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wisconsin engineer
September 2004
Volume 108, Number 4

Icy Answers to Heavenly Questions

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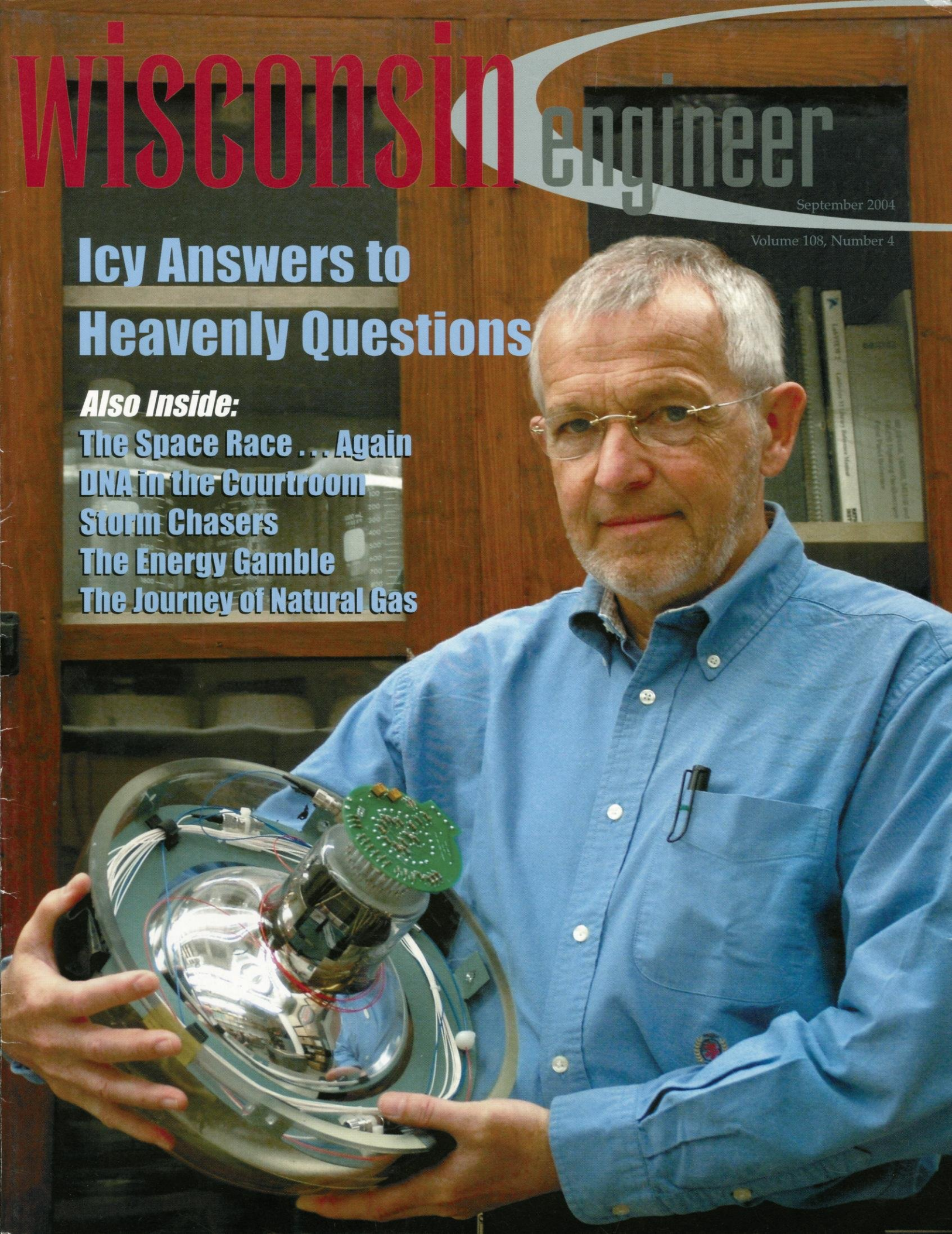

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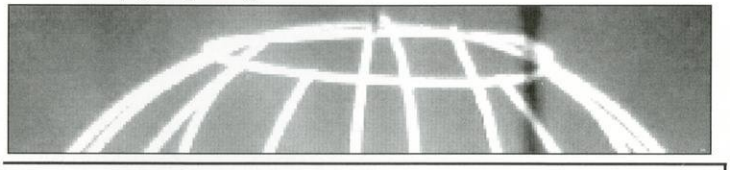

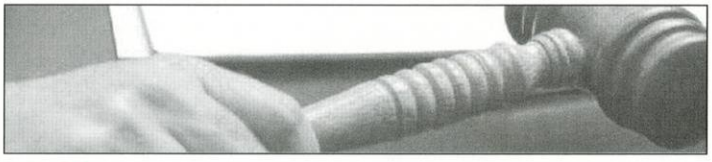

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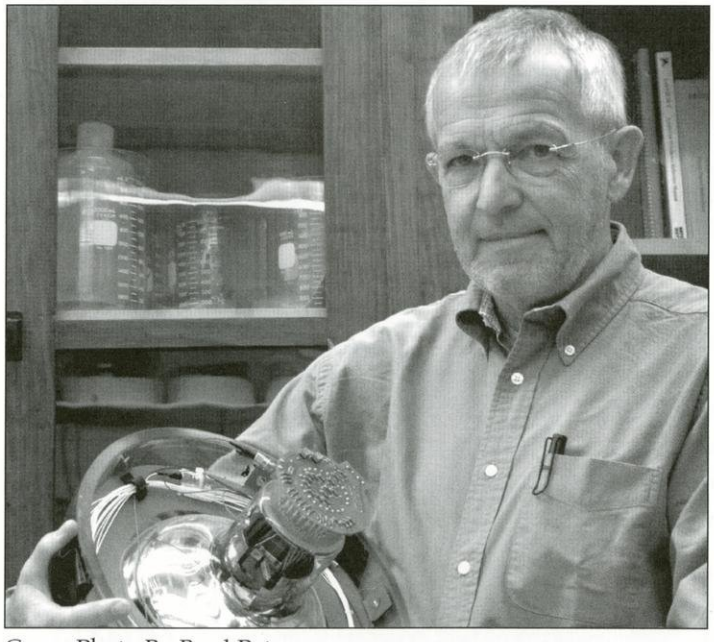

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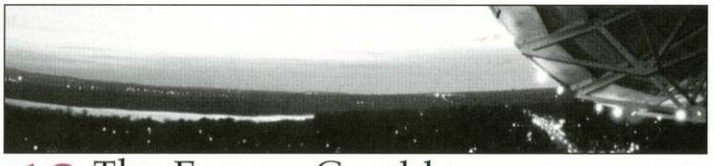

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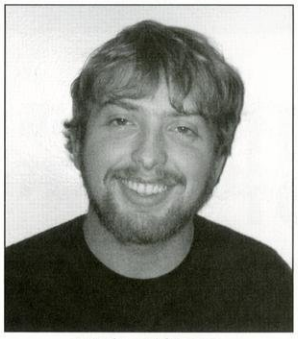

Kyle Oliver,
Writing Editor

Resonant Frequencies

In February, Scientific American reported what fantasy author J.R.R. Tolkien had written half a century before. The creation of the universe, it seems, might be better summarized by "Give us some music" than "Let there be light."

It's high time Tolkien agreed with a scientist.

The article, entitled "The Cosmic Symphony," described how cosmologists have come to reason that the big bang "triggered sound waves that alternately compressed and rarefied regions of the primordial plasma." Scientists have a record of this compression wave phenomenon in the form of the cosmic microwave background, a nearly uniform spread of radiation that has guided cosmologists in their quest to explain some of the mysteries of creation.

But researchers and article authors Wayne Hu and Martin White are not the only ones who believe in a cosmic symphony. In his Middle-Earth creation tale "The Silmarillion," Tolkien tells of how the world was created through music played by Iluvatar--Tolkien's God figure--and his angels:

"And he showed to them a vision, giving to them sight where before was only hearing; and they saw a new World made visible before them…And when the Ainur had gazed for a while and were silent, Iluvatar said again: 'Behold your Music! This is your minstrelsy.'"

Now, I understand Hu and Martin are not claiming the big bang was caused by a cosmic orchestra who ran through some scales then performed Bach's "Brandenburg Concertos" or Stravinsky's "Firebird Suite" until the universe cooled down enough to get on with forming stable matter. Nor do I think that Tolkien's myth was intended as a scientific explanation of creation.

However, this happy convergence has been important for me personally. What gratifies me is that, for once, I do not feel under assault by one of my favorite authors. For Tolkien, men and women of science represent much of what is wrong with humanity. We are symbolized by a fallen wizard who abandons wisdom and embraces a "mind of metal and wheels." Saruman and scientists everywhere, then, are united by their disregard for life and lust for control of all things.

When America dropped the atomic bomb on Hiroshima, Tolkien famously lamented "the utter folly of these lunatic physicists content to do such work for the purposes of war." I do happen to agree that the use of this weapon was far from justified. However, I also believe science is a far more humanistic endeavor than Tolkien--and many in society today--give it credit for.

Like members of any profession, we scientists and engineers have committed our share of atrocities. But most of us do not "work for the purposes of war," and anyone who has benefited from laser surgery, radiation treatment or an MRI can attest to the fact that atomic and nuclear physicists are, to this day, atoning for their profession's sins.

