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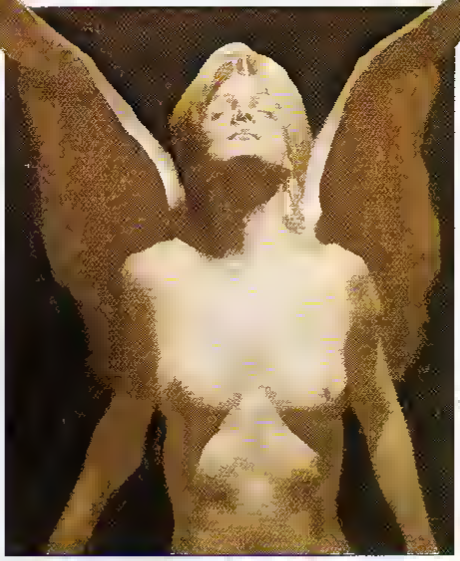
DEPARTMENTS



A mighty rocket ship settles gently onto the rocky terrain of an unknown world on this month's cover (Chris Moore/Artbank). Inside the magazine are stories about internal journeys to equally exotic states of mind: past lives and beyond life as we know it.
(Additional art and photo credits, page 67)

FEATURES

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FIRST WORD

ANTICIPATING TOMORROW'S TECHNOLOGY NEEDS
Ties between academia and industry must be strengthened

By Thomas Dean

Creating new technology is only a small part of how academic institutions participate in producing and refining technology. Academics in computer science depend upon interaction with industry for applications to drive their research. Industry profits from this interaction through solutions and deeper understanding of its problems, and also gains a continuing source of scientists and engineers with broad training and specific insight into technologically relevant issues. Yet despite this mutual dependence, significant interaction between academic and industrial institutions is rare and has become rarer in recent years.

"Significant interaction between academic and industrial institutions is rare," says Dean, "and has become rarer in recent years."

Academic/industrial interaction serves the interests not only of individual companies, but of U.S. industry as a whole. The academic pursuit of generality and elegance of exposition is a driving force to support the transfer of ideas and the generalization of insights won in the pursuit of more narrow, product-driven research. Academia can be a technological conduit between industries isolated by competition, a conduit distributing not application-specific trade secrets, but general principles and widely applicable methodologies. Some of the major consequences of the current lack of interaction include the frequent duplication of design effort, the failure to recognize and exploit the more general lessons to be learned from narrow technical solutions, and a generation of engineers ignorant of the problems driving technology and ill-prepared to solve those problems.

At Brown University for the last six years and Yale for two years before that, my colleagues and I carried out research on database systems for reasoning about events and facts that change over time. By working closely with software developers in both academia and industry, our ideas have seen a great deal of practical refinement and have become part of the repertoire of a growing number of software developers. These results would not have been possible without close interaction between industrial and academic researchers.

In contrast, recent research at Brown and elsewhere on controlling physical robots that interact in the real world and nonphysical robots that interact in the world of networked computers has aroused little interest from industry. The result of this disinterest is that the technology remains in an undeveloped form, graduate students continue to look at the theoretical implications but have little guidance regarding particular applications of interest to government and industry. With few exceptions, United States industry does not see the field of mobile robotics as an area of expansion.

Contrary to the ivory-tower puzzle-palace image that some like to paint of academia, academics welcome industrial interest, with or without attached funding. Academia needs industry as a source of problems to ground its research and prepare its students. Industry needs academia to provide a steady stream of scientists and engineers and to provide a longer-term perspective on the problems it faces. The long-term, knowledge-driven perspective of academia complements the short-term, product-driven perspective of industry. Cooperation in which both parties retain their autonomy benefits both academia and industry.

Industry must realize that long-term profitability depends upon close ties with academia. Academic/industrial cooperation is not a luxury to be maintained only in times of economic health; the production of technology and technologists can not be turned on and off like a faucet. Yet large companies are now withdrawing support for long-term research and development (four-year and longer lead times) in favor of short-term projects involving small advances in existing technologies. This trend must be reversed if we are not merely to live off the reserves left over from past decades of research with no vision to take us into the twenty-first century. ☐

Thomas Dean is associate professor of computer science at Brown University and co-author with Michael Wellman of a recent text, *Planning and Control*, Morgan Kaufmann, 1991.

COMMUNICATIONS

READERS' WRITES
Illusions of grandeur, moving to Venus, and having a cow

The Fault Lies Not in Themselves
"Grand Illusions," in your June 1992 issue does an injustice to some of the great discoverers of the past 500 years. So what if they twisted or deemphasized data? Their greatness lies in their intuitive reasoning, leaps of logic, and hunches, if you will, about the workings of the universe. Without their intuition, scientists would be reduced to accountants and dry historians, not to mention that we'd still be in the Dark Ages.

E. Marcus
Tel Aviv, Israel

I hope that you will follow Linda Marsa's article on scientific fraud with an article on the suppression of honest and accurate research by the vested interests of scientists in their theories, of foundations in their programs, of pharmaceutical corporations in their products, and the FDA in its political correctness. Restraint upon inquiry and publication especially with regard to life-enhancing and life-saving procedures is as dangerous to the scientific enterprise and to the public as is the perpetration of fraud.

Mary McDermott Shideler
Boulder, CO

Loved Levendis
I haven't read a more powerful or enjoyable short story than Harlan Ellison's "The Man Who Rowed Christopher Columbus Ashore," [July 1992] in years. *Please* give us more of Mr. Ellison.

John M. Robbins, D.C.
Chino, CA

Oh Venus
Christopher McKay's interest in terraforming Mars [Interview, July 1992] seems like beating a dead horse—or at least a dead planet—when we have a hot prospect like Venus on which to speculate. The present high temperature on Venus is the stumbling block. Are there high plateaus or deep caverns where the temperature might permit inoculation with bacteria? Present bacteria thrive in water on earth near volcanoes in environments over 212°F. Could mutilated bacteria do better? This could jump-start the evolution of Venus to an Earthlike atmosphere and temperature. Could bacteria be cultured to exist in the low H_2O environment? I'd like to see some speculation on this by a biologist.

