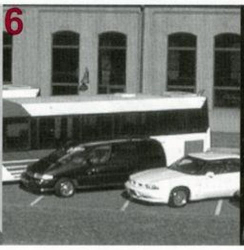

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COMMENTARY

Kyle Oliver
Writing Editor

My New Year's resolution

I'm writing this editorial on New Year's Day. At about this time each year, I experience a welcome revelation; I realize I've finally recovered from what I call the "post-finals funk"--that lingering malaise caused by the emotional trauma of final exams.

I expect you know the feeling. You go on a three-week-long binge of finishing problems sets, writing papers, recopying notes and--if you're really desperate--actually reading the textbook, and you're rewarded only with an empty and anticlimactic sense of apathy and exhaustion. I always picture myself basking in the giddy afterglow of all my hard work immediately after finishing that final test, but it rarely happens. Instead, I'm left with a feeling that, in some ways, resembles a hangover.

This year, I took an extra measure to accelerate the healing process by sticking around in Madison for a full five days after I'd raced through my last papers and exams. This downtime certainly got me started on the road to bouncing back from finals. However, like so many of us, I find it increasingly difficult to relax much during holidays at home; fun but stressful get-togethers with family and high-school friends keep me on edge. Since I usually make it back to Madison for New Year's Eve, it's often not until the first couple days of January that I finally shake the post-finals funk.

Getting some work done usually helps, I guess because it's easier to forget about the past semester when you start working on new projects (like magazine editorials). But the going is usually tough at first, so this year I sought guidance from my favorite writer, Douglas Adams. As I toyed with possible editorial ideas, I embraced the New Year's spirit and reread a column Adams wrote just before the turn of the millennium. This column was about New Year's resolutions, and it presented the following intriguing suggestion:

"[I]t turns out that there may be a very good reason why we fail to keep our New Year's Resolutions other than the obvious abject feebleness of will. It's this. We can't remember what they are. Simple. And if we actually wrote them down, then we probably can't remember where we put the piece of paper, either."

Thankfully, the New Year's resolution I came up with today involves final exams, so I can be pretty sure I haven't violated it in the past 21 hours. Thus, I can forget whatever lame resolutions my friends and I came up with last night as the ball was dropping and, instead, offer up in writing the following resolution for 2006: I, Kyle Oliver, will do everything in my power to alleviate or entirely prevent the post-finals funk.

When I first got this idea, it occurred to me that I had no clue how to actually keep this resolution, so I went back to idly reading Adams' column. I chuckled when I got to his request for reader feedback, though, since it wasn't suggestions for resolutions he wanted. No, he wanted suggestions for New Year's hangover cures.

The more I think about it, the more I think the keys to preventing the post-finals funk are the same as the keys to preventing hangovers: moderation and preparation. Moderation means easing up on how much work I do, which I think I can accomplish by studying smarter and not sweating the little stuff. Preparation is about getting started early, building plenty of breaks into my schedule and, most importantly, knowing when to quit.

So there it is, my 2006 New Year's resolution. As usual, it's just one of those things I tell myself pretty much every year and at which I'll probably fail. But I can't possibly fail until May, which is longer than most of my resolutions make it.

Plus, I definitely won't forget where I wrote it down.

Kyle Oliver

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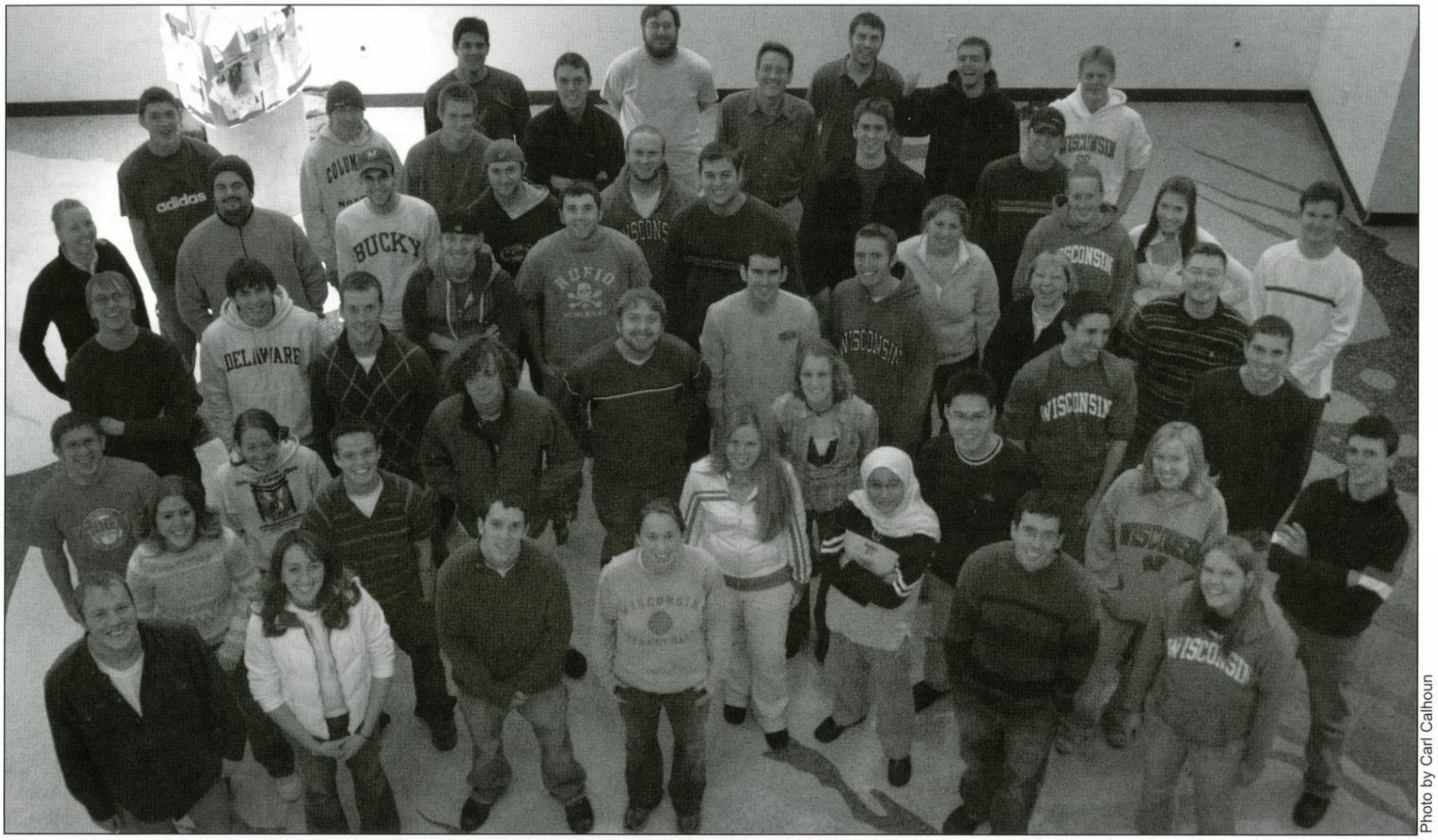

Photo by Carl Calhoun

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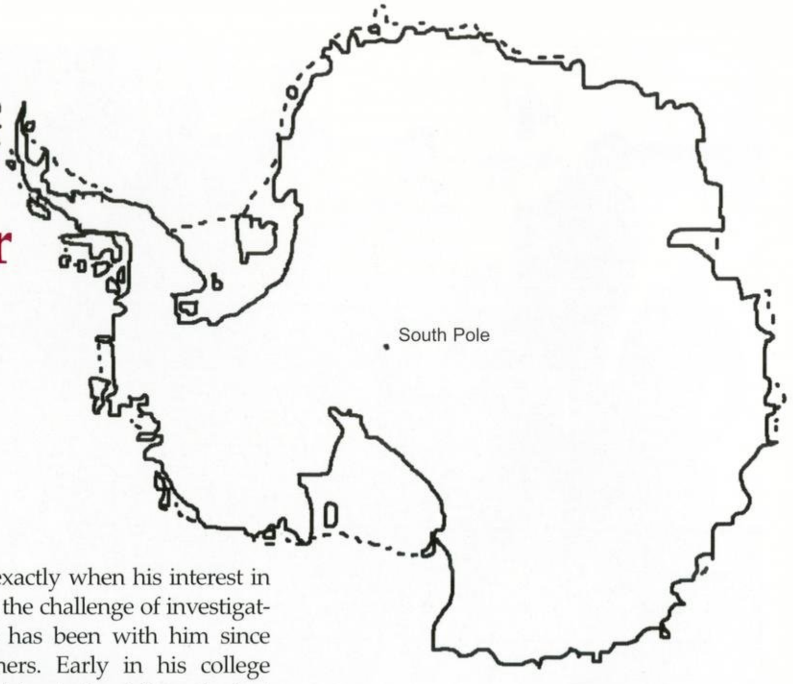
Albrecht Karle:
The traveling professor



By Carly Mulliken and Nicole Rybeck

At first sight, Albrecht Karle might seem like your typical physicist. Who would guess that this UW-Madison professor spends at least one month of every year at the South Pole?

Albrecht Karle grew up on a farm in southern Germany with his parents, two brothers and a sister. He says that his parents always encouraged their children to seek higher education. Karle describes how his family would sit around the dinner table discussing various issues and ideas as a way of stimulating their minds. The children were urged to be competitive and aim high, a mind-set that has stuck with him throughout life.

Karle graduated from the University of Munich with a degree in astrophysics. He continued his education by earning his doctorate at the Max Planck Research Institute for Physics in Berlin. Karle then worked in the field for some time before being hired at UW-Madison in 1997 as a physics professor.

