TECHNOLOGY OBSERVER

The science and technology magazine created and published by students of the Albert Dorman Honors College of New Jersey Institute of Technology.

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TECHNOLOGYOBSERVER

NJIT New Jersey's Science & Technology University

When I go out into the countryside and see
the sun and the green and everything flowering,
I say to myself, "Yes indeed, all that belongs to me!"

Henri Rousseau
19th Century Painter

mother earth.

Will tomorrow still be there if we overuse what we have today? Technology holds the key to our future, but our tomorrows are numbered and stamped "Please Handle With Care." The future deserves more than our disregard for the way we have treated Mother Earth, and the time has come to rectify our behavior.

The state of the planet, though indeed in peril, is also in need of our prudence just as much as our science. As we have progressed towards a more efficient frontier of technology, we have also ignored our impact on the Earth's resources. And so, the environment has now become the object of our progression, the reason why looking forward to another day is also looking forward to a cleaner, healthier, and brighter tomorrow.

From recycling programs to innovations in solar technology, institutions of higher learning are taking remarkable initiatives on the going green path. This issue of the *Technology Observer* covers topics ranging from the approach to answering our emergency need of energy, the transition towards eco-effectiveness, the technology behind one of the most rapidly developing fields of alternative energy resource, solar, and humans' detrimental impact on one of the planet's most prized traits: biodiversity. The issue also includes several research endeavors from the NJIT's engineering and science departments, as well as ground-breaking work from other institutions also at the forefront of modern technology and science.

On behalf of the dedicated staff of the magazine, it is our pleasure to present to you the ninth edition of the *Technology Observer*. Enjoy!

Respectfully Yours,

Fatima Elgammal,
EDITOR-IN-CHIEF

:: we are...

the technology observer staff

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:: content ::

Eberhardt Hall at New Jersey Institute of Technology

PHOTOGRAPHER: BABAJIDE AKEREDOLU

About New Jersey Institute of Technology

THE EDGE IN KNOWLEDGE

New Jersey Institute of Technology is a public research university enrolling nearly 8,400 bachelors, masters, and doctoral students in 96 degree programs through its six colleges: Newark College of Engineering, College of Architecture and Design, College of Science and Liberal Arts, School of Management, College of Computing Sciences, and the Albert Dorman Honors College. A top-tier research university, NJIT houses laboratories in 48 key areas and 20 state-of-the-art multidisciplinary centers. Research initiatives include manufacturing, microelectronics, multimedia, mathematical sciences, transportation, computer science, solar astrophysics, environmental engineering and science, and architecture and building science.

About the Albert Dorman Honors College

ENGAGING THE FUTURE

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

The Albert Dorman Honors College currently enrolls over 620 students, with average SAT scores above 1300. Students are enrolled in honors courses, participate in leadership colloquia, partake in 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

Letter from the Dean

Dear Reader,

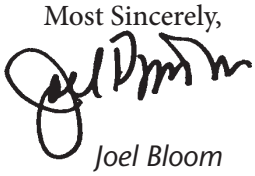
Welcome to the eighth edition of the *Technology Observer*, a publication founded, managed, researched, written and designed by Dorman Honors College students in order to report on emerging technologies. The production of this edition was very ably led by Fatima Elgammal, our Editor-in-Chief.

A definition of "technology" refers to tools, machines and systems that may be used to solve real-world problems. In this the eighth edition of the *Technology Observer*, the student writers focus on real-world problems of "The Energy Emergency," "Eco-efficiency," "Extinction: Earth's Biggest Threat," neurological disorders, dysfunctions in eye movements, and glaucoma.

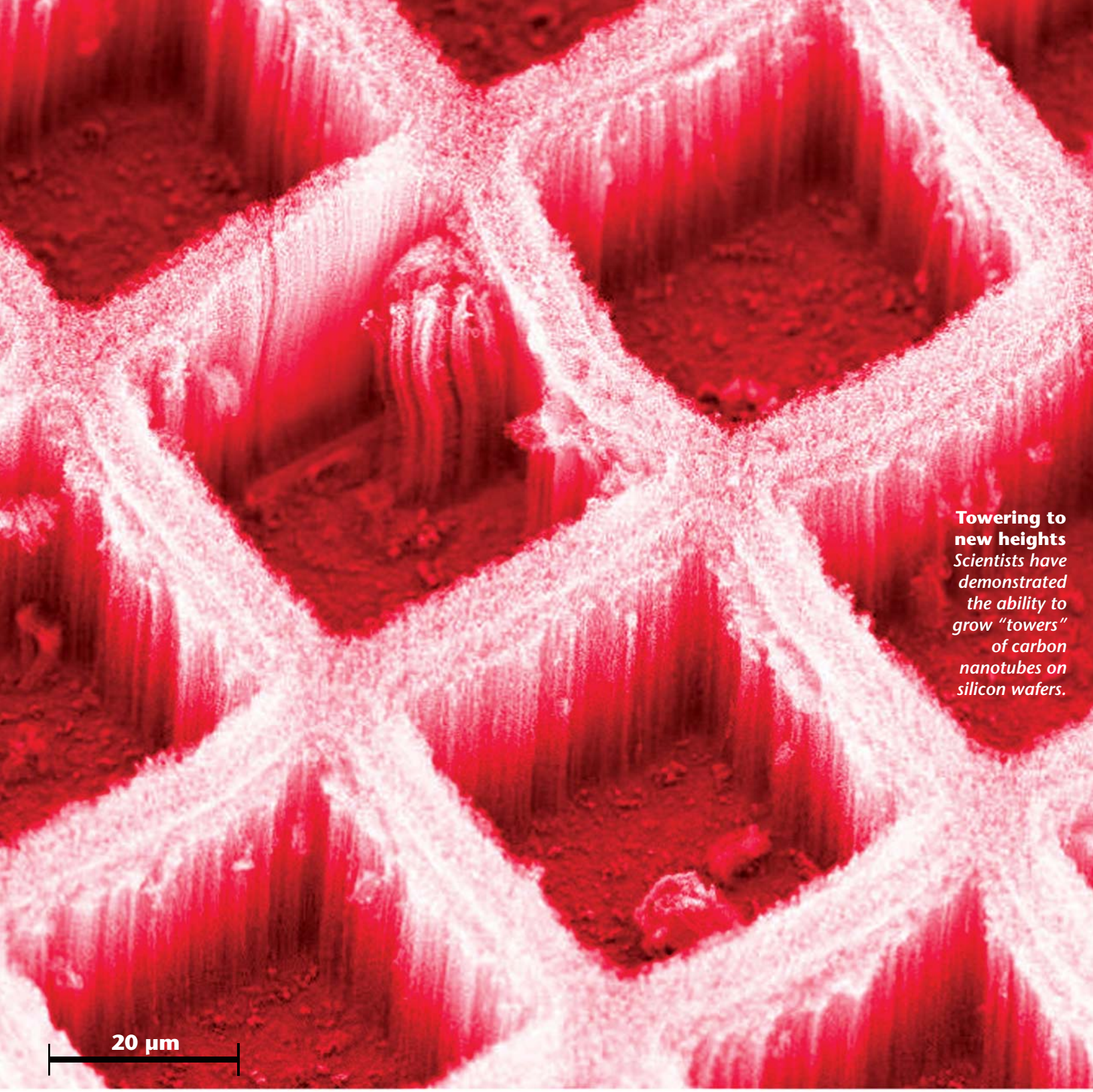
Our student writers explore a variety of technologies and their application to these complex problems. Oluwasen Aladese's article delves into solar technology and includes an interview with NJIT's Professor Somenath Mitra who is working on a "painted-on solar cell", a more affordable solar energy source. Matthew Deek does an objective, detailed review of fossil fuels versus renewable energy sources and concludes that the applicable technology for energy generation may be very dependent on regional differences, as well as energy preservation. Francesco Gennarini's article challenges the reader to think about "cradle-to-cradle eco-effectiveness" and introduces how this system was applied to an award winning home design. David Thompson in his article discusses some of the adverse applications of technology resulting in the possible extinction of some of our planet's flora and fauna. Crystal Kania's articles explore several diseases and technological applications to ameliorate their debilitating effects. In her first article, she discusses Parkinson's disease and the application of Deep Brain Stimulation Surgery. In her second one, she presents some of NJIT's research in science, technology and medicine. Crystal highlights the research being done NJIT Professors Zafar Iqbal and Haim Grebel on nanotubes; Timothy Chang's work on affordable, accurate diagnoses of cancer; Tara Alvarez' research on how the brain adjusts to dysfunctions in eye movements, and her work with a team including Professor Gordon Thomas and recent PhD Irene Nwosuh to invent a self-tonometer for use by glaucoma patients to measure their intraocular pressure. One of the applications of the "Drawing on Air" technology researched by Kristen Cheng in her article is biomechanics.

The writing and presentation of information by the student authors is excellent. Similarly, the work of the team of designers, integrating art, layout and technology is so compelling that I believe the reader is drawn into the text of the article. It is my good fortune to learn from and enjoy the good work of these student scholars. I thank them and this edition's advisor, Paul Dine. It is my pleasure to invite you to read this edition of the *Technology Observer*.

Most Sincerely,



Joel Bloom
DEAN, ALBERT DORMAN HONORS COLLEGE
VICE PRESIDENT OF ACADEMIC & STUDENT SERVICES, NJIT



Towering to new heights *Scientists have demonstrated the ability to grow "towers" of carbon nanotubes on silicon wafers.*

Insight to Innovation: Advances in Solar Technology

The complex new studies in solar research and the research of Dr. Somenath Mitra

:: BY OLUWASEUN ALADESE ::

Solar energy is simply energy from the sun. It is used in the forms of heat, light and electricity. The conversion of solar energy to electrical energy is achieved using a photovoltaic cell. The word photovoltaic, usually abbreviated as PV, comes from the words photo, meaning light, and volt, an electric measurement. While PV cells are able to convert solar energy to electrical energy, their efficiency is only about 10 to 20 percent. The photovoltaic process for conversion of sunlight to electricity can be broken down as follows:

- Conventional solar cells are made of silicon based photovoltaics in the form of thin wafers to which an element such as phosphorous is added to give the wafer a negative character, its excess electrons. This layer is referred to as the n-layer.
- Boron is added to a second wafer which gives it a positive charge, its power to attract electrons. This layer is referred to as the p-layer.
- When placed together, the p-layer attracts free electrons from the n-layer. A barrier is formed between these layers and is referred to as the p-n junction.
- When sunlight hits electrons in the p-n junction, it causes the electrons to be attracted to the positive charge in the n-layer and repelled by the negative charge in the p-layer.
- A wire attached to both layers allows the flow of the free electrons to an external source in the form of electric current.

Drawbacks in Solar Energy Adoption

In his research on Catalysis in Solar Energy, Thomas H. Maugh II describes the optimism and reality surrounding solar cell research. "The vision is, indeed, impressive, but the reality is somewhat more pessimistic. Sunlight may be free, but technology is expensive, and electrical energy from a power grid is still relatively cheap" (1358).

He provides a history of the solar cell as derived from extensive research at Bell Laboratories. "The classical silicon solar cell, invented in 1941 by Russell F. Ohl of Bell Laboratories and perfected in 1954 by D. M. Chapin, C. S. Fuller, and G. L. Pearson also of Bell" (1359).

Maugh examined the viability of photo-electrochemical cells as alternatives to silicon based cells, and later outlined the need for further development for improved efficiency.

In The Case for Thin-Film Solar Cells, Anwar Shah and his colleagues examine the developments in photovoltaic technology. They conclude that "it is safe to assume that thin-film solar cells will play an increasing role in the future of the PV market."

Some scientists, such as John Bockris of Texas A&M, argue that solar energy will be "the single most important energy source of the next 50 years." Others hold a more reserved view, believing it "will have a more modest impact and that most applications will be small and localized." What ever the case may be, it can be concluded that solar energy will play a significant role in the planets energy future.

Another limitation in the adoption of solar energy has been the availability and cost of materials used to develop photovoltaic cells. In the interview to follow, Dr. Somenath Mitra, professor and chair of the Chemistry and Environmental Science Department at NJIT, comments on the expense of infrastructural setup necessary for renewable energies to become less expensive and describes the possibilities of Single Wall Carbon Nanotubes in achieving higher efficiency for solar to electrical energy.

Following the inferences of such studies, the major pitfall in the success of solar to electric research is efficiency. Maugh, in addition to his considerations on the efficiency of photovoltaic cells, describes the cause of limitations in efficiency as attributable to the recombination of electrons and holes. "Left to their own devices, electrons and holes recombine rapidly, releasing either heat or light. The ultimate goal of all solar electric research is to find a way to keep them separated long enough for them to carry out useful work before they recombine" (Catalysis, 1359). This finding has remained largely elusive until now.

