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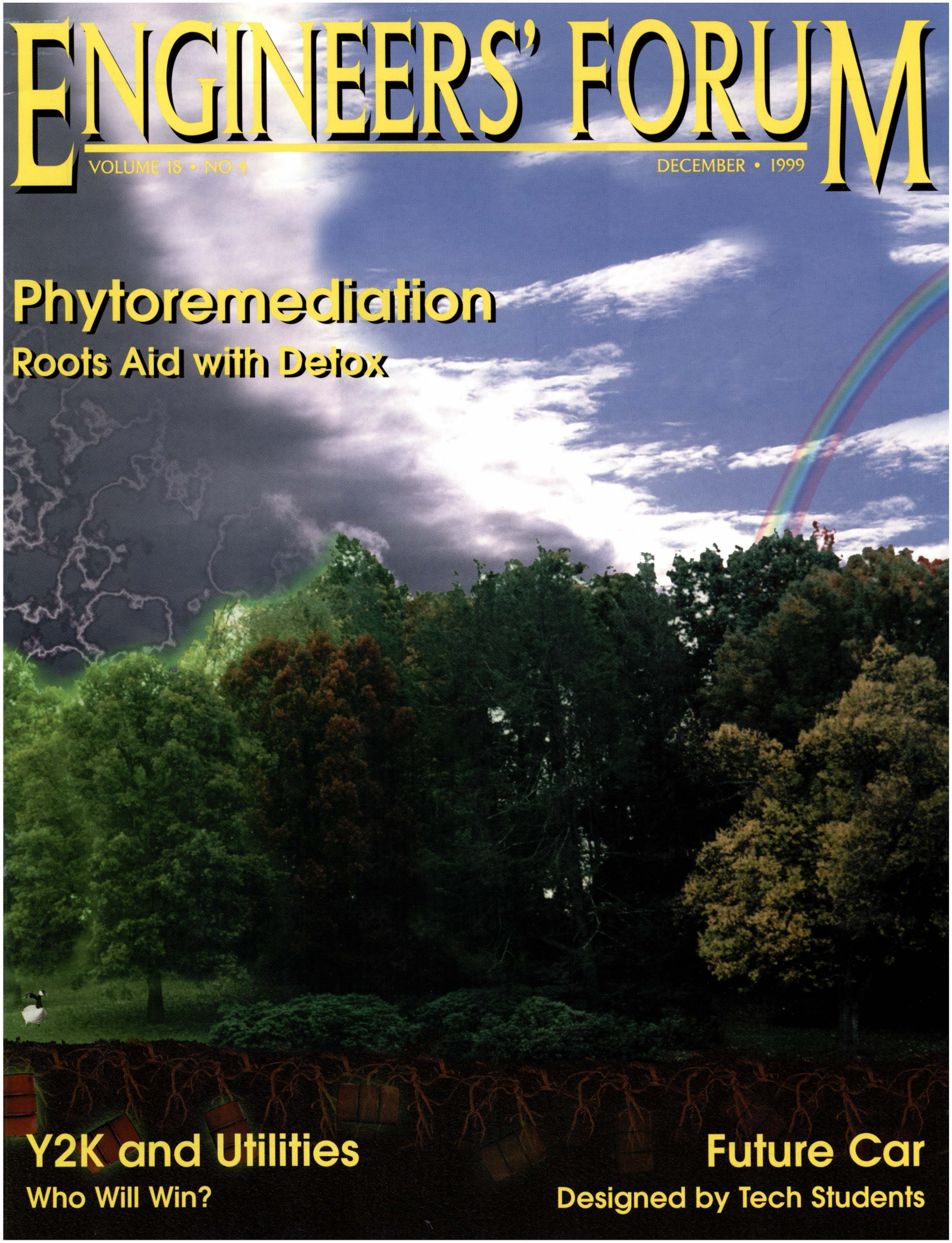

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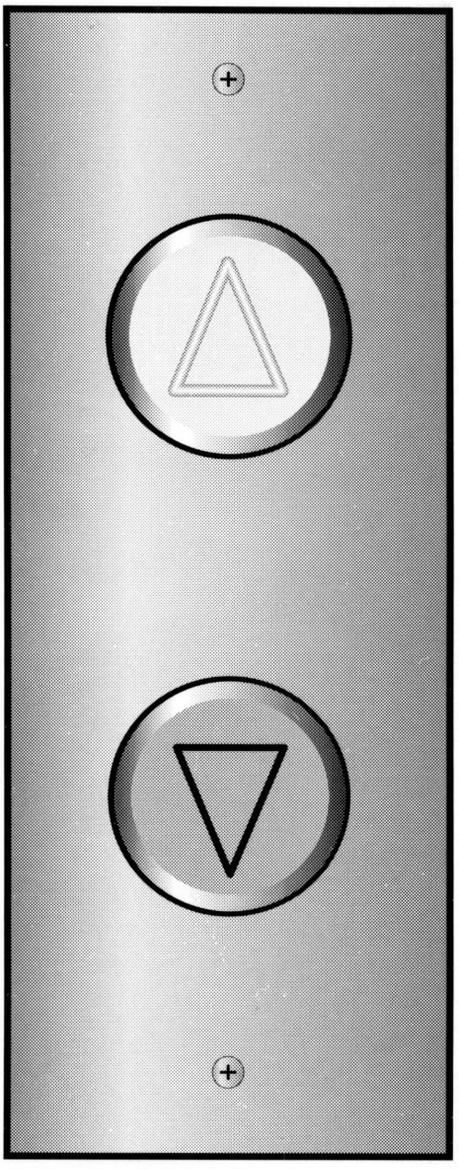
Future Car

Designed by Tech Students



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http://fbox.vt.edu:10021/eng/forum
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How Will Y2K Affect Electric Utilities?

by Sara Renee Johnson

Everyone has heard the big hype about Y2K, how computers and embedded chips everywhere will shutdown. Things we use everyday, ATM machines, gas pumps, and even our electricity will go out because they are unable to handle the year 2000. Some people are so worried they have been stockpiling food, water and gas. But will our electricity really go out? Certainly electric companies are aware of the problem. In fact, they have spent millions of dollars to fix the problem. So why are people still worried about what is going to happen when the date changes?

The story begins in the 1950s when programmers, who were trying to save space on punch cards that were used to program computers, decided to represent the date with just six digits, instead of the full eight. Now power plants everywhere have computers and embedded chips that read only two digits to determine the year. If left unfixed, when the year 2000 hits, many of the systems that depend on the computers and chips will go offline or trip.

Everyone is worried about January 1, 2000, but what most people do not realize is that there are other critical dates that may stump computers that are not programmed properly. Y2K critical dates also include August 22, 1999, September 9, 1999, February 29, 2000, and December 31, 2000. August 22, 1999 was critical because of the Global Positioning System that orbits the earth tracks time as the number of weeks since the launch of the system in 1980. On August 22, 1999 the counter will overflow to 0000. The Global Positioning System is used in the power industry to establish the exact time of day for transaction logging. September 9, 1999 was critical because computer programmers often used 9999 to signal the end of data. When computers see this as the date, they may interpret it as something else. The last two dates can be attributed to the fact that the year 2000 is an uncommon leap year. The rule goes years divisible by four are leap years, and years divisible by 100 are not leap years, unless they are also divisible by 400. Programs written by those who did not know about this complex rule may fail on either the 29th of February or the 31st of December, depending on the way they keep track of the date. The programs that operate by counting the days in the year will fail in December, and programs that just look at the date will fail in February.

Before finding out how power plants will be affected by Y2K critical dates, it is important to know a little bit about how power is generated and distributed. In the U.S., 22% of power is generated by nuclear plants, and fossil fuel plants generate 68% of power. The last 10% is generated by different types of renewable energy sources like wind, geothermal energy, solar energy, and flowing water. After the power is generated, it then has to be transmitted and distributed. Power companies route the power generated to a distribution facility. All of the distribution lines are interconnected and make up what is commonly referred to as the power grid. If a utility goes offline suddenly, referred to in the industry as tripping, it can affect other areas of the power grid. A major disturbance in the grid can have an immediate effect throughout the connection.

There are four areas that posses the greatest risk to electricity. The first area is power production. Generating units scheduled to operate must be able to start-up and deliver electricity without tripping. The second area is the energy management systems. These computer systems monitor and control transmission lines and dispatches generating units to meet the electrical demand. Energy management systems retain historical data and allow for the manual and automatic control of field equipment. The third area is telecommunications. Electric utilities depend highly on satellite communications, telephones, VHF radio, and microwaves. The fourth and final area is substations and protection systems. There are controls in substations that provide protection relays, which quickly isolate equipment if an electrical fault occurs. The newer protection devices are digital and therefore vulnerable to Y2K. Substations also have remote terminal units (RTUs). The RTUs receive signals from lines that let the control system know when there is a fault in a line. If there is an RTU failure, it could cause widespread outages.

For fossil fuel power generation, there is also the added concern that to stay online, fuel must be delivered. Most fossil fuel facilities have from one to three weeks, but these reserves allow only for minor disruptions of fuel supply lines.