Karle cannot say exactly when his interest in science began, but the challenge of investigating the unknown has been with him since those family dinners. Early in his college career, he intended to study philosophy but decided against it.

"[Philosophy doesn't] lead you to definite answers. The next fundamental thing is physics, which lets you ask questions about nature and the universe," he says.

Additionally, Karle says his time at the University of Munich was a driving force in his interest in scientific research. He says that he saw people around him investigating new and undiscovered phenomena, helping him realize he wanted to challenge these unknowns. He says he sought to know, "What are the fundamental laws? Why are things the way they are?"

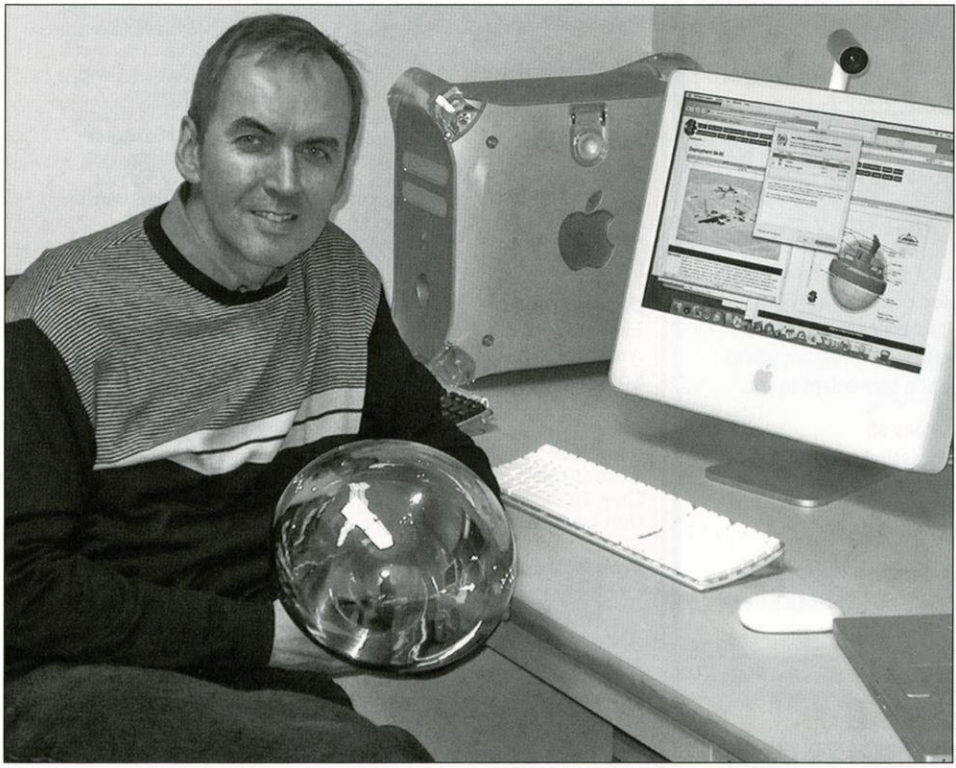


Photo by Nick Gindt

Physics professor Albrecht Karle holds a photomultiplier tube which is used to detect neutrino collisions.

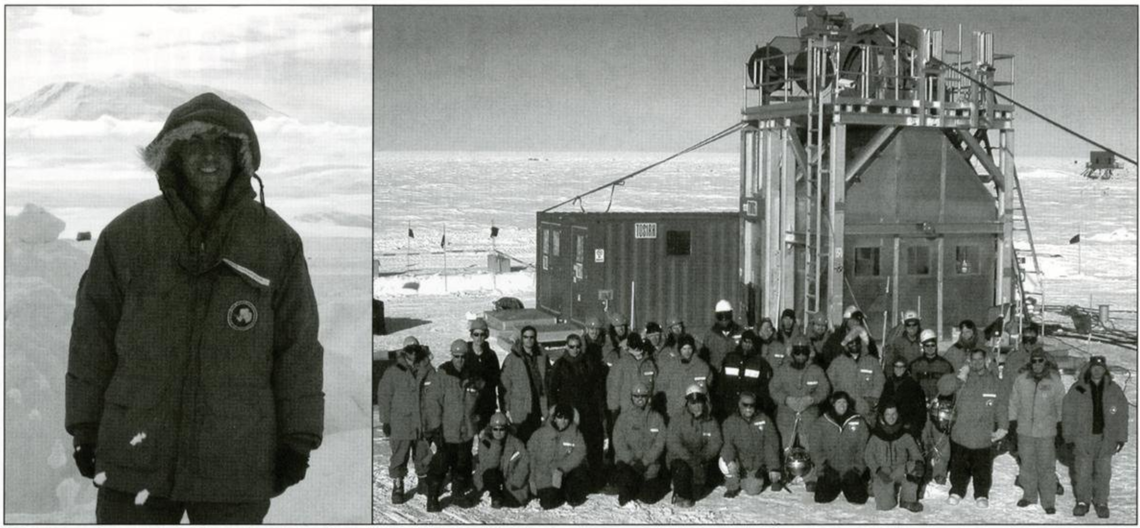
In 1995, Karle was asked to be a part of a project at UW-Madison known as Ice Cube (see "Icy answers to heavenly questions," Sept. 2004). Karle says that he was initially drawn to the research project because "it looked like a challenge."

Essentially, Ice Cube is an extremely large (one-cubic-kilometer) high-energy neutrino telescope. The telescope has been appropriately named the Antarctic Muon and Neutrino Detector Array (AMANDA). The Antarctic location of Ice Cube is critical to its collection of accurate data, because it requires a large volume of pure ice. The current location was chosen after many failed test sites, and it is now stationed below the surface of the South Pole where the ice is clear and free of impurities. Karle says that the location is potentially "the world's cleanest environment."

"[The ice is] so clear you wouldn't believe it," he says.

Researchers expect to finish construction of Ice Cube in 2010. Karle says that it is the single largest project researchers at UW-Madison have ever participated in, with a grant of over $200 million. Karle believes the project should be considered a long-term investment into the future of high-energy astrophysics.

"[Ice Cube] allows us to see astrophysics in a new way," Karle says.



Photos from the South Pole from January 2005: left, Professor Albrecht Karle wearing extreme cold weather clothing. Right, Ice Cube group members pose in front of one of their many South Pole research facilities.

Photos courtesy of Professor Karle Albrecht

Karle's duties within this project are varied. He serves as associate director of science and instruments.

"In this role, I share responsibility for the successful design and production of the instrument and its installation at the South Pole. I work closely with the 'Level 2' managers in their respective fields, and also with the project director on all strategic matters for Ice Cube," Karle says.

According to Karle, in a typical day at the station, researchers are either working, talking about their work, eating or sleeping. For Karle, the day starts at 6 a.m. with breakfast "in the beautiful new cafeteria, which has a view of the South Pole and the construction site of Ice Cube."

After breakfast, Karle spends the rest of his 12-hour shift working on the five megawatt Ice Cube drill, making sure it runs smoothly and that it is ready to install a string of sensors. He also oversees the actual installation of the sensors and their deployment, which goes on into the next shift and through the night.

During the day, Karle is in contact with people all over the site via e-mail because he is responsible for Ice Cube operations while he is there.

"[With] only about 45 people on the ice for Ice Cube, it is a big operation and requires constant communication," he says.

Karle's day does not end until 1:30 a.m., or until he has checked the deployment of the sensors, more e-mails and the satellite for next day's weather. In the evening, Karle has time to talk to other people about the day and what is in store for the next.

"The sense of community is amazing," he says. "It is a different social life for many reasons; there is no money, no keys, no TV, no radio, no other place to go. Drillers, construction people, scientists, university professors, dozer drivers all wear the same clothing and eat at the same place; they talk to each other like equals. It's a great place in a harsh world."

When he's not traveling Karle enjoys "breaking loose" by spending time outdoors. He is a dedicated road biker, and he stands out from his fellow cyclists with his distinctive red tires. Karle also is an active member of Hoofers Sailing Club and says he likes to sail "when the wind is right."

Karle hopes the work he is doing will set up the framework for future generations of researchers to go beyond the known.

"Ice Cube will open a new window to the universe," he says.

Author Bio: This is Carly's third article for Wisconsin Engineer. She is a senior majoring in English and working toward a technical communications certificate. Nicole is a sophomore majoring in industrial and systems engineering and French. She is an active member of Polygon Engineering Student Council as well as an on-site coordinator for LeaderShape 2006.

"Look Mom, no hands!"

Photo courtesy of oof.org/words/ biodiesel.htmll

By Brad Groh

It's a typical weekday. You get up, drink your cup of coffee and hop into your vehicle on your way to another day at work. Once you reach the interstate, you see it: complete chaos. Somebody lost control of a vehicle and slammed into a bridge. You know there's no way around this one--you're stuck in rush hour traffic and are going to be late for work.

Now imagine a world where the entire transportation system is controlled by a computer that can observe and control every vehicle on the roadway simultaneously. Instead of emotional or distracted drivers maneuvering vehicles into oncoming traffic, a computer system would ensure every vehicle arrived safely and by the most efficient route.

Photo by Brad Groh

David Noyce, professor of transportation engineering at UW-Madison, shares his views on "smart" highways.

Does this scenario sound too far-fetched to believe? Actually, the technology may be much closer to reality than you think. With ongoing research into Automated Highway System (AHS) technology, "smart" highways may one day make unexpected delays and driver mistakes a problem of the past.

According to David Noyce, professor of transportation engineering at UW-Madison, smart highways "are simply a roadway system that is hands off, feet off. The roadway talks to the vehicle." In fact, the communication between roads and vehicles takes place through electronic equipment and magnets embedded in roadways that send signals to a processor located inside each vehicle. Vehicles would receive all commands relating to guidance, acceleration, spacing and braking from the roadway instead of the driver. In essence, while traveling on a road with AHS technology, the driver could simply program a route and then sit back as the road and the vehicle do the rest of the work.

