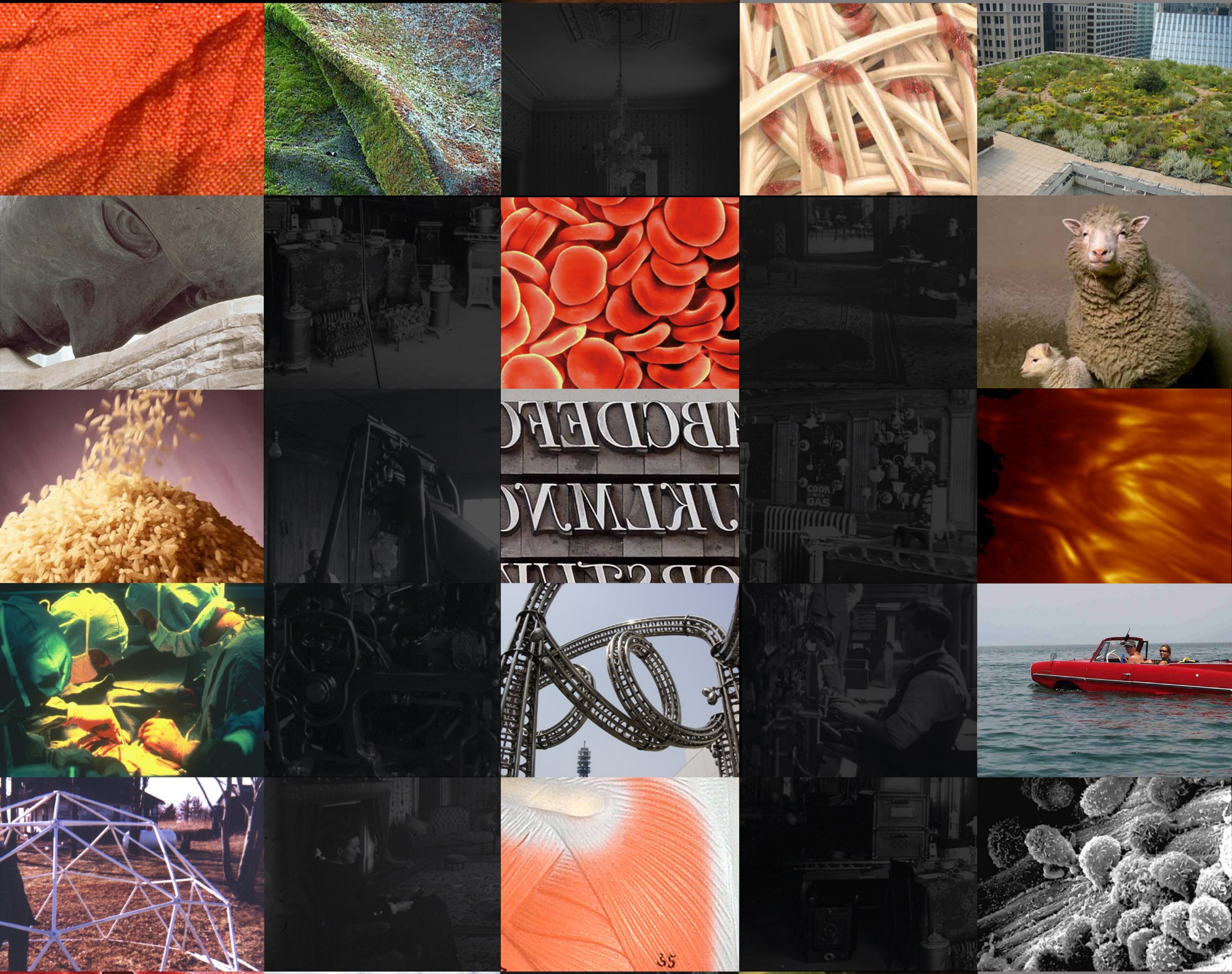
TECHNOLOGY™ OBSERVER

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



NJIT
New Jersey's Science & Technology University

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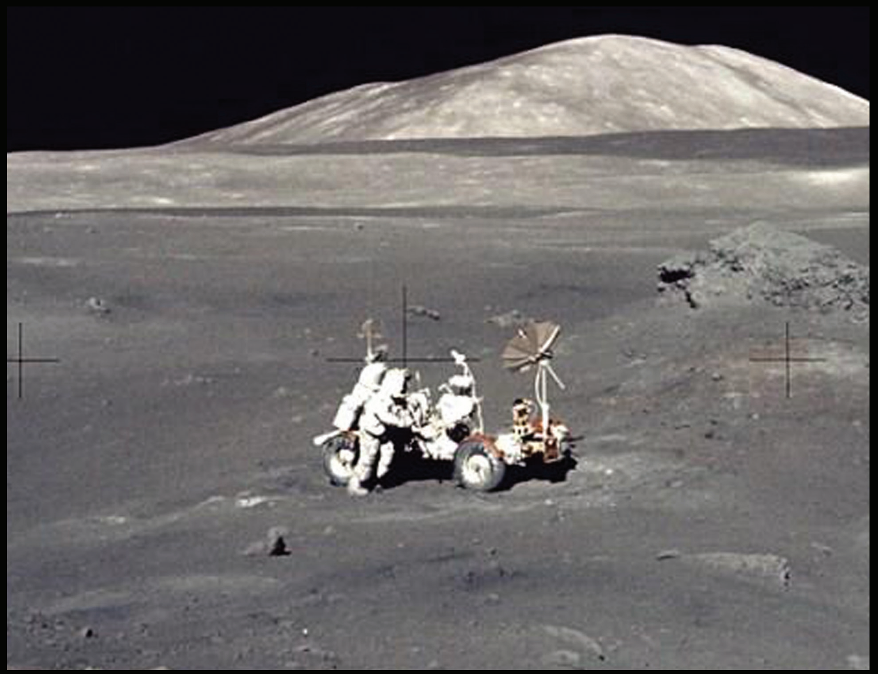

It suddenly struck me that that tiny pea, pretty and blue, was the Earth. I put up my thumb and shut one eye, and my thumb blotted out the planet Earth.

I didn't feel like a giant. I felt very, very small.

~ Neil Armstrong ~

PERIPHERY

In this fast-paced world everything changes.

+ With every advancement, we throw away last month's model for the new and improved. We become lost in trends in search of the newest, the hottest, the latest. The once shocking possibilities of the Internet revolution become common. Our cell phones are better connected, have more processing power and certainly have more style than the bulky room-sized NASA computer that helped to relay Neil Armstrong's immortal first steps on the moon to Earth. In another year, our "must have" IPODs will seem as dated and unfashionable as the car phone or the polyester leisure suit in your father's closet. We can't compete. In this world of high fashion technology, you either adapt or you become obsolete.

Yet, thankfully not every new technology is victim to such fickle tastes. It is easy to become seduced with flashy new technologies, but when it comes down to it, it's the technologies on the periphery of this scientific media circus that affect us the most. Revolutionary advances like the DNA Printing Press may lack the sex appeal of the latest GPS navigational system and thus may be easily overlooked. Nevertheless, this and similar new technologies will soon change the way we live. Whether it is the DNA Printing Press's potential for fast and cheap detection of genetic disease, or the development of new "smart bomb" cancer treatments on the scale of a nanometer; these are the technologies that will one day allow us to live longer, healthier, more productive lives.

It is with this interest we begin the sixth installment of the *Technology Observer*. We have maintained the *Observer's* commitment to the publication of new exciting technologies, but we have also expanded our gaze to cover 'non traditional' technologies such as Green Architecture and topics of scientific debate, including whether the term 'planet' is still scientific? With our look at new advances in Hand Shape Recognition technology developed by students at New Jersey Institute of Technology, we have also made an attempt to address how we, future scientists, designers and engineers, can play a role in new technological developments. It is our hope that this comprehensive look across the contemporary field of science will spark an awareness and interest in the vast and extraordinary potential of developing technologies.

enjoy!

LoriAnne Jones, Editor
Christian Howell, Editor

CONTENT

WE ARE...

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+ We would like to express special thanks to Ms. Lois Hulin for her tireless effort and dedication in helping to make this issue of the *Technology Observer* a grand success.

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NJIT

The Technology Observer is a publication of Albert Dorman Honors College at New Jersey Institute of Technology.

A letter from our advisor

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

Dear Reader,

This is the sixth edition of the *Technology Observer*, a publication founded, managed, researched and written by Dorman Honors College students for the purpose of reporting on emerging technologies. This issue has a particular focus on technologies and applications in the health sciences: "synthetic muscles," "nanoshells" to treat disease, "supramolecular nano-stamping" in order to detect genetic disorders, and "hand shape recognition technology" used to translate American Sign Language into a digital format for the hearing impaired.

As important as the new technologies are, the process by which they are developed is just as significant. In their research, the students repeatedly found interdisciplinary teams of scientists, engineers, mathematicians, and at times architects, working together to contribute to the outcome of better science and engineering in order to solve human problems. Often, these teams were university-based, University of Michigan, University of Bath, MIT and NJIT. The teams are working at the edge of new theories, designs and materials. This is evident for the technologies discussed above and those which are presented in the *Observer's* remaining articles, "green architecture," "environmental architecture," "adaptive biomimetic design," and what is a planet?

The team of students led by LoriAnne Jones and Christian Howell, senior Architecture students, have produced an Observer which reports on fascinating science, engineering and technology, is very well written and beautifully designed. I hope that you reach a similar conclusion about this edition of the Observer, and share it with a middle or high school student who may be drawn into these high demand professions which make significant contributions to our quality of life.

Thank you.

Most sincerely,

Joel Bloom

The Campus Center at New Jersey Institute of Technology.

About New Jersey Institute of Technology

THE EDGE IN KNOWLEDGE

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

For more information :: njit.edu

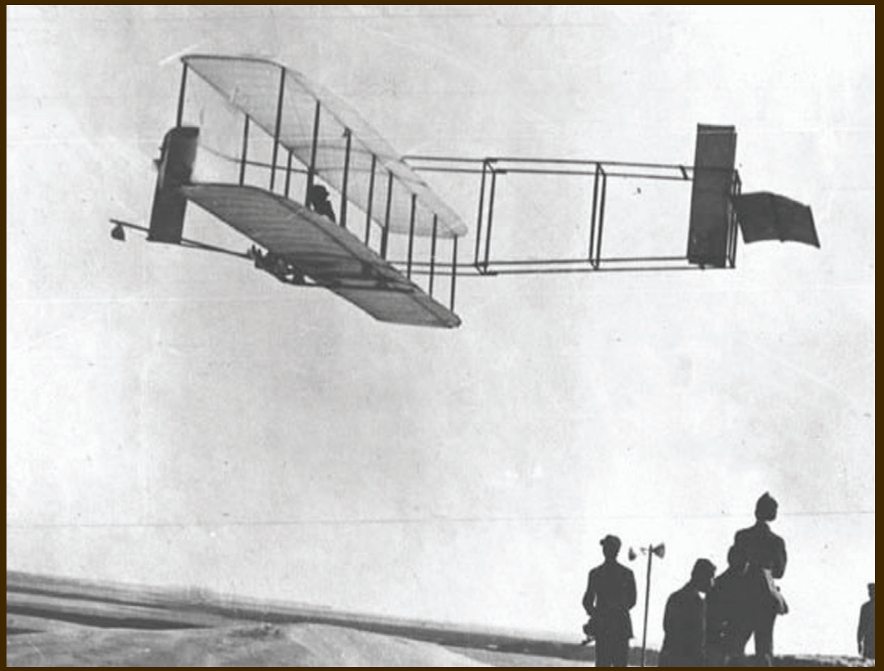
About the Albert Dorman Honors College

ENGAGING THE FUTURE

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

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

For more information :: honors.njit.edu



No flying machine will ever fly from New York to Paris.
~ Orville Wright ~

:: Artist rendering of "Smart Bomb" Nanotechnology ::

