Wisconsin engineer. Volume 113, Number 2 February 2009

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

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wisconsin engineer

FEBRUARY 2009 VOLUME 113, NUMBER 2

One Laptop per Child

Powered by $199 XO p.10

Also inside:

Published by the Students of the University of Wisconsin-Madison VOLUME 113, NUMBER 2 FEBRUARY 2009

Cover photo by Preston Judkins & Ross Tillman

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Aardvark to buyarrhea

By Victoria Yakovleva

If you're looking to vent your obsessive-compulsive tendencies, become a writing editor. I've been editing for the magazine for over a year now, and what I've learned most from the experience is this: you are never done. I'll read an article five times over, and each time, I'll find something new to change. If I were to graph my edits, they'd probably exponentially decrease towards infinity. However, being a magazine, we have deadlines, and there are only so many rounds of edits we have time for.

The hours upon hours I have spent editing for the magazine have dramatically increased my appreciation for journalism. Back in middle school when I used to write stories about the adventures of my pet cat, I had no regard for my audience, context and style; I just wrote whatever I could conjure. Now, I have to make sure that the stories that are printed in the magazine are factually correct, grammatically sound and appealing to readers. The consuming amount of time I have spent reordering words and cutting up sentences is nothing I would have ever pictured myself doing as an engineering major.

So why do I do it?

Most engineers seem to have small panic attacks when it comes to writing. Maybe that's why so many of them put off taking their required communications courses. I, on the other hand, was admittedly disappointed when I heard that chemical engineers don't have to take EPD 397. Thus, each semester, I've been looking through courses in the English department, trying to find a communications course I could fit into my busy schedule.

At this point, you may be thinking I have lost my mind. Why would an engineering major go out of her way to write?

Well, at a young age, I realized that the best way for me to get my thoughts across was through writing. English being my second language, I struggled for a long time with mispronouncing words and getting laughed at for it by my classmates. Determined to learn the language, I would pick up a dictionary in my spare time and go through it page-by-page, writing out words, trying to memorize what they meant.

I'll be honest, I didn't even get to the "c" section. There are over 1,500 words that start with the letters "a" and "b" and, at the time of my obsession to learn English, I was easily distracted by playing in the jungle gym. But if you ever need to know a word from aardvark to buyarrhea, I'm your gal.

The English teachers I had growing up further fueled my addiction to words. They'd put post-its of words for me to learn on my desk, they'd give me spelling exercise sheets and they'd recommend books for me to read. As a result, by age 10, I was on a three-year streak of not getting a single spelling test score of below 100 percent and receiving the annual award for most books read in my grade.

This account of my childhood successes in reading and writing might inevitably cause you to wonder why I chose to pursue a degree heavy in math and science instead. My interests in math and science came later, circa eighth grade. My teacher that year was notorious for being a stickler for proper use of grammar and punctuation. As a result, my English skyrocketed, so much so that at the age of 13 I got a score of 28 on the English portion of the ACT.

As strict as my English teacher was (there was a rumor that he gave out one A every five years), I was eager to excel in his class. Our last assignment of the year was to write a free verse composition written to someone or something, the impetus of which was Langston Hughes' poem "Mother to Son." I poured out my soul into that assignment and edited it nearly 20 times. When it came time to hand it in, I was incredibly proud of what I had accomplished. I expected my teacher to applaud my prose's excellence and push me to publish it.

Though I still don't know what grade I received on that assignment, since my teacher never handed it back, I certainly didn't get any applause or publication offer. I didn't even get the A I was striving for. That's when my writing obsession died out and my interest in math and science emerged. In high school, I realized I preferred dissecting animals over dissecting my soul to write a piece of prose.

Writing is exhausting. Just writing this editorial has bitten out a good chunk of my time. I spent about two hours thinking of what to write about, another two hours writing (not counting the time spent away from my computer during my writer's block) and I will probably spend about an hour re-reading and editing this.

You'd think I safely avoided pursuing a career in writing by choosing to major in chemical engineering, but any engineering professional development course will teach you that this isn't so. I'm still following the path paved by my childhood of becoming a writer, just in a unique way.

Regardless of whether you want to be a doctor, a lawyer, or a professor, you're going to need to communicate with others; and, until we reach an age where we can transfer messages through brain waves, this means you're going to need to be able to write and present. That's why I slave away my free hours working on this magazine. I am able to refine my skills in technical writing, meeting deadlines and working with others. If that's not preparing myself for my career, I don't know what is. WE

Victoria Yakovleva

COLLEGE OF ENGINEERING
UNIVERSITY OF WISCONSIN-MADISON

THE UNIVERSITY of WISCONSIN MADISON

The *Wisconsin Engineer* magazine, a member of the Associated Collegiate Press, is published by and for engineering students at UW-Madison. Philosophies and opinions expressed in this magazine do not necessarily reflect those of the College of Engineering and its management. All interested students have an equal opportunity to contribute to this publication.

Faculty Advisor: Steven Zwickel **Publisher:** American Printing Company, Madison, WI **Web address:** http://www.wisconsinengineer.com

Correspondence: *Wisconsin Engineer* Magazine; 1550 Engineering Drive; Madison, WI 53706 **Phone:** (608) 262-3494 **E-Mail:** wiscengr@cae.wisc.edu

The *Wisconsin Engineer* is published four times yearly in September, November, February and April by the Wisconsin Engineering Journal Association.

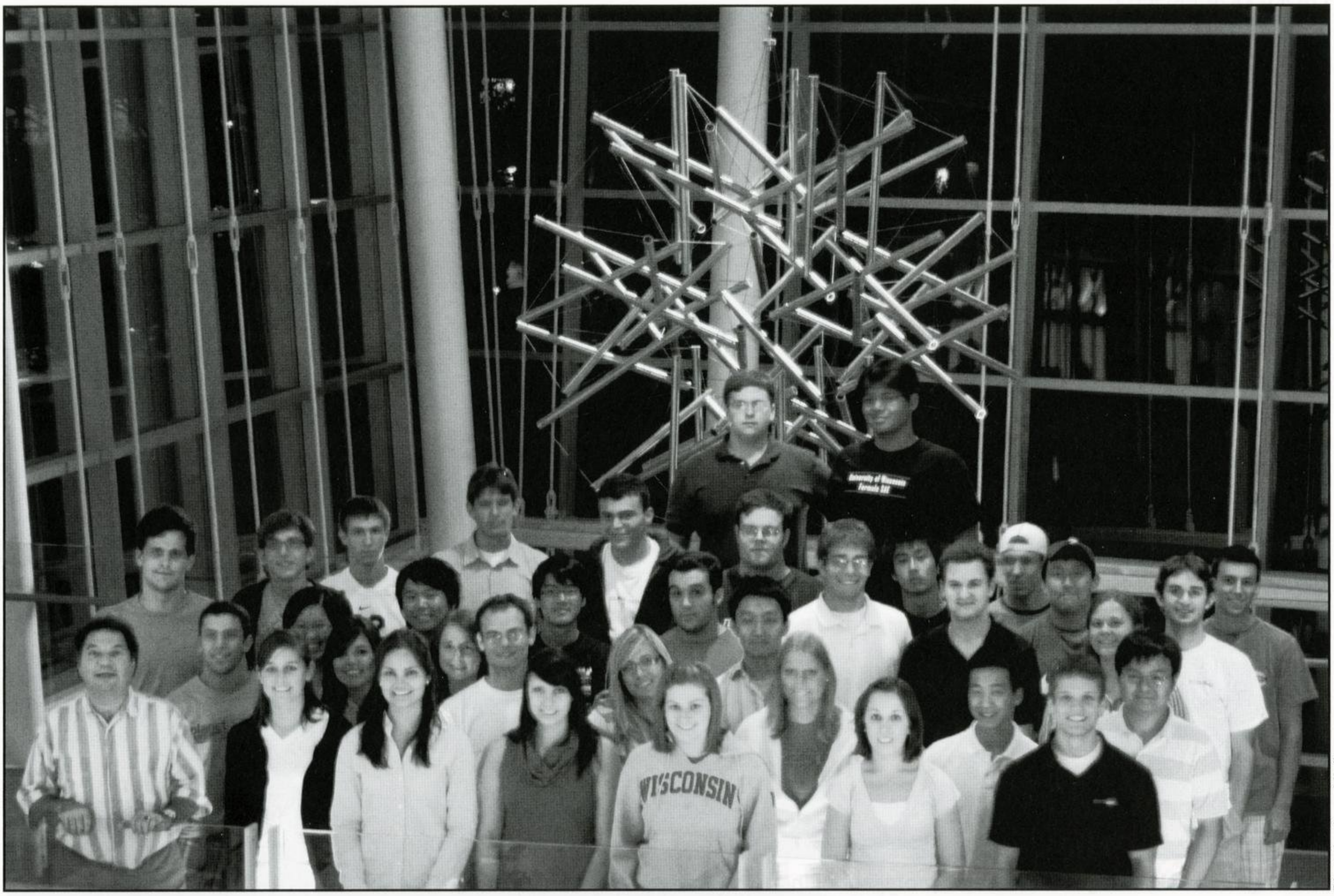

Photo by Anna Mielke

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Bridging the gap between technology and humans

Photo by Evan Owens

Although Pascale Carayon has been a professor of industrial and systems engineering on both sides of the Atlantic Ocean, she is happy to call UW-Madison home.

