Technology Observer

NJIT™
New Jersey's Science & Technology University

The Science & Technology Magazine Published by students of Albert Dorman Honors College of New Jersey Institute of Technology

ISSUE 07 Volume 1

“I have not failed. I’ve just found 10,000 ways that won’t work.”

- Thomas A. Edison

“There’s a better way to do it - find it.”

- Thomas A. Edison

Letter from the editor

Advances in particle theory, amazing medical breakthroughs, and the discovery of new planets are just some of the changes that technology has brought to our planet. While technology has enabled some people to acquire immense wealth, it has given hope to others with its contributions in the worldwide battle against hunger and disease. Technology has enabled the sharing of immense amounts of information over enormous distances, and although you still cannot quite transport yourself to the other side of the planet via the internet alone, you can rest assured that someone somewhere is working on that.

With all of the advances in technology that clog the media, like smaller and more powerful cell phones, larger and more vivid HD televisions, and cars filled with the latest gadgets, not much attention is paid to what goes into the manufacturing of modern products, or how one might recycle their old or more likely outdated electronic toys. The truth is that there are several companies out there that are making a serious effort to remove certain chemicals, like mercury and arsenic and other harmful or environmentally unfriendly substances, from their factories and products. Even so, their efforts are overshadowed by the inflexibility of the automobile industry. Car companies may or may not be removing harmful chemicals from their vehicles, but they are also replacing steel and other durable materials in their cars with plastics and ceramics so that the vehicles are lighter and burn less gasoline.

Even though burning less fuel is a good thing, the method that most car companies have adopted is a prime example of applying a patch fix instead of attacking the root cause of the issue. The problem is poor fuel economy, and the most direct way to remedy this, and the most logical on many fronts, would be to improve the efficiency of the engine or to change the engine so that it uses a fuel that is more plentiful and more environmentally friendly than the currently used source. Instead of using one of these approaches, manufacturers have replaced steel bumpers with plastic, and although they do make the car lighter, these bumpers are also easier to break. This means that, now that the average bumper is plastic, when a car hits an ice bank after a storm, or taps another car on the road, the odds are that the plastic bumper will dent very nicely or even shatter completely instead of just scratching like a solid steel bumper would. Since the extent of the damage is more severe, the dealer or body shop can now charge hundreds of dollars to repair or more likely replace the shattered bumper, instead of the driver being able to shrug off the minor accident since it only caused a scratch.

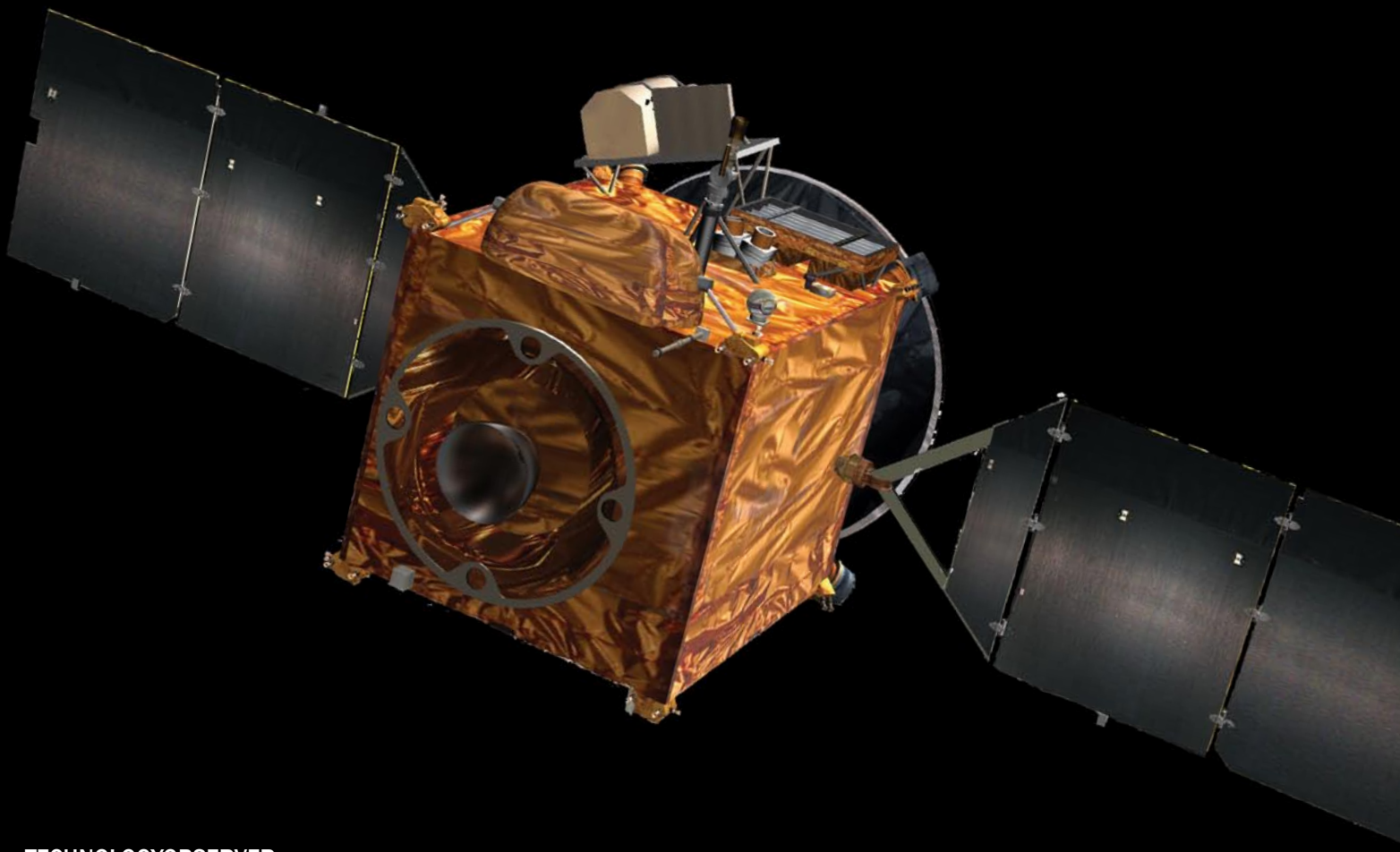
Beyond this new method for making even more money off the consumer, car companies are extremely resistant to putting any real effort into improving the miles per gallon (mpg) or the emission ratings of their vehicles. They are so resistant that when the state of California attempted to create legislation that would require all vehicles sold within the state to meet China's current standard for mpg within a decade, the automobile companies cried that it was too difficult for them to meet such a high standard. Too difficult to meet the standards of China, a country that is not even near the top of the list for strict emissions and mpg regulations.

Since it is more helpful to have a solution ready when pointing out a problem, this issue of our magazine contains an article about Tesla Motors, one of two United States-based companies that are working hard to make electric cars a reality. The cars being produced by Tesla Motors are far more efficient than virtually any other car on the market. The hefty price tag that these cars have makes them inaccessible to most people, but the company is working to get their second and third vehicles to production, which will be less sporty and targeted more towards the average consumer. Even though these vehicles are not expected to be for sale for several years, there are other ways for people to become more energy efficient. Investing in solar panels or geothermal heating are two very viable ways for the average consumer not only to save money on electric and heating bills, but they also help make the world a cleaner place to live. As research towards making solar panels more efficient progresses, more and more homes and businesses will begin to switch over, and many have already.

Although this issue of the *Technology Observer* does not cover all of the issues raised, we hope to include articles concerning these and other similar subjects in future issues. Our goal is to bring readers interesting and informative articles on a wide range of topics, so that readers will feel inspired to do further reading and research in areas that have caught their imagination. Just because something does not make the headlines, or make someone a millionaire, does not mean it is not important and worth looking into. Knowledge and understanding are powerful tools – accumulate as much as possible and use it well.

Sincerely,

Naphtaly Ehrenberg
Editor



Observing the Present with an Eye on the Future

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We would like to express a special thanks to Ms. Lois Hulin, Dr. Paul Dine, LoriAnne Jones, and Christian Howell for their tireless effort and dedication in helping to make this issue of the *Technology Observer* a grand success.

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A letter from our advisor

Dr. Joel Bloom
Dean of the Albert Dorman Honors College
VP for Academic and Student Services

Dear Reader,

In his 2006 lecture, “Educating Engineers for 2020 and Beyond,” Charles Vest, President Emeritus, MIT stated that, “I envy the next generation of engineering students. This is without question the most exciting period of human history in science, technology, and engineering.” In discussing the engineer of the future; he cited the blurring of the lines of science and engineering; the intersection of physical, life, and information sciences; and the need to work with operating systems of great complexity within sustainable development. He described the engineer as reflecting a diverse society with an ability to write and communicate well, focused on ethics and social responsibility, and prepared to live and work as global citizens. The engineering student would be “driven by passion, curiosity, engagement and dreams… We must ensure the best and the brightest become engineers of 2020 and beyond. We can’t afford to fail.” October 12, 2006, Brunel Lecture Series on Complex Systems, MIT

This seventh edition of the *Technology Observer*, a publication founded, managed, researched and written by Dorman Honors College students in order to report on emerging technologies, resonates well with Vest’s observations of the engineer of the future. Our editor, Naphtaly Ehrenberg, in his article about the DARPA Grand Challenge and NJIT’s entry “Optimus,” an autonomous, “driver-less” ground vehicle; Salman Naqvi’s article about the Tesla, a high speed oil-less electric car; and Chris Sabatelli and Francesco Gennarini’s article about Alternative Geothermal Heating, a most efficient heating and cooling technology which is pollution free and also free from using any oil or other fossil fuels, are three of the articles focused on the “blurring lines of science and engineering.”

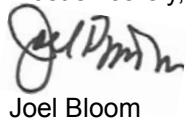
Bhininder Kaur, in her article about stem cell research, explores “one of the greatest revolutions in modern medicine,” as well as a controversial one, balancing what some perceive as social and ethical responsibility. Bhininder also cites the work of NJIT’s Professor Treena Livingston Arinzeh, which uses adult stem cells for the treatment of spinal cord injuries. Alexander Sheppard’s article on “As Science Fiction Approaches Reality” explores the intersection of the brain’s senses with engineered implants currently being used to help some sensory impaired individuals to overcome deprivations of hearing, vision, and touch. He also sees the frontier of the wearable computer for healthy individuals. Both articles are focused on the intersection of the physical, life and information sciences.

Other articles in this *Technology Observer* by Shivang Adhyaru on “Extraterrestrial Agriculture,” “Micro & Nano Robotics” by Bhininder Kaur and Joseph Curcuru’s “The Ghost Particle” all are part of the science and engineering frontier Vest sees in the Engineer for 2020.

An innovation in this edition is a guest editorial written by Professor Richard Foulds of the Biomedical Engineering Department at NJIT. Foulds engages Rudyard Kipling to assist him in reconciling the often perceived irreconcilable university functions of teaching and research. He works closely with the Honors College students and models the reconciliation by creating an integrated learning environment of discovery, research and mentoring. These are our next generation of engineers and scientists. They are as Vest observes: diverse, write and communicate well, driven by compassion, curiosity, engagement and dreams.

Thank you.

Most sincerely,



Joel Bloom

The Campus Center at New Jersey Institute of Technology.

About New Jersey Institute of Technology

THE EDGE IN KNOWLEDGE

NJIT is a public research university enrolling over 8,300 bachelor's, master's, and doctoral students in 76 degree programs through its six colleges, including: Newark College of Engineering, New Jersey School of Architecture, College of Science and Liberal Arts, School of Management, College of Computing Sciences, and Albert Dorman Honors College. Research initiatives include manufacturing, microelectronics, multimedia, transportation, computer science, solar astrophysics, environmental engineering and science, and architecture and building science.

For more information :: njit.edu

About the Albert Dorman Honors College

ENGAGING THE FUTURE

The vision of Albert Dorman Honors College is the engagement of excellent students with the best faculty, original research, and practice oriented projects. The context of this engagement is inquiry based learning, a computer intense campus, an urban setting, diverse populations, global relationships, and an environment that is erudite and transformational.

The Honors College currently enrolls over 500 students, with average SAT scores above 1300. They are enrolled in honors courses, participate in leadership colloquia, are involved with professional projects, and conduct research with faculty at various NJIT research centers. These scholars work closely with national and international businesses and industries, and participate locally in community activities. They are leaders on the NJIT campus, and future leaders in the science, engineering, mathematics, and technology professions.

For more information :: honors.njit.edu

Stanley & team with their $2 million check

Source: www.darpa.mil/grandchallenge/overview.asp

Highlander Racing's OPTIMUS

Source: Highlander Racing

Autonomous Ground Vehicles and the Highlander Racing Team

By: Naphtaly Ehrenberg

Imagine catching a ride in a cab with no actual driver. Imagine telling your car where you want it to go, sitting back to read the paper, and alleviating all the stress of watching the road. This kind of capability would enable people to work while in transit, in the comfort of their own cars, without having to follow the schedule of a train or airplane. Alternately, think about how much safer military supply chain workers would be if they did not have to "baby sit" every convoy in poorly armored trucks once the trucks can drive themselves. While these applications are not yet available, they are some of the primary initiatives behind the government's Defense Advanced Research Projects Agency, known as DARPA, which is actively pushing this area of research and development forward.

DARPA has already held two desert races to test autonomous ground vehicles. To compete in these races, several teams designed and built vehicles with a variety of onboard sensors and computing power. The vehicle was intended to be capable of navigating through or around several representations of common roadway obstacles, including stopped cars, debris, or tight squeezes along the vehicle's path. The first race was held in 2004, but unfortunately none of the participating vehicles even came close to finishing the race as they were plagued with a variety of issues, including poor navigation and unsuccessful turns. The prize incentive for the first race had been $1 million, and with no winner, DARPA upped the ante to $2 million and scheduled another race for October of 2005.[1 2]

To compete in the second race, a team had to be among the forty semifinalists selected to compete in the two-round national qualification event from among the teams visited by DARPA officials. From those forty, twenty-three teams were selected based on performance to compete in the actual race – a 131.6-mile course through the Mojave Desert. The national qualification event consisted of a race track with several obstacles and gates that the vehicles were required to either navigate through or around, including a stopped vehicle sitting in the middle of the track, a pair of 55-gallon drums set up with just enough room between them for a vehicle to pass, and an above-ground tunnel. The Stanford University racing team, whose vehicle was named Stanley, was the only robot to avoid all obstacles and pass through both gates on all of its qualifying runs.[1 2 3 4] Unfortunately, NJIT's racing team, which had only recently been formed, was not able to bring their vehicle, called OPTIMUS, up to spec in time for the national qualification event, as the internal coordinate system for navigation was flipped.

