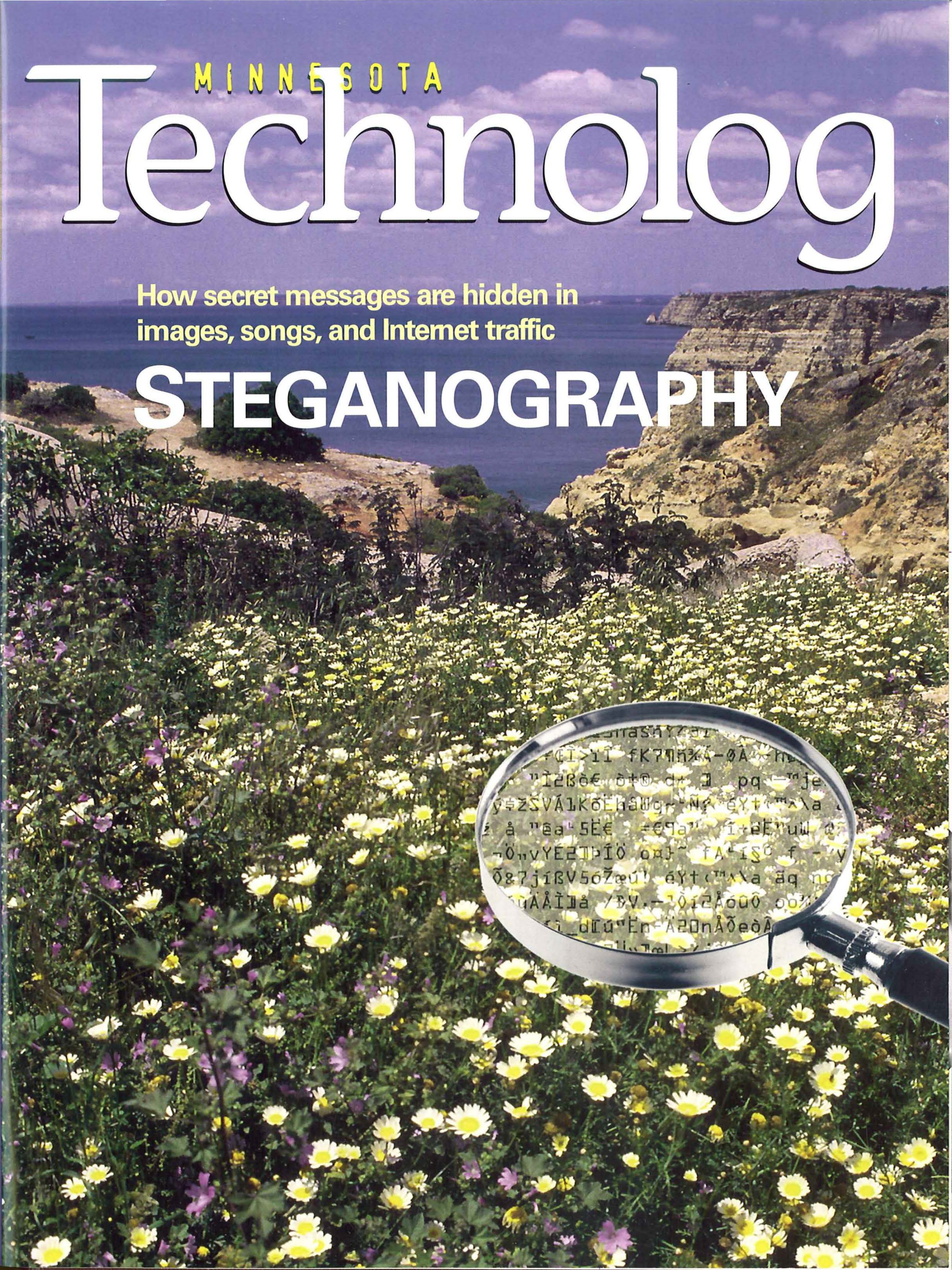
MINNESOTA Technolog



How secret messages are hidden in images, songs, and Internet traffic

STEGANOGRAPHY

MINNESOTA
Technolog

FALL 2004

COVER STORY

FEATURES

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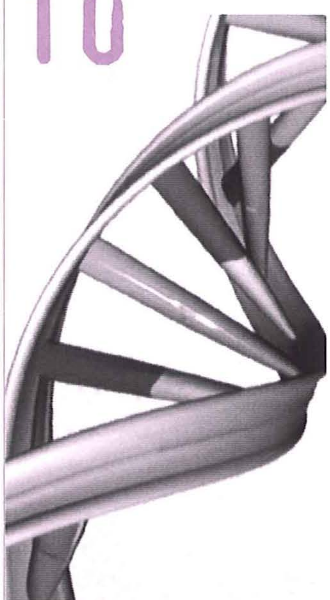

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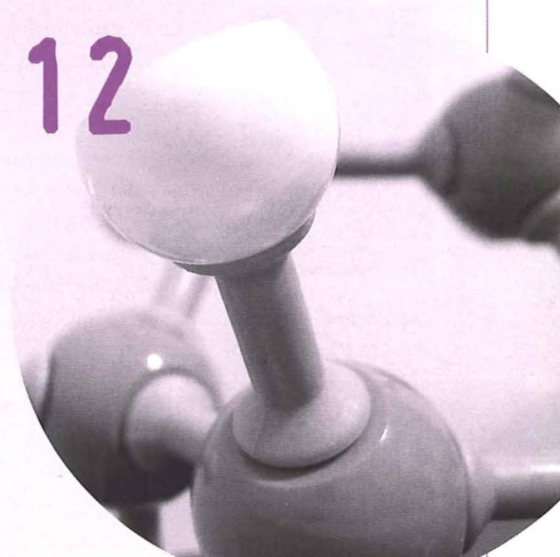


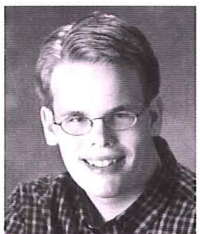
CONTRIBUTORS


Dolan

Jacques Dolan is a sophomore in mechanical engineering. He loves what he studies because he wants to work for NASA designing Martian rovers or high-tech mechanical systems. Jacques plays the violin and guitar and spends any of his extra time at the rock wall climbing and working out new and harder problems. Between getting his laundry done, wasting time doing nothing, or struggling to get all of his homework done, he always find time to play his guitar.


Idziorek

Now a first year dental student, it seems **Jen Idziorek** will never leave ITSP. Currently she is working on re-establishing her caffeine dependency after almost nine months on the wagon. She enjoys not-so-small-anymore lions, driving the west coast, GTA, and tearing around Minneapolis. Much love to the body buddies- "work hard, play hard."


Johnson

When electrical engineering student **Nate Johnson** isn't cruising around in his shiny blue (Jen: Green!) convertible, he is responding to nasty emails and posting them on the wall. He enjoys jamming out to the tunes of Blues Traveler, playing guitar, and paging through old *Technolog* issues in search of the mysterious censored articles.


Mosher

Though **Andrea Mosher** is looking forward to graduating this year with a degree in landscape architecture, she is frantic about what she will do after graduation. She will not worry about that until she must, because in the meantime she will be studying in France and traveling around Europe. This is her last semester with the Technolog and she looks back with fond memories (tear). Check back for her work as a foreign correspondent in the spring or summer issue.

WRITE? RIGHT! WRITE? RIGHT! WRITE? RIGHT! WRITE? RIGHT! WRITE? RIGHT! WRITE? RIGHT! WRITE? RIGHT!

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WRITE? RIGHT! WRITE? RIGHT! WRITE? RIGHT! WRITE? RIGHT! WRITE? RIGHT! WRITE? RIGHT! WRITE? RIGHT!


Renshaw

Jon Renshaw has just completed his Bachelors degree in Computer Science and sails the treacherous waters of the tech job market. When he isn't busy sending out flocks of job applications, Jon can be found indulging his newfound fascination with the game mechanics of turn-based strategy games. He soon hopes to be helping develop one in his free time.


Rusin

Ethan Rusin is wrapping up his 5th year in the ME program here at the U. When not delving into the scientifically bizarre, he can usually be found enjoying music, looking for a durable rocking chair, or taking a nap when possible.