With nuclear power, there is the added worry of whether the safety systems will fail or not. The Nuclear Regulatory Commission (NRC) has setup specific guidelines for nuclear facilities. Each nuclear facility must have been Y2K ready by July 1, 1999, and any plant that was not had to report to the NRC. The NRC is now

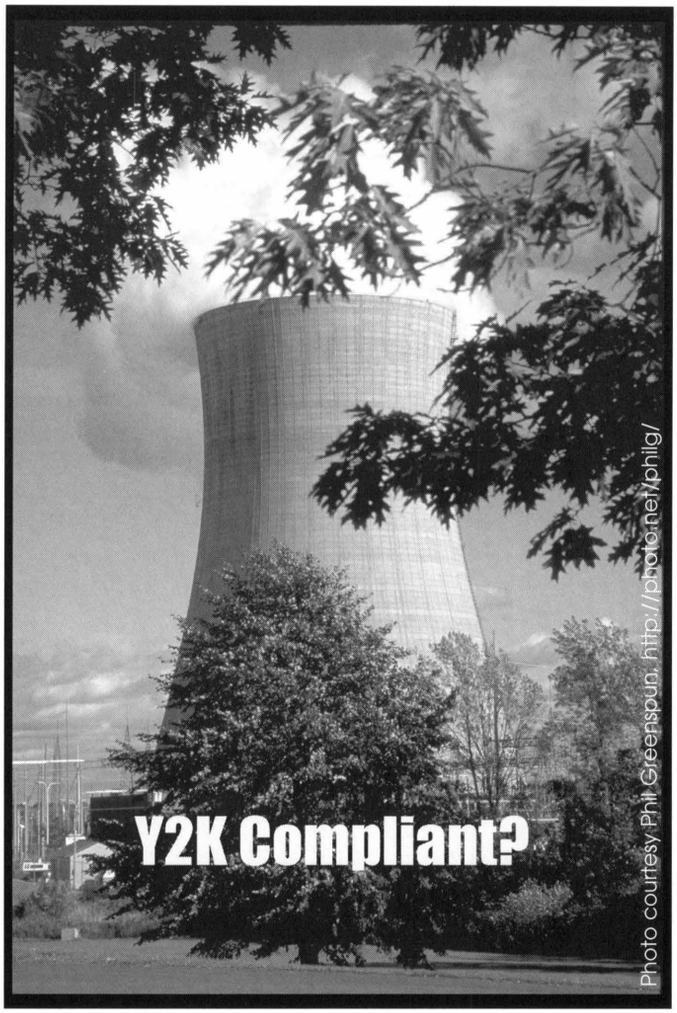
There are alarm systems, emissions monitoring, protective relays, substation controllers, heating and ventilation systems and security access systems that have Y2K problems.

tracking the progress of those plants that were not ready and will shut them down prior to January 1 if they are unable to operate safely. Last fall, the NRC audited 12 nuclear plants. They found that there were no problems suggesting that plants would not be able to achieve Y2K readiness, and no problems have been found that will directly affect the functioning of safety systems. So, even if nuclear plants are unable to produce electricity, they will pose no risk at all to the public.

On April 30, 1999 the North American Electric Reliability Council (NERC) issued a status report, a work plan for "Preparing the Electric Power Systems of North America for Transition to the Year 2000". The report was the third in a series of comprehensive quarterly status reports on the preparation of North America's electric power suppliers and delivery systems. The final report was issued in July 1999 and this report let us know where we are today. The report outlines five key results.

The first result is that there has been substantial progress in remedying Y2K problems and in testing equipment for compliance. The owners of generation units and delivery systems have completed 75% of the process to remedy and test their systems for Y2K problems. The NERC established a target date of June 30, 1999 for Y2K testing to be complete, and most facilities were ready by that date.

The second result is the industry has discovered that the transition through the critical Y2K dates will have a minimal impact in electric systems operations. The industry has estimated that fewer than 3% of items tested before any work is done on them have difficulty with Y2K date manipulations. Most of the devices that do experience trouble are mostly nuisance errors. The date is incorrect on displays, or the date-time stamps used for data logging are wrong. In most cases, Y2K does not affect the primary systems that keep generation and distribution facilities in service.

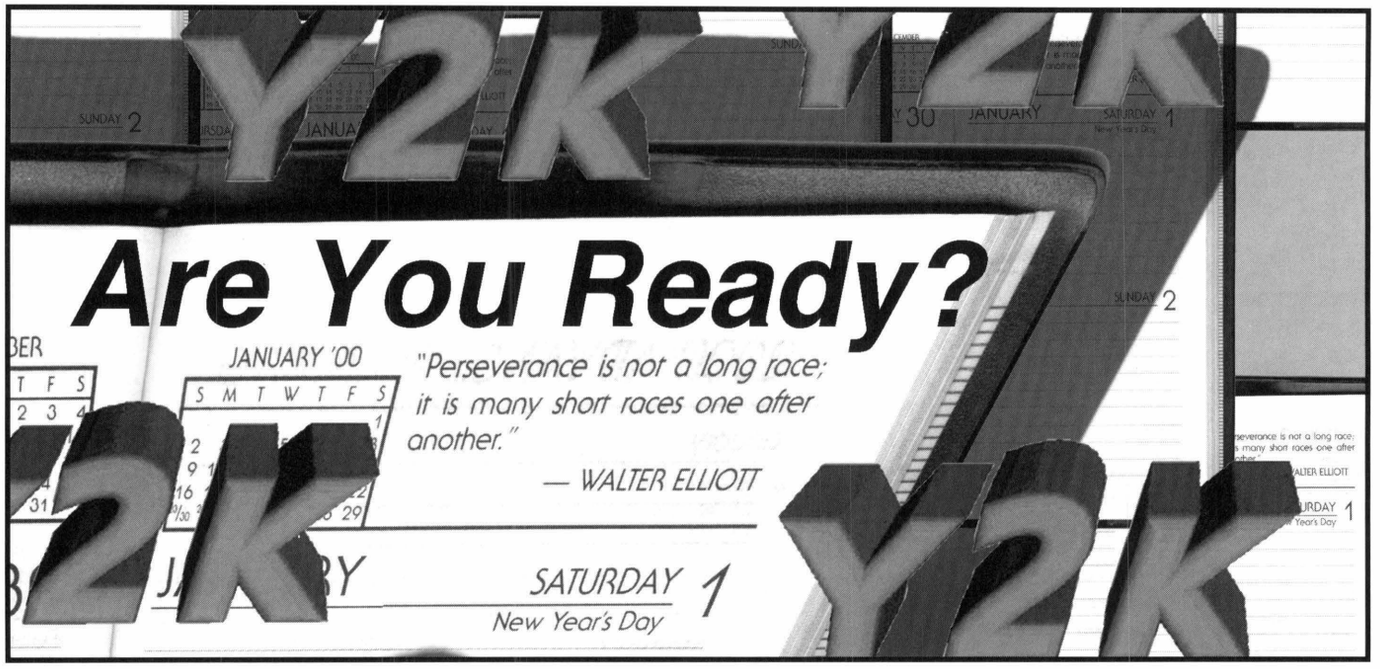


Nuclear Power Plants: Y2K Compliant?

The third result is that even with most of the problems being minimal, Y2K issues cannot be ignored. Both in generation and in transmission and distribution, problems exist that must be dealt with. There are alarm systems, emissions monitoring, protective relays, substation controllers, heating and ventilation systems, and security access systems that have Y2k problems. All of these are important for the safe generation and delivery of electricity to customers.

The fourth result found was, even though the impacts of Y2k are expected to have minimal effects on the ability to reliably operate electric power systems, it is important that the industry is taking active steps to prepare for possible problems. Reviews of Y2K operating plans indicate that operating units are taking the appropriate steps to evaluate operating risks and adopt contingency response plans. The operating plans and contingency response plans were both to be ready by June 30, 1999. Anything that deviates from normal operation was listed in these plans.

The fifth result involves back up plans for telecommunications. On April 9, 1999, the industry conducted the first ever drill simulating the partial loss of voice and data communications to simulate what could happen on critical Y2K dates. The drill involved more than 200 electric power organizations. The object was to demonstrate safe and reliable practices with the loss of primary communications. The industry learned that improvements and training are needed on back up communications systems. A second test was conducted in September.



Overall, sufficient generating capacity is anticipated to be available to meet the demand during critical transition periods. This includes additional fuel reserves and quick start units that do not depend on computer systems. All nuclear generating facilities are expected to be able to supply their share of electricity needs and all safety systems are to be fully ready for Y2K. Although there may be transmission outages, they are expected to be minimal and will be able to be handled appropriately by contingency plans. The distribution facilities are less sensitive to Y2K issues than other areas, but since they have less back-up options testing and contingency planning are important. The weakest link may be telecommunications. This is mainly because they are from external service providers that the industry has no control over. Joint efforts between the electric industry and telecommunication facilities to test the telecommunications systems are important.

From the reviews from industry organizations, it seems that Y2K issues are well under control. An example of this can be shown by looking at a generating station in Delta Pennsylvania called Peach Bottom Atomic Power Station (PBAPS). Peach Bottom has two nuclear generation units and is part of PECO Energy. The electricity supplied by PECO Energy is from a combination of hydro-electricity, fossil fuel plants including coal and fuel, and two nuclear plants. On the 8th of February this year, there was an incident at PBAPS during Y2K testing.

Technicians were testing a system called the Rod Worth Minimizer (RWM), which is used mainly during periods of low power output to track the position of the control rods that regulate the nuclear reaction. The RWM feeds data into the Plant Monitoring System (PMS). PMS is a computer station in the control room where operators can call up displays on various systems in the plant and is more commonly referred to as the Safety Parameter Display System (SPDS). Because SPDS contains valuable information on virtually everything going on in the plant, it is an invaluable tool for the operators and the lockup of this system requires NRC notification. The test had been completed successfully in the on-site

On April 9, 1999, the industry conducted the first ever drill simulating the partial loss of voice and data communications to simulate what could happen on critical Y2K dates.

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simulator and it was time to take it to the real units.

The technician was supposed to connect the system to and external clock and set that clock ahead to January 1, 2000. Instead the technician changed the time on the back up PMS. Since the backup was offline, nothing appeared to happen. The technician decided to re-enter the date, and this time the SPDS displays went dark. When the technician had re-entered the date it went to the primary system and that was what had caused the failure of PMS. The plant was not shutdown, and after seven hours, the system was restored to normal functioning.

PMS is not a safety related system, nor is it the primary source of data in the control room. The crash of the system would not have impeded safe shutdown of the plant, but it would slow down the operator's ability to respond to problems. The shutdown of the system was determined to be human error, not a Y2K problem. The NRC did not fine PECO since they were doing what they were supposed to be doing. The NRC simply said, "We would rather have them doing this testing now as opposed to a year later."

The crash of the system would not have impeded safe shutdown of the plant, but it would slow down the operator's ability to respond to problems.

What this incident shows is that PECO Energy is taking active measures to ensure that their customers will have electricity on Y2K critical dates. As electric companies work to remedy their Y2K problems, things may go wrong, but they are working to fix the problems. Nuclear facilities like Peach Bottom pose no threat to the public because safety systems are not affected by Y2K problems.