On October 8, 2005, the twenty-three finalists lined up in the Mojave Desert and started a historic race. Almost seven hours later the first vehicle crossed the finish line. Stanley, the Stanford University robot, won its team the $2 million prize and finished the race in just under six hours and fifty-four minutes. About ten minutes later, Stanley was followed by one of Carnegie Mellon University's robots, called Sandstorm, and another ten minutes after that by the University's other robot, Highlander. About fifteen minutes later, the fourth-place vehicle, Gray team's KAT-5, or Graybot crossed the finish

From the top: Stanley #1, Sandstorm #2, Highlander #3, Graybot #4, TerraMax #5 but past the ten-hour limit.
Source: www.darpa.mil/grandchallenge/overview.asp

line, and was the last to finish the race before the mandated ten-hour limit. One other vehicle, the Oshkosh TerraMax, also finished the race.[1 2]

Stanley, the winner of the race, was a modified diesel-powered Volkswagen Touareg R5, with a drive-by-wire control actuation system that was developed by Volkswagen of America Electronic Research Lab. The actuation system in Stanley was controlled by a computing cluster comprised of seven Pentium M processors running off of an electronically controlled power supply. This computer system was attached to a variety of sensor equipment that provided the necessary information for Stanley to make navigation and speed decisions, which were then sent to the actuation system for implementation.[3 4]

Stanley's sensory system was responsible for providing the computing cluster with two different types of information - position with respect to the way points of the course, and environmental perception. The position system incorporated measurements from a GPS receiver, a 6 degree of freedom (DOF) inertial measurement unit, and a wheel speed monitoring device. The GPS receiver provided position information by using the United States Navy's satellite-based Global Positioning System. The 6 DOF inertial measurement unit supplied acceleration and velocity measurements in six directions, and its readings were combined with the wheel speed device to produce an accurate picture of the vehicle's velocity. By using all of this sometimes overlapping information, the control system was able to maintain a reasonably accurate reading of where the vehicle was located with regard to the race track way points.[3 4]

The environmental perception system, however, was much more complex as it had to provide detailed information about the location of obstacles and their size, in addition to following the drivable area of the track. This system employed four laser range finders, radar, a stereo camera pair, and a monocular camera system. The laser and radar systems were used to define the distance the vehicle was from an obstacle, and the relative space dimensions of the obstacle when relevant. The stereo and monocular cameras were needed to find drivable areas of track far ahead of the vehicle so that they could provide the computing system with a long line of sight and enable the vehicle to safely travel at high speeds. Together, the information received from the position and environmental perception systems was incorporated into navigational decisions at a rate of about 10Hz. This two-part system performed well and allowed Stanley to not only finish the race with an average speed of about 19 mph, but to pass another moving vehicle as it was traveling along the race track.[3 4]

The Urban Challenge

In 2006, DARPA announced the next step in their project to promote the development of autonomous ground vehicles: an Urban Challenge. In this third race, the participating vehicles will not only have to follow a path and avoid obstacles, but they will also have to obey traffic regulations and coexist with other traffic as they travel through a simulated urban environment on a mock supply mission. Some specific challenges include maintaining proper speeds and following distances while navigating a series of road types: well paved streets, potholes, dirt and gravel – all the while not unnecessarily crossing double yellow lines or riding up onto the curb. Vehicles will also be expected to park correctly and will be penalized if they fail to enter far enough into a parking spot, or do so at a significant angle. A complete list of the rules for the Urban Challenge can be found on DARPA's website.[5]

For this race DARPA has created two tracks which are open to all participants. The first track, officially called Track A, is for participants who fill out the necessary paperwork and agree to meet a four-point milestone schedule leading up to the final race. Teams approved for this track will be eligible for up to $1 million in technological development funding from DARPA. Track B, which is for all other participants, has two qualification

events preceded by a site visit. The technical requirements for both shared qualification events will be the same to ensure that there is an equal level of performance present in both tracks. All teams that pass the final qualification event will be invited to participate in the Urban Challenge, which has prizes of $2 million for the first-place vehicle, $1 million for the second, and $500,000 for the third.[5]

NJIT's racing team, called Highlander Racing, is hard at work on their vehicle, OPTIMUS, short for OPerational Transporter for IMmediately Unknown Surfaces, a 2000 Chevy Blazer donated by GM. Highlander Racing, which is also sponsored by IBM, L3, Kearfott, and BAE systems, to name a few, is a member of Track B and is preparing for their video submission.[6]

OPTIMUS has four sets of sensory equipment that collect the necessary information for its computer to make navigation decisions, and these systems fall into two groups, positional and external or environmental sensors. The positional system contains an inertial navigation system, and a differential GPS (DGPS). Direction and speed can be calculated from the positional information received from the DGPS. In order to make up for lag time between GPS readings, and weak or non-existent GPS signals, the inertial navigation system readings provide fairly accurate extrapolated position, orientation, and speed information to keep the system running even without GPS.[6]

OPTIMUS has three types of environmental sensors, including radar (radio detection and ranging), ladar (laser detection and ranging), and stereo-mounted high-resolution cameras. Several long-range Vorad radars will be used to detect the distance, velocity and angular position of objects each within a 12° field of view (FOV) from a given detector that are far away from the vehicle, while ladar, which has a field of view (FOV) of 180°, is used to get distance readings for objects that are nearby. A few ladar devices will be angled towards the ground to provide information on terrain features and to help detect the road edge. The stereo-mounted cameras provide location and texture information on stationary and moving objects, detailed information about the terrain ahead, and assistance in detecting the edge of the roadway.[6 7]

All of the information collected by the position and environmental sensing systems is processed by OPTIMUS's computer and is turned into a plot of the surrounding area. Each point on this plot is assigned a value, where high values indicate areas that are either impassable or are supposed to be avoided due to traffic regulations, and low values indicate areas that are drivable and easily navigable. The computer then attempts to plot a path that follows the waypoints that have been preprogrammed and has the lowest point value. For avoiding dynamic objects, or objects that are moving, the computer has to rapidly update its chosen path to correct for the movement of the object it is trying to avoid. Once a path has been chosen by the computer, instructions are sent to the drive-by-wire system in OPTIMUS which steers the vehicle in the calculated direction.[6] This method is only one of several possible designs proposed for the artificial intelligence of OPTIMUS. Several new and improved methods and algorithms have recently been developed but are being kept secret by the Highlander Racing team.

The successful completion of this challenge will be a major advance towards making the dream of autonomous ground vehicles a reality, and could be an indication that within a decade or two, vehicles of this type may become available to the public. This type of breakthrough in transportation could revolutionize the way the world moves around on the ground and even in the air. It could lead to cheaper public transportation, since driverless vehicles would not require paid overtime, and overnight wages. Driverless vehicles could also alleviate a driver's worst fear, aside from falling asleep at the wheel – namely, getting lost, since a highly sophisticated, satellite-controlled vehicle would be taking the wheel.

Parker motor attached to steering wheel

Parker motors attached to brakes

LADAR and RADAR mounts

Metal platform for computers

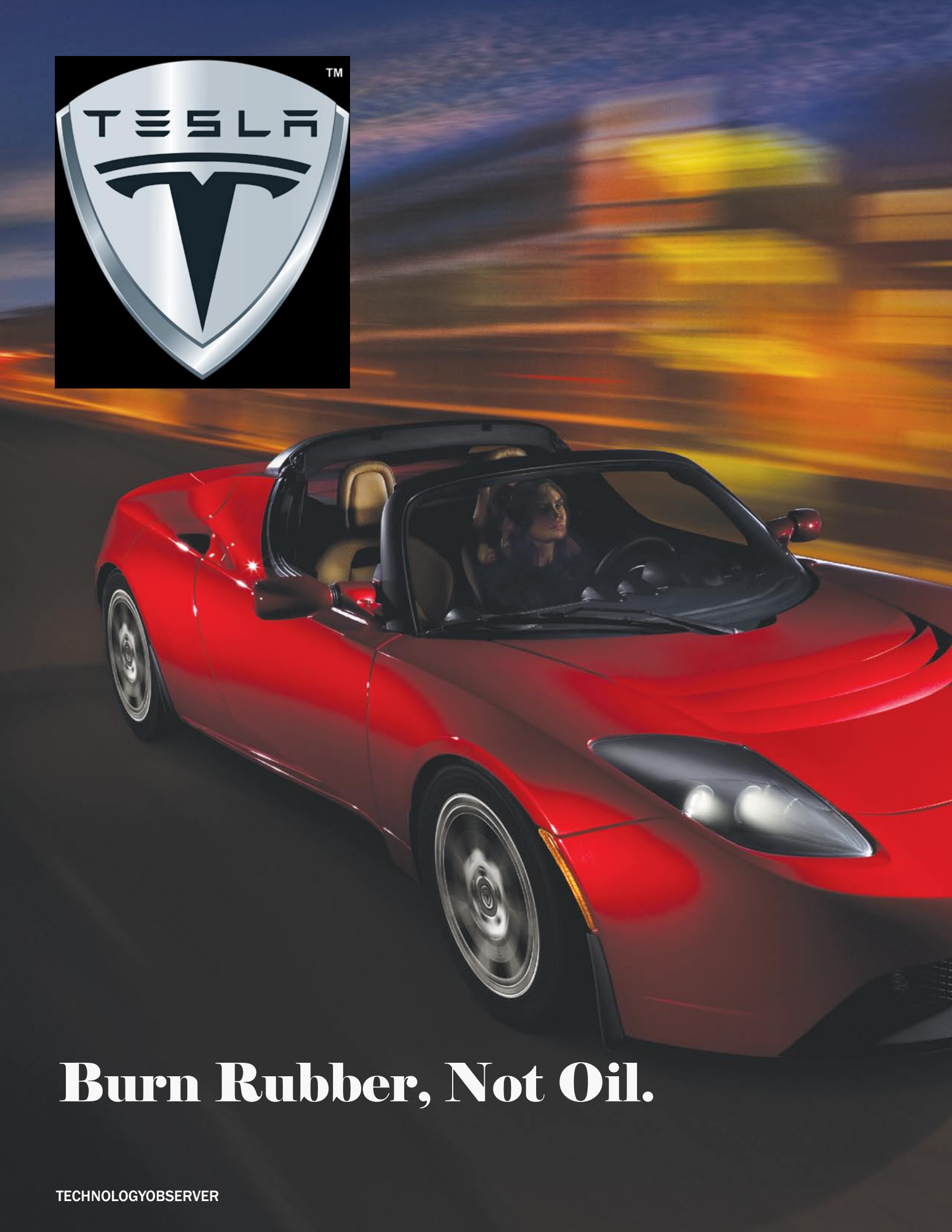
Highlander Racing Team Logo

Generator attached to tire rack

Source: Highlander Racing

Four views of OPTIMUS while under development.

The Highlander Racing Team and their vehicle OPTIMUS.


TESLA
TM
Burn Rubber, Not Oil.

It Goes from Zero to Sixty in Four Seconds, But You Still Won't Hear It Coming

By: Salman Naqvi

Your amazement will find no bounds with this futuristic beauty on wheels. Adding another word to the twenty-first century's dictionary of inventions, we would describe anything that has style on wheels, is ready to beat a Porsche and Ferrari alike, goes from zero to 60 in 4 seconds, tops out at more than 130 M.P.H. and appears to be missing a gas tank, as a Tesla Roadster! It is the 'future' of the road runners. Equipped with four wheels and an electric motor, this bright red vehicle may look like a Ferrari but with a rechargeable lithium-ion battery pack instead of a gas tank, it is nothing like it. These attributes do not do justice in describing this hot sports car. Capable of 250 miles of travel (400 kilometers) on a single full charge, which takes just over three and a half hours, and a structural style that is matched by no other puts this car in a unique class of its own. Such novelty makes it the preference of environmentalists, car fanatics, and the top choice for fast-paced drivers and efficiency seekers. Tesla Motors is on the road and is breaking all the speed, distance, and efficiency records for an environmentally friendly car.

Its internal combustion-free engine and no-emission system governs the fact that Tesla is the first among car manufacturers to make a serious attempt at salvaging the environment. The eco-friendliness of their product is at the top of Tesla Motors' agenda, up there along with performance. Intensive research is being conducted in the field of environmental protection, and this vehicle by Martin Eberhard – Chief Executive Officer of this California based firm – is a major step in the right direction. Eberhard is a man on a mission, determined to reach his goal to mass produce electric vehicles that meet consumer expectations and abolish the trend of oil dependency. "We need to break our addiction to oil",[1] he says but admits that not everyone is as inclined towards sharing his socio-political convictions. In order to bring the market to life, "Tesla can't just ask Americans to behave like better people; we have to build better cars", the CEO stresses. Tesla thus set out to build a "zero emissions" vehicle that can't be accused of being an "emissions-elsewhere" car. Imagine the satisfaction of accelerating at top speed, knowing that the only emissions are the product of the subwoofers and that the only oil present is in the car's transmission as lubricant.

This relieves the driver of oil reliance but also from dependence on any specific power source. Regardless of the primary method of electric power manufacturing that the world adopts, this car will be compatible with it. Whether the electricity is produced by natural gas, coal, solar, wind, hydro or nuclear sources – or a combination of all of them -- the car's design needs no adjustment. Even with the most efficient gasoline engine, you cannot remove all carbon dioxide from the emission, so the only solution to global warming is to remove the whole engine. That is precisely what Tesla Motors has accomplished. California Governor Schwarzenegger has recently pushed vehicle makers to lower emissions and enthusiastically spoke of Tesla Roadster new technology, "I want to say get on board, [but] the train has already left!"[2] You can drive this car and be free of worries of spoiling the environment. We all care for global warming, we all care for our existence on earth, "but we also like to drive!" Mr. Eberhard disclosed his personal feelings saying, "when I drive, I'm beating the hell out of my car, I'm wasting energy too you know. It's just the way I am, and I think that I'm not the only one like that."[3]

He is not the only one like that and hopefully by next year, if anyone can get around the 200 plus person waiting list, they can also rock on the sporting wheels of the Roadster, and trace down what makes them tick. All that Tesla has to offer is unique to this Roadster and lacking in past electric vehicles and even modern vehicles. This visually striking package features a double-wishbone suspension under its light-weight body. It embodies a number of technical features one would expect of a costly sports car, including cross-drilled Brembo brakes readily visible behind its machine-forged ultra-light alloy wheels. 'Why could the electric cars not win wide acceptance in the past?' is a question that has been asked for a long time. Electric cars had two innate problems: first being a lack of driving finesse, and second being a very short range per charge. The Roadster has addressed both of these issues, with its great finesse and long range.