Single Wall Carbon Nanotubes

Dr. Mitra's research on Single Wall Carbon Nanotubes (SWNTs) ties in to its use with Organic Photovoltaics (OPVs), which are polymer-based solar cells. SWNTs are unique materials that exhibit properties which, in the case of solar research, make

"The solar cell will certainly not be the only form of energy but it will certainly supplement all the other sources."

—DR. SOMENATH MITRA, PROFESSOR, CHEMISTRY & ENVIRONMENTAL SCIENCE, NJIT

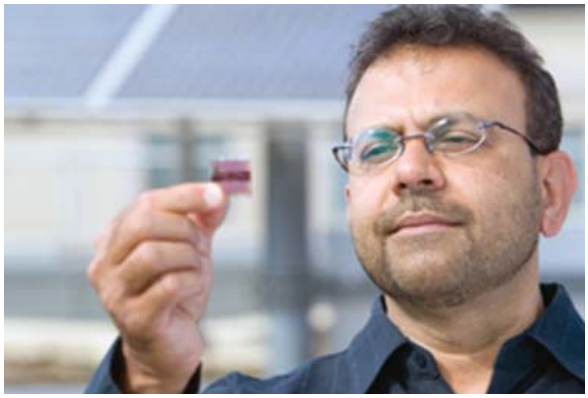
the storage of electric charges possible.

The structure of these SWNTs is such that they possess mechanical and electronic properties which make them useful in applications such as nano-structured composite materials, and nanotube based transistors. They are also a viable resource due to their very small size. "A single-wall carbon nanotube (SWNT), a cylindrical variation of a fullerene, offers a solution owing to its shape. SWNTs have a nanometer-scale diameter and exhibit ballistic electrical conductivity (many times better than copper) that can serve as tiny wires," writes Dr. Mitra.

"Single-wall carbon nanotubes have a nanometer-scale diameter and exhibit ballistic electrical conductivity...that can serve as tiny wires."
—DR. MITRA

About the Research

Dr. Mitra notes in his study, "the key to OPV technology is the mechanism of effective separation and transport of the electrons and holes (charge carriers)." Energy is wasted if they recombine since it is released in the form of light or heat. The solution to this problem is in the form of a carbon allotrope capable of holding the electrons. Such an allotrope is C60, a spherical fullerene. Its cylindrical variation, the single-wall carbon nanotube (SWNT) described above, offers the proper charge and conductive property that make it ideal for "preventing the recombination of electrons and holes."


Dr. Somenath Mitra

About the Researcher

Dr. Somenath Mitra is a professor of chemistry and the chairperson of the Department of Chemistry and Environmental Sciences at New Jersey Institute of Technology. His research on solar energy has been featured in various publications, including the *Journal of Materials Chemistry* published by the Royal Society of Chemistry.

Dr. Somenath Mitra exudes a relaxed and welcoming persona. His thoughts revealed a keen sense of the work that still lay ahead in the development of functional systems as well as palpable optimism on the impact of the research. Excerpts from the interview follow.

Dr. Somenath Mitra obtained his BS in chemical engineering from the Indian Institute of Technology in 1981 and his MS in environmental engineering from Southern Illinois University in 1984.

He received his PhD in analytical chemistry from Southern Illinois University in 1988 and has published numerous papers on topics ranging from the chromatography of self-assembled single-wall carbon nanotubes to microwave assisted purification of single-wall carbon nanotubes without sidewall functionalization.

In an interview with Dr. Mitra, he was able to provide some insight into his research as well as his views on energy and the environment.

Highlights from the Interview:

[Oluwaseun Aladese]: What inspired you in this line of research?

[Somenath Mitra]: Well, we were working on an experiment on coatings and one of the things that came about was, can we use the coatings to generate power? So that was how we started working on a coating for the solar cell.

[OA]: Was cost a major issue in the beginning or was this something you realized along the way?

[SM]: Initially, that was no a major issue, but as we moved along we began to realize its importance as a more affordable energy source.

[OA]: Why, in your opinion, do you believe solar energy has still not been adopted by the larger population?

[SM]: Well, solar energy is still very expensive compared to gasoline and coal and all the other energy sources, and there has not been much investment into that research because oil has been so freely available and relatively inexpensive. Another part of it is that

these alternative sources also require quite a lot of infrastructure.
It doesn't require that kind of cost [the] other energy sources need, but once you set up a power plant, it is quite cheap.

[OA]: Does the research involve any aspect on how it could be directly incorporated for home use?
[SM]: In principle you could paint the material on the roof or sidings of the side of your house that faces the sun, and it could be connected easily to an outlet in the house.

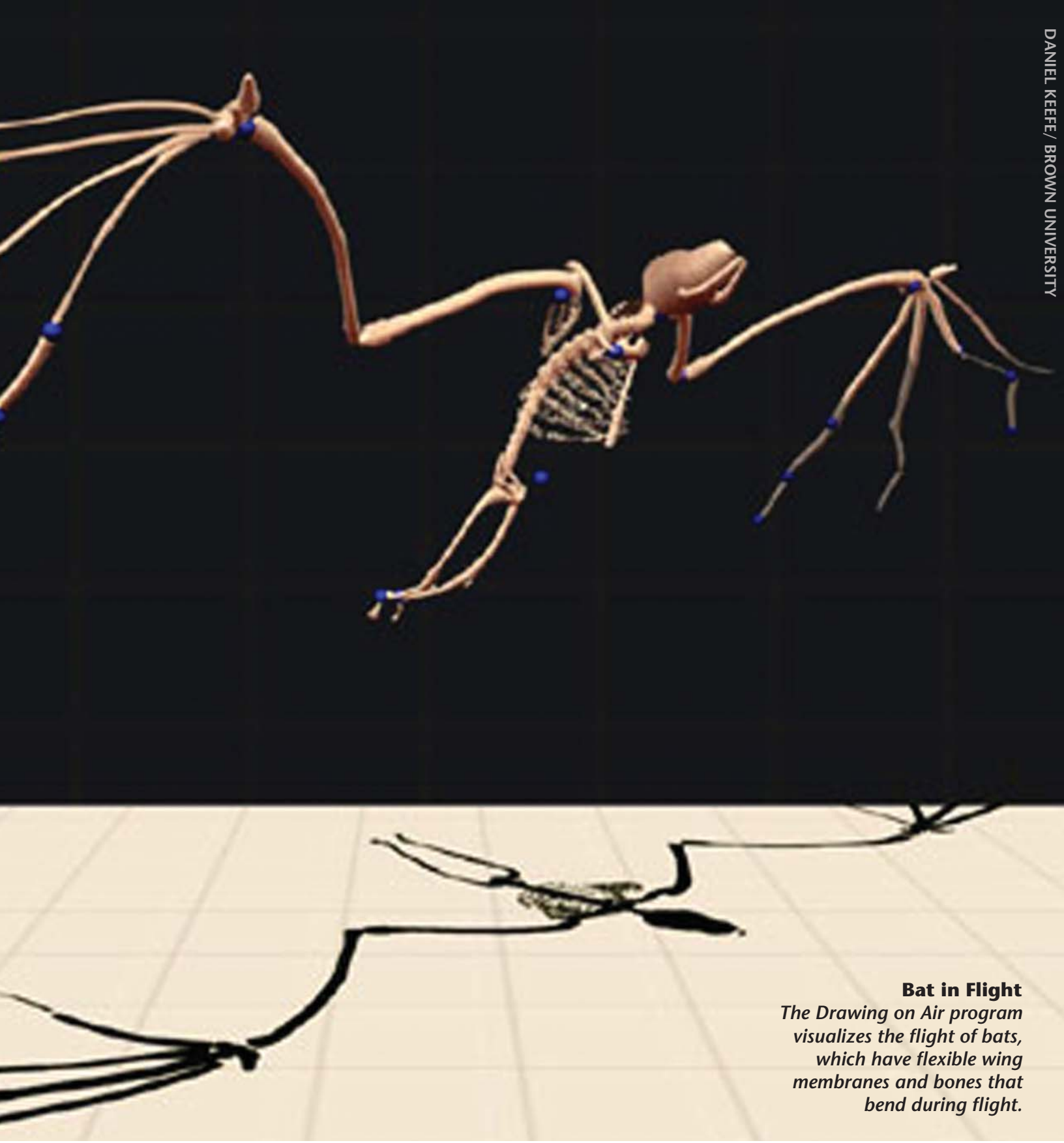
[OA]: Could you talk briefly about the Single Wall Carbon Nanotubes and how they improve the polymers?
[SM]: The single walled nanotubes are very good charge carriers, so as a result putting them in helps efficiency. You see in electricity generation, you basically have to carry the charge. In essence, the carbon nanotubes are very good electrical conductors and they are very small in size so they can infuse into paint.

[OA]: What stage of the research are you on right now?
[SM]: We are still doing research on improving the system, so we have to improve efficiency, develop manufacturing techniques, and so on.

[OA]: How do your foresee the impact of this research on the general public in the near or distant future?
[SM]: I think in the long run, from 5 years onwards, if oil prices keep going up we will see a tremendous amount of solar cell applications being used everywhere. And bringing the technology forward – this is certainly one of the best ways to use it.

[OA]: When oil prices go down, it tends to affect ongoing research on renewable energies, do you believe we're at a stage where people are more willing to invest in alternative energy sources?
[SM]: I think so. I think it has been like a wake-up call, and in the long run, I don't think the oil prices will stay down. In the short run possibly, because now as you know, the oil consumption base is very large. If you travel to Asia and South America, more and more people are driving cars along with other things that use energy. Prices have come down a lot and as a result the consumer base for oil products is increasing dramatically, but this is in the short term. ■

Power of the Sun
Siemens, the world's leading producer of comprehensive solutions for energy conversion, has clad the façade of a waste recycling plant in Trezzo in Lombardy with solar modules and linked the system up to the local power supply network. It is the first photovoltaic system of this size in Italy that has been integrated into a building.



DANIEL KEEFE/ BROWN UNIVERSITY

Bat in Flight
The Drawing on Air program visualizes the flight of bats, which have flexible wing membranes and bones that bend during flight.

A Canvas of Air

Using a new medium not just for art, but science

:: BY KRISTINE CHENG ::

Imagine putting on a virtual reality mask, grasping a stylus and a tracking device, and being able to draw three dimensional objects in the air with unbelievable precision. "Drawing on Air" is a new program that allows artists to depict intricate artistic, scientific, and medical subjects. Researchers that developed the computer program made sure that the interface is sensitive and provides the necessary tools to accommodate what the artist needs.

Daniel Keefe, Robert Zeleznik, and David Laidlaw, computer scientists from Brown University, were the first to introduce the innovative program, which starred in an issue of *IEEE Transactions on Visualization and Computer Graphics*. They explain the system through two approaches: the one-handed and the two-handed methods. Each method caters to drawing different variations of curves, screening, and revising the work. "Drawing on Air" boasts the success of attaining a higher degree of control compared to other drawing systems that limit artists to only rough sketches.

"Drawing on Air" utilizes drawing guidelines, force feedback, and two-handed relationships to assist artists in illustrating a curve more accurately. A curve drawn in the air is relatively hard to depict. Daniel Keefe explains, "First, think about a curve found in some interesting 3D shape—the handlebar of a road bike is a good example because it follows a smooth 3D curve. O.K., now take your index finger and try to trace that curve out in the air in front of you. If you were able to leave a trail of paint behind your finger as it moves through the air, what you would notice from this exercise is that drawing a nice shape is really hard to do. First, you would probably notice that your drawing is quiet wobbly. Second, you would probably find that the 3D proportion of the form is off. The 3D drawing is transferred into the computer for the purpose of 3D modeling, design, and illustration programs.

The two-handed method originates from the "tape-drawing" method. The tape-drawing method is an extremely controlled two-handed procedure for drawing in two dimensions. An artist must hold a stylus in one hand, while holding a tracker, which is connected to the virtual reality setup; the other hand is used for identifying the direction of the line. The user directs the movement of both hands to analyze the work from diverse angles and draws accordingly. The two-handed method has its advantages in offering more control for professionals.

The one-handed "drag" technique is simpler to understand and additionally, more suitable for portraying circular shapes due to the fact that the artist's arms are not required to transverse. With only one hand, the user can define the direction of the line and the line itself. This method is similar to a pen being pulled behind the artist's stylus as if on a tow rope. The pull of the artist's stylus creates a drawing direction before really drawing. The two-handed and one-handed versions permit artists to stylize the curves while drawing by dynamically altering line thickness and color. "Once you have this ability to sketch in the air, there are so many different artistic directions you can go with it," proclaims Keefe. Users of the program can effortlessly change back and forth among the two versions.