According to the NERC, massive national disruptions in power are very unlikely. Some minor local outages may occur, but the industry is prepared to deal with these outages. Electric companies deal with local outages every time there is a flood or storm. The NERC has been working with the electric industry to make sure that every phase of generation, transmission, and distribution will be able to operate safely. Any problems that are encountered will be handled promptly because of contingency planning. Electric companies know that they may encounter problems, and that is why they are stockpiling extra fuel and preparing quick start units to counter act potential problems. Just remember that electric companies do not want to lose money any more than you want to lose your electricity. EF

Phytoremediation: Roots Aid with Detox

by Tom Catherwood

Seventy years ago, McLaren Mine produced gold that fed the booming American economy. Thousands of workers and their families populated mining towns across the wide-open western plains. Today, the only remnants of this bygone golden era are rusted steel machines and acre upon acre of open waste pits. McLaren Mine no longer produces gold. Today it produces poisoned groundwater, waste-strewn prairies, and rivers that flow Day-Glo colors. In 1978, toxins oozed out of a landfill and into a suburban housing development called Love Canal in upstate New York. Subsequent studies have found the toxins caused increased death rates, cancer and birth problems among residents. Right now the ground water of Commerce City, Colorado is being contaminated by chlorinated pesticides, heavy metals and volatile organic compounds that are leaching from a chemical company's waste pits.

Hazardous materials consisting of toxic waste, concentrated organic and inorganic compounds, pesticides, heavy metals and more, threaten the very livelihood of our environment and world. The examples mentioned above are a drop in the bucket of hazardous waste contamination that exists in every city, in every state in America. Acids and heavy metals from old mines alone are causing ecological problems that will last an estimated 3,000 years!

The story of toxic pollution does not have to end like the Love Canal. Numerous environmental and community groups are working in conjunction with the Environmental Protection Agency (EPA) to clean up, or reclaim, hazardous waste sites across the nation. The EPA manages a program called Superfund that aims to reclaim the largest and most threatening sites.

Methods for reclaiming waste sites include containment, treatment, and complete removal. Containment includes consolidating contaminated materials (soil and rocks containing hazardous waste) and placing them in lined pits that are capped (or covered) with clay or plastic. This way little to no surface water comes into contact with the waste, and the liners prevent contaminated runoff, often referred to as leachate, from reaching the water table. Treatments could include building water treatment facilities and spreading lime on affected areas to neutralize acid. In complete removal, the most drastic measure, all the contaminated soil and rock is removed from a site, incinerated or recycled, and replaced with new, uncontaminated soil.

Yet, with limited funds, personnel, and current technology, the EPA and smaller environmental and community groups have little hope of reclaiming the thousands of known—and most likely thousands of unknown—polluted waste sites. A key reason for this is the sheer magnitude and cost of reclaiming hazardous waste sites. For example, with containment, the liners cost in the neighborhood of $100,000 an acre. Furthermore, these liners must be monitored closely as factors like seismic activity and incorrect installation may cause them to fail. Treatment requires the planning, building and operation of treatment facilities. Similarly, the cost of removing and replacing entire contaminated areas is astronomical. The site in Commerce City, Colorado mentioned at the beginning of the article used complete removal and ended up costing $1 million an acre to reclaim.

The cost of removing and replacing entire contaminated areas is astronomical.

From engineering firms to environmental scientists to researchers in universities across the world, including Virginia Tech, people are saying, "There has to be a better way." Studies and experiments that have spanned the last decade and a half show that there is a better way, called phytoremediation.

Phytoremediation is the use of plants, trees, and grasses to remove, destroy or sequester hazardous substances from the environment. Imagine the possibilities: no bulldozers or dump trucks, no acres of impervious plastic lining, no areas void of existence except for capped waste piles, containment ponds and treatment facilities. Instead, trees and fields of green grass use the sun's energy to passively clean our contaminated environment. It may sound too good to be true, but be assured the use of phytoremediation to

clean hazardous waste sites is a very realistic possibility.

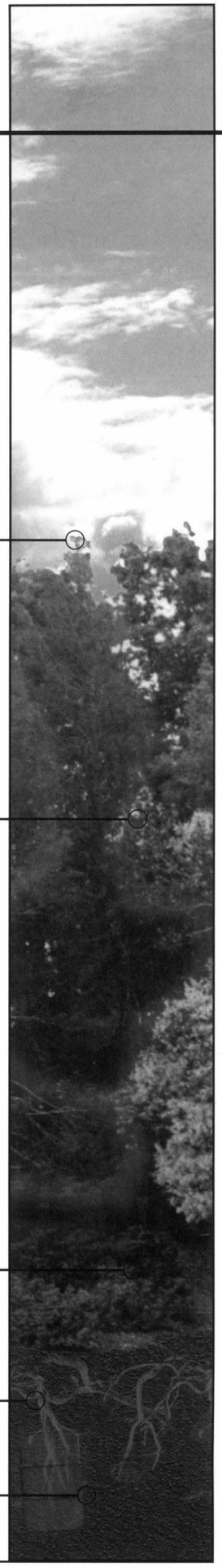
When applied to a hazardous waste site, phytoremediation works much like the three methods of mechanical reclamation. Plants can contain, treat, and completely remove hazardous chemicals. Unlike its mechanical counterpart though, phytoremediation utilizes a plant's natural processes and inherent characteristics to reclaim sites.

In mechanical reclamation, containment consists of consolidating waste in a lined and capped pit. The respective goals of capping and lining are to protect surface water from contamination and prevent seepage of hazardous leachate into ground water. Phytoremediation can accomplish both of these goals with natural processes. In place of plastic and clay caps are vegetative caps. Vegetative caps refer to a dense layers of plant roots situated above a hazardous waste site that control erosion and minimize seepage of water into the waste below.

Since some water does get through, hazardous waste must be contained in order to prevent leaching and ground water contamination. Instead of expensive plastic lining, seepage and leachate is kept from contaminating water by rhizofiltration and hydraulic pumps. Rhizofiltration, which is best used for removing contaminants from water, filters contaminants and absorbs them onto or into the plant's roots. Hazardous materials cannot pollute groundwater if they are contained within plant roots.

When full grown, many deep-rooted trees, like poplar, cottonwood, and willow absorb and transpire between 50 to 300 gallons of ground water per day. This massive uptake of water produces an inground capillary action known as hydraulic pumping. Hydraulic pumping can prevent hazardous waste from moving against the gradient down through the soil and into the ground water supply.

Containment is only a fraction of the full potential of phytoremediation. Natural processes of certain plants can change, alter, degrade, and neutralize hazardous waste much like the treatment facilities of mechanical reclamation. Two natural processes that attack hazardous waste are phytodegradation and rhizodegradation. In phytodegradation plant enzymes break down contaminants on or within root systems. These enzymes take



Tools of the Trade

Increasingly, environmental engineers are cleaning up groundwater and soil pollution with techniques that are biological—not mechanical. Here's a synopsis of what can be done:

phytovolatilization

Plants absorb soil contaminants through their roots, transport the contaminants to their leaves, and relase the contaminants harmlessly into the atmosphere.

phytoextraction

Plants absorb soil contaminants through their roots, then transport the contaminants to the leaves and stems of the plants, which are later removed.

phytodegradation

A plant's enzymes break soil contaminants down into simpler organic chemicals, then use those chemicals for the plant's growth.

rhizofiltration

Plants trap soil contaminants in their roots.

rhizodegradation

Microorganisms break soil contaminants down into harmless organic chemicals.

People are saying,
"There has to be a better way."

hazardous materials with complex organic molecules and degrade them into smaller, simpler, less harmful molecules. These altered and neutralized compounds are incorporated with fibers into the roots to help the plant grow. Studies have shown that some phytodegradation enzymes can degrade ammunition wastes, chlorinated solvents and herbicides.

The root systems of trees, grasses and other plants release natural substances like sugars, alcohols and acids as byproducts of metabolism. These natural substances contain organic carbon. In turn, organic carbon provides food for a myriad of soil microorganisms. The amazing thing is that many of these microorganisms can alter and digest hazardous waste producing harmless end products. The use of such microorganisms, mainly heterotrophic bacteria, to degrade hazardous waste is known as rhizodegradation. Though much slower than phytodegradation, rhizodegradation still has incredible potential based on the fact that it is a passive treatment process fueled by the waste products of plants. In essence, plants can aid in the breakdown of hazardous materials by producing their natural byproducts and allowing the microorganisms to do all the work.

The final method of reclamation is complete removal and replacement of soil, rocks, and other materials contaminated by hazardous waste. Phytoremediation is able to remove hazardous waste from contaminated sites just like mechanical reclamation. However, phytoremediation accomplishes this removal while leaving the layers of soil and rock intact. This removal is done by one of two processes, phytoextraction and phytovolatilization.

In phytoextraction, plant roots take up, or accumulate, hazardous wastes like heavy metals and deposit them in above ground portions of the plant like branches and leaves. Depending on the accumulation and growth rate of a specific plant, the plant is harvested and incinerated after a number of growing seasons. The same species of plant can then be replanted and phytoextraction continues until all contaminants are gone.

Phytovolatlization refers to the uptake, transportation and successive evaporation of certain contaminants, most notably organic compounds. Contaminants are absorbed through roots, travel through a plant, and evaporate through the leaves. Though this process has proven successful in a handful of studies, it may not eliminate the danger of many contaminants. The contaminants may no longer be present in the ground, but they are freely floating in the atmosphere and further study of their airborne effects is necessary.

The use of plants to clean hazardous waste sites has numerous direct and indirect advantages as compared to mechanical reclamation. For example, planting trees, grasses and other plants can be significantly cheaper than containment, treatment, and complete removal. As opposed to its counterpart, the phytoremediation process is environmentally friendly, aesthetically pleasing, and generates little or no secondary waste. Also, if done correctly, phytoremediation requires minimal monitoring and upkeep, and is virtually permanent.