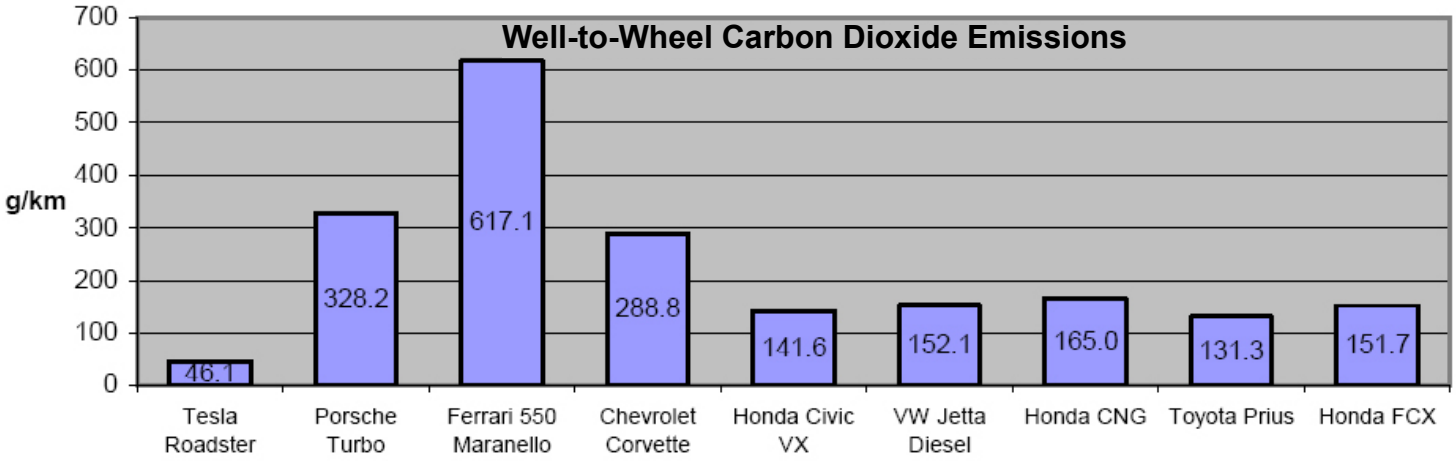
Tesla Motors draws on the progress made in lithium-ion batteries over the past fifteen years and fits in the Roadster's battery pack, 6831 lithium-ion. The increase in power demands of consumer electronic products has increased energy and power densities while dropping cost and making lithium-ion the choice for an electric car. The battery

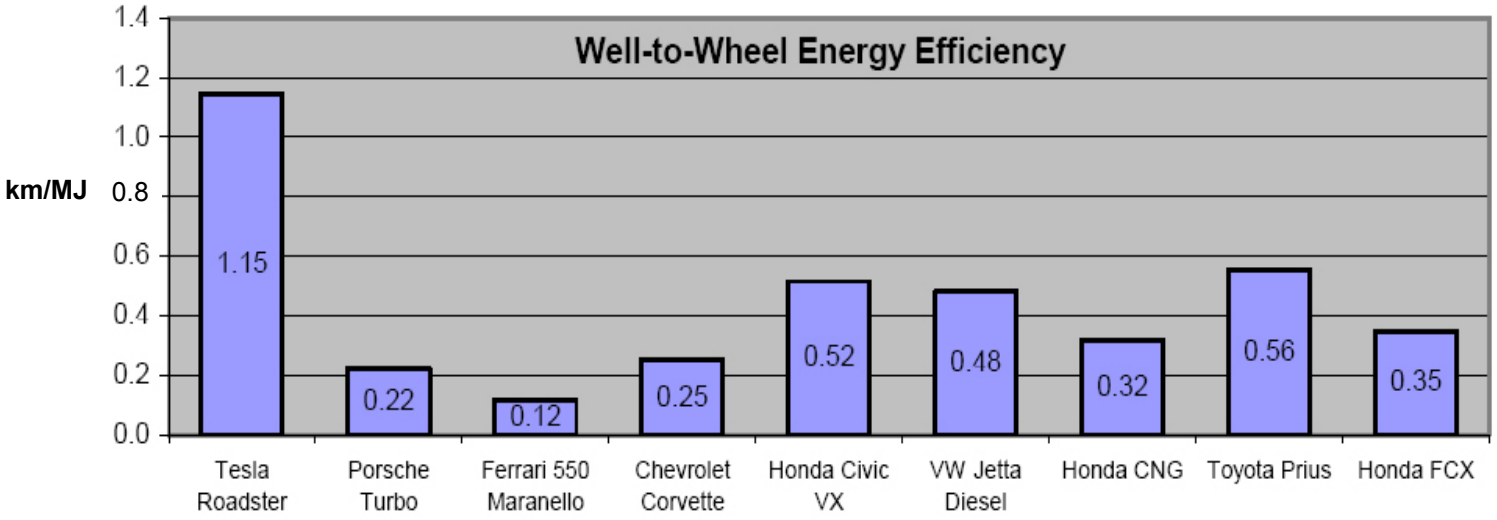
pack operates at 375 volts, and stores about 50 KWH of electrical energy (equivalent of just eight liters of gasoline). Each battery cell has an internal Current Interrupt Device (CID) and a fuse that serves to protect cells from excessive pressure and if this occurs, the CID electronically disconnects the cell.[4] Moreover, efficiency and safety are ensured by the microprocessor present inside each battery pack that communicates with the rest of the vehicle's micro-controllers, broadcasting the voltage and temperature measurements of its cell. With such rigorous technical specification, Tesla's Chief Executive stresses that "40 percent of engineering work has gone into the battery pack."[3] Moreover, Roadster takes a mere three and a half hours to charge from empty to full capacity, which converts to 250 miles of continuous travel in between charges. The Roadster can be plugged in at night, along with a cell phone or palm, and be fully charged in the morning ready and waiting for the morning commute. With no fear of battery memory, the car can be recharged daily even if the battery pack is nowhere near empty. High electric bills are not even an issue, as the car burns electricity at about one cent per mile.

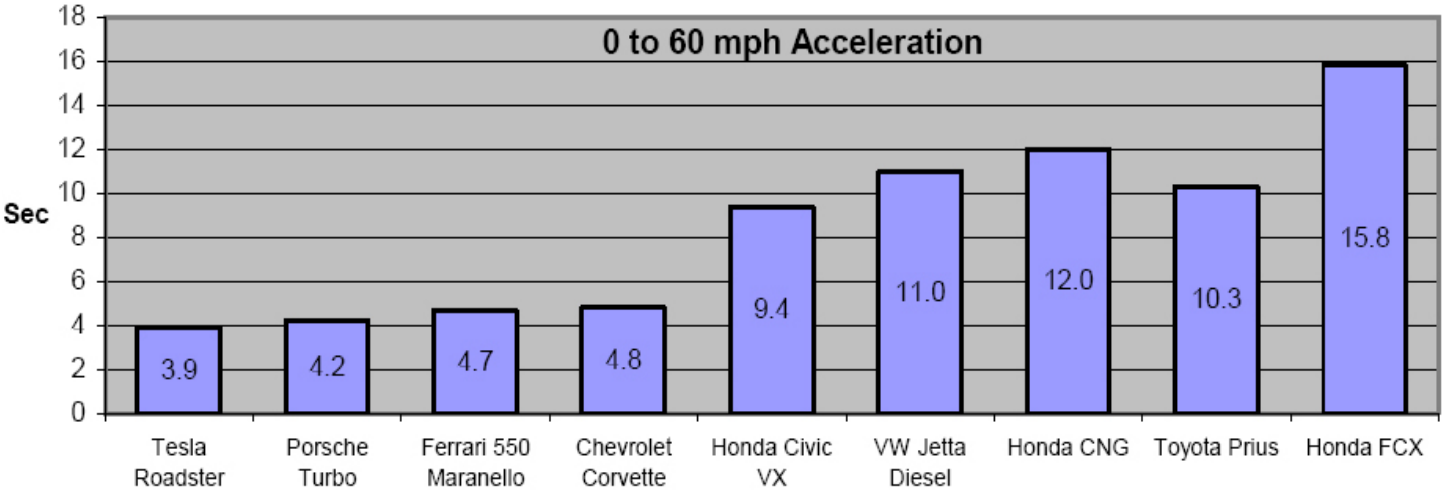
The rest of the 60% of engineering work has gone into improving engine efficiency, transmission performance, and integrating the entire electronic system. A gasoline engine has very little torque at low rpm and delivers reasonable horsepower in narrow rpm ranges, but Tesla's electric motor has high torque at zero rpm, and delivers almost constant torque up to 6000 rpm and continues to deliver high power above 13,500 rpm.[5] This means that a performance electric car can be extremely fast and responsive without a complex transmission or clutch. Moving the lever on the electronic gear shift is all that is needed, as an electronic control system takes care of the shift, enabling the car to blast off from stationary to highway speed without needing the driver to focus on anything except the road, the accelerator and the wheel. Furthermore, as every component of this car is electronically integrated, whenever gears are shifted or the accelerator is pressed, Power Electric Modules (PEM) translate commands into precisely timed voltages, telling the motor exactly how to respond with proper speed and direction of rotation.

Such qualities single this car out from others, but it does not mean that this car is for everyone at present. BMW-riding car freaks would not have any trouble getting this car for their birthday, but the lofty price tag that accompanies this car makes it inaccessible to the masses. The founder of internet's popular eBay auction site and chairman of Tesla Motors' board, Elon Musk, has responded to this issue saying, "These vehicles won't compete on price, [they] will compete on performance"[3] that matches any of the highest-powered gasoline-driven sports-cars. Mr. Eberhard, who has been a member of the team during the three and a half years of work on this project, confirms that Roadster targets a narrow, high-priced niche "rather then being a $25,000 car for everyone the first time."[3] The company is planning to target high-traffic, environmentally sensitive U.S. markets in the first phase, beginning with San Francisco, Los Angeles, Chicago and New York. With 140 orders already in and with the first 100 buyers required to submit 100 percent down payment, Roadster has gotten off to a great start. The public need not worry about the price, as this technology has already knocked the doors of this market down and there are a large number of brilliant future prospects awaiting implementation.

While the two-seater Roadster is nearing its retail stage, Tesla has already begun planning the sister product. Targeted more for mainstream consumers, it will be a five-seater sedan, more on the order of the four-door Audi A4. With production projected at 10,000 and up, Tesla is finalizing the plans for an assembly plant to begin producing the sedan by 2009. Even with its hefty price tag, now that Tesla has eliminated the sources of growing concerns of environmental damage, fuel inefficiency and limited acceleration from their product, the Roadster is set to win a large number of admirers.





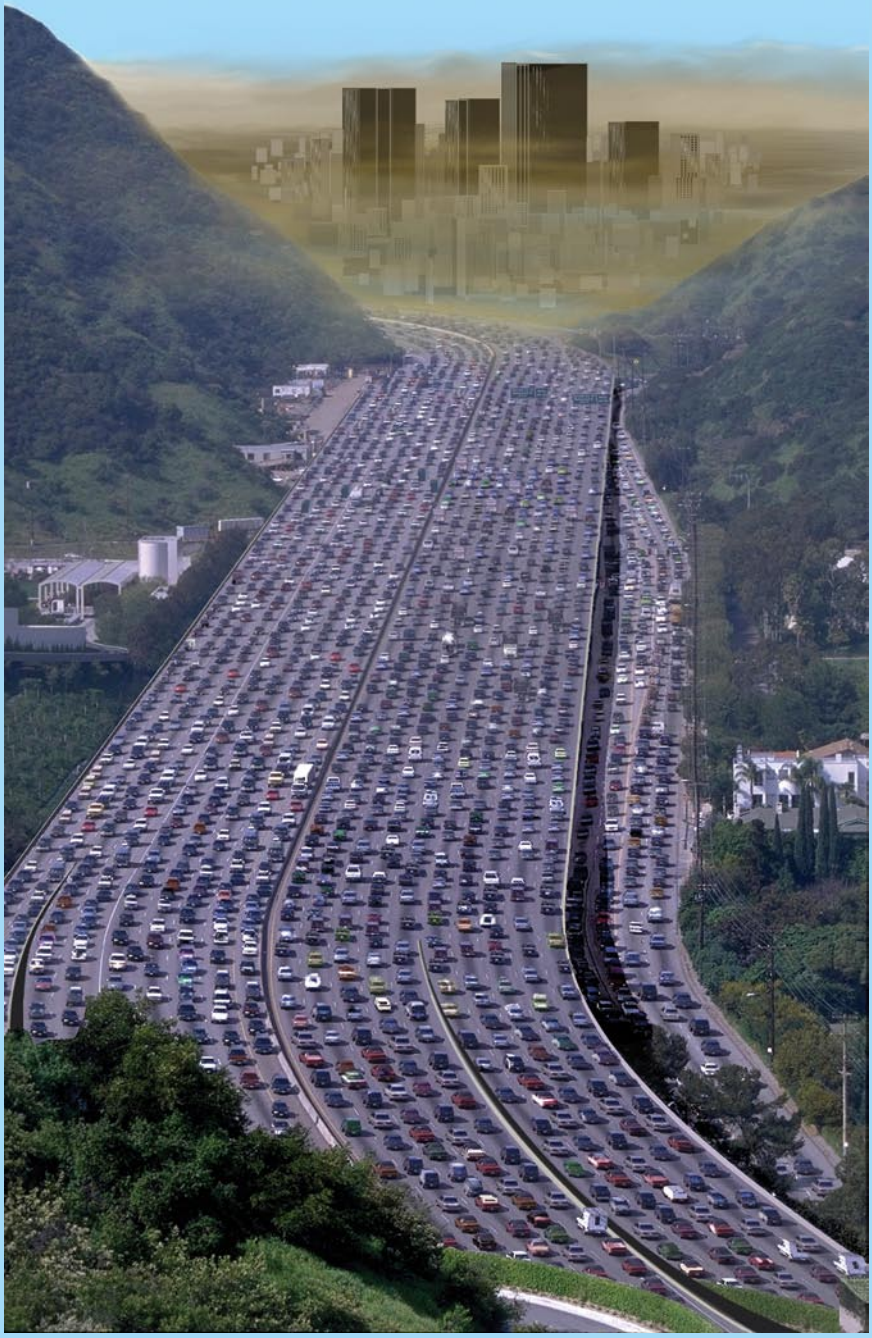


Technology	Example Car	Gas mileage	Well-to-Wheel Efficiency	Well-to-Wheel CO_2 Emissions	0 to 60 mph Acceleration
Electric	Tesla Roadster	110 Wh/km	1.15 km/MJ	46.1 g/km	3.9 sec
Gasoline Engine (Turbo 6-cyl)	Porsche Turbo	22.0 mpg	0.22 km/MJ	328.2 g/km	4.2 sec
Gasoline Engine (V12)	Ferrari 550 Maranello	11.7 mpg	0.12 km/MJ	617.1 g/km	4.7 sec
Gasoline Engine (V8)	Chevrolet Corvette	25.0 mpg	0.25 km/MJ	288.8 g/km	4.8 sec
Gasoline Engine (VTEC 4-cyl)	Honda Civic VX	51.0 mpg	0.52 km/MJ	141.6 g/km	9.4 sec
Diesel Engine (4-cyl)	VW Jetta Diesel	50.0 mpg	0.48 km/MJ	152.1 g/km	11.0 sec
Natural Gas Engine (4-cyl)	Honda CNG	35.0 mpg	0.32 km/MJ	165.0 g/km	12.0 sec
Hybrid (3-cyl Gas/Electric)	Toyota Prius	55.0 mpg	0.56 km/MJ	131.3 g/km	10.3 sec
Hydrogen Fuel Cell	Honda FCX	64 mi/kg	0.35 km/MJ	151.7 g/km	15.8 sec

“Most of the luxuries and many of the so-called comforts of life are not only NOT indispensible, but positive hindrances to the elevation of mankind.”