Frank G. Pollard
Farmington Hills, MI

Cow Economics
I found your interview [June 1992] with Garrett Hardin deeply disturbing. I agree that overpopulation is an issue of great concern in the world today. I also agree with Hardin that there are a lot of dangerous ideas being circulated in our society about the issue of population. Unfortunately, Hardin's ideas are some of the most dangerous, because they allow the wealthy of this world to shift all the blame to the poor without questioning their own consumption-oriented lifestyles. Hardin's ideas also obscure the relationships between the affluence of the "developed" countries, the poverty of the majority of the world's people, and the implications this poverty has for the questions of population and environmental degradation. To use Hardin's analogy, we do not have a condition in which each person starts with one cow, while the remaining 10 percent have six or seven cows apiece grazing on the common land. Hardin seems to focus on the 90 percent of the people who are forced by their poverty to do whatever they can to survive rather than on the overconsumption of the 10 percent who control over half of the world's wealth.

Robert Ballinger
Syracuse, NY

Thank you, and Garrett Hardin, for the excellent article on the world's greatest problem—overpopulation. Regarding the efforts of many well-intentioned people to save the children: Remember the children you save this year, you will also have to save next year.

George Warnock
Winnipeg, Manitoba
Canada

DIGS

STONES ON THE SCREEN

Computer visualization gives archaeologists a dazzling glimpse into the past

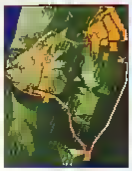
By Gregg Keizer

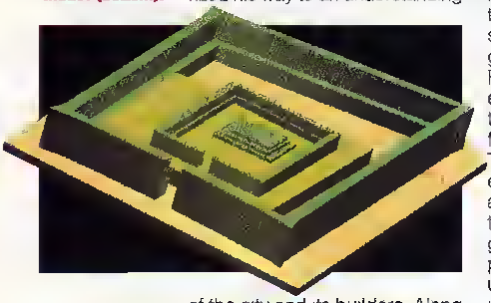
William Ayres may not move mountains, but he does move huge blocks of stone with just a finger.

Ayres, an archaeologist at the University of Oregon, puts powerful computers to work digging into the past. Using computer-aided-design (CAD) software, a familiar tool to architects, Ayres plays with three-dimensional simulations of one of the Pacific's most intriguing archaeological sites, Nan Madol.

On Pohnpei, a volcanic speck among the Caroline Islands, natives built a city in a shallow lagoon by dragging quarried stone to the shore and erecting structures that rose 25 feet above high tide. Between 500 and 1500 A.D., they created a complex of nearly 100 artificial islets reaching about half a mile into the water. Filled with temples, tombs, and homes of the religious and political elite, Nan Madol served as the stage for elaborate rituals. During his 13 summers at Nan Madol, Ayres has dug and theorized his way to an understanding of the city and its builders. Along the way, he helped pioneer CAD in archaeology.

With computer-aided-design software, archaeologists have analyzed the routes Hernando de Soto may have taken through the American South (top) and re-created tombs from ancient Nan Madol (bottom).





"CAD is useful because it's really difficult to visualize relationships and architectural features when the structure has been destroyed," Ayres says. "But we can rebuild it on the computer."

Measurements and drawings pinpointing each part of a structure, attained through traditional archaeological methods, provide the data the CAD workstations and software need to re-create the monument. Ayres then "picks up" the pieces and puts them back together, juggling them until the fit seems right. "We're reconstructing what the original architecture was like—the house foundations, the platforms, the enclosures that we actually see when we map the structures today," Ayres says.

Such computer re-creations offer hints of what Nan Madol was really like. "The technology helps us interpret how the islands were actually used and the activities that took place there," Ayres says. "We're in a better position to understand how it archaeologically evolved from a complex of very small, simple, artificial islands to a massive center of 100 artificial islands of various sizes and shapes and functions."

Ayres isn't alone in his CAD connection. James Wiseman of Boston University is in the preliminary stages of his exploration of the region around Nicopolis, a city the Roman Emperor Augustus founded in 29 B.C. to celebrate his victory two years earlier over the fleets of Antony and Cleopatra. The ancient towns and fortresses near Nicopolis will be picked apart electronically using everything from satellite imaging to ground-penetrating radar. "We plan to record above-ground monuments and to transfer the data into a CAD program and then carry out some 3-D computer reconstructions," Wiseman says. The Greek Archaeological Service, a co-sponsor of the effort, hopes the project will provide valuable information needed to help protect ancient sites threatened by encroaching development.

Several hundred miles to the east, in northern Syria, teams from the University of Melbourne in Australia have excavated el-Qitar, an ancient mountaintop fortress overlooking the Euphrates River. Back in Australia, Clifford Ogleby, manager of the university's Computer-Aided Design Centre, helped archaeologists create 3-D simulations of el-Qitar, complete with walls, gates, and towers. The Australians even added movement to their re-creations, producing animated views of the city as it might have looked to attackers approaching on the river.

Closer to home, Fred Limp, director of the Center for Advanced Spatial Technologies at the University of Arkansas in Fayetteville, has built computer simulations of Hernando de Soto's sixteenth-century expedition through the South. "We use the technology to visualize different routes," Limp explains. "We look at the most probable and analyze such things as slope and steepness of the area and then compare those to de Soto's narratives." The 3-D models confirmed some of the paths archaeologists believe de Soto took from the Mississippi River to the Ouachita Mountains, and eliminated others.

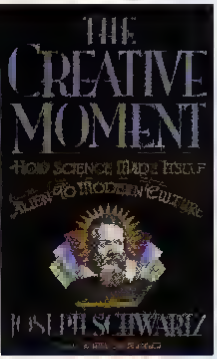
"One of the most difficult things about American archaeology north of Mexico is the absence of stone architecture," Limp notes. "What we've got are literally holes in the ground. GIS [geographical information systems] software lets us see what it all looked like."