By Emilie Siverling

Most engineering professors are fascinated by either a material they're synthesizing, a process they're improving or a device they're designing. Professor Pascale Carayon's fascination, however, is with people. As an industrial and systems engineering (ISyE) professor with a focus in human factors and ergonomics, she studies how people work. She then combines her findings with her knowledge of technologies to design systems that improve the working environment.

As a high school student in France, Carayon excelled in math and physics. Based on the recommendation of a high school teacher, she applied and was accepted to one of the top engineering schools in France. For her specialization, she chose engineering economy, which is similar to ISyE in the United States. Carayon then traveled to UW-Madison and earned her PhD. When offered a position teaching at the university, she accepted, citing UW-Madison's ISyE department's quality and breadth.

"The nice thing about this department is that it's not narrowly focused," Carayon says. "It includes all kinds of disciplines of industrial engineering, [including] the human factors and ergonomics piece."

Carayon has since then climbed the academia ladder and is now the director of the Center for Quality and Productivity Improvement. In 2001, the department received a grant from the Agency for Healthcare Research and Quality to study patient safety and medical errors. This allowed Carayon to expand her research into a hospital environment, which, she says, is more challenging than researching a typical work environment. Most of her current research is done in intensive care units (ICUs), which is a very complex environment since most patients in intensive care have such unstable health that a small error could be deadly.

"Trying to implement any change [or] new technology can have tremendous positive impacts, but it could have huge, disastrous consequences," Carayon says of the challenges of researching in ICUs.

Despite these difficulties, Carayon feels up to the challenge. She still does much of her own primary research, observing and interviewing nurses, physicians, pharmacists and other healthcare professionals who have an impact on the way the ICU is organized and run. From this data collection, she can work on solving problems with solutions as simple as reorganizing a supply closet or as complex as implementing an entirely different system with new, unfamiliar technology.

Any new instrument or software that is put into the ICU needs to be studied to make sure it helps job performance and communication. By improving the usability of technology, flow of information, design of systems and other processes that support the performance of healthcare professionals, Carayon is confident that many medical errors can be eliminated. This helps the professionals, who are more efficient and happy with their jobs, and the patients, who receive better care.

Like her research, many of the classes Carayon teaches deal with the "people side" of engineering—human factors and ergonomics. Over the years, she has found that the best way to teach is in a very participatory fashion, as opposed to just lecturing.

"I have a lot of knowledge and expertise that I like to share with the students," Carayon says in reference to her teaching style. "But if I don't interact with the students…it's very difficult for me to be an effective teacher."

To engage her students, Carayon assigns readings, projects and small group exer-

Photo by Evan Owens

Professor Carayon and her graduate students come from a variety of backgrounds, but they all work together to improve the well-being of patients and medical professionals. From left: Teresa Thuemling, Prof. Pascale Carayon, Randi Carthmill, Kerry McGuire, Helene Faye, Bonnie Paris, Pat Ferrara and Nana Khunlertkit.

cises. She also brings back many examples from her research to the classroom to make the subjects she teaches more real and interesting for the students.

"These are really very interesting topics to me," Carayon says. "So if I can share some of my enthusiasm with students, then I've done my job, and I'm happy with that."

Carayon's passion for people is also evident in her activities outside of the university. Since her family still lives in France, she calls them at least once a week, in addition to e-mails. One way she keeps up with her nieces is to read what they are reading, so she often reads in both English and French.

Carayon's other activities include preparing for a mini-triathlon and art metallurgy. She enjoys these activities because they balance out her research and teaching, but that doesn't mean that they are easy.

"I like swimming, and I like biking," Carayon says of her preparation for the mini-triathlon. "But of all the other sports that I have done, running was always…a nightmare for me."

Carayon also enjoys traveling, a lot of which she has been able to do by volunteering for international activities like the International Ergonomics Association. Last year, she gave a work-related talk in Brazil, which allowed her to enjoy a small vacation exploring the country.

While talking to Carayon, her enthusiasm towards understanding people and helping them is evident. Even in the short time we met, Carayon cared enough to inquire about my life. I entered the interview expecting a discussion of her life, education and work; I left having also chatted about my interests and goals.

After all, learning about people is what she does best. WE

Author Bio: Emilie Siverling is a senior majoring in materials science and engineering. This is her fifth semester with the magazine and first in writing.

Nick Rakovec is driving the internal combustion snowmobile during the Handling and Driveability event at the Clean Snowmobile Challenge last year.

By Cody Wenzel

In March of 2000, just outside of Yellowstone National Park, the Society of Automotive Engineers (SAE) Clean Snowmobile Competition (CSC) was born. It began as a result of increased pressure to ban snowmobiling in national parks due to snowmobile manufactures doing little to meet environmental standards. Now, nine years after the start of the competition, employees from all the top snowmobile manufactures come to the CSC to check out the innovations developed by competitors.

UW-Madison joined the CSC in 2002 and now participates in two separate clean snowmobile competitions. The first of these is the internal combustion (IC) competition. In this competition, the team uses their Bucky 750 FX, a modified 2003 Polaris Frontier Classic, powered by a 750cc four-stroke engine that has been redesigned and rebuilt as a flex fuel engine to accept E10 to E85 ethanol.

"This required a lot of sleepless nights, but now, after a few years of doing it, it's not as painful and we don't blow up engines nearly as often," Ethan Brodsky, the team advisor, says. Along with redesigning the engine, the team also designed and built their own custom exhaust system with a three way catalyst to greatly reduce emissions of carbon monoxide and hydrocarbons. "With the requirement this year to run E85, we were one of only four teams in the 15 teams competing to pass the CSC emissions test," Nick Rakovec, the team leader, says.

Reducing noise emissions is another big goal of the CSC, so along with redesigning their muffler the team spent many hours reducing the noise being emitted from the tunnel and track of their Bucky 750 FX. This year, the team plans to improve their IC sled design, starting with the brand new 2007 Polaris FST chassis. Another modification to be incorporated in the 2009 design is a turbocharger. Rakovec anticipates the new and improved Bucky 750 FX will be the fastest sled running a turbo this March.

Three years ago, a new category of "Zero Emissions" was added to the CSC. This category was produced by the National Science Foundation's need for a vehicle to transport scientists and equipment in pristine areas of the north and south poles for climate and pollution research. Last year, the UW-Madison CSC team decided to enter the Zero Emissions (ZE) category and build a completely electrically powered snow machine dubbed BuckEV. The EV suffix came from the Delphi EV 1 electric motor, which is the power source in this exceptionally fast machine. The team recalls the huge smiles on the judges' faces at last year's competition, who were overwhelmingly impressed by the power that the 100 horsepower engine generated. The power to supply this motor results from the 84 28-volt lithium-ion battery packs, sold to the team by Milwaukee Tools—the team's sponsor last year—at production cost. Together these batteries produce 78 kilowatts of power at 336 volts. "[This] is enough power to run several houses with every single thing in the house running simultaneously. At 6.5 kilowatt-hours you can run 100 65-watt light bulbs for a full hour," Brodsky says. But BuckEV is not just all brawn. At 50 feet away, this snowmobile emits only 55 decibels, which is roughly the noise level inside the average house.