—Henry David Thoreau *Walden*

View of the early West Side Highway in New York City-
the solution to slow and dangerous traffic movement.
Image > http://www.skyscrapercity.com/



Artist's vision of future automobile usage-
Is this really a solution?
Image > http://www.TransFuture.net

Electronic Facial

By: Bhininder Kaur

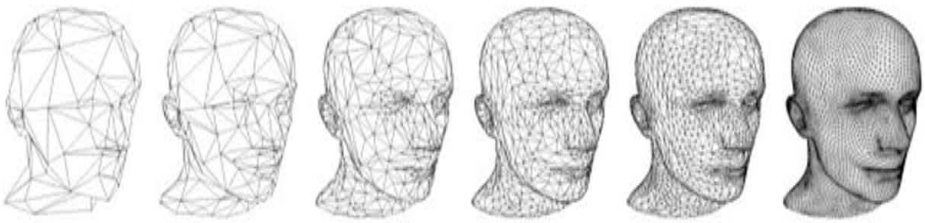
:: Most people can recognize the face of New Jersey Governor Jon Corzine, and so can modern electronics. ::
Image > NJIT University Communications

The human brain has an amazing capacity for recognizing and recalling thousands of faces. Though creating software to emulate this ability has proven difficult, there has been technological progress in the past few years. Benefits of such software to security are extensive, and can range from securing personal data to combating terrorism.

There are two distinct uses for facial recognition software: verification and identification. Verification compares a subject face to a database of face scans. The accuracy of current facial recognition software is very good when used for verification because the subjects in front of the camera typically volunteer for a face scan. As such, all key facial features that the software uses for identification verification are within the range of the scanner, and this results in an optimal scan.

Facial recognition software can significantly increase the security of computers by replacing standard username/password systems, which have traditionally been vulnerable to keyloggers that sniff passwords as they are typed. Other methods of password input, like the use of an onscreen virtual keyboard meant to thwart keyloggers, also have security issues. Sophisticated logging devices can even record the movements of a computer mouse. Facial recognition software presents a solution to these security problems by making the user's face act as the password. This type of application would secure the privacy of individuals and businesses. In this age, information is precious and highly sought and should be kept as secure as possible.

Another use of facial recognition software is for the identification of persons of interest based on images stored in institutional databases. This includes the FBI, and information can be gathered by a department of motor vehicles. The software could be used to identify an escaped convict within a crowd and alert law enforcement agents. It could also be used by intelligence agencies in tracking terrorists and other dangerous individuals. However, the success rate of facial recognition software for such identification and surveillance has not proven very high. In reality, no felon or terrorist would subject themselves to a facial scan, and are not likely to do



Recognition Systems

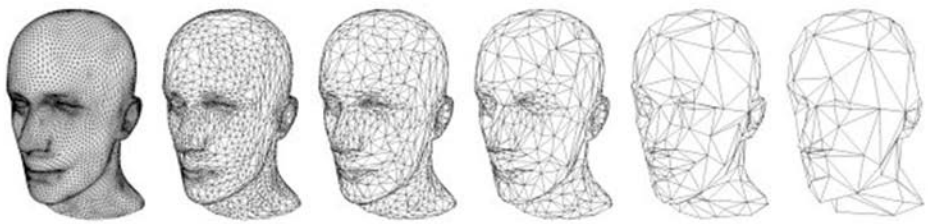
so accidentally while under surveillance, as most people do not orient their faces for proper scan while they go about their daily activities. This need for a direct facial view makes it difficult to get matches in a crowd, and renders this type of facial recognition mostly useless for observation work.

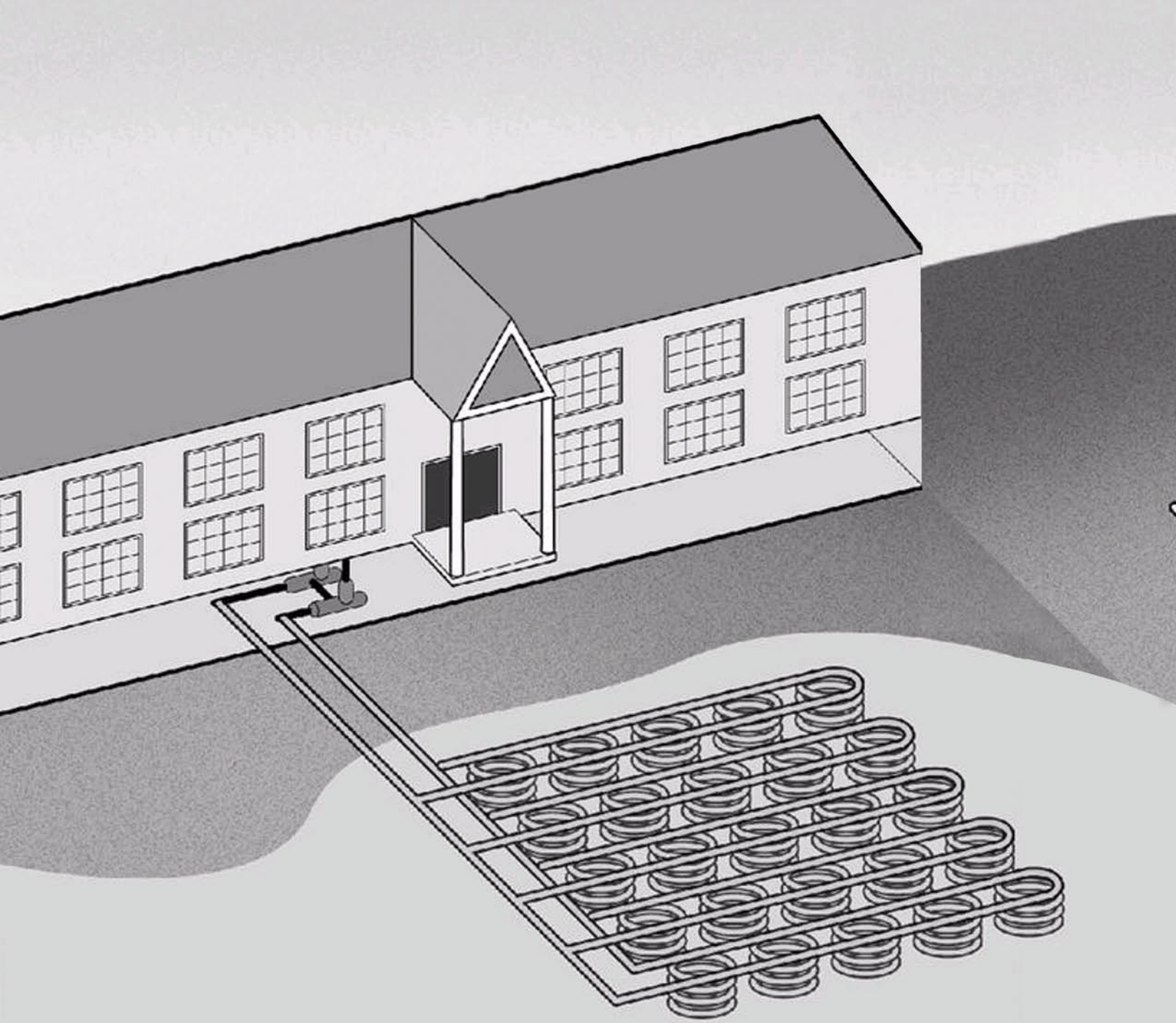
According to an article posted online at USA Today.com, the current software packages are sensitive to changes in light and "need to obtain a full view of the face with both eyes visible and at an angle that doesn't stray far from center." Face scans of people walking across a room or spotted in a crowd seldom fit this form, resulting in false-positive or false-negative readings. If the side of the face of someone walking into a train station or airport is captured by security cameras and compared to a database of frontal images, it is very likely that a computer would not find a match even if it existed.

Many companies and government agencies are working to find a solution. The goal is to create software that can recognize people no matter what the angle, light, or changes in the person's face, to compensate for typical variations and uncontrollable factors. Today's software may not be perfect, but it is much better at identifying people now than it was just a few years ago.

One of the most exciting breakthroughs made recently in facial recognition is the ability to turn 2-D images into 3-D views of a subject. Frontal and profile pictures are combined using the software in order to create a digital real-life model of the person. This effectively solves the problem of comparing images taken at previously inconvenient angles to mug shots and the like. This technology, called the Integrated Law Enforcement Face-Identification System (ILEFIS), is used by the government to track down terrorists and criminals. Frances Zelazny of New Jersey-based Visionics Corp., one of the leaders in facial recognition technology, said it currently has the ability to accurately match surveillance footage taken within 35 degrees of the 3-D images in the database. "Beyond that, you lose accuracy." Even with all of the advances that have been made in software, advances in hardware may also result in more effective facial recognition systems.

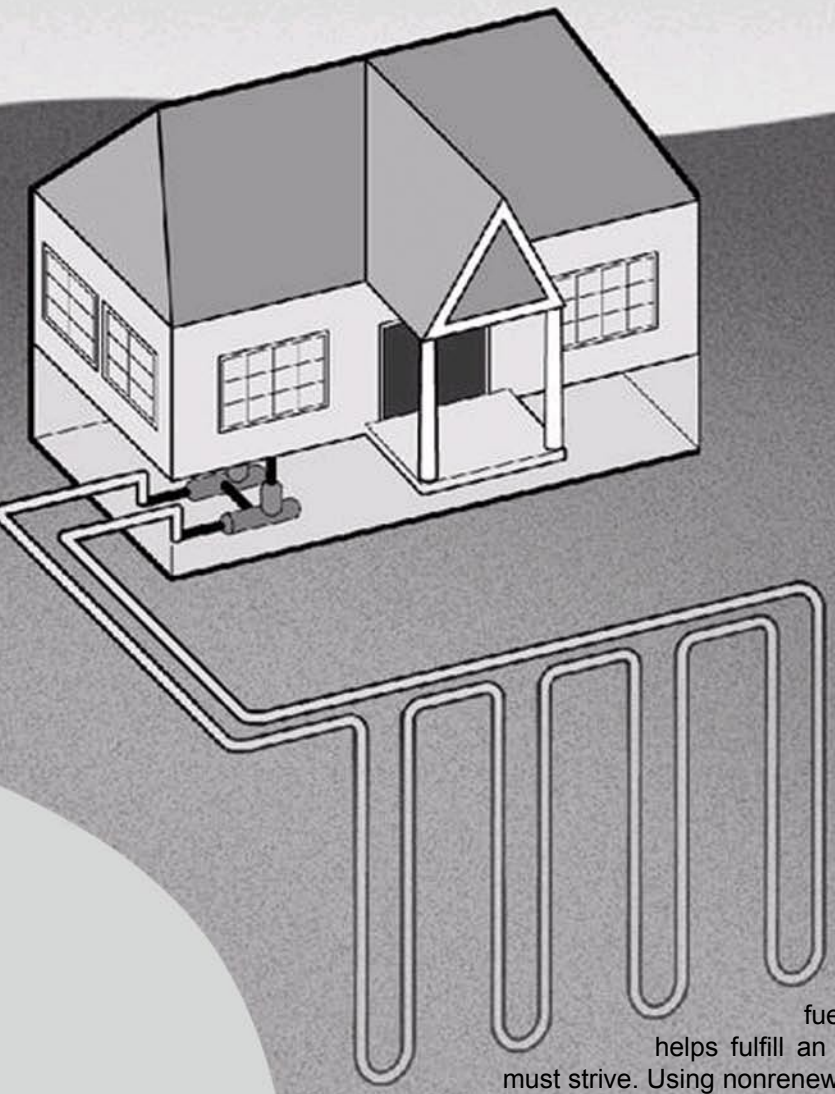
:: We can also recognize the governor in this profile picture, but electronic systems typically cannot. ::
Image > NJIT University Communications





Alternative Heating from the Rock on Which We Stand

By: CHRIS SABATELLI & FRANCESCO GENNARINI



In America today, the talk of rising heating costs and the price of oil are on everyone's mind. Means for saving on heating bills have been evaluated—from insulation to sophisticated thermostats—in order to reduce the demand for the fuels which have become expensive commodities in America. The solutions being sought are trying not just to cut corners, but to completely revolutionize the home heating process. Solutions of this nature have been researched for many years now, with energy being harnessed from such sources as the sun and water. However, these have met little success in the mass market as yet.

Aside from seeking an alternative to rising fuel costs, research into alternative energy and heating also helps fulfill an ecological commitment to the world for which all people must strive. Using nonrenewable energy sources like oil or coal is a choice which is not environmentally sound and will not provide an answer to the imminent danger of these sources expiring, as is predicted to occur within this century. Therefore, energy of the future must seek renewable sources.

A new alternative to oil fuels has been extensively researched and has been met with varying levels of success around the world in recent decades. This alternative, known as geothermal heating, can possibly hold the answer for many eco-conscious homeowners who would also like to save on their monthly utility bills. The technology relies on a constant heat source beneath our feet every day—the Earth.

The Earth absorbs about 47% of the energy that it receives from the Sun and stores it as ground heat, a clean source of renewable energy. Geothermal heating, as the name implies, draws heat from the year-round warmth of the Earth, which remains at a constant 55 degrees merely a few feet below our feet. Thanks to this average temperature, it is possible to extract warmth from the ground during the winter to heat a space and coolness during the summer to cool that same space. The geothermal heating system, therefore, can serve the owner year-round and obtains the same result with a unique system that is about four times more efficient than traditional heating methods.

Three components make up a geothermal energy system: a heat pump, underground pipes, and a distribution system. Of these three, the underground pipes are the only component unique to this system; the rest are utilized in any conventional heating or cooling system. The heat pump, or pumps, can be located inside or outside the building, the underground pipes are drilled either vertically or on a slight diagonal in the adjacent yard to the structure, and the interior distribution system can be of many varieties and replicates typical fossil fuel systems (e.g. radiators, baseboards, or air ducts).

Artist rendering of Geothermal Heating Equipment
Image > http://www.uwsp.edu/cnr/wcee/keep

-DOING THE MATH-
ECONOMIC COMPARISON OF TECHNOLOGIES:

A family decides to substitute their traditional heating and cooling system.
They choose a Geothermal Heating option for their typical 2,000 square foot house.
The installation cost for this system would amount to $5,750.