Smart highways have already been constructed and tested. The Partners for Advanced Transportation and Highways (PATH) and the California Transportation Department developed an experimental stretch of highway I-15 near San Diego in 1997 and have been testing AHS technology there ever since. According to PATH, they have been successfully able to manage "a platoon of cars driving at 60 miles per hour with six feet of space between each vehicle."

With computers controlling all the vehicles on the road, Automated Highway System (AHS) technology may one day revolutionize the way people think about driving.

Large cities would stand to benefit the most from AHS technology. Modern metropolitan areas such as Los Angeles are reaching a limit on the number of highway lanes a city can accommodate.

"They don't have the room to keep building freeways out there. They have to find ways to move more efficiently," Noyce says.

Smart highways attempt to improve roadway efficiency in several ways. Because the human driving expectations have been removed from the traveling experience, vehicle headways (the distance between two consecutive vehicles) can be reduced. By tightening up this spacing, the number of vehicles occupying the same stretch of roadway can be increased. The system also would reduce the number of vehicle collisions, since most accidents are caused by driver error. With fewer crashes to delay traffic, the efficiency--and the safety--of the highway network would improve significantly.

Many skeptics of smart highway technologies point out the high cost of implementing these systems. From installation costs, to maintenance costs, to the costs of updating the technologies in all vehicles, the potential expenditures required for smart highways are daunting.

Noyce acknowledges the cost of smart highways as a limiting factor. However, based upon the space constraints in large cities, he believes there will be opportunities for smart highways to prove their value.

"It's supply and demand," Noyce says. "It becomes an investment. I think technology-wise, once we see that this can work, it might become the economically smart thing to do."

Beyond the cost considerations, transportation engineers must overcome several other challenges before smart highways can become a reality. For instance, they will have to develop methods to transition vehicles from roadways that use AHS technology to unwired roads and vice versa.

"How do you transition from a dumb road to a smart road?" Noyce asks. "These issues will require a complete re-analysis of the design system. [Transportation engineers] may have to use staging areas or some sort of filtering out of vehicles."

This re-analysis will not be limited to vehicle transitions, though.

"Traffic control systems are based on a macroscopic level. [AHS tecnology] works on a microscopic level," Noyce says.

In other words, AHS technology would require a system that is currently designed to understand streams of vehicles to now understand what each individual vehicle needs at any given time.

There is also the issue of making AHS technology understand what to do in high-density urban travel areas. As roadways become larger and more complex, designing an effective route for each vehicle becomes even more challenging.

"Some of these California highways have eight to 10 lanes," Noyce says. "How do you get someone to their exit across eight lanes of traffic? It's a programming issue."

With urban areas reaching their saturation limits for roadways, there is a need for this type of technology to increase the capacity of existing roads. If researchers continue to make progress, AHS technology stands to one day completely redefine the way everyone thinks about driving.

photo courtesy of www.cs.cmu.edu

The Pontiac Transport is the current workhorse for the Automated Highway System technology.

Author Bio: Brad Groh is a senior majoring in civil engineering. He is currently a co-chair for the UW-Madison concrete canoe team as they seek their fourth consecutive national championship.

Photo courtesy of www.cs.cmu.edu

Pictured here are five demo vehicles from the Automated Highway System labs. From left, Houston Metro Bus I and II, Oldsmobile Silhouette van, Bonneville II and Bonneville I.

Lithium ion batteries

Photo by Steve Ng and Muhamad Asyraf Yahaya

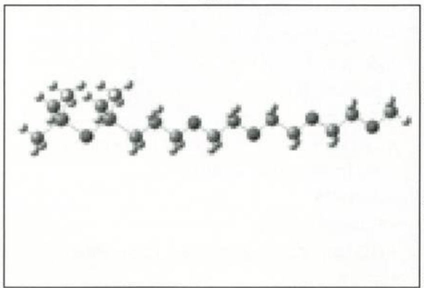
Getting a new charge from organosilicon electrolytes

By Matt Stauffer

Researchers are getting charged up about the potential of silicone electrolytes in electrical applications. Not only are silicon-based electrolytes out-performing current carbonate electrolytes, they are also more stable and environmentally friendly.

The function of an electrolyte in a lithium ion battery is to attach to the lithium ion and transport it from anode to cathode. Batteries produce a charge when the positive terminal, the cathode, reacts with the negative terminal, the anode, via the transfer of free electrons associated with the lithium ions. UW-Madison professor of chemistry Robert West, along with colleagues at the Organosilicon Research Center, have synthesized a new breed of silicon-based electrolytes that are being implemented in lithium ion batteries.

"We wanted to use silicones because of their stability, but the problem is that they are nonconductive," West says.



3-D Representation courtesy of Robert West

A three-dimensional representation of siloxane that is used in the Bion battery. Developed by Professor West, the compound helps Bion last up to 12 years.

Conventional batteries use a carbonate electrolyte that is volatile, flammable and corrosive. Silicon, the earth's second most abundant element making up 27.7 percent of the earth's crust, is a stable, naturally occurring element.

The most conductive silicon-based electrolyte is a compound called polysiloxane. The "head" of this compound contains two silicon atoms separated by a single oxygen atom. The "tail" is a chain of oxygen atoms separated by two carbon atoms bonded in what organic chemists call the "cis" conformation. This compound functions as an electrolyte because any two electronegative oxygen atoms are the perfect distance apart to bond to a positive lithium ion. The head stabilizes the entire compound.

"We are unsure exactly how the silicon atoms are able to stabilize this compound," West says. Researchers know the molecule would not function as an electrolyte without it, though. The synthesis of silicon-based elec-

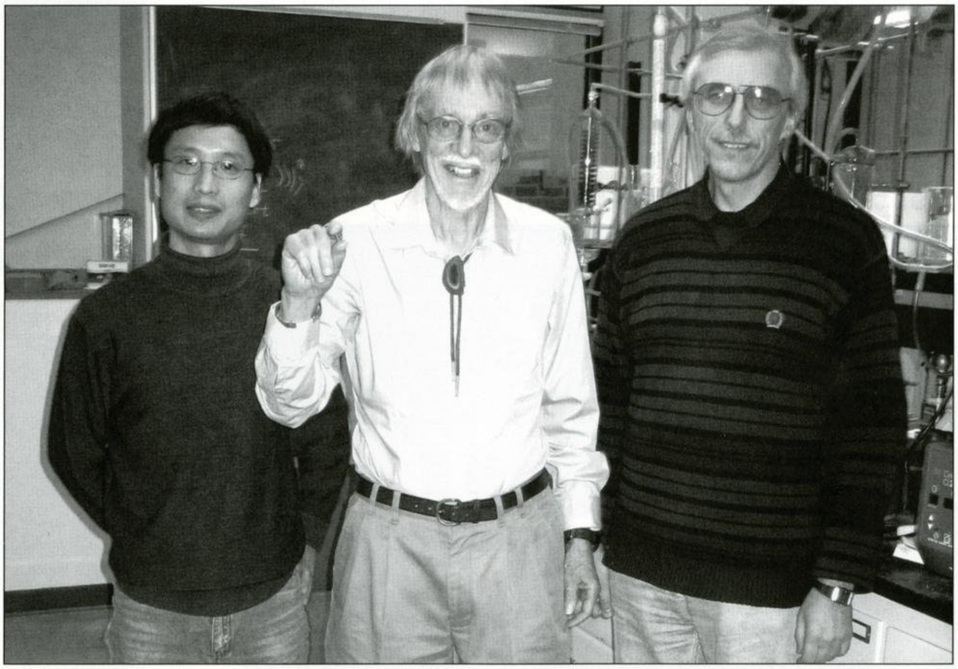


Photo by Steve Ng and Muhamad Asyraf Yahaya

From left Lingzhi Zhang, Robert West and Viacheslav Dementiev. Robert West, professor of chemistry, holds the lithium ion battery that uses the conductive silicon-based electrolyte he developed.

trolytes has proven to be a very intricate process. This process was invented by West and his colleagues and is patented by Quallion, the California-based manufacturer of the lithium batteries that use polysiloxane.

"You have to obtain a high level of purity in the synthesis to maximize the potential of the electrolyte," West says.

The Bion is a neurostimulator capable of alleviating many of the debilitating symptoms of epilepsy, strokes, Parkinson's disease and spinal cord injuries.

The pure polysiloxane electrolytes are producing amazing results. When compared to the carbonate electrolyte, the polysiloxane electrolyte proved to be superior in every way. In a test to simulate the batteries' life spans, the two batteries are charged and discharged repeatedly. The battery using the carbonate electrolyte failed after 500 cycles, which is equivalent to approximately two years of use. Results from this same test show a projected lifetime of over twelve years for the battery using the polysiloxane electrolyte. This increase is a direct result of polysiloxane's superior electrochemical stability. Furthermore, silicone electrolytes are nonflammable, environmentally benign and nontoxic, all of which are necessary for the battery to be implantable in the human body.

Quallion already uses the electrolytes developed at UW-Madison in new lithium batteries that power an implant device called the Bion. This device is a neurostimulator capable of alleviating many of the debilitating symptoms of epilepsy, strokes, Parkinson's disease and spinal cord injuries. The Bion is only 18 millimeters long and three millimeters in diameter. It is implanted using a hypodermic needle near the point where a nerve connection has been broken. The neurostimulator relays electrical signals from one side of the severed nerve to the other, effectively bridging the gap.

"The idea is that wherever you have a broken nerve connection, you can supply an electrical impulse to complete the circuit," West says. R&D Magazine recognized this device as an important innovation by awarding it with a 2005 R&D 100 award for new technologies. The original intent of Quallion was to use this new battery in cardiac pacemakers to give the devices a longer life span. Other uses for this superior battery include mobile phones, cameras and computers, all of which currently use the carbonate electrolyte batteries.