Even though phytoremediation has been around since the mid 1980's, it has yet to receive the widespread consideration and acceptance of the reclamation industry. Despite its infinite poten-

The amazing thing: microorganisms can alter and digest hazardous waste, producing harmless end products.

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tial, phytoremediation, like all other innovative technologies, must prove its efficacy and cost effectiveness before it can become a standard practice.

Also keeping phytoremediation from being a mainstream remediation practice are the inherent limitations and shortcomings of the technologies. Phytoremediation tends to be much slower than typical mechanical reclamation practices, and the longer the process takes, the more contaminants affect the environment. Plants have to grow in order to clean up hazardous waste, and growth is regulated by numerous environmental factors. A tree that breaks down organic contaminants in Florida may not have the same effect in Wyoming where the weather is significantly different and the growing season is shorter. Phytoremediation may be effective only at waste sites with shallow contamination because plant's roots, which control treatment and containment of contamination, grow only so deep. Furthermore, while numerous studies are ongoing, scientists still do not know of potential harmful byproducts or adverse environment reactions inherent to phytoremediation.

Another problem with phytoremediation technology is that many people undersimplify the entire process. They think that phytoremediation is as simple as planting a few poplar trees or patches of ryegrass. However, phytoremediation requires an incredible amount of site analysis, testing and preparation. What good is phytoremediation if the wrong plants are used? In fact, the skills of biochemists, soil specialists, foresters, engineers and hydrogeologists are all crucial for proper setup of a phytoremediation site.

Even with these drawbacks, phytoremediation is creating a place for itself in the American economy. The general public is attracted to the aesthetically pleasing, solar energy driven cleanup technique. Companies and engineering firms have taken notice and the estimated 1999 market size of phytoremediation is between $33.8 and $49.7 million. Though only a small fraction of the entire reclamation market, current estimates put phytoremediation at $50-86 million by 2000, $100-170 million by 2002, and $235-400 million by 2005. This may be a fledgling technology, but it has the potential to revolutionize an industry.

Another possible use of phytoremediation is as complementary source of reclamation in combination with mechanical methods. Liners could prevent leaching in sites where the contamination is too deep for phytoremediation to be effective. Then specific plants and trees could be utilized to remediate the top layers of contaminated soil, which would create more aesthetically and environmentally pleasing hazardous waste sites.

There is a finite amount of clean soil and fresh water on this planet. Both are crucial for the survival of human life. Hazardous waste contaminates both water and soil, making them unfit for drinking or farming. Granted, there are certain mechanical methods to clean the soil and water, but there is such a large amount of hazardous waste—and such limited cleanup funds—that contamination far outpaces remediation. That is where phytoremediation fits in. Harnessing the natural processes of certain plants to clean our environment, at a fraction of the cost of mechanical cleanup, could save the world's farms, prairies, streams, rivers, and lakes. However, phytoremediation is far from perfect at this time. In fact, it may take years of research to master the art of phytoremediation. Yet, with more and more hazardous waste polluting our world and environment every day there may come a time when, with the aid of phytoremediation, we will turn control of our natural environment back to nature itself. EF

Planting trees and grasses can be significantly cheaper than mechanical clean-up.

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Engineering Students Create Future Car

by Chris Smith

"THE CAR'S ONLY

At first look, you definitely know that this car is not normal. After all, its not every day that you see a chromalusion maroon and orange Chevy Lumina driving around town with all kinds of stickers on it and what sounds likes a jet engine under the hood. But that's just the beginning — open the hood up and you're in for an even bigger surprise. Under the fiberglass hood is a tightly packed maze of stainless steel tubing, mysterious black boxes, and a large green object that everything seems to be either going into or coming out of. Take a look inside the passenger area and things seem to be pretty normal except for the LCD touch screen in the console and the words "Hydrogen Only" on the fuel gauge. At this point you might just walk away and think to yourself, that's weird! But like most engineers, you'd probably find yourself with just a few questions . . .

The car your looking at was put together by a group of students called the Hybrid Electric Vehicle Team of Virginia Tech, or HEVT for short. Last year's entry into the Department of Energy's Future Car Challenge was a hybrid Chevy Lumina, named Animul H2, converted to run on pure hydrogen. Obviously not something you'd find at your local gas station, however the car's only exhaust is hot humid air.

The key components of the car include 28 advanced lead-acid 12-volt batteries, one proton exchange membrane fuel cell, two large tanks of 3600 psi hydrogen, an air/hydrogen humidification system, a larger than average cooling system, an air compressor, a 60 to 336 volt boost converter, an Ecostar 145 ft/lb electric motor, and two computers making up one excellent control and user interface system. Clearly this car was not thrown together from parts picked up at the local auto shop. Sixty engineering students put over 10,000 hours into making this car the only production car converted to run on hydrogen.

The basic concept behind the car is, in principle, fairly simple, although in reality takes a lot of perfecting. This made the project a little more interesting and is also something that the big three automakers are putting a lot of research into. Remember back in high school chemistry when you might have done the experiment where you take a glass of water and put two electrodes into a glass of water, ran a current across them, and produced hydrogen and oxygen. Well, this is basically the exact opposite. Hydrogen and air are combined in the PEM fuel cell to create water, which gives off electrons producing a small charge. When stacked with 100

Because of all the noise, the team relies on hand signals during one of the test runs.

Photo by Mark Schmale

other cells, this small charge adds up. The output, typically 60 volts is boosted up to 336 volts and either routed to the motor or the battery pack depending on where it is needed. When the battery pack is charged, the fuel cell system shuts down and the car can run off of the battery pack. Later, if the pack becomes low or a lot of juice is required for a quick acceleration or hill climb, the fuel cell system returns to operation.

For the fuel cell to operate correctly it needs the constant supply of both oxygen and hydrogen. Also, the reactants must have a certain humidity and be delivered at the proper flow rates for a specified power demand. Additionally, all of the unused reactants and humidification water must be recovered and reused. These are just a few of the properties that are incorporated into the air, hydrogen, and cooling systems.

For all of the systems to work correctly together, they must be precisely controlled according to current system conditions. Initially, it took a car packed full of students frantically flipping control switches and yelling out pressures, temperatures, flow rates, and voltages. A typical test run looked similar to the floor the stock market, only there was an ear splitting compressor drowning out any spoken communication. Critical control messages were relayed with frenzied waves and hand signals.

One of the major design factors of the car is consumer acceptability. No consumer would tolerate or be able to watch all the dials and control all of the systems. This is where the control computer takes over. The control computer consists of a Z-180 processor coupled with relay drivers and analog and digital inputs. While running the control code the micro-controller reads from the inputs from sensors, makes decisions based on the values, and executes responses by sending the right signals to solenoids and switches, all in a matter of seconds.

A temporary setup was used before everything was put in the car. In front is the stainless steel cooling water reservoir.

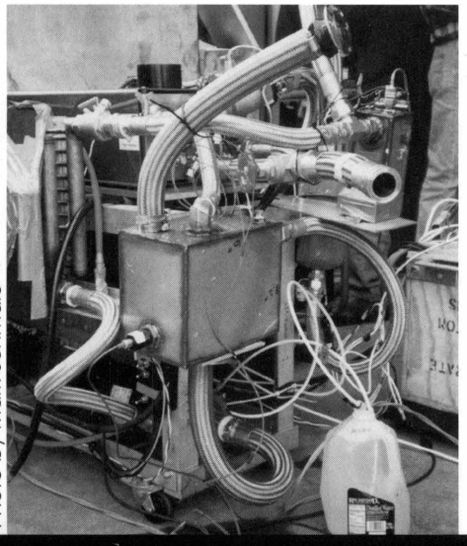


Photo by Mark Schmale

"EMISSION IS WARM HUMID AIR."

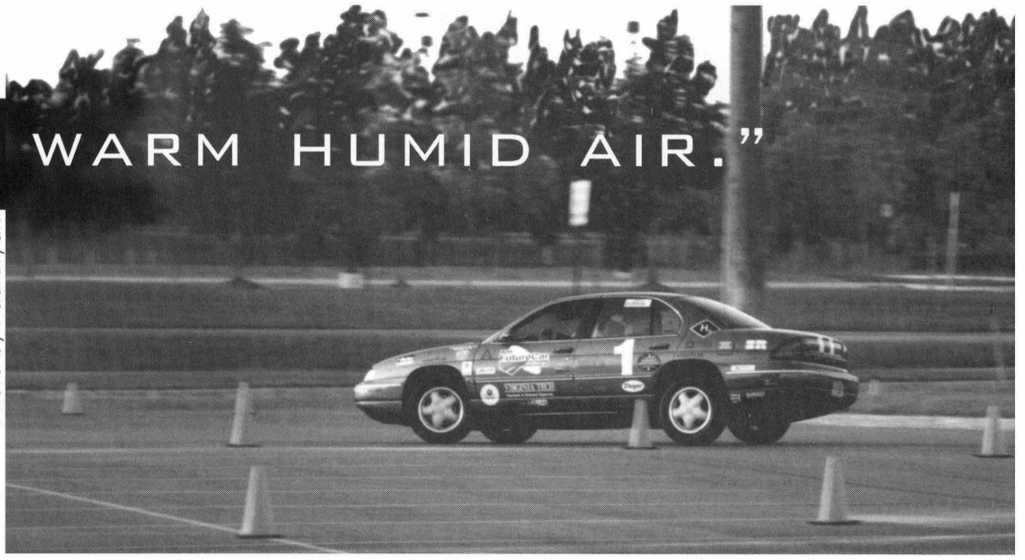


Photo by Paul Bryan

The car blazes through the slalom course during competition at Auburn Hills, Michigan..

After everything was stuffed into the car and perfected, the team was off to Auburn Hills, Michigan for the Future Car Challenge. At the event, the car was put through a variety of tests, inspections, and design presentations. In the end, the team finished second place and was the only team to successfully finish building a hydrogen car. The winning team, University of Wisconsin, won with a special ultra-light aluminum frame vehicle. Their car was powered by a small diesel engine and a small electric motor.