All the work the team put into BuckEV paid off when they were crowned the 2008 ZE national champion. As a result, they earned a roundtrip ticket to Summit Station, a National Science Foundation (NSF) research station located at the peak of the Greenland ice cap, to test the sled's potential in aiding arctic research. There the sled remained for two and a half months, traveling a total distance of over 300 miles. Researchers kept logs of every trip on BuckEV, while the data logger the UW-Madison team had installed on board kept track of its activities. The data showed that BuckEV was able to haul a total of 1,800 pounds, which more than doubles the towing capacity the sled was designed for.

Photo by Snowmobile SAE team

The Snowmobile SAE team from left: Kevin King, Adam Schumacher, Ashley Driver, Brad Hall, Bucky, Nick Rakovec, Michael Maney, Glenn Bower, Michael Peitz and Brian Olenski.

Though BuckEV goes above and beyond the performance specifications that NSF sought after, the costs of building the sled prevent it from becoming readily available. According to Brodsky, the material and component costs range from $60,000 to $90,000, with the EV1 motor and controller alone ringing up at nearly $30,000. The majority of the supplies and components the CSC team uses each year come from recycled components from other engineering projects and industry donations. With the hours of build time required, "[the] snowmobile comes out to 100 to 150 thousand dollars of engineering efforts, which is actually pretty reasonable for building a prototype like this," Brodsky says. Unfortunately, these costs are still too high for the declining budget of NSF.

On top of impressing the NSF, BuckEV also impressed the natives of Alaska at last fall's convention. In Alaska, energy isn't cheap. Gasoline is at $11 to $12 per gallon. Thus, the federal government assists many villages by putting up windmills and providing residents with free electricity. For this reason, it would be economically advantageous for Alaskans to use electric vehicles, which is why one man at the convention even offered to buy BuckEV for $90,000.

"We demonstrate that it's not that hard to make these vehicles cleaner; yet, the industry protests and says it's too hard," Brodsky says. One good example of the CSC impact on the snowmobile industry is the emissions test. Originally developed for the annual competition, the emissions test is now used as an industry-wide standard to test snow machines. "The emissions testing used now for industry was developed over the first three years of this competition," Brodsky says. "Soon we are going to show everyone that that's not good enough anymore." WE

Author Bio: Cody Wenzel is a transfer student from UW-Lacrosse. He is a junior majoring in chemical engineering. He is an active member in Concrete Canoe and AIChe. This is his second semester with the magazine.

Photo by Summit Camp Staff

The BuckEV in front of the US Air Force C-130 that carried it to Greenland for competition.

What lies beneath

Geophysics research reaches great depths at the Halliburton Geoscience Visualization Center

Photo by Mario DiDenedetto

By Roxanne Wienkes

Finding fossil fuels such as oil and natural gas poses a big problem since the most concentrated deposits are often buried deep beneath the earth's surface or ocean floor. Precision in locating deposits is critical, or millions of dollars could be wasted drilling a well where there is no fuel. To reduce risk and cut cost of finding fossil fuels, researchers have developed a technology that begins with sound waves and ends with 3D images of the earth's subsurface. Fortunately for students at UW-Madison, the industry's hope to get students familiar with the technology has brought the Visualization Lab to the geology department here on campus where it is used as so much more than a tool to find fossil fuels.

Photo by Mario DiDenedetto

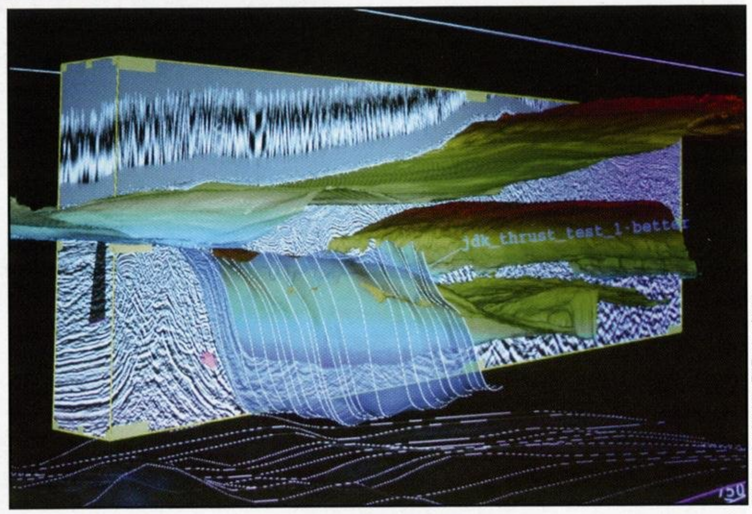
An expert in seismic imaginging, Professor Tobin has recently returned from the coast of Japan where he was collecting data for his work on tsunamis.

The Halliburton Geoscience Visualization Center (HGVC) is a computer lab, located in Weeks Hall, used for the manipulation and viewing of seismic images—images produced by wave propagations through the earth. The lab was donated by Landmark Graphics, a subsidiary of Halliburton, through their collaboration with the geology and geophysics department on campus. The HGVC is led by Harold Tobin, a UW-Madison associate professor of geophysics. The main attraction of the lab is a twelve foot screen operating on four LCD projectors. The screen is essentially a giant computer monitor with three-dimensional stereo capabilities. Once you put on the polarizing glasses, you can practically reach out and touch the images.

The 30 gigabyte data files containing the seismic images do not make it to the computer screen effortlessly. Collecting data for underground images is a time-consuming process. The most common method is to send seismic waves into the ground which

With data of Devil's Lake State Park the system can vividly project 3D stereogwwraphic images of topographic maps and contour lines.

Each black and white ripple on the box represents a layer of rock. A particular rock layer can be highligheted to stand out as a continuous sheet of color.



Photos by Mario DiBenedetto

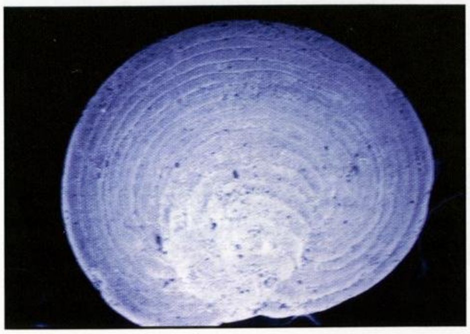
then bounce off of rocks in the subsurface. Highly sensitive microphones are positioned to pick up the reflected sound waves and the data collected is used to create a two-dimensional profile of the depths of the rock and sediment formations. "It's like an ultrasound to image below the surface of the earth," Tobin says. The two-dimensional profiles are then processed and combined to create an image with depth, height and width.

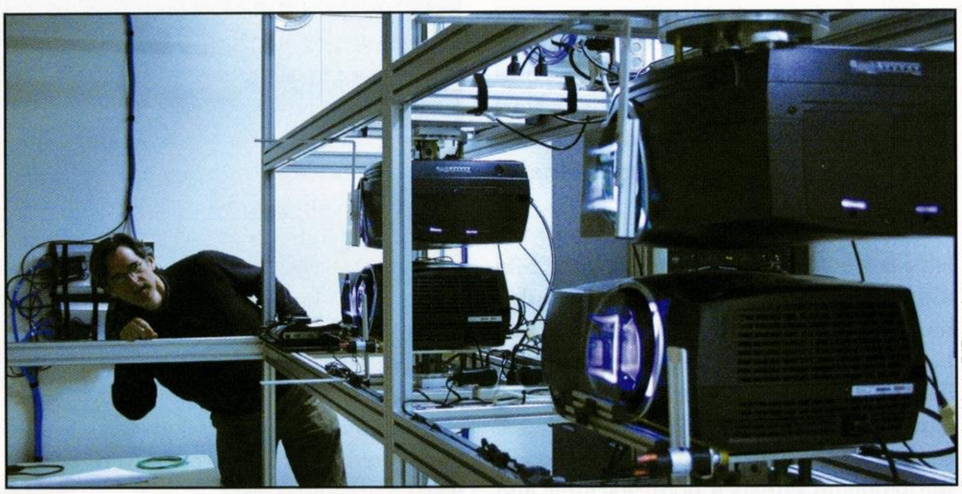
Although seismic imaging was originally created for finding fossil fuels, the technology is now being used for a variety of other purposes. The development of this technology has allowed exploration geophysicists to take research to new depths—literally. "We can image to the core of the earth," Tobin says. Depending on the purpose of the research, the image acquisition and resolution can be adjusted for the appropriate depth into the earth's surface. For instance, Tobin's work focuses on plate tectonics. For his research on the cause of tsunamis, he can obtain high resolution images 10 miles below the ocean floor.