"Polysiloxane is an expensive product because of the tedious nature of its synthesis," West says. "But prices are bound to drop as production increases; that is just the way the market works." The military is beginning to use these batteries in field equipment, and NASA is using them in spacecraft due to the superior life span.

Silicone electrolytes also can be applied in supercapacitors. Viacheslav Dementiev, a UW-Madison chemist, realized that using a silicon-based dielectric liquid could increase the storage capacity of capacitors. A capacitor is a device that can store an electrical charge and then deliver it as a high voltage burst of energy. Capacitors are composed of two metallic plates that are separated from each other by a material known as a dielectric.

"Silicone is a good dielectric because it can store a larger charge and can operate at much higher voltages due to the stability of the silicon compound," Dementiev says.

Supercapacitors--regular capacitors that operate at much higher voltages--have potential applications in electric cars as well as wind and solar energy systems. When a car begins to move, there is an enormous energy barrier to overcome. A battery alone cannot provide sufficient energy to overcome this barrier. A supercapacitor would be able to deliver the initial boost of energy that is needed to get a car rolling. From there the batteries would be able to sustain the current needed to drive the car. When the car slows to a stop, a great deal of kinetic energy is lost from the system. A supercapacitor would be able to store this energy as potential electric energy and then use it to get the car rolling again.

In wind and solar applications, a supercapacitor would store the energy produced so it could be delivered in 120-volt AC form that standard appliances in North America need.

By founding the Organosilicon Research Center, West has not only helped over 80 students earn doctorates in organic chemistry, but also has provided UW-Madison with a valuable research infrastructure, positioning the university as a world leader in organosilicon research.

Author Bio: Matt Stauffer is a sophomore majoring in materials science and engineering.

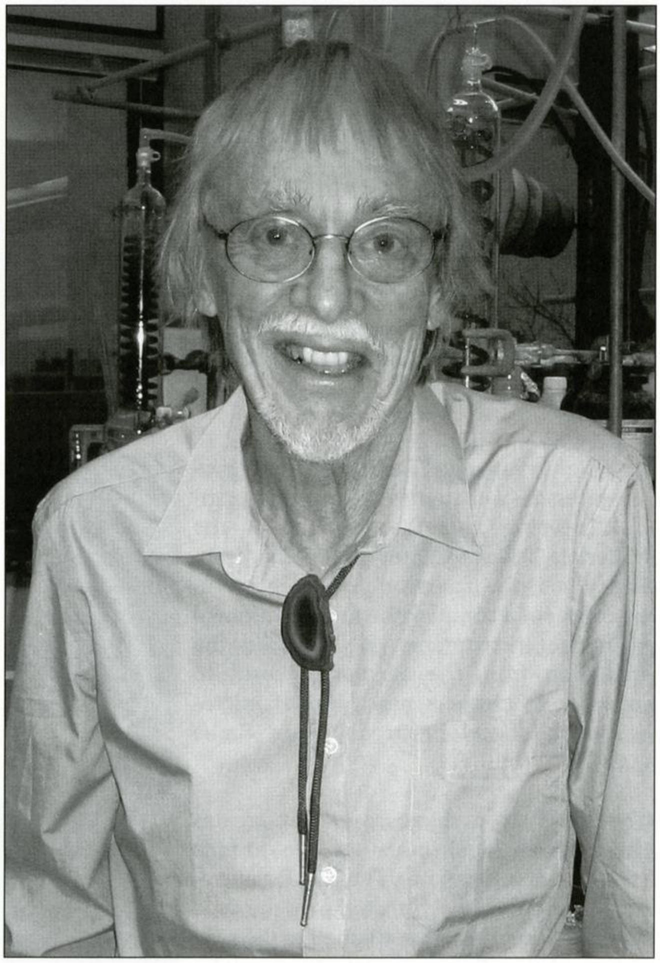


Photo by Steve Ng and Muhamad Asyraf Yahaya

"The idea is that wherever you have a broken nerve connection, you can supply an electrical impulse to complete the circuit."
- Robert West

Making the LEAP from research to industry

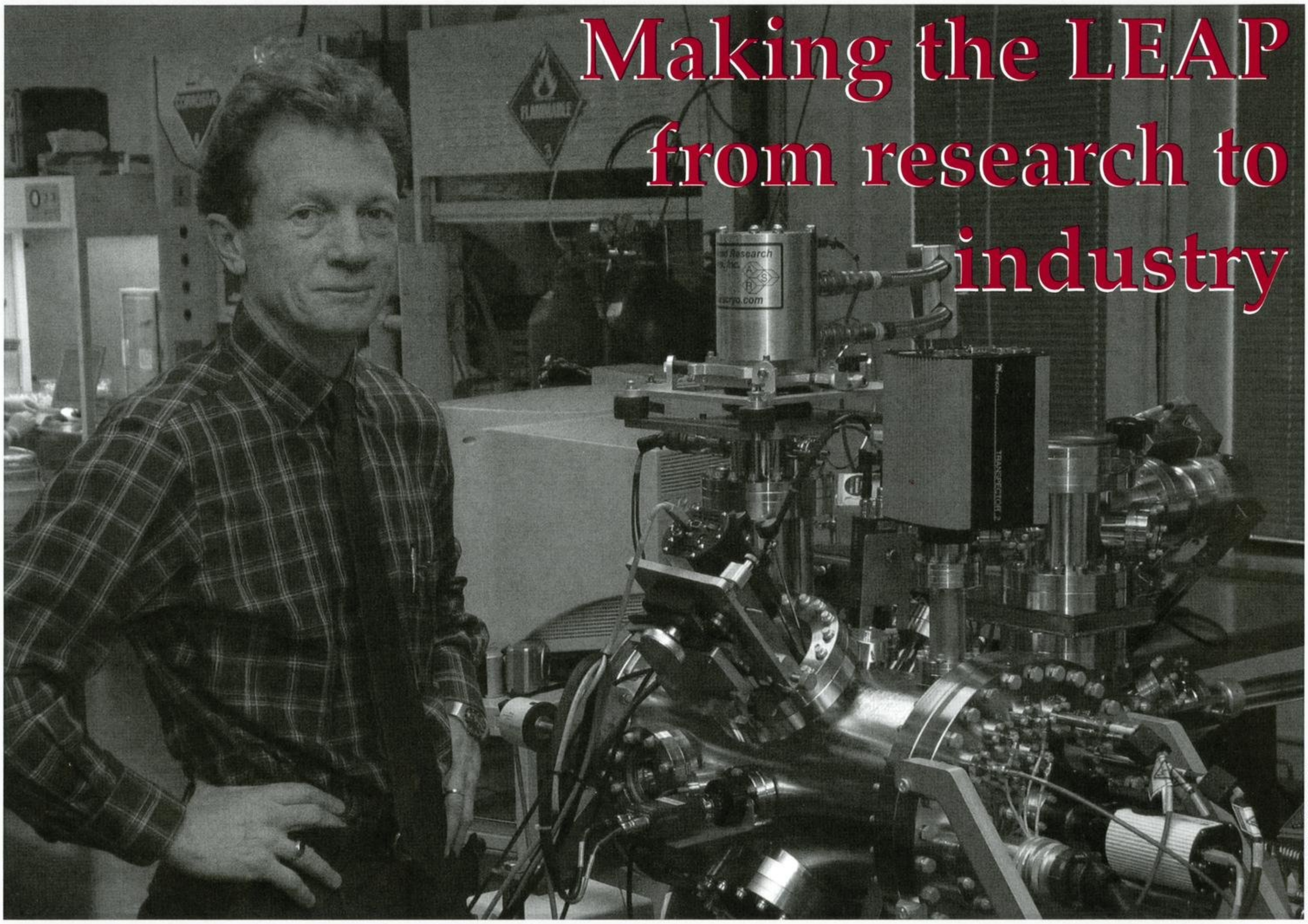


Photo by Justin Novshek

By David Michael Drenk

Eight years ago, Tom Kelly was a professor of materials science and engineering and the director of the Materials Science Center at UW-Madison. Today he is the chairman and chief technical officer of a company he founded, Imago Scientific Instruments. Kelly made the transition from the academic world to industry to create a new kind of microscope: the Local Electrode Atom Probe (LEAP).

The LEAP is a microscope that creates three-dimensional maps of the atomic structure of a substance. The LEAP can create a computer image that shows the type and location of atoms contained in the substance. This allows manufacturers, who use the microscope to find defects or contaminants in their products, to map the distribution of dopants (intentional impurities) in semiconductors and redesign tools and circuits on the scale of nanometers. Kelly's invention made this technology practical for industry with greater speed and accuracy than previous atom probes.

"The first atom probes were one-dimensional instruments," Kelly says. "They just eroded the specimen and recorded what was coming through the aperture as a function of time."

The first atom probe was built at Penn State University in the 1960s and used extremely cold temperatures, high voltage pulses and a phosphorus plate to record a one-dimensional sequence of atoms.

"It was a matter of an engineering problem, not a science problem."
-Tom Kelly

To use these early probes, researchers would carve a sample of the substance under examination into the shape of a needle with a very sharp point. They would then place this needle in a vacuum chamber and decrease the temperature to almost absolute zero. Next, they would apply a high voltage to the sample. The voltage difference between the sample and the chamber produced an electric field that was strongest at the tip of the needle. The atoms at the tip would become charged ions and be pulled loose by the electric field. These ions would travel to a detector made of phosphorus and produce a visible flash of light on impact.

This design was improved in 1988 when the first three-dimensional atom probe was invented at the University of Oxford. The Oxford researchers added a position-sensitive detector.