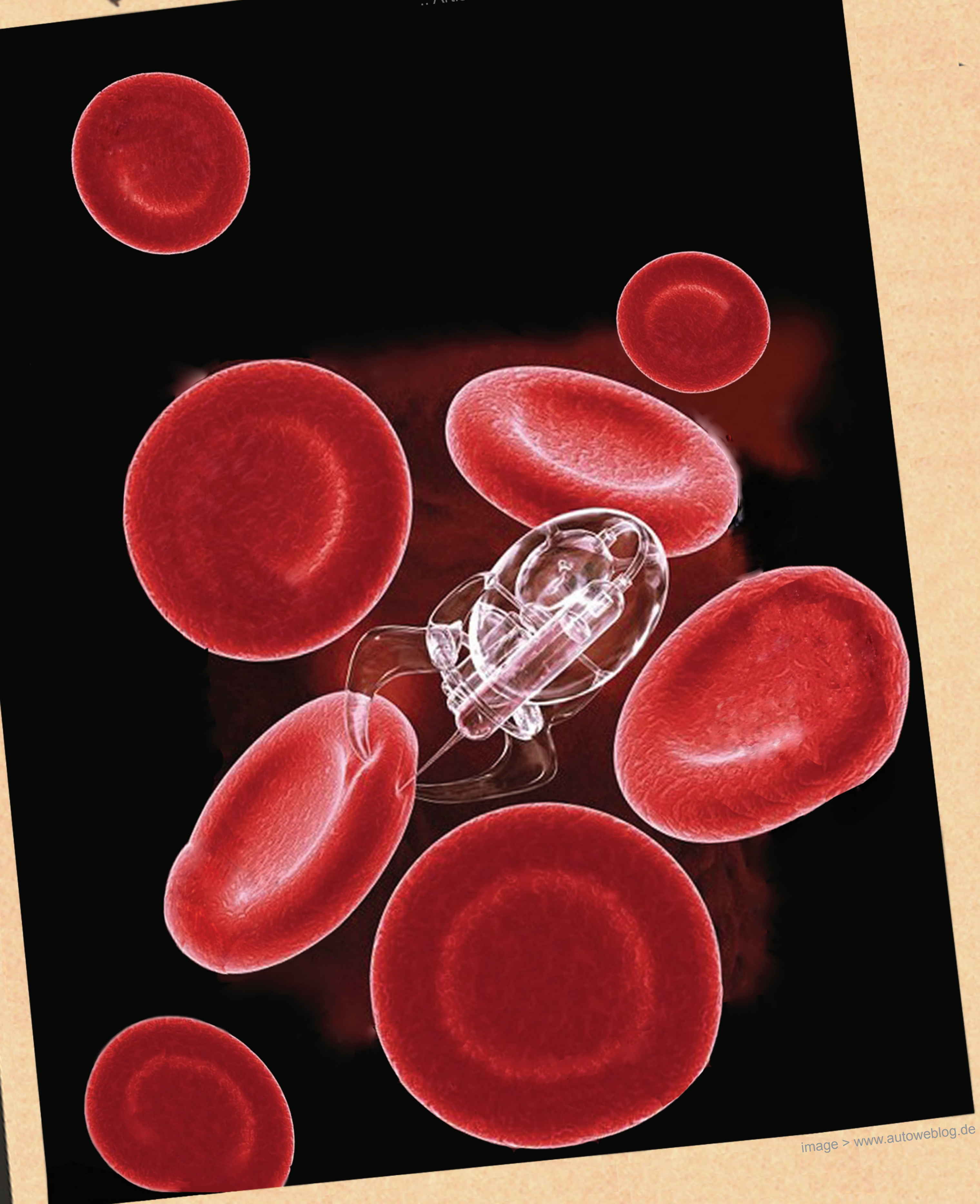


image > www.autoweblog.de

INVASION OF THE SUPERCELLS

Quiet, stealthy, unexpected

SPECIAL ISSUE

NANO

TNT.

TARGETED NANO TECHNOLOGY
and the new war on cancer.

:: NAPTHALY EHRENBERG ::

The science fiction novel has often been the springboard for many futuristic ideas and fantasies. Perhaps the most awe inspiring and beneficial among these is the dream of one day being able to heal any disease or sickness that ails the human body. This fantastic cure-all would stimulate cells to repair themselves and divide quickly. Instead of the weeks or months needed to heal, this quick repair would heal damage to the body in a matter of hours or days. While modern science hasn't quite arrived at this cure, the development of such technology seems more realistic every day. Some recent research from the past few years has advanced the search for this technology far ahead of its time. Perhaps most astounding is that many of these studies are being performed at a scale of a nanometer, far beyond the average person's imagination.

A nanometer is one times ten to the negative ninth power. It is from this miniature scale that the relatively new field of nanotechnology derives its name. As recently as the year 2000, nanotechnology research topics sounded as if they had been invented by an author of science fiction. Nanotechnology hardly seemed like it could ever be brought into real life. (Voss 60). Now, just a few years later, these once fantastic ideas are fast approaching reality. In an introduction to an article in the January and February 2000 edition of *Technology Review*, Voss states, "Minuscule 'smart bombs' that find cancer cells, kill them with the help of lasers and report the kills."

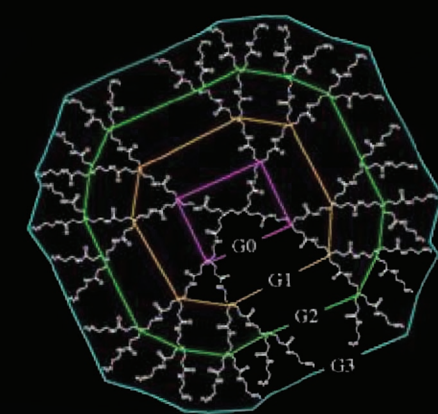
Sounds crazy? Guess again. That treatment scenario may be less than a decade away." (Voss 60). The technology backgrounder section of the NCI (National Cancer Institute) Alliance for Nanotechnology in Cancer's website, gives a short summary of several rapidly developing cancer treatment methods that use nanotechnology. One such treatment method uses nanoshells, which are small nanoparticles that can be linked to a tumor specific antibody [see figure 1]. These nanoshells specifically enter only cancer cells, and then are activated by a beam of light applied to the area which is absorbed only by the nanoshells. The light heats the nanoshells, effectively destroying the cancer cells the nanoshells have attached to and leaving the healthy tissue alone.

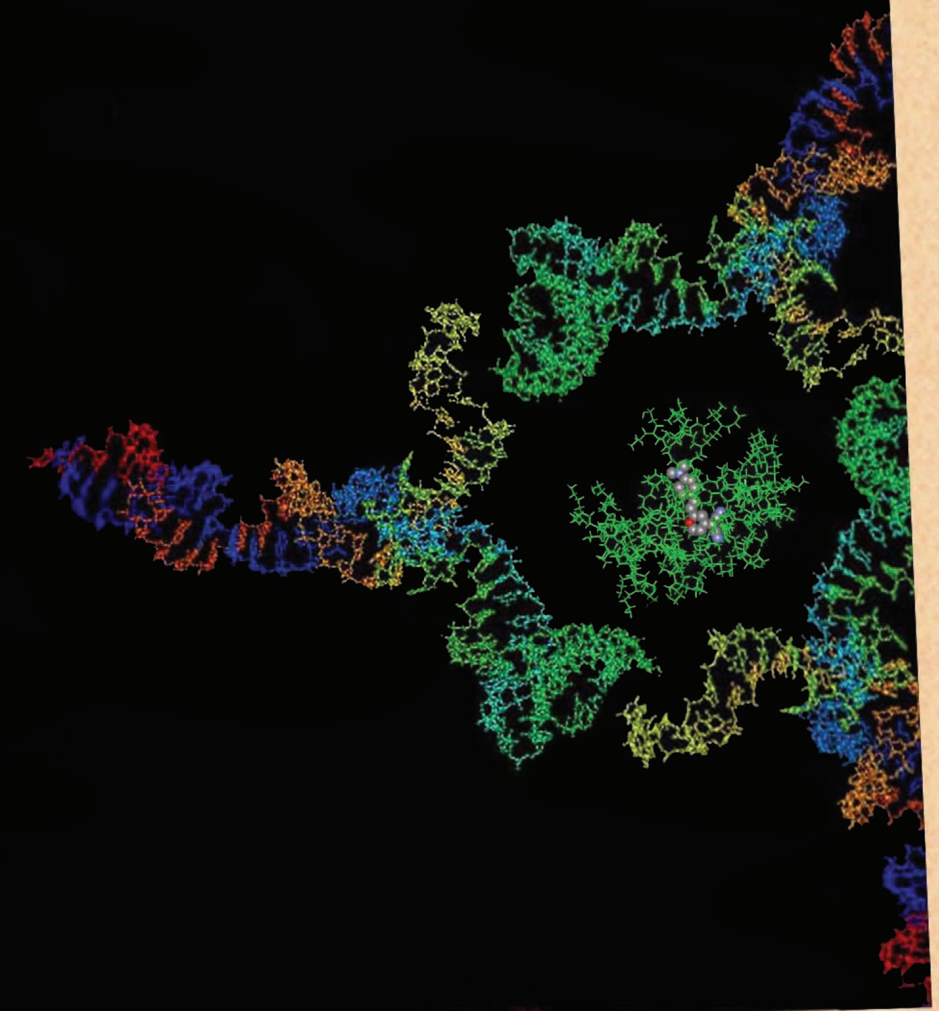
In 2000, new obstacles caused the direction of several areas of medical research to be reevaluated. One popular idea for the treatment of diseases like diabetes and other disorders where the body fails to produce a specific type of substance needed for normal function was to use gene therapy. In gene therapy, researchers locate the code of DNA needed to synthesize a specific substance. A virus is then modified to carry this DNA information. The virus is then injected into the body of a person who lacks this correct DNA sequence. The virus then enters nearby cells and implants the DNA into the nuclei of the cells. The cell then reads the DNA and produces the proteins needed to correct the deficiency. The primary problem with this treatment method is that in order for it to be successful a large quantity of the virus needs to be injected into the patient in a single dose. This single large injection usually results in a massive response from the person's immune system, and can result in a host of serious complications.

This was known to be a problem but ultimately led to disaster when doctors used gene therapy on a patient who later died of complications within four days of the therapy. This new obstacle prompted researchers to look for a different approach (Voss 60-63).

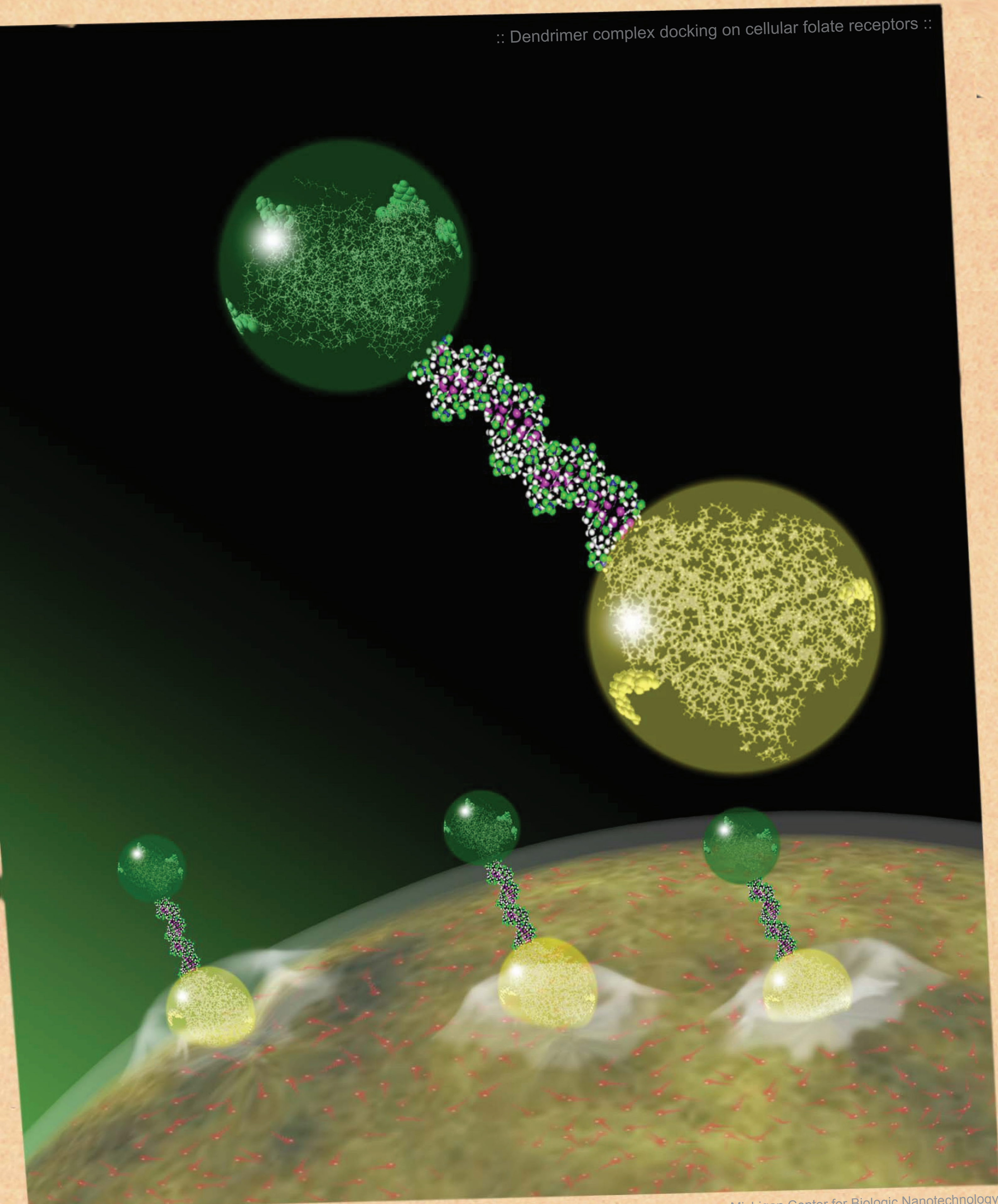
:: Figure 1 [right] ::
The Nanoshell technology linking to cancer specific cells.
Birck Nanotechnology Center, Purdue University.