The acquisition and installation expenses are financed through a loan with a 5% yearly interest rate for 7 years.
The total amount financed is $5,000; the monthly rate of the loan is $70.
The monthly utility bill with the new system is estimated at $57.
With the use of a traditional system, the utility bill would be $137 a month.

The savings on the utility bills amount to $80 while the monthly financing rate for the new system is -$70.
Therefore, positive cash flow is $10.

After the loan period of seven years, the family will increase their positive cash flow to the full $80 monthly savings.
Although the initial installation of the system is $2,000 greater than a standard system in this case, the family could net a total savings of
$18,000 over a span of 25 years.

Source: Geonet Magazine (web.tiscalinet.it/geonet)

The logistics of a geothermal heat pump system are not very complex. The heat pump's interred pipes are in tight contact with the spires of an evaporator which contains a refrigerant liquid. The refrigerant comes in contact with the hot pipes and evaporates. Once it is in a vaporous state, it is sent to a compressor. Here, the gas is highly compressed and therefore heated and ready to be sent to the exchanger with the interior environment to release heat. Once the refrigerant cools down, it returns to its previous liquid state and the cycle starts over. During the summer, the cycle is inverted, and the system extracts the heat from the internal environment cooling it down. That heat is sent down into the ground.

The exchange of heat with the ground is achieved through a loop of pipes made of polyethylene (a thermoplastic) that may be drilled diagonally into the earth near the building to be serviced. They are drilled vertically if the space around the building is limited. The length and depth of the tubes, as well as the number of loops to be placed in the ground, is calculated according to the latitude of the location, the type of subsoil, and the thermal necessities and volume of the building. (See diagram)

Geothermal implants have been installed in the United States, Canada, Australia and northern Europe, and their validity has been widely demonstrated. Their versatility lends itself to a vast array of building types: residential, commercial, schools, greenhouses, hotels, and office buildings. Installation of these systems is quick and simple, whether in new construction or as integrated into existing structures, and the number of qualified geothermal heating installation specialists is growing.

While the initial investment of a geothermal heat pump can be pricey, government incentives can offset the cost. Also, as the technology becomes more widely applied, competition within the field will help lower the cost. Any extra installation costs will be made back in savings within a few years (see diagram). The circuit does not provoke any visible disturbance to the surrounding ground, and once installed, it can be easily forgotten due to its virtual invisibility and low service need. The technology has been improved greatly through many years of improvements, and prior problems with the delicate underground piping have been alleviated by using higher quality materials and insulation.

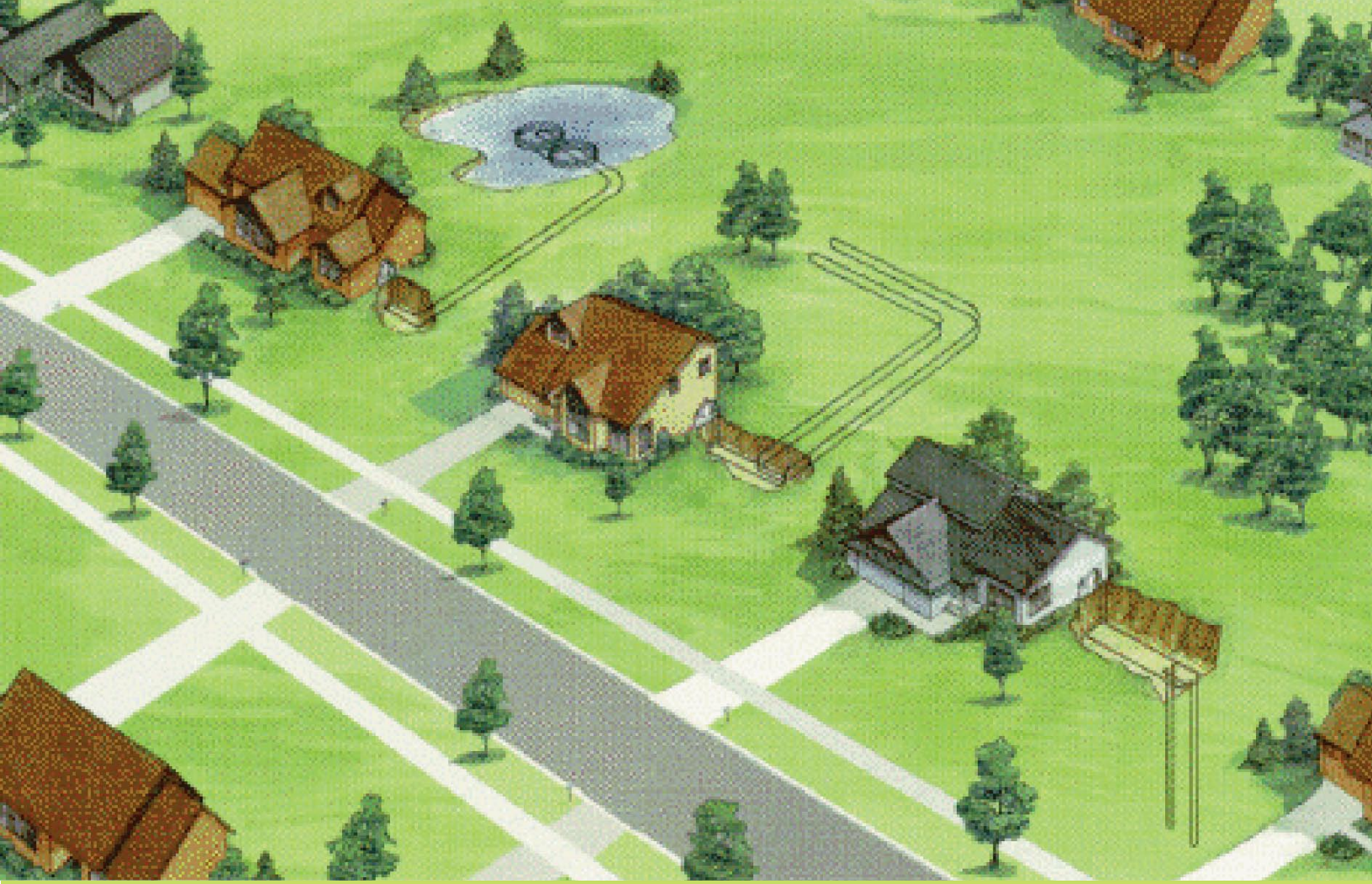
A system of geothermal energy guarantees a very high level of comfort. A single element provides heating, air conditioning, dehumidification, and hot water production. The system consumes a minimal quantity of natural resources, using about one-third the energy of typical systems to run the heat pump. The pump can be located either within or near a building, and is nearly inaudible. Also, the unit's manageable size does not resemble the unsightly equipment typically found on the roof or nearby to a building.

Geothermal heating systems are safe; there is no combustion, open flame, breathable gas in the air, or residue, scent, or pollution deposited in the living

Limited List of Geothermal Heating Suppliers Nationwide

Company Name	Location	Contact
Able Environmental	Bay Head, NJ	Ray Meyer
Advanced Geothermal Technology	Reading, PA	Don S. Creyts
ClimateMaster	Oklahoma City, OK	Dan Ellis
Eastern Heating & Cooling Council	Mt. Laurel, NJ	Jil Sherako
FHP Manufacturing	Ft. Lauderdale, FL	Chris Smith
Geo Comfort	Greenville, IL	Steven Smith
J & P Engineers, P.A.	Linwood, NJ	Jitendra B. Singh, P.E.
Robert L. Cave Inc.	Pennsauken, NJ	Robert Cave
The Trane Company	McGregor, TX	Tim Hughes
WaterFurnace International, Inc.	Ft. Wayne, IN	Bruce Ritchey

Source: Geothermal Heat Pump Consortium www.geoexchange.org



environment. Finally, geothermal technology is superior in its ability to adapt to any building application, from historical buildings to super-modern, from commercial buildings to places of worship. The integrity of the architectural style can be maintained thanks to the potential lack of visible external units.

According to the Environmental Protection Agency (EPA), there is no heating and cooling technology on the market today more efficient (in terms of energy) or cleaner for the environment than Geothermal Technology. Geothermal fuel pumps allow for the reduction of energy up to 40% over air-air heat pumps, and up to 75% over electric and gas heating. During the summer, the heat extracted from the environment can be used to obtain hot water at virtually zero cost, and during the rest of the year, one may save even 30% in generating hot water compared with gas and electrical systems.

Advantages of Geothermal Heating Systems:

-Low life cycle costs
-Increase value of real estate
-Generate a safer and cleaner environment
-Single provider for heating, cooling, and hot water
-Reduced heating, cooling, and hot water costs by 70%.
-SmartStart and Energy Star rebates defer initial cost
-Worldwide installation possibilities

History of long life and low maintenance due to:

-Units are placed within an edifice
-The use of closed refrigerant circuits
-Temperatures involved are very mild with low variations compared with the extreme variations used in traditional devices that make use of combustion or external air.

Advantages to the region and even the country:

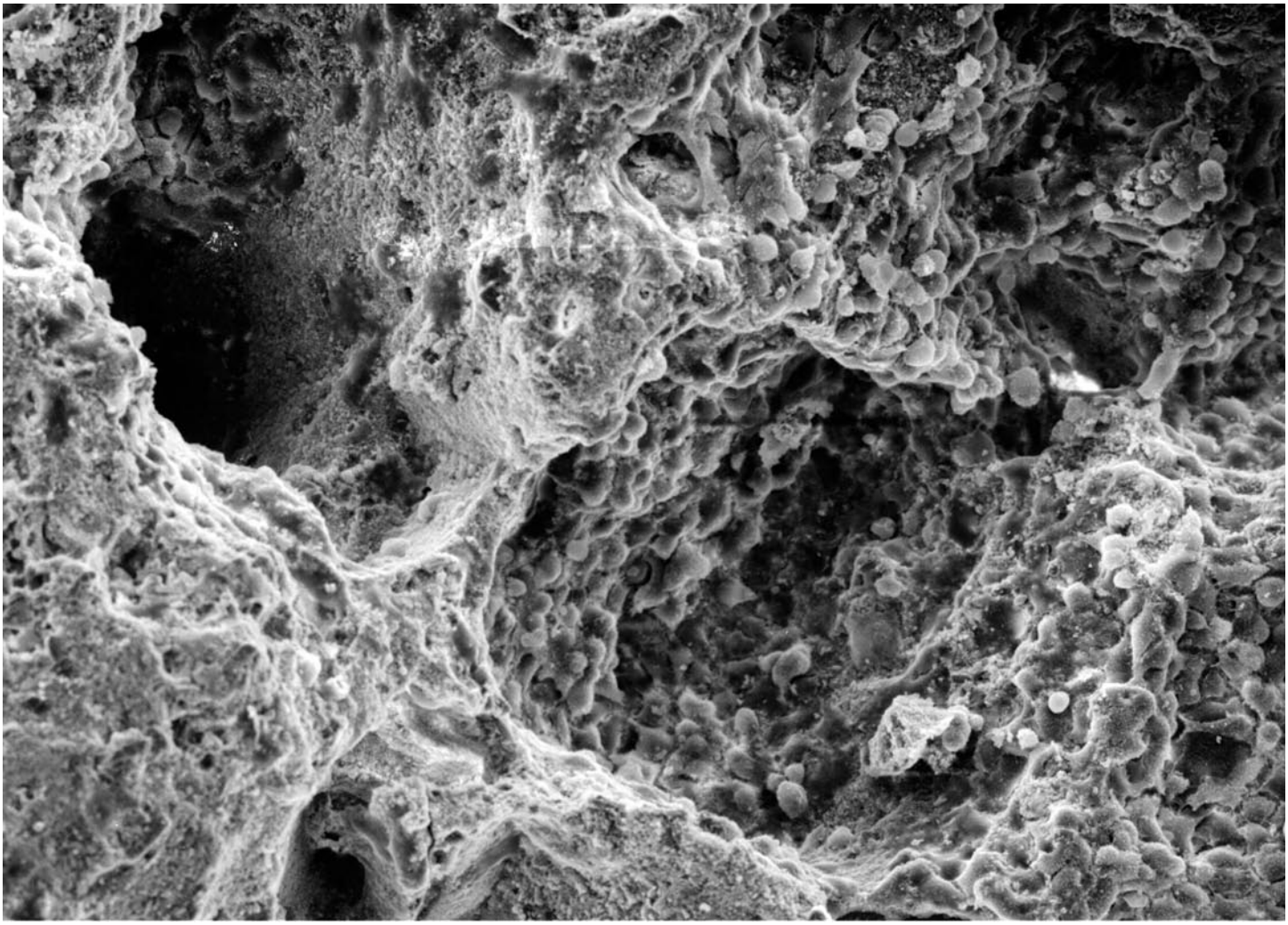
-Promote conservation of the land
-Reduce the consumption of fossil fuels
-Reduce reliance on importation of petroleum
-Increase of energy efficient buildings
-Reduced use of natural resources

Advantages for the energy provider:

-Reduction of peak requests for energy
-Fewer blackouts

Advantages for the ecology:

-No pollution
-No combustion or waste water



Stem Cell Research

By: Bhininder Kaur

Stem cell research, described as “one of the greatest revolutions in modern medicine”, is a subject of both great controversy and great promise. Numerous studies have been conducted, mainly on rats, which have indicated the feasibility of successfully differentiating embryonic stem cells in the laboratory, encouraging the scientific community to continue research that has the potential to benefit more than 100 million Americans.[6] Stem cell research is a field displaying the makings of immense success even in its infancy, and is at the forefront of medicinal breakthroughs.[7] It advances the borders of science and challenges human beings to understand exactly how we form, then provides the resources to manipulate this information in order to cure the thousands of ailments that inflict pain and suffering upon us. Methods are currently being developed that can time- and cost-efficiently “coax” stem cells, which were discovered almost two decades ago, to specialize into cells that can perform near-miracles. For instance, one of the goals of this area of research is to form insulin for the 16 million patients worldwide who suffer from diabetes. Manipulating undifferentiated cells into the more than 200 specialized cell types and inserting them into patients with minimal risk of rejection is the ultimate objective.[6] In fact, an article in the medical journal *Diabetes* states that “using human embryonic stem cells…we observed spontaneous in vitro differentiation that included the generation of cells with characteristics of insulin-producing cells.”[1]

Currently, the only main sources of stem cells are fertility clinics. Frozen, unwanted embryos stored in these facilities can be used to derive stem cells at their earliest stages of development. This extra supply of embryos is present due to the fact that doctors create backups during in-vitro fertilization. Since many of these embryos are never used, it is logical to find ways to improve the lives of millions by performing research on them.