"They were able to take the entire emitted pattern and make a position-sensitive detector so they could record where each atom hit. This allowed them to know where the atoms were in two dimensions on the surface," Kelly says. "The third dimension was the erosion sequence," that is, the order in which the atoms were extracted from the sample. "The kicker is, these images took as much as two weeks to collect."

Kelly became interested in improving the speed of atom probes.

"It was obvious that the result, at least in an academic setting, was worth the wait in many cases, but that was never going to be adequate if this tool was ever going to have a life beyond the research lab," Kelly says. He knew the process for creating three-dimensional images on an atomic scale quickly and accurately was theoretically possible, but the equipment needed to make it happen did not exist.

"It was a matter of an engineering problem, not a science problem," Kelly says.

Kelly already had a strong engineering background before he came to UW-Madison. He earned a bachelor's degree in mechanical engineering from Northeastern University in Boston, Mass. and a doctorate in materials science from the Massachusetts Institute of Technology (MIT). He was a professor of materials science and engineering at UW-Madison for 17 years. In 1993, during his time at UW-Madison, Kelly came up with the idea for the Local Electrode Atom Probe.

The problem with the older atom probes had to do with calculating the time of flight, the time it takes an atom to travel from the tip of the sample to the detector. By measuring the time of flight, scientists can calculate the mass of an atom, which indicates what kind of atom is being collected. In order to determine when the time of flight begins, voltage is applied to the sample in pulses.

"If we put a one nanosecond voltage pulse on the sample, we know to within a nanosecond when the atoms were evaporated. The problem was, pulsing was very difficult to do at high repetition rates because it involved very high voltages," Kelly says.

The Local Electrode Atom Probe improves the speed and accuracy of mapping substances at the atomic level.

Kelly's idea was to create a local electrode that was very close to the sample. The electrode is shaped like the cone of a volcano. The ring formed by the very edge of the electrode can be centered over the tip of the sample at a distance of only 20 microns.

"We need to get a certain electric field to pull atoms off. By moving the electrode much closer, we can get that field at a much lower voltage across the electrode," Kelly says.

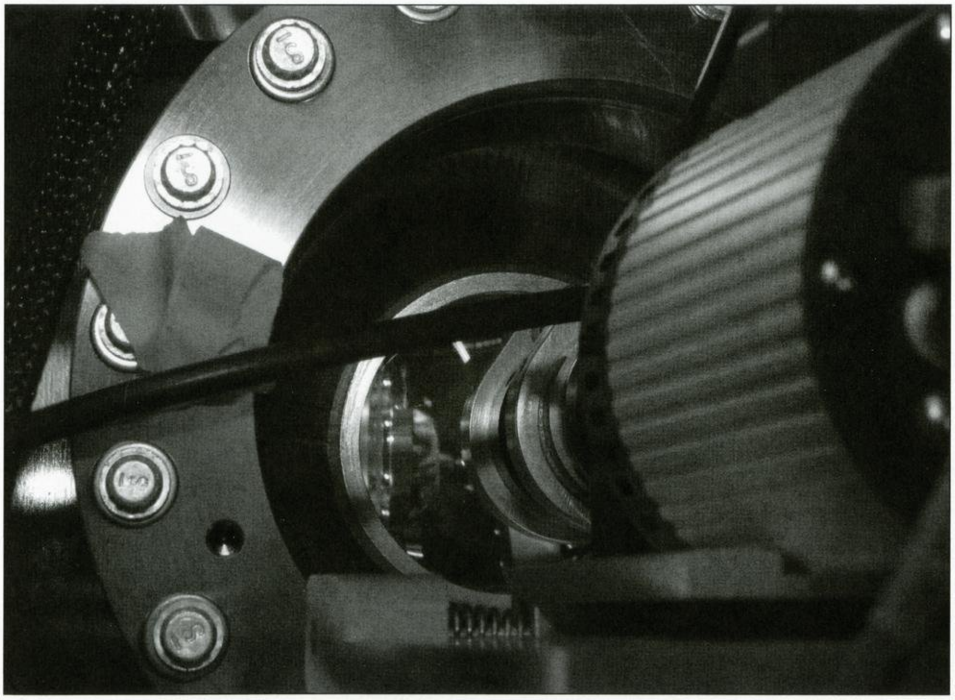


Photo by Justin Novshek

Close-up of the LEAP microscope, and the camera used to align the sample prior to imaging.

Kelly patented his idea through the Wisconsin Alumni Research Foundation (see "Patent pending," Sept. 2005) and got a grant for its development from the National Science Foundation. The grant amounted to about $300,000 for three years, which had to pay for both the hardware and personnel. That was enough to test various concepts, but it wasn't enough to build a complete microscope.

"We just didn't have the resources," Kelly says. "It really took going to a commercial setting where the resources were dedicated to doing it right."

Kelly's mother was the first person to invest in his company. Investments from friends, family members and businesses followed. In April 1998, Kelly hired his first employee, Tye Gribb, a UW-Madison graduate with a doctorate in metallurgical engineering.

Kelly tried to balance teaching and family life with the creation of a business, but after a year, he still hadn't completed a business plan. Kelly decided he needed more time to devote to his invention.

From 1999 to 2001 Kelly took a two-year sabbatical from the university and focused on creating the LEAP microscope. When the sabbatical ended, Kelly was required to return to full-time work at the university if he wanted to remain on the faculty. Instead, Kelly decided to officially leave the university and become the chief technical officer of the company he founded, Imago Scientific Instruments.

Imago shipped the beta version of the LEAP microscope in June 2003, and the refined LEAP 3000 in February 2004. Imago has sold the LEAP microscope to companies in Australia, Japan and the United States, and already has orders for a new model that will be available this summer.

Kelly's local electrode invention has several advantages over other atom probes. One advantage is speed. By using a much lower voltage, atoms can be extracted faster because the voltage doesn't have as far to drop between each pulse.

"Nowadays other atom probes collect about ten atoms per second. At much lower voltage, we're able to build pulsers that can run 1,000 times faster, and we're collecting 10,000 atoms per second routinely. Now instead of a week, it takes ten minutes to collect an image," Kelly says.

Another advantage is accuracy. Because the local electrode can be placed close to the tip of a needle, each sample can contain as many as 50 needles, which the LEAP microscope can address individually.

The newest LEAP also will feature a laser-pulsing mode, which uses a laser to trigger atom extraction from a sample with a static charge. This feature allows the LEAP to analyze semiconductor materials in addition to the metals and highly conductive materials that the previous designs could handle using only voltage pulsing.

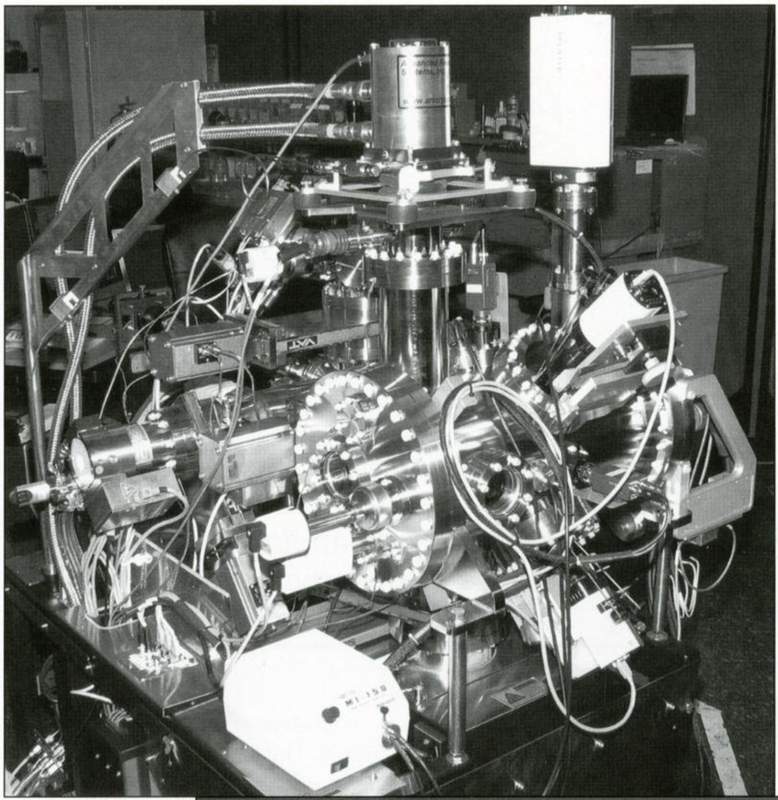


Photo by Justin Novshek

In spite of his new career, Kelly still has many ties to the university. Close to 20 of Imago's employees are graduates of UW-Madison's College of Engineering, and the College's professors and students frequently work with Imago employees on research projects. UW-Madison researchers are allowed to use Imago's equipment, and Imago employees still use the microscopes in the materials science and engineering lab. But thanks to Kelly, atom probes are no longer confined to academic settings.

"We can realistically build companies an instrument that can give them data in a time frame that's useful," Kelly says. WE

Author Bio: David Michael Drenk is a UW-Madison graduate with a bachelor's degree in electrical engineering and computer science. He returned to the university in 2005 to obtain a technical communications certificate from the College of Engineering and is now pursuing a career as a technical writer.