The HGVC lab is not only for underground seismic imaging. "It is a combination of a research tool and teaching tool," Tobin says. Students in introductory geology courses can go into the lab, put on the polarizing glasses and view contour maps in an interactive manner. "Our job is to help students learn what is going on in the earth ," Tobin says.

Getting students familiar with the technology that geologists use can help students explore future careers. Most oil companies, which employ a high volume of geologists, have labs similar to the HGVC. The lab is a major step in integrating the professional world into education and exposing students to what a career in geology has to offer. "The hope is it will get students excited about geology and show them that it is more than just banging on rocks," Tobin says. we

Author Bio: Roxanne is a junior studying environmental engineering. She loves the winter months.





Photos by Mario DiBenedetto

(above) The image produced is so large that it requires four projectors
(upper left) Mechanical energy behaves like sound waves in the Earth. From distortions in seismic data, various rock layers can be inferred by differing densities.
(lower left) The HGVC technology can be used to explore all types and sizes of objects; like the shell pictured here.

XO marks the spot

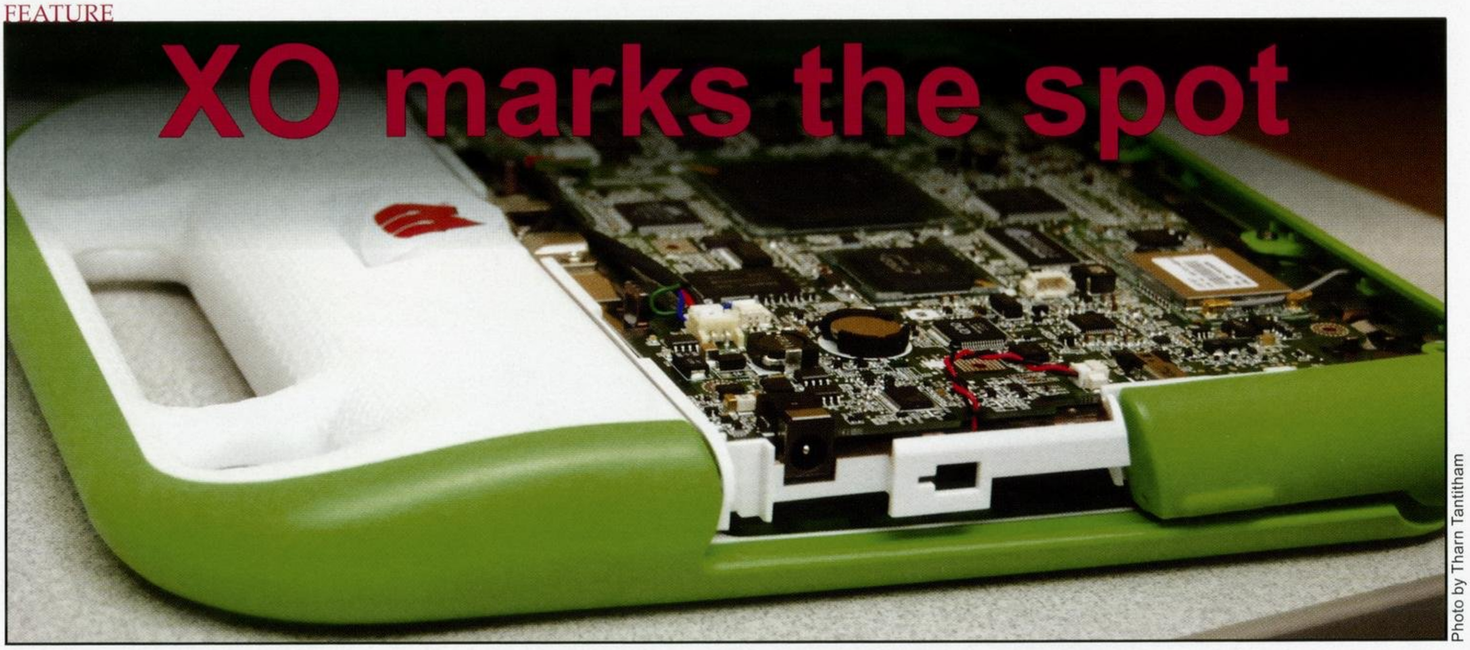


Photo by Tharn Tantitham

By Carrie Boecher

In a small office on the UW-Madison campus, I sit with Silas Bernardoni, a senior in industrial engineering at UW-Madison, as he sorts through a pile of laptops. The computers are compact, made of hard white plastic and trimmed in lime green. Each one is adorned with a colorful "X" and "O," which are arranged to form the outline of a child. Appropriately, these computers are called XO laptops, and they are rapidly making their mark on the international community, as well as on the computing world. Bernardoni pulls out a couple of the laptops and flips them open, talking all the while about the colossal project surrounding them.

"This whole thing is incredible because it's gone from an idea to a million computers in the field in three years," Bernardoni says. "The incredible speed with which things are happening is just phenomenal."

He's talking about One Laptop Per Child (OLPC), a non-profit organization founded four years ago by the head of MIT Media Labs, Nicholas Negroponte. According to the OLPC website, the mission of the organization is to supply affordable, durable computers to teachers and students around the world to enhance both teaching and learning experiences. Though the project is only a few years old, there are already 11 countries participating and another 18 engaged in pilot programs.

After seeing a story about OLPC on the news program "60 Minutes," former UW-Madison Chancellor John Wiley convinced Negroponte that the XO laptops could also be used effectively for disadvantaged elementary school children in the United States. Negroponte finally agreed, and the program donated 10 laptops to UW-Madison. This past summer, Bernardoni, with the help of engineering professional development professors Sandy Courter and George Johnson, put together a pilot program to explore the ways in which the XO laptops could be used to teach children.

"We didn't have any training; we didn't have anything," Bernardoni says of the pilot. "We just had 10 computers and we went out and tried to teach kids."

Through the pilot, the team observed how the kids reacted to the programs on the XO laptops, deciding which ones worked and which ones didn't.

"There are hundreds of programs out there, some of which are just horrible," Bernardoni says, referring to the open source software used by the XO laptops. "It was our job to decide which ones were best to teach literature, which ones were best to teach math and so on."

All of the software used by the XO laptops is open source, meaning it is free to anyone, and users are capable of altering it in any way they see fit. Using such software on the XO laptops allows people from all over the world to write, share and improve the programs found on the XO laptops. These capabilities further emphasize the computer's role as a flexible and innovative learning tool.

The exclusive use of open source software is only one facet of the XO laptop that distinguishes it from a typical Windows or Apple laptop. Physically, the computers are designed to withstand harsh natural conditions of developing countries, from the sandy deserts of Africa to the wet rainforests of South America. Unlike a fragile Macbook or Dell laptop, the XO laptops are robust enough to withstand a hard fall from a desk or a spilled glass of water. Moreover, each physical component on the XO laptops has one or more very specific functions. Two latches on the outer edge of the computer, for instance, act as clasps when the computer is shut and as wireless antennas when it's open.

In addition to its unique physical design, the software on the XO laptops is completely different from anything else found on the market. While Apple and Windows computers have their stylistic differences, both systems utilize a similar format in which applications and documents are organized into files and folders. However, the software system on the XO laptops, called Sugar, completely does away with this "desktop metaphor." Instead, activities—a more child-friendly term for programs—are represented by playful icons and arranged in a circle around an XO child figure on the home screen. All data is saved automatically in each activity, so there is no need for files and folders.

One of the most significant capabilities of the Sugar software is its mesh network, which allows young students to interact electronically, even without the internet. In the neighborhood view on the laptops, all students using the computers at any given time appear as different colored XO icons. By simply clicking on one of these icons, one student can invite another to collaborate in a virtual activity, such as painting a picture, playing a game, making music or writing a paper. In this way, a sense of community is created among the students, and learning becomes a group endeavor rather than an individual task.