Limp has used computers in his work for 15 years, and he's convinced that they will become only more vital to archaeology. One day, he declares, we'll walk through simulated exhibits in a museum or routinely use our home computers to re-create monuments of the past. ⊠

BOOKS

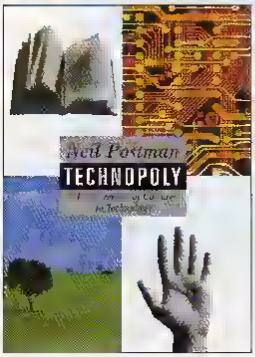
THE SOUL IN THE MACHINE
Reconnecting ourselves with the meaning of science

By James D. Hornfischer



The brainy physicist who, despite his knowledge of warped time and curved space, cannot fix a flat bicycle tire is a justly celebrated American folk hero. His awkwardness with practical matters puts his expertise into perspective. He's human, and he's aware of his limitations.

Joseph Schwartz is such a physicist. In *The Creative Moment: How Science Made Itself Alien to Modern Culture* (HarperCollins, May 1992), Schwartz recalls traveling to the Ukraine in the 1960s to visit his family. A student of high-energy physics at Berkeley, he tried to explain the gist of his studies to his grandmother. Somewhat overawed, she innocently asked whether he could repair her television. He couldn't. It bothered him. Using this revelation as a springboard to larger issues, Schwartz argues that Americans are missing the point, the meaning, of science.



So what exactly does science "mean"? According to Schwartz, "Science is an accumulation of written narratives about our relationship to nature." He argues that when science lost touch with nature, the general public lost touch with science.

When Galileo used math to avoid Church persecution, he began a trend which made science less meaningful to the average person.

But how could science lose touch with nature, the very object of its inquiry? To answer the question, Schwartz looks to history. When Galileo's study of the motion of heavenly bodies ran him afoul of the Catholic Church, he chose to couch his arguments in the cryptic language of mathematics. The general public was powerless to understand Galileo's ciphers, the Pope was pleased, and a trend was begun.

Isaac Newton too deliberately clouded his theories about gravity and motion with the symbols of math. His *Principia* opened the door for the onset of a mathematical babel in science for the next three centuries. "Number has become irrationally reverenced," Schwartz writes. "The form in which understanding in physics is expressed has been mistaken for the understanding itself."

Nowhere is the misunderstanding more profound than with Einstein's theory of general relativity. Today Einstein is the paradigm of the arcane. But it was not always so. In the five years after its publication in 1916, relativity energized revolutionaries. With its basic notion that nothing is absolute, that even the experience of time itself is not uniform but varies with an object's velocity, it overturned assumptions about the structure of the universe. However, the spread of industrialization in which complex products spilled forth miraculously from mysterious factories, alienated people from the processes of science and technology. Not knowing how their radios worked, people gave up on trying to connect relativity to their daily lives. Einstein became a wizard, his theory strange runes on parchment.

In today's labs, researchers in many fields accept physics as the queen of the sciences. Molecular biologists, for example, scrutinizing ever-smaller particles of living matter, look past the larger processes of nature that might show the way to cures for diseases such as cancer and AIDS. "For the physicist," Schwartz notes, "to understand the quark is to understand the world. The rest is just detail." It's like trying to understand the game of baseball by taking a microscope to a catcher's mitt.

The vital questions are: Can scientists change rigidly held mechanistic strategies and reconnect with nature? and, How can we, the public, pressure them to do so when the necessary expertise is limited to experts able to communicate only with each other?

This dilemma is at the heart of another important book on science and culture. Neil Postman's *Technopoly: The Surrender of Culture to Technology* (Knopf, February 1992). A mischievous spirit, Postman suggests an experiment. Tell a friend that, according to a recent study, the more people jog, the less intelligent they become. (You can make up any wild claim you like.) Postman has found that two-thirds of his subjects will not wholly disbelieve such crazy theories. Why? He proposes that science's revelations are so commonly perplexing that we've lost a consistent picture of the world that could be used to assess a given idea. Our judgment has been cowed by the "thought-world" of Technopoly, in which the findings of endless studies wield unquestioned authority without a sense of meaning or purpose. Technology, which once served us well, spawned Technopoly our master.

By advocating science criticism, much akin to criticism in the arts, Schwartz and Postman wish to restore science's relevance to the larger culture. While they are better at defining problems than finding solutions, they thoughtfully build upon the work of such thinkers as C. P. Snow and (Postman particularly) George Orwell. If you worry about where the dizzying technological developments of our day might lead us, both of these books deserve some time in your lap. ∞

SPACE

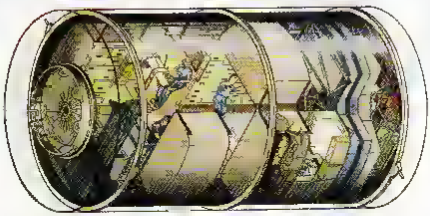
DECORATING FOR LIFE 300 MILES UP

Making the space station livable requires more than rugs and curtains

By Steve Nadis

In 1985, a year after Ronald Reagan endorsed the construction of a new U.S. space station, design work began on the station's private crew quarters. The designers figured that a 150-cubic-foot cabin would enable astronauts to work and sleep in different positions and even have a private conversation with a colleague. Then budget cuts limited the crew quarters to 75 cubic feet, about the size of a telephone booth. Still, at least astronauts would have the personal space considered essential for life in confined environments. However, when the station was scaled down yet again in 1991, the crew quarters disappeared altogether. They've been replaced by "privacy accommodations," which consist of sleeping bags that the crew must tether to the walls,

Current plans for the habitation module on the U.S. space station *Freedom* include places to eat, meet, and exercise—but no private crew quarters.



says Joe Hale, a human-factors engineer at NASA's Marshall Space Flight Center.