Steichen

Senior **Bethany Steichen** is currently doing her best to avoid figuring out what to do in her life as a soon-to-be-graduated chemical engineering student. Instead she occupies herself with frolics through apple orchards, late-night movies, learning to swing dance, hanging out with the fabulous SWE folk, cooking with pumpkins, and spending countless precious hours on unit ops. Here's to a new and fantrousertastic year at the Technolog!


Tabah

Nangah Tabah is a senior in chemical engineering. She tries to balance enormous amounts of homework with writing poems, reading, or watching CNN or the food network. Her favorite season is autumn. When she's not outdoors absorbing nature's colors, chances are she's talking on the phone with her sisters.


Walter

Michelle Walter is a senior in scientific and technical communication. (That's in COAFES, by the way.) If Michelle had a million dollars, she'd sit around and do nothing. But she has a job/internship now, she gives campus tours, plays volleyball with her Ambassador friends, hangs out in the *Technolog* office, and frets about what she will do for money after May 2005.

FILE PHOTO

EDITORIAL

Each spring the Technolog staff attends the annual conference of the Engineering College Magazines Associated. ECMA is the national organization that the Technolog and about 15 other college magazines belong to (and helped found in 1920). After hosting the conference at the U of M in 2003, it was a relief to leave the planning up to others and just fly out to the University of Pennsylvania in Philadelphia. At the conference, we met editors and writers from magazines in Colorado, Nebraska, Wisconsin, Cornell, Virginia, Ohio, and of course Pennsylvania. We attended workshops on how to write better stories, take better pictures, get more advertising, and promote teamwork. We ate traditional Philly cheese steak sandwiches, water ice, and Tasty Kakes. We explored the city on foot and on the Septa and took pictures with the founder of Penn, Benjamin Franklin.

At the awards banquet, the Technolog picked up three awards.
First Place, Best Feature Article for "Behind the Bricks: Neil Amundson" by Eric Tsai.
Third Place, Writing: Science and Technology article for "Quaking Campus" by Michelle Walter
Third Place, Magazine of the Year

The Technolog staff has some new editions! As two of our editors are graduating in May and we were without a webmaster, we needed some replacements. Introducing the future of the Technolog!

Kelly Striegel is a long time reader, first time editor of Technolog. She is a young third year student pursuing a degree in compujounrahistoarchaeology. She fancies being caffeinated at all times and her hobbies include long walks on the beach, reading, conversating, space travel, spending time with her comrades, and of course correbcting errors in the Technolog. She likes her coffee black, her food breakfasty, and her music electronic. Kelly will be taking over Michelle's story editor position after this year. Nate will be sticking around another year.

Matthew Krieger and Murtaza Adam will be splitting the layout editor duties. (Andrea is so special, we need two people to replace her!)

Matt is a first year student at the U and is thrilled to be able to continue artistic endeavors while pursuing a degree in electrical engineering. Matt's hobbies include sleeping...when he wakes he likes to listen to music...which usually puts him back to sleep. While not sleeping, Matt enjoys wandering the earth and getting in fun and exciting adventures.

Murtaza is a 3rd year Biomedical Engineering student here at the U. He relishes the feel of satin sheets and the thrill of compulsively washing his hands. If he could only pass one thing on to his children from his experiences in college, it would have to be the weird disease he picked up in Tijuana. Well, according to the doctors he doesn't really have a choice.

A.J. Larson, our new webmaster, is a junior in computer engineering, which he finds to be a bit more difficult than growing up on the streets of Eden Prairie. He loves sports and has many hobbies, including mild obsessions with the Minnesota Twins, ping-pong, and the news. When not designing the Technolog website, you could probably find him in the gym—"No matter what career you choose to pursue in life, it always helps to have muscles ripping out of your skin."

--Nate Johnson and Michelle Walter (with staff contributions)

FILE PHOTO

Minnesota Technolog

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Behind the Bricks: Tate Laboratory of Physics

Smith. Kolthoff. Tate. Amundson. Shepherd. Lind. Although hundreds of IT students pour through buildings bearing these names on a daily basis, few of us know anything about the people for whom they are named. This series, "Behind the Bricks," provides biographical insight into the influential scientists and engineers who helped shape the Institute of Technology and whose legacies live on within the walls of our buildings.

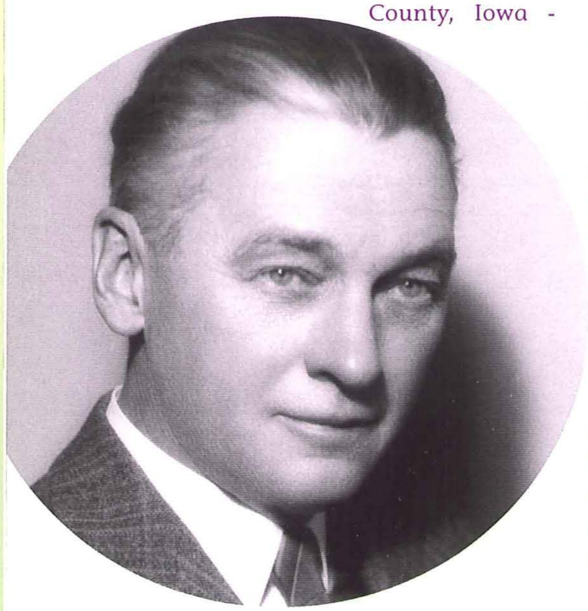
John Torrence Tate

BY BETHANY STEICHEN

Often we think buildings and awards are named for scientists who have contributed to scientific knowledge through prolific publications. John Torrence Tate, for whom Tate Laboratories of Physics is named, was not such a man. Although a formidable researcher who contributed to early investigations into quantum physics, Tate was remembered as much for facilitating others' research and promoting excellence in young scientists as conducting his own experiments.

Young Life

Tate was born in 1889 in rural Adams County, Iowa - the nearest population center was across the county line and had roughly a thousand people in it. His father was the local country doctor and was often away on calls. After Tate's mother died in 1899, John was sent to live in New York with his uncle's family.



During high school Tate became fascinated with science and was known to explode things on occasion with his home chemistry set. His fondness for chemistry was so well known to his classmates that the rhyme written for his graduating class's yearbook was "Terribly taciturn Tate, with HCl on his pate."

Tate returned to the Midwest for college, majoring in electrical engineering at the University of Nebraska. During the summer, he worked at a power plant on the Rosebud Indian Reservation in South Dakota, where his father had taken a physician's assignment.

In 1910, Tate graduated and elected to remain at University of Nebraska as a physics graduate student. From there he moved to Germany and received a Ph.D. after only two years at the University of Berlin. World War I forced Tate to return to America and also prevented the publication of his dissertation.

When the University of Nebraska offered an instructorship to Tate in 1914, he accepted, but by 1916 he had been recruited to the University of Minnesota. He started out as a physics instructor paid $1500 per year with the promise of promotion for good work. In the next four years he was promoted three times and by the age of thirty-one, he was a full professor.

Tate briefly left University of Minnesota from 1917 to 1918 to serve as a lieutenant in the Signal Corps during World War I. Another U of M professor had taken a position with the Bureau of Standards in Washington D.C. and was able to collaborate with Tate on weekends and evenings.

At this time, Tate and his colleagues verified the existence of discrete energy levels and showed that there was a difference in the amount of energy required to spur radiation and the amount of energy that needed for ionization. This helped connect Bohr's theories and those of Heisenberg and Schrödinger in quantum mechanics.

Despite his shifting job location and work with the war, Tate evidently found personal time as he married Lois Fossler in 1917. They had meet while he was at Nebraska and they had one son together, John Torrence Tate, Jr. (who incidentally also became an acclaimed scientist and mathematician - he is currently at the University of Austin).

In 1919 Tate returned to teaching at the University of Minnesota. He was so well liked that his graduate course, "Seminar in Contemporary Experimental Physics," was often taken every semester of a student's career at U of M al-

though it would only count for a grade once.

Around this time Tate was made Editor-in-Chief of the Physical Review publication and became active in the American Physical Society. These connections provided cutting edge material for his graduate students to work on and also the latest in physics theory to be presented at the University. By 1923 he was the primary advisor for students in experimental physics.