:: Figure 2 [below] ::
Typical Dendrimer Structural Model.
Alliance for Nanotechnology in Cancer. 3 Nov. 2005





Due to the problems encountered with conventional methods of gene therapy, Dr. Baker, founder of the University of Michigan's Center for Biological Nanotechnology, who was very involved in gene therapy research; proposed a different method for delivering the DNA into the cells of a patient (Voss 61-62) using a dendrimer [see figure 2]. A dendrimer is a small nanoparticle that is grown from a center molecule through very specific and controlled steps called generations or G's. A first generation dendrimer would be called G0, and a second, G1, and so on. The conditions of the dendrimer's growth are very specific because the details of its structure and composition result in very diverse properties of the particle. Since these properties can be controlled, researchers can design different dendrimers for different situations ("Nanotechnology Glossary"). Dr. Baker's research explored the use of a dendrimer specifically designed to enclose a section of DNA that could be introduced into the body without inducing a response from the immune system. If the dendrimer could avoid an attack by the body's immune system, then it would be free to travel and enter specific cells and release its enclosed DNA, completing its function. In addition to the application of dendrimers in gene therapy, Dr. Baker also began research to investigate other possible medical uses for dendrimers in very specific targeted treatments (Voss 65).



:: Dendrimer complex docking on cellular folate receptors ::

image > Michigan Center for Biologic Nanotechnology.

A recent article published in the journal *Cancer Research* discusses a study lead by Dr. Baker, using a derivative of his original dendrimer idea. In this study, the research team used a G5 polyamindoamine, or PAMAM, dendrimer, which is capable of delivering a large number of molecules to a specific location in a patient. Groups of reactive chemicals on its surface allow this unique ability, which can be used to attach therapeutic drugs, targeting chemicals and imaging compounds in virtually any configuration.

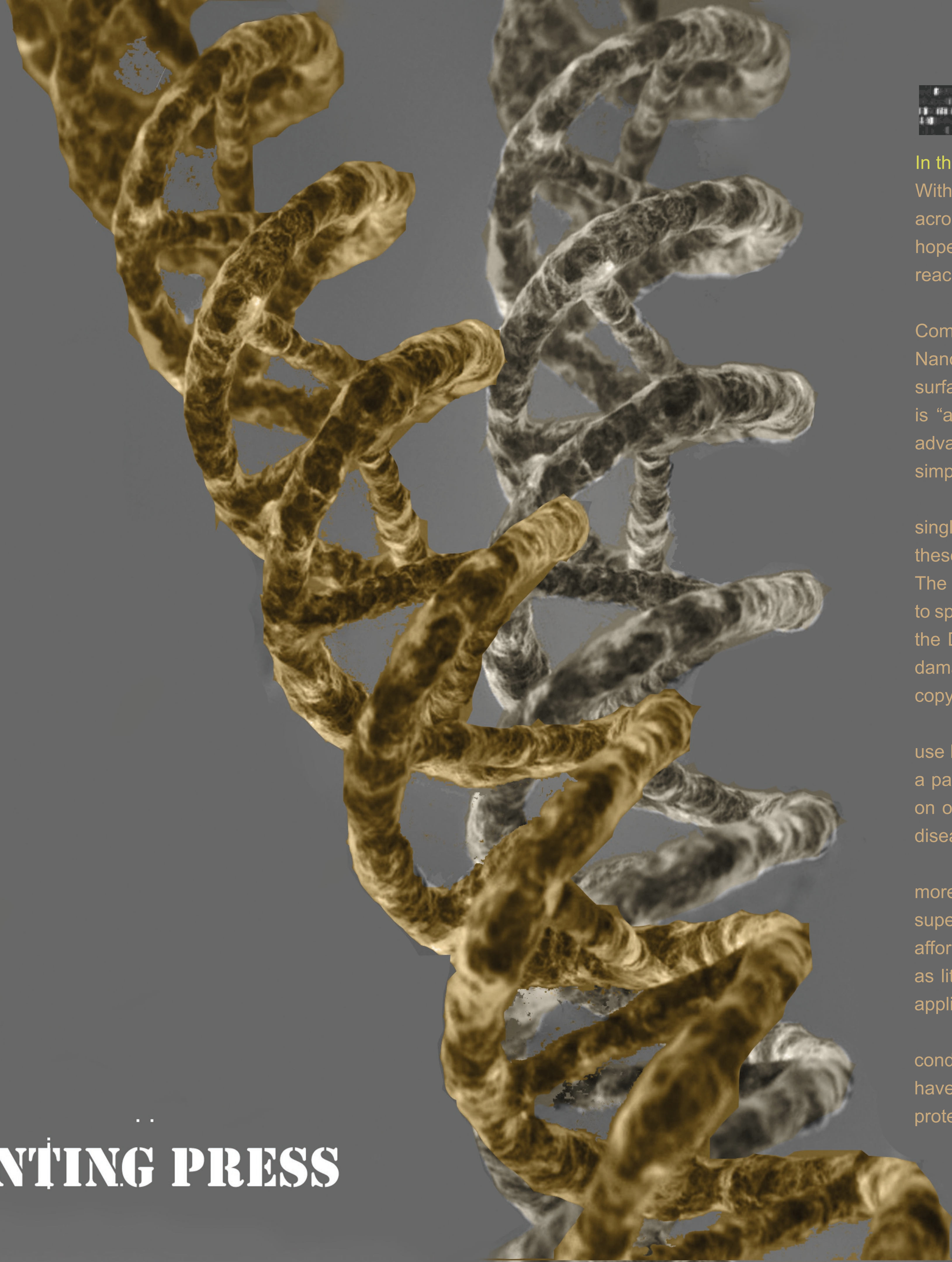
For this study, the team attached methotrexate, folate, and a fluorescent to the dendrimer. Methotrexate is a very toxic but effective anticancer drug and folate targets a high-affinity folic acid receptor on cell membranes, which many cancer cells over express. The fluorescent, used as an imaging agent enabling the team to track the dendrimer's distribution, was either fluorescein or 6-carboxytetramethylrhodamine. Quantities of this laden dendrimer were then injected into a group of mice previously injected with human epithelial cancer cells. This experiment was a test of the efficiency of the dendrimer targeting and delivery system ("*Nanotech News* June, 15 2005").

Using confocal microscopy, the team confirmed that the folate targeting compound caused the dendrimers with the anticancer drug attached to be taken up by the cancer cells. This specific targeting of the anticancer drug enabled increased anticancer effectiveness while significantly decreasing the toxic effect on the host. This makes it possible to inject higher doses of the drug with a lesser risk of immune system complications. Additionally, the test revealed that the mice's immune systems did not attack the dendrimer as if it were a foreign body (Kukowska-Latallo 5317).

This research revealed several important facts about the advance of nanotechnology in recent years. It demonstrated that researchers have been able to isolate a variety of chemical markers that are unique to cancer cells, and use them for chemical guidance. It also showed that the particular dendrimer and its configuration in the test conducted by Dr. Baker did not trigger an immune response. This suggests the possibility of using the methods illustrated in the experiment to configure the dendrimer for different compounds to suit the specific needs of other conditions.

Since the introduction of nanotechnology at the beginning of this century, tremendous progress has been made in the areas of nanomaterials and nanotechniques. The field of medicine has tremendous potential uses for nanotechnology. Researchers have already made great progress towards being able to begin the testing of directed drug delivery systems on human patients. Dr. Baker's team hopes to test its dendrimers in humans within the next two years. Other researchers in the field are working on nanosized constructs called cantilevers that can act as detectors for cancer. These constructs change shape when certain substances created by cancer cells bind to them, informing doctors not only of the location of a cancer, but also its relative size based on the concentration of activated constructs ("Media Backgrounder").

With only this small glimpse into the world of nanotechnology, it is clear that the field has not only grown significantly in the last few years, but it will also continue to expand in the future. Indeed, science is rapidly realizing what was once only science fiction.



DNA PRINTING PRESS

:: LoriAnne Jones ::

In the 1450s Johann Gutenberg reinvented the printing press in the West. With the advent of moveable type came a great shift in the transfer of information across the world. Today at Massachusetts Institute of Technology, scientists hope that they have developed a new printing press that can have the same wide reaching effects for the medical world.

Developed at Massachusetts Institute of Technology and Virginia Commonwealth University, researchers call the new technique Supramolecular Nano-Stamping (SuNS). This printing method allows DNA strands to gather on a surface. The result, as described by team leader Professor Francisco Stellacci, is "an information-rich pattern" of DNA sequences. The team hopes that with advances in nanostamping technology someone could go for a DNA test, just as simply as one can take a blood test now.

To make a print, a scientist begins with a template surface filled with singled DNA strands of known sequences. Specially engineered ends attach these strands to the surface. The template is then dipped in a DNA rich solution. The process of molecular recognition allows for the complemetary DNA strands to spontaneously assemble into double helixes. A second surface is attached and the DNA strands are heated to 105 degrees to separate them without causing damage. From there the scientist can use the master print to make copy upon copy.

Before nanostamping the only way to represent DNA sequences was to use DNA microarray chips. The dots produced on microarray chips represented a patient's genetic code and could be used to predict diabetes or cancer early on or even to determine a couple's potential for having a children with genetic disease.

Even though the technology has obvious advances, microarrays require more than 400 printing steps and can cost upwards of $500 for each test. With supermolecular nanostamping researchers may indeed have a more viable and affordable printing press. It requires only three printing steps; and with a cost as little as $50, this new process could become very commonplace in medical applications.

Aside from detecting diseases that are known to be genetic, research conducted with nanostamping could help scientists learn what other conditions have genetic causes. This process may be used to print other things such as proteins, antibodies and viruses to make them available for further study.

HAND LANGUAGE

:: Christian Howell ::

PROJECT :: HANDSHAPE RECOGNITION SYSTEM

INSTITUTION :: NEW JERSEY INSTITUTE OF TECHNOLOGY

LOCATION :: NEWARK, NEW JERSEY.

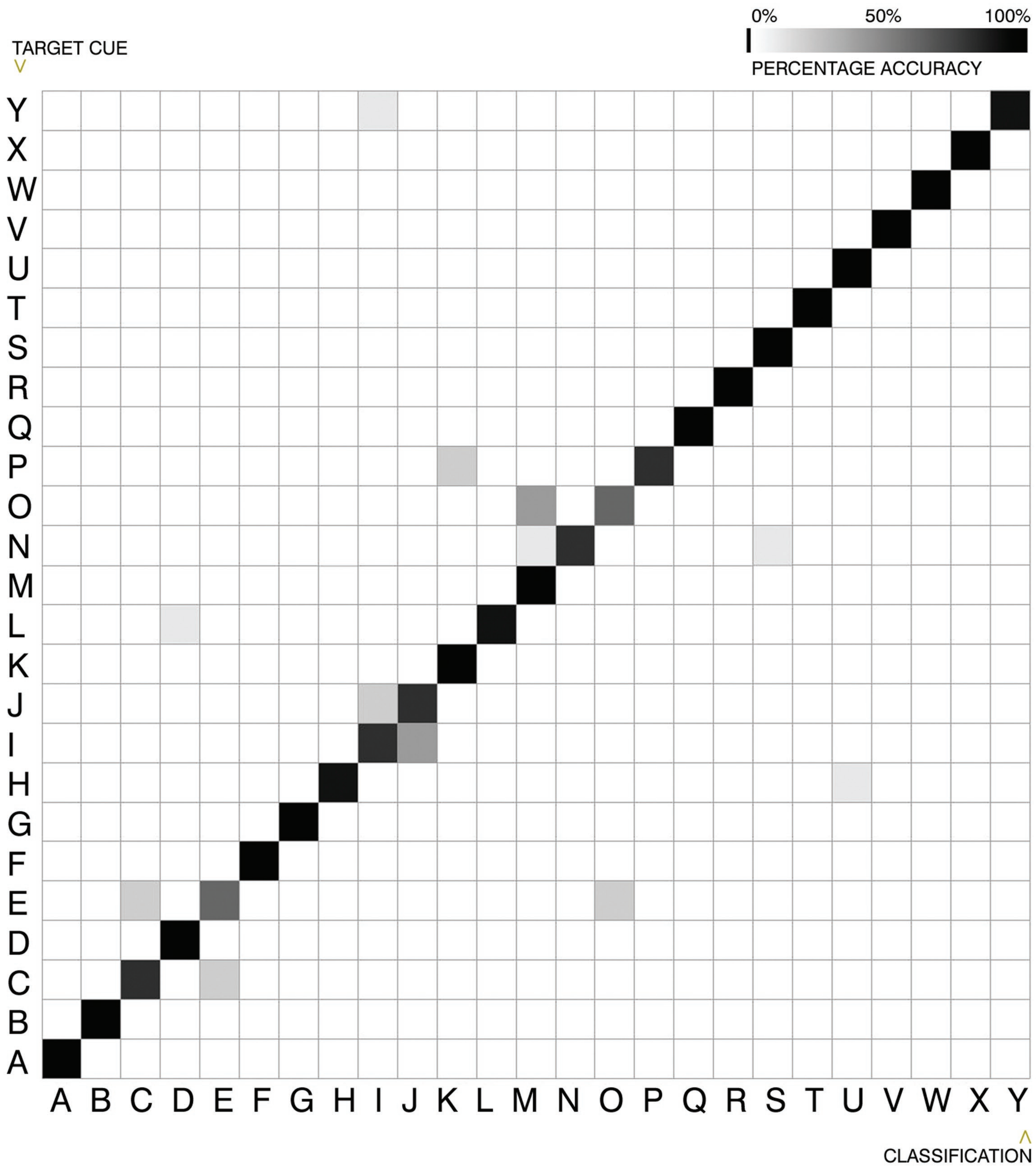
FACULTY ADVISOR :: DR. RICHARD FOULDS, ECE DEPARTMENT

TEAM MEMBERS :: BRAD GALEGO, BSCoE BSHCI, 2005 [HONORS GRADUATE]
JOSEPH LALLO, BSCoE, 2005 [HONORS GRADUATE]
MICHELLE PAULTER, BSCoE, 2005
ROHAN SHINDE, BSCoE, 2005 [HONORS GRADUATE]
SARAH KELSALL, BSPhysics [Bryn Mawr College], 2005

PURPOSE :: TO DESIGN A DEVICE CAPABLE OF DETECTING, RECORDING AND TRANSLATING THE AMERICAN SIGN LANGUAGE INTO A DIGITAL FORMAT WITH THE ULTIMATE GOAL OF A PERSONAL, EFFICIENT MEANS OF DIGITAL SIGN LANGUAGE HANDSHAPE RECOGNITION SYSTEM.