Unfortunately, unwanted embryos are not always an option for many research facilities because of political and legal controversy. As a result, an alternative method to obtaining embryos from fertility clinics, called therapeutic cloning, is in the works. Therapeutic

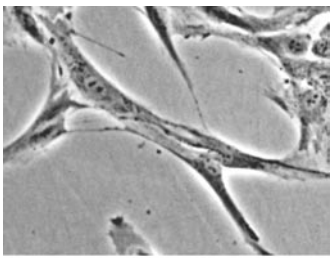
cloning involves the extraction of a patient's DNA and the subsequent fusion of the genetic material into a hollowed-out egg cell. Since the resulting stem cells that are attained from the embryo are exact replicas of the patient's DNA, "the cells could regenerate damaged tissue without the risk of rejection".[6] Therapeutic cloning would therefore personalize cures to each patient's needs. AOL News reported a breakthrough in which South Korean scientists produced "human embryos through cloning and then extracting their stem cells. It is a major advancement in the quest to grow patients' own replacement tissue to treat diseases."

The stem-cell debate has gone so far within the ranks of the government that a number of states have voted to outlaw federal funding of the research completely; others are considering following in their footsteps. On the other hand, there are three states to date – New Jersey, California, and Pennsylvania – in which stem-cell research is legal and supported by governmental initiatives. New Jersey, Pennsylvania, and Delaware are jointly putting forth $1 billion for the cause; in Wisconsin, which is "considering approval", "Governor Doyle, whose mother has Parkinson's, announced plans in April to invest $750 million in public and private funds to spur in-state stem-cell research." [9]

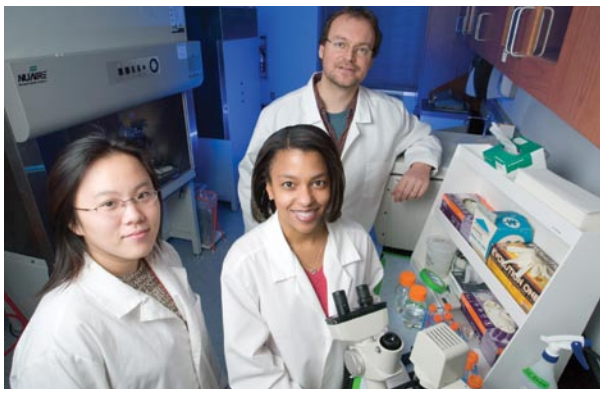
As a last resort, adult stem cells can be used for research purposes. Although this practice is commonly considered more acceptable, as it does not involve the destruction of embryos, there are many disadvantages to this approach. The most glaring setback to conducting research on adult stem cells is that the "full potential to continue" to multiply and specialize into the upwards of 200 special cell types in the human body may not be reachable, according to H. Merschtina, teacher of anatomy and physiology at William L. Dickinson High School in Jersey City, New Jersey. Merschtina calls the science of stem cells and the various connections that can be drawn between it and gene therapy and other possible fields of application "mind boggling": "Who knows which directions this research might take five years from now." He adds, "When I was in school, we studied macro-biology. Now, it's literally become microbiology." The technology that has evolved over the span of a few decades has indeed made it possible to seek the answers to the world's problems, especially those that can be treated and cured, inside not only a single cell, but also a single gene. The future of the genetic research market is best summed up by the October 25, 2004 *Newsweek:* New pro-research legislation would create "a haven for science and a 21st-century gold rush for biologists and biotech companies."

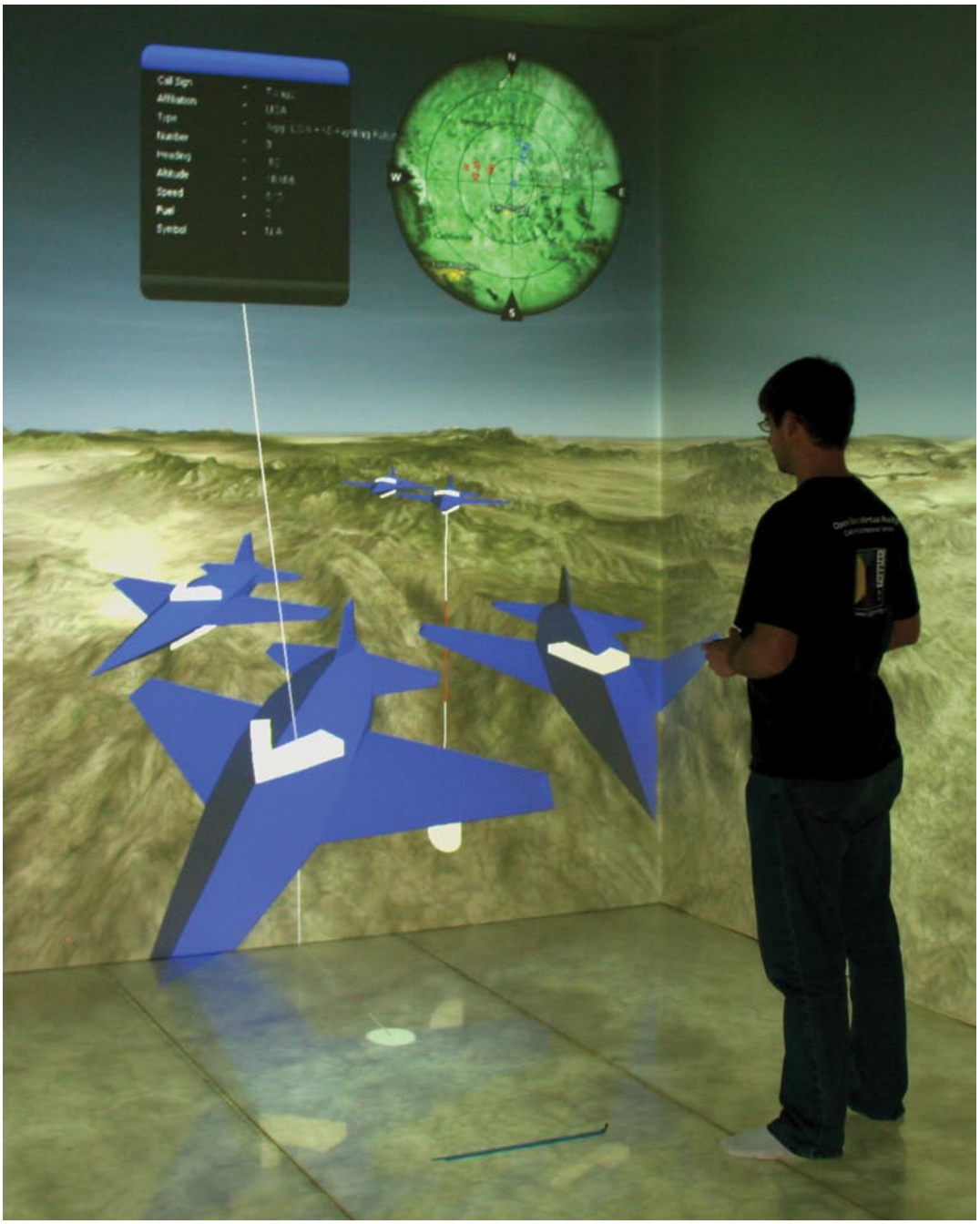
In 2005, Dr. Treena Livingston Arinzeh, PhD, an associate professor of biomedical engineering at the New Jersey Institute of Technology who is considered one of the leading stem cell researchers in the United States, made two important breakthroughs in stem cell research. She demonstrated that when stem cells are mixed with nano-scale scaffolds, the stem cells aid the body in bone growth and repair. Dr. Arinzeh also proved that stem cells extracted from one person could successfully be implanted into another. In 2006, Dr. Arinzeh received a grant from the New Jersey Commission for Spinal Cord Research grants to further her work in testing to see if stem cells taken from adult bone marrow could be coaxed into becoming neurons when implanted with different types of nano-scaffolding. This research is geared towards developing a treatment for spinal cord injuries, where the patient would have a scaffold and stem cells implanted at the point of injury, and the stem cells would over time develop into neurons and bridge the gap between the two sections of the spinal cord. Dr. Arinzeh also received a grant from the New Jersey Commission on Science and Technology to allow her to apply her stem cell scaffolds to help people with cartilage damage. Dr. Arinzeh and her partner, Dr. Michael Jaffe, PhD, professor of biomedical engineering and chemistry at NJIT, will test several different scaffolding biomaterials to determine which will best catalyze cell differentiation.[10]

The field of stem cell research is a rapidly growing and changing one, and it holds great promise for the future medical treatment of countless conditions. Fortunately, much of the controversy in the field has died down, with demonstrations of the potential that adult stem cells have, greatly reducing demand for contested embryonic stem cells. With many of the existing roadblocks moved aside, stem cell research can rocket forward, and only time will tell just how powerful stem cells can be.



Opposite: Scanning electron micrograph of adult mesenchymal stem cells attached to a bioactive ceramic scaffold. This construct is used for bone repair.
Left: Light micrograph of an adult mesenchymal stem cell, derived from the bone marrow, in culture (20x objective).
Source: Courtesy of Dr. Livingston Arinzeh.
Right: From Left to right: Yee-Shun Lee, Dr. Treena Livingston Arinzeh, Norbert Weber of the stem cell research team.
Photo: Kai Chan
Source: Courtesy of NJIT University Communications





As Science Fiction Approaches Reality: Brain Computer Interfaces & Virtual Reality

By: Alexander Sheppard

The human brain is currently the world's most powerful computer. As of 2007, there was no competitor that could match it even in raw processing power, let alone energy efficiency—the brain is possibly ten times faster than the world's leading supercomputer and only uses 20 watts of power, around a fifth of what a light bulb uses. The brain achieves these superior results using parallel processing and a very complex and specialized architecture.

The brain, however, cannot access the internet or any other digital sources of information. Unlike the heroes from the movie *The Matrix*, humans do not have input/output jacks on the back of their heads and are only capable of receiving and disseminating information through powerful but limited sensory and auditory organs. Essentially, humans can only receive information via their tactile, auditory, and olfactory organs to name a few, and these organs are drastically limited in range and sensitivity, especially the tactile sense.

What if these constraints could be eliminated? What if it was possible to simply will your eyes and ears to take in information from a different source, connecting

yourself to the vast world of digital information? Physical transportation might even become unnecessary were this possible, since people would be able to hear and feel as if they were in a completely different place. They could then live at least partly on the internet, "traveling" from place to place by accessing sensors stationed at their destination of choice. Physical distance would be irrelevant, with travel being limited only by the speed of electronic communication.

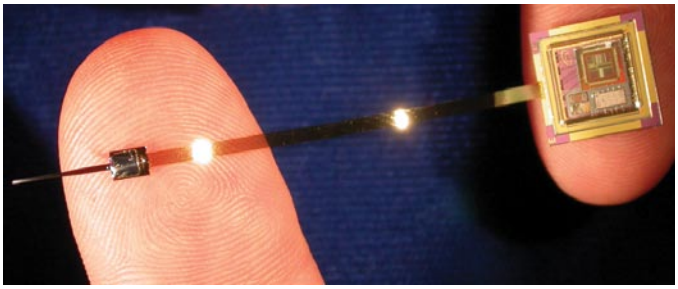
Hearing

This vision is a fantasy, but even today there are primitive versions of these technologies that are in development that could someday develop into a reality. Cochlear implants are the most developed example at present. These devices have enabled around one hundred thousand hearing impaired individuals to regain their auditory sense. Some hearing aids have already been integrated with wireless internet technology, and this begs the question of whether cochlear implants might one day be as well. In order for such a device to be desirable to healthy individuals, it would have to be somehow superior to the natural ear, which could always be coupled with a simple wireless headset to hear sounds from distant locations. Current implants have a long way to go, as they make conversation sound like "a croaking robot with laryngitis," according to one user.

Achieving superiority to the human ear is a daunting task. The human ear is capable of sensing pressure waves with amplitudes of one-tenth of an atomic diameter, over a frequency range extending from 20 Hz (cycles per second) to over 22 kHz. The level of sensitivity of the ear leads one to surmise that attempts at improving it should start with building on existing machinery rather than starting over, as the designers of cochlear implants are forced to do. One might envision headsets which import signals received from distant locations, allowing one to hear, say, a young child running around the house by employing sensors scattered throughout the area.

Nevertheless, impressive strides are expected in cochlear implant technology over the next five years. For instance, a new device developed at the University of Michigan employs thin film electrodes to relay almost ten times the number of frequency channels as compared with existing devices. David Wise, the leader of the team that developed the device, says: "Eventually the idea is…to control actuators in an insertion tool, so that the electrode array can achieve deep insertion and navigate around any obstacles in its path." In other words, in addition to being positioned by surgeons, this implant may in part position itself. That should allow lower frequencies to be relayed than ever before, and with better accuracy. Current implants use a bundle of wires as opposed to a thin film, posing difficult implantation issues in the ear's narrow cochlea. Still, even the new implant will fall short by more than an order of magnitude of the number of channels in the natural ear.[1]

A crucial feature of any implant desirable to healthy individuals will be the ability to modify sound perception and in some cases turn it off completely. Just think of the many cases where perceiving sound is an annoyance rather than an aid. Large amounts of research are currently devoted to noise reduction in cities and other environments; with the ability to control the perception of sound, these problems would have an instant remedy. Many students can appreciate the difficulty of studying amid the clamor of a college dormitory, and of how nice it would be to replace the noise entirely with the pleasing sound of a distant waterfall or a light breeze. Implantation research in this direction has been largely absent, apparently because existing technology is too crude to offer useful results. Still, the ability to modify hearing seems to present a more surmountable challenge than improving a normal ear's sensitivity.



Opposite: C6, a six-sided virtual reality room at Iowa State University, shown here with a demonstration of how virtual reality could be used to control unmanned aircraft.
Above: New cochlear implant, developed at the University of Michigan

Vision

Unknown to most of the public, primitive retinal implants exist and have restored some capability to previously blind individuals since the late 1970s. However, the capability restored is not particularly useful; it amounts to "looking at snapshots in a photo album through holes punched in a note card," in the words of one researcher.[2] Since such machines cannot be applied to most ordinary activities, there is little market for commercialization. Recently, progress in this area has accelerated rapidly and many more people have joined research efforts.

One area of focus centers on building specialized chips that simulate the kinds of processes that occur in the retina and visual cortex. Such neuromorphic chips, as they are called, may be important in improving energy efficiency. The brain, after all, is not a general purpose device; it is a highly specialized one with circuits devoted to processing each of the five senses, along with many others for managing thinking and lower-level processes like sleep. The idea behind neuromorphic chips is to take a cue from the brain and design the hardware specifically for the task at hand, limiting general capability but improving it in specific applications.