In 1931 Tate helped found the American Institute of Physics and travel became a regular feature of his life. Between editing, meetings, teaching courses, grading exams (he insisted on marking his own tests), and his duties to guide his students' research, Tate had very little time left for his own studies. His council, however, was valued highly by faculty as well as students and he was well respected for the caliber of students he produced.

James Gray, in writing a history of University of Minnesota, remarked that Tate was "a teacher with the hardihood to insist that all his students must make a decent attempt at being geniuses." In fact, the annual volume Men of Science, which served as a "who's who" in physical science at that time, named as many Minnesota graduates as "particularly bright" in physics as they did MIT grads.

Under his editorship, the length of the publication quadrupled and its readership tripled. The success of the journal was so great that Tate started a quarterly journal Reviews of Modern Physics in 1929 and another, Physics, in 1931.

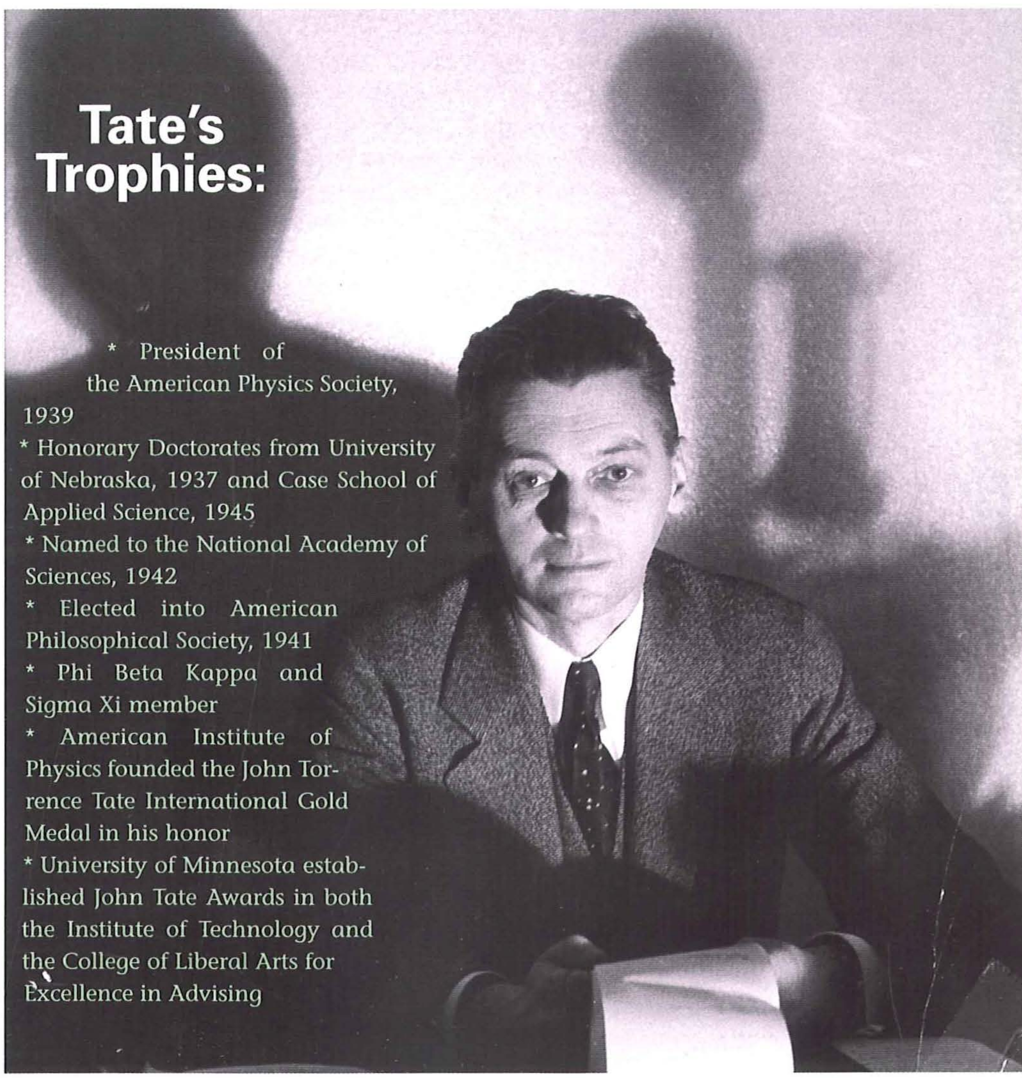
In addition to his seemingly uncanny ability to understand new developments in physics, Tate was known across the campus for being a man of many talents. He was an early proponent of liberal education and believed that science and human values needed to go together. He was an avid golfer, a champion billiard player, a tennis player, an amateur photographer, and an artist. Because of his varied interests and talents, he was selected to be the dean of an experimental "Select College" in 1930. By 1937 he had been promoted to Dean of the College of Science, Literature, and the Arts-by far the largest college at the school. As a result of his new responsibilities and continued editorship and advising duties, Tate was forced to give up teaching.

World War II

When World War II broke out, Tate returned to service and gave up his deanship. Unfortunately, the war years were made more difficult for Tate by the death of his wife Lois in 1939. He dedicated himself even more fully to his job, if that was possible.

Submarine technology had improved greatly since the First World War and the Navy asked the National Defense Research Committee to create a special unit to work on the issue. Division 6 was created for this task and John Tate was asked to head the program. He also served as the scientific advisor to the Commander-in-Chief, United States Fleet, Assistant Chief of the Office of Field Services of the Office of Scientific Research and Development in charge of Operations Research, and Chief Member of the Rocket Ordnance Division of the National Defense Research Committee. For his work in the war, Tate was awarded the Presidential Medal for Merit by the US government and the King George's Medal for Service in the Cause of Freedom by the British government.

TATE continues on page 13



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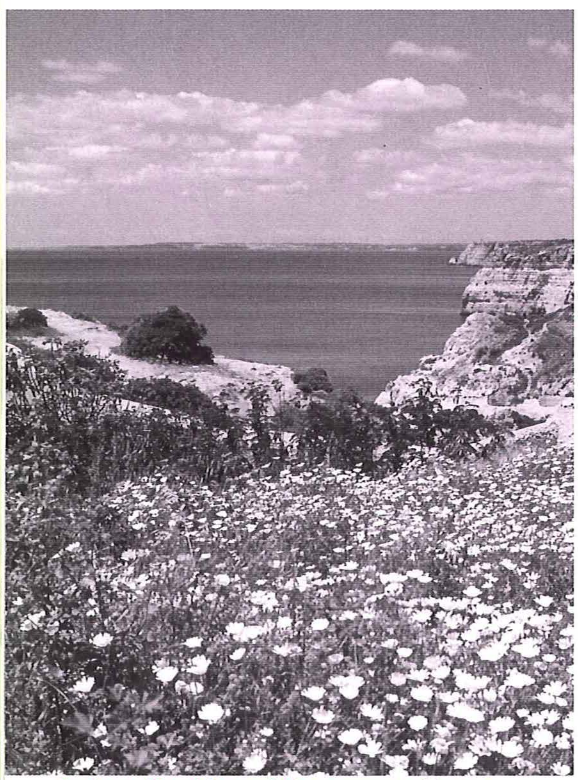
Steganography

Steganography and watermarking: Publishing information that isn't meant to be seen (mostly)

BY JON RENSHAW

At a young age, many of us have a brief fascination with secret codes. We get excited about scrambling letters so that only our friends can read a message or writing in invisible ink. Little did we know that we were delving into the field of cryptography, the art of protecting information from interpretation by unfriendly eyes. We were also practicing techniques from a related, but lesser known, field: steganography. Steganography takes the idea of cryptographic communication one step further: not only must the message be unreadable by all but the intended receiver, but no one else should even know that there is a message.



A photo like this could be converted into a Steg-object and hold an encrypted message.

History is rife with examples of clever steganography. Herodotus tells of a slave whose head was tattooed with the details of Persian military plans and then sent to warn the Greeks...once his hair grew back. During World War II, "microdots" were developed in Germany to hide text. What appeared to be an ordinary period in an uninteresting letter could actually be an entire message in incredibly tiny print. Only extreme magnification could show the difference. These days, steganography has moved into the realm of computers and become its own field of study.