THIS DEVICE IS INTENDED TO BE WEARABLE.
THIS DEVICE IS INTENDED TO BE PERSONAL.

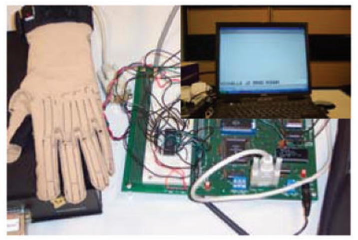
Miscommunication has often been the biggest barrier to progress. Most often this obstacle expresses itself in the form of a language barrier. The nature of this language barrier is not always a spoken one, French to German, or Mandarin to English. There is an even greater language barrier for blind, hearing impaired and other handicapped individuals. While forms of communication for these communities exist and are as effective as the spoken word, their ability to communicate from one community to another across the language barrier has always been limited. It is very easy for a sign language user to communicate with another common user, but for the same person to communicate to a non- user can be frustrating to say the least. However, new technologies are beginning to bridge this gap and bring once separated communities together in a common form of communication.



One of the most exciting potential technologies is a system capable of recognizing American Sign Language words and characters through the interface of a sophisticated glove worn by a user; and decoding that content into a digital format where it can easily transfer into a digital spoken or written form. The possibilities for communication progress from this research are numerous, especially for the hearing impaired community. With the simple non-invasive technology of the glove, a user can potentially perform an ASL (American Sign Language) character or gesture and have it translate digitally to a spoken representation. This technology could give the hearing impaired a spoken voice.

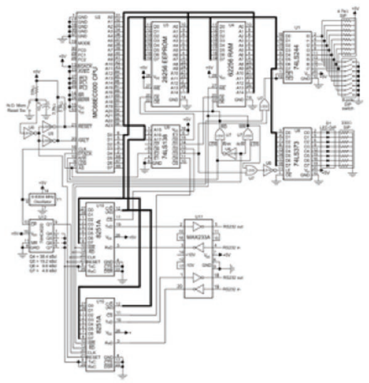
There are several research and product developments initiatives for this "Handshape Recognition" Technology. Most of these are focused on robustness and efficiency, with very little thought for the feasibility and ease of use for the wearer. In most of these initiatives the user would only be able to utilize the technological glove in one space equipped with the necessary computer processing stations. Further, the glove itself is often bulky and unwieldy. A research initiative at New Jersey Institute of Technology in Newark, NJ began to address some of these issues and limitations to Handshape Recognition Technology.

In the fall of 2004, four Electrical and Computer Engineering students under their advisor, Dr. Richard Foulds; began their senior project to develop an ASL Translation System. The goal of the project was to develop a "wearable, personal" glove that used as little computing power and simple algorithms to reliably recognize ASL gestures. If a minimum of computing power is needed to compute a simple algorithm then the power saved could be applied and improve the performance and capabilities of other parts of the system. The project also limited equipment to a Motorola 6800 single board computer and sensory glove with 11 sensors. All of these moves to reduce redundancy and excess within the system led to an incredibly efficient simplified system capable of accurately reading ASL movements to a percentage of over 90%. While the system may not be as robust as some larger systems, it's clear that the simplified equipment, algorithm and glove are far more wearable than other bulkier systems in development. It is feasible that with advances in Bluetooth and other wireless communication technologies, the sensory glove could one day soon be modified into a portable system worn by a user.



ASL Translation Systems

Single Board Computer (SBC) Schematic



Abstract

Gesture-based communication systems, such as American Sign Language (ASL) provide an interface through which the hearing-impaired can interact with the world at large. Using the Single Board Computer, with the Motorola 68EC000, we have created a device that receives input from a sensory glove, interprets the user's hand position, and outputs the letter the user is fingerspelling. By constructing such a system, we intend to demonstrate the feasibility and capabilities of a small (potentially wearable) device that can interpret the ASL alphabet through hand shape recognition.

American Sign Language (ASL) is a linguistically complete, visual-spatial language facilitating communication for the hearing impaired.
Signs in this complex language can be classified by five major parameters ([1]):
-Hand shape
-Orientation
-Movement
-Location
-Non-manuals

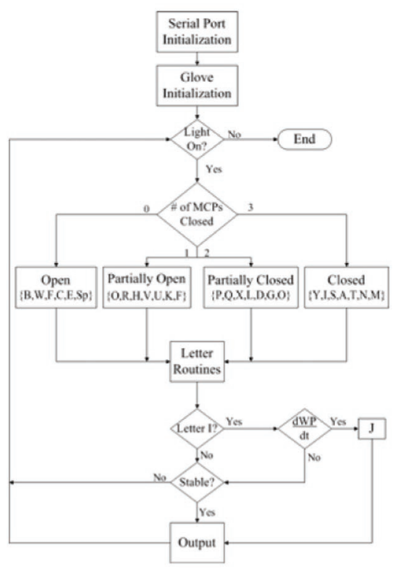
Using a sensory glove it is possible to obtain information on hand shape, orientation, and movement that is localized to the hand.
Using this information, the signs which comprise the ASL alphabet can be identified and translated by our system.

System Characteristics

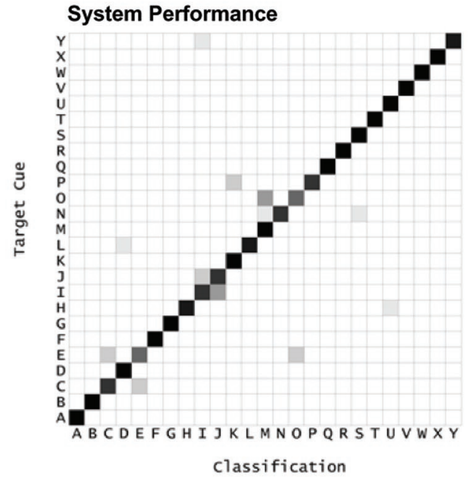
System Clock Speed:	9.8 MHz
Serial Transfer Rate:	38.4 KBd
Mean Sampling Rate:	45 Hz
Stability Interval:	1.08 s

Sensors

1. Thumb Rotation
2. Thumb Abduction
3. Index Metacarpophalangeal
4. Index Proximal Interphalangeal
5. Middle Metacarpophalangeal
6. Middle Proximal Interphalangeal
7. Index-Middle Abduction
8. Ring Metacarpophalangeal
9. Little Proximal Interphalangeal
10. Wrist Pitch
11. Wrist Yaw



System Performance



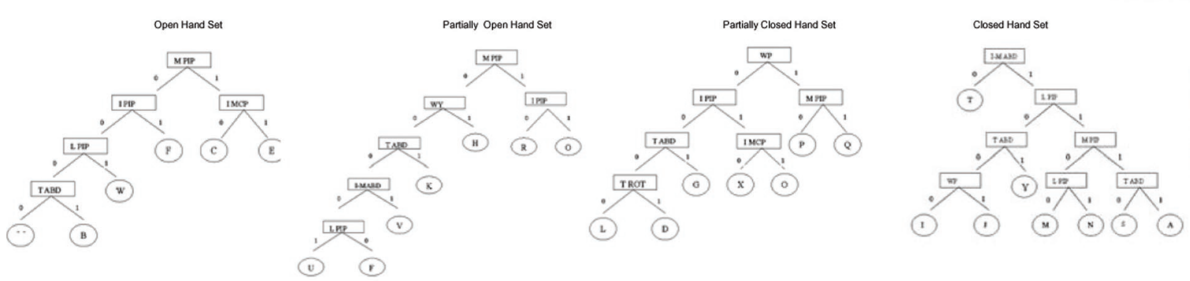
Local accuracies of 100% were achievable using calibrations specific the individual user. Globally, accuracy was approximately 92%.

Algorithm

The hand shape is classified into one of four possible subsets based on the number of MCP joints which are closed. These represent gross hand positions. Once the program enters one of the four subset routines, it performs a series of binary compares (using pre-determined calibration values) to discriminate between letters in that subset. These discriminates were chosen to provide maximum accuracy and be phonetically significant. The system must decide upon the same hand shape for an interval of 1.08 seconds before the appropriate letter is output.
An exception is the letter "J," which contains internal movement. The system classifies the letter first as "I", then checks to determine if the wrist is moving (pitching). If this wrist pitch exceeds threshold, the letter "J" is output.

Conclusion

We have demonstrated that recognizing dynamic handshapes at accuracies over 90% is possible using minimal computing power. Future applications can use this in a more comprehensive system covering all parameters of ASL. This can then be coupled with a further layer of abstraction capable of applying ASL lexicon and performing full sign translation.



References

[1] J.M. Allen and R. Foulds. "An Approach to Animating Sign Language: A Spoken English to Sign English Translator System," in *Bioengineering Conference, 2004. Proceedings of the IEEE 30th Annual Northeast* pp. 43-44, April 2004.

[2] "The μProcessor Project" Available at web.njit.edu/~rosensta/classes/architecture/252software/suppnote.pdf pp. 41

Perhaps most striking about this version of the Handshape Recognition Technology is its ability to be personalized to the individual user. Like handwriting, a user's use of ASL hand gestures is highly personal and unique. The sensors within the glove can be adjusted to compensate and read these unique qualities and achieve a 100% accuracy rate of ASL shape recognition. ASL is a complete natural language. Thus, like any language there are a series of rules and idiosyncratic characteristics that must be first understood then deciphered in order to ensure an error-proof Handshape Recoginition system. For instance, during research it was found that the letter J possessed an internal movement. The sensors did not sense this movement and instead read the J as an I. This problem was easily resolved by adjusting the sensors to read the initial I reading, then to check for any inflections

According to one of the students working on the project, Brad Gallego, an Albert Dorman Honors College student and NJIT graduate with a BSCoE and BSHCI; the process by which the project's Handshape Recognition system identifies and decodes ASL hand gestures to digital information is not unlike the biological systems in the human body. "For instance, the visual system distributes signal processing across the entire system – indeed, at the second level of processing (bipolar and ganglion cells) the signal is already being filtered and shaped for transmission along the optic nerve (which, itself, does more than just transmit information). Thus, we enjoy the idea of smaller, 'dumber' systems placed closer to the site of transduction, distributing the signal processing, and the computation complexity across the system." Mr. Gallego also goes on to conjecture that using synthetic versions modeled on these natural systems is the only way to achieve a reliable, wearable ASL Handshape Recognition Technology.

DOCUMENT :: FURTHER INFORMATION

Handshape Recognition Systems.
All Information courtesy of Brad Galego and the H.R.S. Research Team.