Science embodies the curious, adventurous, creative spirit Tolkien so admired and with which he endowed his beloved hobbits. If our generation of scientists and engineers is mindful of the ethical responsibilities that also accompany our humanistic field, perhaps Tolkien would be proud to agree with a bunch of "lunatic physicists."

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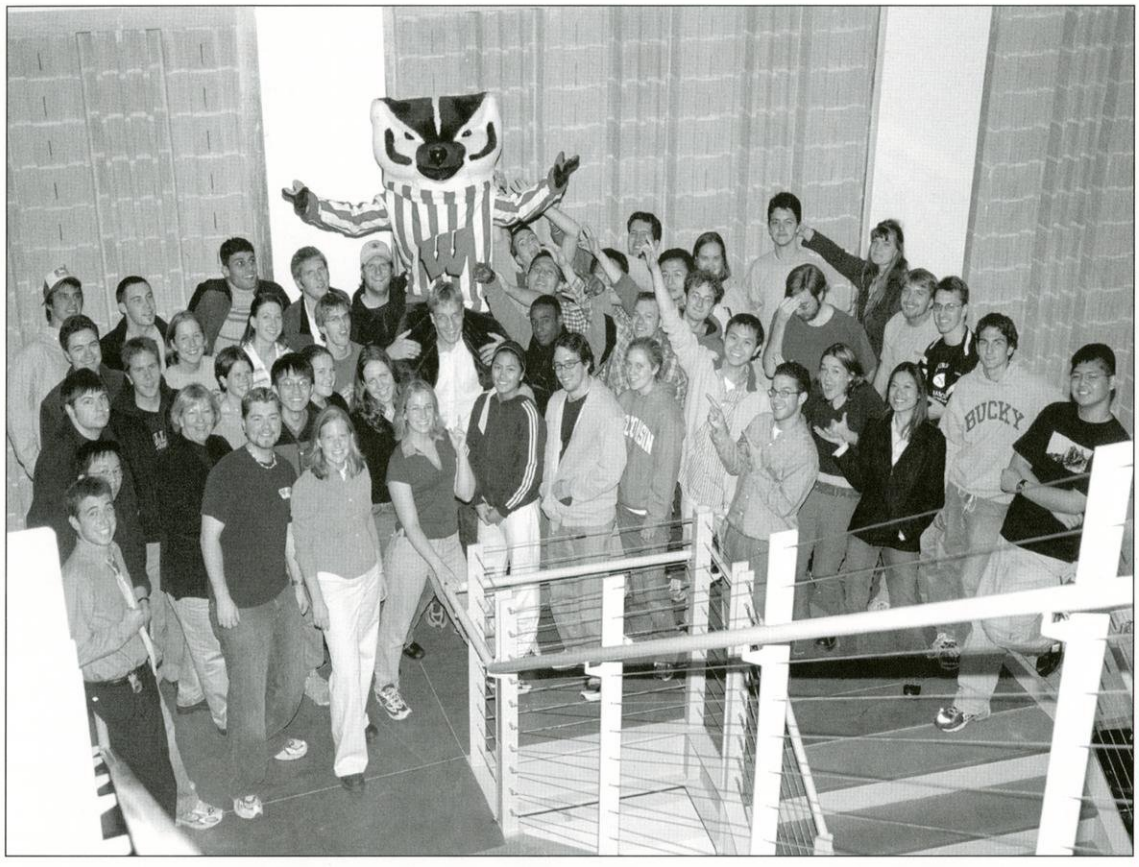

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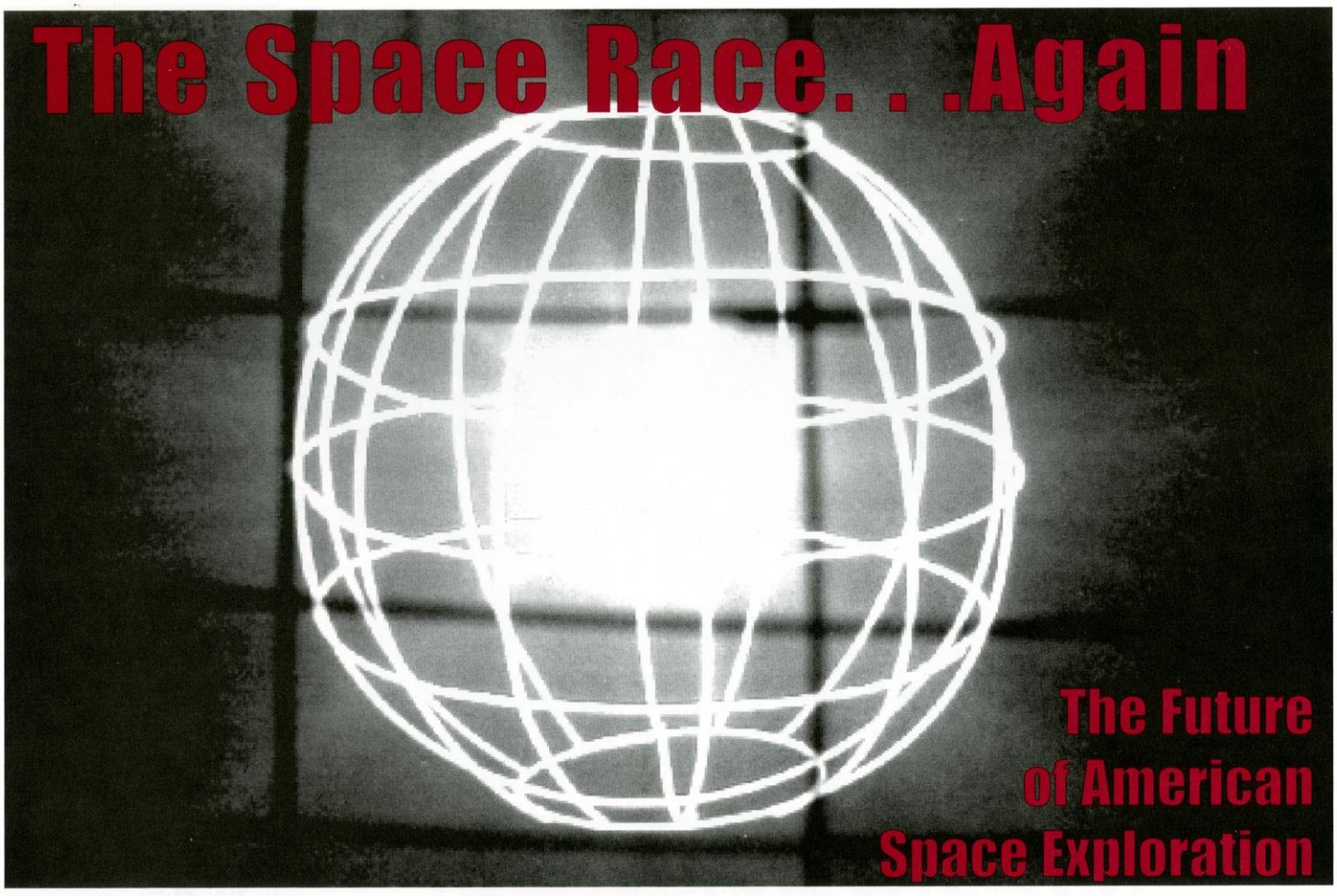


The Future of American Space Exploration

By Jenny Tang

Can you imagine the elimination of all coal and fission plants? Can you envision an energy source that did not create any radioactive waste? Better yet, could you fathom staying at the Hilton on the moon or living there and coming back to Earth to visit your parents? Some of these things could be possible under President George Bush's proposed plan for exploration of the moon and later Mars.

The Program

On Jan. 14 Bush unveiled his ambitious plan to return Americans to the moon by 2020 and go on future manned trips to Mars and beyond.

"We do not know where this journey will end, yet we know this -- human beings are headed into the cosmos," Bush said in an interview with CNN. "Mankind is drawn to the heavens for the same reason we were once drawn into unknown lands and across the open sea. We choose to explore space because doing so improves our lives and lifts our national spirit."

Bush proposed spending $12 billion over the next five years in an effort to send new manned space vehicles that will fly with a crew in 10 years and return humans to the moon within 16 years.

The initial funding will be used to develop and test the new manned space vehicle by 2008, conduct the first manned mission by 2014 and establish a lunar base and launch pad. Future funding will be determined by the progress and what is discovered in the explorations.

The Controversy

Bush's proposition has prompted skepticism and controversy from congress, academics and the public.

Some members of Congress are concerned that Bush's ambitious goals will exceed the proposed budget. Others are concerned with Bush's motives, since his proposed plan for space exploration occurs during a presidential election year.

Critics argue that missions using robots would be cheaper. Furthermore, insufficient funding for manned missions could result in a disaster like the explosions of the Columbia and Challenger.