Trying to make the craft's interior livable while the entire structure has been reconfigured time after time has sorely tried the patience of those involved in the project. The basic contours of the space station have been resolved—for now. It will consist of a 28-foot-long U.S. lab module, two 44-foot lab mods, one European and one Japanese, and a 28-foot U.S. habitation module for sleeping, eating, and exercising. The shuttle will drop off four astronauts for missions lasting between 90 and 180 days.

To avoid disorientation that may occur in a weightless environment up and down will remain constant throughout the entire ship. The floors on all the modules will be on the side of the craft facing Earth. The shades of paint on compartment walls will provide further orientation: lighter ones on top and darker ones on the bottom. "On Earth, we get our cues for which way is up from the natural environment," explains Yvonne Clearwater, a NASA Ames environmental psychologist and head of the habitability research program. "Even underwater, it's almost always brighter above and darker below."

Reversible wall panels with different colors and textures will give astronauts the chance to modify their environment to some extent, and lighting effects can also make the modules more appealing. "Uniform lighting is boring, it allows you to see all the space at the same time," Clearwater says.

Windows are a key design element because they offer "psychological escape," according to Jim Wise, a human-factors psychologist at Battelle Pacific Northwest Labs who has worked on the space station design as a NASA research contractor. The space station will have at least one window in the wardroom (dining and meeting area), plus one or two multipaned cupolas that will afford striking views of Earth. Photos or paintings of landscapes can have a similarly relaxing effect. "People like looking outdoors, even if it's only a simulated view," Clearwater says.

On the Russian space station *Mir*, the cosmonauts often prefer watching video images of the homeland to looking out the windows. *Mir* also has a public-address system which broadcasts familiar sounds from Earth—animal sounds, street noises, and music specially programmed for working and eating. Instead of Muzak, NASA's astronauts will be able to listen to anything they want on personal headsets.

With virtually every cubic inch of the space station accounted for, great care goes into the smallest details, including the size and shape of the wardroom table. Decades of research on U.S. and Russian astronauts, submarine crews, and Antarctic teams point to a simple conclusion, notes B. J. Bluth of the Space Station Program Office: "Productivity is related to design. Simple things can be simply frustrating." That's especially true on long-term space flights, which are considered fundamentally different from short space shuttle junkets. "It's the difference between going on a date and getting married," Bluth says.

The longest U.S. mission so far was an 84-day *Skylab* stint in 1973–74. The former Soviets have had much more experience, including a mission lasting a mind-boggling 366 days. Their success stems largely from an uncompromising commitment to the well-being of their cosmonauts.

Human factors hold a much lower priority in the U.S. space program. "We know how to build in habitat features that alleviate stress and boredom, but those are just the things that get axed," Wise says.

The space station may offer worse conditions than its predecessor of 25 years, *Skylab*—a fact Wise considers unacceptable. "If we take out the features that make the space station habitable, the project isn't worth doing in its current form. All we'll demonstrate is that people can't live and work to their full potential in space." ◻

MIND

HEART SURGERY'S HIDDEN HEARTBREAK:
Are heart bypass operations hazardous to the brain?

By Jeff Goldberg

For many patients, bypass surgery is a double-edged sword. Although the operation unquestionably fixes the failing heart, it can exact a mental and emotional toll, with symptoms ranging from a slight loss of IQ to severe depression. As many as one half of all bypass patients may experience persistent psychological side effects, estimates Dr. John Murkin, a Canadian physician who believes symptoms might result from subtle forms of brain damage caused by the surgery itself.

Some of the 400,000 annual bypass patients may experience subtle and lasting mental side effects.

An anesthesiologist on the open-heart surgery team at the University Hospital at the University of Western Ontario, Murkin received funding from the Ontario Heart and Stroke Foundation to work with psychologists and neurologists to test such factors as hand-eye coordination, concentration, reflexes, and short-term memory of 300 patients before and after bypass procedures. Fully half the patients studied had lower test scores seven days following surgery, Murkin found. Despite marked improvement in their physical health, a third of these patients still exhibited subtle mental deficits when they were reexamined two months later.

"Their psychological and neurological performance was clearly impaired," says Murkin. "They changed, and the only event that took place was that they had undergone heart surgery." Murkin cautions that most of the symptoms were mild. "Their intelligence scores are a little lower, they don't handle stress as well, don't make decisions as clearly. They're just not as sharp as they were." Even if the effects are modest— the mental equivalent of gaining ten points on your golf game," according to Murkin— the approximately 400,000 coronary bypass procedures performed in the United States each year provide "a powerful multiplier," demanding further research.

His concern was echoed recently by a six-nation study, published in 1990 by German cardiac surgeon, Georg Rodewald, and Allen Willner, an American psychologist, who found that the aftermath of open-heart surgery can sometimes be marked by stroke, severe cases of anxiety and depression, or even hallucinations. Their study concluded that bypass surgery produces more psychological trauma than any other major surgery, generating emotional disorders in as many as 50 percent of patients.

Now we need to find out how long these problems persist and how we can modify our present techniques to prevent them," Murkin insists. One possible explanation, he thinks, may stem from the fact that to minimize tissue damage to the heart during bypass surgery, the patient's blood is cooled about 10 degrees Centigrade. As a result, levels of CO_2 in the blood decrease. Carbon dioxide is critically important in regulating blood flow to the brain. To compensate for this loss, the doctors routinely add extra CO_2 to the blood as it circulates through the heart-lungs machine, which is used during bypass surgery to pump and filter blood while the surgeon grafts veins from the patient's leg to replace clogged heart arteries.

Ironically, Murkin suspects this process might allow microemboli—tiny particles and gas bubbles—to enter the circulation, causing brain-cell-damaging ministrokes. "We're beginning to think that adding CO_2 while the blood cools is wrong," he adds. "It actually increases blood flow to the brain to levels greater than necessary for normal function. We may be interfering with nature's way of preventing the damage we're seeing. Lowering blood flow is more appropriate during surgery. Less blood flow may mean fewer emboli will reach the brain and, presumably, less neurological damage."