All totaled over $750,000 was put into this project. Besides relying on support from the Mechanical and Electrical Engineering Departments, HEVT relies on sponsors to help fund its enormous budget. A grant from the Department of Energy paid Energy Partners for the quarter million dollar fuel cell. Also most of the other components that make up the car were either donated or provided at a reduced price. This price tag is considerably more than the average family sedan, but don't expect to pay anywhere near this amount in the future. Advances in fuel cell technology and mass manufacturing promise to bring the price down lower than the average gas engine. Also, researchers think that the lifespan of a fuel cell could be indefinite because it has no moving parts.

While the fuel cell makes up the heart of the vehicle the various other accessory systems are important for both driver comfort and proper fuel cell operation. These systems present new and different design challenges. In a conventional car, energy needed to power large systems is exchanged in a mechanical form, such as belt drive. However in a fuel cell vehicle the power is typically not available in a mechanical form. This is both good and bad. On the upside, this allows you to use high power electronics to do the same thing that was once done with gearing ratios, leaving even less moving parts. On the downside this area is a fairly new field. Also, many motors needed to power compressors and pumps must be specially ordered at a high cost. Because this area is so new the reliability of these components is not always proven. Some designers have fallen back on older technologies in favor of compatibility and easier system integration, while sacrificing things like

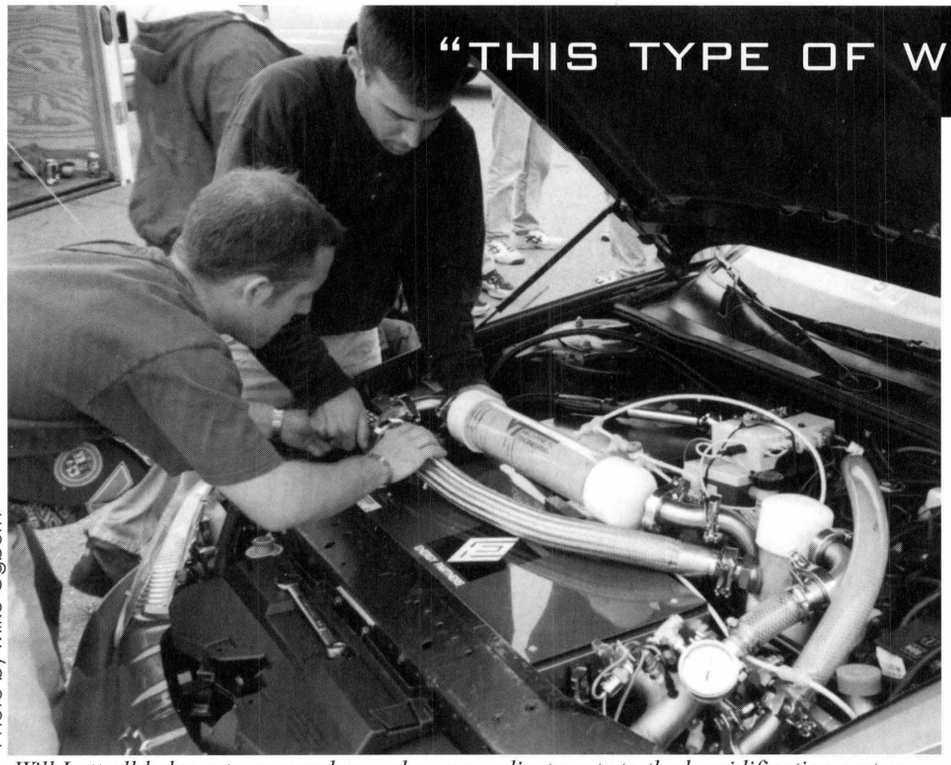


Photo by Mike Ogborn

Will Luttrell helps a team member make some adjustments to the humidification system.

"THIS TYPE OF WORK REALLY PUTS

theoretical system efficiency.

One example of this is the use of the battery pack in Animul H_2. Battery technology has made many improvements but can still be a problem. After a few months of use the batteries in the pack may begin to charge unequally. This causes some batteries to become overcharged while others are undercharged. This can seriously decrease the range of the vehicle. Ideally, batteries would be avoided all together. However, in this design they were used because the fuel cell only delivers 20kW. As mentioned before one of the design criteria was keeping similar vehicle performance characteristics. This requires roughly 80kW to meet the acceleration requirements so batteries were added to provide the extra power when needed. Several big automakers have produced vehicles that are powered off of only fuel cells.

Another potential problem is the existing infrastructure for delivering gasoline.

Part of the competition was showcasing the designs and meeting with senators in Washington D.C.

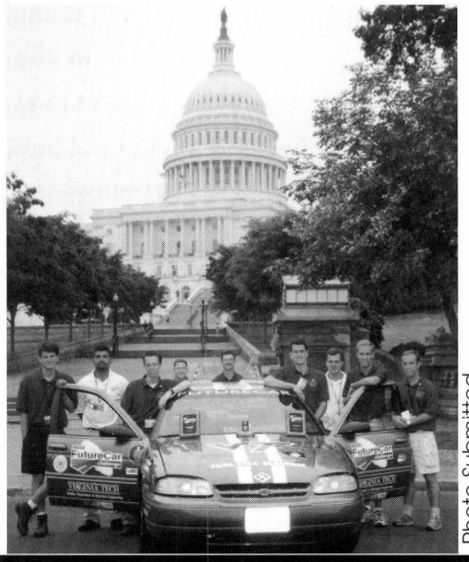
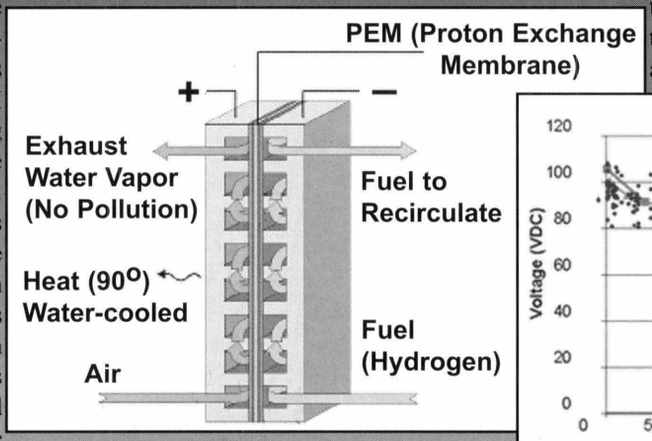
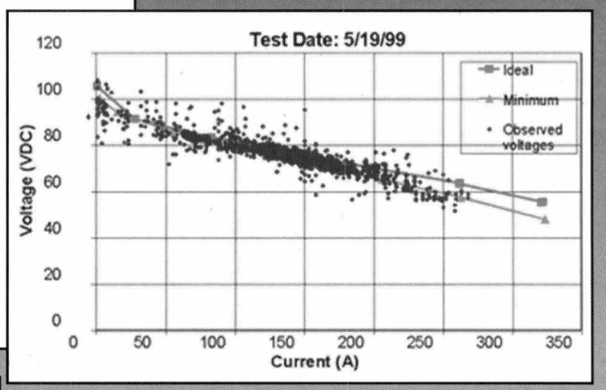


Photo Submitted

How it works . . .

Hydrogen and oxygen are supplied on either side of the cell. Graphite plates have channels in them so that the reactants are evenly distributed over the platinum catalysts. The hydrogen and oxygen meet on separate sides of a sandwich made up of the catalyst, the proton exchange membrane (PEM), and another catalyst. Hydrogen atoms cannot pass through the PEM and are forced to take the long way around to get back to the catalyst on the other side. This path is where the load is connected. On the other side of the cell the protons join back up with their electrons and react with oxygen to form water. Each cell supplies about 1.1 volts with no load on the cell. These cells are connected in series to form a stack. In reality the fuel cell isn't a constant voltage source, when a load is added the electrons begin to flow from the platinum catalysts producing a current. An increase in the current causes a decrease in voltage. This is shown on the polarization curve below. Things like reactant flow rates, humidity, and pressures change the curve. The DOE GATE fuel cell group at Virginia Tech is doing research in this area. Also, different operating procedures must be strictly followed so that the stack is not damaged. For instance if the reactant flow is cutoff and there is still a load on the fuel cell the reactants in the fuel cell will be depleted creating a vacuum that causes irreversible damage. Designing a system that achieves maximum power output and safely operates the fuel cell is difficult but critical.





THE THINGS YOU LEARN IN CLASS TO THE TEST."

Obviously hydrogen has to be handled differently than gasoline. Over time, gas stations may upgrade to some type of hydrogen delivery system, but right now researchers are experimenting with reformers that would convert common liquid fuels such as ethanol into something that can be processed by a fuel cell. Also, some people have speculated that fuel cells themselves could function as batteries by also operating in a reverse mode. The water that is normally given off as exhaust would be captured and saved. Energy would be put into the system to convert the water back into hydrogen. After the vehicle was done "charging," it would be refueled and ready to go.