Perhaps the most amazing aspect of the XO is how economical it is. According to Bernardoni, a standard introductory laptop costs about $700, while the XO costs only about $180. Even more amazing is the fact that these little computers are produced at the same plants as Windows and Apple laptops.

"The computer industry doesn't like it, because OLPC came around and proved that you can actually [build computers at such a low price]," Bernardoni says.

Photo by Tharn Tantitham

Silas Bernardoni is showing off one of the XO laptops, which he brings into the Madison community to teach children basic computing.

The low price led Chancellor Wiley to purchase $20,000 worth of the laptops as one of his last acts as chancellor, increasing the UW-Madison collection to 110. These computers are being used throughout the community at schools, churches and community centers to assess how they can best be used to teach children. Currently Bernardoni and the other volunteers regularly visit four locations around Madison with the XO laptops, teaching children how to use the computers and observing how the computers teach the children. Although Bernardoni and his team have put hundreds of hours into the project, there is a lot of work yet to be done—and they need help.

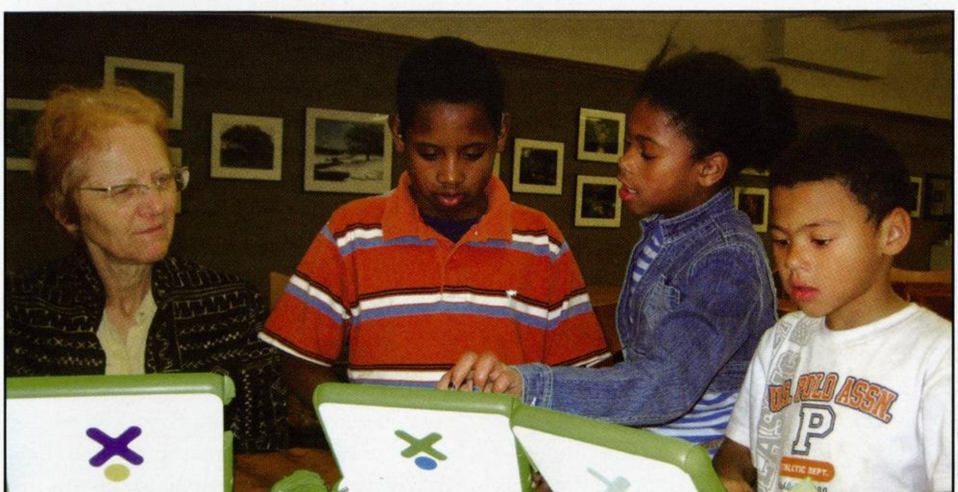


Photo provided by Silas Bernardoni

The unique software system is designed for learning and aimed toward children.

"We need people, in this case students, who are interested in this [project] to go out to schools with us and tutor kids. We just sit with [the kids] and help them with their homework, then figure out ways we can use the XO to help them with their work," Bernardoni says.

In addition to helping in the classroom, UW-Madison students can earn credit for their work with the program. A class in volunteering will be offered spring semester of 2009, in which participants will be trained on the XO laptops. Some will even have the opportunity to travel to Paraguay to help start an OLPC branch.

For now, however, Bernardoni and others at UW-Madison will continue to assess the value of the XO for underprivileged children here in Madison.

"The whole goal is to find out how to help disadvantaged kids," Bernardoni says. "The more we can help them, the more [the XO] is successful as an educational tool." WE

Author Bio: Carrie Boecher is a junior in civil and environmental engineering. This is her fifth story for the magazine.

Into The Future

Photo by Ross Tillman

By Matt Stauffer

It was shortly after the Manhattan Project in the early 1950s that nuclear technology was first used for power production. The first light water nuclear reactors to produce electricity were derived from the design the U.S. Navy used to build a nuclear-powered fleet. Second generation nuclear reactor models were built in the 1960s, designed specifically for the production of electricity; these models are operating in the U.S. today. Third and fourth generation models have been designed and tested and will likely be used in the development of future plants.

Photo by Ross Tillman

Uranium fuel cells are cooled by ultra pure water in the UW research reactor. The characteristic glow is caused by Cherenkov radiation, which occurs when charged particles move faster than the speed of light in a medium.

In general, nuclear technology is used for three purposes: power production, medical imaging and defense. Uranium, the primary nuclear fuel source, is the heaviest naturally occurring element on Earth. It naturally decays from its pure state to lighter elements because it is radioactive. As it decays, it trends toward the element lead and gets there through a series of reactions. During these reactions, it sheds protons and gives off energy, which can be captured as heat for electricity generation. Uranium forms a number of complex minerals in nature depending on its surroundings, specifically the element's proximity to the atmosphere and to water.

It was in the early 1980s that the world consumption of uranium exceeded the global production. Very little uranium is mined in the U.S. while Canada and Australia are the world leaders of its production. "As usual, the U.S. production piece of the pie is tiny compared to its consumption," Philip Brown, UW-Madison professor of geology and geophysics, says. "We have been behind for the past 30 years… so there needs to be some explanation to how we run this business with the gaping deficit, and it is a wonderfully ironic answer," Brown says. The "answer" that Brown is referring to is the decommissioning and recycling of nuclear weapons that have extremely rich uranium compensates. By mixing the weapon-grade uranium with newly mined low-grade uranium ore, researchers have discovered that it is possible to make vast amounts of fuel-grade uranium.

But how long will this fuel supply last? In terms of oil consumption, one study predicts that the average energy consumption will asymptote at an energy equivalent of 15 barrels of oil per person per year while the world population is predicted to level out at 10 billion people in the mid-21st century. In this century alone, however, the study estimates that humans will consume an energy equivalent of thirteen 13 barrels of oil, a quantity far greater than even the most generous estimation of six trillion barrels of the world's reserve of fossil fuels. Clearly, we cannot continue to rely on this energy source.

But rhetoric about conventional nuclear power being the energy crisis's "silver bullet" to eternally meet world energy demands is misleading. "We are nowhere near forever…Uranium in normal [light water] reactors has the potential to get us out through the next few decades, but it is not a limitless supply," Brown says. Technologies currently exist, however, that allow for secondary use of spent fuel. A reactor technology known as fast reactors, or breeder reactors, takes the spent nuclear fuel from light water reactors, enriches it and allows it to further decay and capture more energy from the fuel source.

"If we don't use uranium in the proper way, fission reactors don't have much of a future—only 40 years, 50 years at the most," Gerald Kulcinski, UW-Madison professor of engineering physics and director of the Fusion Technology Institute, says.

One concern of nuclear reactors, common to all energy production methods, is waste. However, engineering physics professor Michael Corradini points out that comparing the waste from coal and natural gas to the waste from nuclear reactors is comparing apples to oranges; the waste from nuclear reactors, though highly radioactive, is very compact and locally contained, while the waste from coal and gas is highly dispersed and released directly into the atmosphere.

There's also the concern that nuclear power emits harmful radiation. Natural background radiation is around two-tenths of a rem (the unit of radiation). Two thousand times natural background is deadly, while 25 times natural background is allowed for workers in fields that use radiation. The EPA legislates that three times natural background is acceptable to expose to the general public, a number that is equivalent to about four x-rays in one year.

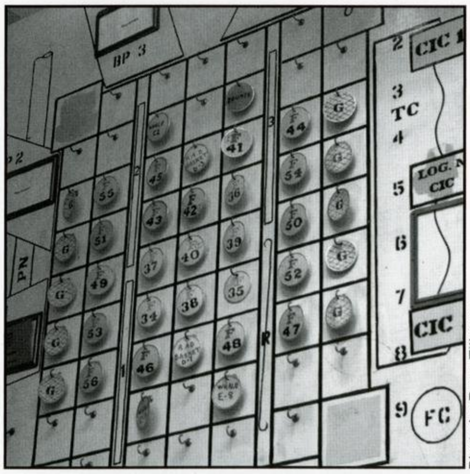


Photo by Ross Tillman

The pegboard in the control room of the UW research reactor is used to track fuel rods, which have a life expectancy of 60 years at their current usage rate.


Photo by Ross Tillman

Matthew Pagel, an undergraduate lab technician, is staffing the control panel of UW's research reactor, during a routine safety check.

"A nuclear power plant releases one percent natural background [radiation] to the public each year," Corradini says. This is very small, arguably insignificant, compared to radiation exposure from flying and medical imaging.