The professional study of digital steganography has advanced the field in surprising directions. Modern steganography focuses largely on the creation of so-called "digital watermarks." Such watermarks are modifications to images, songs, or other copyrighted media that amount to a high-tech cattle brand. Copyright holders can indelibly mark their work so that no matter how many times the media is copied or distorted, their copyright information will still be stamped upon it. Watermarking techniques are somewhat different from traditional steganography. Watermark designers are unconcerned if their work is detectable as long as it remains unremovable. While most steganographers are occupied by watermarking techniques, there are still those interested in good old-fashioned covert communication.

Steganography in computer data and communication takes many forms, but the basic pattern never changes. A secret message is composed and is embedded into some innocent data, referred to as cover-data. The resulting data with hidden meaning is called a stego-object. Three main criteria separate good steganography methods from poor. First, the stego-object must be able to reach its destination without its secret message being filtered or garbled. Second, if the stego-object is intercepted by an "attacker", the attacker must be unable to determine whether it contains a secret message — even if they know how the secret message was embedded. Finally, of course, the intended receiver must be capable of reading the message. A lot of good sending an undetected message would do if NO ONE could read it.

While images are popular sources of cover-data for steganography, there are numerous other strategies for hiding digital information. The whitespace in text files can be replaced with other invisible characters that spell out a message, sound files can have stego messages hiding in the audio noise, executable programs can have dead spots that hold hidden meaning, and even network traffic can have secret messages piggybacking on it.

Why are so many different strategies needed? Were rogue cryptographers just so bored that they invented new ways of hiding information? Not precisely. The field of steganography is home to steganalysts as well as steganographers. Steganalysts make it their task to find the weaknesses and mistakes in steganography schemes. Published steganalysis papers force steganography to grow in new directions. More sophisticated methods of hiding information are developed as the simpler schemes are picked apart by steganalysts.

Image steganography is easily the

PHOTO: MORGUEFILE.COM

most popular form of digital stego. An astonishing list of programs is available, but only the barest handful lack published attacks against them. Among the hordes of broken and obsolete methods stands steghide. Freely available for Windows or UNIX systems, steghide can embed any digital file into your choice of JPEG, BMP, WAV, or AU files. Steghide is not vulnerable to any published attack as of this writing. With support for multiple advanced encryption algorithms, the only thing steghide lacks is a graphical front end.

Steghide cannot hide nearly as much data as numerous other methods. Differences in their design philosophies help explain this. Steghide is designed to embed messages that will not be detectable by determined attackers. Methods that can hide dramatically more data are designed to be undetectable at a glance. The difference is that the more common methods can easily be seen through if an attacker guesses how the secret data was embedded. The method used by steghide is undetectable even if an attacker knows how steghide works.

Even apparently bulletproof steganography methods are not perfect. For instance, if the cover-file used is an image whose original is easily unearthed (say, a popular wallpaper image), then a secret message can be detected (but not necessarily read) by a simple comparison to the original. Digital camera photos or scanned images are harder to analyze this way. As if that weren't enough, advances in steganalysis render steg programs obsolete all the time. Good digital steganography is already difficult to pull off. As steganalysis advances, new steg methods will continue to be more complicated and hide less data. Until universal "big brother" surveillance becomes a reality, though, steganography will stick around.

More Info: http://steghide.sourceforge.net/
http://www.jjtc.com/Steganography/

PHOTO: MORGUEFILE.COM

So how does it work?

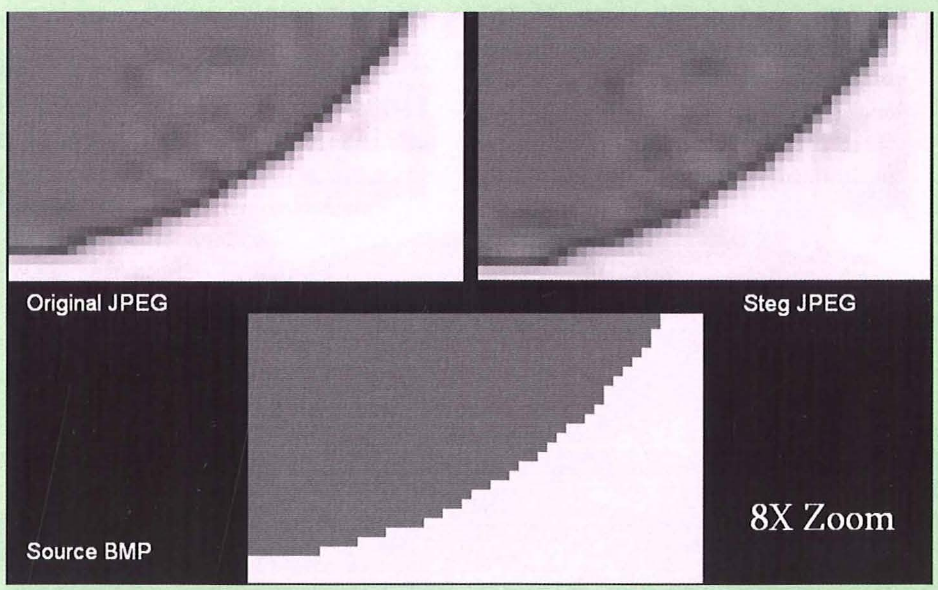
With a passphrase, an advanced encryption algorithm, a cryptographic hashing algorithm, and some graph theory. The following paragraph is taken directly from the steghide manual:

"Steghide uses a graph-theoretic approach to steganography. You do not need to know anything about graph theory to use steghide and you can safely skip the rest of this paragraph if you are not interested in the technical details. The embedding algorithm roughly works as follows: At first, the secret data is compressed and encrypted. Then a sequence of positions of pixels in the cover file is created based on a pseudo-random number generator initialized with the passphrase (the secret data will be embedded in the pixels at these positions). Of these positions those that do not need to be changed (because they already contain the correct value by chance) are sorted out. Then a graph-theoretic matching algorithm finds pairs of positions such that exchanging their values has the effect of embedding the corresponding part of the secret data. If the algorithm cannot find any more such pairs all exchanges are actually performed. The pixels at the remaining positions (the positions that are not part of such a pair) are also modified to contain the embedded data (but this is done by overwriting them, not by exchanging them with other pixels). The fact that (most of) the embedding is done by exchanging pixel values implies that the first-order statistics (i.e. the number of times a color occurs in the picture) is not changed. For audio files the algorithm is the same, except that audio samples are used instead of pixels."

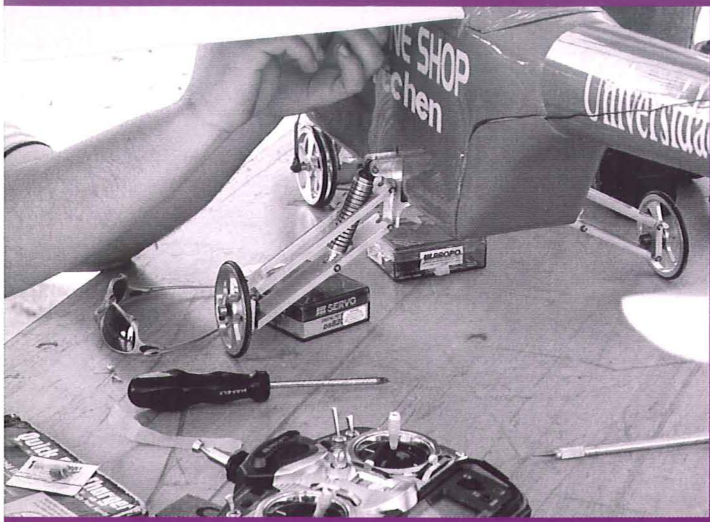
To download and use steghide, point your browser to http://steghide.sourceforge.net/. The latest windows version is steghide-0.5.1-win32.zip. After extracting the contents of the zip file, open an MS-DOS command window in that folder by selecting "Run" from the windows start menu and entering "cmd". If you are unfamiliar with the MS-DOS command line, you can get up to speed by checking out the tutorial at http://www.tnd.com/camosun/elex130/dostutor1.html. Now you should be ready for action.