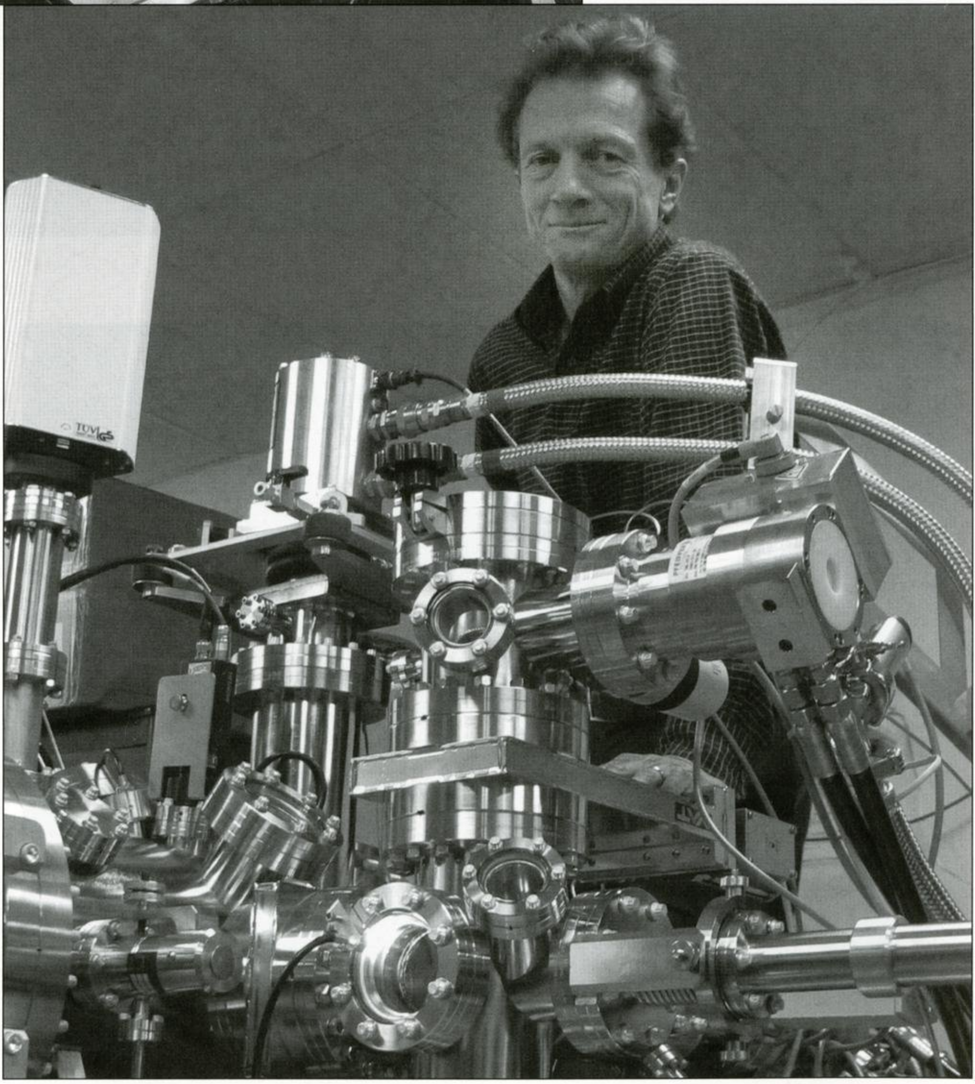


Photo by Aaron Arnold

Dr. Tom Kelly, entrepreneur and inventor of the Local Elelctrode Atom Probe (LEAP) microscope, at his company Imago Inc. in Madison, WI.

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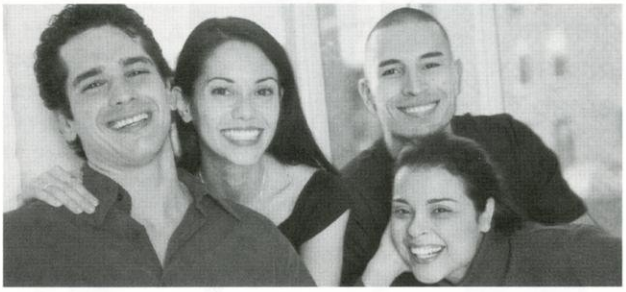

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Round two:

Sony and Microsoft renew gaming rivalry

By Nate Holton

It's been a showdown like no other: Microsoft and Sony are competing for the hearts and minds of video gamers around the world. With souped up processors, high-definition television (HDTV) compatibility and a host of entertainment options, Sony's Playstation 3 and Microsoft's Xbox 360 are battling for video gaming superiority.

So which unit will ultimately come out on top? At this point it's impossible to tell, as Microsoft and Sony both have sizable fan bases.

"Many people just stick with what they know and what they are used to. Plus, each system has popular game titles that aren't available to the other system," an EB Games employee associate reports.

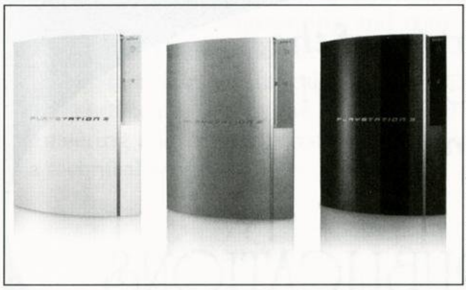


Photo courtesy of www.thagreated3.tripod.com

The new Playstation 3 will hit stores in late 2006 and will offer three console color options.

While the Xbox 360 was released during the 2005 holiday season, the Playstation 3 will not be out until late 2006 at the earliest.

Gamers will have to wait for the release of the Playstation 3 before they can decide for themselves which unit is better, although many of the specifications of the Playstation 3 have been released; comparing this information to the Xbox 360 offers at least a vague basis for comparison of the products.

The central processing unit (CPU), also called the microprocessor, lies at the heart of any computer. Since the Playstation 3 and the Xbox 360 are nothing more than highly specified computers, it is appropriate to first compare the power of their respective CPUs.

The power of each is unprecedented for a video gaming system. The Xbox 360 sports a 165 million transistor, multi-core processor running three 3.2 gigahertz (GHz) cores. Each core is capable of processing two threads, which are sets of instructions within a program's code, simultaneously. In other words, the Xbox 360 processor is actually the equivalent of six conventional processors.

Photo courtesy of www.computerandvideogamers.com

The futuristic-looking Playstation 3 controller varies greatly from previous controller designs.

Not to be outdone, Sony worked with Toshiba and IBM to create its "cell processor." At the center of the system is a 3.2 GHz CPU. Though this processor could easily run a computer alone, it actually acts as a managing processor, doling out responsibilities to the eight 3.2 GHz Synergistic Processing Elements (SPE) that are located on the same chip. The chip processor neatly organizes all the work that is to be done, and the powerful SPEs do the grunt work.

It remains to be seen which processor setup will yield the better results, but the CPU of a game console, though important, is merely one piece of the puzzle. Another critical piece of hardware involved in making vivid and life-like video games is the graphic processing unit (GPU).

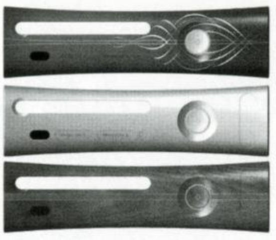


Photo courtesy of www.xbox.com

Players can change the look of their Xbox 360 with different faceplates.

The Playstation 3 will contain the RSX "Reality Processor," a 550 MHz GPU designed by Sony along with popular graphics card manufacturer NVIDIA. Meanwhile, the Xbox 360 will come with a custom-built 500 MHz ATI graphics processor card.

With souped up processors, high-definition television (HDTV) compatibility and a host of entertainment options, Sony's Playstation 3 and Microsoft's Xbox 360 are battling for video gaming superiority.

While the Playstation's GPU seems to be a stronger choice based on the processing speed alone, there is more to the story when one looks at the details. The ATI card is built on a unified shader architecture. This novel setup combines pixel shaders--which are used to alter the lighting, color and surface of each tiny colored dot on the screen--and vertex shaders--which work by manipulating an object's position in 3-D space. Traditionally, and in the case of the Playstation 3, these operations are handled separately. For the Xbox 360, they are done simultaneously. By combining the two processes Microsoft essentially kills two birds with one stone, and the result is faster graphics computation.

Because of the advanced GPUs featured in each system, both the Playstation 3 and the Xbox 360 have the power to be HDTV compatible. Each system will be capable of displaying its games with up to 1,080 scan lines on the screen, which is equivalent to an HDTV signal (see "Highly defined: A new world of television," Nov. 2005). The difference is that the Playstation 3 will be capable of displaying 1,080 scan lines in a progressive format, where every line on the television screen is renewed once per update, while the Xbox 360 uses an interlaced format, where only every other line is renewed per update. Though each format results in a highly detailed HDTV image, the interlaced format of the Xbox 360 can cause flickering on the screen.


photo courtesy of www.xbox.com

Pictured left, the wireless controller adapter for the Xbox 360.

Of course, playing video games is merely one part of the entertainment package that will come with an Xbox 360 or a Playstation 3. Each system supports the use of wireless controllers, Wi-Fi Internet capabilities and USB ports that can be used to connect a host of electronic gizmos to either system.

One notable difference between the systems is the range of disc types they support. The Xbox supports a variety of discs currently in use, such as CD-ROM, CDR+W, DVD, DVD-ROM and DVD-R. However, the Playstation 3 supports all of these as well as the forthcoming Blu-ray discs, which hold an incredible amount of data and may eventually replace DVDs (see "Discs of the future," Feb. 2005). While a typical DVD holds about 4.7 gigabytes (GB), a Blu-ray disc would hold up to 54 GB of data. If game makers decide to take advantage of this increased storage space, the Playstation 3 will hold a considerable edge over the Xbox 360 in terms of the complexity and size of its games.

As the Xbox 360 and Playstation 3 square off to decide which system reigns supreme, the ultimate winner will be the video game enthusiasts.

Though the specs of each system can be analyzed forever, it will ultimately come down to which system the consumer prefers. Until each system can be played side-by-side it will be impossible to accurately compare their game play. And even though one system may lose this match, the battle itself is a win-win situation for video game enthusiasts.