Murkin's provocative findings have been criticized by some colleagues, who contend that bypass surgery's 98-percent success rate against chronic heart disease overshadows any potential for harm. "The benefits far outweigh the risks of subtle forms of neurological damage," states Patrick McCarthy, a staff cardiac surgeon at the Cleveland Clinic. "These patients have a life-threatening disease. A patient should be happy if the only effect is that he scores less well on a test."

Murkin argues that neurological and psychological side effects should not be overlooked in the midst of dramatic strides forward in the operating room. "The normal examination after bypass surgery consists of the physician standing at the foot of the bed and asking, 'How are you, Mr. Smith?' If the patient says okay, you chalk up another medical triumph," Murkin observes. "We're saying that even though we've repaired someone's heart, now he's got a problem with his brain. Maybe it's subtle, but we should look to see whether there are things we can do differently during the procedure that might help to minimize these problems." ☒

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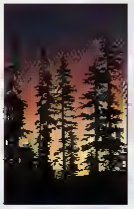
EARTH

OUT ON A LIMB

A grass-roots organization changes the fate of the forest

By Kathryn Phillips



When a tree falls in the forest, this group of environmentalists and Forest Service employees hears it.

After U.S. Forest Service biologist Marynell Oechsner was asked to determine how a proposed timber sale would affect wildlife, she did what she thought was right. She told the truth.

Oechsner believed the logging plan would open too many roads and cut too much timber in important grizzly bear territory in the Kootenai National Forest in northwestern Montana. Unless the plan was changed, the biologist reported, the great bear would be more vulnerable to extinction.

Oechsner soon discovered that the truth wasn't what the Forest Service wanted to hear—at least not in her district, where the timber industry was a big source of jobs and revenue. She would later testify at a Congressional hearing that the district ranger would not accept her report unless she changed it.

Oechsner refused. Within a few months she received her only bad job performance review in 14 years of government service. Oechsner's experience isn't an isolated incident, according to Jeff DeBonis, a former Forest Service employee who founded the Association of Forest Service Employees for Environmental Ethics (AFSEEE) in 1989. In some districts, he says, employees feel pressured to change their environmental assessments to clear the way for timber sales.

What is unusual about Oechsner is that she went public with her problem—recently testifying about it at a U.S. House subcommittee hearing on timber sales. In fact, a quiet internal debate within the Forest Service increasingly is becoming loud and public as employees push for reform. "There's a civil war going on in the Forest Service," DeBonis says.

On one side is Forest Service old guard, dominated by career foresters who believe the agency is right on target when it comes to logging and mining policies. On the other side are employees who think the agency is too beholden to industry.

This reform group is dominated by younger employees, often found among the Forest Service "ologists"—the biologists, archaeologists, and other scientists charged with protecting the forest's fish, wildlife, and recreational resources. Also included are foresters like DeBonis who tend to look at a forest more as an ecosystem and less as a timberman's shopping mall.

In February Congress's Office of Technology Assessment concluded in a report that the U.S. Forest Service isn't doing enough to balance logging demands with the need to protect the forest ecosystem. It was just the latest in a stream of studies that have criticized the Forest Service's resource management.

Forest Service spokesman Andrew Fisher defends the agency, however, saying it works hard to satisfy ecosystem needs and responsibly manage timber resources. "Over 70 percent of Forest Service lands are off-limits to timber harvesting," he says. And, he notes, two years ago the agency launched "New Perspectives" to better integrate ecosystem needs into forest management.

But to DeBonis, the OTA's findings echo what he and many Forest Service employees have been saying for years. Like Oechsner, DeBonis found himself butting heads with his supervisors while working in 1989 as a timber sales planner and administrator in the Willamette National Forest in western Oregon, one of the most heavily logged of the Forest Service's holdings.

One day DeBonis was sent to check the site of a timber sale. "I was appalled," he recalls. A mountainside wash, once thick with tall firs, was cut bald. More logging in the area was likely to cause erosion that would muddy the downstream home of salmon and steelhead. Logging, moreover, would barge through protected spotted owl habitat.

DeBonis wrote a report urging revisions in the plans. When his plan was not accepted, he leaked it to environmentalists. Soon the national press began writing about DeBonis, sparking a public debate about Forest Service timber policy.

DeBonis responded by founding AFSEEE and ended a 12-year career with the agency in 1990 to work full-time for the organization. Today the group has 8,000 members—nearly 2,000 of whom are Service employees.

The organization doesn't bargain for hours or pay, like a union. Instead, it argues for Forest Service employees' rights to express their professional opinions without threat of losing their jobs. It presses the Forest Service to reform. And it has become a key resource for Congress.

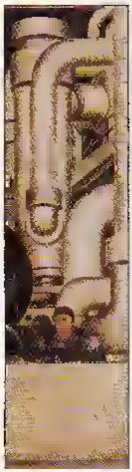
Forest Service spokesman Fisher says AFSEEE's impact on the agency has been negligible, noting that its Forest Service members represent less than 5 percent of the agency's work force. Nevertheless, some district rangers have banned DeBonis from talking to employees, an action DeBonis takes as a sign the agency believes his organization is effective. As Oechsner says, "AFSEEE is helping us small-potato people be heard."

WHEELS

INSIDE AN AUTO PLANT:
Has manufacturing turned up the hype on human surrogates?

By Jeffrey Zygmont

Artist Diego Rivera did not romanticize the laborer's worth: The men in his frescoes strain at back-breaking tasks. He wanted automation to free them from menial labor.