UW-Madison has been making its own strides to research solutions in nuclear power. The UW-Madison Energy Hub Conference, held in Madison in November 2008, was host to energy policy makers, leading researchers, industry professionals and concerned students and citizens. Patrick Moore opened the conference with an address that called nuclear energy the most cost-effective way of reducing carbon emissions and consumption of fossil fuels. Moore, one of the founding members of Greenpeace, is the co-chair of the Clean Energy Coalition, a group in favor of pursuing nuclear energy. As an advocate for nuclear energy, Moore points to the outstanding safety record of nuclear plants, along with the technology's longevity and potential to improve air quality by displacing coal and other fossil fuel power plants.

The UW-Madison nuclear engineering department is also conducting research on energy solutions. While the current technology is effective, improvements in engineering design and advancements of future technology can continually be pursued. Fission reactors, for example, could use higher efficiency, reduced waste streams, operational safety and prolonged safety and storage of spent fuel. In fact, there is theoretical technology being developed at UW-Madison that aims to produce nuclear energy with zero radioactive byproducts.

"What I am talking about is not something that is going to happen tomorrow…it is something that is farther out. But it is important to plan for the long range because, if we focus on the short range, we get ourselves into trouble," Kulcinski says. "We have to link near-term, mid-term and long-term goals all together." WE

Author Bio: Matt Stauffer is a fifth year senior in materials science. As a word of advice from Mr. H.J. Simpson "never leave your car keys in the reactor core."

Did you know?

- UW-Madison has produced more unique designs of power plants (>50) than any other private or public entity in the world.
- UW-Madison is currently running four independent research projects on nuclear fusion in addition to the fission research being done on campus.
- UW-Madison researchers have identified a nuclear fusion fuel source which, when consumed, produces zero radioactive byproducts; the estimated supply could meet world energy demands for 1000 years to come.

Physical Sciences Laboratory:

Serving the research community since 1967

Photo by Wa'el Abdel Samad

Several members of the Physical Sciences Laboratory from left: Harold Mattison, Dan Wenman, Dan Wahl, Farshid Feyzi, Lee Greenler, Jack Ambuel and Ken Kriesel.

By Melody Pierson

For research programs to be successful, researchers need to collaborate with engineers and manufacturers to acquire the equipment and procedures needed to make their experiments as accurate as possible. At UW-Madison, the Physical Sciences Laboratory (PSL) was created to address this need.

PSL is located about 14 miles from campus in Stoughton, WI on grounds that were the property of the Midwestern Universities Research Association (MURA) in the 40s and 50s. In 1967, after MURA came to an end, it was decided that all of MURA's assets and staff would become the property of UW-Madison. The university named this new establishment the Physical Sciences Laboratory of the University of Wisconsin. Its mission is to "provide facilities and technical knowledge to promote education and research."

PSL runs as an engineering consulting agency available to professors and research programs. "We are not an academic department; we are a service facility," Farshid Feyzi, technical director at PSL, says of PSL's relationship with the university. "We don't get any money [directly] from the university, although we get the building and we don't pay for electricity. We do charge for our time and for all of our services and materials," John Morgan, PSL's marketing director, adds that "it [PSL] is part of the UW, but it supports itself."

> **"The unique thing about PSL is that it's...highly specialized in working with researchers."**
>
> **-John Morgan**

The type of engineering services that PSL provides is what makes it such an exceptional institution. "The unique thing about PSL is that it's really, really, highly specialized in working with researchers," Morgan says. This expertise is extremely helpful to UW-Madison researchers, which is why Feyzi says it "is good [for students] to know that it exists."

The size and time frame of projects at PSL vary greatly.. Researchers at PSL are typically always working on at least one long-term and complicated project that may involve many other collaborators. In addition, there are also a variety of smaller consulting projects that PSL takes on. While PSL does a large amount of work with UW-Madison groups to constantly improve and reinvent their equipment, it also does a great deal of work with private company and government research initiatives.

An example of a local private company project was the PSL's collaboration with Tomotherapy, a research company that was founded in 1997 by two UW-Madison professors. For over a decade, researchers at PSL worked with collaborators at Tomotherapy on developing a more effective method of radiation treatment of cancer. Combining methods of intensity modulated radiation therapy and a type of image sectioning called computed tomography, Tomotherapy and PSL came up with a prototype of a multi-leaf collimator. This collimator is a very specialized machine that has a pinpoint accuracy of radiation. The collimator is now distributed worldwide.

The PSL has also been involved in global government research initiatives involving the development and construction of the largest scientific instrument ever made—the Large Hadron Collider (LHC) at The European Council for Nuclear Research in Switzerland. The LHC is a particle accelerator 100 meters underground that is used to study the smallest building blocks of all types of matter. According to The European Council's website, the LHC recreates the conditions immediately after the big bang by colliding particle beams of very high energy. The particles are then analyzed by physicists using two kinds of special detectors. One of these two detectors is the Compact Muon Solenoid (CMS). The CMS consists of a huge superconducting coil that creates a magnetic field (a solenoid) about 100,000 times stronger than the earth's magnetic field. This particular component of the LHC caused quite a bit of controversy among scientists who predicted that the mini black holes and magnetic monopoles that were created would cause doomsday.

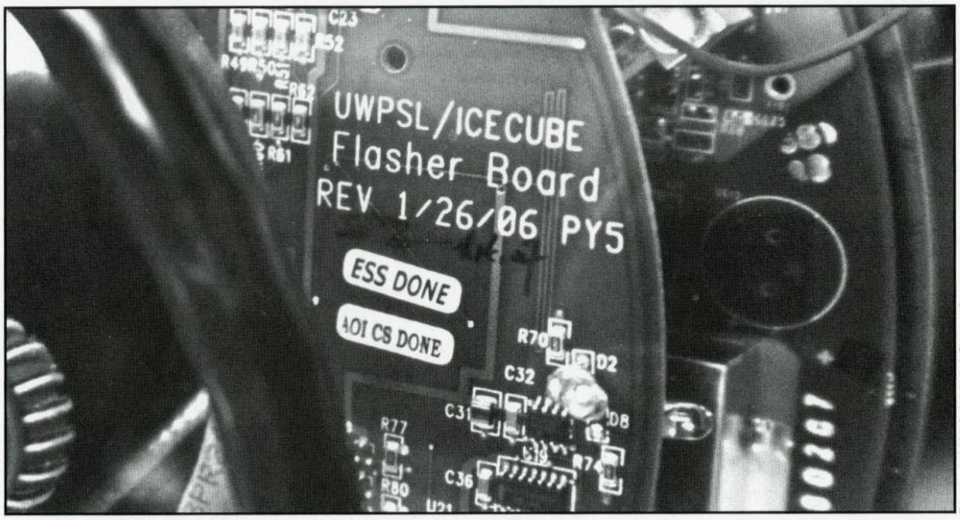


Photo by Wa'el Abdel Samad

A component of a digital optical module used in the IceCube project, which allows for accurate drilling of holes in polar ice up to 2,500 meters thick.

In this research initiative, PSL was given the job of designing and constructing the two end caps of the CMS. According to a PSL pamphlet, each of these components weighs about 3,000 tons. The caps contain over two million hair-like wires for detection of particles and 310,000 electric channels. The largest feat of constructing the CMS was that each of its fully constructed components had to be lowered 100 meters underground and then assembled together. PSL was responsible not only for the design of the end caps but also the design and supervision of the construction of each part and the lowering procedure. This was a very successful project for the lab, and, according to PSL, each end cap was lowered underground without breaking a single wire.

Another large research project that PSL is involved in is the Global IceCube project in the South Pole. PSL has designed, constructed and tested the Enhanced Hot Water Drill, which is able to accurately drill holes through ice up to 2,500 meters thick in an energy and cost-efficient manner. They have also designed, and are still in the process of fabricating, 4,000 digital optical modules that are able to withstand conditions 2,400 meters below the Antarctic ice for twenty years.

The IceCube project relies on PSL for a good percentage of its operation. Because PSL engineered the majority of the equipment used in this project and has been working across the board of the project, the facilitation and implementation of this research has become "really intertwined," Morgan says.

Whether the project is a prototype for a local company, the design of a particle accelerator, or the construction of a water drill, PSL serves engineers worldwide in their research endeavors. The lab is one more reason for UW-Madison to be proud of its continually advancing research. WE

Author Bio: Melody is a sophomore studying nuclear engineering. This is her first semester on the writing staff.