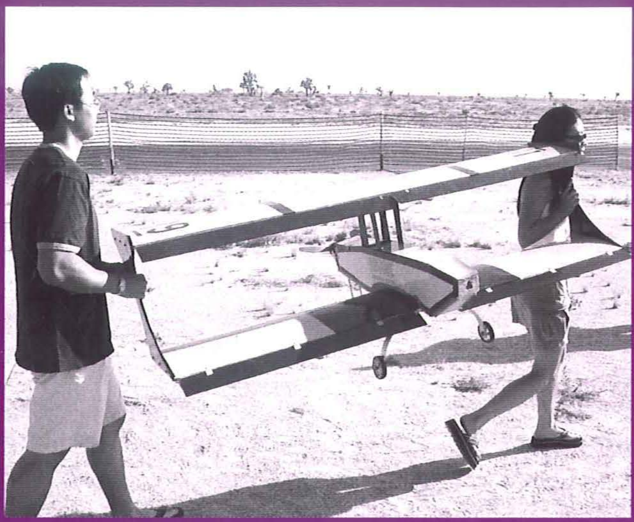
The first step to hiding information is to find a file with enough complexity for steghide to be able

STEG continued on page 16



The original JPEG has been compressed from the BMP one time. JPEG compression doesn't work well on images like the one shown and the result is evident. The steghide program was used to develop the second JPEG image from the first. The flaws from the first compression are recreated very closely by the second compression.





ON BOARD TO THE FUTURE OF AE

BY JAQUES DOLAN

Little ripples of refracted light surge upward off runway blacktop in the Texas summer heat. Among the bustling commotion of people organizing engineering teams and piecing together broken balsa wood, the high-pitched whine of a model airplane engine diverts all attention to it. There couldn't be more riding on the coming flights. Young engineers wait with anticipation as their very future in the field floats away on a wing and a prayer. This was the aero-design challenge.

For the last two summers I've been an honorary member of the South Dakota School of Mines and Technology aero-design team, and I had the privilege of joining them at competition. I am a student at the University of Minnesota, but my dad is the advisor for the School of Mines, so I got the lucky spot. I was more than excited to have a chance to see what a large number of people in my proposed profession actually do when they get out into business.

Over thirty teams from all over the western United States, Canada, and Mexico come to compete in the Society of Automotive Engineers (SAE) AERO Design West competition. The competition is usually held in June and this year took place in Fort Worth, Texas. In previous years, the competition has been held in Salt Lake City, Utah and other cities in the Southwest. The competition is a team-building, industry-driven test of skill and expertise in the development of a small-scale, radio-controlled aircraft. Teams competing here will move on to become the next generation of airplane designers. According to the companies who hire these up-and-coming designers and Bob Sechler in particular, an SAE engineer and the man who started the AERO Design challenge, "Engineering students who enter this competition are two years ahead [of their peers] when they enter industry." Some automotive companies have even initiated training programs for those new employees who have not had the competitive advantage that SAE challenges offer them.

Although the specifics change every year, the main objective is to take off, fly once around a circular path and land with the greatest possible payload.

SAE is an engineering society that sets standards in the automotive industry that we see every day. Many internships or co-op jobs, especially in mechanical engineering, are offered through SAE. The organization also of-

PHOTOS BY JAQUES DOLAN

ERONAUTICAL DESIGN

fers students scholarship and job-skill opportunities in some major engineering frontiers. Mainly through design challenges and competitions like the Mini-Baja, Formula car, and high-mileage vehicle, SAE provides several interesting challenges and opportunities for students in engineering. Engineering competitions are intended to teach students organizational skills, team-building, logistics training, and problem-solving.

An inherent main reason for any engineering project is design. For the most part, the design of these planes is evolutionary. Most teams have some affiliations with model-builders or model airplane pilots, so students get information that has been tried and tested. The University of Akron, a team that has won several previous competitions, consistently builds a plane with balsa wood triangular framing. Most commercial airplanes, or models, are made in the same way. Many teams use carbon fiber or fiberglass, and some even Styrofoam. Many teams experiment with different types of materials including innovative high-strength, lightweight composites and plastics.

The goal of the AERO Design competition is to build an airplane about the size of a large remote controlled model that anybody could buy at their local hobby shop. Although the specifics change every year, the main objective is to take off, fly once around a circular path and land with the greatest possible payload. This year the minimum wingspan was ten feet, and the most competitive planes lifted around twenty pounds or more. Other specifications include which of two motors teams can choose from, fuels, mufflers, radio receivers, and transmitters, etc. There is also an open class section of the competition. Planes in the open class are encouraged to lift as much as possible using basically whatever they want. One graduate student team from UCLA with an open class plane used some unique composite manufacturing techniques to fabricate the wings, including carbon fiber and extruded plastic. UCLA implemented a motorcycle engine and off-the-shelf aluminum landing gear to lift over one hundred and twenty pounds.

The airplane competition was the best experience I have had in college so far for practical knowledge in engineering. Among the engineers, students, and major industry leaders, I made some incredible connections. There were designers there from Lockheed Martin, including many from projects like the F-117 Stealth Fighter and the F-22 Raptor. I met some of the leaders of SAE including those aerospace engineers at the head of that part of the organization. All around it was an incredible event. ●

PHOTOS BY JAQUES DOLAN

WHAT HAPPENED TO THE HUMAN GENOME PROJECT?

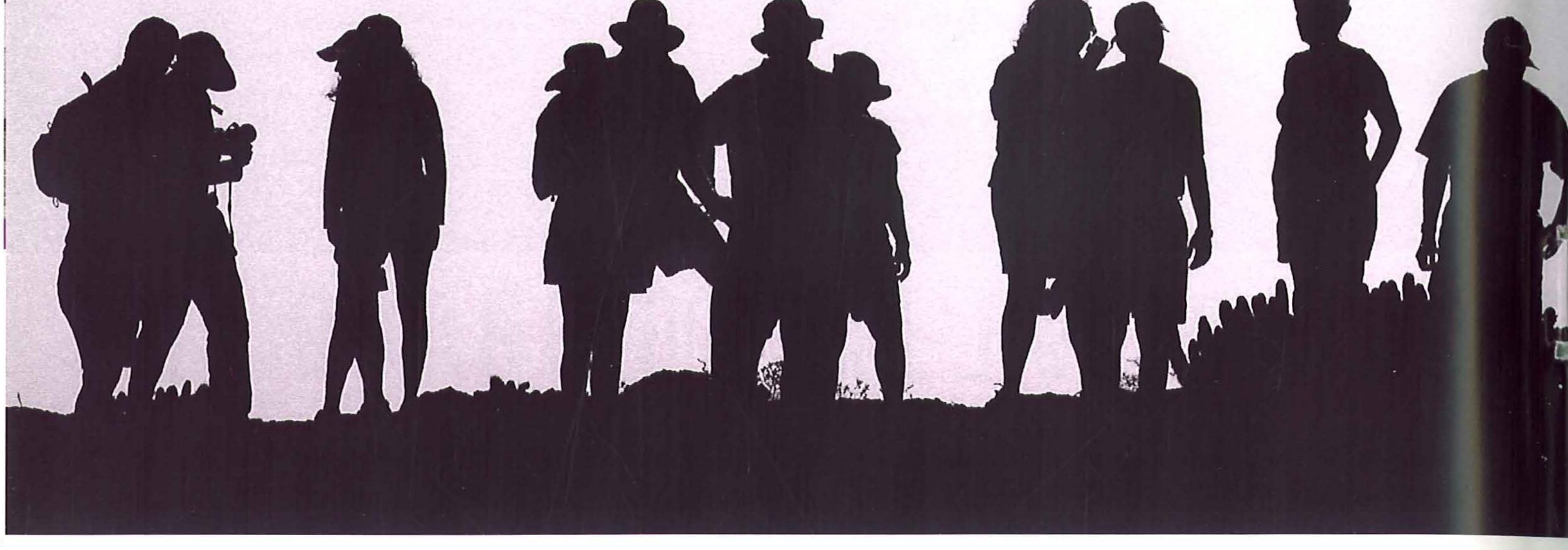


PHOTO COURTESY OFF MORGUEFILE.COM

BY JEN IDZIOREK

Do you remember back when the whole world was anxiously waiting for scientists to determine the human genome? What ever became of that enormous effort? Did we learn anything valuable, or was it overrated? Do you know what the Human Genome Project was? For those who are behind on the molecular biology times, here is a brief update of how genetic science is racing along in the background to change your life and mine.

