TECHNOLOGY™ OBSERVER

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

Electronic Ink | Cell Phone Technology | Hydrogen Fuel | Video Camouflage

2005 Issue 5

NJIT
New Jersey Institute of Technology

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OUR ADVISOR

Dear Reader,

As the result of the very able leadership of Victor Keto and his team we have the opportunity to read the fifth edition of the Technology Observer, a publication conceived, led and managed by Albert Dorman Honors College Students. The effort and the product are emblematic of the Dorman Honors students: curious, creative, entrepreneurial and outcome oriented.

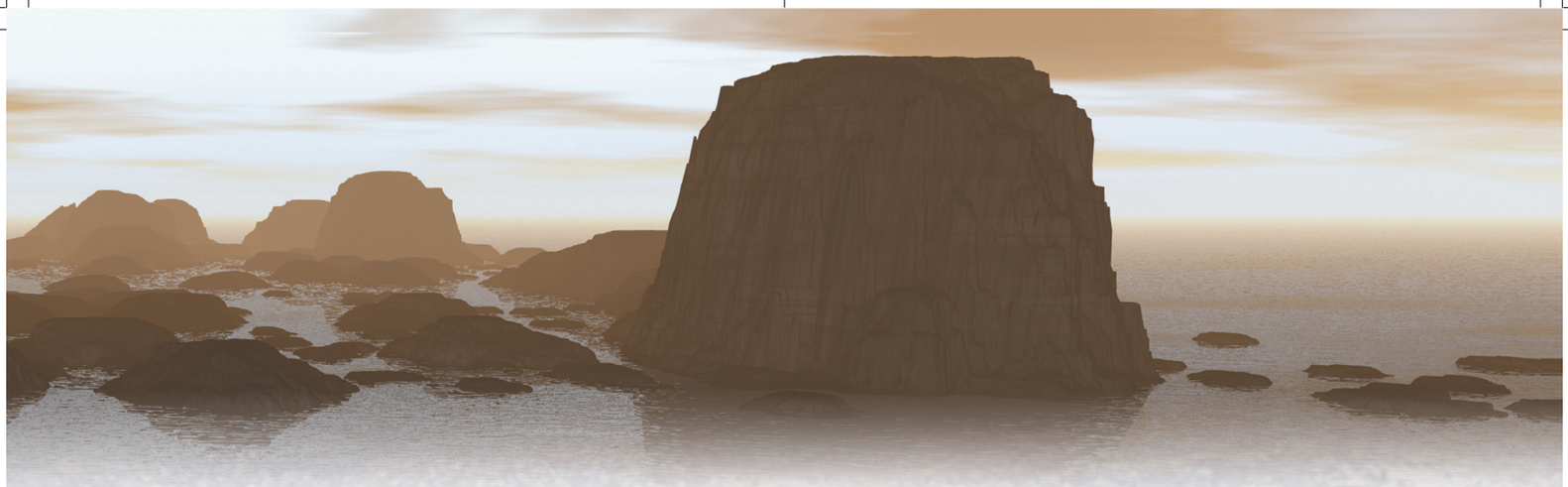
In keeping with the tag line of the Technology Observer: “Observing the present while keeping an eye on the future,” the student investigators/writers focused on emerging technologies: Electronic Ink, Cell Phone Technology, Hydrogen Fuel and Optical Camouflage. In each article, we are introduced to the state-of-the-art technology, asked to consider the future, and recognize the significant challenges the scientists and engineers face in developing the next generation of each of these transformational technologies. I am confident that in the future, the scientists and engineers that we will be reading about will include Dorman Honors alumni.

I hope you find the articles informative, thought-provoking, and we invite your comments about the magazine and its content. We also invite your inquiries about how you can support this endeavor and the students in their educational pursuits. Thank you.

Sincerely,

Joel Bloom
Vice President for Academic and Student Services

Dean, Albert Dorman Honors College



LETTER from the EDITOR

Dear Reader,

Technology Observer Magazine issue five, produced by students of Albert Dorman Honors College and NJIT's other schools, is a unique publication containing vividly descriptive articles covering many of today's most significant technological advances in the fields of science and engineering. The purpose of our magazine is to inform the NJIT community of the latest advancements in technology through the explanation of both their physical functions and societal implications, as they develop from conceptual ideas into marketable products. Within these pages you will find many thoughtfully written expositions describing technologies ranging from hydrogen fuel to video camouflage systems.

During the past year the Technology Observer production team has worked diligently to compile and develop the written and pictorial content found within the Observer. I thank Kunal Batra and Bobby Soriano for contributing exceptional articles to our 2005 publication. I thank Moinuddin Ahmad, Kunal Batra, Jeremy J George, LoriAnne Jones, and Christian Howell for helping to create our graphics and illustrations.

The Technology Observer production team and I hope that you will find issue five of our magazine edifying, insightful, and also entertaining.

Sincerely,

Victor Keto
Editor-In-Chief

NJIT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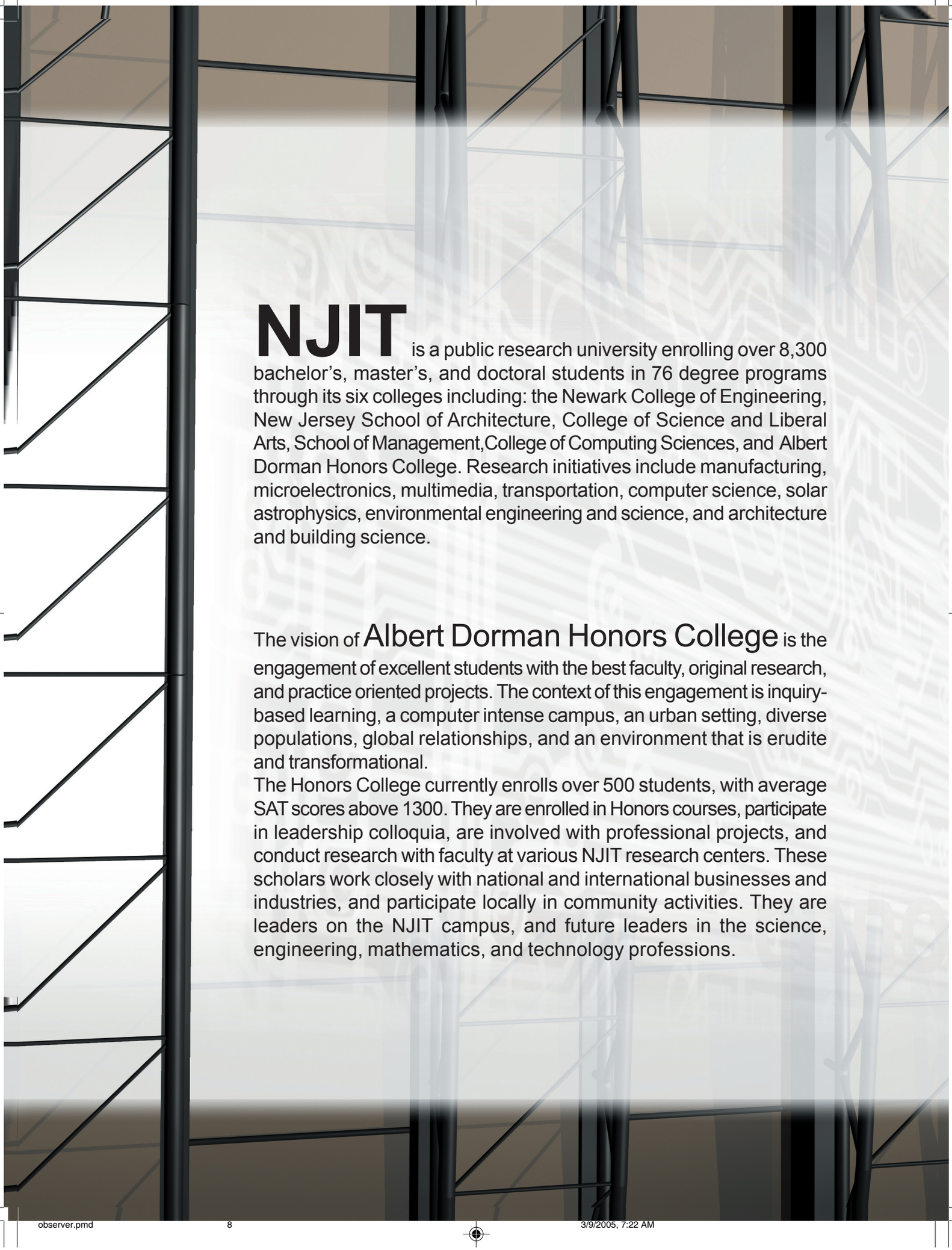


NJIT is a public research university enrolling over 8,300 bachelor's, master's, and doctoral students in 76 degree programs through its six colleges including: the Newark College of Engineering, New Jersey School of Architecture, College of Science and Liberal Arts, School of Management,College of Computing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

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

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


A D H C
A D H C


Video
Favorites
Options
End

CELL PHONE TECHNOLOGY

BY KUNAL BATRA

Today's cell phones, which are evolving into portable offices, are quickly becoming more than a simple means of voice communication. People look to these devices for email, faxes, Internet, imaging, as well as traditional voice communication. To put it simply, they have become portable computers, each with their own unique phone number. Even though cell phones have advanced considerably, can we expect more new and exciting applications for them in the future or have we reached the point of stagnation?