An Associated Press poll found that more than half of the respondents would rather invest money in domestic programs rather

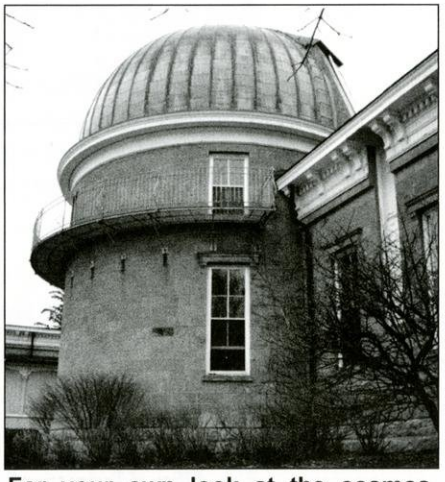


Photo By Jamie Tabaka

For your own look at the cosmos, check out the Washburn Observatory. Public viewings are held the first and third Wednesdays of each month. For more info, call 262-WASH.

than space research. Members of the public are anxious about the war on terrorism, the war in Iraq and the faltering economy.

The Justification

The benefits of space exploration and research are mostly long-term, making it hard for the average American to support. The money spent for solar space research won't benefit the common American for probably 10 to 15 years. However, government money spent on space exploration will negatively impact tax payers immediately after the plan is put into action.

"In general, the major benefits to humankind and solar system research are to better understand the working of our planet by studying the solar system as a whole," Christopher Anderson, UW-Madison astronomy professor, says. For instance, the Apollo mission taught researchers more about the origin of the earth and its orbits.

UW-Madison nuclear engineering professor Gerald Kulcinski believes manned space exploration and research is important for the nation. Although many argue that missions should be done with robots because they are less expensive, Kulcinski believes robots do not have the same reliability as several pairs of eyes or brains.

Similarly, Bush said, "We need to see and examine and touch for ourselves, and only human beings are capable of adapting to the inevitable uncertainties posed by space travel."

Professor Kulcinski also believes the challenge of a new space mission will bring people together because they have an exterior challenge that can pull the whole country together.

"We'll always have pot holes in the streets and social problems. [The Apollo mission] lifted the vision people had above their regular problems," Kulcinski says. "Youth today has not yet experienced the excitement. As Kennedy said, 'we did it not because it was easy, but because it was hard.'"

More than lifting the spirits of Americans, Bush's mission to the moon and Mars will create new jobs. For example, the invention of Velcro and Teflon during the Apollo program created many jobs in manufacturing. Kulcinski believes there will be an increase in the need for engineers and scientists, bolstering America's higher education system.

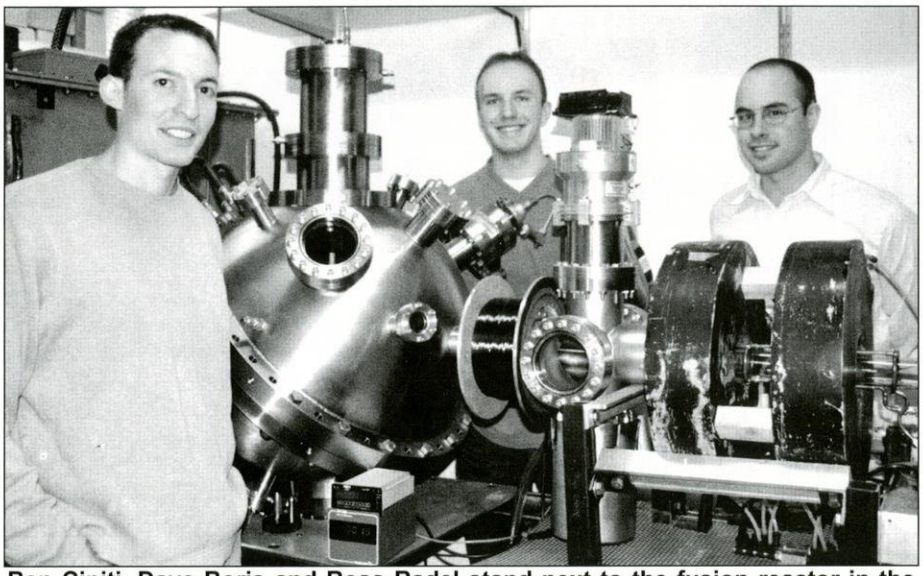


Photo By Jamie Tabaka

Ben Cipiti, Dave Boris and Ross Radel stand next to the fusion reactor in the Engineering Research Building. The reactor is used to experiment with 3DHe fusion.

A major benefit of space exploration and research is the mining and consolidation of advanced fuels such as Helium Three (He_3) from the moon, which is one of Kulcinski's research interests. The fuel has been deposited on the lunar surface by solar winds over the last 4.5 billion years. It is important because it may someday be used on earth to generate electricity without the radioactive waste of current fission power plants. Researchers at UW-Madison are studying this process, called nuclear fusion, but it is still in early stages of development.

One space shuttle full of He_3 could generate electricity in the U.S. for an entire year. Hence, it is extremely valuable; for comparison, oil costs $28 per barrel, whereas He_3 is worth $2 million per pound. Researchers currently have enough He3 to research fusion technology and eventually build the first 500 MW power plant. However, a larger supply would decrease the cost of their research.

Only time will tell if Americans will decide that the benefits of space exploration outweigh the costs. Bush surely hopes they will look past the immediate expense and consider the importance of exploration for humanity.

"We need to see and examine and touch for ourselves, and only human beings are capable of adapting to the inevitable uncertainties posed by space travel," he said.

Author Bio: Jenny Tang is a junior studying industrial engineering. we

DNA Evidence
Controversy in the Modern Courtroom

By Sonny Suciawan

In 1986, police found 15 year old Dawn Ashworth raped and murdered in Narborough, Leicestershire, England. Just three years before, a girl of the same age, Lynda Mann, was found in the same condition in the same area. The police arrested the prime suspect - a local resident named Richard Buckland. After some questioning, Buckland confessed to the murder of Ashworth but denied any involvement in Mann's death.

The police were convinced that the two murders were done by the same person- Richard Buckland. They submitted Buckland's DNA (deoxyribonucleic acid) to Dr. Alec Jeffreys. Dr. Jeffreys examined semen samples on the two victims and discovered that the murders were in fact committed by the same person. However, that person was not Buckland. Charges against Buckland were dropped immediately and he was released from police custody.

Then a massive manhunt ensued. The residents of Narborough and two surrounding villages were required to submit their DNA to the authorities. This proved unsuccessful, as there were no matches, leaving the case unsolved. The twist came a year later. A woman reported that she overheard her colleague claim he substituted his own DNA sample in the Narborough test for that of his friend, Colin Pitchfork. Police obtained Pitchfork's DNA sample and found it matched the ones found on the two victims. After further investigation, Pitchfork, a baker, was arrested and charged with their rape and murder. He was sentenced to life in prison in 1988.

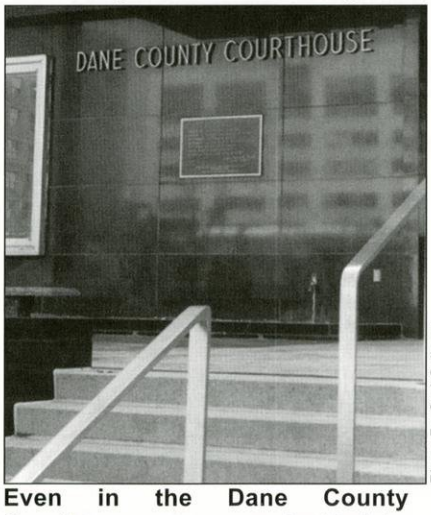


Photo By Carl Calhoun

Even in the Dane County Courthouse cases are decided by DNA evidence.

This was the first recorded case to ever use DNA evidence as a means to exonerate or convict someone of a crime. From then on, use of DNA evidence became predominant in the courtroom. As DNA testing a scientific procedure based upon logic, it is easy to view it as infallible. However, there are other factors that may affect the truthfulness of the result.

Prior to the above case, DNA evidence was primarily used as a tool for paternity testing. This was the first recorded use of DNA as evidence in the criminal justice system. Though many had questioned the possibility of using it in the legal system, no one had ever attempted it until Dr. Jeffreys. The effect was immediate. By the middle of 1989, there were already close to a hundred cases relying on DNA as evidence.

DNA evidence is usually in the form of bodily secretions such as semen, urine, saliva as well as samples extracted from the body such as hair, skin or blood. It is important to note, however, that in order for DNA samples to be used as evidence they must be relevant. UW-Madison law professor John Pray gives the following example: suppose in the scene of a crime a fresh cigarette butt is found with saliva sample. Are the authorities to assume that the saliva sample is the one that belongs to the criminal? This is where critical thinking comes into play. Unless someone witnessed the perpetrator drop that cigarette butt, it is difficult to establish the relevance of the DNA sample to the case.

In the late 1980's DNA evidence was deemed admissible in court. However, despite the public acceptance of the new method, it did not escape scrutiny. The case of New York vs. Jose Castro is an example of such criticisms coming to the surface.
In February, 1987, the bodies of Vilma Ponce and her daughter Natasha were found in a pool of blood. After questioning several witnesses, the police had a suspect -- Jose Castro. The janitor of a nearby building fit the description of a person spotted near the scene of the crime at the time of the murder. While questioning him, the detective noticed a bloodstain on Castro's clothing. Confiscating it as evidence, he ordered the forensic lab to checkup on the bloodstain. After examination, the bloodstain matched that of Vilma Ponce.