The Human Genome Project

First formally proposed in 1985 and officially started in 1990, the Human Genome Project (HPG) was an international effort to sequence the entire human genome that was completed in April 2003, over two years ahead of schedule. Both private and public laboratories around the world participated in the elucidation of the sequence of 2.91 billion base pairs within the human chromosomes. The Project brought about major technological advances, including improvements on the Sanger dideoxy DNA sequencing method, the expressed sequence tag (EST) method (another DNA sequencing method), the use of bacterial artificial chromosomes (BACs) to clone DNA sequences, and the whole-genome shotgun method, the most effective sequencing technique to date. These and other advances increased the speed of the sequencing enormously: by January 2000, it was possible to sequence 1000 base pairs per second, whereas only fifteen years before that could only be accomplished in the length of a day. The HGP more than exceeded its goals: mapping to higher resolution, more sequence-tagged sites (STSs), a higher percentage of the sequence, and the genomes of several model organisms, such as the simple worm C. elegans, as well. The data generated was quickly made available to both the public and scientific community even before publication in order to increase public benefit from the research. Though the sequence is now finished, there is still much to be done. Among subsequent projects are detailed maps of single nucleotide polymorphisms (SNPs), haplotypes, and the human proteome. The multitude of uses for the genome will be apparent over time; in this, the beginning of the "genome era," the complete human DNA sequence paves the way to solving the puzzles given to us by cancer, heart disease, diabetes, and many other afflictions to mankind.

The multitude of uses for the genome will be apparent over time; in this, the beginning of the "genome era," the complete human DNA sequence paves the way to solving the puzzles given to us by cancer, heart disease, diabetes, and many other afflictions to mankind.

SNPs

Single nucleotide polymorphisms or SNPs (pronounced "snips") are simple phenomena with enormous implications. SNPs are the results of single mutations in DNA, mismatches between a single nucleotide pair at a position in one individual's DNA with another at the same position in another individual's DNA. The mutations come from unique events throughout the history of our species, and can be used not only to trace ancestry, but to change the future of medicine.

So far, over 1.8 millions SNPs have been mapped through the collaborative efforts of The SNP Consortium, a collection of pharmaceutical companies, academic institutions and a private foundation, as well as the Human Genome Project and various private businesses. They are estimated to occur every 1,000-2,000 bases on average, which would translate to somewhere between 1.6 million and 3.2 million total in the human genome, but there are likely many more than predicted. Along with base insertions or deletions, they make up the bulk of genetic variation.

The SNP Consortium used reduced representation shotgun (RRS) sequencing, a modified take on the whole-genome shotgun method, as its main detection method. The DNA of an ethnically diverse panel of twenty-four individuals was cut into fragments with restriction enzymes and mixed. From this, a library of fragments with specific lengths was made, and through a complicated set of rules those sequences representing the same genetic loci were aligned. By comparing the matched loci, those nucleotide bases that varied between fragments were named SNPs with 95% accuracy. A detailed map was made by associating the aligned fragments containing SNPs to the human genome. Chromosomal coordinates were mapped and are currently available to the public at http://snp.cshl.org.

Ancestry can be traced through genetic similarity, much like family members having like features. By tracking parallels and divergences in SNPs throughout different ethnic groups and races, population geneticists will be able to determine common ancestors and evolutionary history. The polymorphisms found in mitochondria and the Y chromosome may prove most useful for this purpose, as they do not undergo recombination like the rest of the genome.

The medical benefits of SNP mapping do not come from identifying harmful traits caused by SNPs themselves, but by identifying SNPs that are near on the chromosome to genes that encode harmful mutations. Due to this proximity, SNPs may be used to identify an individual or population's risk for various diseases and determine their reaction to a treatment or to a certain environment, and therefore to develop new drugs and therapies.

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Whereas the mapping of SNPs is not yet 100% accurate, new algorithms and validation studies are being developed and tested. As more SNPs are discovered, we are able to look farther into both the future and the past.

Human Proteome Organization

February 8, 2001 marked the launch of HUPO, the Human Proteome Organization, a governing body to aid the sequencing and classification of the human proteome. Like its predecessor for the genome, the Human Genome Organization (HUGO), HUPO will attempt to coordinate the efforts of national and private labs worldwide and standardize the knowledge gained in a database available to the public. Its mission statement is to consolidate national and regional proteome organizations into an international body, to engage in scientific and educational activities to encourage the spread of proteomics technologies pertaining to the human and model organisms, and to assist in disseminating knowledge about the proteome and model organisms through shared, public systems.

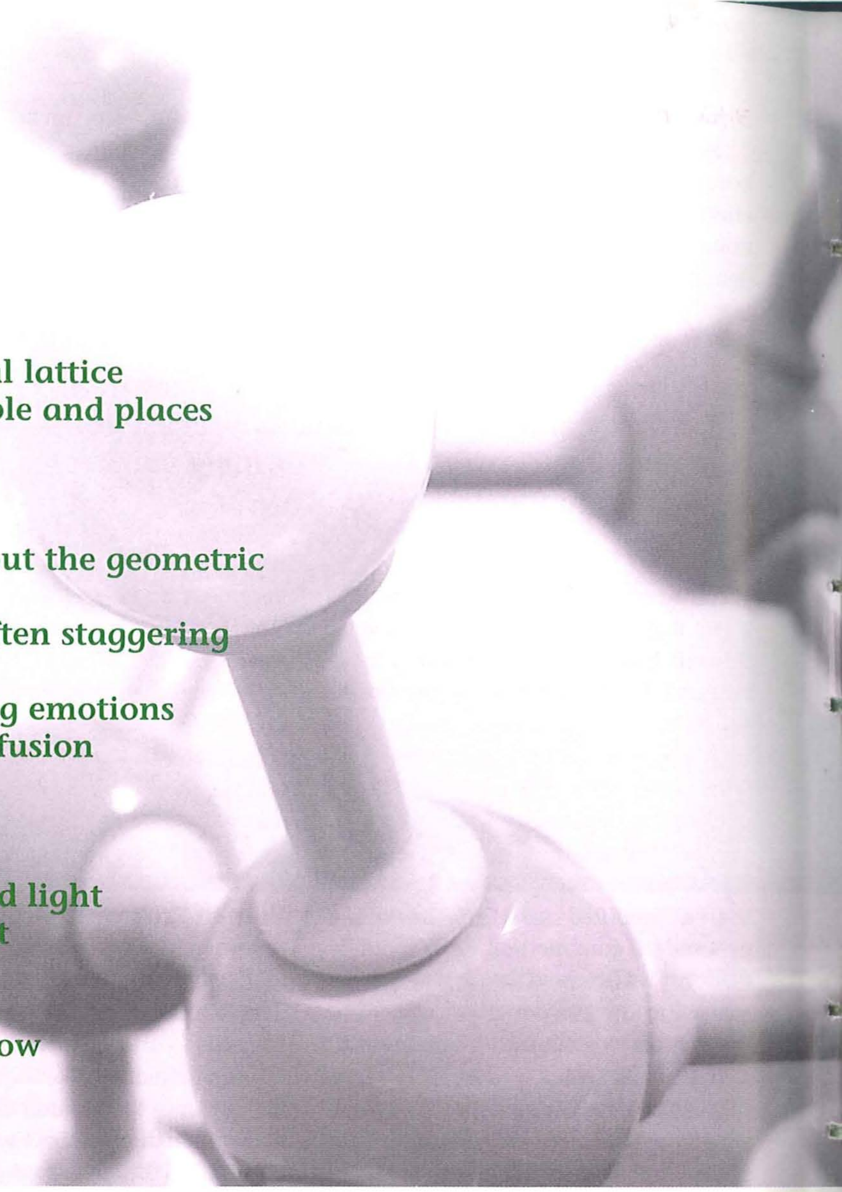
The major initiatives organized by HUGO are the Plasma Proteome Project (PPP), the Liver Proteome Project (LPP), the Brain Proteome Project (BPP) and the effort to create antibodies for every protein encoded by the human genome. Several of the projects have pilot phases already in operation, with expectations for full-scale productions within years. Some research groups are also undertaking relatively smaller labors, such as characterizing all of the proteins in subcellular structures such as those in the mitochondria and golgi bodies.