Figure 1.1

Will tomorrow's cell phones merely become ever more aesthetically pleasing, or will they also be capable of performing valuable new functions that can improve the lives of people worldwide? Possible answers to such questions can be found in the far east, where cell phones being developed and marketed in Japan are far more advanced than those available to us living in the U.S.

Economic necessity is a key factor driving the development of Japanese cell phones. The price for Japanese citizens to make local calls via land lines is very expensive. As a result, most people can not afford the high cost of ground-based communication, which we take for granted in the United States. Not only are land line phones in Japan costly, but personal computers and electricity are as well.

In the U.S, PCs are the most commonly used tool by individuals for accessing the internet. However, because of higher computer and energy costs in Japan, Japanese companies such as NTT DoCoMo have had to find new and innovative ways of avoiding the expenses associated with land lines and PCs.

In today's computer age, email has become a key form of communication in a variety of settings, including personal, academic, and business environments. The Japanese, wishing to make electronic mail use more common within their county, needed to find ways of making digital communication accessible through lower cost alternatives to traditional PCs. NTT DoCoMo, one of the world's leading companies in the telecom industry, realized the need for an alternative, and sought a marketable solution. The company's answer was to create cell phones capable of accessing the internet and sending email. This advancement was a direct result of the necessity of the Japanese people to become part of the information age. During the past two decades, the Japanese technology market has evolved to a state at least two years ahead of our own. Because Japan has a history of pioneering innovations in cell phone technology, it is wise to observe the latest advances in Japan when speculating about the future development of cellular phones.

One of the most interesting advances that NTT DoCoMo has developed is the micro fuel cell. According to NTT DoCoMo's online site, the micro fuel cell is "...a stand-alone device shaped like a cradle for recharging handsets. It generates electric power by combining hydrogen and cheap, environmentally safe methanol to create a chemical reaction. Hydrogen ions are extracted from the air via a layer of material placed between positive and negative electrodes." The use of the micro fuel cell significantly reduces the operating cost of cell phones, allowing its users to spend less

Figure 1.2

money on electricity. If this technology is imported into the United States, there would be no more need for plugging our cell phones into wall outlets. All we would need is a cradle shaped charger and access to very cheap methanol cartridges.

Portable fuel cell chargers represent one of many new technologies that could soon enter the US market. In Japan, Fujitsu has already started selling the F900iC, more commonly known as the mobile wallet handset. With the aid of NTT DoCoMo's i-Mode FeliCa mobile wallet system service, this handset allows users to make bank withdrawals and credit card payments, among other types of information transactions, via their cell phones. The NTT DoCoMo network carries its user's personal information and sends this data to special readers installed in cash registers and ATM machines. This is one service that many people are personally looking forward to using. Americans may enjoy the convenience of having their cell phones perform the identification functions commonly attributed to numerous credit cards and other space filling items that can make our wallets bulky. Along with saving valuable pocket space, this phone can also keep its user's data secure even if the phone is lost. It is equipped with a finger print scanner for locking and unlocking the phone so that its user's personal information can not be accessed by anyone else. The phone is also equipped with a remote lock out service that allows you to terminate its wallet function or even the phone itself if it falls into the wrong hands.

Figure 2.1 Fujitsu F900iC
Source- Mobileburn.com

Through the increasing intelligence of their features, customization, and level of interactive communication they provide, cell phones are arguably becoming more like people, each with its own unique personality, shape and size. Nokia is taking advantage of this phenomenon by marketing a new style of phone to appeal to a different type of crowd. The Nokia 7280, unlike most phones, does not come with a keypad. To answer the question of how users can place calls from it, this phone uses a stylish rotary dial that lets callers scroll through a small number of digits to select the phone number they want to dial. Another interesting fact about the Nokia 7280 is that it includes a mirror like display. This means that when the phone is not powered on, the display can be used as a compact mirror.

"It is equipped with a finger print scanner for locking and unlocking the phone"

Another phone that may significantly impact the market is the Motorola V80. What makes the V80 stand out from other phones currently available is not innovative software, but rather its design. Today's two dominant styles of phones are the bar shape and the flip phone. The V80, however, is in a different form. It has a unique swivel style opening, which can be seen in the illustrations on page 15.

As we can see, cell phone development is far from ever reaching a point of stagnation. Even though we have taken great strides in the advancement of cellular technology, there will be many more advancements to come. The innovations seen in today's most advanced cellular phones illustrate the potential for future applications of this technology, many of which have not yet been conceived.

Figure 2.2 Fujitsu F900iC
Source- Mobileburn.com

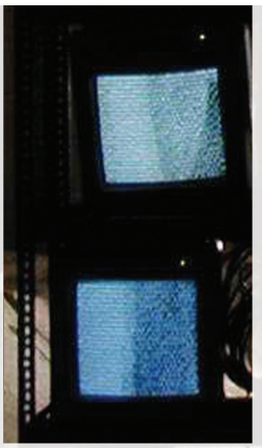
Figure 2.3 Fujitsu F900iC
Source- Mobileburn.com

Figure 2.4 Phone Wallet Service
Source- Mobileburn.com

Figure 3.1 Nokia 7280
Source- Mobileburn.com

Figure 3.2 Motorola V80
Source- Mobileburn.com

Figure 3.3 Motorola V80
Source- Mobileburn.com



The advertising industry has always been seeking new avenues through which to market products to consumers. The latest such avenue being pioneered by the industry is the display of video ads on cellular phones. Cenuco, an advertising company that produces software for the streaming of live audio and video content wirelessly onto computers and cell phones, plans to bring internet advertising to cellular handsets.

Company President and CEO Steven Bettinger stated in a November 2004 press release that, “by combining Cenuco’s wireless streaming video technology and the expertise of our recently announced acquisition in the on-line advertising industry we have created the next generation in advertising - targeted commercials on your cell phone. Consumers will be able to opt-in to receive special offers and promotions on products and services they have an interest in. Wireless streaming video commercials will be sent directly to their cell phone.”

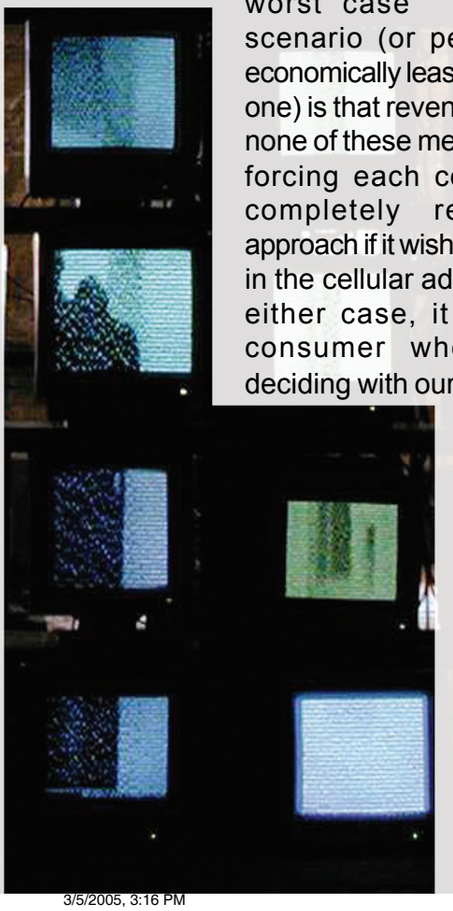
Today, Cenuco’s data transmission software is mainly used by customers for the viewing of live video from security cameras or home electronics on their cell phones. The company’s service works independently of one’s carrier service, location, or type of phone. Cenuco’s newly formed branch, the Online and Cellular Advertising Division, was created in part to manage and distribute the company’s upcoming video advertising services.

“The company’s Online and Cellular Advertising offerings will utilize Cenuco’s core wireless technology to create a new advertising platform for delivery of streaming video and audio marketing messages directly to hand held cellular devices, as well as through internet driven targeted campaigns.” –cenuco.com

The technological infrastructure needed for cell phone based video advertising was created during the 1990s when three key technologies were developed. The first was broadband wireless networks for phones, which will only be increasing in speed and data transfer capacity. The second technology is the development of miniaturized cameras able to be fit inside of today’s relatively small cellular phones without disturbing the ergonomics of their forms. Recorded video can be transmitted over the wireless network, taking advantage of its high speed data transmission ability. The third key advancement is the LCD screen on today’s phones, which was once only monochromatic with slow refresh rates, and is now able to display twenty-four frames per second of color video. The development of the LCD screen’s video display ability was encouraged by the need to allow cellular customers to view the content of their video recordings. These three key technologies were each developed in response to or in conjunction with preceding technologies.