During the trial however, the defense questioned the credibility of the tests. They claimed that the tests were not conducted appropriately, and therefore, the results were tainted. They argued that if the tests were not conducted as regulated, then the DNA evidence could not hold up in court. With this, the defense succeeded in excluding the DNA evidence from the trial. The Castro case serves to illustrate that DNA evidence is fallible. Although Castro later confessed to the murder, the case shed a negative light on the credibility of DNA testing.

The OJ Simpson trial of 1996 is another case with controversial use of DNA evidence. Simpson's ex-wife Nicole Brown and her lover Ron Goldman were found dead in front of Brown's residence. During the forensic analysis, police found traces of blood did not belong to Brown or Goldman. Simpson, the prime suspect, was a match for these DNA examples. Police also found a glove on the scene of the crime stained with the victims' blood, and its counterpart in Simpson's possession. With this, police arrested Simpson and charged him with murder.

During the trial, the defense raised questions on the credibility of the DNA testing. Criminologist Henry Lee testified that the blood brought in for examination was unusually packaged, leading the defense to propose the evidence was tampered with. Lee also suggested that the DNA samples were mishandled as they were transported in a truck without consideration to the degradation of the contents. If Lee's testimony was true, the test results would have

been greatly affected. The jury found the DNA evidence, which was the strongest basis for the murder charge, to be inconclusive. Simpson was later ruled innocent and acquitted of all criminal charges.

Since DNA testing is a scientific method, there are many steps involved in the testing process. From gathering the sample to analyzing it in the lab, each of these steps must be closely adhered to avoid the risk of contamination. "In trials, to argue against DNA evidence, the defense would usually attempt to attack the procedures of the way the DNA testing were carried out," says Professor John Pray.

After serving 11 long years for a crime he did not commit, Ochoa was a free man

Attorneys can dispute DNA evidence from a variety of different angles ranging from the accuracy and cleanliness of a testing facility, to the credibility of the person performing the tests. In some cases the defense may even try to establish that the DNA evidence was planted by corrupt police officers.

The Wisconsin Innocence Project at the UW-Madison Law School works with wrongfully convicted inmates to overturn their sentences. The Innocence project often relies on DNA testing to help exonerate their clients. According to Pray, who serves as a co-director of the project, one of it's biggest success stories is that of Christopher Ochoa.

Christopher Ochoa spent eleven years of his life serving a life sentence in the state of Texas. In 1988, he pleaded guilty for the rape and murder of a Texan woman. It was later revealed that authorities coerced Ochoa to confess by telling him there was sufficient evidence to indict him. If convicted of the crime in Texas, Ochoa's confession would automatically give him a life sentence, sparing him from the death penalty.

The Wisconsin Innocence Project looked into Ochoa's case and examined a piece of DNA evidence that had not been released in 1988. After retesting the semen sample found at the crime scene, they proved it did not match Ochoa. In 2001, the case was retried with the new DNA evidence. This time Ochoa was proven innocent. On January 15th 2001, after serving 11 long years for a crime he did not commit, Ochoa was a free man.

It's such powerful evidence now, that if your client's DNA sample is there, you'd better plead guilty

The test that convicted Ochoa in 1988 included him as a possible match to the DNA. However, with the current methodology of polymerase chain reaction based short tandem repeats (PCR-based STR), the new tests used at the urging of the Wisconsin Innocence Project, excluded Ochoa as a possible as match for the semen sample.

The basic idea of PCR-based STR is that the cells available are replicated. This method allows copying of DNA to produce a larger sample size. With this procedure, given the proper atmospheric conditions, it is possible to copy a billion cells within 3 hours. The larger sample size minimizes the possibility of error. The method employed in the initial trial placed 23% of the population, including Ochoa, as possible matches to the semen sample. With PCR-based STR, the population percentage was drastically reduced ultimately excluding Ochoa.

Ideally DNA evidence would be infallible, but one must realize that anything from technological factors to human behavior can alter DNA test results. Despite it's shortcomings, if handled correctly DNA evidence is a determining factor in the outcome of trials. "It's such powerful evidence now, that if your client's (relevant) DNA sample is there (at the scene of the crime), you basically just tell him, "You'd better plead guilty," says Pray. we

Author Bio: Sonny Suciawan is a senior in industrial engineering. He fights an uphill battle daily against the temptation of not attending class and keeping awake when he does. You can spot him nodding off at an IE class near you.

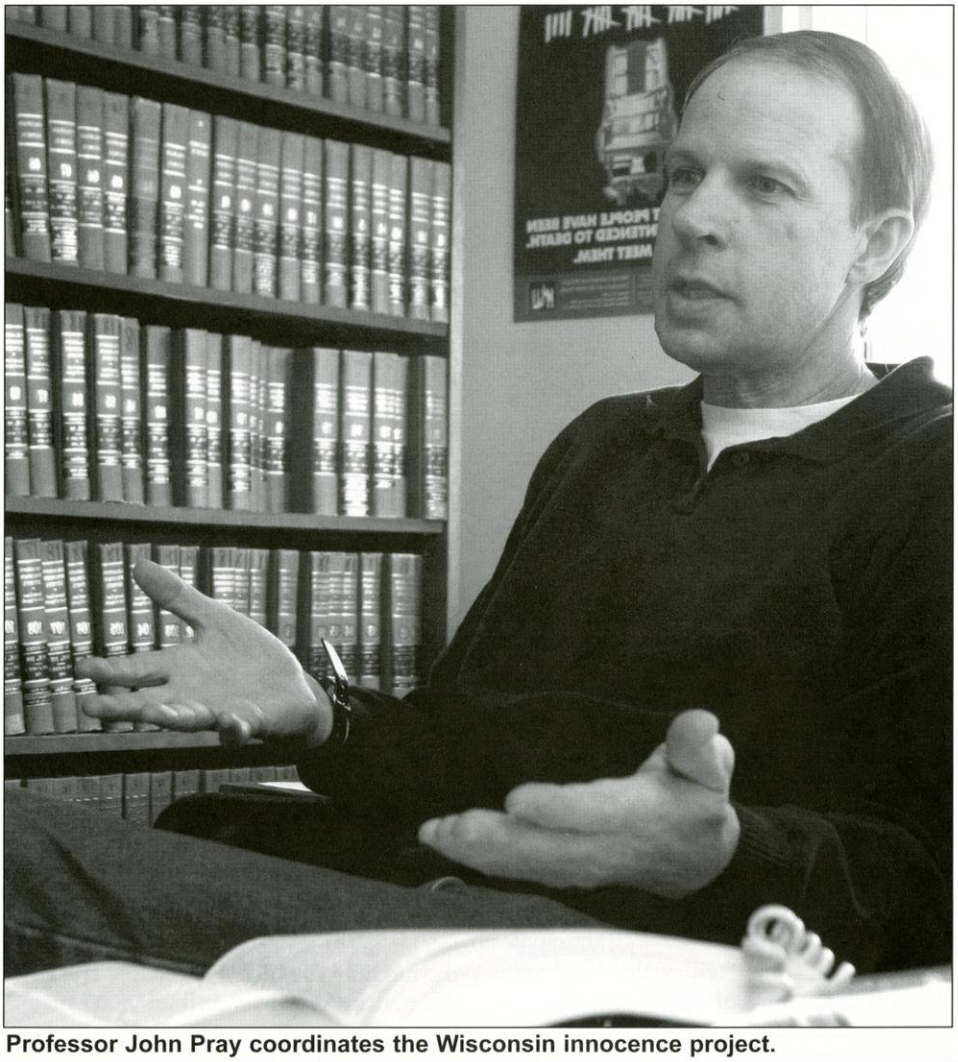


Photo By Carl Calhoun

Professor John Pray coordinates the Wisconsin innocence project.

Icy Answers to Heavenly Questions

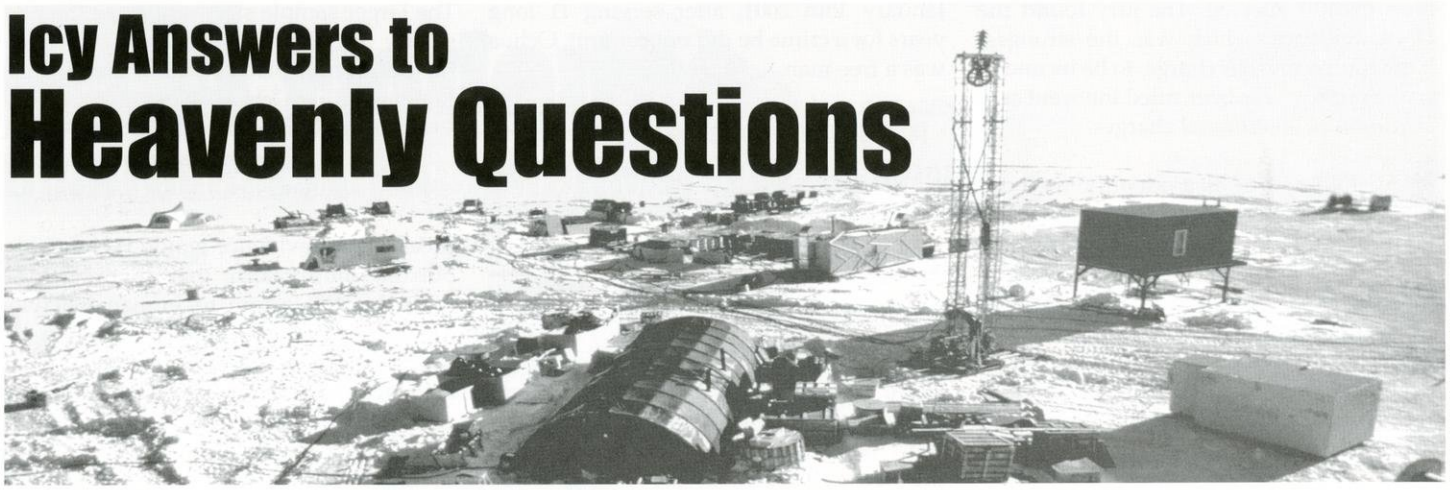


Photo Courtesy of NSF

By Martin Grasse

From the time of Galileo, humans have used telescopes to look up and observe the cosmos. But now scientists are looking down for answers. The Antarctic Muon and Neutrino Detector Array (AMANDA) is an idea proposed by UW-Madison's own professor Francis Halzen that has blossomed into a huge endeavor involving universities and organizations around the world.