To map the proteins of the human body is a daunting task. The proteome is defined as all the proteins expressed by the genome, in all cells under all conditions. It is a dynamic, myriad number of proteins that differ from individual to individual and from cell to cell, and also depend on the health of the cell or tissue they populate. Not only that, but countless numbers of chemical modifications are made to proteins throughout their "lifetime," changing their enzymatic activities, binding capabilities, and length of activation. This set of alterations can up the ante to more than 10 million chemically distinct polypeptides in a tissue. HUPO has a great and complex charge before it.

Unlike the Human Genome project, the technology to speed and simplify the task a hand has not yet been developed. The majority of proteins are available only in small amounts, surrounded by other proteins that are difficult to separate out. There is no way to amplify polypeptides ala the polymerase chain reaction amplification of DNA that is employed in gene mapping. The most useful of technologies are 2D-PAGE, in which proteins can be separated by charge and weight, and mass spectroscopy, which fragments the molecule and separates the pieces by weight; chromatography, bioinformatics, and protein "chips" are also being used. Although there are methods available, they are expensive and tedious, and the need for new processes abounds.

HUPO aspires to many ends for its undertaking. Given that most drugs target proteins, a map of the proteome will be invaluable to human health. The Plasma Proteome Project is HUPO's main priority because it focuses on finding blood-borne proteins that are signs of disease. An understanding of protein-protein interactions will serve to give a better picture of the modifications that occur in disease such as cancer, heart disease, and neuroses. Eventually, the proteome can be backtracked to its "transcriptome," providing another link on the

HUGO continues on page 13



CRYSTAL LATTICE

BY NANGAH TABAH

I have come to think of life as a crystal lattice
A beautiful framework for fitting people and places
A superb scaffold for hers and his
A magnificent structure, a solid basis

I have often pondered on who works out the geometric
combinations
Who designs the array of events, an often staggering
construction
Who solves the sequence of bewildering emotions
Who writes the codes to break the confusion

I myself stand clear of all blame
As clear as this crystal frame
With its angles and contours sharp and light
And its beautiful body hard and bright

I glisten with a morning glow
A simple reflection of this diamond show
A mere atom in a firm bond
A shining piece right where it belongs

Author Explanation:

I was inspired to write this after a Materials Science 3011 lecture on crystals=lattice + basis. As Professor Bates enthusiastically laid the groundwork for the course, I considered idly that the lecture might be a good idea for a poem. His words still resound with me - "A lattice is a framework for placing atoms and a basis is an atom or group of atoms or molecules associated with each lattice point". It was an interesting process matching people to atoms and a lattice to the framework of life itself. You now have what I hope is the exciting task of interpreting further any deeper meaning you might see in this piece and to decide how you might relate to it. I will say, though, that I think at the time I wrote this poem I was feeling very much a strong part of life's beautiful order/chaos, whatever. I guess I realize I am embracing life's wonderful although sometimes painful process and thanking those who help keep me grounded.

Do you write poetry, engage in creative writing, do illustrations, or anything else creative pertaining to science or technology? Please send us your creative works so we can show off the artistic side of IT: technolog@it.umn.edu

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long chain between a protein and its gene. Last, and certainly not least, HUPO is organizing a widespread educational effort in the form of workshops, courses, and seminars in proteomics, in order to increase its breadth and train the researchers of the next generation.

High-throughput

High-throughput screening is the catch-all term for the collection of relatively new technologies that allows for the rapid assaying of compounds with potential to become pharmaceuticals. These technologies have been developed in light of the fact that it is extremely difficult if not impossible to analyze the amount of potential drug candidates produced by the advent of research methods such as combinatorial chemistry. To identify potential drugs, a new and automated technique was required to screen thousands upon thousand of compounds within a reasonable time and price range.

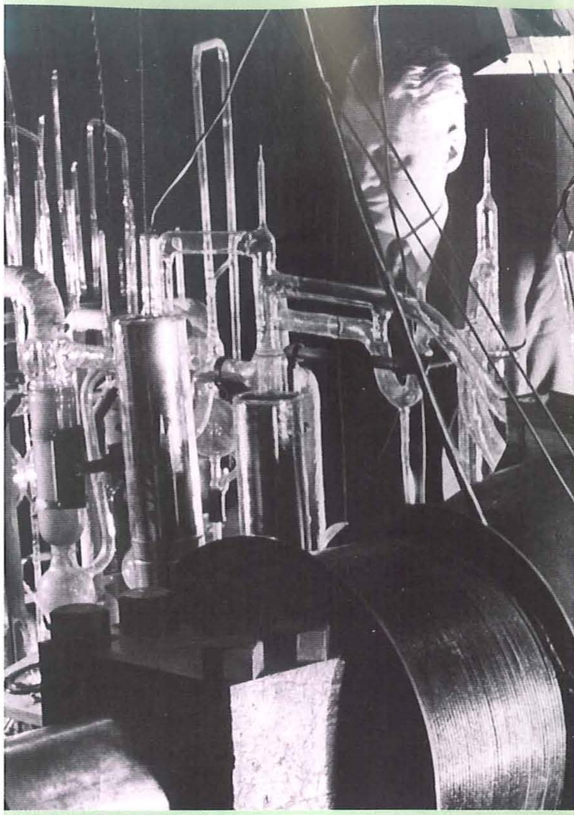
Genomics has led to the discovery of an increasing number of drug targets that haven no known chemical inhibitors or modulators and has inspired a massive search for new potential drugs, or leads. Many screening systems involve a five-axis industrial articulated robotic arm that is able to move back and forth down a track. It facilitates the transfer of micro-wellplates to various instruments for analysis and runs on user-programmable protocol. As high-throughput screening becomes more and more necessary, the degree to which such robotics can be customized for different uses increases.

A major key to developing the machinery necessary for high-throughput screening has been the use of smaller and smaller amounts of compounds, or miniaturization. Not only is it more cost-effective to use minute amounts of compounds for screening but it also preserves more of the already limited quantity of compounds that are being tested as leads. In response to this need, well plates the same size as 96-well plates are being developed with as many as 9,600 wells that accommodate assays of reduced size. Additional benefits include shorter time to run screens, decreased disposal costs, and reduced amounts of reagents or drugs used for assays.

As laboratories become more automated and miniaturization becomes more feasible, libraries of 500,000 plasmids are typical and yield approximately 5 million data points depending on the kind of assays run. To manage this data, a system must be in place that can associate a number of types of information: molecule structures, assay parameters, chemical registrations, molecular spectra, various forms of biological data, and the high-throughput results themselves. A diverse range of knowledge through both biology and chemistry is required in order to effectively integrate and analyze the data now available from high-throughput screening.

High-throughput technologies are becoming more essential to competing in modern research. As they continue to improve and their cost-effectiveness increases, they will be used for a wider range of applications. New ways to screen intermolecular interactions using a specialized method of mass spectrometry and novel fluorescent labeling proteins will further ease data analysis.

The echoes of the Human Genome Project are many and diverse. Not only did its course give life to new technologies and methods, it set an international standard of partnership for the scientific community. As time hurtles ever forward and the Human Genome Project pales in comparison to new discoveries and incredible advances, may we all be able to look back and appreciate it for the foundation that it is and was to science and the world. ●



John Tate in 1940.

TATE continued from page 5

In 1945, Tate re-married, this time to Madeline Mitchell who had been the Publication Manager for the American Institute of Physics since 1931. Tate returned to the University of Minnesota in 1946 as a Research Professor of Physics and was able to resume teaching and advising duties. Physical Review enjoyed a post-war boom in interest and Tate continued to be heavily involved with it. The Argonne National Laboratory made him a Chairman of the Board of Governors from 1946 to 1949 and he also served as the Chairman of the Committee on Undersea Warfare for the National Research Council.