With the technology for transmitting and viewing video, companies including Samsung Electronics and Nokia are manufacturing phones capable of displaying live video from major sports organizations such as the NBA and Major League Baseball. Other services, such as MobiTV, provided by Idetic, stream to your cell phone broadcasts from cable networks including MSNBC, and Fox Sports. Unlike Cenuco which is focusing its efforts primarily on individual advertisements, Samsung, Nokia, and Idetic are each taking the cellular-phone-as-handheld-TV approach to delivering video content by offering advertising bundled with sports and entertainment broadcasts

With many companies moving into the new cellular advertising industry, each with its own business model, the race is on to find the most lucrative approach to marketing via this new medium. Companies such as Cenuco and Samsung are hoping that the established advertising methods that have proven successful in television and the internet will also work on cellular phones. The best-case scenario for each of these companies is that both TV and Internet style ads will work well over the long term on phones. The worst case scenario (or perhaps the economically least convenient one) is that revenue is lost as none of these methods work, forcing each company to completely rethink its approach if it wishes to remain in the cellular ad industry. In either case, it is we the consumer who will be deciding with our disposable income which advertising approaches will be successful and which will be failures.




by Victor Keto


E-INK
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Today's digital technologies are saving valuable resources by allowing society to perform an increasing number of functions at greater speed without the use of paper and with less physical labor. The pocket calculator is our digital tool for performing complex mathematical operations instantaneously without using paper or overly taxing our mental faculties. Email can be sent to its destination faster than physical letters, while saving both paper and the labor associated with the postal delivery process. Word processing software allows us to type reports without the required leaves of paper and physical maintenance needed when using a typewriter. A new technology known as electronic ink represents the next step in the advancement of digital technology, the digitization of not only the processes that humans once performed solely with paper, but also the paper itself.

Figure 1: Source: e-ink.com

Electronic ink, a plastic film comprised of digitally controlled microscopic beads of ink, will significantly affect how our society receives and views information. Perhaps the most significant use of this technology will be in replacing the common newspaper, which is a leading source of paper consumption. Instead of merely purchasing a newspaper for a single day and then discarding it, people will be able to purchase a thin sheet of plastic film that is automatically updated daily via a wireless network connection from its publishing center. This new video technology, the dynamic newspaper, will represent the merging of Internet news sites with the traditional paper newsprint. Replacing the common newspaper is one of the first goals being set by the Electronic Ink Company for marketing this new and revolutionary product.

The anatomy of electronic ink is a novel assortment of plastics, circuitry, and ink, incorporating the ground breaking idea that video screens can be produced from sheets of plastic instead of with liquid crystal or cathode rays. The thousands of small ink filled capsules that make up the projection surface are too small to be seen by the human eye, but the combined image they create for the viewer is bold and sharp.

The tiny ink filled capsules produce video projections in a unique way. The capsules contain white particles that are positively charged and black particles that are negatively

charged. Each type of particle within the capsules is submerged in a transparent fluid. When a negative electric current is applied to the particles through their connecting circuitry, the white particles quickly move to the top of their capsules where viewers can see them. The combined effect of the white particles rising is a white spot seen on the video screen. While the lighter particles are at the top of the capsules, an electric field of opposite polarity pulls the darker particles to the back of the capsules and out of the viewer's sight. When the electric fields are reversed, the darker particles move to the front of the capsules while the lighter ones move to the back.

"To form an E-Ink electronic display, the ink is printed onto a sheet of plastic film that is laminated to a layer of circuitry. The circuitry forms a pattern of pixels that can then be controlled by a display driver. These microcapsules are suspended in a liquid carrier medium allowing them to be printed using existing screen-printing processes onto virtually any surface, including glass, plastic, fabric and even paper. Ultimately electronic ink will permit most any surface to become a display, bringing dynamic information display out of the confines of traditional devices and into the world around us." -Source: E-ink Incorporated

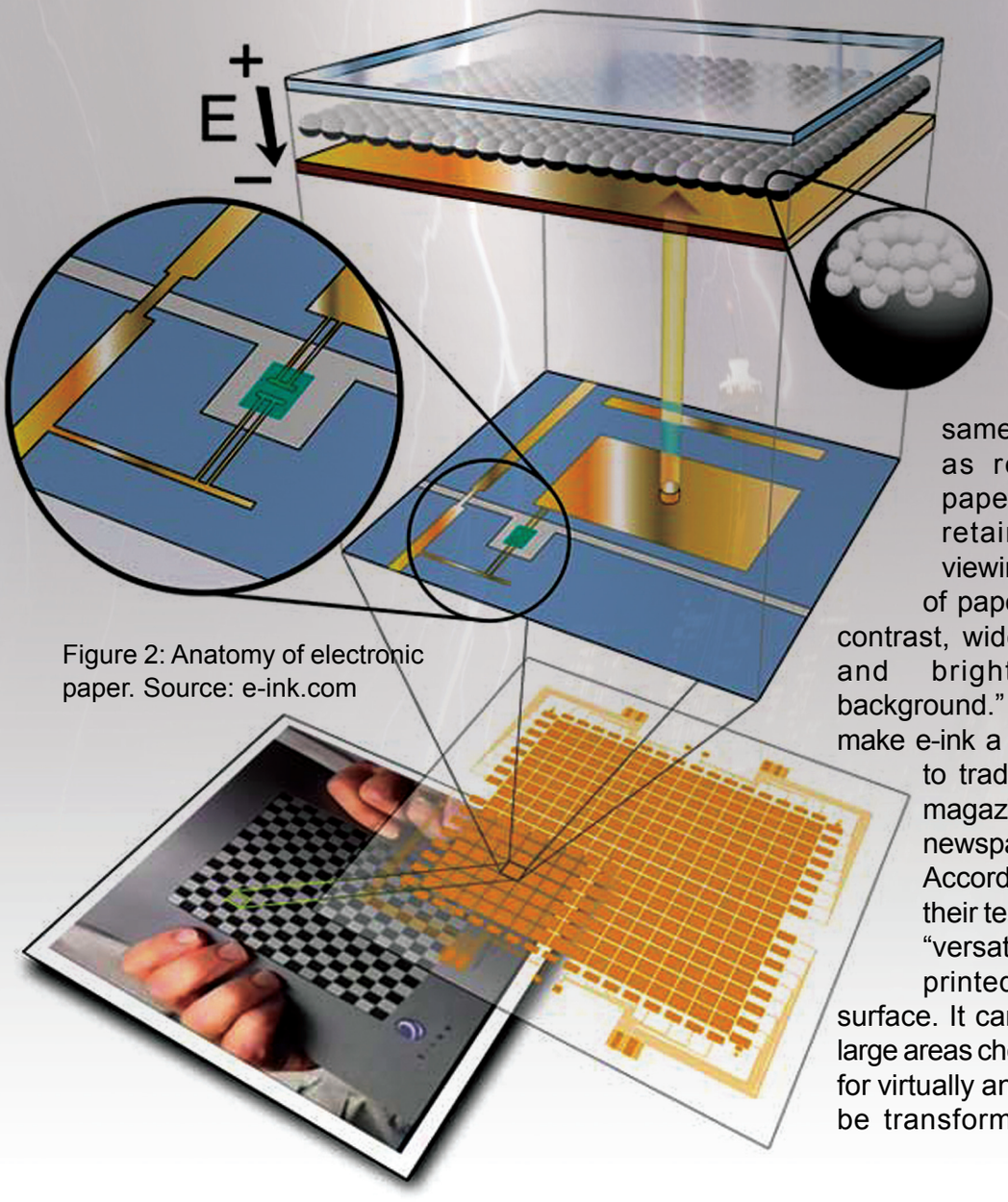


Figure 2: Anatomy of electronic paper. Source: e-ink.com

E-ink Incorporated outlines a few of its technology's key features on its web site at Eink.com. Electronic paper is said to have a "superior look because it is made from the same basic materials as regular ink and paper. Electronic ink retains the superior viewing characteristics of paper, including high contrast, wide viewing angle, and bright paper-white background." This attribute will make e-ink a viable alternative to traditional paper for magazine and newspaper publishers. According to E-ink Inc, their technology is also "versatile since it can be printed on almost any surface. It can be coated over large areas cheaply." This allows for virtually any solid surface to be transformed into a video

display. These sheets of video plastic also have a low power consumption rate. “It displays an image even when the power is turned off and is also legible in low light reducing the need for a backlight” (Eink.com) Most importantly, electronic paper is also scalable, meaning that it can be easily mass produced in larger sizes without manufacturing becoming prohibitively expensive.

Besides replacing the traditional newspaper, there are many other commercial applications for electronic ink. This new technology of flexible plastic projection surfaces can be used in place of LCD screens on cellular phones. It can also be used for computer monitors, allowing them to produce visible imagery even when directly facing sunlight. Television screens that incorporate this technology can be produced less expensively than today’s plasma screens and cathode ray tubes. Electronic ink could even be used to produce clothing, after the problem of water contacting the electrical circuitry while worn is resolved. In spite of these ingenious potential uses for plastic displays, the resource consuming newspaper stands as one of e-inks first products to improve upon.

Large quantities of paper will be saved as a result of electronic paper’s wide-spread use. This will greatly reduce the effort needed to recycle today’s vast quantity of paper products, as well as decrease the worldwide demand for lumber. Even though the environmental benefits of using this new technology are significant, E-ink’s success will derive only from its many uses and applications. The PC when introduced in the 1970s became highly successful for the same reason.