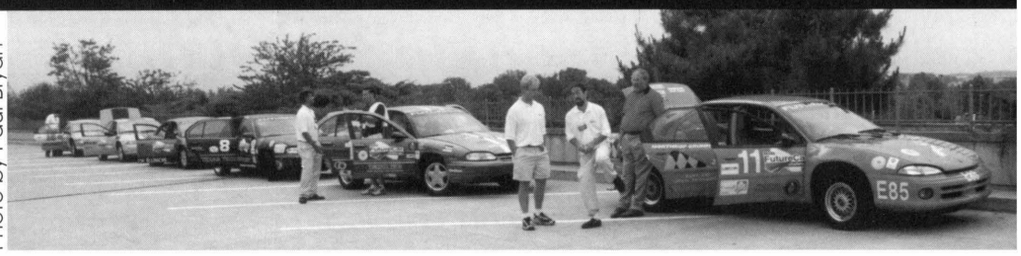
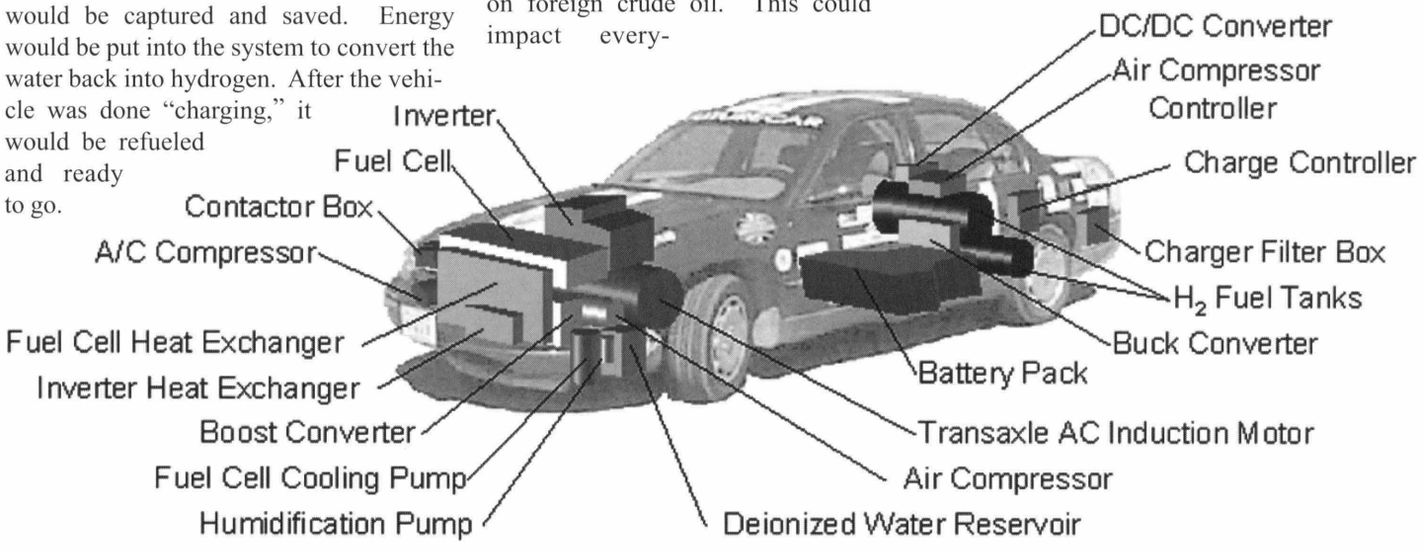


Photo by Paul Bryan

All the teams line up before a drive through Arlington National Cemetery .

No one knows exactly what the future will hold, but if fuel cell technology pans out it could drastically reduce our reliance on foreign crude oil. This could impact everything from your everyday life, to US economic structure, and possibly foreign relations. EF



WHAT'S TO COME . . .

This year's vehicle is a 2000 model GMC Suburban. The team plans to convert the Suburban to run on four fuel cells for the future truck challenge to be held in Mesa, Arizona. Events at the course will be foucsed on truck performace with events such as offroad handling and towing. The vehicle will have over 200kW of electric motors powering all 4 wheels, and a towing capacity of 7,000 pounds. The team is obviously undertaking an even bigger project this year. They hope to improve on what they learned last year by learning from last year's mistakes and improving fuel cell support system efficiency. With these improvments they'll need to put in plenty of hours designing and building the Suburban.

Working on cutting edge technology is fairly challenging, but it's also a lot of fun. Handling over 400 amps is definitely exhilarating. That amount of current provides a phenomenal amount of torque to the motor producing clouds of white smoke and the smell of burnt rubber or in some cases sheared axles.

With so much on the line, this type of work really puts the things you learn in class to the test. There's nothing like the moment just before you connect a 336 volt battery pack. Everything was planned out, designed, and double-checked. This is going to work, right? Ok, flip the switch. Stand back. Flick, wow, it works!

The project is linked with a mechanical engineering design class, ME 4015 and 4016. Most of the team is made up of senior mechanical engineering students taking the class, but with all the different systems there's definitely something for everyone even if you happening to be majoring in something else. The team meets on Monday nights at 7pm in Randolph 120 and anyone and everyone is welcome to attend meetings and find out how they can help out. Also, check out http://www.vt.edu:10021/org/hybridcar for more information.

THE LAWS OF ANALYSIS

1 Engineering is done with numbers. Analysis without numbers is only an opinion.

2 Design is an iterative process. The necessary number of iterations is one more than the number you have currently done. This is true at any point in time.

3 Your best design efforts will inevitably wind up being useless in the final design. Learn to live with the disappointment.

4 (Mar's Law) Everything is linear if plotted log-log with a fat magic marker.

5 At the start of any design effort, the person who most wants to be team leader is least likely to be capable of it.

6 In nature, the optimum is almost always in the middle somewhere. Distrust assertions that the optimum is at an extreme point.

7 Not having all the information you need is never a satisfactory excuse for not starting the analysis.

8 When in doubt, estimate. In an emergency, guess. But be sure to go back and clean up the mess when the real numbers come along.

9 Sometimes, the fastest way to get to the end is to throw everything out and start over.

10 There is never a single right solution. There are always multiple wrong ones, though.

11 (Edison's Law) "Better" is the enemy of "good".

12 (Shea's Law) The ability to improve a design occurs primarily at the interfaces. This is also the prime location for screwing it up.

13 The previous people who did a similar analysis did not have a direct pipeline to the wisdom of the ages. There is therefore no reason to believe their analysis over yours.

14 The fact that an analysis appears in print has no relationship to the likelihood of its being correct.

15 The odds are greatly against you being immensely smarter than everyone else in the field. If your analysis says your terminal velocity is twice the speed of light, you may have invented warp drive, but the chances are a lot better that you've screwed up.

16 A bad design with a good presentation is doomed eventually. A good design with a bad presentation is doomed immediately.

17 (Larrabee's Law) Half of everything you hear in a classroom is crap. Education is figuring out which half is which.

18 The schedule you develop will seem like a complete work of fiction up until the time your customer fires you for not meeting it.

19 It's called a "Work Breakdown Structure" because the Work remaining will grow until you have a Breakdown, unless you enforce some Structure on it.

20 (Bowden's Law) Following a testing failure, it's always possible to refine the analysis to show that you really had negative margins all along.

21 (Montemerlo's Law) Don't do nuthin' dumb.

22 (Varsi's Law) Schedules only move in one direction.

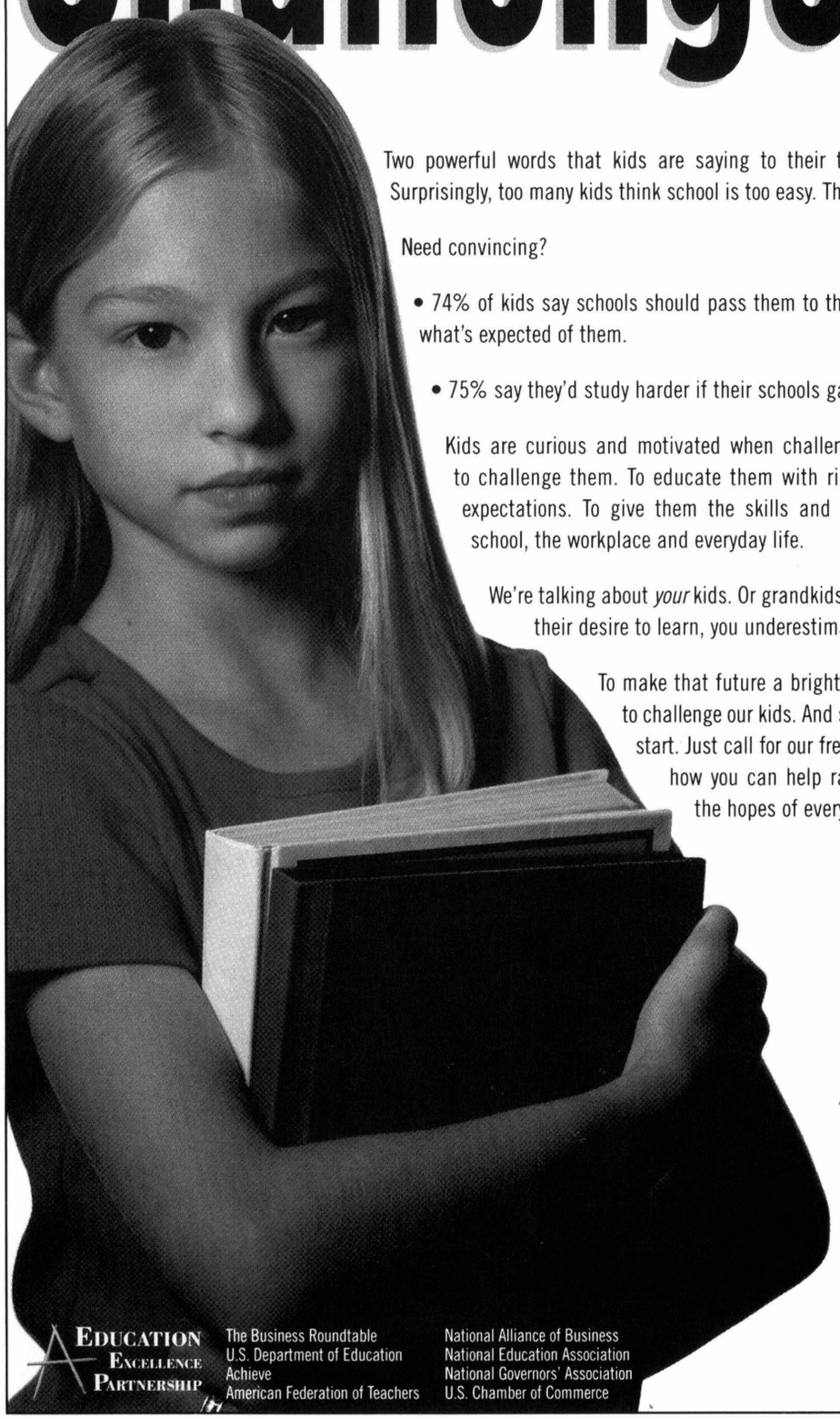
23 (von Tiesenhausen's Law of Program Management) To get an accurate estimate of final program requirements, multiply the initial time estimates by pi, and slide the decimal point on the cost estimates one place to the right.