When Mexican muralist Diego Rivera visited Ford's Rouge Complex in 1932 he witnessed an apotheosis of human enterprise. toil and dynamism transforming heaps of iron ore into automobiles He painted it as an intimate synchrony of men and machines. Rivera s frescoes at the Detroit Institute of Arts portray auto making as a self-contained, sealed-off undertaking in which serpentine conveyors choreograph with strong-armed workers beneath idolized turbines It s an infernal world, where perfect order appears chaotic because your senses are simply overwhelmed by the immensity of it

Some 60 years later, the vista within the world's newest car factory mimics Rivera s vision remarkably Chrysler Corporation s Jefferson North Assembly Plant in Detroit contains nearly seven miles of conveyors About 1,000 workers ply the assembly line during each of the plant s two shifts making Chrysler s new Jeep Grand Cherokee family wagons Most of them work in the final assembly section, fitting and fastening parts to car bodies that have been welded together by robots and superhuman handlers People in final assembly work in twos and threes at stations maybe 20 feet apart, walking beside the slowly conveyed car bodies to install brakes and wires and seats and engines and ashtrays even In all, about 1,800 separate parts go into each Cherokee—many like engine and transmission, comprise hundreds of parts themselves A finished vehicle rolls out of final assembly every 80 seconds To appreciate the accomplishment, you have to stand at the midpoint of the central aisle that s as wide as a country highway and takes 460 steps to traverse amid the din and whir and clank of power tools, beneath the ceiling that's three stories up and obscured by criss-crossing beams and ducts and catwalks and conveyor returns and pipes, watching the incessant motion of machine-wielding workers who match their pace to the ineluctable creep of the assembly line

Of course some significant advances in auto making attest to the six decades that have intervened since Rivera painted his masterwork Computer controllers in cabinets the size of bank-vault doors are everywhere Their accession is so advanced that in some sections they banish workers entirely Robots now rule the paint shop where human laborers used to foul up when their arms fatigued from the heavy spray guns The body shop is so automated that a driver atop a yellow forklift looks eerily misplaced as he cruises a wide aisle between the unmanned welding stations where car floors and sides and roofs get fried together to form vehicle hulls

Still Chrysler calls Jefferson North a workers' plant Walls are white and conveyor lines are color coded In magenta, teal, orange, lemon yellow, and apple green Hand tools are more lightweight The plant has playing fields and exercise rooms.

Now it seems that after years of trying to match the capabilities of workers with computer-driven machines, companies are waking up to the obvious people are the ultimate robots, possessing the judgment, the versatility, adaptability flexibility and reprogrammability that machine designers still only dream about.

But machines don't call in sick They occasionally break down, but they never sass back Besides, industrial robots handle repetitive tasks very well Even at Jefferson, the workers' plant automation claims new territory Windshields are installed automatically, whereas Chrysler used to team workers with robots to put the glass in place

The relationship between workers and automation will continue to evolve because human capabilities remain fixed while machine intelligence and dexterity advance Already it s feasible in certain operations to run machines without people as long as workers maintain and set them up Why couldn't the whole job eventually become peopleless?

Before specters of mechanodomination and mass unemployment appear, consider that if the pace of automation is relentless, it is also very slow Sixty years of advances only reaffirms the value of human labor at Jefferson Machines still have a long way to go before they exceed the capabilities of their creators

POLITICAL SCIENCE

HI-TECH JOBS, BYE-TECH JOBS
Just when you thought your fancy white-collar job was safe

By Tom Dworetzky

I was having a bad dream. In it I whipped open the paper and saw the headline: "High-Tech Jobs Follow Low-Leave Country. Nothing Left for Anyone."

The story said that because of the availability of well-educated people in places such as Asia or the Commonwealth of Independent States, multinationals were assigning all of their high-tech R&D work to offshore workers. Phones and faxes were all they needed. Unfortunately, even though I'm awake now, this is not by any stretch just a bad dream.

U.S. leaders excused the loss of our manufacturing base and blue-collar work by saying, "Don't worry, information-based jobs will take their place."

But first a brief historical aside. Consider England in the late 1700s. The biggest Boyz in the Industrial Hood had built their empire by importing raw material and exporting manufactured goods, most notably fine textiles. Their edge: advanced technology in the form of sophisticated automatic looms. American entrepreneurs couldn't just go to Britain, however, and buy their advanced weaving machines. They had to steal them. English law made it illegal for workmen knowledgeable about the looms to emigrate. The former colonies, nonetheless, regularly advertised in the British papers. Noticing one such enticing offer, a young Derbyshire apprentice named Samuel Slater snuck out of his country with all the designs neatly tucked in his noodle and wound up building the first successful textile factory in the United States.

The relevant point: not that crime pays, but that knowledge and technology are unstoppably portable. This is even truer today than 200 years ago. In our global economy, information and knowledge flow everywhere instantaneously. Jobs follow that knowledge.

Public schooling provided an American labor pool able to take advantage of new technology and outproduce its competition. The collapse of our present education system comes at an especially bad time. Simultaneously, advances in transportation and telecommunications allow employers to make use of educated people wherever they are.

The opening of the former Soviet Union, for example, has started to make my nightmare come true. The United States now employs highly qualified high-energy physicists at a Moscow institute for about $21,000 a year. Try buying an American physicist for that. Data entry, typesetting, phone sales, computer programming, and other types of employment have also found offshore havens where workers are skilled, educated, and a good buy.

True, the job-flight deluge hasn't really built up to a tsunami yet. Companies that have attempted to go global with R&D people scattered all over the world have run into problems. The touchy-feely aspect of work is still important. Phones, faxes, and Fed Ex don't really provide a total substitute for proximity. But as fiber optics spreads its tentacles around the planet, as the aerospace plane (ours or someone else's) makes it possible to gather people together in the same room even though they're miles away, the moment of truth will arrive.

Then only efficiency in processing, manufacture, and productivity of our work force will ensure a place at the world's job bazaar. Availability of capital, access to raw materials, and possession of competitive technology will all be equal anywhere on earth. Only a nation's people resources will make the difference.

If we lose our glam-tech gigs, all we'll have left is the export of raw materials (like our trees in the Northwest) and the import of manufactured goods. That's the working definition of an economic colony. That's the short end of the global trade stick.