“It displays an image even when the power is turned off”

When society accepts the notion of digital paper, the world will change significantly. We will come to view video projection on different media not as a unique phenomenon found only in certain devices, but as merely a common property of the surfaces around us. When asked to describe objects, we will categorize them as animated or static. As a resource saving reusable digital display product, electronic ink is the projection surface of the future.

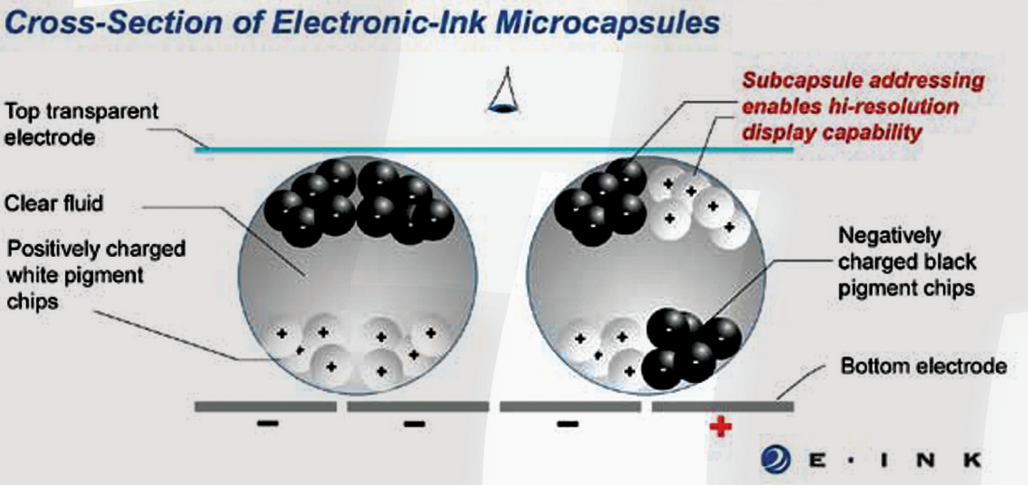


Figure 3: Ink Capsule Diagram
Source: e-ink.com

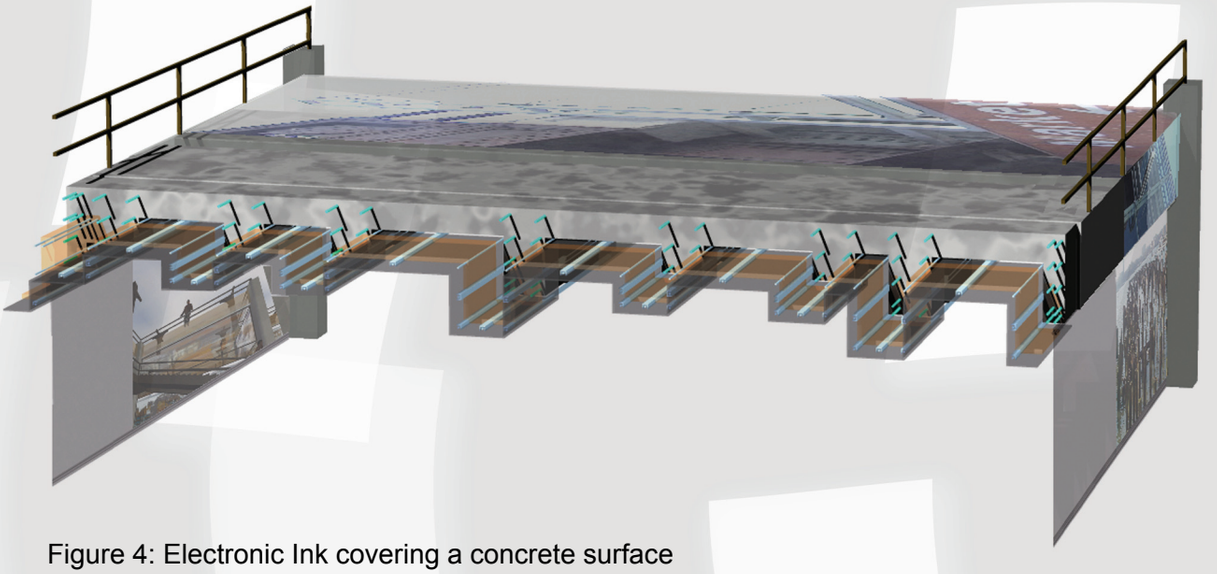
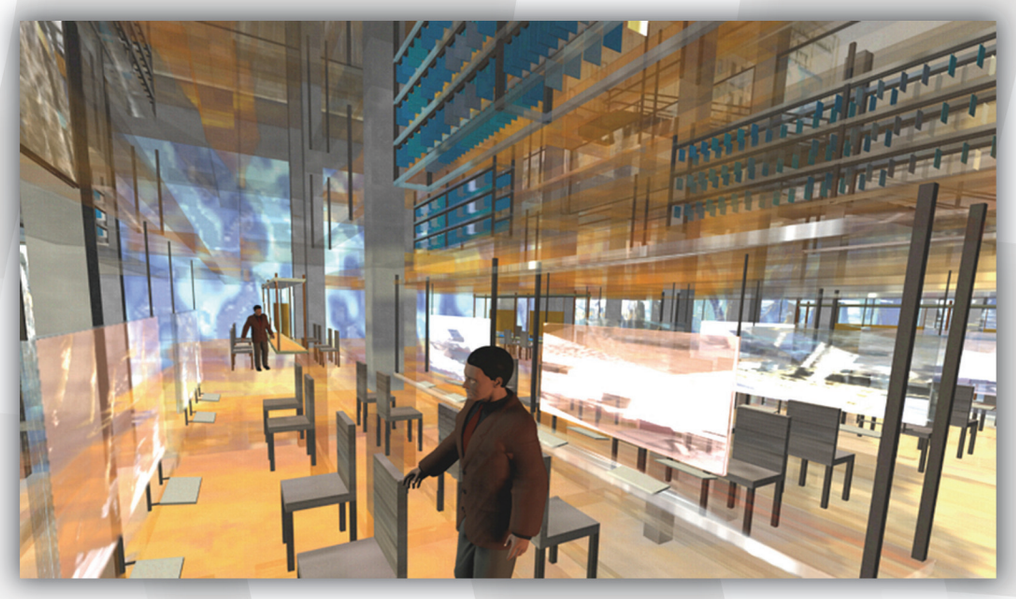


Figure 4: Electronic Ink covering a concrete surface

Figure 5: Electronic Ink projecting video on interior surfaces of a library



Hydrogen Fuel

By Bobby Soriano

Hydrogen Fuel: The Energy of the Future

With oil prices reaching record highs in many parts of the country during the summer of 2004, more and more people are searching for ways to get around the rising cost of gasoline-powered travel. Some people have looked towards buying more fuel-efficient cars, while others have tried various means of public transportation. Another alternative, however, may soon become reality, one that would revolutionize travel and change our very lives. Yet it would still originate from the simplest element in the universe…

The next generation of automobiles might not be gasoline powered, but rather hydrogen powered. Hydrogen based fuel has come a long way from its conception and experts believe it may soon be replacing petroleum across the country.

What is Hydrogen?

Hydrogen is the most abundant element in our universe, with the simplest and lightest chemical structure. It is however, hard to find in nature not combined with other elements such as oxygen and carbon. Once it has been separated from these other elements, hydrogen has the potential to become the ultimate form of clean fuel. This new fuel will be easy to manufacture, produce no odorous or harmful emissions, and even have better efficiency than its petroleum counterpart! President Bush in his praise of hydrogen fuel has stated that it will "make a fundamental difference for the future of our children" and help the United States to "take the lead when it comes to tackling the long-term challenges of global climate change." But if such a fuel exists, then why are people still stuck in the 20th century relying on gasoline that does as much harm as it does good?

Figure 1: The ever evolving gas station has been with us for decades.

Why Is Hydrogen Fuel Not Widely Used?

The answer is that our nation along with the entire world is built on a transportation infrastructure that relies almost exclusively on gasoline. It is an infrastructure that has been in use since the development of the automobile, and continues to grow to serve our needs. Out of the estimated 16 million cars sold last year, only 50,000 of them were hybrids—or cars that rely on means of fuel other than gasoline. All of our gas guzzling cars however must still rely on the stuff they get at the local gas station. For hydrogen fuel to be considered as a mainstream fuel source say scientists, the leaders of the world must agree on preparing an infrastructure that would allow hydrogen fuel to be as easily accessible as a gallon of gasoline.

Figure 2: A compressed hydrogen gas tank. Source: eere.energy.gov

"replacing petroluem"

Another problem with hydrogen fuel, despite all of its benefits as a revolutionary fuel, is that it has some tricky characteristics that must be overcome. Industry analysts continue to debate which state of hydrogen would be most beneficial for use as fuel, since hydrogen

in any state, solid, liquid, or gas, is difficult to contain. As a gas, hydrogen would not be able to fit into an average size gasoline tank without extreme pressurization. Today's fuel tanks and engines are simply not strong enough to contain the fuel at that size. Further research on stronger storage materials would have to be done if the industry decides to take the gas route. Hydrogen as a liquid isn't any easier to control either. Even though liquid hydrogen would not require as much space as its gas counterpart, it would have to be kept continually cold at very low temperatures (approximately -423º Fahrenheit) to remain a liquid. This requirement takes a tremendous amount of energy, more than what the fuel would provide.