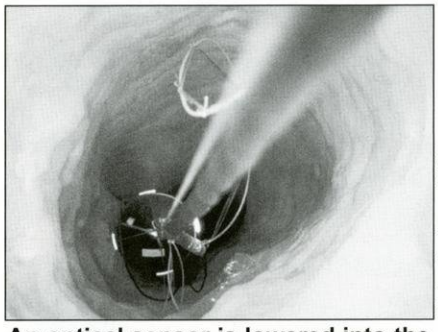


Photo Courtesy of NSF

An optical sensor is lowered into the ice.

Scientists are using AMANDA to study neutrinos, which are tiny particles given off by radioactive events. They do not interact with other particles at all, because they have nearly no mass and no electric charge. Because of this, neutrinos are extremely difficult to detect. In fact, for a long time they only existed in theory. Scientists hope that by using AMANDA, they will be able to confirm some of the most bizarre theories in physics. Studying neutrinos may shed light on everything from black holes and quasars to the origins of the universe. Halzen calls AMANDA "a new way to take a picture of the universe" and anticipates that the "telescope" will yield discoveries beyond the dreams of scientists today.

The basic idea behind AMANDA is this: tiny particles of all sorts are constantly bombarding the Earth. Because of the special properties of neutrinos, they are able to pass through the Earth, leaving all of the other particles behind. Thus, the planet acts as a filter of sorts. Most of the time, neutrinos simply pass through the planet unhindered. On occasion, though, a neutrino will collide with another particle. This collision generates a much larger particle (called a muon), and a tiny flash of light.

This is where AMANDA comes in. AMANDA consists of 667 optical sensors buried deep in the Antarctic ice. These sensors pick up the flash of blue light. This light is then converted into voltage using photomultiplier tubes. Photomultiplier tubes (PMT's) are devices that look like large light bulbs but function in the exact opposite way. Rather than the bulb using voltage to give off light, a PMT takes in light and creates voltage. The tube then multiplies this voltage several million times.

But why Antarctica? In order to detect the neutrino collisions, one needs approximately 1 teraliter (that's 1,000,000,000,000 liters) of transparent material. Before AMANDA, the only thing that anyone thought to use was water. There was even a project that UW-Madison was affiliated with called the Deep Underwater Muon and Neutrino Detector (DUMAND).

The goal of DUMAND was to build a device similar to AMANDA in the deep-ocean water off the coast of Hawaii. There were many problems with this, including waves, storms and other natural phenomena. It was at this time that Halzen became interested in the possibility of using ice as the medium for such a telescope. The ice at the South Pole is more than 2,000 meters thick and is exceptionally clear -- an ideal environment for observing neutrino collisions.

A telescope buried deep in the Antarctic ice detects neutrino collisions and uncovers clues about the universe

The current system in Antarctica is actually the second phase of AMANDA, termed AMANDA-II. The first phase employed the use of 302 sensors, and the second has more than doubled that number. Now, the team is working on a huge next step, called IceCube. As its name implies, IceCube will cover a cubic kilometer of Antarctic ice, and will boast nearly 5,000 optical sensors.

Photo courtesy of NSF

Professor Francis Halzen displays an optical sensor.

Photo Courtesy of NSF

Drilling occurs in December and January at the AMANDA project in Antarctica.

According to Halzen, AMANDA currently detects only about one out of every million neutrinos that pass it, which translates into about four or five neutrino "events" each day. IceCube, once finished, will be able to detect several hundred events every day.

"IceCube will study what AMANDA discovers in 'high resolution,'" Halzen says.

In order to get the sensors down deep enough into the ice to detect neutrino collisions accurately, Halzen and his team use a unique drilling process. Basically, the "drill" consists of a hot-water jet that shoots water straight down, melting the ice. Rather than removing the melted ice from the hole, as a conventional drill would do, the apparatus simply keeps the hot water circulating in the hole as it bores deeper. Once the drilling is done, the team has plenty of time to lower the strings of sensors and photomultiplier tubes into the hole before the ice refreezes.

The team is on a tight timeline to complete IceCube. Only the Antarctic summer (winter in the Northern Hemisphere) is warm enough to get any work done due to winter wind chills that regularly reach 100 degrees below zero. Furthermore, only the months of December and January are warm enough to allow the drilling process to occur. During other months, the ice will refreeze too quickly for workers to lower the sensors into the holes. The team plans to begin work on expanding AMANDA into IceCube in January of 2005 and forecasts the project to be finished in 2009.

Even when it is too cold to work in Antarctica, the team is still busy interpreting the data that AMANDA has collected over the last few years. The data is analyzed one year at a time. Right now the team is about to begin looking at the second year of data. Most of the neutrino events that show up are a product of cosmic rays hitting the atmosphere. In order to see past the atmosphere, the team has to look for large clusters of events. Hopefully, after examining the second year's data, the scientists will know whether the clusters previously observed are truly objects in space or just statistical anomalies. Halzen doesn't know what AMANDA and IceCube might exactly discover.

"Throughout history, whenever someone opens a new window on the universe, the most interesting thing they find is something that they never predicted," he says.

we

Author Bio: Martin Grasse is a sophomore studying biomedical engineering and technical communication.

For more information, visit the AMANDA project at:

http://amanda.uci.edu/

Storm Chasers & Meteorologists:

Staying One Step Ahead of the Weather

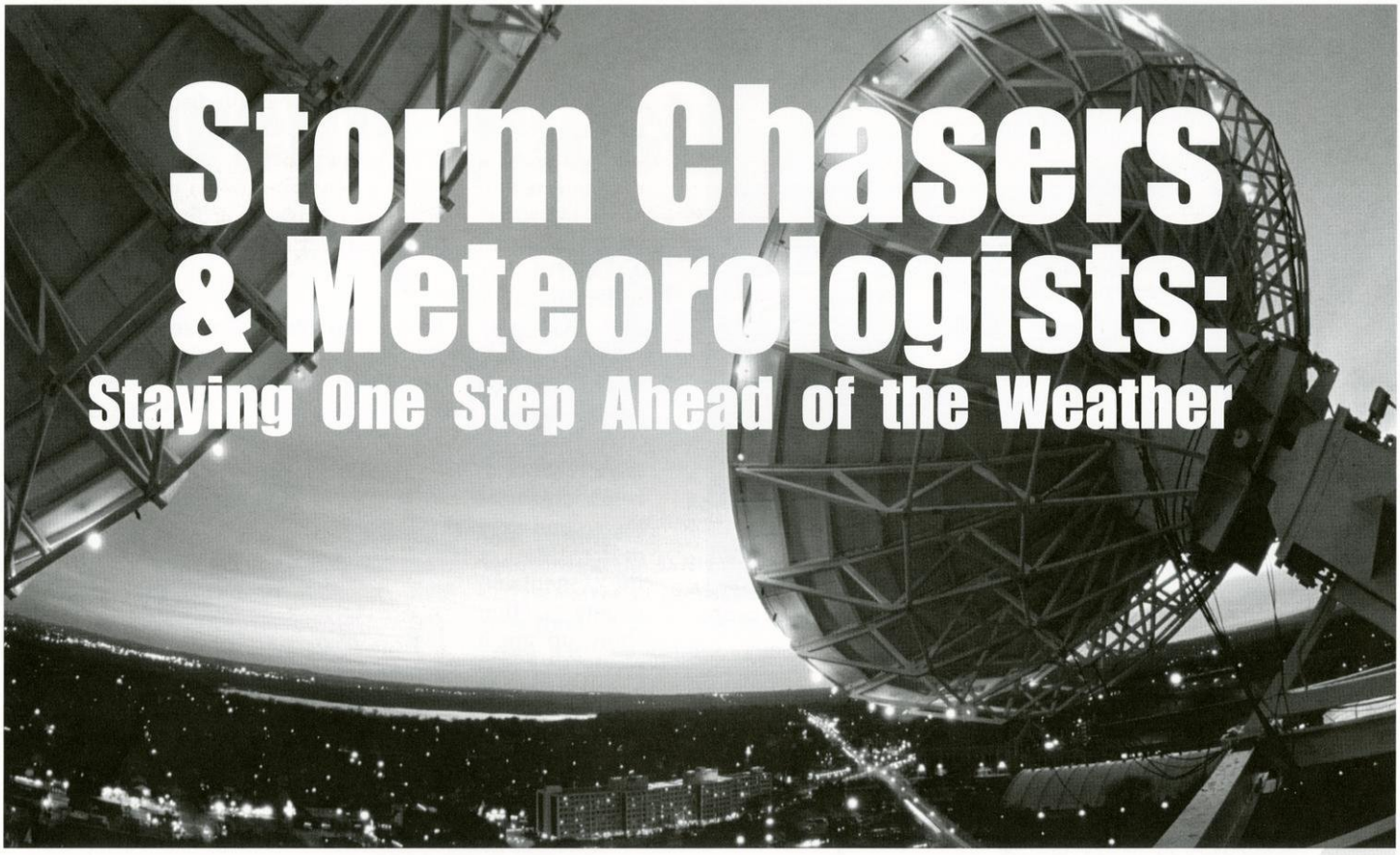


Photo By Jeff Miller

By Emily Niebuhr

Lazy sun rays stretch across the sky's blue haze and tree branches swing gently in the sultry breeze with hardly a hint of what is to come. As the day wears on, white wisps of clouds crawl across the sky and seep into a deeper gray. By three o'clock the air is still as the sky melts into a dark emerald. Before the sirens warn of a coming tornado, meteorologists are on the case.