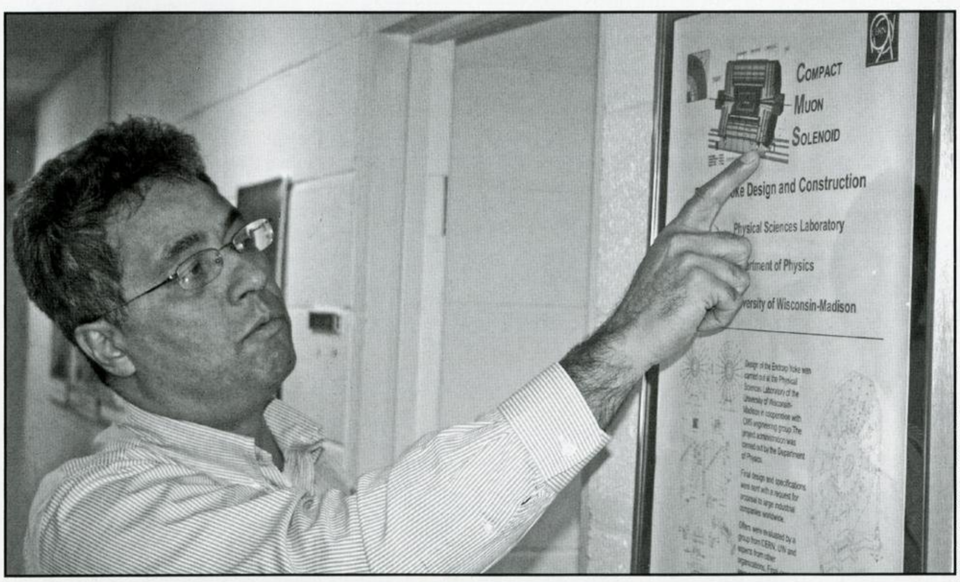


Photo by Wa'el Abdel Samad

Farshid Feyzi explains the Compact Muon Solenoid, a component of the Large Hadron Collider .

Livescribe Pulse Smartpen

By Bonnie Atkinson

Ever find yourself scrambling to get down every equation your professor is scribbling on the board? Ever find gaps between your notes—either because you got distracted by the text messages your friend was sending you or because you fell asleep in the middle of lecture?

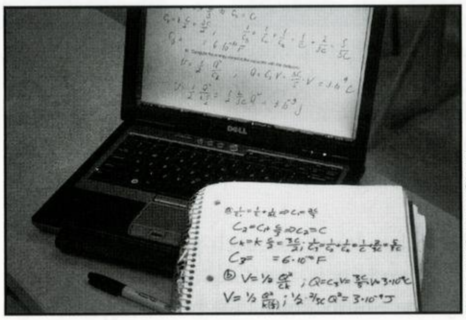


Photo by Steven Shutt

The pen can digitize your notes.

Regardless of what note-taking predicament you may have faced in your college career, there may be a solution in your near future: the Livescribe Pulse Smartpen.

The Smartpen enables you to digitally transfer handwritten notes and sync them to an audio recording. So, as you are taking notes, the Smartpen records what your professor is saying, therefore ensuring you never miss a word. Later, when you go back to review your notes, you can tap anywhere on the page to bring up the audio that was recorded while you were writing at that point in time. This function is made possible by the specialized paper produced by Livescribe, which has tiny dots that, much like a connect-the-dots puzzle, can map out exactly what is written on a page. At the bottom of the paper are buttons for functions like record, play, stop, fast-forward and rewind, which allow the user to control the audio play-back. The Smartpen, at about six inches long and twice as wide as a regular pen, can hold up to two gigabytes of memory, which means it's capable of 150 to 200 hours of recording time—or 60,000 pages of notes.

Written notes can be transferred to a computer through a USB dock and are imported into the Livescribe's software interface. From there, notes can be organized, manipulated and shared. The specialized paper enables the software to animate pen strokes so that the notes appear on screen the way they were written on paper. The Smartpen also comes with handwriting recognition software, allowing you to search for words in your notes.

One of the unique accessories that come with the Smartpen is the 3D recording headset. The headset looks and functions like a normal pair of headphones, but on the backside are a pair of binaural microphones. These microphones are designed to render sound in the entire audio field so that the playback of the audio will sound exactly the way you experienced it. For example, if your professor moves across the room while lecturing, you will hear the sound transfer from one ear to the other.

Despite the many benefits of the Smartpen, engineering students at UW-Madison aren't quite sold.

"I don't think the pen would actually work. It doesn't seem like it's made for math or science," Jena Lange, a senior in engineering mechanics and astronautics, says. "The find function would be difficult to use; it would be a fiasco when it comes to Greek letters and other symbols." Jena, like many other engineering students, has few notes with actual words. Most notes are written mathematically or in vector diagrams.

The Smartpen comes with a 100-page dotted notebook, a 3D recording headset, ink and stylus refills, USB cradle, Livescribe Desktop application and 250 megabytes of online storage, selling at $149 for the one gigabyte model and at $199 for the two gigabyte model. "If the Smartpen was more cost efficient, I would buy it," Jesse Weidner, a junior in mechanical engineering, says.

For many students, the cost of the Smartpen far outweighs its benefits. Students like John Krippinger and Adam Krohn, also juniors in mechanical engineering, agree. "If you miss something you can most likely get it from a friend. You won't miss that much that you would need this pen," Adam says. John agrees, adding that he wouldn't spend over $50 for the Smartpen.

In the future, the Livescribe Pulse Smartpen may have a home with college students, but for now the advantages don't appear to be causing a revolutionary change in the way college students take notes. Perhaps the Smartpen needs a drop in price and a more convincing sales pitch for students to take advantage of this technical marvel.

Author Bio: Bonnie is a second-year journalism major. This is her first semester with the magazine.

Do-it-yourself: Building a PC

By Erik Sua

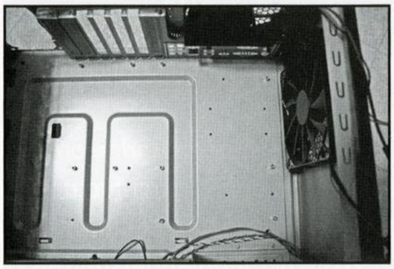
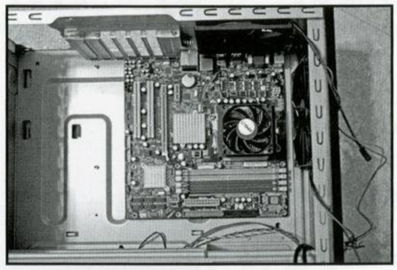
Whether it's for writing papers or running simulations, the personal computer is an asset to student productivity. Anyone can pick up an inexpensive computer from Best Buy, but what about those of us who just need to make things our own? This section is for you.

This article details what you need to buy to make your own PC from scratch with parts you can purchase at any electronics retailer. You can build almost anything you want, from a basic computer for word processing to a super, number-crunching computer. You will typically spend less money building your own PC than buying a PC off the shelf (at the expense of a warranty). This example build is for the college student on a budget who wants to run graphics editing software and play a game from time to time.

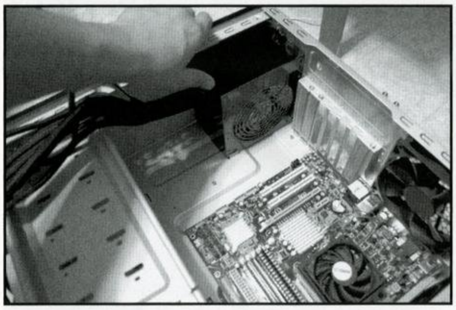
Please note that this is intended to be a basic overview of how to build a PC from scratch. For more detailed information please visit www.tomshardware.com or www.anandtech.com. These sites have PC build guides every few months.