Figure 3: A liquid hydrogen tank. Source: eere.energy.gov

"Hydrogen storage"

The best option for hydrogen fuel at this point seems to be in a solid state. It would not have to be 100% pure in this state, but rather combined with another solid material that would absorb the hydrogen at fill-up and then release it when it is needed by an engine. Unlike liquid hydrogen, the right material would be able to store hydrogen at less extreme storage temperatures. And unlike gaseous hydrogen, the solid could also store ample amounts of energy in a small shape. The problem however with this idea is that the time it would take for a substance to absorb the hydrogen would be much longer than the usual couple of minutes needed at today's gasoline fill-ups. In some instances, a large amount of heat is also required to get the hydrogen out. Currently scientists are looking towards developing porous nano-tech materials in hopes of overcoming these obstacles.

What Are We Doing with Hydrogen Now?

Despite the many difficulties scientists are still having with turning hydrogen into a mainstream source of energy, there have been several successful applications of this element. Hydrogen today is widely used by the chemical industry for a variety of commercial applications. These applications include using it to produce ammonia for fertilizer, methanol production, welding, and cryogenic freezing. Hydrogen fuel has existed on the market for many decades, but has yet to become a staple product of mainstream transportation. NASA's rocket scientists have used liquid hydrogen to send space shuttles into outer space since the 1970s. Hydrogen fuel cells are also used to power its ships' electrical systems, with pure water as the by-product for our astronauts.

There have been steps taken by the automotive industry to make the dream of hydrogen fuel a reality for everyone.

Since 1999, major automotive manufacturers have been putting gasoline-electric hybrids on the market in the United States. These include the Toyota Prius, the first hybrid to be sold in the US, as well as the Honda Civic Hybrid, the Honda Insight, and the recently redesigned Ford Escape Hybrid. Although technologically no where near pure electric hydrogen-driven cars, sales of these cars have shown car companies that there is a market for cleaner alternatives to gasoline, as long as hydrogen performs to the same standards. These hybrids have also led auto manufacturers to produce prototypes of what they think the future holds for hydrogen vehicles, some with promising results.

Figure 4: The FCHV-4 Source: www.hakonet.de

Hydrogen Fuel for Today's Cars

Since 1992, Toyota has developed many fuel cell vehicles, including the FCHV-4 and FCHV-5 (Fuel Cell Hybrid Vehicle).

The FCHV-4 being tested under the Toyota Highlander design is equipped with a fuel cell hybrid system. This system, based primarily on the Prius' gasoline/electric hybrid setup, includes hydrogen storage tanks, a fuel cell stack, a power control unit and a secondary battery. Electricity to run the entire car comes from the fuel cells where hydrogen and oxygen from air compressors are chemically reacted to create power. The secondary battery is used to store spare energy, which increases fuel efficiency.

The FCHV-4 Hydrogen Vehicle

Current specs have allowed the FCHV-4 to reach speeds of up to 95 miles/hour from 110 horsepower of pure hydrogen electric energy. Several FCHVs have already made their way to universities and private companies in hopes that they will further develop this infant technology. "Fuel cell vehicles are widely held as the automotive technology of the future, but Toyota is taking the lead by getting hands-on experience today," said Jim Press, Toyota's chief operating officer at a 2003 press conference. "The universities (and other partners) are playing a vital role by providing feedback and data that will help us evolve this technology for tomorrow's consumers."

Toyota isn't the only company in the hydrogen fuel limelight. Daimler-Chrysler's own NECAR 5 completed the first trans-continental trip for hydrogen cars in 2002. The cross-country trip, which began in San Francisco and ended in our nation's capitol took twelve days and included several records being broken for alternative fuel vehicles. These records include a total distance of 3262 miles, and top speed of 99 miles per hour in western Nevada.

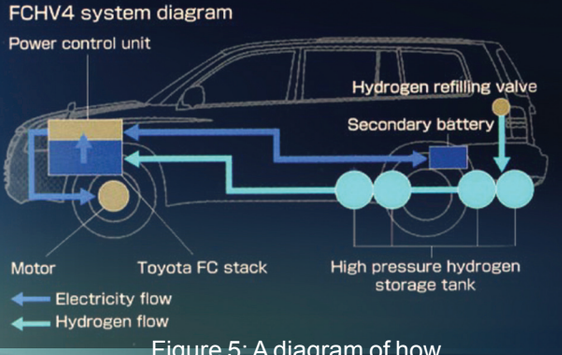


Figure 5: A diagram of how the hydrogen system works.
Source: www.hakonet.de

Daimler-Chrysler has already invested more than $1 billion in the development of fuel cells for cars, and hopes to continue being on the forefront of the hydrogen revolution. "With this journey we are sending an important message to the world that tremendous progress is taking place in the development of fuel cell powered vehicles," said Bernard Robertson, Daimler-Chrysler Senior Vice President of Engineering Technologies and Regulatory Affairs. "We have reduced the size and now we are working on enhancing endurance. However, we are still in the early stages of commercialization: the ultimate hurdles will be affordability and fuel infrastructure." - Ewire.com

Plans for a Hydrogen Future

With more developments in hydrogen fuel and scientists further expanding their knowledge of this fledgling technology, the idea of a hydrogen-based economy is slowly becoming a reality.

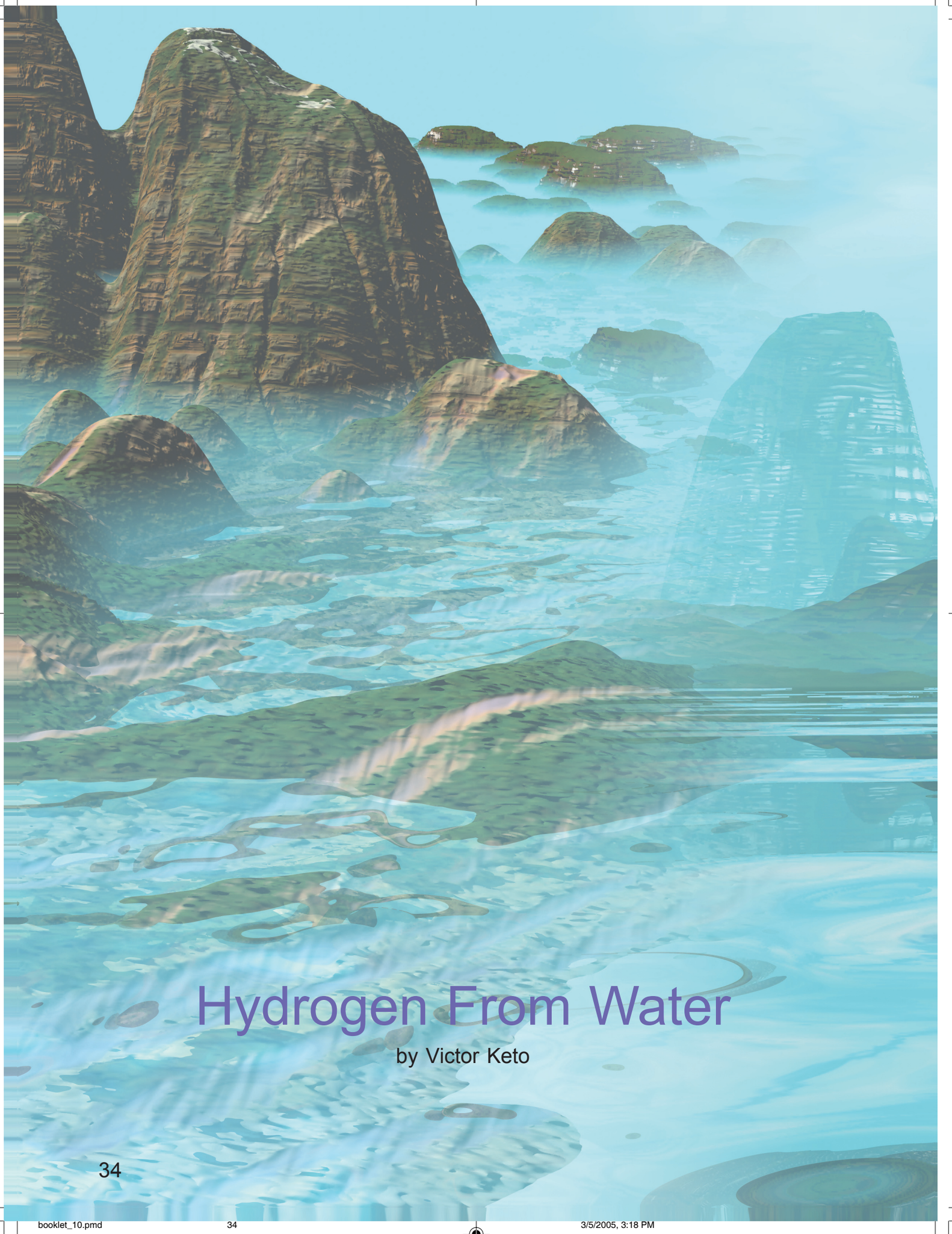
Several nations, including the United States, have developed their own federally funded hydrogen fuel programs. In 2003 President Bush announced the Hydrogen Fuel Initiative, a $1.2 billion dollar program aimed at providing scientists with the resources they need to create an economy that will make hydrogen fuel a commercially viable alternative.