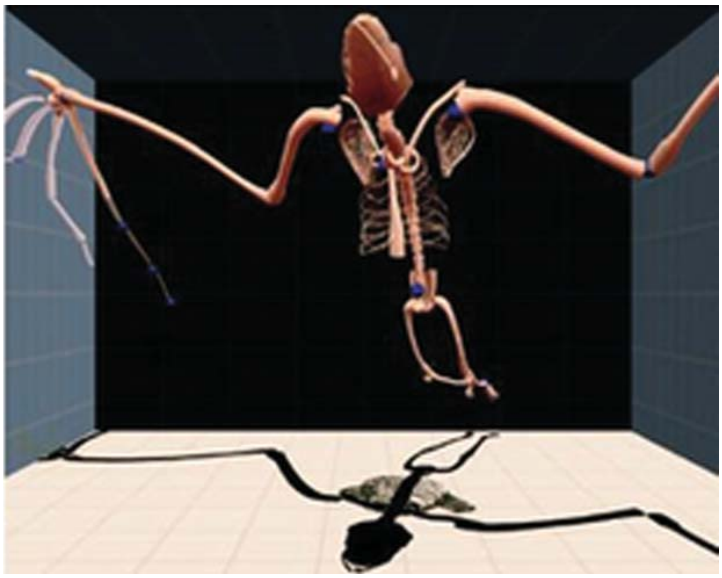
The system's features also include editing options. One of these options is the redrawing mode, which allows the artist to produce sharp breaks. Another option featured in the system is the haptic polyline constraint. This option lets the artist create a sweeping arc. "Drawing on Air" also provides the option of varying the line weight. To modify the line weight of a curve utilizing the one-handed method, the user must push his/her finger tip on a custom elastic controller, which is configured by a spring-loaded hinge fastened to the stylus. The more force applied to the elastic controller, the more the hinge deflects. When the hinge deflects, the width of the stroke is expanded and the color is adjusted to produce a thicker 3D mark. If the artist needs a thinner line, he/she would release the spring device. Colors are selected from a gradient scale chosen by the user. Users usually import their own color palettes and change the gradients to heighten the contrast with the background color. Changing the line weight using the two-handed method is similar to what the physical media calls for to vary thickness. Just as a brush or piece of charcoal is pressed against

"If we can boost the precision with which scientist[s] can interact with their 3D data...then many more scientific uses for virtual reality technology may become possible."

—DANIEL KEEFE, COMPUTER SCIENTIST, BROWN UNIVERSITY

the canvas to vary the weight of the mark, users press against this line constraint to create the same effect.

The Brown University scientists that developed "Drawing on Air" also designed and implemented a formal evaluation of the one-handed "drag" mode and the two-handed "tape" mode drawing techniques so to better understand how they compare to each other. They also compared the two drawing modes



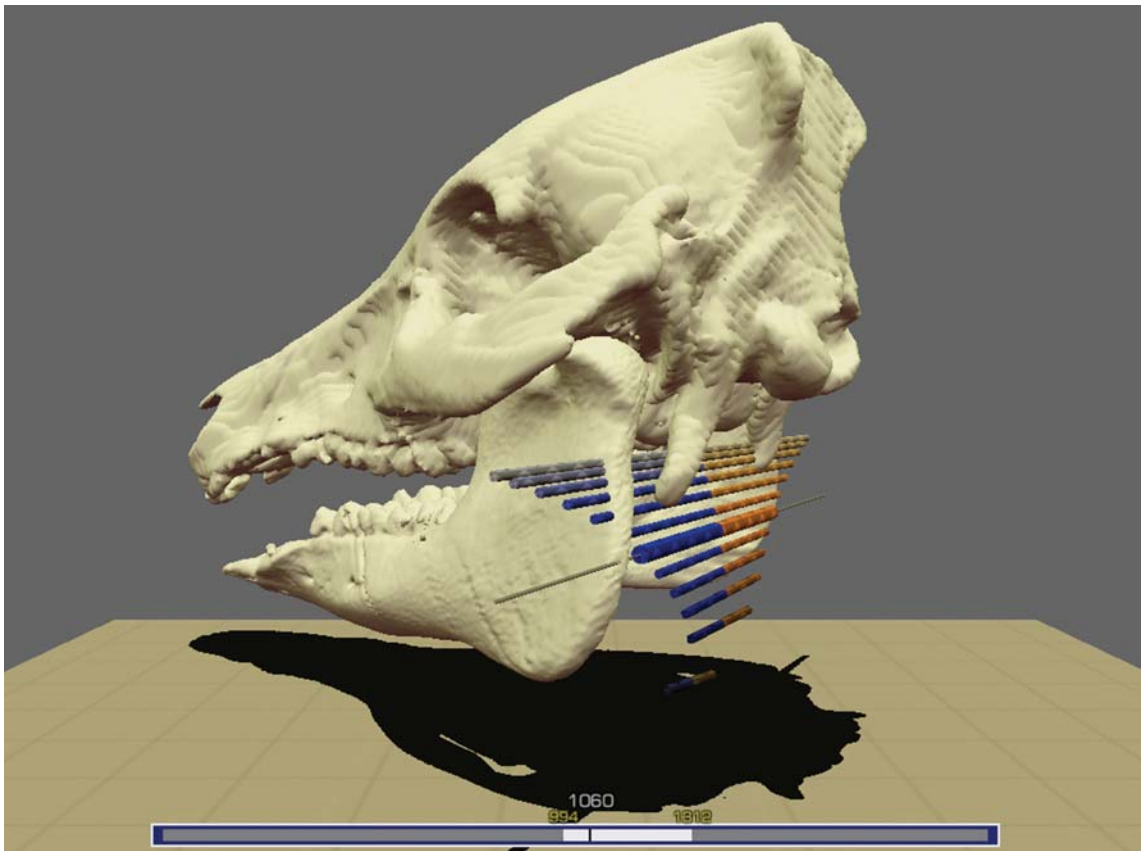
A different kind of paintbrush
An artist (above) uses Drawing on Air, which uses a sterscopic desktop display, stylus and tracking device. (Right) An illustration of a bat skeleton using the program.

of "Drawing on Air" to two freehand drawing techniques to institute the benefits of working with their new program comparative to standard methods. The scientists asked users who knew how to draw with traditional physical media to participate in the evaluation. Another objective of the study was to find out if users, who were generally inexperienced with computers, would be able to pick up their program. This study included the testing of the efficiency of four drawing techniques: drag, tape, sand, and free. Drag and tape techniques are implemented in the new program. The sand condition is a freehand drawing technique that has no constraints on movement of the stylus or the resulting line. Users describe this method as if they are moving a brush through a bucket of loose sand. The last method that was compared to the drawing techniques of "Drawing on Air" is the "free" procedure, which is also freehand but without the use of any haptic forces.

The results of the study were in favor of "Drawing on Air." Participants were asked to rank the four drawing methods in order from best to worst in terms of control of position, control of direction, and control of both position and direction combined. The sand technique was constantly placed third and the "free" method was always placed last. For position, tape obtained nine first place ranks to drag's three votes. In terms of direction, tape obtained five first place votes to drag's seven votes. For control over position and direction, tape received eight first place votes compared to the four votes for the drag technique. Participants were also asked to rate how likely they would be to utilize the four methods, including the tape and drag drawing methods of "Drawing on Air." On a scale from one to seven, with one being "not likely" and seven being "very likely," their mean ratings were tape 6.5, drag 6.5, sand 4.0, and free 2.0.

Because of this study, it is now known that drag seems to be faster than tape for drawing approximate shapes, but slower for depicting very precise shapes. It concluded that both the drag and tape techniques are vital parts of a controlled 3D drawing package. User preference given a specific line to draw may be the best way to choose a drawing method; therefore, the close incorporation of both techniques into the program makes sense due to the stage of control participants demonstrated with each.

The sand and free techniques have a so-called "sweet spot" for drawing speed. If the depiction is done too fast, it is challenging to precisely capture the shape of the curve. If the drawing is done too gradually, it

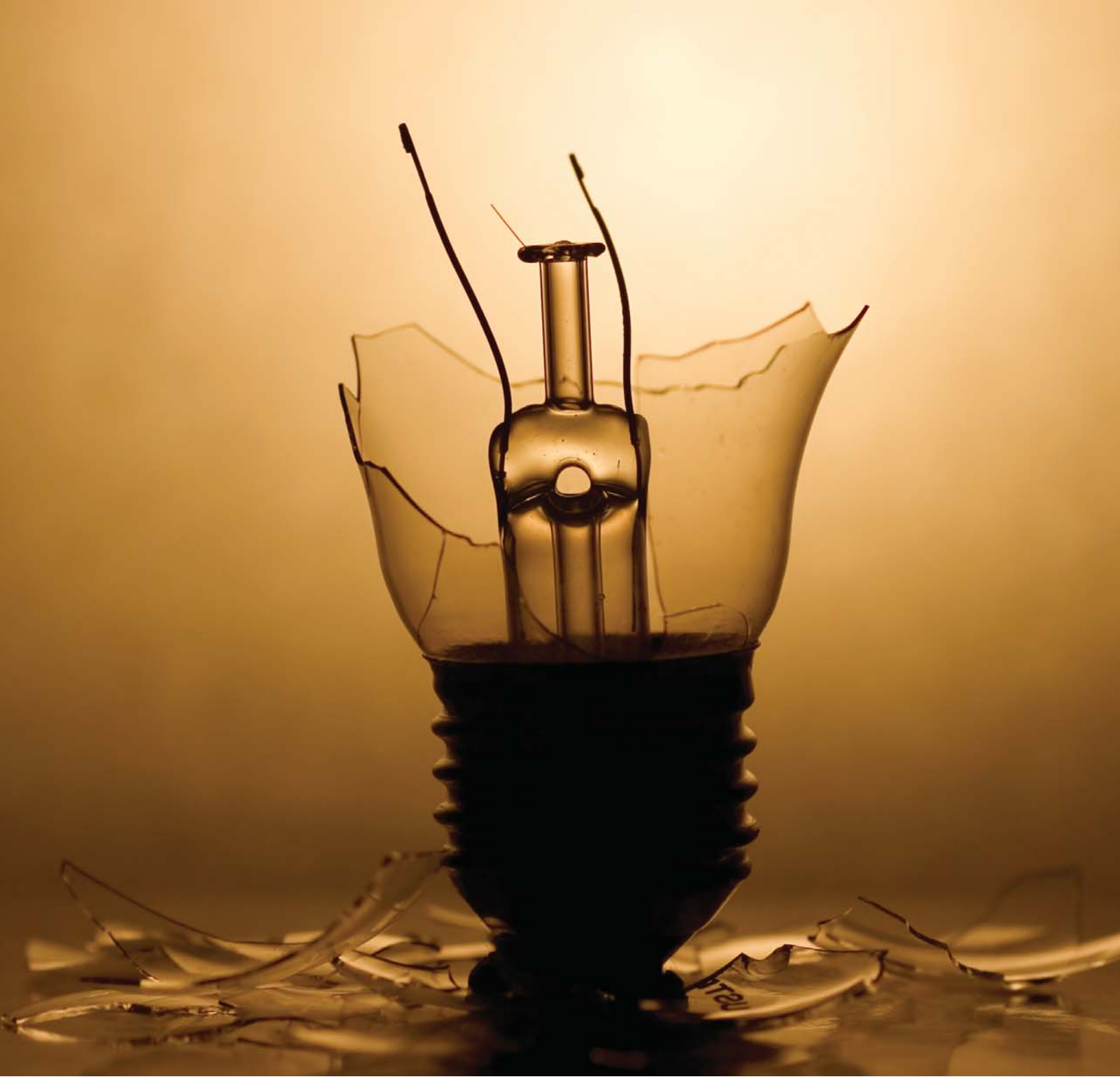


Biomechanics
Left side view of a pig mandible

is challenging to maintain a smooth movement of the hand, therefore controlling directional error.

On the other hand, methods for "Drawing on Air" allow deliberate drawing. There is no motor control penalty related with drawing slowly and carefully. Guidelines are also built within the program, which enables the user to continuously check the position and orientation in space It has been demonstrated that "Drawing on Air" is straightforward, easy to learn, and offers sufficient control to generate elaborate 3D subjects. "We're not too far from this sort of thing being available to consumers," Keefe adds. "Right now, the cost is prohibitive, but with the advent of technologies like camera based 3D tracking, I would expect the cost to create two-handed input systems like this to come down from thousands of dollars to hundreds of dollars in the next few years… If we can boost the precision with which scientist[s] can interact with their 3D data using a computer, then many more scientific uses for virtual reality technology may become possible." An example of a vital use of this program came into play when biologists were studying a bat's flight. Precise 3D drawings were very important, due to the fact that bats have a flexible wing membrane and curved bones that bend while flying. Using "Drawing on Air", artists were able to uncover features of the bat's body in motion and simplify the tedious parts of the physique. Almost all anatomical drawings and even preserved specimens of bats have been portrayed with the wing membrane and skeleton completely flattened, as biologists would expect of a bird's wing or a fixed wing aircraft. Recent research has terminated this belief. Bat flight is seven times more complex than that of birds due to the 3D deformations its flexible wing membrane and bones undergo during flight. Because 3D understanding is so crucial in this problem, 3D illustrations of bats modeled in flight are enormously critical tools for biologist researchers. Several features of "Drawing on Air" aided the correct representation of a bat. Smooth curves of the wing bones are clearly indicated. The wing bones actually bend during flight. Therefore, their shape is significant and would be unattainable to convey accurately with a freehand method.