Author Bio: Nate Holton is a senior majoring in philosophy and mechanical engineering. Upon graduation, he plans to attend law school.


Photo courtesy of infuzemag.com

Microsoft stayed true to its roots with an Xbox 360 controller design very similar to the original Xbox controller.

Revolutionary ideas:

Researchers look for tips from Mother Nature

By Robert Beets

Scientists often contemplate the origins of life, juggling interpretive knowedge about today's world and speculating on the conditions of past eras. UW-Madison engineers are investigating the possible history of proteins within these predicted environments and their role before biological systems, DNA or the cell evolved. Besides solving a mystery of life, this research could have important applications for the design of self-repairing materials.

A genetic code is often referred to as the blueprint of life, holding all the information needed to construct cells, tissues, organs and entire organisms. But even with blueprints, a building cannot be constructed without a crew of contractors, masons and electricians. In the same way, proteins are the constructors and maintainers of life at the cellular level.

"Proteins do a lot of the chemistry inside the living cell. When people begin to think about the earliest forms of life or even prebiotic chemistries, what kinds of chemistry had to occur in order for living systems to come about?" John Yin, professor of chemical and biological engineering, asks.

Proteins, being so essential to life, were probably part of the environment when organisms and life started to take shape, but today's organisms create proteins by linking chains of amino acids. How then did amino acids join before cells or organisms facilitated their linking?

Chemical and biological engineers are looking to Mother Nature for tips on designing new materials. On the way, they may also figure out how life began.

Yin, who conducted the research with graduate student Joseph Napier, tested conditions where amino acids, called monomers, could link together and form chains, called proteins. In their experiment, monomers of alanine and dissolved copper salt settled in a moist environment as water evaporated from plastic tubes. Even after the environment was dry, two alanine molecules likely associated themselves with each copper atom. Once near each other around the copper, the alanines then cotinued to join through condensation reactions, which were partially induced by evaporation from continuously applied heat.

"I think that was one of the surprises for us. We thought, looking at the work of others, that once it dried this chemistry would not continue, but Joe did the controls and said, 'Let's dry it a little longer and see what happens.' And low and behold you look and the peaks in your chromatograph get larger," Yin explains, clarifying that chromatograph peaks signify an increased number of reactions between monomers.

This discovery could prove beneficial because finding environments, especially those lacking water, that encourage linking of monomers could provide clues to how proteins and life began. Yin and Napier conducted the drying with only alanine, but future experiments could explore what happens when other amino acid monomers are available. Such experiments might show how specific mixtures of amino acids might enable or catalyze the condensation reaction.

"I've always had an interest in how living systems design [themselves]. And if you ask biologists, they'll say it's not a rational process, it's really a trial and error process. Evolutionary processes create a lot of different designs and designs that work well get rewarded," Yin says.

Since the dawn of proteins and life on Earth, natural processes have molded biological structure, function and mechanics. So the question Yin's research asks is this: Why should engineers always reinvent the wheel when current life forms embody eons of trial and error and selection for what works?

"Nature has found a way of tapping into that repertoire and creating very complex systems. We as engineers are interested in starting from the basics and seeing if [the chemistry] can facilitate the joining of these monomers," Yin says.

If monomers of amino acids can be joined in the absence of water, then linking monomers of other substances can be applied to materials design. Yin calls this the "science fiction" aspect of his research, which could eventually be used to create self-repairing materials.

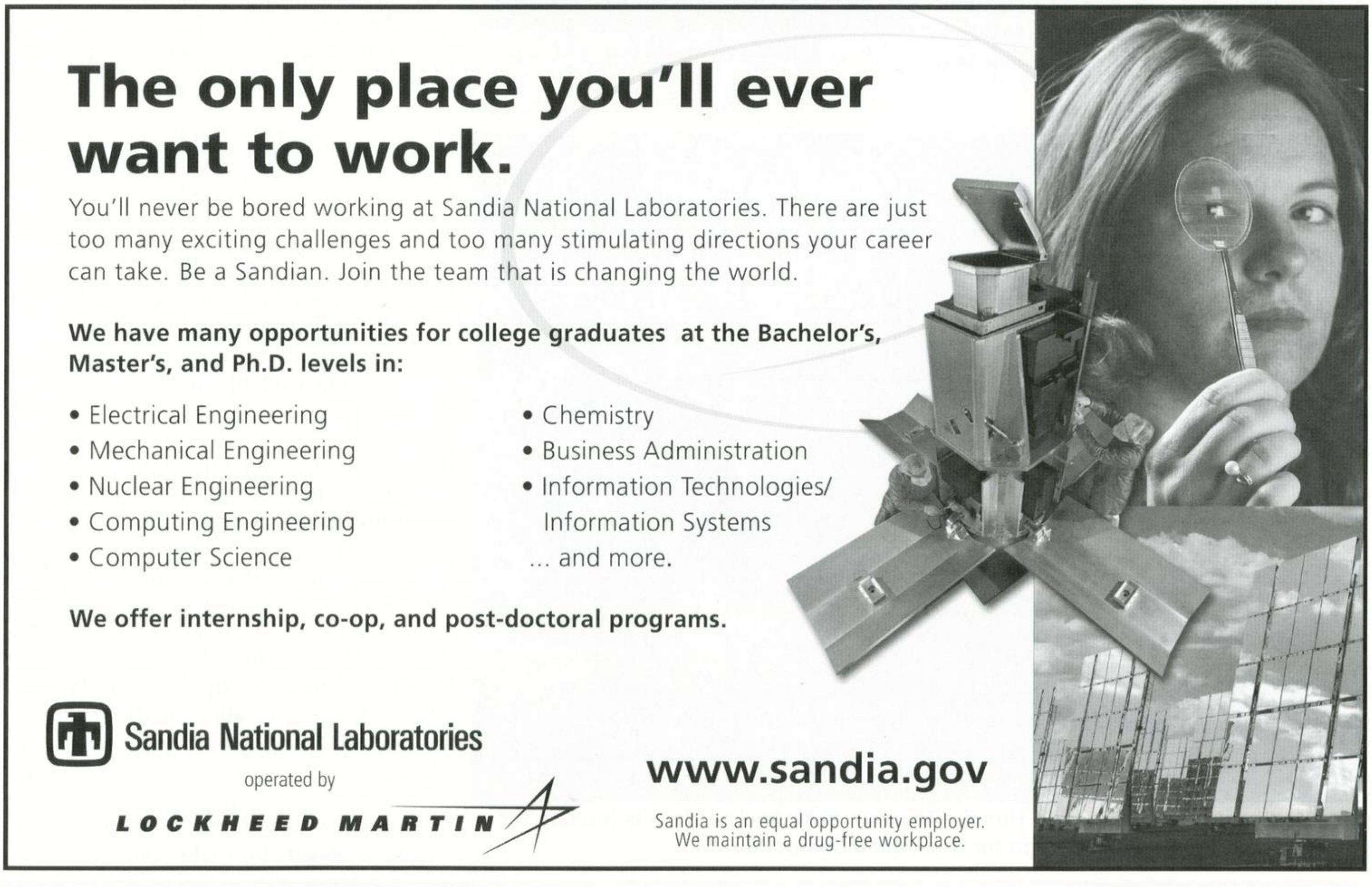
Materials that can repair themselves would be useful in many applications, from clothing to structural steel support. Bridges could retard the effects of weathering and prolong their lifespan; coats could react to current temperature by adjusting thickness; shoes could have soles that never wear thin.

Alanine monomers have been successfully joined in dry environments with the aid of copper salt and applied heat. These two structures come together an unimaginable number of times every day in each of our bodies. The chemists and engineers exploring these complicated life processes are developing useful tools for possible materials applications and delving deeper into the mysteries of life.

Author Bio: Robert is writing toward a career in environmental journalism. His goal is to instill public and corporate awareness of environmental issues crucial for the sustainability of our planet.

Photo by Heidi Marie Mielke and Puteri Syafawati Faizan

John Yin (right), UW-Madison professor of chemical and biological systems engineering, and graduate student Joe Napier (left) at one of the chemical and biological engineering labs at UW-Madison.



Gearing Up

Vehicle team learns from past mistakes

By Sarah Michaels and Kevin Jayne

Engineering students at UW-Madison have yet another venue for extending classroom knowledge into practical experience.

Last year, the American Society of Mechanical Engineers (ASME) Human Powered Vehicle Challenge (HPVC) joined the College of Engineering's repertoire of competitive design teams. HPVC provides an opportunity for engineering students not only to have a diversion from everyday study sessions, but also to transfer theories of engineering into a final product. In addition, the project requires students to develop skills in teamwork, organization and technical presentation.

"It's great to be involved with a project that allows me to practically apply the flood of technical information presented to me in class and gain a hands on opportunity to understand the technical concepts," Aaron Arnold, a junior in mechanical engineering, says.

At present there are several types of HPVs suited for land, air and water. ASME's challenge is a land-based competition in which the vehicles have the appearance of a bicycle but must meet a wide variety of design criteria. The purpose of the HPVC is to create a vehicle which incorporates principles of aerodynamics, aesthetics and safety. Once completed, the vehicles compete in three events: speed, utility and endurance.