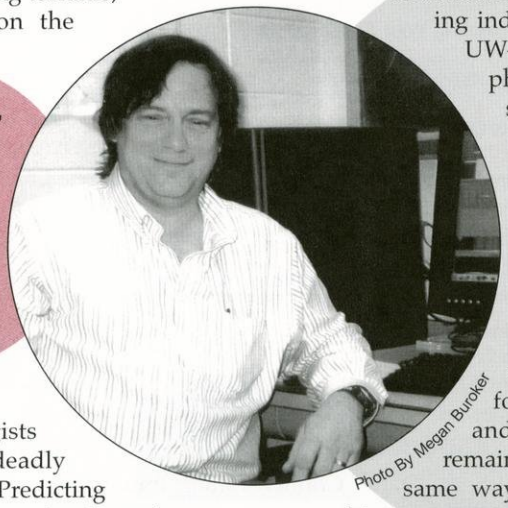


Photo By Megan Burcker

Gregory Tripoli, a professor of atmospheric and oceanic sciences, uses the computer for weather simulations.

How do meteorologists know when these deadly monsters will erupt? Predicting severe weather is no simple task. Although forecasting involves such fundamental concepts as conservation of mass and conservation of heat, the equations are quite complex. Even simple forecasts require the integration of complicated formulas that reflect temperature, humidity and even wind. Advances in computer technology enable meteorologists to use these equations to make increasingly prompt and accurate forecasts.

Meteorology's dependence on computers has served as a catalyst for the advancement of the computing industry, according to UW-Madison atmospheric and oceanic sciences professor Gregory Tripoli.

"The first computers back in the forties were developed for two reasons: one, for nuclear research and two for meteorologists--and to this date it remains pretty much the same way. The science has driven computer development for the past fifty years, and computer development in return has driven the science," he says.

As an atmospheric model researcher and storm chaser, Tripoli depends on the accuracy of computer generated forecasts when deciding where the greatest chance of severe weather exists. For several summers he has given meteorology students the opportunity of a lifetime. Driving all the way to Oklahoma, Tripoli and his students watch these storms from a distance-sometimes too close for comfort--in hopes of catching a glimpse of a full-fledged tornado. To plan for these trips, Tripoli heads straight for the computer to compare the University of Wisconsin and National Weather Service models with predictions from the Severe Storms Prediction Center. The accuracy of current models impress Tripoli.

"We've had situations where we've driven to a location where the computer says there is going to be a storm, and we just had to stand there and wait. However, in many of the cases it's less distinct where things are going to be and then you have to use your sense," he says.

Once on the road, Tripoli and his students must be resourceful to stay on top of the weather without direct access to high-powered computers and radars. Armed with only a van, Tripoli and his students must

rely on one person back in Madison to monitor the weather equipment and warn the crew of any new developments. The most helpful innovation in this form of storm chasing has been the cell phone. Now, instead of having to stop every few minutes to make a payphone call from a fast food chain or a local restaurant, chasers use cell phones to continuously keep in touch with their base.

Although once only pursued by scientists, storm chasing continues to grow as a pastime as technology becomes more available to the public. Some storm enthusiasts travel across the country in pursuit of the "perfect storm."

Storm chasing can foster a circus-like atmosphere as crowds wait for the storms to appear and clutch their cameras for the perfect shot. Chasing, however, should not be treated like other sports. Due to the inherent risks, experts recommend that anyone interested in chasing severe weather go with a well-trained, experienced spotter. Not only are the movements of storms difficult to predict, but hidden hazards also threaten novice chasers.

As chief meteorologist for WISC-TV, Gary Cannalte predicts weather conditions for areas in southern Wisconsin.

Photo By Megan Buroker

Tripoli has observed that car accidents pose as great a threat as the severe weather because of the large number of cars in a small area.

While technology continues to improve the process of forecasting severe weather, one of the most important tools for warning the public about inclement weather is the human eye. Radar capabilities are limited to shorter distances because their beams travel in a straight line while the earth continues to curve underneath.

"For roughly every ten miles away, the radar beam raises 1000 ft off the ground. So if you are looking at a severe storm that is fifty miles away from radar you are looking at what's going on in the storm at the level of 5000 feet off of the ground," Gary Cannalte, chief meteorologist of WISC-TV, says.

Meteorologists can alert the public about severe weather on the radio using this equipment.

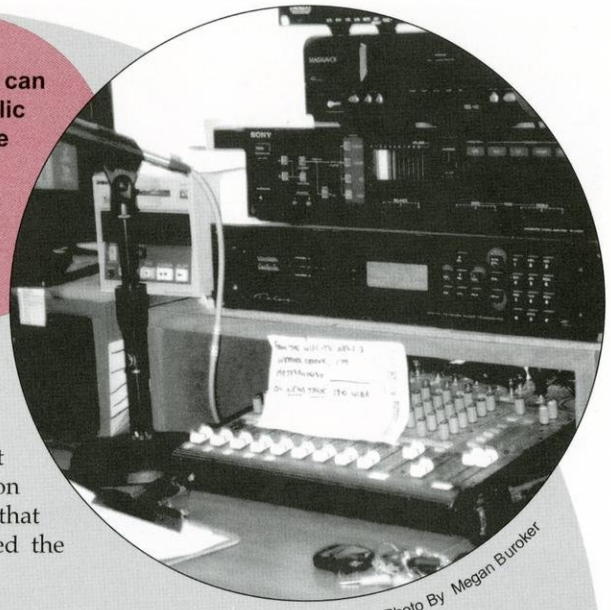


Photo By Megan Buroker

Due to this problem, broadcast meteorologists often depend on spotters in the area to confirm that tornados have officially touched the ground.

Improvements in technology have also enabled broadcast meteorologists to reach more people and relay timely information on inclement weather. One of the simplest ways to warn the public is to scroll text, known as a 'crawl,' along the bottom of the television screen or to show maps of the affected area. Meteorologists only break into programming if there is a tornado or a particularly nasty thunderstorm headed toward a densely populated area.

"If it's the last ten minutes of Survivor, for instance, and it's something that can wait, like an update of a situation, we don't need to break into programming," Cannalte says. "If there is a tornado warning we are going to break into programming--it's not a question."

Broadcast meteorologists use many of the same tools available to professors and chasers to make the public more aware of hazardous situations. In addition to the accuracy of a forecast, the success of a broadcast meteorologist can be measured in saved lives.

On June 17 1992, a powerful tornado ripped across southern Dane County, severely damaging over 200 homes.

This tornado posed a particular threat because it appeared during the time that the sirens are typically tested. This left many residents unaware of their immediate danger.

Although there were a few close calls, due to the extensive warnings from the media, no one was killed.

Gary Cannalte recalls how one of his viewers was saved by his warnings.

"One guy heard me say that [a tornado was approaching] and ran down his basement steps. By the time he got down to the bottom of the steps the windows were already blown out of his house."

Although the art and science of forecasting continues to improve, there are still obstacles to face. For instance, meteorological technology in the U.S. has suffered due to strict laws that require government agencies such as the National Weather Service to buy only American-made computers. Long at the forefront of atmospheric forecasting, the US is now lagging behind European technology. While American forecasters face budget cuts, European forecasters are provided with computers made by Japanese companies with nearly twenty times the computing power.

However, despite all of their challenges, American meteorologists continue to make progress in researching and predicting of severe weather and are excelling in their most important goal: saving lives. we

Author Bio: Emily Niebuhr is a sophomore studying atmospheric and oceanic sciences as well as English.

The Energy Gamble

Wisconsin Re-examines Nuclear Power

By Nate Altfeather

On Feb. 10, the energy and utilities committee of the Wisconsin State Assembly devised a bill to lift a 20-year ban on nuclear power.

Wisconsin currently has three nuclear generators providing about 20% of the state's energy. With the increase in demand for energy, and the aging of Wisconsin's existing power plants, construction of new facilities is imminent. The question remains whether to invite nuclear power back to the table as a viable energy option.

Instability in fossil fuel supply and prices, along with increasing concerns for the environment, makes nuclear power attractive. But have the concerns that led Wisconsin to ban new construction of power plants been adequately addressed? The nuclear industry says yes, while the public is debating whether to raise the stakes again after it lost the bet the last time.