The function and future of "Drawing on Air" has endless possibilities. "Drawing on Air" is an important first step toward producing enhanced 3D illustration as approachable as drawing on paper. Advances toward this vision will make possible significant artistic endeavors and more successful scientific and medical drawings. ■



The Energy Emergency

A Need to Balance Business, Environmental, and Human Concerns

:: BY MATTHEW DEEK ::

Energy, in its various forms, is essential to every individual and society; it is also a key factor for the stability of our economy. It has been so across the ages, although becoming more complex as the need for power increases. The United States has traditionally depended on fossil fuel for its energy needs. By the mid-20th century, convenience and economic considerations gradually caused a shift from reliance on local coal to foreign oil and natural gas. Concerns over environmental implications, as well as renewed economic considerations, are again creating momentum for another shift, this time from fossil fuels to other sources of energy.

Without energy, it will be difficult to function as a modern society. We use it to cook our food and heat our homes. It powers the systems that allow businesses to function, facilitates travel locally and globally, and enables the transportation of goods. The United States relies heavily on all three types of fossil fuels, coal, oil, and natural gas, for its energy needs. Historically, the U.S. met most of its energy needs from its domestic supply of coal. A change occurred in the early 1950s when the U.S. began to depend increasingly on imported oil and gas, particularly when prices went down as new oil fields were discovered (Deffeyes 23). Today, the world is facing some uncertainties about its energy supplies triggered by three key reasons: the growing demand for energy because of population growth, the need for more power to sustain new emerging economies, and local disruption of fuel production due to geopolitical conflicts. Dependence on oil as the primary source for energy will not be sufficient to satisfy the increasing need for power unless a mixture of all possible energy sources, such as solar, wind, geothermal, hydroelectric, nuclear, coal, and oil combine to keep up with the demand.

The Balancing Act in the Diversification of Energy Sources

A debate about fossil fuels has been taking place in the U.S. since the 70s. More recently, it seems as if the rest of world has joined in. Scientists, economists, legislators, environmentalists, petroleum companies, and oil producing countries have all weighed in with their opinions. Meanwhile, the public finds itself confused by the debate and its complex scientific arguments. Often, the facts from the two differing sides vary greatly, making it even harder to understand the underlying issues. Very few, however, dispute that an energy crisis exists. The fluctuating prices of gasoline, the costs of heating and cooling our homes, and the costs of food and other commodities are becoming noticeably higher for all consumers. Even if we concede the viewpoint that the oil supply is healthy and there remains an abundance of fossil fuels in reserve, it is reasonable to accept that the streams of non-renewable resources are finite and they will eventually run out. The concerns about the energy supply are not new. Geologist and researcher M. King Hubbert advanced a position in 1956 that predicted a shortage in oil production in the US and a permanent decline after a peak that would occur around 1970 (Hubbert 16). He later produced a model that illustrated the rise, peak, and decline in production over time. Hubbert's work received renewed interest after Kenneth Deffeyes, a geologist and researcher who worked with Hubbert at a research laboratory, wrote his own book about the same subject. Deffeyes' model shows that global oil production will reach its "Hubbert's Peak" in 2005 (Deffeyes 158).

The Finite Nature of Oil, Coal, and Gas: Their Economic Impact and Environmental Implications

The depletion of oil, coal, and natural gas is understandable since fossil fuel deposits beneath the earth have taken hundreds of millions of years to be created. Ancient natural substances deep within the earth's crust, in the form of plant and animal remains, have become today's oil and natural gas. The energy stored by plants that lived hundreds of millions of years ago has been preserved in coal, the most abundant fossil fuel available in the U.S. The economic health of the US, at least in the short term, is dependent on having access to secure, reliable, and affordable fossil fuels. Nearly all of our energy needs are met with fossil fuels, providing for the largest chunk of our electricity and nearly all of our transportation power. Coal, the most economically available source of energy, has been used extensively since the Industrial Revolution (Deffeyes 82). It has since lost ground to oil. The United States' dependence on oil and the fact that it does not produce enough of it to meet its own demands is a source of vulnerability. The global increase in demand for energy will place further strain on supply. At the same time, the reliance on energy will further increase in order to meet the rising demands even with the exploitation

of new sources. For the U.S., even if its reserve of oil and gas is sufficient to sustain its economic growth, there must be a provision to address the fact that the largest supply of such resources are located only in a handful of places around the world. Thus, the import of oil from other countries creates economic and social uncertainties for the U.S. as supply and prices can become subject to a number of different regional and global factors.

The impact of the use of fossil fuels on the environment further complicates the confusing debate regarding energy. Some insist that energy that comes from fossil fuels produces greenhouse gases that have severely affected the world's climate, as evidenced by the high atmospheric concentrations of carbon dioxide. There are scientists that blame the existence of excessively large amounts of carbon dioxide and its consequences on the combustion of fossil fuels (Jacobson 2). Others counter that the role of human activity in changing the climate, although possible, is unlikely and there is a need for stronger evidence before blaming climate change on humans (Robinson et al. 81). Objectively, fossils fuels alone are not the sole reason for the increase in carbon dioxide, as it occurs naturally in the environment. After all, animals, plants, fungi, and microorganisms produce it, and volcanoes and other sources emit it as well. However, some forms of environmental degradation are hard to dispute such as the risks associated with extracting and utilizing fossil fuels. It is evident that mining for coal and drilling for oil changes the surrounding landscapes. Reducing our dependence on oil and coal can lessen adverse environmental impact. Consequently, there is work focusing on new technologies that will make the production and use of fossil fuels cleaner, more efficient, and more environmentally friendly (Schlager and Weisblatt 337). There is also similar work aiming to create machinery that can locate and mine oil, coal, and gas beyond the current scope. Exploiting other sources of oil using new methods and tools has already greatly benefited offshore tar-sand oil production (Deffeyes 102). The oil sands of northern Alberta in Canada are already being mined and used because of better technology that also give promise to being able to mine the oil shale in the western US, which contains a huge reserve of energy. More importantly, there are significant efforts, with evident success, to maximize energy supply from renewable sources.

Some scientists... suggest that the Great Plains...could alone produce wind energy to supply all of the country's energy needs.

Renewable Energy and Environmental Benefits

Renewable energy, generated from natural resources, is guaranteed and clean. Wind, rain, tides, and the earth's own heat are examples of abundant and naturally replenished energy. A small portion of global energy consumption now comes from renewable sources. As technologies for solar, wind, hydroelectric, and geothermal power continue to evolve so will the adoption of this type of energy. The logic for tapping into solar energy is compelling; we can always count on the sun rising tomorrow. Similar to plants, solar panels absorb rays from the sun and day-light into their solar cells (Chiras 3). Energy created from the transformation of these rays is stored in a battery or generator for later use. An advantage of solar power is its one-time investment cost. The solar panels, easily integrated within the architectural design of buildings, are mounted on the rooftops of structures. They will last a lifetime and require little maintenance. Wind, much like solar power, is a reliable form of renewable energy (Chiras 11). It has great promise in certain landscapes like the bare and broad plains of the Midwestern states. Wind power, actually a form of solar power because it is caused by the heat of the sun, is capable of generating up to 20 percent of future U.S. power, according to the Department of Energy (DOE 2). Some scientists are much more optimistic and suggest that the Great Plains, acting as home for tall turbines, could alone produce wind energy to supply all of the country's energy needs (Leighty 411). As a side benefit, harnessing the energy of the wind in the Midwest will create job opportunities rarely seen in those rural states. A less well-known, but promising, resource is geothermal energy, which can offer a continual supply of power. Harnessing the heat stored in the Earth's crust may be a possible option in many places. Geothermal energy, as a renewable, offers advantages over fossil fuel sources, but also over other renewable sources. For example, geothermal power plants are unaffected by changing weather conditions as they receive their energy replenishment from deep beneath the Earth's surface. Underground aquifers and hot springs can provide hot water and generate

electricity. Geothermal heat pumps can use the Earth as either a heat source or a heat sink. Hydropower, already accepted and exploited in many places, generates energy by harnessing the power created by moving waters (Chiras 32). The waters flowing in rivers and shifting tidal waves in oceans can be great homes for strategically located turbines that will produce alternative energy in the form of electricity. That Earth contains over 1.1 trillion gallons of water makes this an option hard not to pursue (U.S. Geological Survey).

Nuclear power, another form of renewable energy, stands in a class by itself. Although it is risky because of potential toxic accidents, it is clean and very efficient. For example, a single nuclear fission gives 10 million times more energy than the burning of fossil fuels making it an appealing source for energy to satisfy a growing world population that is poised to exceed 10 billion by the year 2050 (Bilgen, Kaygusuz, and Sari 1119). Nuclear power also has some disadvantages, mainly producing radioactive waste that requires management and presents potential health risks. However, with reprocessing, much of the nuclear waste can be reused. A major concern of the communities in which nuclear power stations are located is accidents. The risk of terrorism, yet another security concern regarding nuclear power, needs mitigation. This explains why the U.S. continues to rebuff this clean and reliable form of energy. Clearly, the diversity of energy options on the renewable side makes it a necessity to consider solutions to the complex energy problem that will include these sources. The combination of renewable sources of energy with the existing supply of fossil fuels will ease the shortage and reduce the burden on the environment.

Conclusion

With the uncertainties of crude oil pricing and the likelihood of its climbing, the tone of the debate over possible solutions will also increase. Some will insist on an increase in domestic drilling while others will demand a switch to renewable sources of energy. Neither alone is the ultimate solution. The current policy of relying almost exclusively on one source of energy to power an entire nation is the core of the current crisis. It is apparent that excessive dependence on oil, as a primary source for energy, will not be sufficient to satisfy the increasing need for power. The devising of a careful plan for bringing together a combination of renewable energy sources, such as solar, wind, nuclear, coal, geothermal, hydro, along with fossil fuels, should be developed in order to keep up with the growing demand. Recognizing that not all sources of energy are available everywhere, or maybe even suitable, different countries need to establish how they may gain access to, or possibly produce, some or all of their own needed supply of energy. This may come from renewable, non-renewable, or a combination of both sources. Countries can create scenarios for modeling efficient energy use in their own local environments based on their energy demand and the supply of energy resources accessible to them (Sorensen 436). The availability of local resources would dictate the mix of options. This should eventually lead to the discarding of some of the current inefficient systems of energy generation. As the pattern of energy supply and demand points to a mismatch between the regions where energy is needed and those where the resources are located, it makes sense to engage in a trade, an exchange of some sort, between different regions of the world (Sorensen 436). This will ensure the maximum use of all available energy options and should lead to a balanced and sustained energy utilization model. At the same time, there is a need to accelerate the development of new technologies for both fossil fuel and renewable energy, in addition to increasing conservation measures. Gradual reduction in fossil fuel consumption will naturally occur as the supply of renewable energy resources increases. Furthermore, education can play a key role in informing consumers of various means for cutting consumption. The message is simple: Resource preservation is as important as resource generation. Such costly investments in research, development, and awareness programs will pay for themselves in a number of ways. It is then that a balance between human needs and the environment is forged. As a start, reducing carbon emission into the environment will have positive health consequences for everyone. Next, reversing the effects of global warming may become the target, a daunting but attainable task. ■

As the pattern of energy supply and demand... mismatch between regions where energy is needed and where resources are, it makes sense to trade.

Efficiency or Effectiveness?

Flipping the page from cradle-to-grave efficiency to cradle-to-cradle eco-effectiveness

:: BY FRANCESCO GENNARINI ::

No one doubts the possibilities of an ecological alternative that proposes to reduce, avoid, minimize, sustain, limit and detain. These have become the basic terms in most of the environmental debates of current industries which, seeking an exit strategy from the crisis of natural resources and energy, are proposing to become more efficient. "Eco-efficiency" means "to do more with less," a precept which in ecological terms is not recommendable at all, considering that even though it is an apparently admirable concept, even noble, it is not a long-term exit strategy because it does not seek to eradicate the problem at its roots. The term "Eco-efficiency" was officially promoted by the Business Council for Sustainable Development, a group of 48 industrial promoters that included industries which are known as non-ecological, such as Dow Chemical and DuPont. This group is the one that coined the three 'R's –Reduce, Reuse, and Recycle– which have become so popular among the ecologist avant-garde. Evidently reducing consummation of resources, the use of energy, emissions and residues is beneficial for the environment and for people's morale, but the fact is that Reduce, Reuse, Recycle, is not the answer. Proposals have been made to limit the quantity of dangerous emissions produced by industry, all in the name of eco-efficiency. But obviously, the current rhythm of reducing is not enough to avoid the disastrous consequences for our ecosystem. The reuse of certain residues by some companies is also commendable but does not address the toxicity of the residues as they are manipulated. In most cases the result of this recycling only moves the problem from one location to another. We must admit that our world survives on designs which are destructive and unintelligent. We may promote norms, but in reality, as demonstrated by the "buying and selling of emissions" proposed by the Kyoto Protocol, what we are doing is legalizing licenses to do more damage. These licenses give a paper mill in Southeast Asia the authorization to pour chlorine products into waters that will reach the general population, provoking illness and the destruction of the eco-system, all under the protection of international law and under the cover of efficiency.