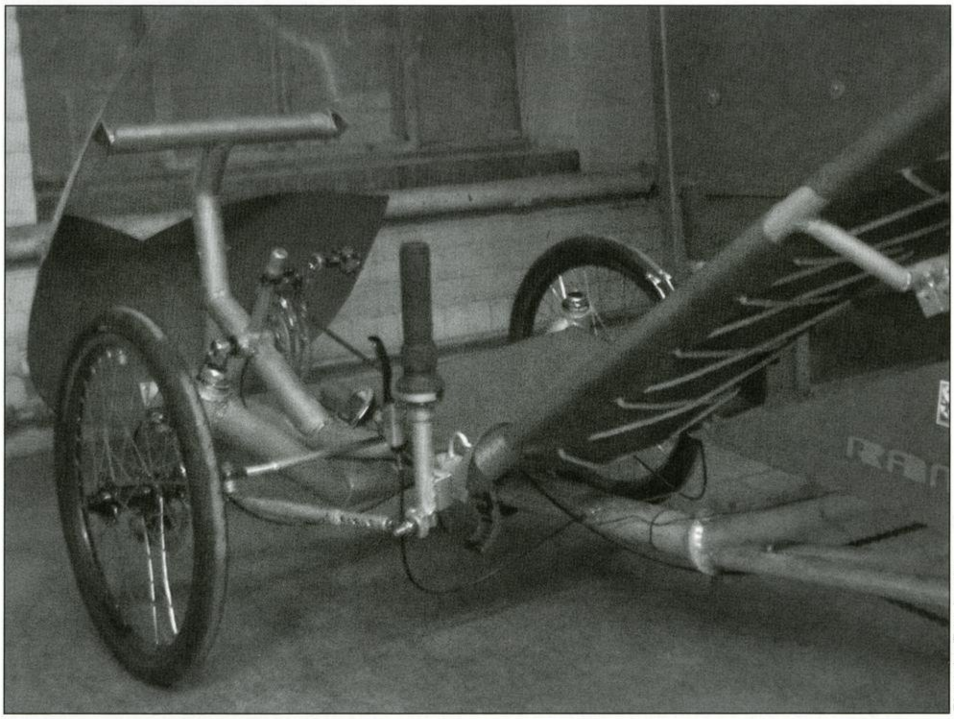


Photo by Erin Jacobs

UW-Madison's first generation Human Powered Vehicle. The team is looking for new ways to improve the design for this year's competition.

According to ASME's national HPVC Web site, prototypes with speeds of 60 miles per hour have been recorded in the speed event. In the utility event, prototypes are tested for flexibility in extreme maneuvers such as tight hairpin and S-turns. The last event tests the durability of the prototype in a forty-mile stretch that includes terrain differentials such as a C-shaped track, turns with varying radii and lengthy straight-aways.

The competition also incorporates a technical communication component. Team members prepare a written design report and a presentation to illustrate the processes leading to the final product.

In only a year, the team has learned a lot about the wide range of design possibilities, internal team organization strategies and logistical improvements. The guidelines for the HPVC allow for limitless variations in design. There are no constraining requirements such as number of wheels or number of prototype drivers. The potential for unbounded creativity in designing an HPV became evident after last year's competition.

"Last year we ran out of time," Jessica Sanfilippo, president of the team says. "It basically became our goal to get a bike out."

Last year was a perfect example of the challenges in the early stages of the engineering design process. New to the HPVC, the team was still frantically working on the finishing touches on the eve of the competition. The organization of the team has drastically changed from last year to this year.

Equipped with last year's experience, the team is eager to make the necessary improvements for an even better second year. One of the most crucial changes the team made is implementing a more task-oriented structure. The 21 members are currently divided into seven subgroups, each with a distinct focus in the vehicle's design:

- o Brake and Drivetrain
- o Energy Storage
- o Frame
- o Fairing
- o Seat
- o Steering
- o Testing

"Since HPV is one of my first opportunities to get involved in the design process, I'm anxious to move forward on the project," Jason Scherk, a member of the seat subgroup, says. "It is also exciting to be part of the team in only its second year of existence here at Madison, since it should give us a chance to greatly improve on the bike from last year."

In addition to improving their organization, the team also is tackling new structural design challenges. For instance, the team is considering drastic changes to the drivetrain, the system that transfers the action of pedaling into forward motion.

"Our greatest challenge in this year's design is definitely making the transition from a rear-wheel driven system to a front-wheel driven system," Arnold says. "The drivetrain is the assembly most heavily impacted by the decision to go front wheel drive. The difficulty in a front-wheel driven bike lies in the availability of parts, and the potential necessity for custom parts."

The focused goals of the drivetrain and braking subgroup are just one example of what a single year of experience can do to improve future designs.

"Last year it was all straight pieces welded together. We want a little bit more fluidity in our design, which we hope we will get this year," Sanfilippo says.

Sanfilippo hopes this year's design will incorporate hydraulic and carbon fiber components, and do so in a way that is more aesthetically pleasing than last year's model. She also hopes the team can finish early in order to have an opportunity to test their prototype before the competition and make any necessary last-minute changes. Overall, the team has a positive outlook for their second year in a new engineering extracurricular activity.

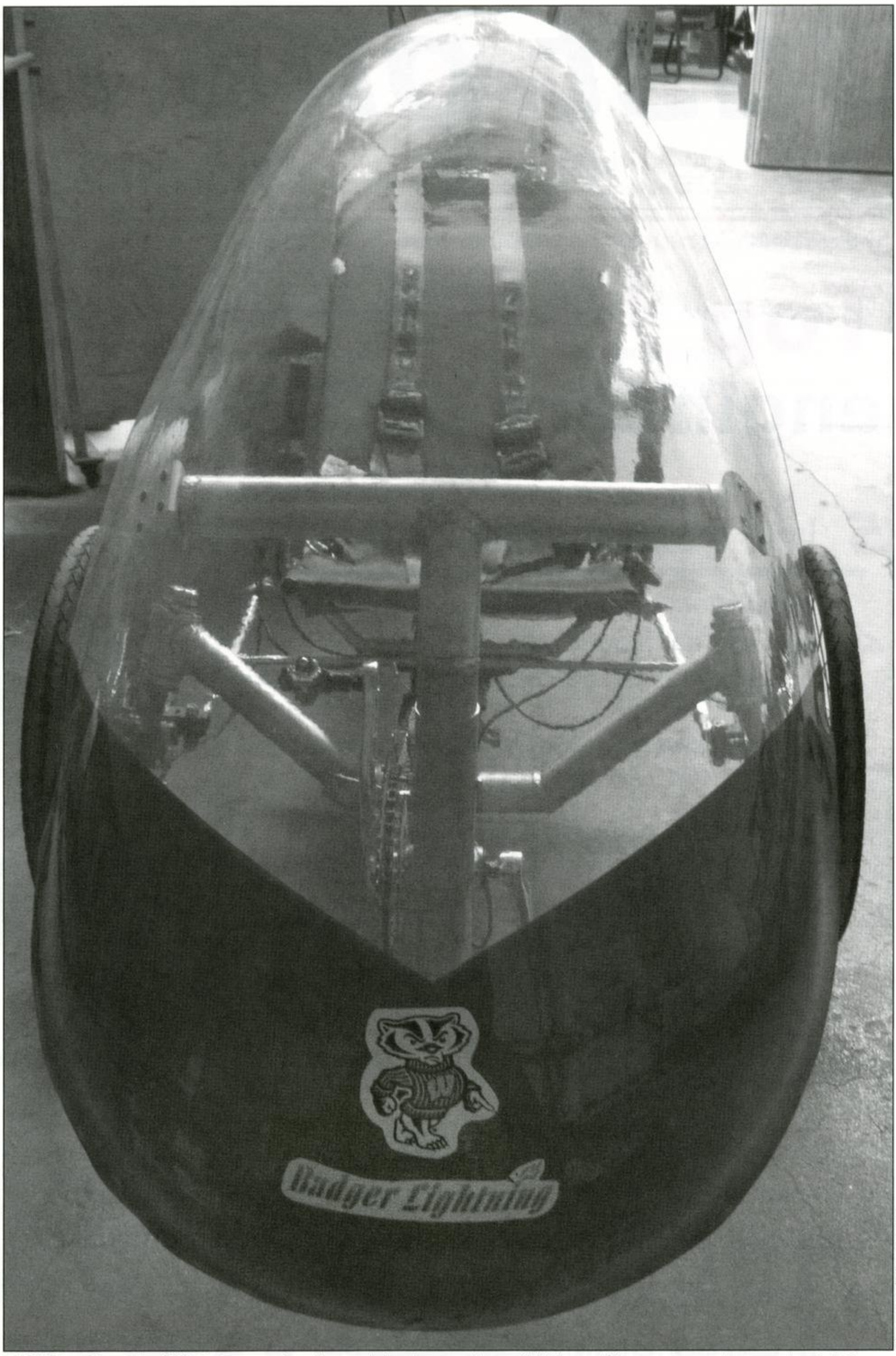


Photo by Erin Jacobs

UW-Madison's HPV team designed last year's vehicle with an aerodynamic fairing to reduce drag forces that could slow down the vehicle during competition.

"I look forward to being able to collaborate with my peers to work on a project that is truly ours, and I therefore take a lot of pride in my work on the HPV team," Arnold says. "The collective innovation and determination of HPV team members will be what propels us past any challenges that arise en route to our end goal."

The mistakes of last year are slowly transforming into the successful team organization and improved design ideas of this year. Past difficulties have driven the team to improve their approach and, they hope, their entry in the competition. WE

Author Bio: Sarah Michaels is a senior studying English literature and technical communication. Kevin Jayne is a junior studying mechanical engineering and technical communication.

Just one more

The finest in eclectic humor

By Skye McAllister

Top +/- 5 things engineers do when they graduate

-5 Look for boyfriend/girlfriend.

-4 Go 'Office Space' on TI 83.

-3 Re-adjust to sunlight.

-2 Calculate the uncertainty involved in finding a job.

-1 Tell freshmen it's not worth it.

0 Bungee jump off of the Engineering Research Building.

1 Urinate on the laboratory of hygiene.

2 Don't make any hypotheses or come to any conclusions.

3 Surgically remove stick from…

4 Get a degree in something enjoyable.

5 Stop, sigh, and then realize you have to start a real job.

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