In the same year, the European Commission endorsed the creation of the European Hydrogen and Fuel Cell Technology Platform (HFP). The HFP's goal is to assist in coordinating the European nations into a unified program that will not only help in the development of hydrogen fuel technology, but eventually become a central part of the hydrogen market within the European Union and the rest of the world.

HYDROGEN

Figure 6: The NECAR-5 arriving in Washington D.C.
Source: DaimlerChrysler.com

Figure 7: Hydrogen pumps like these could some day replace gas stations.
Source: whitehouse.gov



Hydrogen From Water

by Victor Keto

Photosynthesis has long been one of nature's most efficient means of transforming solar energy into chemical energy. Today, the energy company Hydrogen Solar of Guilford, England is pioneering a new method for using the sun's energy to separate the oxygen and hydrogen atoms of water molecules.

In a recent Wired news interview Hydrogen Solar CEO David Auty said his company's Tandem Cell technology, "uses two solar cells that together capture sunlight from every part of the ultraviolet spectrum. The interaction of photons with a semiconductor material causes a photoelectrochemical reaction that excites electrons and causes water molecules to break up into hydrogen and oxygen." The photoelectrochemical process of harvesting hydrogen atoms is more efficient than electrolysis, because it is a one step instead of a two-step process. The two steps required for electrolysis are first that nuclear, fossil, or solar energy be converted to electricity and that a metallic catalyst then use this electricity to separate the hydrogen and oxygen atoms of water. The metal catalysts are usually expensive rare materials including platinum that are not economically feasible to use on a large scale. In contrast, the photoelectrochemical process can occur when certain metal oxide materials are submerged in a shallow body of water that is exposed to the sun's rays. The nanotechnologically engineered metal-oxide reacts to the sun's light be separating the atoms of water molecules surrounding it. A few kilograms of hydrogen can be produced daily using ten square inches of Hydrogen Solar's new solar cells. Auty believes that this production capacity will allow his company's technology to be a viable solution to carbon based fuels.

"Visible light has enough energy to split water," said John Turner, one of the National Renewable Energy Lab's chief scientists, who is researching more efficient materials for use in hydrogen harvesting photoelectrochemical reactions. The use of cheaper metal-oxides will substantially lower hydrogen production costs, while the simplicity and efficiency of this single step process will lead to increased adoption of this technology for mining hydrogen. Turner hopes that his work will help lead to hydrogen's replacing of fossil fuel within the next two decades.

Hydrogen Solar's (HS) newly proposed hydrogen gas station to be built in Las Vegas as a proof-of-concept for the photoelectrochemical process will boldly introduce their new technology to the automobile industry. Even though the station may not be frequently used due to the small number of hydrogen powered vehicles on our roadways, it will stand as a sign, symbolizing future change in the energy industry.

"Visible light has enough energy to split water"

One of the first products that Hydrogen Solar (HS) plans on marketing within the next twelve months is a garage roof mounted solar panel capable of producing enough hydrogen to run a hydrogen fuel cell car for at least ten thousand miles each year. This 10% efficient solar panel will constantly produce hydrogen while the sun's rays contact its surface. If this product saturates the market, it will mark the beginning of hydrogen's mainstream use. With over two thirds of the world covered in water and a virtually endless supply of sunlight, Hydrogen Solar's new photoelectrochemical process could one day be capable of providing enough hydrogen to power every automobile, home, and business on earth.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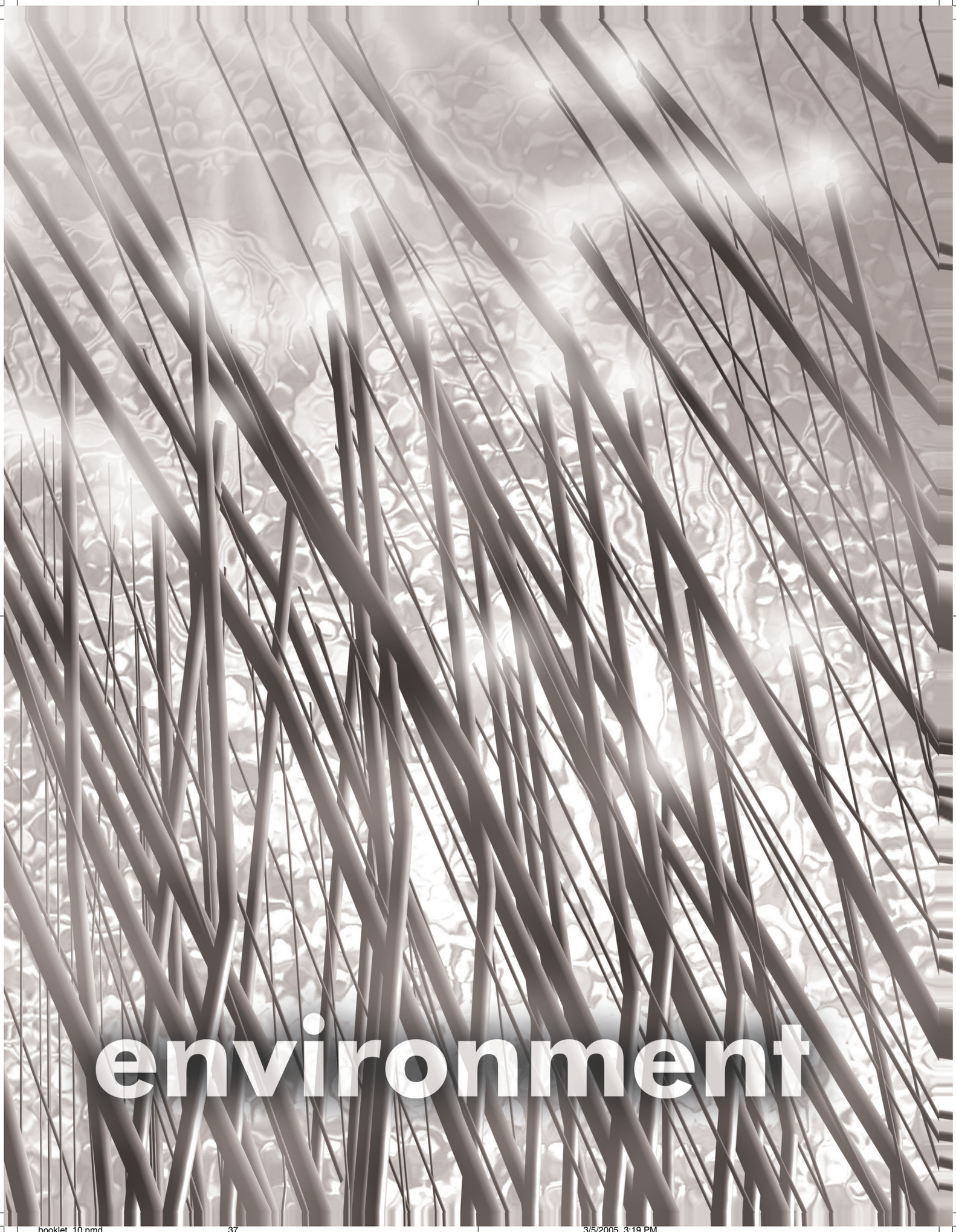
environment

INVISIBILITY VIA VIDEO CAMOUFLAGE

by Victor Keto

Video projection systems have developed from low-resolution monochromatic displays into high definition viewing screens. With companies such as Sony, Hitachi, Magnavox, and Samsung producing ultra sharp video projectors that create photo-realistic imagery, the notion of using video as a cloaking device has entered the realm of possibility. Leading the development of a new technology called video camouflage is Philip Moynihan and Maurice Langevin of Caltech, and Dr. Sasumu Tachi, professor of computer science at the University of Tokyo. These scientists are each striving to achieve the same goal, that of projecting imagery from the far side of an object onto the front of an object so that when objects are observed, only their far side is seen and not the object itself. The potential uses of video cloaks are numerous, ranging from military to civilian applications.