24 (von Tiesenhausen's Law of Engineering Design) If you want to have a maximum effect on the design of a new engineering system, learn to draw. Engineers always wind up designing the vehicle to look like the initial artist's concept.

25 The 90-90 rule of project schedules: The first 90 percent of the project takes 90 percent of the alloted time. The last 10 percent takes the other 90 percent.

(Formerly Akin's Laws of Spacecraft Design)

Challenge me.



Two powerful words that kids are saying to their teachers, their schools, their parents. Surprisingly, too many kids think school is too easy. They need, and *want*, to be challenged.

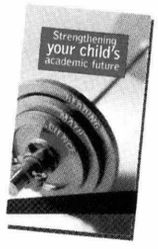
Need convincing?

- 74% of kids say schools should pass them to the next grade only when they've learned what's expected of them.
- 75% say they'd study harder if their schools gave them tougher tests.

Kids are curious and motivated when challenged in school. Now it's our challenge to challenge them. To educate them with rigorous academic standards and high expectations. To give them the skills and knowledge they'll need to succeed in school, the workplace and everyday life.

We're talking about *your* kids. Or grandkids. Or kids you know. If you underestimate their desire to learn, you underestimate their future. And ours.

To make that future a bright one, we need to challenge our schools to challenge our kids. And support schools in that effort. It's easy to start. Just call for our free booklet. It's filled with information on how you can help raise academic achievement. And raise the hopes of every kid who wants to succeed.



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U.S. Chamber of Commerce

Ad Council

Buyer Beware
Online Trading Truth

by Theodore Hessing

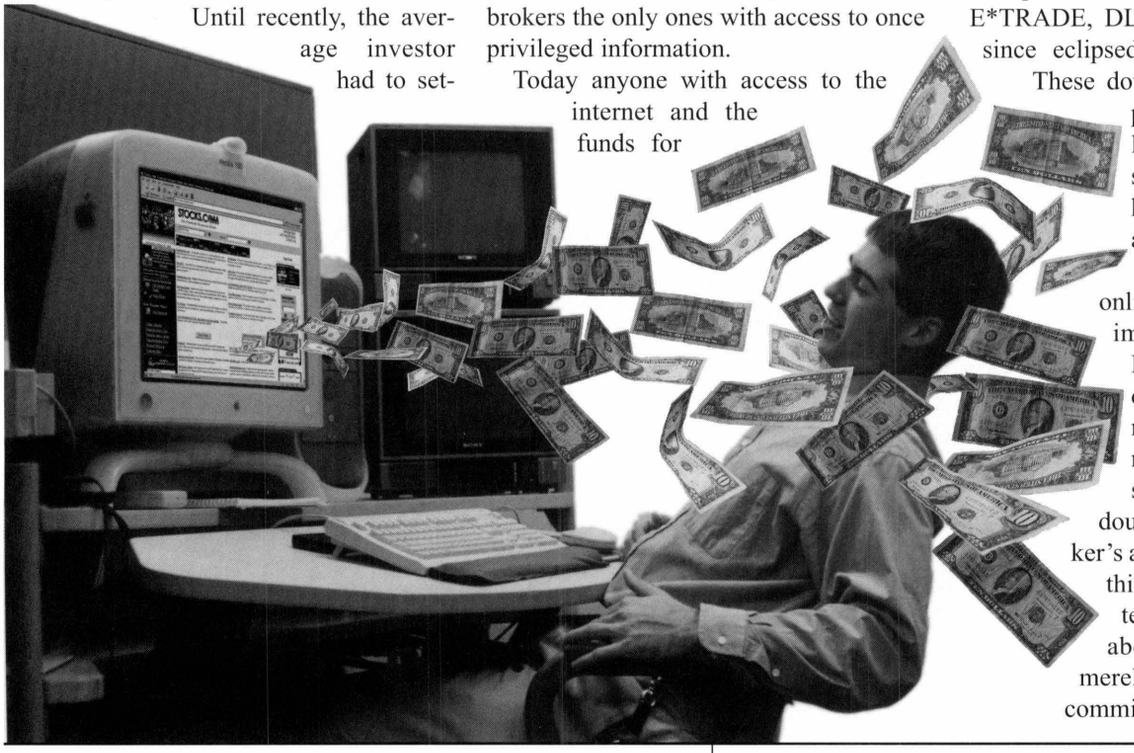
A month has passed since the lucrative job fair sponsored by the SEC and visions of sugarplums are still dancing in my head. In between lectures or driving home from classes, I drift into a commercial-inspired daydream of online trading with the possibilities of a new income and my pending stock options. Just like the ads with the wealthy Grandma coming to a small country's aid or the Gen X-er with the nose ring, I too can enjoy spontaneous radical riches… Those ads boasting instantaneous wealth seem too good to be true. Are they?

For almost a century stock trading has been the purview of the already wealthy and the financial cognoscenti of the investment world. They have enjoyed almost exclusive access to the lifeblood of investing -- timely, accurate information. Until recently, the average investor had to settle for mutual funds or the whims of a broker.

Why was this so? A stock exchange is a market for the sale and purchase of securities of corporations. Due to government regulations, only members who prove their solvency can trade on a stock exchange. The limit placed on the number of seats an exchange issues results in the each seat being enormously expensive. Those who own seats, and thus are able to trade on the exchange, are classified into two broad categories: the commission broker and the private trader. Commission brokers are in the business of using their membership on an exchange to purchase securities for their clients for a transaction fee. For years, the general public's only access to exchanges the world over were commissioned brokers. This is true no longer. Nor are the brokers the only ones with access to once privileged information.

Those ads boasting instantaneous wealth seem too good to be true. Are They?

Today anyone with access to the internet and the funds for an initial deposit can play the Wall Street game. A plethora of web-based companies have grown to fill the void between 'publicly-traded shares' and the public. Companies such as Ameritrade, E*TRADE, DLJ Direct, and others have since eclipsed the commission broker. These dot-com startups often boast prices for trades much lower than the commissions that traditional brokers place on every transaction an investor makes.



To the do-it-yourselfer, online trading has definite and immediate advantages. Brokers, electronic and traditional alike, get paid regardless of if an investor makes a profit or not. The skeptical investor may doubt the veracity of his broker's assurances when he realizes this. There is no sure way to tell if a broker truly cares about your interests or is merely concerned with his own commission.

"Full-service brokers are expensive. For each trade executed a fee is charged. Typically 7% of total dollar amount."

The Do-it-yourselfer's most poignant concern must be the objective evaluation of his own ability to successfully manage his funds. Like that broken garage door out back, it may be safer (and worthwhile) to enlist professional help.

Common sense tells us that the best technique for asset protection is knowledge. A basic understanding of financial principals is fundamental. The ability to trade securities with the click of a mouse is efficient and powerful. An understanding of the market is essential to success in any sort of investment venture. The discipline to perform the necessary investment research is especially pertinent when trades can be conveniently made at any hour of the day, at anyplace where you have an internet connection.

Brokerage Basics

A person who wishes to buy shares of stock must place an order with a broker or a brokerage firm. The broker, traditional or otherwise, obtains the price from a computer system and relays the order to the stock exchange. Small orders are executed electronically in seconds. A record of the transaction is sent immediately to stock tickers and electronic ticker display devices at brokerage firms throughout the country.

The traditional brokerage

How it works:

The oldest member of the security trading family is the full-service brokerage firm, or traditional broker. To place a trade with a traditional broker all an investor needs to do is open an account with an existing brokerage. This is as simple as opening a new bank account. However, unlike a bank account, the same professional handles an investor's financial concerns. When the time comes to purchase or sell a security all the investor needs to do is to contact the broker who he opened an account with and ask the broker's advice on the market, securities, and specific types of transactions possible.

Advantages:

The no 'look ma, no hands' approach is very valuable for those who are easily confused by or don't have time to research the market. Relying on a professional's advice can be extremely rewarding. Brokers trade professionally everyday. They have experience and training well beyond the everyday investor.

"Many brokers do not care if the investor makes money or loses money for his clients, he makes a commission either way."

John Mendez, a former stock broker based in New York, had this to say: "Having a broker is has its advantages. You have access to information that is not publicly known.

Also you can get involved with IPOs (Initial Public Offerings)." In a world that can turn upside down in a heartbeat with pending news, the ability to access and interpret information is vital. The ability to take advantage of IPOs, limit orders, and other brokerage-specifics can be very valuable to an investor's bottom line.

What to watch for

Full-service brokers are expensive. For each trade executed a fee is charged. "I charged at least $250 a trade," Mendez remembers. "Typically 7% of total dollar amount." This exorbitant pricing system can build up on the unwary investor.

Another common problem amongst customers of the full-service brokerage is lack of trust. Because the broker receives a commission (often a percentage of the value of the trade), it is difficult to discern whether the advice to trade the broker gives you is designed to increase your portfolio or to rate another commission. "Many brokers do not care if the investor makes money or loses money for his clients," Medez cites. "He makes a commission either way."

It is important to note that few brokers are interested in generating a quick one-time score on a commission earned off of a bogus tip. Most brokers are interested in having a long-term partnership with their clients, thus generating a lifetime of commissions.

The Discount Brokerage

How it works:

This is the pre-information superhighway version of the do-it-yourself trade.

Much like the traditional broker, for an investor to make a trade with a discount broker all he needs to do is to contact the company that he has an account with. However, the trade is just that simple. The investor simply relays his desires to a broker who executes the transaction.

Advantages:

Trading with a discount broker can be relatively inexpensive when compared to their traditional brethren. Although the

	Full-Service	Discount	Online
Price Per Trade:	$250+	$60-$100	$10-$30
Advice:	yes	for sale	no
Confirmation	paper	paper	paper/electronic reply
Human Contact:	no	yes	yes

discount brokerage doesn't hold your hand on investment matters, if they sense that a trade that you are doing is exceptionally risky they are required by law to warn you of your decision. Discount brokers may also point you in the direction of reliable financial research.

What to watch for:
Discount brokerages are not in the business of providing fiscal counseling or portfolio support the way that full-service brokers do. They are simply there to provide access to the market and to collect their toll along the way.