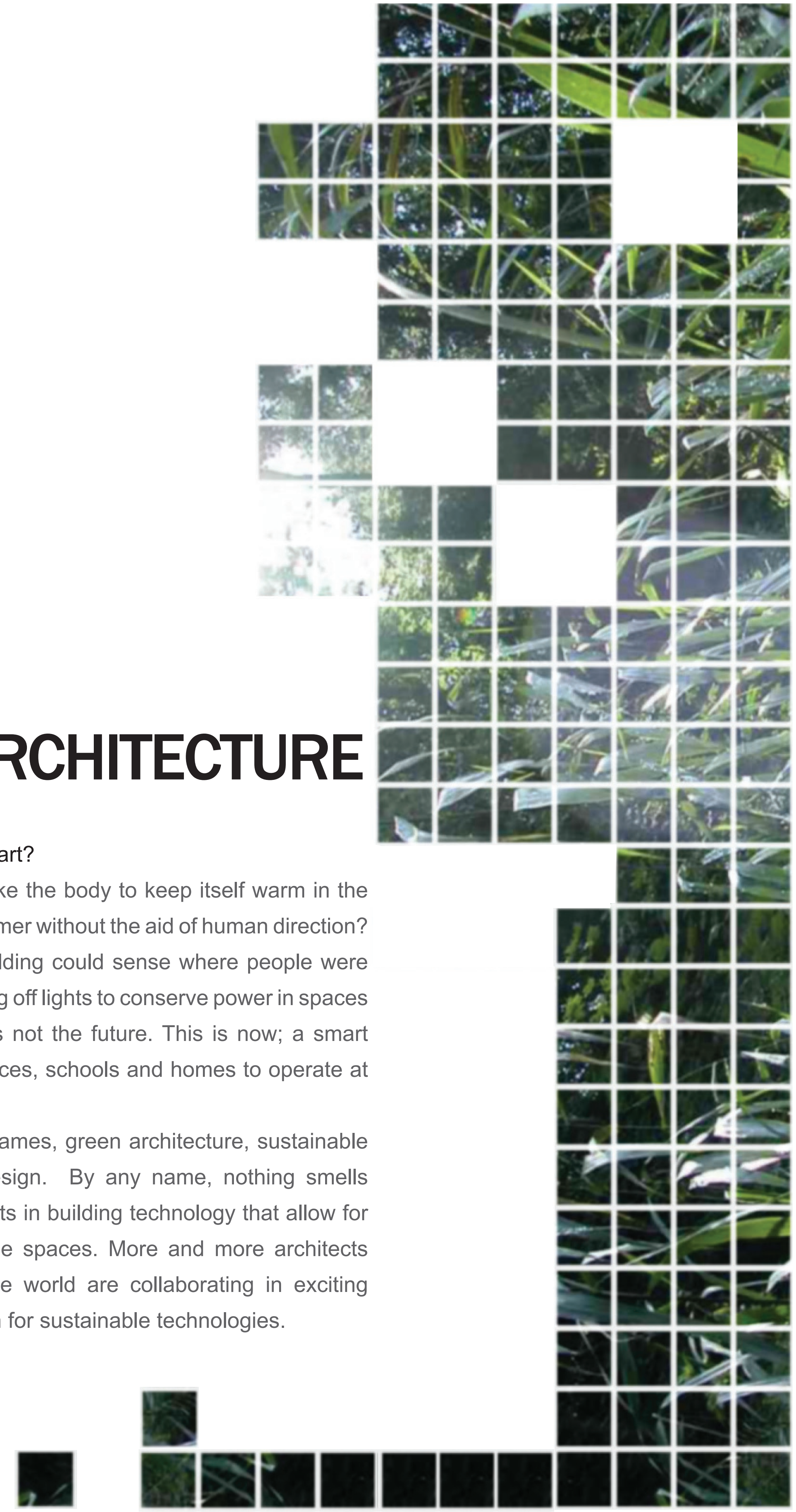
This project was presented at Senior Project day, Spring 2005; NJIT.
It placed as a Bronze Award Winner.

A presentation was also given to Honors College Board of Visitors.
The *Inertial Position System Project* was presented to the 2005 BioMEMs summer program.

ONLINE INFORMATION IS AVAILABLE AT >
http://ece.njit.edu/academics/undergraduate/seniorprojects/winners_s05.php

GREEN ARCHITECTURE

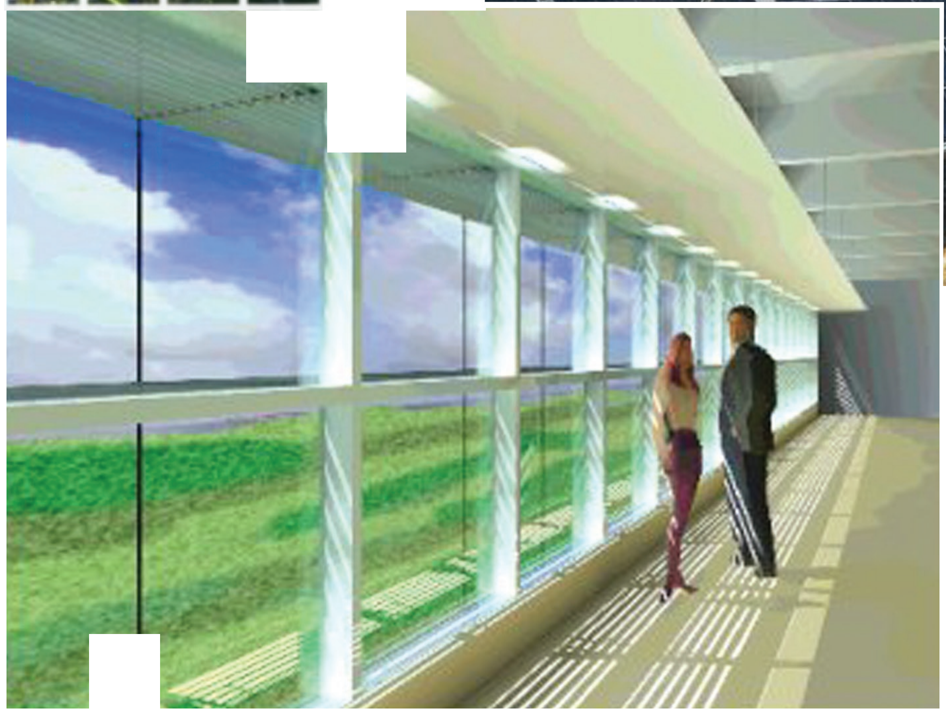
:: LORIANNE JONES ::



What if buildings were smart?

What if a building knew like the body to keep itself warm in the winter and cool in the summer without the aid of human direction? Imagine now that this building could sense where people were inside it, dimming or turning off lights to conserve power in spaces that were vacant. This is not the future. This is now; a smart design that allows our offices, schools and homes to operate at their peak performance.

It goes by many names, green architecture, sustainable design or even smart design. By any name, nothing smells sweeter than developments in building technology that allow for more efficient, comfortable spaces. More and more architects and engineers around the world are collaborating in exciting ways to create and design for sustainable technologies.



From Left to Right.
Rendering of Light Shelf designed for BC Gas Operations Center; Surrey, BC.

Solar Panels on Green Roof

Opposite Page.
Photograph of the Green Roof of the Vancouver Public Library, British Columbia.

There are many systems that can be incorporated into a building's design to give a high-performance edge. Some of these technologies allow buildings to minimize their strain on city power grids. The most widely known form of green building is solar panels. These photovoltaic cells harness the energy from the sun. They can either be affixed to buildings on facades that receive the most daily sun. Or they can be placed on roof tops where they have the freedom to rotate and follow the sun's angles throughout the day. This not only maximizes energy gains but helps to reduce the building's dependence on city power.

Often hidden away on building roof tops are green roofs. They too help lessen a building's impact on city infrastructure by lessening the amount of rainwater that must be deposited into city sewers. They are categorized as either extensive, semi-intensive or intensive depending on their soil depth. They serve not only to manage storm water runoff from a building but they are an added amenity for building occupants. As an added benefit they help to insulate the building, reducing heating costs. Within high density areas they also create a much needed natural environment for wildlife and add more oxygen to the air.

Other technological advances may only be skin deep, starting at the building's perimeter, yet they bring powerful benefits to the building at large. Instead of double pane windows, high performance insulating glass can be used. It draws in daylight yet controls heat gain. A typical configuration of a high performance window calls for three layers of glass: an outer layer of tinted glass and two layers of clear glass with low emission film. The gaps between are filled with argon gas. The overall window glazing amounts to a larger cost than double pane insulated glass yet the savings in heating more than make up for it. A building with high-performance windows does not need to have perimeter heating.

Climate walls provide buildings with double skins. A waterproofed exterior layer is paired with an inner layer to create a circulation system between them. This circulation cavity improves energy efficiency because it reduces the strain on normal mechanical systems. Computers control vents at the outer layer of the curtain wall. Hot air can be selectively vented out to cool buildings in the summer. In winter months these vents stay closed to allow the sun to warm the circulating cavity air during the day. Fans can circulate this warmth across the façade, minimizing the need for mechanical heating. Mechanized shading devices can also be installed insides the double glazing.

Light shelves and mechanized shades can be employed on facades to further reduce heat gains at building perimeters. Shelves can be used to direct light to ceilings with reflective ceiling tiles, allowing light to bounce and penetrate deeper into interior spaces. Above the selves louvers can be used to control varying sun angles. These areas often have clear untreated glass to allow the most daylight to enter. Below the shelves, mechanized translucent shades filter light. Here treated glass with low emissions coatings are in place.

When it comes to electric lights, lighting systems can be connected to sensors. Dimming systems allow rooms to adjust their lighting levels as the sun's movement affects the availability of natural light. Occupancy sensors turn lights on or off as needed by the presence of people.

Employing sustainable strategies like these early on in a project's design phase makes for a not only more efficient buildings but also better architectural spaces for building inhabitants.

ENVIRONMENTAL ARCHITECTURE

:: CHRISTOPHER SABATELLI ::

The design principles of "Green Architecture," once discussed as a European concern or an eco-friendly corporate marketing tool, are beginning to break into the mainstream of American architecture. While there are many award winning architects now beginning to incorporate green design into their buildings, (Sir Norman Foster for example), William McDonough is perhaps not only one of the most progressive but experienced architects in the field.

Twenty-five years after establishing his initial architectural firm, William McDonough + Partners is now a world-class group, designing at multiple scales- from major corporate headquarters to the comprehensive design of entire Chinese cities. McDonough has made healthy, "green" building practices the priority of his firm since his first major commission brought the concern of hazardous chemicals used in building materials to public attention. Now, he is dedicated to assuring that his designs are not only sustainable, but that they also incorporate green roofs and make as small of a long-term environmental impact as possible; sometimes referred to as a zero footprint architecture.

His dedication to green design has paid off. Now even clients who could once be considered major environmental offenders are recruiting 'Green Architects' in their design projects.

One current McDonough project is the construction of a new Ford assembly plant. [pictured below] This new plant will incorporate the largest continuous green roof in the world. It is quite a sign of the change in public opinion when a high profile car company such as Ford considers green design principles a major concern in the construction of a new assembly plant.

Mr. McDonough has advanced his design qualifications beyond even those of the industry standard, LEED Certification. Through a certification process more sophisticated and extensive than LEED, he puts his unofficial seal of approval on companies and manufacturers in recognition of their compliance with approved methods and traditions.

Perhaps, McDonough's most lasting legacy in architecture will be his ability to adeptly share his design principles with the architectural design community, including both working professionals and students.

Cradle to Cradle, co-written by McDonough with Michael Braungart in 2002, clearly and succinctly lays out these principles for safe environmentally conscious architectural and manufacturing design for all to follow. In *Cradle to Cradle*, McDonough pays particular concern to the great need for the awareness of the promotion of eco-friendly architecture and manufacturing on a global scale. McDonough believes that we are currently living in a time of environmental crisis, and immediate action must be taken to alleviate these concerns.

William McDonough and his design partner lecture frequently on the topic of Architecture and its environmental impacts. Mr. McDonough himself appeared at New Jersey School of Architecture at NJIT in 2005 for a well-attended, highly anticipated talk. Here he shared the most recent examples of his design principles manifest in his firm's most recent projects.

More information on the design principles of Environmental Architecture and William McDonough can be found in *Cradle to Cradle*, or online at ::
www.mcdonoughpartners.com.

PLANET ?

:: Christian Howell ::

Ask any child of elementary-school age to name the planets in our solar system; you might not be surprised by their answers. The order might be a little less than accurate, but you would be quite surprised to hear anything but the following; Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. Ask the same question of Dr. Neil DeGrasse Tyson, the Director of the Hayden Planetarium of the Rose Institute in New York City, one of the most respected planetariums worldwide; and you might be surprised that he will only name eight. The last excluded planet, Pluto, has never been a favorite. It's impossible to see with the naked eye and even difficult to glimpse with even the most sophisticated modern telescope. In 1977 when launching the Voyager II deep space probe, NASA was given the choice between a glimpse of Pluto or of the moons of Saturn, NASA chose Saturn. It's clear that our most distant planet has never been able to capture our imaginations like the rings of Saturn or the mysterious red glow of Mars, but why Dr. Tyson believes so strongly in Pluto's exclusion may surprise you.