History

There were two predictions that sparked the nuclear energy rush after World War II. The first was the continuation of rapid growth of energy consumption in the United States. With this, the nuclear industry assured that as demand for nuclear power grew, their refined technology would render nuclear energy "too cheap to meter."

The forecasted increases in energy demand never came true. Instead, the oil embargo of the 1970's along with wildly fluctuating energy prices changed American consumption habits. Furthermore, complicated health and safety regulations, as well as unexpected construction hurdles caused expensive delays in power plant construction.

Amidst the declining demand for energy, it was impossible to recover these unexpected costs. Many utilities were left with deep financial wounds. This negative experience with nuclear power left a bad taste in the mouths of many utilities. As a result, they were reluctant to invest any more money in nuclear power.

Nuclear power plant construction could return to Wisconsin

California and Wisconsin soon passed a moratorium on new nuclear power construction. The states' public service commissions refused to approve new nuclear construction until the federal government established a nuclear waste depository (each utility currently stores its own waste) and until there was evidence that enough had changed to make nuclear power economically attractive.

Michael Corradini, chairman of the nuclear engineering and engineering physics department at UW-Madison, says the problem with the moratorium is "more psychological than anything." According to Corradini, the Wisconsin moratorium inhibits a utility from presenting nuclear power as a "possible planning" strategy for Wisconsin's future. Hence, removing the moratorium would put nuclear power "back on the table for discussion."

"You're still going to have to prove from a safety context, a regulatory context, and an economic liability context that it ought to be on the table," Corradini says.

So what has changed in the last 20 years?

Waste Storage

The federal government chose Yucca Mountain in Nevada as the site for the new federal nuclear waste depository. The Department of Energy (DOE) received permission to begin designing the building and operations.

However, Yucca Mountain is far from a long-term solution for nuclear waste storage. According to Corradini, who is also a member of a federal nuclear advisory board to the DOE, current plans call for the site to accept waste "through about 2015, but if they [government] change the legal limit to match the technical limit, it will be closer to 2050."

Furthermore, there are still considerable barriers to securing Yucca Mountain. Six years ago the government promised there would be a federal nuclear waste storage facility in place, but construction has yet to begin. By the time Yucca Mountain is finished it may be time to build the next storage facility.

Once Yucca Mountain is full, new locations must be created for nuclear waste storage. Alternatives considered in the original search, such as the Wolf River Batholiths in Central Wisconsin, will be at the top of the list.

Economic Viability

As for the state's second criterion for removing the moratorium, it is unclear whether nuclear power is currently any more economically feasible.

"The honest answer is nothing has really changed," Corradini says. "Some utilities did a hell of job. Some did a piss-poor job; most of those are out of the business. If you did it right, [nuclear plants] weren't that expensive."

Still, those backing new nuclear plant construction claim that nuclear power could, in fact, be cheaper now than before.

"The construction engineering business has changed," Corradini says. "Now they are doing a lot more modular parts of the construction. They will do a lot of the work they would have done on site in modules ahead of time and ship it to the site."

This could cut the "first concrete to first fuel load" time by 30-50%. Pre-approved standardized designs would also streamline regulation by allowing regulators to become familiar with reactors rather dealing with a unique design for each utility.

The nuclear industry and the federal government have made considerable investments to streamline nuclear licensing. In 1992, Congress granted the Nuclear Regulatory Committee (NRC) the authority to provide "all in one" licenses that include both construction and operation. This was an attempt to alleviate the expensive delays faced upon completing construction by eliminating the operating license application process.

Regardless of the technology and policy advances, the nuclear industry needs public acceptance of nuclear power before advancing into the future. For the nuclear industry, maintaining safe operation of today's plants is critical. It only takes a single incident to raise public concern over the safety of nuclear energy, which could be the final nail in the nuclear coffin.

Safety

One major misconception is that nuclear power plants emit excessive radiation. Common background radiation from natural and man-made sources is about 360 millirem per year, while nuclear power plants emit only 1 millirem.

The worst accident in American history is the infamous Three-Mile Island (TMI) incident. TMI was technically a meltdown and no body was hurt. The containment dome, which the famous plant at Chernobyl didn't have, withstood melting of the core and a hydrogen explosion. The nuclear establishment claims this is proof of the safety of the American design. Proponents of nuclear power claim that advances in design and the use of modular standardized reactor designs would make today's nuclear power even safer.

Benefits of Nuclear Power

The two main benefits of nuclear power are its cheap, abundant fuel, and its non-emitting method of creating power. Although today many environmentalist speak out against nuclear power, when nuclear power was first introduced environmentalists backed it. Unlike coal and natural gas, the two prominent power production methods used today, the waste from nuclear power production is entirely contained and none is released to the environment. Studies estimate that nuclear power in the United States has prevented 1.6 billion tons of carbon dioxide, 65 million tons of sulfur dioxide and 27 million tons of nitrogen oxides from being released into the environment.

The Gamble

However, an Extreme Nuclear Occurrence (ENO)--the industry term for an accident like Chernobyl-would create a different breed of environmental problems. Chernobyl killed more than 30 people, caused acute radiation poisoning of the surrounding area and spread radiation in over Northern and Eastern Europe. Total clean up costs were estimated at over $300 billion in 1986.

Opponents to nuclear power feel that the horrible consequences of an ENO, small as the risk may be, along with economic and waste storage concerns, is enough to fold when the bet on Wisconsin's energy future is raised to critical levels. **we**

Author Bio: Nate Altfeather is a graduate student in biological systems engineering. He isalso working on a graduate certificate in energy analysis and policy. This is Nate's second article for Wisconsin Engineer.

From Reservoir to Range
The Epic Journey of Natural Gas

By Jonathan C. Hedstrom

Just as the blaze was extinguished, the local fire chief informed TV crews on site that "it could have gone off like a nuclear bomb!" In reality the situation was less dire. When Dan Johnson, a field services team leader for We Energies in Waukesha, WI, arrived on scene, fire fighters were leery to allow him near the site. But he knew there was little danger; his coworkers from the gas company were not running. He knew that if there were something wrong, they would know when to hit the dirt.

In the example above, a 1/8 inch steel pipe had broken off inside of a small metal shed where the chemical Mercaptan is added to natural gas, giving it its characteristic smell. Once the gas ignited it was just a "Bunsen burner on steroids," says Johnson, with only about a two foot flame. The gas technicians simply shut off some valves and the flame went out.

This was just a simple case of natural gas losing its way on the long journey from source to destination. What is natural gas? Where can it be found? How does it get to the consumer? Well, natural gas is in fact methane. Methane can be found in swamps, a person's intestines and underground. Because it is associated with decomposing organic matter, the gas is often thought of as having a rotten, fecal smell, but surprisingly it is odorless and colorless in its pure form. For safety reasons, natural gas is given its familiar odor by adding Mercaptan once the local distribution company receives the gas. This makes leaks and other safety concerns easy to detect.

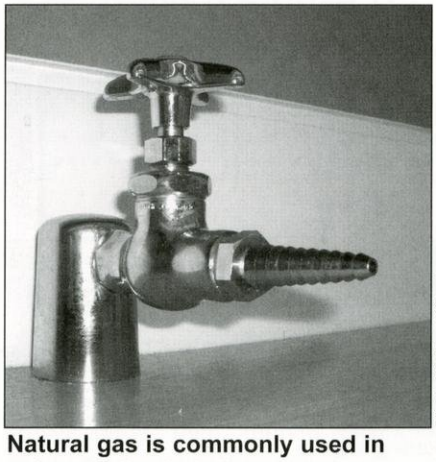


Photo By Tom Gilbert

Natural gas is commonly used in science labs, in industry and on campus.

Despite the recent leaps made in collecting and processing methane from cow manure and the new possibilities with methane hydrates (methane trapped in ice in places like the Arctic), almost all natural gas is collected from underground sources in much the same way as oil. Once a reservoir is found, it is usually a simple matter of installing a well and allowing the gas to flow out under its own pressure. However, there are possibilities of hitting pockets of explosively large pressures, so the wellhead must be able to withstand up to 20,000 psi of pressure.

Methane can be found in swamps, a person's intestines, and underground

Removing the gas is the easy part. What is much harder is finding a viable reservoir. Back in the 1800s, someone would come across bubbles rising to the surface of a creek and dig a well by hand. Now corporations use 3D seismic imaging, gravimeters (used to measure minute differences in gravity), test wells and even a NASA satellite called Magsat to map differences in magnetic fields. All of this new technology gives engineers a detailed layout of the geology of rock formations thousands of feet beneath the earth. From these detailed diagrams they can infer not only where the gas is located but also the perfect positions for wells. This new technology may add a much greater precision than ever before possible, but this accuracy is not cheap. A 3D seismic image of a 50 square mile area costs up to $1 million.

When the gas leaves the well it is too impure to use. The gas is almost always 'wet' gas. Since the methane is found so deep underground, water vapor often catches a ride out of the well with the methane. This is taken care of by several different methods, but, essentially, a chemical sponge is used to soak up the water molecules and let the rest pass by.

Encountering what is termed 'sour' gas is an unpleasant experience. It usually reeks of rotten eggs because of the sulfur compounds which it contains. These can make the gas extremely corrosive and even lethal if inhaled. Special amine solutions are used to 'sweeten' the gas (extract the sulfur compounds) before it continues on.