"The notion of using video as a cloaking device has entered the realm of possibility"

Adaptive camouflage is currently being developed by Philip Moynihan and Maurice Langevin of Caltech for NASA's Jet Propulsion Laboratory. This technology, which will be capable of rendering an object virtually invisible, is comprised of thousands of microscopic light sensors and light emitters. The term "adaptive camouflage" is used to describe the technology's ability to change its video display in response to the environment unlike conventional camouflage, which consists merely of static imagery or props. Adaptive camouflage could project the scenery of a forest if worn by soldiers conducting reconnaissance in a wooded area, and then project scenes from a desert as the troops move into a vast expanse of sand dunes. Figure 1 shows a tank with one half of its surface cloaked with adaptive camouflage. This technology will be very effective because the imagery used for cloaking objects is identical to the scenery surrounding the object. One of the first ideas to be put forth for adaptive camouflage was to use it as a video cloak for soldiers in combat. Over time, a variety of additional military applications were later conceived, such as cloaking large machinery on the ground and in the air. Other uses for this cloaking technology include using it as "an electronic window that would display a nearby outdoor scene in an office that lacks a real window." – NASA's Jet Propulsion Laboratory New Technology Report filed in August of 2000 describes the hardware components of adaptive camouflage and provides a detailed proposal of how this technology will work. "A typical adaptive camouflage system would likely include a network of

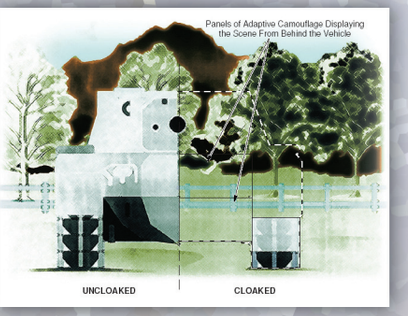

Figure 1 Source: NASA Jet Propulsion Laboratory

Figure 2: Foot soldiers engaging their cloaking devices

electronic flat-panel display units arrayed in the form of a blanket that would cover all observable surfaces of an object that one seeks to cloak. Each display panel would contain an active-pixel sensor (APS) (or possibly another advanced image sensor) that would look outward from the panel through an aperture that would occupy only a small fraction of the area of the panel. The blanket would also contain a wiring harness that would include a cross-connected fiber-optic network, through which the image from each APS would be transferred to a complementary display panel on the opposite side of the cloaked object.

The positions and orientations of all the image sensors would be slaved to the position and orientation of one image sensor that would be designated a master imager. A leveling instrument sensed by the master imager would determine the orientations. A central controller connected to an external light meter would automatically adjust the brightness levels of all the display panels to make them conform to the ambient lighting conditions. The underside of the cloaked object would be illuminated artificially so that the display from the top of the cloaked object would show the ground as though in ambient light. If this were not done, then an observer looking down from above would see an obvious shadow-induced discontinuity.

The display panels could be sized and configured so that a common inventory of such panels could be used to cloak a variety of objects, without need to modify the objects. Sizes and weights of representative adaptive camouflage systems and subsystems have been estimated: The volume of a typical image sensor would be less than about 1 in.^{3} (16 cm^3). A system to completely cloak an object 10 m long by 3 m high by 5 m wide would weigh less than about 100 lb (45 kg). If the object to be cloaked were a vehicle, then the adaptive camouflage system could readily be operated on power provided by the vehicle's electrical system, without adversely affecting the operation of the vehicle." – NASA JPL New technology Report NPO-20706

"Invisibility"

Developing his own brand of video camouflage since 1977 is Dr. Sasumu Tachi working in the department of Information Physics and Computing at the University of Tokyo. He is a well-known engineer and computer scientist who has invented a new type of optical fabric known as retro-reflectum. The purpose of his technology is to act in a similar fashion to adaptive camouflage, by shielding objects or people from view via video projection. Retro reflectum has the unique property of allowing those viewing it to see three-dimensional imagery. Unlike Moynihan's optical camouflage however, these realistic views must be projected onto the fabric by a nearby projector. This factor limits the technology's potential applications because the illusion of invisibility can only be achieved from a specific perspective using a network of cameras and projectors. Figure 3 illustrates the system working to produce the effect of invisibility.

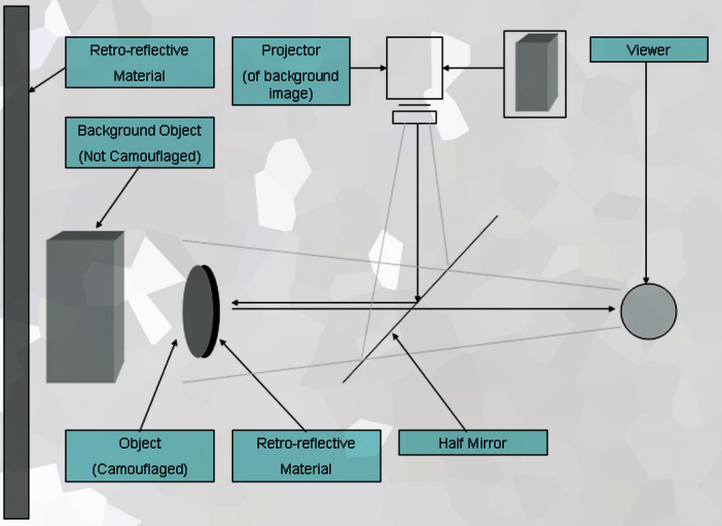

Figure 3: Tachi projection system components

Even though retro-reflectum would not be a feasible tool for soldiers in battle because of its many free standing parts, it could be used as a projection device in movie theaters or staged performances: anywhere that an observer's view is confined to a limited range of perspectives. If someone where to view an 'invisible' object from the side, he of she would not be visually fooled by the technology because only half of the object would be seen reflecting 3D imagery.

For both adaptive camouflage and retro-reflectum, a flawless projection of the far side image onto the front of an object will allow viewers to clearly see the far side scenery, hence perfect invisibility. However, there are many hurdles facing Dr. Tachi, Moynihan and Langevin as they work to perfect their technologies. The most challenging obstacles to overcome involve computing power, energy consumption, heat gain, and accuracy of video projection. Moynihan's adaptive camouflage requires enormous amounts of computing power to work effectively. This is because the thousands of light sensors and emitters must constantly project imagery from the far side of an object while accounting for the changing lighting conditions and movement of objects. If the projection surface is folded, the light emitters must recalculate the correct angle needed to project light to maintain the illusion of invisibility around an object. If the sun rises behind the cloaked object, the sensors must know how to adjust to the increased light intensity. Unlike retro-reflectum which merely reflects light shined onto its surface, adaptive camouflage is a self contained system that must generate its own light to project at the right intensity. Being self contained, the adaptive camouflage system must also be equipped with an on board power supply capable of providing the kilowatts of power needed to keep the light sensors and emitters working. During the day, vast amounts of power will be needed to effectively project a convincing image of the sun's rays. Until battery sizes shrink and energy storage capacities increase by at least a factor of ten, a fully functional prototype of this technology producing perfect invisibility can not be manufactured. Retro-reflectum has the advantage of not having to produce electricity on board the object to project the 3D imagery that is reflected from its surface. For adaptive camouflage to be feasible as a military technology, the issue of extreme heat gain must also be resolved. A soldier, even though visually cloaked, could be easily detected by

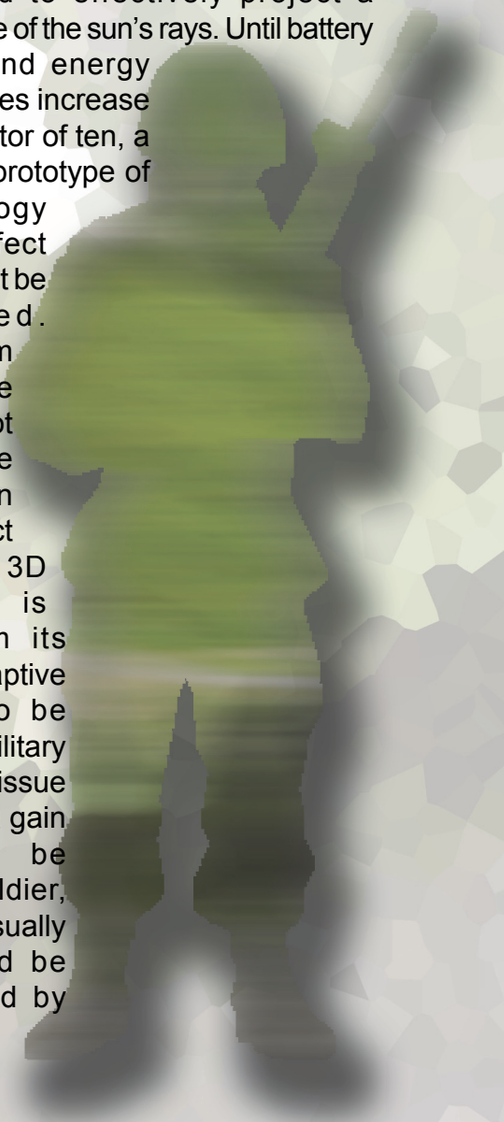

Figure 4 (Pg. 42 bottom left) Man wearing cloak
Figure 5 (below) Surveillance cameras

heat sensors on the battlefield if adaptive camouflage generates too much heat. Today's silicon processors are notorious for producing heat and must be constantly cooled. An invisibility suit using the computing power of hundreds of processors while also needing to keep cool will require either an elaborate refrigeration system or cooler while in operation. Solving these problems while not becoming too heavy to be worn is yet another challenge. Because retro-reflectum is only a fabric, it does not require any on board processors or cooling systems. For both adaptive camouflage and retro-reflectum, making the illusion of invisibility believable will require the far side imagery to perfectly match the surrounding view. If the contrast, color, position, or light intensity of the projected scenery does not match the real scene, the illusion will not be convincing.