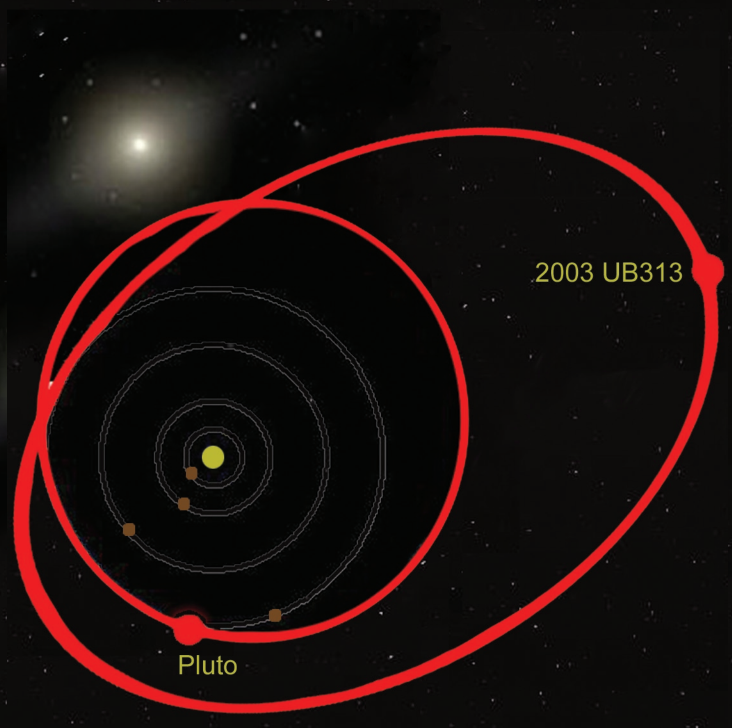
Dr. Tyson is just one voice among a growing constituency in the academic astronomical world who believes that Pluto is little more than an oversized asteroid caught in the far reaches of our Sun's second asteroid belt, the Kuiper Belt. He and other leading academics at the Planetarium believe in this classification so strongly that they have removed all traces of Pluto's name and likeness from all lists of planets in the museum's exhibits. Granted this scientific classification could still be considered a minority in the much larger astronomical community; it is a fast growing one. Perhaps most alarming is not the potential loss of another "planet" in our childhood textbooks, but that this new classification system challenges the relevance of rather antique scientific classification invented in the 18th century at the advent of modern science. Do terms derived in times of lesser technologies and knowledge still apply and define the ever expanding boundaries and classifications of modern science?

Great discoveries in astronomy have always exactly paralleled the advancement of new more sophisticated astronomical observation technology.

Galileo's revolutionary techniques and advances with the primitive telescope in the 17th century, allowed man to see further into the night sky. With this technology came the discovery of Jupiter's many moons. As science progressed, even more planets and moons joined the Jovian giant's ranks. In 1930 when Clyde Tombaugh of the Lowell Observatory announced the discovery of the ninth planet Pluto, which slugged about the sun at a distance previously unimaginable, the discovery piggy backed along the new advancements of telemetry and optical devices developed in the First World War.

When NASA launched the Hubble Space Telescope in 1990, the scienctific world predicted that its launch would spark an explosion of astronomical discovery. Hubble used ground breaking advances and research in angular resolution and optic lenses to extend the field of vision beyond that of earthbound telescopes. As the images of distant galaxies, stars and would-be planets, once only blips on an electromagnetic light chart, spread across news screens world wide; science was validated. Since Hubble's launch, even more sophisticated astronomical equipment has been launched into orbit to observe the night sky above. With every new technology and subsequent machined advancement, the field of astronomy adds one if not hundreds of previously unknown terrestrial bodies to its growing list of trans, hyper and meta solar objects; many of these potential new 'plnets' bear shocking similarities to Pluto.

Still science marches heaven ward. New telescopes with 145th times the power of Hubble make their short lived ancestor appear as clunky and arcane as the room sized computer aboard the Apollo spacecrafts; which possessed little more than the processing capacity of a modern calculator. In fact , within the time it takes you to finish reading this article there will be no fewer than 5 new objects discovered deep in space.



Many believed that the discovery of Pluto in 1930 finalized the list of major solar planets. Yet, on June 29, 2005, Dr. Brown, the head of a research team at the Palomar Observatory of the California Institute of Technology, announced the discovery of 2003 UB313. UB313 lies beyond Pluto's orbit in the distant Kuiper Belt, a belt of solar debris, asteroids and minor planets at the limits of the suns gravitational pull.

Dr. Brown has amusingly titled this would be planet Xena, in reference to the theory of Planet X. While UB313's diminutive size proves that it is not Planet X, it is still significantly larger than Pluto with a diameter around 3000km as compared to Pluto's 2306km. However, 2003 UB313's discovery is far from unique. Two other TNO (Trans Neptunian Objects) were discovered on the same day of 'Xena's' announcement. UB 313's only distinguishing factor is its size. The media immediately took to calling UB313 the tenth planet. This leads to the obvious question; is the term planet still applicable to modern science if it's only qualification is the fulfillment of a size requirement?
Dr. Brown himself believes that his new discovery should not be considered a planet in the traditional scientific sense. His view concurs with that of Dr. Tyson of the Rose Planetarium. Both men feel that the only factor for classifying Pluto and her new Kuiper Belt sister UB 313 is location. Dr. Tyson speculates if UB313, and Pluto for that matter, had been located within the inner Asteroid Belt it would exhibit behavior much like a comet; melting its methane surface into a tail as it chased around the sun. Imagine if Mars had streaked a tail of red dust into the ancient sky, it most certainly would have been labeled a comet by the first atronomers. Thus, just because UB 313 lies far enough outside of the sun's rays to avoid this meltdown, does not mean that it should be given the title of planet. In fact this meltdown is estimated to decrease the speculated diameter and mass of UB 313 by 4%. This may not seem extreme, but when one considers this loss on the scale of kilometers and kilograms, the results are startling.

So what's in a name? The International Astronomical Union, the international scientific body charged with the naming of all new scientifically accepted galaxies, stars, trans Neptunian objects and planets; has a rigorous set of qualifications which all must be met in order for a new planet to obtain the title 'planet.' If UB 313 is determined to be a 'planet,' it will receive a name of a figure of ancient Greek mythology as approved by the Committee on Small Bodies Nomenclature of the IAU. Mythological beings and tales hardly qualify as scientific. Futher still, it is quite a stretch to imagine a mythological being in a science fiction novel. Fantasy yes, Science Fiction no. Currently UB 313 has begun this long process, and Dr. Brown believes it will most likely ultimately remain stuck within "international committee limbo." He, along with much of the scientific community, has given up hope for full planetary status of UB 313 and has instead settled for the more accurate, yet far less glamorous designation of Trans Neptunian Object.

Should scientists continue to use antiquated names of Greek and Roman mythology to describe their increasingly sophisticated discoveries? Is the term planet still an applicable measure of astronomical identity? The answers are still not clear, but it appears that the scientific community is moving towards an acceptance of less media friendly terms such as Trans Neptunian Object, Scattered Disc Object and Plutino. The scientific bureaucracy of the IAU and it's complicated naming procedures further reinforces this trend. The frustration of Dr. Brown's new discovery's acquisition of a name is akin to the frustration of many French speakers with the Academie Francaise, the official preservator and defender of the French Language. While the Academie continues to deny the validity of contemporary terms like Internet, the word Internet has become common in many French conversations. While the IAU may continue to debate the logistics of qualifications, the greater scientific community has already moved on to the common acceptance of Trans Neptunian Object.

Perhaps even though the antiquated term planet may no longer possess valid modern scientific qualifications, it will always possess rich cultural implications. Future children will continue to learn the planets in grade school. While the numbers may grow or dwindle according to the scientific taste of the times, the word planet will always retain its ability to spark our imaginations and capture our imaginations.

BIOMIMETICS

:: LORIANNE JONES ::

You might not be aware of it, but it is a fast growing field of study with wide reaching applications for every aspect of daily life. It's called biomimietics and as its name implies it follows the simple principle of mimicking systems of biology and nature to advance manmade technology and even art.

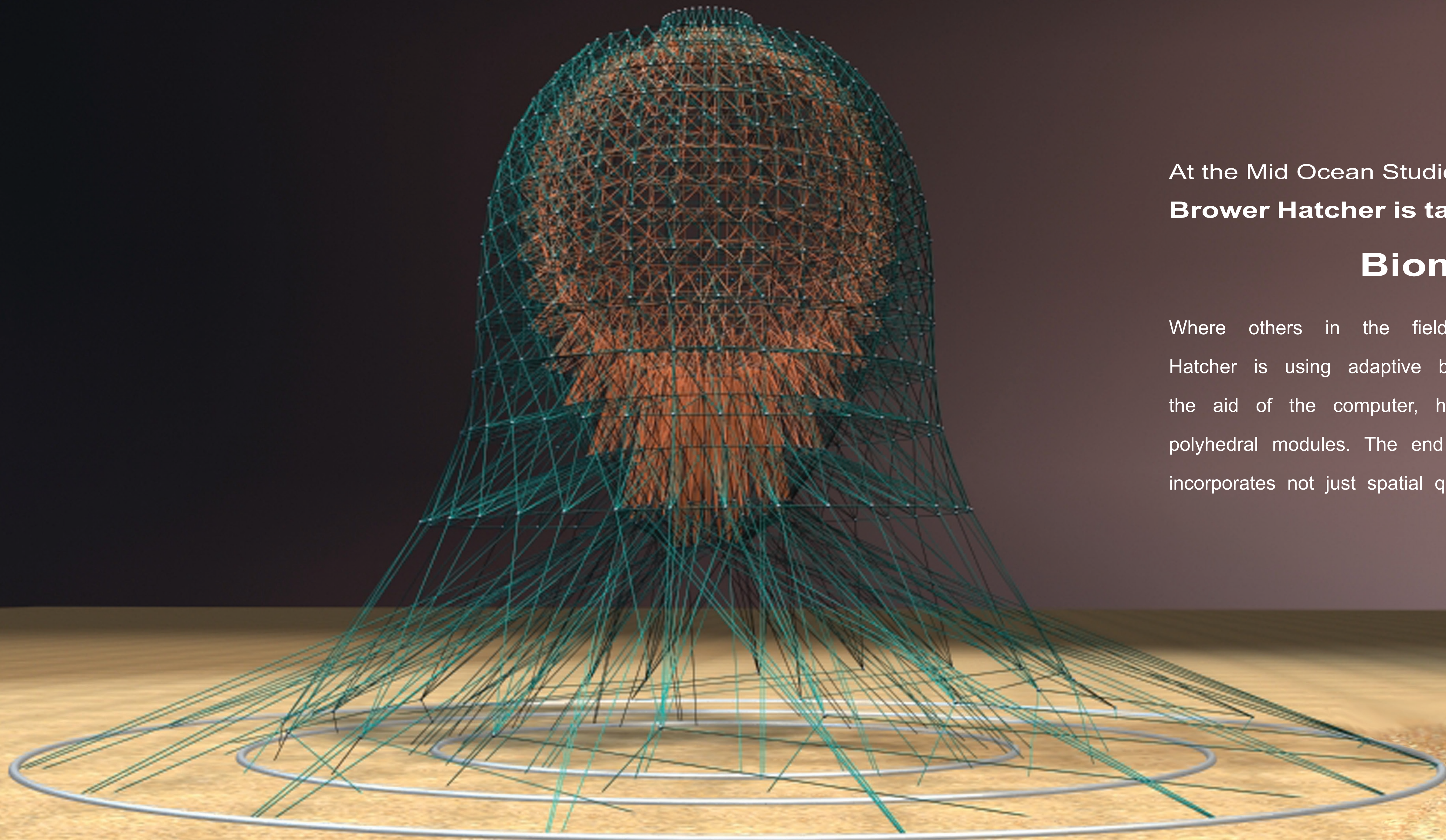
The use of nature as a template is hardly a new idea. The engineering principles of Da Vinci's flying machine drew on his studies of birds in flight. Swiss engineer George de Mestral picked up the idea for Velcro from nature. While cleaning his dog one day he noticed the way in which the hooks of burrs clung to his dog's coat.

So if the idea is not new why is biomimetics such a hot topic today? Well, the reason is that the technology of the time has only now advanced to the level that gives scientist the ability to begin mimic and learn from much of what Mother Nature has to teach us.

Julian Vincent, professor of biomimetics at the University of Bath in the United Kingdom estimates that "at present there is only a 10% overlap between biology and technology in terms of the mechanisms used. As part of the trend for new biomimetic concepts, Vincent and others developed what is termed "smart" clothing in 2004 at the Center for Biomimetics at the University of Bath.

Drawing on the behavior of pinecones, this smart fabric adjusts to properly condition the wearer's body temperature. On the outer layer, flaps 1/5000th of an inch wide cover the garment. When the person wearing the outfit gets too hot, the flaps open on their own to cool the body down. Once the person has cooled off, the flaps close themselves. All the while a second water proof layer keeps the rain out.

An advance like Vincent's only begins to touch on the vast possibilities. Just remember that when it comes to developing new science and technology "there are millions of years of research that can help us, in nature," Anja-Karina Pahl, professor at Bath University.