This research may lead to "high-fidelity prostheses, maybe by 2010," according to Stanford

researcher Kwabena Boahen, at least in cases where it is just the retina that is damaged, as opposed to other parts of the visual system. Boahen envisions that his chip's "3,600 ganglion-cell outputs… [will] provide near normal vision" for individuals suffering from pathologies like retinitis pigmentosa and macular degeneration. However, he cautions that improvements in the biocompatibility of the materials needed to build the device, along with better understanding of cell behavior in the retina, will be needed before it can work in a real person.[3] [4]

In the near future healthy individuals will likely find wearable displays beneficial. These devices are already used in some technical professions where hands-free work is required, and just recently have begun to be marketed to mainstream consumers. Whereas previous viewers had cost several thousand dollars apiece, MicroOptical Corp. now sells a $300 pair of video glasses that connects to an iPod. *The Wall Street Journal* writes that the viewer "looks geeky but offers a comfortable way to watch video", creating "a good-looking visual illusion". MicroOptical's eventual goal is to integrate the viewer into ordinary glasses, thus offsetting the nerd factor. The trend toward seamless integration is clear.

Touch

The tactile sensory system is more difficult to reproduce than either the visual or auditory systems, partly because of the far larger physical spread of its receptors around the body. There are a number of efforts under way to develop technology that does this, often termed haptic technology. For instance, scientists of the International Society for Haptics, based in Mexico City, have recently found a method of tricking the body into perceiving objects that are really soft and flat as being sharp and pointed. The illusion was real enough that subjects could pair the sensation felt on their skin and a specific object, like a saw tooth or pointed peak.[5] Still, given the close connection between tactile sensations and motor functions in the body, it is difficult to see how a fully immersive simulation could be achieved without limiting the range of motion of the wearer. This kind of simulation would necessitate at least a full body suit and possibly even external actuators joined to it.

Brain computer interfaces might eventually provide a more practical and portable solution. Instead of relaying signals through the body's peripheral nervous system, electrodes or nanomachines inhabiting the central nervous system might block signals from the rest of the body and replace them with artificially generated substitutes. Scientists presently have demonstrated basic motor neuroprostheses (NMPs) in paralyzed humans: for instance, quadriplegic Matthew Nagle was able to control a computer cursor by thinking it into motion. [6] How close scientists are to routing signals in the other direction is unknown, but prominent NMP researcher Miguel Nicolelis has estimated that functional prosthetic arms and legs for paralyzed individuals might be a reality in 10-20 years.[7] Given such a device, it does not seems to be much of a leap to envision the signals being used to control virtual bodies in simulated environments, or artificial bodies in a different location.

Above: VisualEyes, a tele-immersive method for long-distance collaboration work on car interior development. Two people sit in a virtual rendering of a possible car interior, which can be updated by a 3D modeling technician based on the suggestions of the developers.
Right: Virtual Sphere enables essentially unlimited walking, running and crawling motion while in a virtual reality environment. The sphere is fully enclosed when in operation and the wheel mechanism below is connected to the computers controlling the virtual environment, where the person's movement incorporated into the simulation.

The Myvu enables iPod video users to watch their movies on the go.

Extraterrestrial Agriculture

By: Shivang Adhyaru

Since the beginning of the space race, mankind has imagined the possibility of outer space exploration and colonization. The first moon landing marked a great moment in history and bore testimony to the progress scientists and engineers had made in space exploration. Now it is 2007, and there has not been a manned mission to another planet since the end of the Apollo program. President Bush has encouraged the idea of a trip to Mars, and Steven Hawking, who is a world-renowned scientist and author of *A Brief History of Time*, has urged mankind to consider space colonization, so one might ask, what is keeping this from happening? One obstacle hindering this goal is one which has plagued humans since the beginning: a reliable food source.

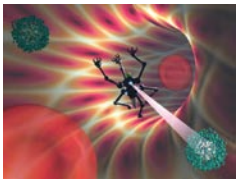
Food is a major obstacle for several reasons. Even though NASA food nutritionists have come a long way (astronauts have 200 different menu options in space), they still would need a self-sustaining food source for long-term missions. A manned flight to Mars and back requires at least three years of supplies, and it is not plausible to store enough food for that long a journey. The answer is that the astronauts must be able to produce their own food. Enter NASA's Salad Bar Program. University scientists at Texas A&M University, who are a part of NASA's Salad Bar Program, are testing lettuce and wheat plants in chambers that replicate the different conditions that Mars, the moon, and Earth present. In addition to providing food for the astronauts, plants take in carbon dioxide and produce oxygen, and on the Mars mission this ability will reduce the amount of oxygen that needs to be carried. It can cost as much as $15,000 dollars per pound to bring along certain materials. The ability to grow food in space will cut this cost, or allow the scientists to bring other necessities into space.

On Mars the atmospheric pressure is one-hundredth that of Earth's while the moon has no pressure at all. Other factors scientists had to consider was the length of a typical day on the celestial bodies in question, the amount of light that reaches them, gravity and what their atmospheres are primarily composed of. The researchers concluded that the light necessary for the plants could be captured and artificially reproduced. On Mars the atmosphere is 95% carbon, which means that the plants will have a good supply of carbon dioxide for photosynthesis; unfortunately the moon does not have the same situation, and astronauts would need to bring carbon dioxide along if their bodies did not produce enough to supply the plants.

The main condition the researchers tackled, however, was the difference in pressure. The scientists have set up a series of low pressure chambers to determine how the plants would grow in these conditions. Interestingly the plants actually grew better and quicker under low pressure than they did in ambient Earth pressure. Under low pressure the plants did not produce as much ethylene, which had inhibited growth under normal conditions. The plants had no adverse reactions to low pressure; in fact, all of the evident effects were positive. Researchers say this is due to the fact that plants use up fewer carbohydrates at night and produce less ethylene, when in a low pressure environment.

Although pressure is only one of many factors that need to be considered, the current research is certainly a sign of progress. As more research like this is done, it will become more and more likely that a mission to Mars could be successfully undertaken. From there, short-term missions to other planets may become possible, and eventually colonization of other planets should follow.

Artist's rendering of a garden in a future Mars base



Micro & Nano Robotics

By: Bhinider Kaur

Technology today has become advanced and reliable enough to allow for the surveillance of suspicious persons without their knowledge. Microrobots, also known as microbots, can go undetected and charge their batteries automatically once they are well implemented, enabling governments of the world and other institutions to effectively employ these technologies to spy on persons of interest. Currently, both audio and video feeds are available in such spy robots. Microbots can be flown into a place of concern, be it a residence, laboratory, or terrorist hideout, whenever the need arises. Controlled by a remote device such as a laptop, microbots can then be used to record and transmit a live stream of audio or video snippets at the will of whoever is at the controls.

This is what fiction novels such as *Deception Point* by Dan Brown[1] would have you believe. And yet, this sort of technology is not too far from reality. It is possible that microbots are being used for top-secret operations in the world today, but information about such missions would obviously not be widely available. After all, the idea of miniature robots allegedly first surfaced in intelligence agencies.

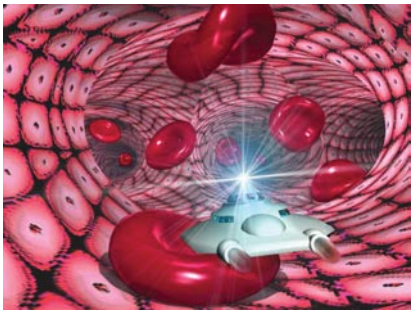
The information on today's microbots available to the public promises accuracy in communications, but not the lightweight, almost unnoticeable presence of the devices that would be needed if they were to be used without the knowledge of the people being watched. Some can be charged simply by being in proximity to a heat or light source, but most need to carry a power source such as a battery. If the robot needs to weigh as little as possible, models that implement power cables can be used, but this greatly inhibits mobility.[2]

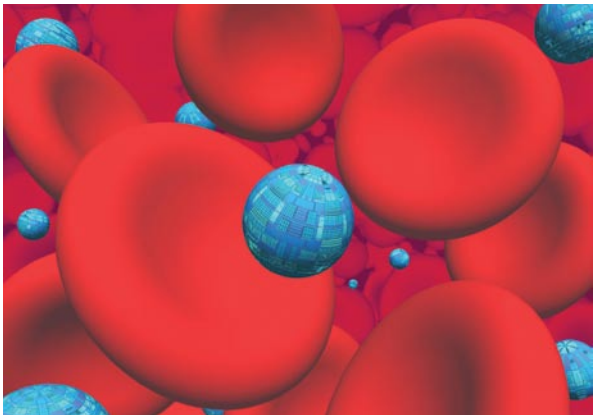
The world's smallest microbot, the Micro Flying Robot (μFR), unveiled by Seiko Epson Corporation in 2003, is called the Monsieur II-P. It is "a prototype microrobot that operates on an ultra-thin, ultrasonic motor and a power-saving Bluetooth module that allows multiple units to be remote-controlled simultaneously." Epson has been rolling out some of the tiniest robots for years, and even made the Guinness Book of Records in 1993 for the original Monsieur prototype.[3]

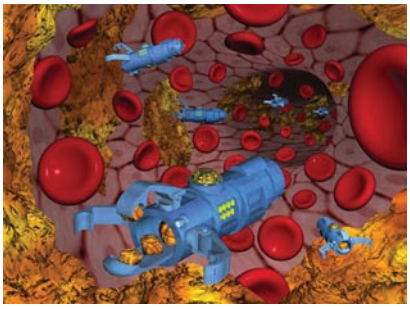
In addition to security and surveillance, microbots are quite useful in the medical field.[4] When a drug or other treatment needs to be transported to a specific part of the body, and be injected into specific tissues, microrobots could perform this job in a virtually harmless fashion. This type of procedure would be relatively simple because the components of a microbot used for this purpose could be biodegradable and eliminated normally once its task has been completed. Robots such as these could be guided by powerful magnets, such as those used in an MRI, if they were partially composed of tiny pieces of biodegradable material that respond to a magnetic field.

Current medical research is using a similar process to deliver drugs to patients of chronic kidney disease (CKD). In many cases of patients who are diagnosed with hypertension and/or diabetes, CKD causes the kidneys to stop their filtering process by forming a layer of extra protein around the kidney. This is the normal reaction of the kidneys, which attempt to protect themselves from the increased amount of blood and other materials that are present as a result of hypertension or sugars in some cases of diabetes. The body cannot function without at least one properly functioning kidney, and a common treatment for this dysfunction is dialysis, which can be brutal on the patient, since it requires multiple hospital visits each week to filter the body's eight liters of blood.[5] A microbot could be used for the delivery of a drug which reduces the amount of protein blocking the kidneys' filters, and since this device would be targeted, the drug would not adversely affect any other parts of the body. Once it had delivered the drug to its target, the remains of the device could be eliminated along with the rest of the body's waste.

Microbots are quite advanced already, and have applications in numerous fields. Even with all of the progress that has been made, work is still being done to improve these devices. More flexible, efficient, and even self-charging robots could help in countless ways as even more industries begin to apply their mostly untapped potential. Much work still has to be done until many of the proposed uses are available, but with the rapid expansion of research in this area, major breakthroughs could be made very soon.



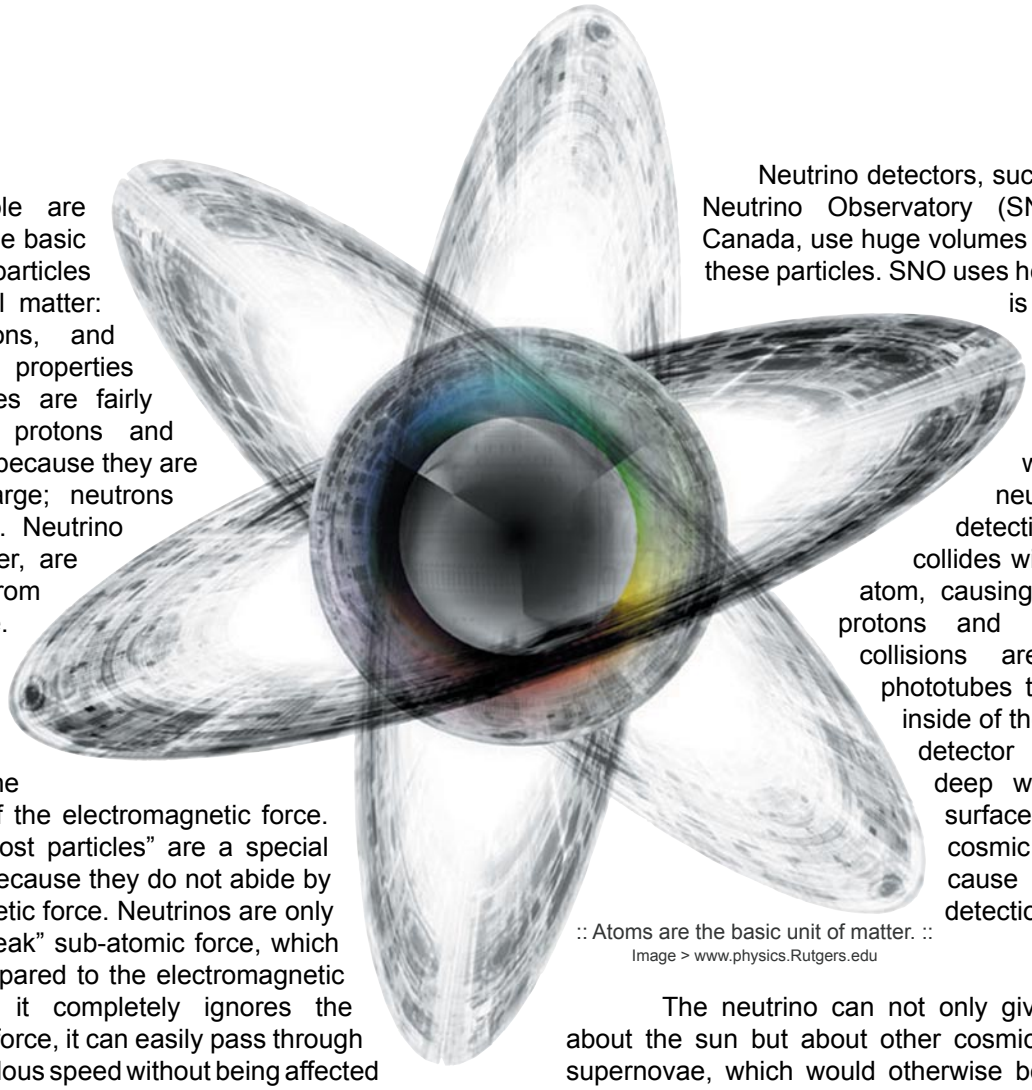




Artist's impression of future nano robots: Clockwise from the top: Germ Hunter, BarberBots, Artery Cleaners, Generic Nanobot, MedicBot

The Ghost Particle

By: Joseph Curcuru



:: Atoms are the basic unit of matter. ::
Image > www.physics.Rutgers.edu

Most people are aware of the three basic subatomic particles that make up all matter: protons, electrons, and neutrons. The properties of these particles are fairly well known – protons and electrons attract because they are of opposite charge; neutrons have no charge. Neutrino particles, however, are quite different from the basic three. Protons and electrons have a very strong affinity to each other inside the atom because of the electromagnetic force. Neutrinos or "ghost particles" are a special type of particle because they do not abide by this electromagnetic force. Neutrinos are only affected by a "weak" sub-atomic force, which is miniscule compared to the electromagnetic force. Because it completely ignores the electromagnetic force, it can easily pass through matter at tremendous speed without being affected by it, hence its nickname "ghost" particle.