The electronic brokerage

How it works:
Online brokerages are the information age's equivalents of the discount broker. All of the information is laid out for the investor at the site. In order to trade, the investor simply logs into your account by way of a password or two and selects the appropriate icons.

Advantages:
The hallmark of the Internet is the ease of transfer of information. Online brokerages thrive in this respect. Most provide up-to-the-minute research, news, and financial reports. The 'web' has numerous sites devoted to the information investors need. Speculation, current market trends, performance of cyclicals, glossary terms, and open chat forums are just a click away. In an industry where fast, accurate information is vital to success, the Internet is king.

Convenience is another sublime benefit of online investing. The 'web' is open 24 hours a day.

Convenience is another sublime benefit of online investing. The 'web' is open 24 hours a day. It caters to your schedule. The same information available at 9:00am is there for your perusal when you return from work.

Another major selling point of online brokerages is their ease of use. If an investor can manage a windows operating system and handle basic internet-browsing techniques then he will have no trouble setting up an account. Like other GUI (Graphical User Interface) systems, it is just as easy as pointing the mouse and clicking.

What to watch for:
The same factors that make the online investing such a success also make it an incredible liability. While it is true that the flow of information across the electronic medium can be described as sublime, there are no filters on that information. Anyone can create a web page and post whatever they wish on it. While it is true that online brokers who provide market research stake their professional image on the information found in those reports many 'official' looking pages do not. Generalized web searching tools do not discriminate between accurate information and that of the specious variety.

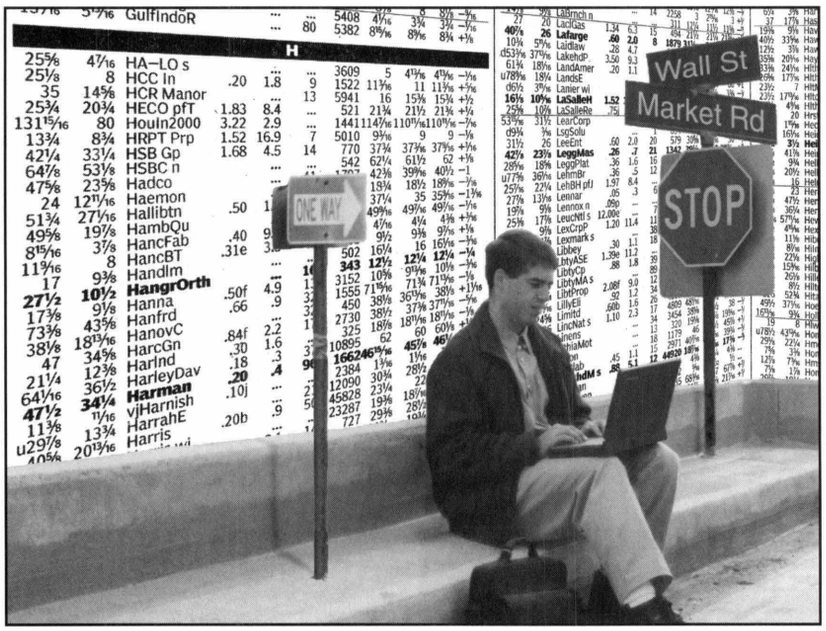
"Brokers do have a great advantage over the home traders." Mendez cites. "The career broker does have access to more info than the average investor on the net. This is a result from doing business with other brokers who tend to share information with each other."

While the convenience of online trading can soothe some of the tension of managing financial responsibilities, the entire operation may seem surrealistic. The investor must realize that while he is simply clicking a button to execute a trade, his money is really being spent. The 'back' button the browser does not erase a trade. Although online trading may seem game-like, there is no reset button.

Finally, the ease of trading online, while simple, errs on the side of deception. When you execute a trade, an order is filed. No matter how fast the execution of the server, how minimal the traffic on the wire, or how speedy the connection is, the trade is not instantaneous. It takes time to process any market order. For nubile investors, this can be confusing. The price of a security may change in during the processing of the trade sometimes resulting in the investor spending more than originally planned. Also, although online trading can be performed at any time, orders received when the market is not in session will be processed on the next business day. Prices can vary drastically in after hours trading on late-breaking news.

In summation, investing, be it electronic or otherwise, is tricky. Be sure to carefully research all of the facts before committing to any trade. BF

"Although online trading can be performed at any time, orders received when the market is not in session will be processed on the next business day."



from the email bag

forum@vt.edu

YOU MIGHT BE AN ENGINEER IF ...

Submitted by Uri Dub

... choosing to buy flowers for your girlfriend or upgrading your RAM is a moral dilemma.
... you take a cruise so you can go on a personal tour of the engine room.
... the sales people at the local computer store can't answer any of your questions.
... you bought your wife a new CD-ROM drive for her birthday.
... you can quote scenes from any Monty Python movie.
... you can type 70 words per minute but can't read your own handwriting.
... you comment to your wife that her straight hair is nice and parallel.
... you have saved every power cord from all your broken appliances.
... you have more friends on the Internet than in real life.
... you know what http:// stands for.
... you look forward to Christmas so you can put the kids' toys together.
... you see a good design and still have to change it.
... you window shop at Radio Shack.
... your laptop computer costs more than your car.
... your wife hasn't the foggiest idea of what you do at work.
... you've already calculated how much you make per second.
... you've tried to repair a $5 radio.

TWO NEW ADDITIONS TO THE PERIODIC TABLE:

Element Name: WOMAN
Symbol: WO
Atomic Weight: (don't even go there)
Physical Properties: Generally round in form. Boils at nothing and may freeze at any time. Melts whenever treated properly. Very bitter if mishandled.
Chemical Properties: Very active. Highly unstable. Possesses strong affinity with gold, silver, platinum, and precious stones. Volatile when left alone. Able to absorb great amounts of exotic food. Turns slightly green when placed next to a shinier specimen.
Usage: Highly ornamental. An extremely good catalyst for dispersion of wealth. Probably the most powerful income-reducing agent known.
Caution: Highly explosive in inexperienced hands.

Element Name: MAN
Symbol: XY
Atomic Weight: (180+/-50)
Physical Properties: Solid at room temperature, but gets bent out of shape easily. Fairly dense and sometimes flaky. Difficult to find a pure sample. Due to rust, aging samples are unable to conduct electricity as easily as young samples.
Chemical Properties: Attempts to bond with WO any chance it can get. Also tends to form strong bonds with itself. Becomes explosive when mixed with KD (Element: Child) for prolonged periods of time.
Usage: None known. Possibly good methane source. Good specimens areable to produce large quantities on command.
Caution: In the absence of WO, this element rapidly decomposes and begins to smell.

letter from the
editor

The Convenience of Technology

Do you often find yourself typing things like 2 + 2 or 3 x 6 into your calculator? Do you find it ridiculous when a store won't accept your check card for payment? Do you find yourself not buying certain brands or using certain services because you can't adequately research them online? Do you get upset when teachers specify that a certain number of your sources for a paper must actually be book? Do you find yourself annoyed when people don't read and respond to their e-mail within an hour or two?

Do you find yourself relying too much on technology? I know I do. It's convenient. It's quicker. It's the way our generation expects things to be. But, I think there is a difference between taking advantage of technology and using it as a crutch.

Recently, I walked into a classroom to take a statistics test and realized that I'd forgotten my calculator. At first, I freaked out and tried to figure out how I'd do in the class if I failed a test, but then I thought about it and realized that the math required was no more than basic algebra and some multiplication. When was the last time that you had to multiply numbers like 6127 x 3324? Do you even remember how? Could you still do long division? I don't see anything wrong with using a calculator all the time, but it is a problem if you don't really understand the problem or what you are doing to get the answer. We should not be so dependent onour calculators that we feel the need to carry backup batteries. There is a reason that they teach you the fundamentals in elementary school.

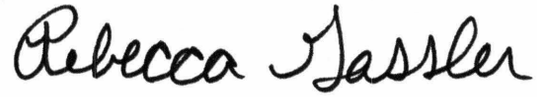
Do you find yourself relying too much on technology?

We become so used to certain conveniences that we don't realize that's what they are — conveniences. Lately, it seems rare that I actually have cash on me. Everyone will take my bank card or my credit card . . . except when I really need them to. I expect that everyone will accept it rather than thinking of it as a benefit to shopping at that store. There is nothing that says that a store has to take electronic forms of payment, but I am willing to bet that a store will lose business if they don't. For example, paying for gas with a credit card at the pump has become so commonplace that I find myself avoiding gas stations without that option. Now, some may call people like me lazy because we are not willing to go into the store to pay, but really, it's just a lot quicker to pay outside. And, if it an option available to me, why not exercise it?

Another novelty that has also become so commonplace that without it, you may be backwards is access to the internet and e-mail. I lookup directions to places, companies I might want to work for, and places I might want to visit. It has come to the point where a company's website determines a large part of its image. It is the first impression many people get, and it is important. If I can't even find a website, a company or service loses a lot of value in my eyes. Internet research has become very common, as well. Why not? It's free, it's easy, and there are recent publications that may be harder to get in a traditional library.

But. . . . the worst technological annoyance to me is e-mail and its users. It can be both a blessing and a curse! In this university especially, I find that there is an ever increasing reliance on e-mail communication. But there are always those few professors and students who check their mail only once a day or every few days — and then they miss meetings or the subject of the e-mail become irrelevant after too much time passes. Now, I'm not one of those people who leaves my e-mail on all of the time, but I do check it several times a day and I try to respond promptly. Sometimes, especially at work, I find that people send messages just "to get things in writing." This seems like a good idea because often phone messages or paper memos can be misplaced, but the mail is always there on your computer. But e-mail is only beneficial if used correctly — many of us are on listserves where people respond to one person by sending a message to the whole list, or who use it as a forum to pass on their chain letters promising them money, or good luck in relationships, or any number of things if they pass it on in under an hour to every person they know. Things like this are an annoyance to all.

Technology like e-mail, or any technology for that matter, is great. But, we can't use it for a substitution to knowledge, we can't take it for granted, and we must utilize it so that it is benficial. So, if you have any comments on this subject, feel free to e-mail me at rgassler@vt.edu and I promise to reply – promptly!



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