Say goodbye to lucrative research jobs, hello to the unemployment line. Soon vocations in computer design and programming, physics, and other glam-tech work will go the way of garment and steel-mill work: offshore. The next wave of cheap labor will be the well-educated, sophisticated engineering types working out of Eastern Europe, Asia, the former USSR, and Third World countries. They will do the work for a fraction of the salary of their American counterparts who by then may be gas-pump jockeys if they can find any work at all.

ELECTRONIC UNIVERSE

THE GDAT: Bane of George and Bill

By Gregg Keizer

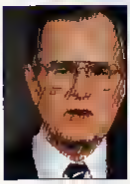
You can just forget about judging the presidential candidates by how they handle the talk-show circuit or even how they cajole the House into transforming position papers into legislation. *We* know how to evaluate Clinton and Bush, with a day or two in front of a computer playing games.

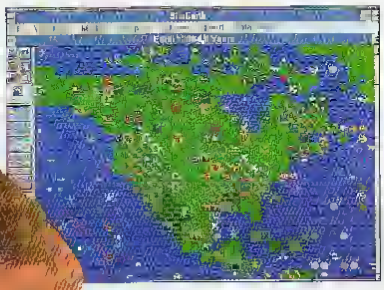
In this electronic universe, candidates can be tested long before we give them the keys to the White House. Think of this GDAT (Game & Digital Aptitude Test) as a political simulator of sorts, a way to put a prospective president in a decision-making crucible without any danger of damaging the country. We make pilots practice on simulators—why shouldn't we let George and Bill practice before they play with the real thing?

The first GDAT task tests patience and perseverance. Set up a no-name PC clone, install *Wing Commander II* on the hard disk drive, and then get the game to run. If a guy can't figure this out on his own (no help from political handlers or Secret Service, please), he'll never puzzle out the country's troubles. Ten points for finishing, five for just getting the PC turned on. This one's a fossil, though Bush supposedly uses a PC in the Oval Office.

Next on the GDAT is a quick game of *Tetris Classic*, that addictive puzzle game where blocks fall from the sky. It'll test reflexes and quick-thinking skills, both essential to dealing with a fast-changing world. How can the president make the right move in Bosnia if he can't in *Tetris*?

Foreign policy's third on the GDAT. Sit Bush and Clinton in front of a PC running *Balance of Power*, a classic geopolitical simulator that puts them head-to-head with the ex-Soviet Union in a game of nuclear chicken. The USSR may be dead, but the game will still reliably test each man's coolness under crisis. Twenty points to anyone who survives the game, and immediate disqualification from the race if the game ends with a nuclear conflagration.





Want to test-drive the candidates? Let's pit them against each other on computer games.

Each man may claim to be the environmental candidate, but why take *their* word? Let's find out with *SimEarth* or *Global Effect*, two games of planetary ecology. Can they turn off global warming or keep an endangered species alive? Manage the forests or manage to eradicate zillions of life forms? Ten points for the best-run planet (as judged by a panel of Nobel Prize winners), five points for simply keeping the world running. Bush will have to cheat on this one, whispers from Gore give Clinton the edge.

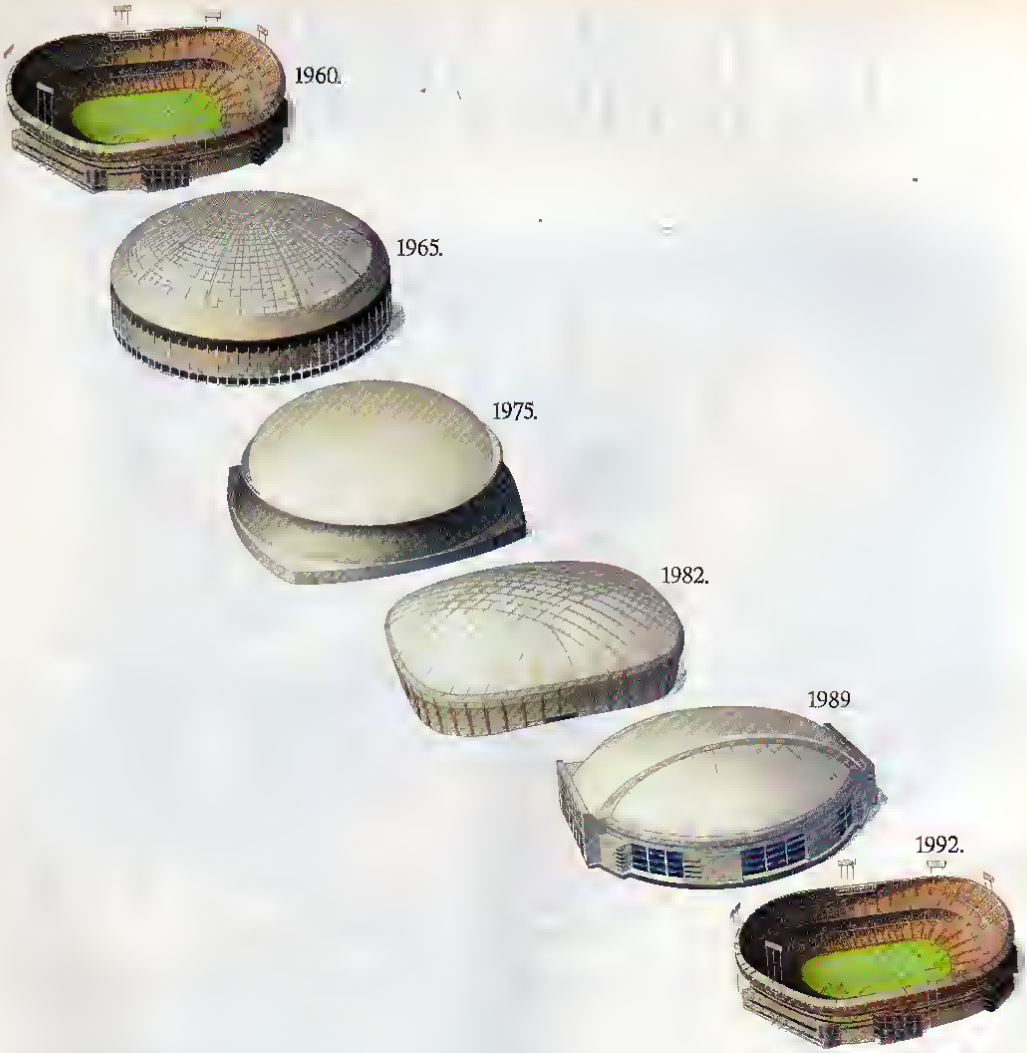
SimCity, SimEarth's predecessor, makes a great inner-city exam. This urban planner on the PC doesn't include South L.A.–style riots, but it'll test the candidates' abilities to manage city growth and even give us some insights into how eager they are to raise taxes. See if Clinton throws money at problems, as his detractors claim, and test Bush's free enterprise zones. Ten points for a happy *SimCity* populous, minus five points if the little people toss the player out of the mayor's office.