The particular properties of neutrinos allow them to be used for special purposes. Fusion reactions in the core of the Sun produce a huge flux of neutrinos. These neutrinos can be detected on Earth using large underground detectors, and the flux of the sun can be measured using calculations based on the workings of the Sun and the Standard Model of particle physics. This experiment was first carried out by astrophysicist Ray Davis in the late 60s in what was called the "Homestake Experiment." As Davis examined his experimental results, he noticed a deficit flux -- the measured flux was roughly a third of what was expected. Why was this? Was our model of the Sun erroneous? It so happens that the deficit of flux was not due to problems with the models of the Sun but by changes in the neutrinos themselves as they travel from the core of the Sun to the earth. This is called flavor oscillation. Neutrinos are of three types or "flavors": electron neutrino, muon neutrino, and tau neutrino. In the phenomenon known as neutrino flavor oscillation, neutrinos are able to oscillate between the three flavors as they propagate through space.

Neutrino detectors, such as the Sudbury Neutrino Observatory (SNO) in Ontario, Canada, use huge volumes of liquid to detect these particles. SNO uses heavy water, which is water that has its hydrogen atoms replaced by deuterium – a hydrogen atom with an extra neutron. During detection, neutrinos collides with this deuterium atom, causing it to break into protons and neutrons; these collisions are detected by phototubes that surround the inside of the tank. A neutrino detector is often buried deep within the earth's surface to protect it from cosmic rays that can cause changes in the detection liquid.

The neutrino can not only give us information about the sun but about other cosmic events such as supernovae, which would otherwise be unattainable. A Supernova Early Warning System (SNEWS), a modern neutrino detection system, is able to detect neutrinos emanating from exploding stars so astronomers have a chance to gather data. A new neutrino detector is currently under construction at the South Pole. Appropriately named "IceCube," it will feature thousands of spherical optical sensors built into holes melted into the ice. These detectors can detect neutrinos in a very high energy range. Like SNEWS, it can detect neutrinos emanating from supernovae. IceCube could also provide another powerful tool to physicists who are trying to prove string theory, a theory that tries to encapsulate the workings of the universe into one single theorem. In order for string theory to work, a model of extra-dimensional space is required, in which there are several other dimensions on top of the three dimensions of space and time. Physicists will detect certain numbers of neutrinos that occur if string theory is correct. This is probably only the beginning in terms of what studying and detecting neutrinos can do for science and the future of technology.

Guest Editorial

The staff of the Technology Observer is comprised of students who are not only dedicated to their normal academic studies, but are also dedicated to keeping up with what is going on in the world of technological research. We value a good article on breakthrough research as much as we value a page in any of our textbooks. There is nothing that thrills us more than when a teacher takes the time to show us how what we are learning in class fits into the big picture of cutting edge research. It is therefore our pleasure to include in this issue of the magazine, a guest editorial on this idea, referred to as *scholarship*, written by a Professor in the Biomedical Engineering department who not only believes in this idea, but strives to live by it, as he explains.

Scholarship for All…

Richard Foulds
Associate Professor
Biomedical Engineering Department
NJIT

No. I am not advocating free tuition. I am thinking about something much more fundamental. Why do we, students-professors-administrators, inhabit a place called a university? Some might answer they are here to study, or to get a degree, or to teach, or to operate an academic business, or to pursue advanced research. Could we all be here for different purposes, or might there be something that binds us together?

Among the tensions we feel in our ivory (or perhaps ivy) tower is the ongoing debate about research vs. teaching at universities. No one questions the educational origins of higher education. But, more recently, campuses have increasingly emphasized externally-funded research that seems very different from traditional teaching. There is no end to the supply of critics who say that research weakens education by distracting faculty from teaching and shifts the attention from undergraduate to graduate students. Some state legislatures advocate mandatory numbers of classroom hours for professors. Students and parents grumble about their increasing tuition bills that seem to support less and less teaching. Others decry the "publish or perish" mentality that skews the tenure and promotion process away from teaching into arcane specialization.

On the other side, advocates argue that research makes professors better teachers, and that research is prestigious and raises a university's reputation. Administrators tell us that tuition no longer pays the bills and that outside grants, supporting new equipment and graduate students, and bringing 50% institutional overhead, offer a badly needed revenue stream. There is even considerable talk that the modern university is no longer just an educational institution, but has a new duality of purpose with teaching and research balanced as equals.

But, after several decades of trying, no one seems to have found a balance that works. The complaints are as loud as ever. One academic leader quoted Rudyard Kipling's poem , "East is east and west is west, and never the twain shall meet…" and suggested that we should just accept that research and education are preordained to remain apart or coexist in some kind of uneasy tension. Some universities try to do both, while some are resigned to be better at one than the other. These thinkers are too pragmatic.

I like visionary thinkers, especially those who give me a framework that helps me focus my own emotions and ideas. Ernst Boyer was that kind of thinker.

In my career, I have always had a research lab and always taught. I could never really understand all the fuss about their incompatibility. Dr. Boyer shared that same thought, and explained it in a wonderfully simple way. In his 1990 book Scholarship Reconsidered, he argued that there was no conflict between teaching and research, as long as one stopped focusing on teaching and research as if they were independent. He proposed the broader notion of 'scholarship' as the sole underpinning of what goes on at a university. He wrote about the activities of faculty, students and administrators as being part of a full range of scholarly activities that are interdependent and enliven the intellectual spirit of a campus. Later, the Carnegie Foundation for the Advancement of Teaching engaged prominent academics to consider the implications of Boyer's idea of university-wide scholarship for undergraduate education at research universities. Known as the Boyer Report in his honor, this document makes real sense to me. It lays out a very believable case for high quality education for all students integrated into an environment that naturally encourages outstanding research. Both the book and the report are easily available, but I doubt many administrators, deans and professors have read them. I suspect even fewer students even know about them. If everyone read them, we all might get along better and all get more out of the time we spend on campus.

The idea of a university united by scholarship is relatively simple. Webster falls into the old trap and first lists the definition as a financial award to pay tuition. But, down a line or two (one should always read to the bottom) is what Boyer believed. Scholarship is the character, the qualities, and activities associated with

attaining knowledge and learning.

Think about it! This really does cover nearly all of what we do or should do on a university campus. Are my hours with students working side by side in a research lab less instructional than those hours I spend lecturing? Do we know everything before we start the experiment, or does our inquiry drive us to expand our knowledge? Are new ideas learned in a class only intended to be repeated on the next exam, or are they the fuel for new ideas that challenge the status quo and pose the next research questions?

I recall my freshman year, many years ago. My most memorable course was one that I could not take. New Media for Creative Expression was an experimental course open only to seniors. I volunteered to help and was rewarded with an unforgettable semester. It was really a material science course with a creative twist. I worked harder in that course than many others, with no grade to show for it. No grade could ever show how much I learned. As a senior, I was allowed to organize a freshman seminar on the History of Boston. It certainly was different from engineering. I invited guest speakers including a pretty corrupt City Counselor, a former Governor/Senator, a direct descendent of Presidents John Adams and John Quincy Adams, and Pasqualle Trevasoni. Mr. Trevasoni, the custodian, emptied the trash in our lab every night and turned out to be the best of the speakers. He talked about growing up without much schooling, but showed himself to be a genuine scholar when we found he had read every one of the books I had put on reserve in the library for the course. Scholars come in all kinds of packages.

I certainly remember my first semester at NJIT, when I was asked to give a Sigma Xi lecture the day before Thanksgiving. Not everyone cut out early that day. One undergraduate student came early and stayed late. He found a research project in my lab, and won 2nd prize in the NJIT McNair Scholar Research Symposium. He recently passed his doctoral qualifying exams and is well along in his Ph.D. research in our department. He was not the only scholar I have come across. His dissertation work could not be done without the assistance of undergraduates. Early work was completed by a senior engineering student who has now moved on to her own Ph.D. program in Physical Therapy. As I write this, two current students are spending their spring break redesigning everything to be ready for data collection later in the semester. Two other undergrads are doing double duty. Besides joining our fledgling video game development team writing original therapeutic games for kids with disabilities, they are designing ways to fill empty hallway corners and unused nooks and crannies with furniture to make our department more conducive to informal interaction and energize scholarly behavior. Not every undergraduate student spends spring break vacationing in Florida!

I realize that I am increasingly surrounded by scholars but never had such a good label for them. We have upper class undergraduates mentoring our freshman engineering design course, and everyone benefits. We have freshmen volunteering to join research labs and catching the spark that ignites their graduate studies. We have students who discover and learn instead of recording and playing back. We have professors who mentor, challenge and learn instead of professing and pronouncing.

Can this idea catch on? Will it work outside of my lab or our department? Why not? It makes life less compartmentalized and actually easier. If I view myself and the students around me to be scholars then every question is an opportunity for discovery and every investigation a chance for learning. My days are not divided into research hours, lectures, office hours, and lunch. It all blends so there are no real boundaries.

Can we really put this into practice? What about “East is east, and west is west, and never the twain shall meet”? Are teaching and research really scholarship? Think about it! What is east to me is west to lots of other people. If we go west together sooner or later we wind up in what we thought was east. Is the west just a back door to the east or is there no boundary at all?

I once used Kipling’s quote in some sophomoric argument about how two things would just never come together. My father, who is my favorite scholar, quietly suggested that I read to the bottom of the poem. Well, like most people, I had the first two lines pretty much the way they are written.

> *OH, East is East, and West is West, and*
> *never the twain shall meet,*
> *Till Earth and Sky stand presently at God’s*
> *great Judgment Seat;*

But, the last two lines taught me something:

> *But there is neither East nor West, Border,*
> *nor Breed, nor Birth,*
> *When two strong men stand face to face,*
> *tho’ they come from the ends of the earth*

We all assume the wrong thing about Mr. Kipling. Think about it! There is hope for our university community. Maybe there is neither east nor west, nor research nor teaching when we choose scholarship as the foundation of our endeavor.

Richard Foulds is an associate professor in the department of biomedical engineering at NJIT. He has been the principal investigator of external research grants totaling ~$20 million and was given the 2005 Annual Faculty Appreciation Award by the NJIT Undergraduate Student Senate for his teaching.

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Left Image: "VisualEyes" Courtesy of the Electronic Visualization Laboratory, University of Illinois at Chicago in conjunction with research conducted with the General Motors Research and Development Center (Randall C. Smith, David A. Brown)
Right Image: Courtesy of virtusphere.com
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Earth: Courtesy of NASA/JPL
Mars & Saturn's Rings: Wikipedia, under Mars and Saturn, respectively.
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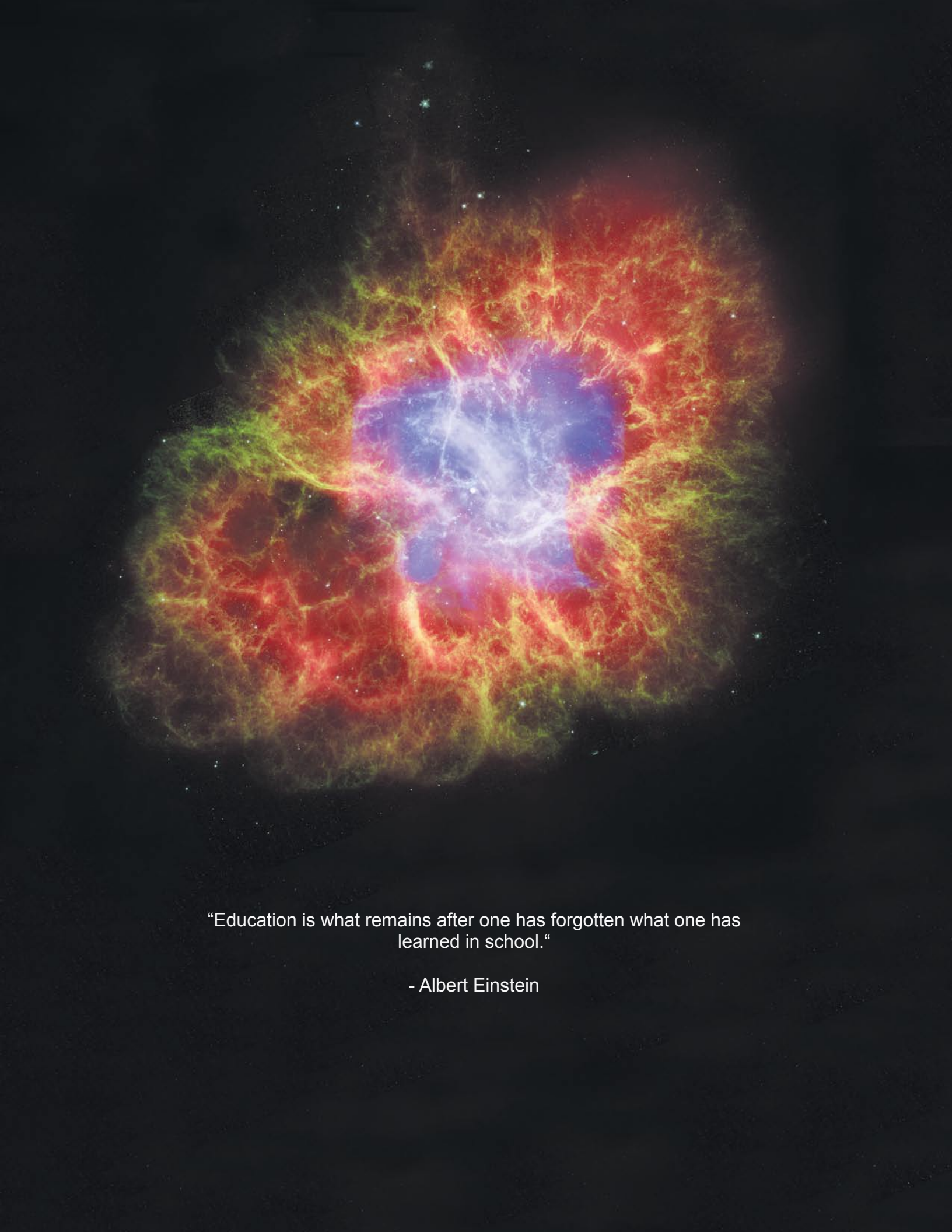

“Education is what remains after one has forgotten what one has learned in school.“

- Albert Einstein

Observing the Present with

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