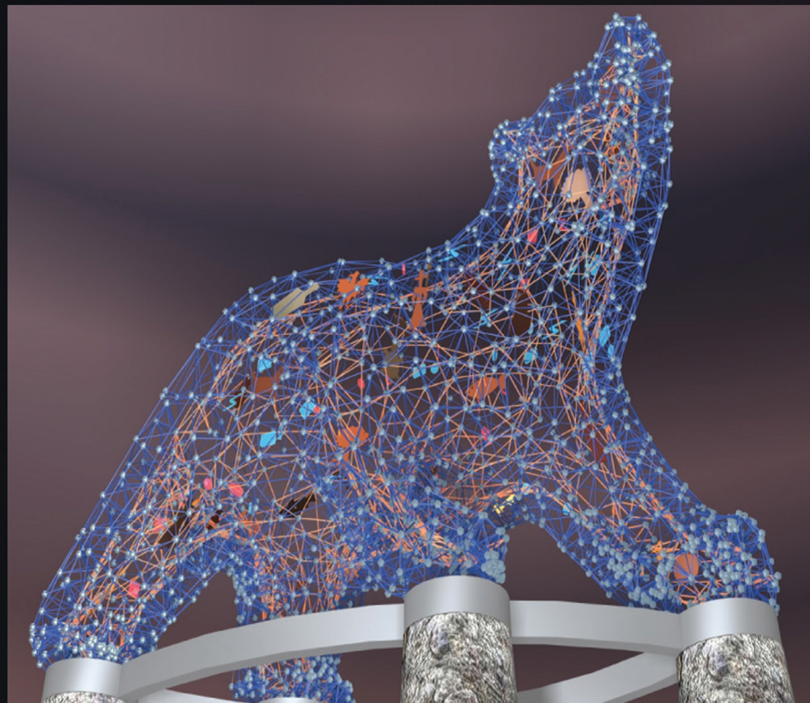
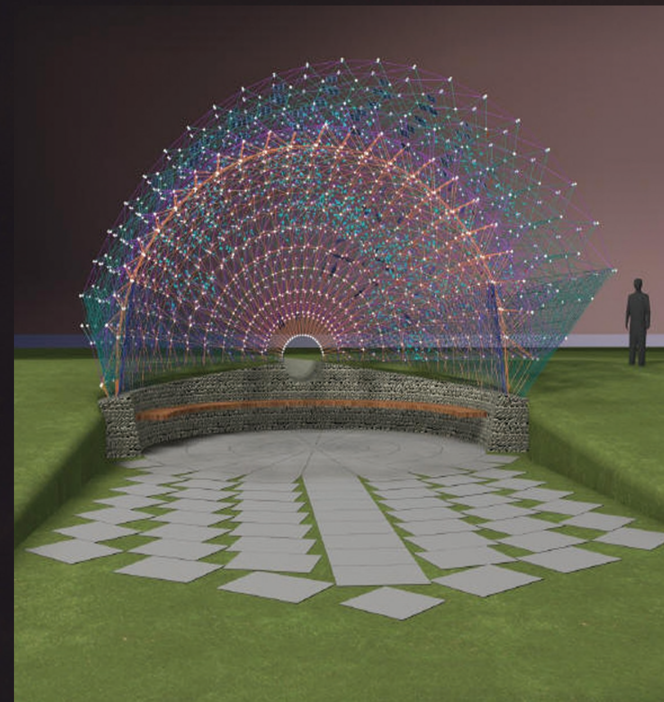
Art From Nature :: A look at the work of artist, Brower Hatcher

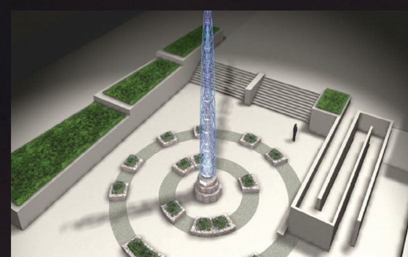
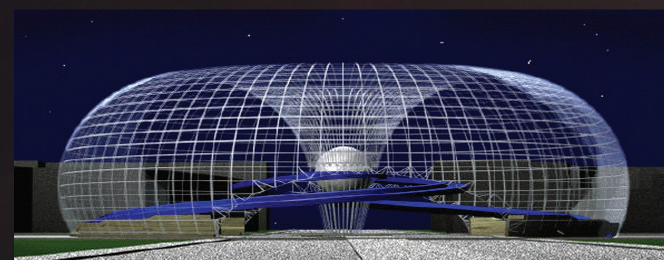
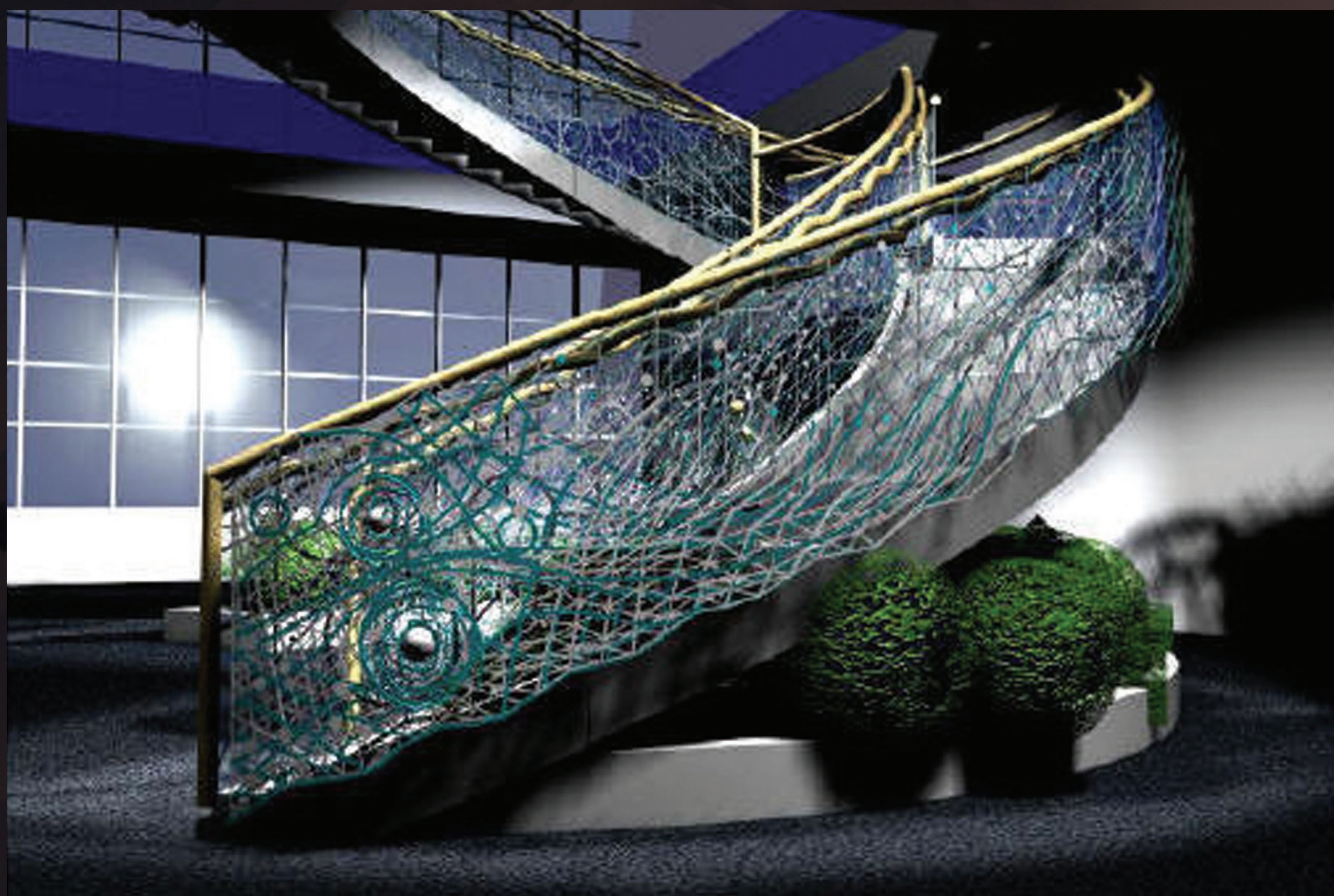
:: LORIANNE JONES ::

At the Mid Ocean Studio in Providence, Rhode Island;
Brower Hatcher is taking a unique approach to

Biomimetics.

Where others in the field are developing new technologies, Hatcher is using adaptive biomimetic design to create art. With the aid of the computer, his sculptures are realized with small polyhedral modules. The end product is site specific sculpture that incorporates not just spatial qualities but structural and organic form.

Brower Hatcher began his education in Engineering in Nashville and in Industrial Design at the Pratt Institute in New York. He later went on to study at St. Martin's School of Arts in London. Now, at Mid-Ocean studio, he leads a team of artists, designers, fabricators, and other technicians, creating sculptures of enormous scale. These designs usually tell a story or depict in metalwork a living object in nature, such as a tree.

Images :: Clockwise from Top Left.

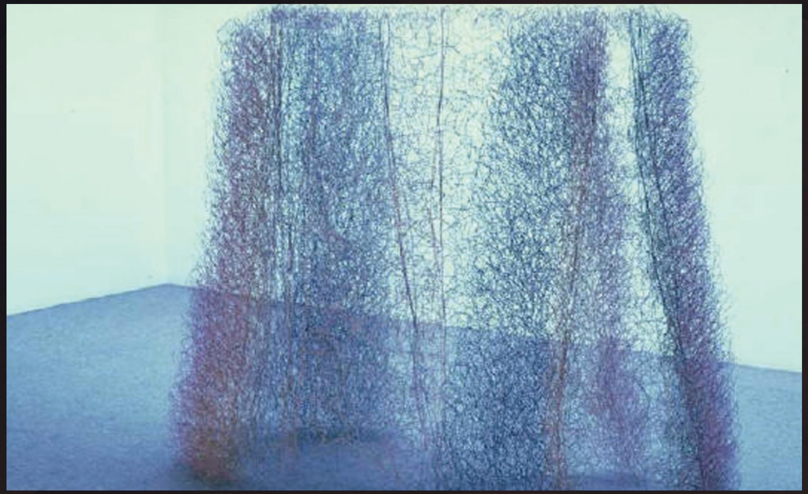
- Great Bear
  Kelowna, British Columbia.
- Spectacle Island
  Boston Harbour, MA.
- Origin [Tuscon Gateway Proposal]
  Tuscon, AZ.
- Staircase
  Santa Fe, NM.
- New Castle County Courthouse
  Wilmington, DE.
- New Castle County Courthouse
  Wilmington, DE.

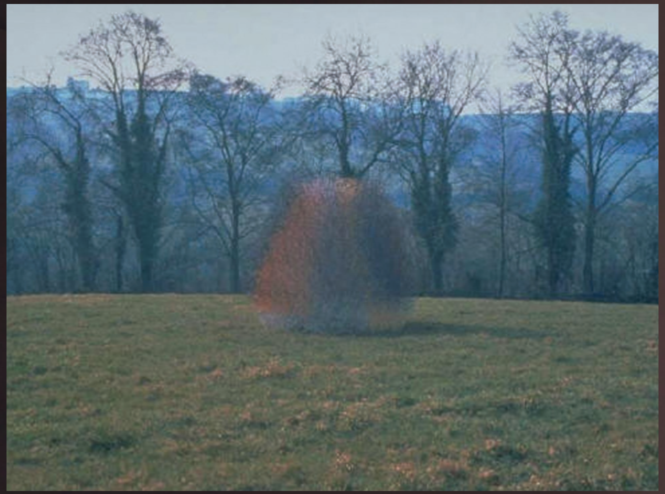

The artist in his studio.
Brower Hatcher at Mid Ocean Studio.

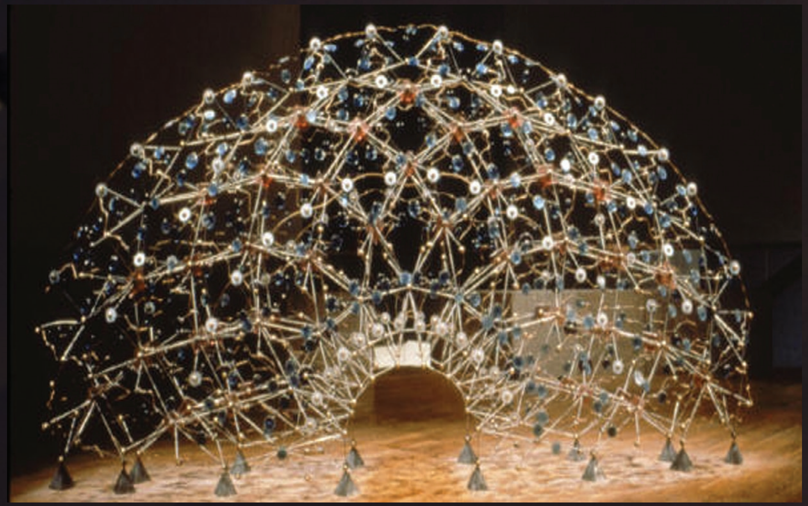
However, his work is not purely an artistic endeavor. The complexity of the designs calls for collaboration with computer scientists, mathematicians, and engineers. Hatcher's work is best defined as matrix based art. Natural forces such as weather, sunlight, geological change, and human activity inform and propel the design process.