Efficiency within the system only postpones the problem, even though moral prescriptions and codes may be put in place. The current common concept of eco-efficiency in the end is simply a compromise. Consumers are invited to limit their consumption. You are invited to buy less, spend less, and have fewer children or none. If you are going to save the planet, you will have to make some sacrifices, share some resources, and make sure your tires have the right pressure so you save gas. So that the environmental problems of today, global warming, deforestation, pollution, waste can continue to survive for future generations, until industry in a quiet and persistent manner terminates everything. The root of the problem is the reconciliation between nature and commerce. This is the thesis of the book *Cradle to Cradle* by the American architect William McDonough and the German chemist Michael Braumgart. This visionary and provocateur's text gives a completely different answer from the one given to us by the green movement, which is simply to reduce the intensity of the productive process, recycle the garbage that derives from it and reduce, avoid, minimize, sustain, limit and detain the consumption of goods.

McDonough and Braumgart propose something revolutionary; it is a proposition that arises from the observation of certain crucial natural phenomena: a tree produces thousands of seeds to guarantee its reproduction, and this overabundance does not represent a waste but more an opportunity in that it makes available material and energy for a vast quantity of other living organisms. The tree has been established in such a way that each part of its cellular tissue, each one of its organs always finds an efficacious position in the context of the ecosystem in which it is located. So the authors propose a third element with respect to the dual growth/protection necessity of environmental equilibrium: this element becomes real in the key word "eco-effectiveness" (very different from eco-efficiency described previously, or environmental sustainability).

Eco-effectiveness is founded on three basic concepts: (1) the establishment of production procedures that ascertain beforehand (starting from the architecture of the industrial edifices until the final product) the re-insertion of the materials in future production cycles– ad infinitum; (2) the clear-cut separation between "biological metabolism" and "technological metabolism"; and (3) to pass from the concept of selling products to the idea of selling services (for example: no longer to sell a TV, but to sell a certain number of hours of program viewing).

The authors of the book make a concrete example through the book itself. One picks up a book, it might

have a plastic cover, and once you get past the cover what you find inside is a tree, or better said, what previously was a tree. The pages in the book will never return to their original form. The most that could happen if the book is ever thrown "away" and possibly recycled is that through the recycling process it will simply consume more energy and resources that are themselves non-renewable. The result will be recycled paper. One might say that recycled paper is a good thing, but the fact is that paper can never truly be fully recycled, so "perhaps it would be more accurate to say downcycled." The book of McDonough and Braumgart is not a tree; it is not made from a tree: "It is printed on a synthetic 'paper' and bound into a book format developed by innovative book packager Charles Melcher of Melcher Media. Unlike the paper with which we are familiar, it does not use any wood pulp or cotton fiber but it is made from plastic resins and inorganic fillers. This material is not only waterproof, extremely durable (more than a conventional paper book), it also has the potential of being recycled by conventional means; it is the prototype for the book as a 'technical nutrient', that is, as a product that can be broken down and circulated infinitely in industrial cycles—made and remade as 'paper' or more importantly it can be re-born as another product."

DuraBooks™, a true innovation in publishing... the ink does not smudge after it is wet... the paper is tear-proof.

These books, called DuraBooks™, have a format that "utilizes revolutionary technology and is completely waterproof, highly durable, and upcyclable. Book publishing is the oldest and most mature of all media, yet innovation has been slow since Gutenberg invented letterpress printing in 1450. DuraBooks™ are a true innovation in the history of publishing (DuraBooks)". These books can go where ordinary books cannot: imagine taking a relaxing bubble-bath and the book you are reading slips out of your hands. No problem at all, you just pull it out of the bath tub and continue reading. The ink does not smudge after it is wet and even more; the 'paper' is tear-proof. The authors explain that rather than working from the "reduce, reuse, recycle," model—which perpetuates the "cradle to grave" manufacturing model, dating to the Industrial Revolution—products can be designed from the onset so that, after their useful lives, they will provide nourishment for something new. The Durabook is a prototype of this new "cradle to cradle" manufacturing model.

So the question becomes how can we harness our resources and use their full potential? How can the production process set in place since the industrial revolution continue its course but be transformed into something beneficial for our eco-system? The design principle is "cradle to cradle"; it rethinks the way we make things. It is applied to chemical research, architecture, urban design, industrial products and the technology that a-priori is involved in the manufacturing process of all these fields. The authors make an example of how elegant and good a cradle to cradle design could be; they describe how the Bedouins in Jordan made tents woven of goat hair that drew hot air up and out, generating a constant breeze and shade in the interiors. "When it rained, the fibers swelled, and the structure became tight as a drum. It was portable and easily repaired: the fabric factory — the goats – followed the Bedouin around" (McDonough). Compare these tents to your everyday nylon tent. "Nature doesn't have a design problem. People do." Everything is designed for us to throw away when finished with it; so where is this "away?" The processes involved in design from conception to finality are detrimental to our very existence in that they have an end.

Let us consider, as described by McDonough and Braumgart, the process of building your typical universal house. The first move of the builders is to scrape away everything on the site to reach a bed of clay or undisturbed soil. That soil is then leveled. Trees are felled and brought to the site under the guise of easily flammable composites; the natural habitat of flora and fauna is destroyed and in the midst of it rises your generic McMansion or modular housing. It does not consider the way the sun might come in to heat the house during the winter, how the surrounding trees might protect it from wind or heat in the summer and how soil and water health might be preserved for the future. On top of everything, a foreign species of grass is placed over the rest of the property. Eventually the

"Nature doesn't have a design problem. People do."
–WILLIAM MCDONOUGH, ARCHITECT, DESIGNER, AND COAUTHOR OF *CRADLE-TO-CRADLE*

house will need to be torn down and the eco-system will be forever changed, in an irreversible way. How can we as humans leave a footprint which will not ultimately be detrimental to our well being but instead provide nourishment for something new?

The fulcrum of this new ecology is strongly tied to the advances in technology and research in all fields. McDonough builds houses and factories that have green roofs that use natural conditions to keep cool in the summer and warm in the winter with an almost non-existent use of fossil fuels to keep them warm, no heavy metals in the materials and unbeatable living conditions. Braumgart has conceived a shampoo that can be poured into the ocean by the tons and a biodegradable carpet that can be used as fertilizer when it has become obsolete.

The authors have extended an invitation to architects and designers to implement the cradle to cradle method for the construction of housing: C2C Home was established as a non-profit in February 2005 to continue the work that started with the successful international housing competition. The organization's objectives include securing adequate funding to support the completion of required technical drawings and construction costs incurred as the selected competition plans are translated into actual homes. C2C Home looks forward to serving as an educational resource for those interested in the future of sustainability, and to building beautiful, affordable, and sustainable homes that were designed by the competition participants. (McDonough) This is the first opportunity to apply C2C principles to home design.

The winning entry for the professional category in competition were Matthew Coates and Tim Meldrum, who designed a home that is not only aesthetically appealing, but also acts as a seed for the betterment of the entire community. The design of this home takes into consideration five points: Energy, Water, Materials, Ventilation, and Community.

The designers postulated the following:

Energy The design utilizes passive solar strategies such as absorbing heat in the winter from the sun and protecting from excessive exposure to the sun in the summer through its thermal mass. Electricity is provided through active solar collection in that the core extends vertically and is "clad with a superconductive Photosynthetic plasma cell skin that is able to generate 200% more electrical voltage per area than contemporary photovoltaics. Building on current research, this living skin is photosynthetic and phototropic. It grows and follows the path of the sun, generating electricity in excess of single family needs. The excess is distributed to the neighboring homes."

Water The fact that the building is integrated with the landscape allows for a vegetated roof system that would collect and filter storm water into the building core in order to supply the household needs. Black and grey water would be released into a septic tank and then as fertilizer for the garden. The system accepts residential waste water from neighboring homes.

Materials The Earth acts as the primary insulator reducing the use of building materials. Rapidly renewable soy-foam wall panels offer greater thermal resistance. Reconstituted concrete with striated polymer mesh reinforcement allows for the re-use of a material that is mostly useless once used, and allows for a flexible plan to accommodate future users.

Ventilation Prevailing summer wind from the southwest would flow freely up the length of the site leading it into the home as it accelerates thanks to its form. The core serves as a stack ventilation tower allowing a controllable flow of hot air up and out of the house.

Community The community becomes essential to the technological success of the project. If the single family remains isolated, no advances in residential housing and technology truly matter. Community interdependence is essential for future growth. One home creates a resource that benefits many. Excess energy is distributed and communal waste is retained on site, collected and treated to nurture common garden space. In time this seed (the home) will generate an entirely new eco-system that will spread and benefit both the individual and the whole.

This revolutionary concept is not at odds with the current economic necessity of industrial production and growth. It does not endorse the common view of the environmentalist who finds business as bad and industry itself as destructive; or industrialist who views environmentalism as an obstacle to production and growth. It does not want industries to be regulated and restrained; it does not promote a halt in progress and development of new technologies; it does not call for sacrifices. It proposes that the two systems can thrive in the same world for the ultimate well being of the children of all species for all time. We do not need efficiency, but effectiveness. ■

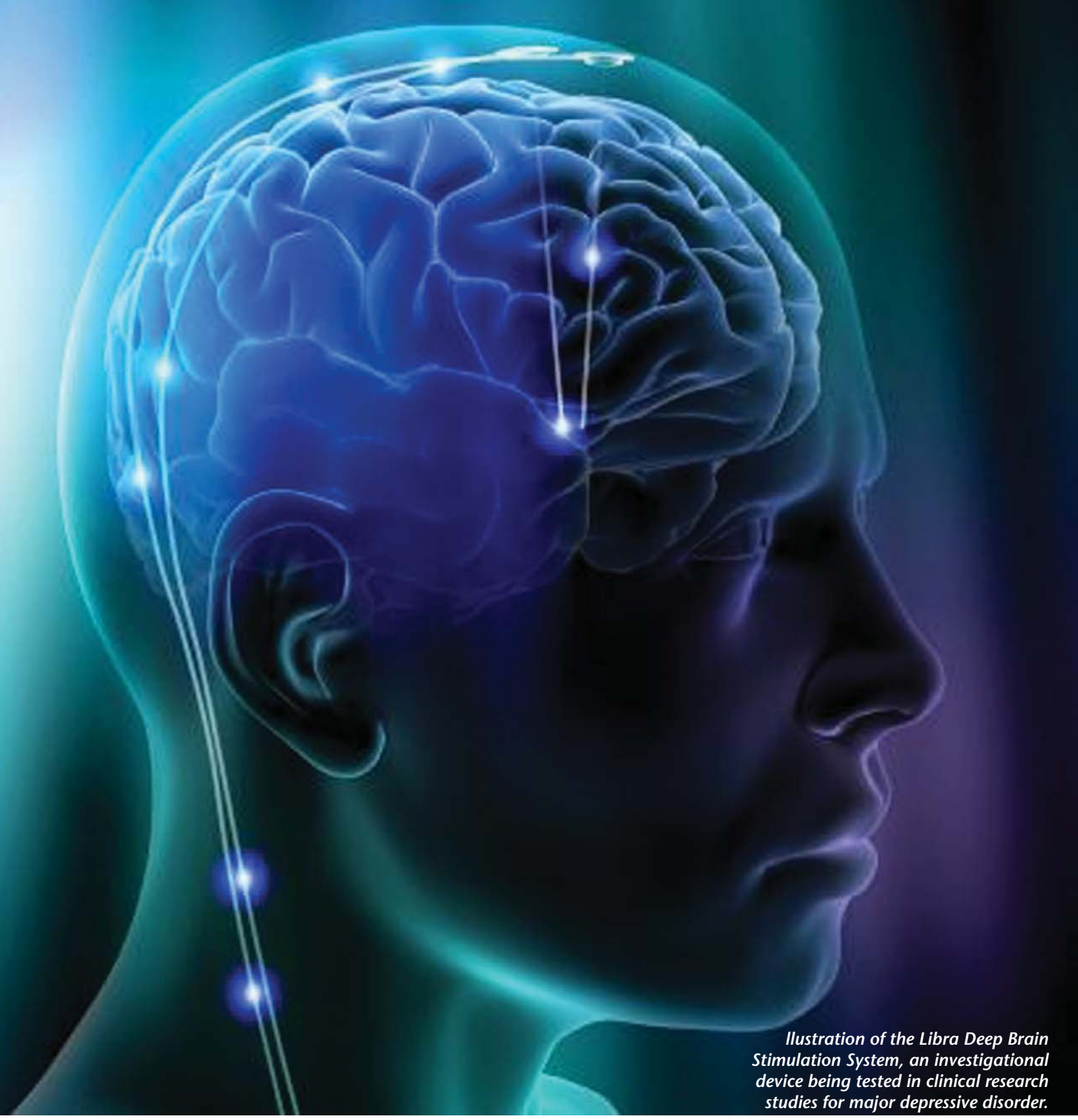


Illustration of the Libra Deep Brain Stimulation System, an investigational device being tested in clinical research studies for major depressive disorder.