After reaching pipeline quality the methane is dubbed 'dry' gas now that most of the impurities like water, ethane, propane, butane and sulfur compounds have been removed. It may now move on towards the consumer.

Johnson describes the equipment involved in the next step in the process as "HUGE compressors, the largest engine you can think of. Then multiplied by ten and put on steroids." These are used to help natural gas on its way by pressurizing it to as high as 1500 psi. This allows the natural gas to travel 15 mph along steel pipe four feet in diameter for tremendous distances.

Most of this gas used in the U.S. originates in Texas, Louisiana or Canada. From there almost all of the pipelines end up in one of 30 major hubs, the largest of which is called the Henry Hub in Louisiana. This is where the marketing takes place--the buying and selling of the gas between companies. After that, it could end up in the Midwest, Mexico or anywhere else there is demand.

Following sometimes thousands of miles of travel, a sample of gas finally reaches the gate station. This is where the gas changes hands from the pipeline corporation to the local distribution company (LDC). These are the people that consumers actually get their gas and, unfortunately for them, their bills from. At this point, along with dropping the pressure to about 300 psi, the LDC adds Mercaptan and reduces the pipe size to 12-16 inches in diameter.

Surprisingly, the end of the supply chain with the LDC is where almost half of the expense of natural gas comes from. This is not as astonishing, though, if one considers the estimated million miles of small distribution pipe in the United States. This infrastructure requires a lot of resources to install and maintain safely.

Because it is associated with decomposing organic matter, the gas is often thought of as having a rotten, fecal smell, but surprisingly it is odorless and colorless in its pure form

Johnson has a good way to look at distribution pipes. He uses a tree analogy. It starts off at the trunk, which is the main interstate pipelines. Then as it moves up the tree it becomes smaller and smaller until it gets down to 2 inch plastic mains. Eventually the 3/4 inch plastic pipes, which feed individual homes at 60 psi, branch off of this main that travels down the street.

Of course, rural residents see something completely different. For them, the delivery of gas is done in person. A local company delivers it and puts it in a large storage tank somewhere outside of the customer's home.

Whichever method is used to supply the end user, purchasing natural gas is not done by volume in the same way as gasoline. Instead, it is bought in British Thermal Units (BTU's). One BTU is the amount of energy needed to heat one pound of water by 1 degree Fahrenheit.

There is a very good reason for buying natural gas in BTU's; the gas actually varies in energy content. Canadian natural gas, for instance, is generally 'colder' than that found in other regions, like the Gulf of Mexico. This means that if two balloons were filled with 1 BTU of gas, each on a different day, the two might not be the same size. They would have different volumes but the same amount of energy. Though the deviation is small, when buying in large quantities, such as to generate electricity in a power plant, it can make a substantial financial difference.

The length of the journey from source to destination for a sample of natural gas is incredibly long and elaborate. With how flammable and explosive it is, one would think transporting gas so far would be very dangerous. Even though there is the occasional accident, natural gas transmission by pipeline is actually one of the safest ways of sending energy. According to the Department of Transportation's Office of Pipeline Safety, there were only 7 deaths associated with these systems in 2001.

According to Johnson, when an incident does occur, those employed to assure the safety of the public cannot say "It's Friday afternoon. I'll get to it Monday." Accidents can occur at any time, weekend or not. That is why Johnson loves his career. For him it is "the most rewarding, fun and great job" he has had, and when called to an emergency "it can even be exciting." He can recall one example where lightning struck a tree and then followed a tracer wire to the main pipeline at the street. There it blew the "T" fitting off and started a fire. He spent all night in the mud working to put out the flames and fix the flooded gas pipe.

Natural gas is now a mainstay of the economy, and despite its long journey from the depths of the Earth to the flames flipping above a kitchen stove, natural gas is one of the most efficient, least polluting and safest energy resources available. It is no surprise that it has become such a success since its rudimentary beginnings lighting city streets with gas lamps some 200 years ago. WE

Author Bio: Jon Hedstrom is a sophomore double majoring in electrical engineering and physics.

Photo By Tom Gilbert

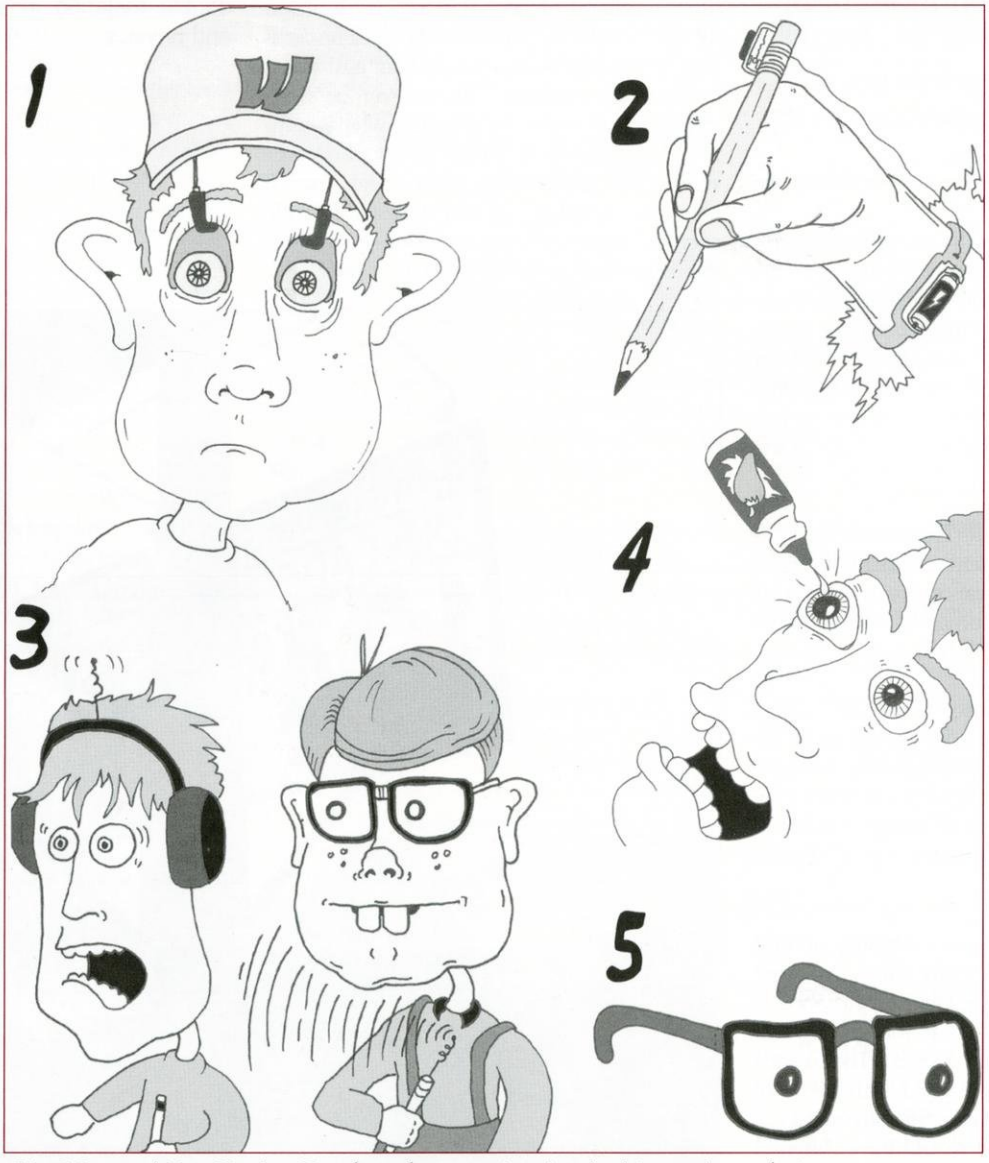
A trip to a convenience store is not necessary for many Americans -- a natural gas infrastructure is in place to provide gas directly to homes.

Just One More

The Finest in Eclectic Humor

By Skye McAllister

5 Inventions to Help You Stay Awake in Class



1. The Stay Hooked - Hat Mounted Eye Hooks. For those hat wearing few looking to keep their eyes open even during the most boring atomic physics lecture, strap on a pair and keep in the game. Do not leave in for more than 1 hour.

2. Noterocute - Motion Sensing Hand Shocker. Do you fall asleep even after your third cup of coffee? If so, the Noteracute system should provide you the jolt you need to stay awake in times of sheer boredom. Use only AAA batteries.

3. Nerd Alert – Transmitting Radio Frequency Package. Ever wish you had the impeccable notes that the astute student next to you has? Then it's time to lend him your new Nerd Alert pencil. Now whenever his pencil hits the paper the piercing ultrasonic noise transmitted to your headphones will tell you that it is time to learn! Choose nerd wisely.

4. Bomb Drops – Jalapeno Eye Solution. In fear of bombing that test in the morning? Well stay up late with the NOW extra spicy Bomb Drops. Only one drop per eye will keep you up into the wee hours of the morning, forcing you to pass the time by studying. Apply in eyes only.

5. Fake-Out Vision - Classic Painted Eye Glasses. Nothing working? Well just give it up and strap on a pair of this classic gag. Use only in large lecture halls and not when your boyfriend or girlfriend wants to have an intimate conversation.

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