In a computer program, wire frame tetrahedral algorithms are allowed to "grow" as a set of reactions on a model of the site. With the use of the software, geometric shapes "generate a force that influences the direction and growth of the new layers, much in the way that sunlight affects the growth of trees." This process generates a matrix representing the original natural elements.

One may wonder if the idea of "art" gets lost in these computer iterations and calculations. But remember that this is biomimetic design. The use of the computer is a necessity for auto generating the structural assemblies that create the sculpture. Fixed component sizes can be more easily worked into the design; thusly the studio team can create works of greater complexity than would be otherwise possible. And because the art form is auto generated from a set of site conditions, this process helps achieve the artist's ultimate dream of producing works that reflect and respond to the environment in which it resides.







The high level of complexity in Mid-Ocean Studio's work did not develop overnight. Like Hatcher's varied educational background, the studios work developed as a layering of different design intentions. His first works centered on the study of the three dimensional visual field, looking mainly at monolithic transparent color. Later the geometry and structure of the sculpture became of great interest and importantance, with a particular focus on the vertices and connections between geometries. A new period in his design began when the shear size of the projects required the use of computer aided design, engineering and mathematics. With these new concerns, the sculptures became more organic in form. The structure itself was viewed as an organism.

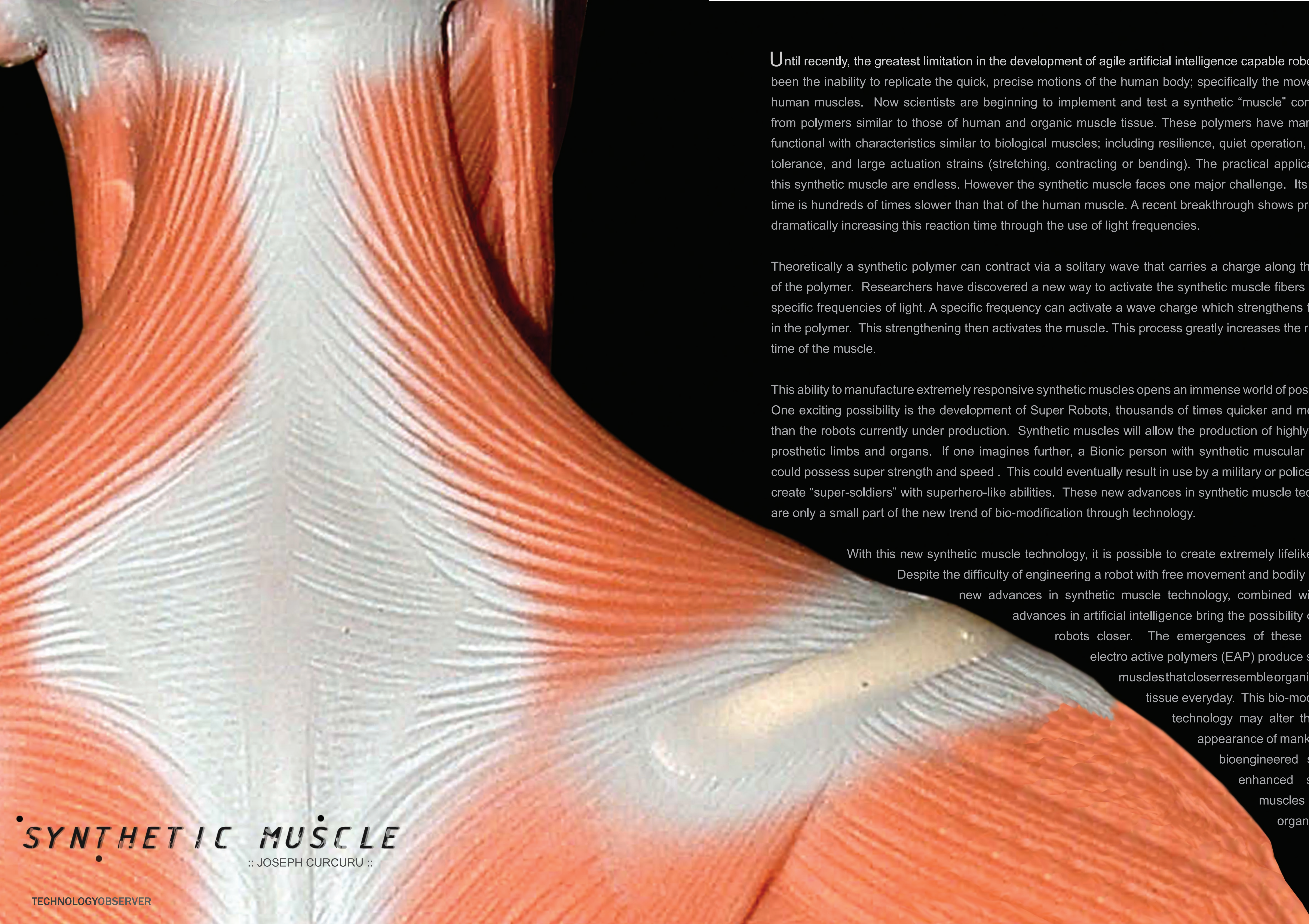
Images :: Clockwise from Top Left.

- Starman [detail]
  Wills Eye Hospital; Philadelphia, PA.
- Color Monolith #7
  United Kingdom
- Staircase
  Santa Fe, NM.
- Fan [Installation]
  Providence, RI
- Color Monolith #9
  United Kingdom

The artist in the field.
Brower Hatcher on site at "Passage."

During a career of more than thirty years, Brower Hatcher and Mid-Ocean studio have produced a number of significant works, many of which are located in prominent public spaces throughout the country. Major projects include the 32-foot standing figure, *The Principle of Justice* in the Municipal Courthouse of Roanoke, Virginia; *Starman in the Ancient Garden* in Philadelphia; *Prophecy of the Ancients* at the Walker Art Center in Minneapolis; and *Seer* at the Museum of Art at Brigham Young University, Provo, Utah.

More information on Brower Hatcher, his recent, current and past projects can be found at http://www.browerhatcher.com



SYNTHETIC MUSCLE

:: JOSEPH CURCURU ::

Until recently, the greatest limitation in the development of agile artificial intelligence capable robotics has been the inability to replicate the quick, precise motions of the human body; specifically the movement of human muscles. Now scientists are beginning to implement and test a synthetic "muscle" constructed from polymers similar to those of human and organic muscle tissue. These polymers have many of the functional with characteristics similar to biological muscles; including resilience, quiet operation, damage tolerance, and large actuation strains (stretching, contracting or bending). The practical applications of this synthetic muscle are endless. However the synthetic muscle faces one major challenge. Its reaction time is hundreds of times slower than that of the human muscle. A recent breakthrough shows promise of dramatically increasing this reaction time through the use of light frequencies.

Theoretically a synthetic polymer can contract via a solitary wave that carries a charge along the length of the polymer. Researchers have discovered a new way to activate the synthetic muscle fibers by using specific frequencies of light. A specific frequency can activate a wave charge which strengthens the bond in the polymer. This strengthening then activates the muscle. This process greatly increases the response time of the muscle.

This ability to manufacture extremely responsive synthetic muscles opens an immense world of possibilities. One exciting possibility is the development of Super Robots, thousands of times quicker and more agile than the robots currently under production. Synthetic muscles will allow the production of highly efficient prosthetic limbs and organs. If one imagines further, a Bionic person with synthetic muscular implants could possess super strength and speed . This could eventually result in use by a military or police force to create "super-soldiers" with superhero-like abilities. These new advances in synthetic muscle technology are only a small part of the new trend of bio-modification through technology.

With this new synthetic muscle technology, it is possible to create extremely lifelike robots. Despite the difficulty of engineering a robot with free movement and bodily motions; new advances in synthetic muscle technology, combined with other advances in artificial intelligence bring the possibility of lifelike robots closer. The emergences of these effective electro active polymers (EAP) produce synthetic muscles that closer resemble organic muscle tissue everyday. This bio-modification technology may alter the future appearance of mankind; with bioengineered strength, enhanced synthetic muscles and organs.

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x 35-36
Image collaged from representative anatomical figure.
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Cover, Front
[from top left to right]
Image of the Moon with Mars.
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Brower Hatcher Artwork, Mid-Ocean Studio Courtesy of Mid-Ocean Studio
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Image of Dolly the Cloned Sheep and offspring.
< http://www.biotechnologyonline.gov.au/human/cloninganimal.cfm
Closeup Image of movable typesets for printing press.
< http://www.yale.edu/yale300/democracy/may1text/may1text.html
Brower Hatcher Artwork, Mid-Ocean Studio Courtesy of Mid-Ocean Studio.
< http://www.browerhatcher.com
Image of a representative anatomical figure.
< http://www.texarkanacollege.edu/.../histology2.html
Microscopic Image of White Blood Cells.
< http://www.uiowa.edu/~cemrf/archive/sem/large
Nanotechnology Dendrimer, an Artist Rendering.
< http://www.autoweblog.de/50226711/bessere_atos_dank_nanotechnologie.php
Image of the Trump World Tower; New York, NY.
< http://www.wirednewyork.com/skyscrapers
Red Blood Cells
< http://www.angelfire.com/ca/x8/red_blood_cells.jpg
Artist Rendering of the Planet Earth.
< http://www.noirextreme.com/earth
Brower Hatcher Artwork, Mid-Ocean Studio Courtesy of Mid-Ocean Studio.
< http://www.browerhatcher.com
Image of the Moon with Sun.
< http://www.spitzer.caltech.edu/.../sig/sig05-018.shtml
Image of ASL Sign Language Gesture.
< http://www.uiowa.edu

Opening
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< www.nasa.gov
Image of the Lunar Rover on the Apollo 17 Mission.
< http://faculty.rmwc.edu/tmichalik/moon9.htm

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Image collaged from artist rendering of red blood cells.
< http://www.angelfire.com/ca/x8/red_blood_cells.jpg

Staff, A letter from our Advisor
All staff photographs taken by LoriAnne Jones and Christian Howell.
Image of Dr. Bloom courtesy of Dr. Bloom.

About NJIT and the Albert Dorman Honors College.
Image of the NJIT Campus Center courtesy of New Jersey Institute of Technology.

Pretext
x 01-02
x quote
< http://www.brainyquote.com/quotes/quotes/o/orvillewri140739.html
Wright Brothers "Flying Machine."
< http://www.au.af.mil/au/afhra/wwwroot/photo_galleries/early_wright_brothers_flying_machines/TOC/photos1902_1913.htm
Image of the Concorde during takeoff.
< http://www.home.arcor.de/hfvogt/aircraft.html

End
Artist rendering of a molecule.
< http://depts.washington.edu/drrpt/2003/stories/

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

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

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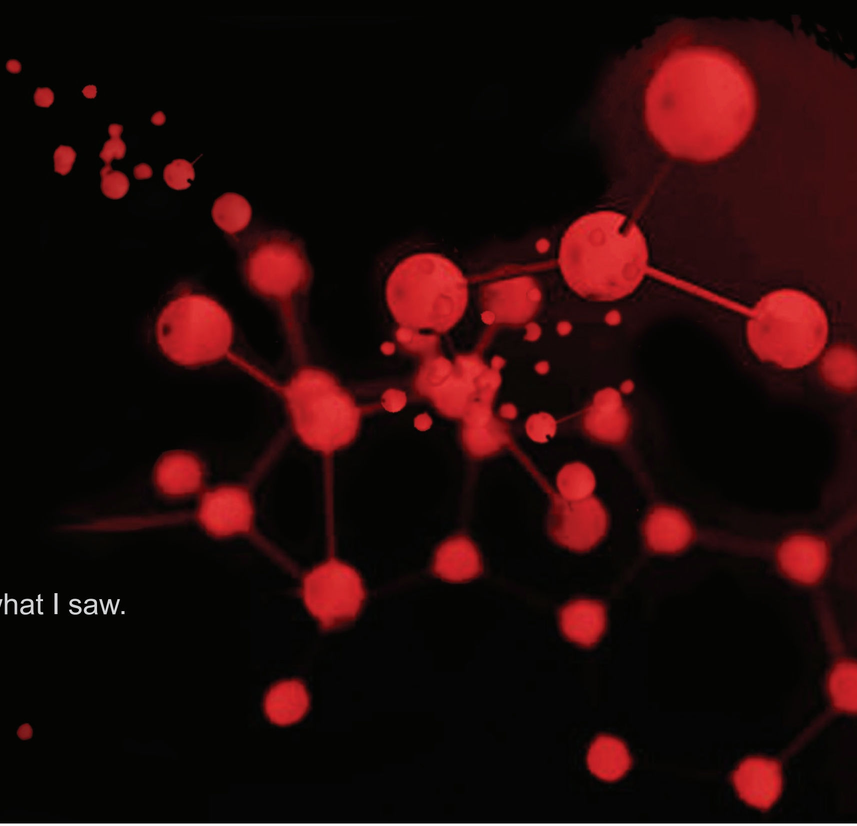
I have not told half of what I saw.

~ Marco Polo ~

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