Deep Brain Stimulation Surgery

How a bioengineered pacemaker for the brain is revolutionizing the treatment of Parkinson's Disease

:: BY CRYSTAL KANIA ::

In the United States alone, 1.5 million people suffer from a progressive neurologically degenerative disorder called Parkinson's disease. Although Parkinson's disease (PD) was first described as "an abnormal shaking of the limb" in 1817 by London Physician James Parkinson, symptoms include a wide range of abnormalities, such as slow movement (bradykinesia), an inability to move (akinesia), rigid limbs, a shuffling gait, and a stooped posture. Symptoms are occasionally confounded with psychological defects such as depression, personality changes, dementia, sleep disturbances, and speech impairments. Although patients under 40 very rarely have Parkinson's disease, all ages are vulnerable to the disorder because its causes, along with old age, are often confounded with exposure to dangerous toxins, genetic inheritance, and chromosomal mutation. On a neurological level, Parkinson's disease is the result of the degeneration of dopamine-producing nerve cells in the substantia nigra and the locus coeruleus parts of the brain. The substantia nigra and locus coeruleus are located in the mesencephalon, or the mid-brain region. Dopamine is a neurohormonal transmitter integral to movement of the body because it increases the actions of the direct neural pathway within the basal ganglia, or the motor control subsystem of the mid-brain region. Since symptoms in patients with PD are detectable only after roughly 80% of dopamine-producing cells have been degenerated, treatment is often risky and ineffective. No existing blood or laboratory tests can detect the presence of Parkinson's disease. A true diagnosis of Parkinson's disease requires patient observation, specifically for motor problems or tremors, as well as preventative testing in the form of neuroimaging, such as a Magnetic Resonance Image or MRI, to search for brain lesions or abnormalities. Together, the two sets of data can diagnose the presence of Parkinson's disease quite accurately.

Medications...have become less effective and side effects become more problematic.

—MICHAEL OH, NEUROSURGEON, UNIVERSITY OF MISSOURI

The medication prescribed for patients diagnosed with Parkinson's disease has two separate functions. First, it helps to limit the progression of the disease in the brain. Second, it helps to suppress symptoms such as tremors, speech impediments, and loss of motor skills. The most popular form of medication is drug therapy; effective drugs include Levodopa and Catechol-O-methyl Transferase (COMT) inhibitors. Levodopa works by killing defective cells in the brain that produce inefficient amounts of dopamine. The drug then is taken up by functional dopamine producing cells and is converted to sufficient amounts of dopamine. COMT inhibitors are part of a new class of drugs that allow even more Levodopa to enter the brain by inhibiting an enzyme in the body called COMT. Further on, a class of drugs called Dopamine agonists work to imitate the role of dopamine in the brain in order to compensate for loss of the neurohormone. While drug therapy is the most popular form of medication for patients with Parkinson's disease, a heavy dependence on the drugs may force the patient to take greater doses over time in order to have the same effects. The costs of multiple drugs and multiple doses jeopardize the patient's financial well-being. Michael Oh, MD, a neurosurgeon at University of Missouri Healthcare says, "As this neurodegenerative disease progresses, medications such as Levodopa become less effective and side effects become more problematic, especially with the development of unwanted, involuntary movements. Parkinson's disease can not only be debilitating, but patients are usually very self-conscious and avoid being in public by isolating themselves. In the late stages of the disease, individuals can become so debilitated that they must completely rely on others for their care." A permanent, more effective treatment is needed for patients with Parkinson's disease. In fact, researcher Gary M. Abrams suggests, "For patients with advanced Parkinson's disease (PD), whose symptoms are insufficiently controlled by pharmacological therapy, surgical treatments can reduce symptoms, enhance functional capacity, and sometimes reduce medication requirements."

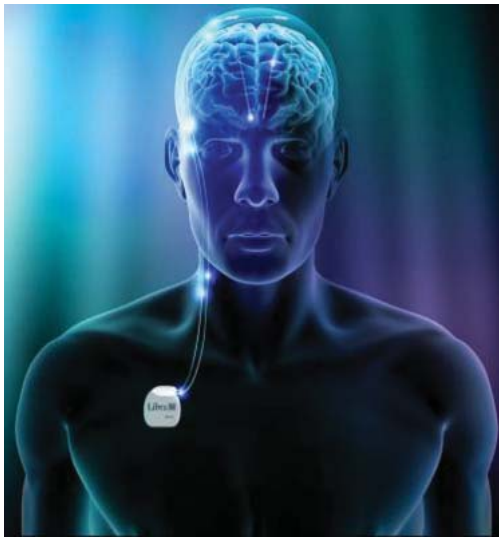
Surgical treatments can reduce symptoms, enhance functional capacity, and sometimes reduce medication requirements.

—GARY ABRAMS, NEUROLOGIST, UNIVERSITY OF CALIFORNIA - SAN FRANSISCO

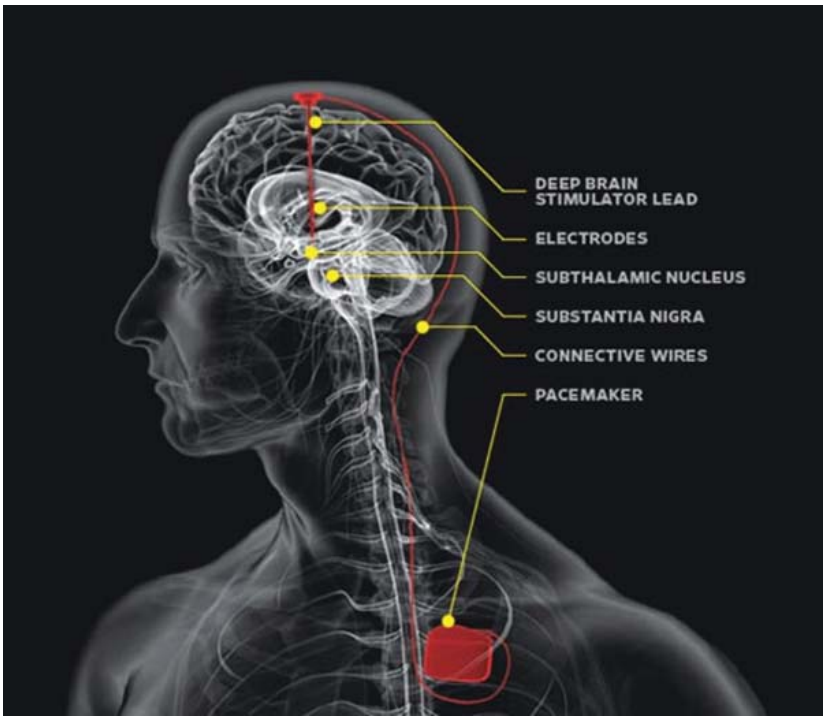
While complete reversal of cellular degeneration in the brain is currently impossible, Deep Brain Stimulation Surgery (DBS) may provide a reliable

method for controlling symptoms and significantly improving the lives of patients. . It provides the brain with electrical stimulation in hopes that it will simulate the pulses which no longer occur due to Parkinson's disease. Not every patient receives the same exact treatment; the region of the brain which is stimulated determines the name of the surgery which the patient receives. Dopamine helps provide regular, constant impulses in the brain; however, those with Parkinson's disease have irregular, spasmodic impulses due to the imbalance caused by irregular levels. Electrical signals provided by the surgery act to replace the role of dopamine in the brain.

Before the surgery, a neurosurgeon uses magnetic resonance imaging (MRI) or a computed tomography (CT) on the patient's brain to detect the origin of PD symptoms. While CT scanning typically uses X-rays to study brain tissue, an MRI, using a similar computerized process, introduces a technology that images your body organs and chemistry without radiation. MRI images detect that patients with Parkinson's disease require more brain activity in various parts of the brain to compensate for basal ganglia dysfunction when patients perform automatic movements. Typically, because PD symptoms are due to the abnormal activities of cells in the basal ganglia, the brain tissue of the substantia nigra usually appears thin and corroded in an MRI of a patient with Parkinson's disease. Next, a neurosurgeon targets and inactivates the subthalamic nucleus of the globus pallidus in the basal nuclei of the brain by implanting an artificial pacemaker, or electrode. The surgeon wants to inactivate the subthalamic nucleus in the basal nuclei because it is the area in which electrical signals from the electrode will intervene to replace neural interactions between already degenerated nerve cells. The electrode system is first calibrated and then connected wirelessly to the patient's chest, which provides an area for "neurostimulation," or voltage power. Once the system is in place, electrical impulses are sent from the chest to the brain. These impulses essentially block synapses of PD causing neural interactions in the brain. They encourage the interactions of PD drug-based medications with the brain cells. Frequencies of electrode impulses can be adjusted and modified to concur with the patient's individual MRI scan.



Wireless Plan
A model of a man's brain wirelessly interacting with an electrode implanted in his chest



Rewiring
A deep brain simulator uses a pacemaker implanted under the clavicle to deliver low-voltage shocks to electrodes near the subthalamic nucleus, a collection of neurons near the center of the brain. The electrodes can turned on or off in order to correct impulses or tremors that result in the loss of motor control.

Although Deep Brain Stimulation has shown very promising results, there are still many improvements which can be made to make the surgery simultaneously more effective and safer. Several variables must be fine-tuned by a neurologist in order to individualize the surgery for the patient's specific need. These factors include the frequency, duration, and amplitude of the pulses

which are used (L14). Unfortunately, there is no real way to test for the specific needs of a specific patient. If neurologists were able to determine the variables prior to the surgery, the amount of time required for the procedure would decrease and the effectiveness of the surgery would increase. Currently researchers are trying to determine how to measure the exact values of these variables computationally. Understanding these variables would provide insight into the exact nature of Parkinson's disease in specific patients, possibly leading to a greater understanding of the problem as a whole.

While DBS is making a technological breakthrough in surgical engineering, considerable risk factors and disadvantages also prevent it from becoming the mainstream treatment for patients with Parkinson's disease. First of all, only about 9% of patients with the disease are suitable candidates because cellular abnormalities in the brain are hard to localize with MRI and CT. Second, the neurostimulating battery within the patients' chests must be removed and replaced every five years in order to prevent infection and battery drainage.

The pros and cons of undergoing Deep Brain Stimulation surgery, as with any surgery, must be considered by both the patient and physician before any treatment can take place. It is clear that DBS has both its advantages and disadvantages. Advantages include the fact that DBS does not destroy brain tissue and will not limit future treatment, that the electrode device can be removed at any time, that the device is adjustable, and that DBS may be more effective in controlling tremors than thalamotomy, an invasive direct surgery on brain tissue. Some disadvantages of undergoing DBS, however, are that the presence of a foreign object in the body may increase the risk of infection, that repeat surgery may be required every three to five years in order to replace the battery in the device, and that uncomfortable sensations may occur during stimulation.

Even with these complications, however, the surgery is providing an optimal opportunity for patients who once felt hopeless in walking, balancing, and standing again. Suzanne Haber, PhD, of University of Rochester Medical School says, "They're (electrodes) like pacemakers. They're abnormal signals that they're trying to bring back to normal. Parkinson's disease leads to an abnormal firing pattern in a specific part of the brain and these brain pacemakers have been very effective in blocking these firing signals. DBS is one of the most promising areas in Parkinson's disease research."

Researchers, moreover, are not limiting DBS as a treatment only for Parkinson's disease. With controlled brain intervention surgery, DBS could be used as a treatment for other neurological disorders such as clinical depression, Tourette syndrome, and even obsessive-compulsive disorder. In August 2007, Nature magazine reported how a 38 year old man who had been in a minimally conscious state for six years was revived using DBS. In September 2007, Dr. Ali R. Rezai of Cincinnati Clinical Hospital relieved his patient from 10 years of severe depression using DBS surgery. Researchers including Mayberg, Lozano, and Voon of the University of Toronto reported in 2005 that electrical stimulation of areas in the frontal cortex of the brain brought about a "striking and sustained remission" in four out of six patients suffering from clinical depression. Research authors noted, "All patients spontaneously reported acute effects including 'sudden calmness or lightness,' 'disappearance of the void' ... 'connectedness, ' and sudden brightening of the room."

Deep Brain Stimulation could be used as a treatment for other neurological disorders such as clinical depression, Tourette syndrome, and even obsessive-compulsive disorder.