Professor Tachi, the inventor of retro-reflectum, says that his next goal is to develop his technology into a virtual window that will allow viewers to see through windowless walls. There are many occupied interior spaces that can benefit from his technology. People working in basement offices, and government personnel living in underground missile silos would all be able to see convincing three dimensional imagery of the outdoors. Artificial outdoor views could solve the problem of people currently deprived of natural light suffering negative psychological effects. Moynihan and Langevin's hope for their technology to one day enter the commercial market as well as military service to protect the lives of our troops in battle.

Even though most conceivable future applications of video cloaking technology are considered positive, there are many potential criminal misuses of this technology that raise ethical concerns. A robber could hypothetically enter a bank during its operating hours, move into an open safe and slip valuable goods under his invisibility cloak without being detected. A spy could go unnoticed while invading someone's privacy. The top floor of a forty story building could be made to seemingly vanish under the feet of unsuspecting people, giving them a heart attack inducing fright. As a result, thousands of people would lose trust in their visual sense and seek other means of security. Wearable infrared proximity sensors, not a common household item today, could become as widely used as glasses for augmenting our vision.

The world will change forever when video-cloaking technology is introduced within the next decade. Dozens of military and civilian applications will be explored as we find new uses for rendering people and objects invisible. The haunting question facing us today is whether society will change for the better or for the worse.


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REFERENCES

Advertising on Cell Phones

Cenuco Pioneers Video Advertising on Cell Phones. Cenuco Inc. Press Release. 15 November 2004. 17 November 2004. <http://www.cenuco.com/nVideoAd.php>

Ives, Nat. "Marketing for the Third Screen." New York Times Magazine 8 November 2004. 10 November 2004. <http://www.nytimes.com/2004/11/08/business/08adcol.html>

Lacy, Sarah. "Cell Phones Ring for Marketers." Business Week Online 23 December 2004. 23 December 2004. <http://www.businessweek.com/technology/content/dec2004/tc20041223_4480_tc119.htm>

Cell Phone Technology

Choo, Jeffery. "Docomo's 3G Mobile Wallet Handset." MobileBurn 10 August 2004. 5 September 2004. <http://www.mobileburn.com/news.jsp?Id=824>

"NTT DoCoMo Develops Prototype Micro Fuel Cell for FOMA Handsets." NTT DoCoMo Press Release. 30 September 2004. 6 Oct. 04. <http://www.nttdocomo.com/presscenter/pressreleases/press/pressrelease.html?param[no]=486>

Oryl, Micheal. "Nokia 7280." MobileBurn 22 September 2004. 10 September 2004. <http://www.mobileburn.com/gallery.jsp?Id=875>

Raja, Siddharth. "Upgraded Fashion: Motorola's V80." MobileBurn 6 February 2004. 12 September 2004. <http://www.mobileburn.com/review.jsp?Id=631>

Electronic Ink

"Electronic Ink Makes its Mark." Wired News 3 May 1999. 8 June 2004. <http://www.eink.com/technology/index.html>

"First Generation Electronic Ink Display from Phillips." Phillips Electronics. Press Release. 24 March 2004. 18 July 2004. <http://www.semiconductors.philips.com/news/content/file_1054.html>

Guernsey, Lisa. "Flexible Displays for Electric Ink." The New York Times Online 30 November 2000. 21 June 2004. <http://www.nytimes.com/2000/11/30/technology/30INK.html>

Hydrogen from Water

Gartner, John. "Sunlight to Fuel Hydrogen Future." Wired News 7 December 2004. 10 December 2004. <http://www.wired.com/news/technology/0,1282,65936,00.html>

Patch, Kimberly. "Molecule Harvests Water's Oxygen." Technology Research News 15 December 2004. 18 December 2004. <http://www.trnmag.com/Stories/2004/121504/Molecule_harvests_water's_hydrogen_121504.html>

Hydrogen Fuel

"Hydrogen Fuel: A Clean and Secure Energy Future." White House Press Release. 28 January 2003. 14 May 2004. <http://www.whitehouse.gov/news/releases/2003/01/20030128-25.html>

Hydrogen Fuel Cells and Infrastructure Technologies Program. US Department of Energy. 2004. 17 May 2004. <http://www.eere.energy.gov/hydrogenandfuelcells>

"Nissan Teams Up with United Tech in Developing Fuel Cells." Hakonet. 2002. 17 May 2004. <http://www.hakonet.de/uk/index.php3?page=rep63.php3>

"Staying Mobile with Hydrogen." Daimler Chrysler Press Release. 25 November 2003. 18 May 2004. <http://www.daimlerchrysler.com/dccom>

"Toyota Motor Corporation Markets Fuel Cell Car." Hakonet. 2002. 17 May 2004. <http://www.hakonet.de/uk/index.php3?page=reports>

Invisibility via Video Camouflage

BBC. "Inventor Plans Invisible Walls." BBC News 14 June 2004. 3 July 2004 <http://news.bbc.co.uk/go/pr/fr/-/2/hi/technology/3791795.stm>

Susumu Tachi, Ph.D. The University of Tokyo, Deptartment of Information Physics and Computing. April 2004 <Http://www.star.t.u-tokyo.ac.jp/~tachi>

United States. NASA. Technology Brief Volume 24, No. 8. JPL New Technology Report NPO-20706 Adaptive Camouflage. August 2000

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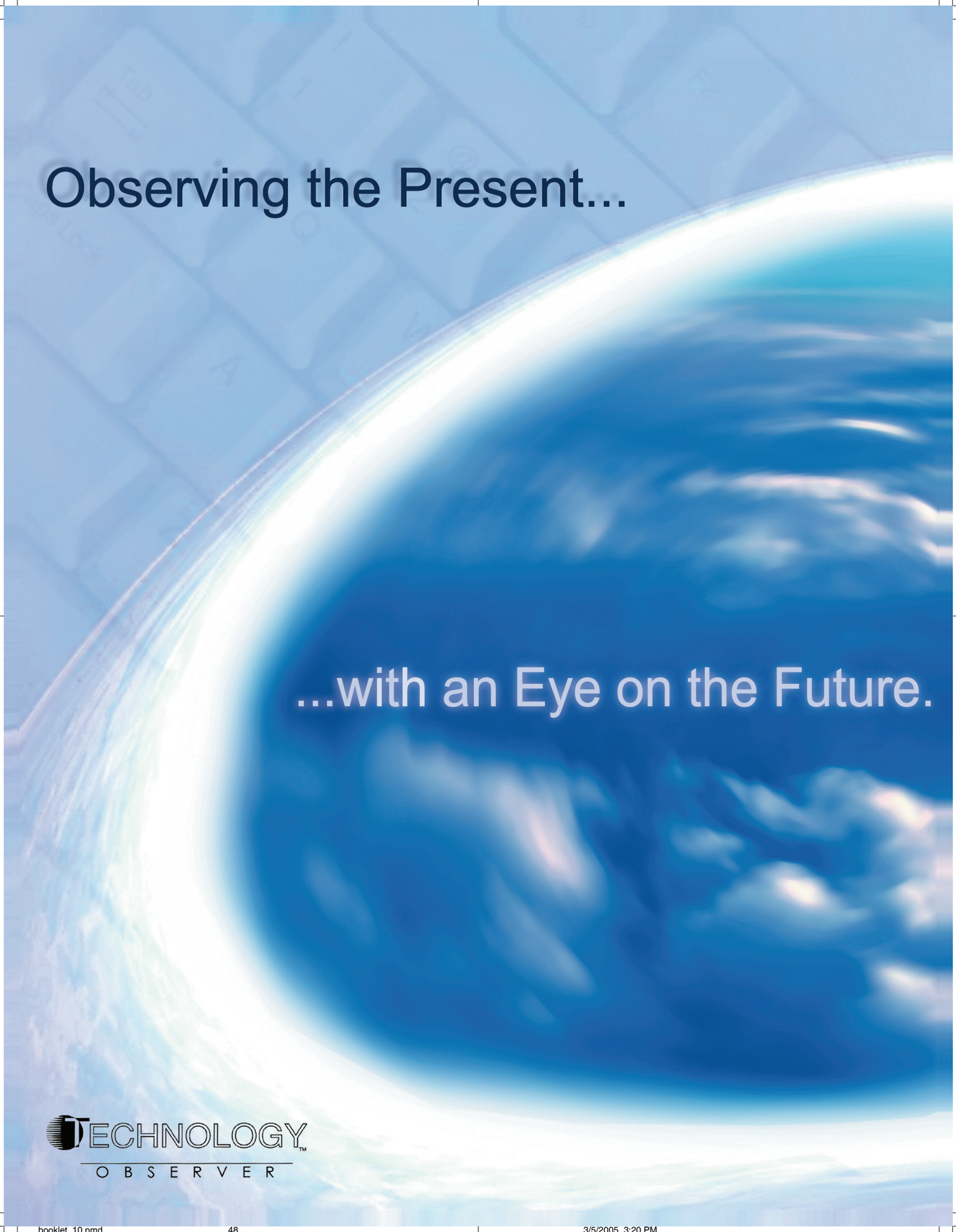
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