In 1949 Tate suffered a stroke, but was still able to take on a lessened work load and attend professional meetings. In May of 1950, at the age of sixty, he died of a cerebral hemorrhage. He is still remembered not just as a leader and driving force in the field of quantum mechanics, but as a leader and driving force in the lives of all the people - physicists and otherwise - that he touched.●

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Nerd News...

Your Dose of Needless and Extraordinary Information

This marks the beginning of the second year of weird news installments. Within it's confines you will find odd but true new pieces on what is going on in the bizarre side of science. The hope is that you enjoy the weird news, and that you send any weird news you find to me (rusi0010@umn.edu) 'cause I can always use the extra help. All the same, enjoy the article and love the science.

BY ETHAN RUSIN

Recipe for using chopsticks

I have never been a confident lad with chopsticks, borderline scared of them to be honest. Thankfully, doctors Qiang Zhao and Jim Al-Khalili of the University of Surrey have conjured a mathematical formula to explain how to use chopsticks. The formula is as follows:

C = (Co*Sqrt(N*n*a*d*(2-d)) /)M*t(1+a))

C = Amount of ease that the chopsticks user has using chopsticks (100 is the highest level of comfort and 1 is symbolic of greatest discomfort)
N = Number of Chinese meals eaten with chopsticks (I'm not sure why it has to be Chinese meals)
T = Time needed to get food from your plate to your mouth
N = Shape of the food
A = Slipperiness of the food
D = Diameter of the food
M = Mass of the food.
Co = A constant that incorporates miscellaneous details, such as how long the chopsticks are and the angle that the chopsticks are held.

According to the research, a beginner with chopsticks who eats a 1 cm piece of shredded duck (results may vary for other edible items) in sauce would need to eat 1,000 Chinese meals before they became as comfortable using chopsticks as they would be eating the food with their fingers.

Irrelativity?

Oh, those goofy Canadians. It was a normal Wednesday for Professor Anthony Key of the University of Toronto. His day began with his lecture for beginning Physics class. On this day, he chose to teach about Einstein, and like all lectures on Einstein, Professor Key came to the theory of relativity. What made this lecture on relativity different from past lectures was that Professor Key was blessed with some sort of divine insight, and managed to disprove Einstein's theory.

Winter brings some comfort

With the coming of winter, we lament the undeniable facts that:
- Shorts must be replaced by pants...and snow pants, boots, two pairs of mittens, hat, scarf, and facemask.
- Wearing swimsuits outdoors will be viewed as a cry for help.
- People will be trapped inside, away from the winter weather with less exposure to sun for the next 5 months.

But, we can actually be thankful for the last fact: scientists have research proving that increased exposure to sunlight may increase a woman's chances of becoming afflicted with the papilloma virus, a common sexually transmitted infection. The reason for this unwanted acquisition, scientists believe, is that sunlight suppresses women's immune system defenses. The papilloma virus is the common cause of cervical cancer in women. The virus is quite deadly, killing roughly 4,000 U.S. women annually. A symptom of the virus is genital warts, but more often than not the virus exhibits no physically visible symptoms or clues to its existence.

The leading researcher behind this discovery is Dr. William Hrushesky of the WJB Dorn Veterans Administration Medical Center in Columbia, S.C. Dr. Hrushesky is viewed as an authority on how disease patterns fluctuate over time, and he presented these findings at a meeting in Orlando of the American Association for Cancer Research. For his research, Dr. Hrushesky looked at more than 900,000 Pap test results done in Southern Holland between 1983 and 1998. The doctor's specific conclusion was that the chances of getting the papilloma virus increase with greater exposure to sunlight. Specifically, the tests showed twice as much evidence for the existence of the papilloma virus in August than in winter months, with the evidence falling off sharply in September. The doctor feels that the high levels in August are not due to increased sexual activity but a

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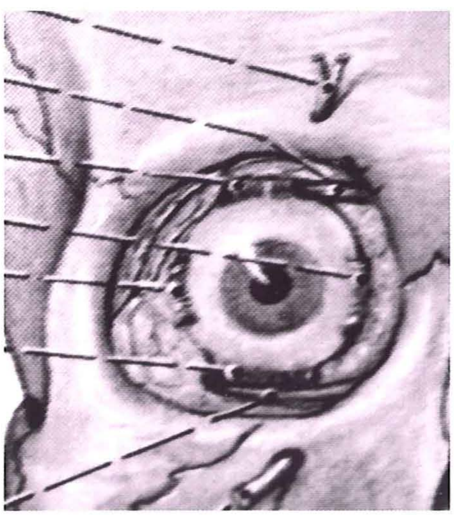
combination of more sunlight and greater exposure to the sunlight. Dr. Hrushesky noted the scientific explanation in the following manner: exposure to the sun can slow our body's production of antibodies and the "activation of protective T cells" (the most common natural defense against infection). Dr. H went on to say that greater exposure to sunlight might also be used to explain a theory that more sunlight leads to greater susceptibility of catching herpes or the adenovirus, among other things.

Dr. Bruce Armstrong of the University of Sydney in Australia, presented his own research at the same conference as Dr. H, but Dr. Armstrong's research resulted in a potential connection between latitude and cancer cases. Specifically, Dr. Armstrong found that many types of cancer are less frequent in Southern areas (so Minnesotans aren't doing themselves any favors by sticking around during the summer). Dr. Armstrong went on to highlight another conclusion in his research: the more sunlight people receive, the smaller their chances of getting non-Hodgkin's lymphoma. Specifically, Dr. Armstrong looked at 1,398 people and found that those who got the most sun had a one-third lower risk than those who got the least.

No need for x-ray vision

I'd be willing to bet that most literate folks out there thought that concrete only came in one color. Well, they are wrong. Our



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lovely Hungarian friends have created clear concrete. Crazy, I know, but they've done it by combining conventional concrete mix with optical fibers to create a new kind of concrete that transmits light. This new material, called LitraCon, is reported to have the strength of the concrete used today, but now it can provide a view of the outside world.

LitraCon's inventor, Áron Losonczi states: "Thousands of optical glass fibers form a matrix and run parallel to each other between the two main surfaces of every block. Shadows on the lighter side will appear with sharp outlines on the darker one. Even the colours remain the same. This special effect creates the general impression that the thickness and weight of a concrete wall will disappear."

The architects of the world who have taken a liking to LitraCon have high hopes that it will help change the reputation of concrete (concrete has a mean reputation) from a dull material of industry to a strong choice in material that has both industrial and aesthetic benefits (such as the ability to substitute for windows in some cases, and to act as natural lights).

Mr. Áron Losonczi is a 27-year-old architect from Csongrád who recently came up with the LitraCon idea while he was studying at the Royal University College of Fine Arts in Stockholm, Sweden. The idea became so successful that Mr. Losonczi has created a company by the same name to commercialize his idea and bring it to the mainstream.

"In theory, a wall structure built out of the light-transmitting concrete can be a couple of meters thick as the fibers work without any loss in light up to 20 m," explained Losonczi. "Load-bearing structures can also be built from the blocks as glass fibers do not have a negative effect on the well-known high compressive strength of concrete. The blocks can be produced in various sizes with embedded heat isolation too."

to hide something inside. Upon finding a candidate image file, you can check its data-hiding capacity:

```
C:\steghide> steghide —info coverfile.jpg
"coverfile.jpg":
 format: jpeg
 capacity: 9.0 KB
Try to get information about embedded data ? (y/n)
```

Now find a file to embed no larger than the cover-file's capacity. Once you have your "secret message" and your cover-file, you may embed the secret:

```
C:\steghide> steghide embed -cf coverfile.jpg -ef secretfile.txt
Enter passphrase:
Re-Enter passphrase:
embedding "secretfile.txt" in "coverfile.jpg"... done
```

Note that it asks you for a password. If you ever forget the password, steghide will be unable to determine whether a message is present in the future.

Now all that's left to do is to see for yourself whether it worked. Move the original secret file out of the directory and recover it from the stego-object you have created:

```
C:\steghide>steghide extract -sf coverfile.jpg
Enter passphrase:
wrote extracted data to "secretfile.txt".
```

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