Today, about 20 central US centers of research and healthcare are leading trials on new applications of DBS, including the treatment of acute epilepsy and chronic pain. While experimental trials and data are still being conducted, when asked his view on DBS, Yoland Smith of the Yerkes Primate Research Center at Emory University responded, "Even if we don't have the whole story of the disease (PD), if we can improve the medication and further understanding at the same time, so much the better. I think experimental studies on DBS can do both. Patients need new therapies now. They can't wait." With a growing interest in human intervention of the brain, possibilities are essentially limitless. In fact, we may be closer to the formula for happiness now than ever before. ■

Jaws, anyone?
With the creation of the Bendix DR, over-fishing and finning has led to endangering some species of sharks.

Extinction: Earth's Biggest Threat

How technology is endangering the planet's flora and fauna

:: BY DAVID THOMPSON ::

When the topic of specie endangerment and extinction is brought into conversation, people generally speak of nineteenth and early twentieth century sailors who hunted whales, African poachers that sought invaluable elephant ivory, and the seventeenth century extinction of the dodo bird. Unfortunately, the current technological influence humans have on the environment by means of illegal hunting and poaching, pollution, and deforestation often plays a much more harmful role in the survival of plants and animals than most are willing to admit.

The first of such issues is the lesser-known topic of shark finning, the practice of cutting off a shark's fins and then releasing it back into the ocean. Since sharks cannot swim without their fins, they sink to the bottom of the ocean where they die. Though the entire shark is edible, the texture and flavor of the sharkfin has produced a new cultural tradition in Asia, where one can find exquisite styles and varieties of sharkfin soup which costs "up to $100 a bowl in high-end Hong Kong restaurants" (Eddy232). In order to counteract the finning of sharks, multiple countries, including the United States, have established laws prohibiting the harvesting of shark fins. However, vast developments in fish finding technology during the mid-twentieth century significantly simplified the previously arduous task of locating fish. In the 1940's, a device known as the Bendix Depth-Recorder (Bendix DR) hit the market. This piece of equipment showed fishermen "instantly and accurately" location of fish, approximately how many there were, how fast and in what direction they are traveling, and, in many cases, the type of species" (Eddy 74). In addition to aiding fishermen fin sharks, technologies such as this helped lead to the over-fishing of the once abundant pacific angel shark. According to the Florida Museum of Natural History, commercial fishing "of this species went from 366 pounds (166 kg) in 1977 to over 700,000 pounds (310,000 kg) in 1984" (Bester). As a result of using technology to both fin and overfish, once-thriving species like the pacific angel shark have been left as endangered.

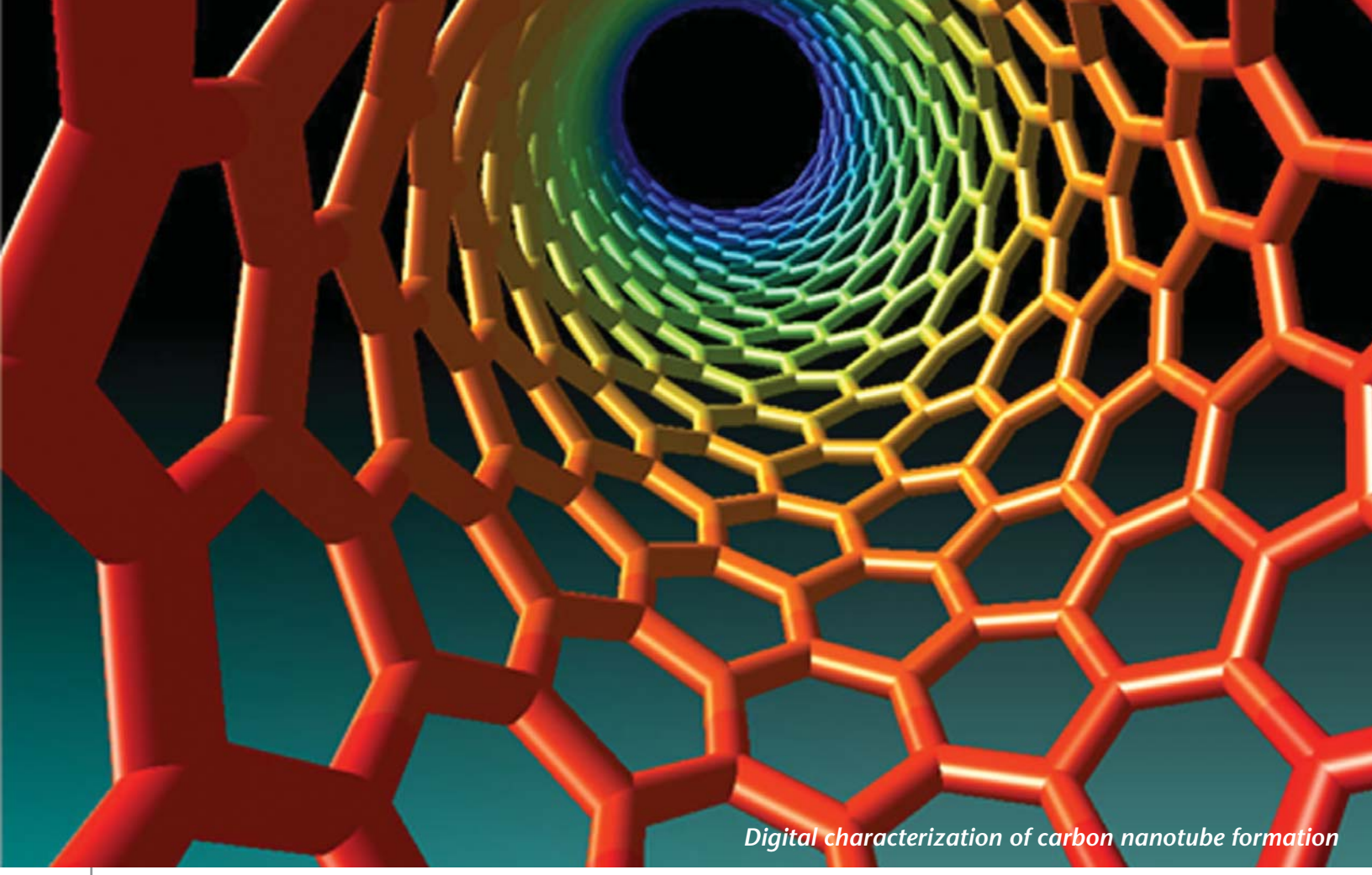
Although companies may have not have negative intentions towards nature, the benefits technological marvels can provide a competitive company often become essential for economic survival. When such technologies emit pollutants, the large scale implementation of these technologies establishes previously unparalleled levels of pollution added to an environment. The most pernicious aspect of pollution is that companies do not always recognize the devastating effects that even a little pollution can have on the environment, and resultantly animals. In Great Britain, one of the most common pollutants released by businesses is nitrogen gas. Over the course of a twenty year study, increased concentrations of nitrogen in the atmosphere caused some species of native British butterflies to suffer as high as seventy-one percent decreases in their populations. "Excess nitrogen can allow a few species, especially grasses, to grow fast and crowd or shade out their neighbors. The nitrogen is deposited from the atmosphere as the result of agricultural fertilization…and fossil fuel combustion" (Highfield 19). In this environment, the excess nitrogen acts as a catalyst for the population growth of species that hinder butterfly reproduction. According to *The Daily Telegraph*, sudden population drops such as those of the butterfly and other British animals are evidence of "the idea [that] the world is undergoing a sixth mass extinction" (Highfield 19). If nothing else, these alarming observations should make us think twice any time we support potentially polluting technology because of its convenience.

Likewise, human treatment of toxic substances and work with chemicals tend to produce undesirable effects on nearby habitats. An example of such a situation exists near the Columbia River in Washington, a place overflowing with facilities important to local communities. These companies' services consist of "sewage treatment plants, bleached-craft pulp mills, aluminum smelters, [and] mining operations" (Feist 1675). Unfortunately, the benefits these companies provide come with a cost to the environment. For example, local populations of white sturgeon have begun dwindling due to the presence of Endocrine Disrupting Chemicals (EDC's). White sturgeon mature between the ages of sixteen and thirty-five, and as a result, the accumulation of these chemicals causes "deleterious effects over a long period of time before the fish reach a stage where they are ready to reproduce" (Feist 1680). Since the chemicals affect the endocrine system before the creatures reach maturity, white sturgeon struggle in order to reproduce substantial numbers of offspring. Local demand for freshwater caviar adds to the specie's struggle for survival as well, as any eggs produced potentially serve as a luxurious snack. With both technology and human affinity for the white sturgeon's caviar depleting the frequency with which baby sturgeon replace dying sturgeon, it seems that the native white sturgeon of the Columbia River may soon find its way onto the endangered species list.

Similarly, the deforestation developing countries often include as a part of their expansion harmfully impacts their environment as well as their populous. Today, most deforestation occurs in South America, a continent rich with rainforests, biodiversity, and pristine environments, as well as with expanding countries. As these countries develop, they not only grow technologically, but their populations increase as well. Consequently, as these countries become more capable of destroying forests, they simultaneously gain more incentive to do so because the demand and need for wood, energy, and food increase. However, when these countries use their natural resources excessively quickly, they place an enormous obstacle in their way. According to The Association of American Geographers, a United States government task force surveyed common effects of deforestation and stated that "the consequences of deforestation are rising prices, floods, siltation, and desertification" (Allen 164). Unfortunately, the over-ambition of developing countries tends to harm not only the diversity of their environments, but also the livability of their lands.

Technology to fin and overfish, once-thriving species...have been left as endangered.

All too often, present day human influence on the environment includes a negative, environment-degrading form. As evidenced in the cases of shark finning, company chemical emissions, and country development, the improvement of technology exponentially increases the potential harm man can do to the environment. The best solution to this dilemma is to ensure that each and every one of us is cognizant of how much even our most minute decisions and actions can affect the environment in the long run. ■



Digital characterization of carbon nanotube formation

New Jersey Institute of Technology in Action

Current Research in Science, Technology and Medicine at NJIT

:: BY CRYSTAL KANIA ::

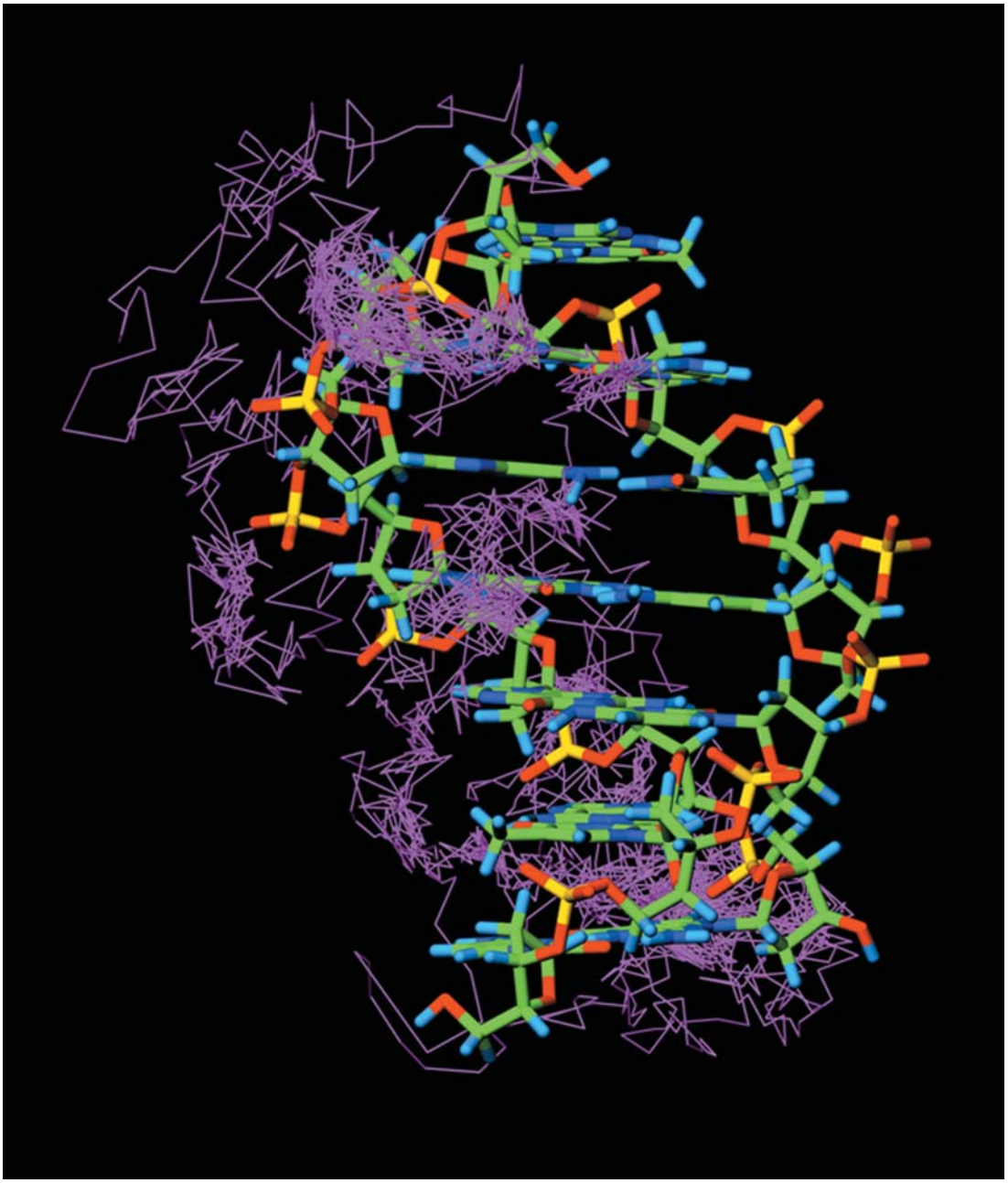
Observing the Growth of Carbon Nanotubes in Real Time

A single wall carbon nanotube, composed of an allotrope of Carbon, is a single-atom thick cylinder with an estimated diameter of one nanometer. Multiple carbon nanotubes (CNTs) can form a durable nanostructure prevalent in different forms of nanotechnology, including electronics, optics, and other derivatives of material science. The strength of carbon nanotubes is due to the nature of bonding within the walls of the cylindrical structures. Carbon is sp2 hybridized, similar to the bonding found in graphite. Nanotubes can merge together through van der Waals forces, increasing the length and stability of the CNT molecules.