Parts information is sourced from either

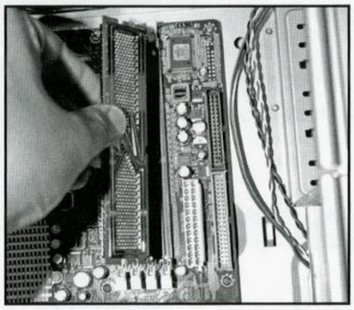
www.newegg.com or tigerdirect.com

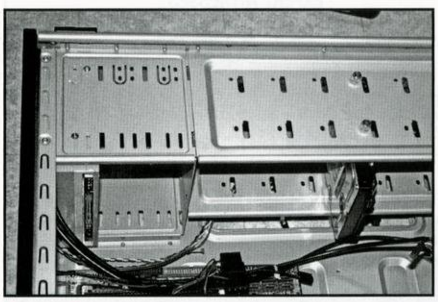
Step 1: Install motherboard into case, taking care to correctly install the motherboard spacers



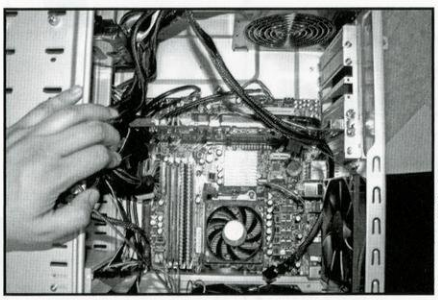
Step 2: Install power supply into case, and screw it in



Step 3: Install processor, heatsink, and RAM. Make sure to follow directions included with your motherboard



Step 4: Install both DVD and hard drives. Screw them into the chassis then connect them to the motherboard. Also connect front panel connectors to the motherboard. Follow directions included with both the case and motherboard



Photos by Erik Sua

Step 5: Install video card and plug power supply to motherboard, videocard, hard drive, and DVD drive. Try to pay attention to where you place cables, and avoid placing them by fans. Zip ties can be a great help for cable management

Step 6: Close case and plug the following into the back panel of your case: monitor, ethernet, speakers, keyboard, mouse and power connector

Step 7: Plug in and turn on the monitor. Turn on the PC, insert the Windows CD and restart your computer. The computer should offer to boot from the CD. After booting from the CD follow on-screen instructions to install Windows.

Step 8: Once windows is installed, install drivers for included hardware in order to make full use of the capabilities of your computer

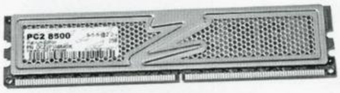
Step 9: Enjoy your home-built PC

Author Bio: Erik Sua is a graduate student in the industrial and systems engineering department. This is his 5th year with the magazine

Components:

CPU (In motherboard) – The Central Processing Unit (CPU) is the brains of the computer. Any modern CPU is capable of doing basic computing tasks like browsing the web or word processing, though you will need more power for running simulations, graphics intensive software, or games. The processor selected here is the AMD Athlon 7750 Retail. This bundle includes a processor that should be sufficient for nearly anything for one's collegiate career, as well as a heatsink and fan to keep the cpu running cool.

Motherboard – The motherboard serves as an interface between each of the parts of the computer. Motherboards often include sound and Ethernet on the board itself. Some even include video. The motherboard must be matched to the CPU you choose to use, in this case the Gigabyte AM2+ AMD 770 motherboard supports the AMD Athlon processor, and includes Ethernet networking and sound.



RAM – Random Access Memory (RAM), offers a temporary holding place for data while it is in use. This type of memory is emptied out every time the computer is turned off. Having more memory keeps your computer running more smoothly. We recommend 4 GB of G.Skill DDR2 800 memory.

Graphics – Having a separate graphics card greatly improves the performance of graphics intensive applications such as 3d modeling, photo manipulation, and gaming. Brand typically doesn't matter as much as the individual type of graphics card, in this case we recommend the Nvidia Geforce 9600 GT. This Video card is capable of most graphically intensive programs currently available.

Hard Drive – Hard drives store data on a permanent basis. That includes your music, documents, videos, and programs. We recommend at least 300 GB of storage. Due to cost constraints, our example build recommends the Samsung Spinpoint T in a 500 GB capacity. This drive uses the SATA interface, so if you get a different motherboard than we recommend, make sure your motherboard supports SATA.

Power – The power supply provides power to all the components of your computer. If you get a poor quality power supply, you run the risk of power spikes damaging or destroying components of your computer. You must also make certain your power supply provides sufficient power for all the components. Our example build recommends the Antec Earthwatts 430W, which is a high quality power supply.

Optical – The optical drive allows you to use CDs, DVDs, and potentially other types of external media. For our budget build, we recommend a basic DVD burner from LITE-ON.

Case – Computer cases come in all shapes and sizes and is highly personal choice for the computer builder. The main requirement is purchasing a case that will fit both your motherboard and your graphics card(s). Poor quality cases can make the build more difficult, so our example uses the Antec Three Hundred Mid-Tower case.

Not pictured

Monitor – The monitor is another highly personal choice. Any monitor will work fine, but to save desk space we recommend a 19-inch LCD monitor.

Input – Any USB keyboard and mouse combination should work sufficiently. We recommend something from Microsoft or Logitech.

Speakers – The sky is the limit with purchasing speakers. Our example system can support anything from 2 speakers to 7.1 surround.

Operating system – Vista Home Premium or XP pro, your choice.

Other – You may want to consider a separate sound card or a wireless networking card if you want to expand the capabilities of your computer

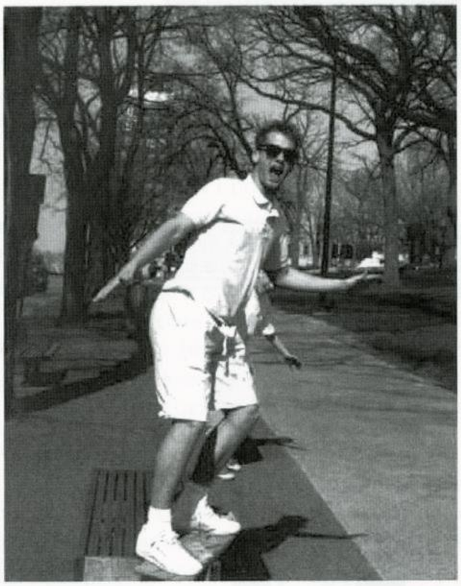
COMMENTARY

Just one more

The finest in eclectic humor

By Harley Hutchins

Joe Engineer



Basic Information

Networks: Wisconsin
Sex: Not recently
Birthday: June, 1896
Hometown: Silicon Valley, CA
Relationship Status: In a Relationship with Homework
Religious Views: Wikipedia

Personal Information

Activities: Wisconsin Engineer magazine, Nerd Pride Society
Interests: Lan parties, working on cars, Legos, RC airplanes, videogames, slide rules, noise canceling headphones, MP3 players that are not iPods, interrupting movies to explain that something is physically impossible
Favorite Books: Popular Mechanics, Popular Science, Gossip Girl
Favorite TV Shows: How It's Made, Modern Marvels, Gossip Girl
Favorite Quotations: "The worst thing about some men is that when they are not drunk they are sober" William Butler Yeats

Education and Work

College: Wisconsin
Engineering, Ballroom Dance
High School: Rydell High Schoool
Employer: Some Engineering Firm
Position: Engineering Intern
Time Period: Summer
Location: Nowhere, USA
Description: Did menial entry-level engineering work. Had to live alone in a studio apartment, living on ramen noodles and RC cola.

Groups

Member of: My GPA is lower than yours because I am an engineer. I am too good at Matlab. Society for the coexistence of the metric and english untis of measure. The Red Gym is actually Bowser's Castle. Humanities Building: WTF. Just because I'm an engineer, doesn't mean I can fix your refridg erator. When I was your age, Pluto was a planet. Energy drinks keep me alive during finals. Pumpkin Chunkin should be an olympic sport. I <3 Gossip Girl.

Information

Networks:
Wisconsin

Relationship Status:
In a Relationship with Homework

Birthday:
June, 1896

Buddies


Alfred Nobel


Melanie Neuhaus


Henry Ford


Pat Maloney


Leonhard Euler


Downtown Abby Brown

CROSS CAMPUS
PHOTO CONTEST

Amateur and practiced photographers are invited to join the 3rd annual *Wisconsin Engineer* Photo Contest!

Winners will receive prizes and be published in the September 2009 issue. Questions should be sent to wemphotocontest@gmail.com

See our website for more information

wisconsinengineer.com

Photo submission ends March 25th.
Voting will occur at Engineering Expo in April!

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