At NJIT, **Zafar Iqbal**, professor from the Chemistry and Environmental Science Department, partnered with Professor Renu Sharma of Arizona State University to record the real time growth of CNTs using a transmission electron microscope. Their study will provide a basis for catalyzing CNT formation and gaining an understanding of the controlled self-assembly of CNTs in high pressure resistant, extremely durable nanoscale devices. Additionally, Dr. Iqbal and Haim Grebel, an Electrical and Computer Engineering professor, are utilizing single wall carbon nanotubes (SWCNTs) in military applications by attempting to create a commercially viable process to form composites of SWCNTs with enhanced mechanical properties. Their work will serve to efficiently utilize SWCTs in materials used to make military weapons, vehicles, and computer hardware. ■

The Application of Robotics to Cancer Diagnosis

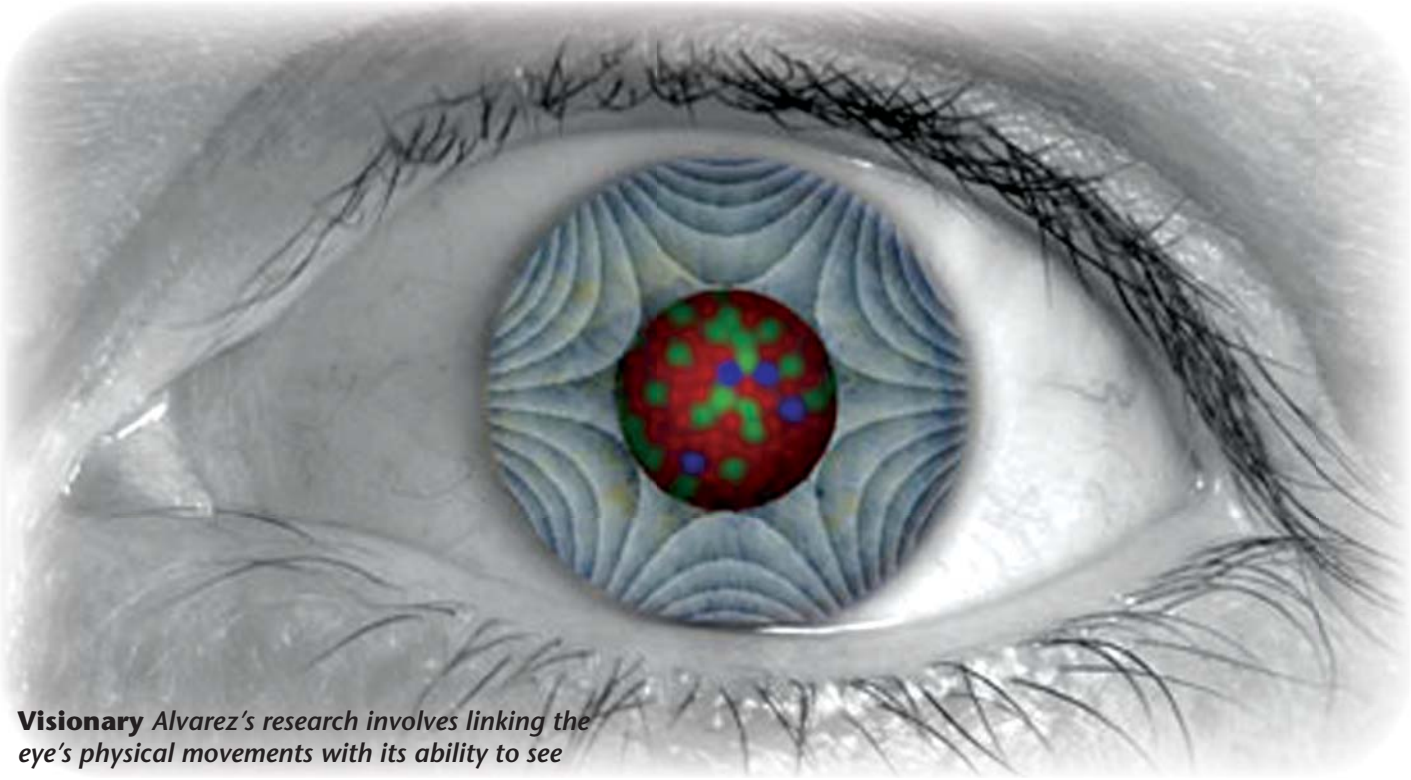
Timothy Chang, professor from the Department of Electrical and Computer Engineering at NJIT, is applying his knowledge in robotics to a problem facing many medical institutions around the world how to efficiently diagnose cancer in patients. With a grant from the National Science Foundation, he has developed an inexpensive robotic technique that could be available to a number of hospitals. The technique requires one to collect the patient's genetic material (DNA) and place it onto a small microscope slide. The robot uses a fiber optic sensor pin (known as a SmartPin) and a piezoelectric nano-positioning device to extract the correct amount of DNA onto the slide and make a gene-based diagnostic decision based on the sample. The SmartPin can also analyze the proteins in the sample, which will help detect changes common in cancer cells such as apoptosis (programmed cell death in multi-cellular organisms) and the translation of certain inhibitory proteins. Timothy Chang is collaborating with Patricia Soteropoulos, director of the Center for Applied Genomics at the Public Health Research Institute, to develop his method further and make it accessible to public health institutions seeking a more affordable, accurate diagnostic method. His patent on this technology won the Thomas A. Edison Patent Award in 2007. ■



Certain genes related to the development of cancer exhibit high rates of mutation.

Observing Convergence and Divergence Movements in the Eyes and Analyzing their Effects on Human Vision

How does the brain interpret what you see as a body in a three-dimensional space? **Tara Alvarez**, PhD, an associate professor of Biomedical Engineering at NJIT, is currently researching how the brain adjusts to control eye movements in motor learning and how dysfunctions in eye movements may hinder the control of visual tracking. Working within the Vision and Neural Engineering Laboratory at NJIT, Dr. Alvarez is using modern technologies to conduct visual experiments on patients suffering from convergence insufficiency, or the inability for the eyes to fixate on objects. Because the patient's eyes cannot properly fixate on objects, many often suffer from dizziness, visual fatigue and double vision. In order to understand eye movement control, Alvarez and her team of students are using Independent Component Analysis (ICA) to unmix the combined signal generated by the eyes to study the neural subcomponents. Dr. Alvarez is also using functional Magnetic Resonance Imaging (fMRI) in her work. fMRI, a state-of-the-art tool, is unlocking the mysteries of the brain to detect the locations at which the brain controls eye movements in response to a stimulus, in order to understand oculomotor learning, attention, and memory. The Vision and Neural Engineering Laboratory's mission is to gain an understanding of oculomotor learning and is beginning to apply what they have learned to help patients with traumatic brain injury. Through Alvarez's research, students will gain a clearer insight into vision and how the physical movements in the eye are linked to vision. Her research will be crucial in the therapy of patients recovering from traumatic brain injury, stroke and other neural diseases. The research is an ongoing project which reveals a clearer picture of the anatomy and physiology of the eye. ■



Visionary *Alvarez's research involves linking the eye's physical movements with its ability to see*

Applications of Physics in Improving Patient Healthcare: The Invention of a Self Tonometer

Glaucoma is a general term used to describe the mass loss of retinal ganglion cells in the inner surface of the retina. It is typically due to a significantly high intraocular pressure in the eye, causing physical damage to the optic nerve. Ultimately, symptoms such as field of vision loss can progress into blindness.

Currently, over three million Americans are estimated to have open angle glaucoma, or irreversible optic nerve damage. It is the primary cause of blindness in the United States. Because glaucoma is related to intraocular pressure (IOP), patients typically must have their IOP measured every three to four months in a doctor's office. These continual check-ups, however, are insufficient because the IOP within patients is known to fluctuate between visits, and even between different hours of the day. Therefore, check-ups can not only mislead the patient, but also cost time and money for a trip to the doctor's office.

Gordon Thomas, professor from the Department of Physics at NJIT, **Tara Alvarez** associate professor of Biomedical Engineering, and **Irene Nwosuh** who has just finished her PhD in Physics, have organized a team interested in inventing a self tonometer. They have built a lab model of the non-invasive device consisting of a custom tip that the patient places over a closed eyelid. The device moves the tip a tiny distance toward the eye and measures the force and distance deformation values in order to calculate the patient's IOP.

Robert Fechtner, professor at the Institute of Ophthalmology and Visual Science at the University of Medicine and Dentistry, who has worked with the team, believes that the device will revolutionize the manner in which patients with glaucoma detect and adjust to their disease. NJIT is currently evaluating a proposal for a US patent. ■

Take-home eye doctor *The self-tonometer, prototype above, allows individuals to measure intraocular pressure without a visit to the ophthalmologist.*

:: reference documentation ::

Cover, Front
[Designed by Horane Henry]
Inspired by the *Planet in Peril* CNN program advertisement.

Opening
x quote
<www.thinkexist.com/quotes/henri_rosseau/>
Image of countryside
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Editorial Note
Image of sprout and dirt in hand
<http://donswanstrom.com/services.htm>

About NJIT and the Albert Dorman Honors College
Image of Eberhardt Hall, New Jersey Institute of Technology
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A letter from the Dean
Image of Dr. Joel Bloom
New Jersey Institute of Technology
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Image of eye
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Image of NJIT Logo
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Insight to Innovation : Oluwaseun Aladese
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x 08
Image of carbon nanotubes atop silicon wafers
Georgia Tech Research News. <http://gtresearchnews.gatech.edu/newsrelease/solartubes.htm>
x 10
Image of Somenath Mitra
Department of Chemistry & Environmental Sciences, NJIT. <http://www.njit.edu/features/innovations/som-mitra.php >.
x 11
Image of solar panels
Press photo Siemens AG, Energy Sector. <http://www.powergeneration.siemens.com/press/press-pictures/clean-energy-solutions/environment-solar-systems-trezzo.htm>

A Canvas of Air : Kristine Cheng
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Image of bat skeleton
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Image of artist and bat skeleton
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x 15
Image of pig mandible
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The Energy Emergency : Matthew Deek
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Image of broken light bulb
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Image of beachbook in fishbowl
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Deep Brain Stimulation Surgery : Crystal Kania
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Image of illustration of Libra Deep Brain Stimulation System
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x 26 [top, right]
Image of electrode wireless simulation
<http://blog.pcnews.ro/2008/02/08/deep-brain-stimulation-for-depression/>
x 26 [bottom, left]
Image of deep brain stimualtor
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Extinction : David Thompson
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x 28
Image of shark
Flatnose shark. Stock.xchng. <http://www.sxc.hu/photo/1145725>

NJIT in Action : Crystal Kania
x 30-33

x 30 [top]
Image of carbon nanotube formation
<http://qt.tn.tudelft.nl/student/studentprojecten/BEP/Sami_nanotube.jpg>
x 31 [bottom, right]
Image of cancer genes
<http://www.thetriplehelix.org/wordpress/wp-content/uploads/2006/12/DNA.jpg>
x 32 [center]
Image of eye
Center for Visual Science, University of Rochester. <http://www.cvs.rochester.edu/Ireland/eye.jpg >
x 33 [bottom, right]
Image of self-tonometer
<http://www.donesolutions.com/English/Tiolat_English/images/iCare1.jpg>

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We hope that you have enjoyed reading this as much as we have enjoyed producing it.

Feel free to send any commentary, corrections, opinions, letters of appreciation or advice our way. We would love to know what you think.

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