Games can't cover everything, of course. There's no budget simulator, for instance, to test each man's skill with numbers. Instead, the GDAT uses a Lotus *1-2-3* or Microsoft *Excel* spreadsheet that tallies up federal income and lists government's expenses. The candidates must fiddle with the numbers until the bottom line's a wash—no deficit allowed.

We can even test candidates for the vice president's spot. In fact, it's easy, since the only skill a VP really needs is golf. We'll run each potential veep through 18 holes of *PGA Tour Golf for Windows*. Bush's man Quayle should capture this easily unless the GDAT throws in a spelling game like Super Solver's *Spellbound!* (*Potato*: P-O-T-A-T-O).

But why stop there? We test kids all the time, looking for the best and the worst. Why not do the same with every politico? Why not uncover the gifted public servants and spot the dullards?

I only want one thing for my idea: the franchise on the remedial classes that'll coach the GDAT. I'll be richer than Croesus in nothing flat. ∞



You always come back to the basics.

CONTINUUM

THE GREAT DINOSAUR RIPOFF:
Striking it rich in dinomania. Plus, huffing and puffing pollution away, and the truth behind the sound bites

Dinosaurs are big—bigger than ever. They are the subject of 300 current books, a prime-time television series, no less than four upcoming movies—including *Jurassic Park*—and myriad decorations from toilet paper to T-shirts.

What's feeding this Mesozoic media frenzy? Our continuing fascination with creatures at once fantastic and real, and a vibrant science, whose odd characters make odder discoveries at an awe-inspiring rate—a new dinosaur species discovered every seven weeks, on average.

But what dinosaur paleontologists realize from dinomania is less than nothing. The total annual budget for all dinosaur explorations around the world is less than $1,000,000. To put this hardship in perspective, consider the problems of transportation alone. Researchers in the former Soviet Union hitchhike to dig sites. Two of the most dinosaur-rich nations on earth, Mongolia and Argentina, have only a single broken-down jeep each for paleontological research.

Journalists and scientists are not taught to be advocates. But somewhere in my travels with dinosaur scientists, the imbalance between dinosaur commerce and dinosaur science hit home. For paleontologist Jack Horner, perhaps the moment of truth came when helping film a documentary at a *T. rex* dig for the Museum of the Rockies, whose entire dig budget—$5,000—was less than the cost of the film canisters. Certainly, dinosaur exploitation hit home for Johns Hopkins University dinosaur scientist David Weishampel when he took his children to see the animated *Land Before Time* and discovered not the slightest resemblance to a true dinosaur world or any acknowledgment of the contributions of dinosaur science.

Many prosper from dinomania, but among scientists only a mediagenic handful are singled out for consultation on toys, rubber robots, or films. Most manufacturers, and too many museums, produce dinosaur images and exhibits based on outmoded or half-baked notions never consulting those who've researched the subject. Instead of a scientifically accurate, engagingly fresh representation, our children get the same stale dinosaur dope.

As a result of commercial misrepresentations and institutional neglect of a science, children's dawning interest in science is often squashed permanently, a process paleontologist Stephen Jay Gould calls "the great dinosaur ripoff."

And the rest of us remain caught in these misperceptions as well. Most Americans, according to a recent poll, believe dinosaurs lived at the same time as primitive humans, when we actually missed each other, Fred Flintstone and Dino excepted, by 64 million years.

What's to be done? As the only previously reliable source of funding for research—government grants—dries up, scientists must look elsewhere for support. And to create better educational opportunities for children, scientists—and journalists—must take on an active role in commerce.

To address dinosaur abuse head-on, I've joined several scientists and popularizers to form The Dinosaur Society, a nonprofit alliance of scientists, artists, educators, and writers worldwide. We've created a monthly newspaper for children, *Dino Times*, with "all the news that's old" and a kid's dinosaur club to give children accurate and up-to-date images of dinosaurs, dinosaur scientists, and the scientific process itself. A quarterly newspaper for adults, *The Dinosaur Report*, fills the same void for older dinosaur aficionados. We're also building museum exhibits, the Society's seal of approval is being awarded to commercial products that achieve our goals, and we're offering manufacturers the services of scientists and artists.

It's too late to save the dinosaurs. But dinosaur science may yet prosper. For information on The Dinosaur Society and its programs, write P.O. Box 2098, New Bedford, Massachusetts 02162.

—DON LESSEM

CONTINUUM

PRESSURE POINTS

Taking blood-pressure measurements may look easy, but it's actually surprisingly difficult. Even many health professionals don't fully understand how to do it correctly. Now a new study indicates that diastolic pressure, the measurement that should register around 80, reads higher when the patient sits on an examining table rather than in a chair.

William Cushman and his colleagues at the Veterans Affairs Medical Center in Jackson, Mississippi, took blood-pressure measurements from 48 people who sat first in a chair and then on an examining table. The researchers found no difference in the systolic pressure, the higher number that should read around 120, but the diastolic pressure rose 6.5 points when the subjects sat on the table.

Cushman, now working at the VA Medical Center in Memphis, Tennessee, is unsure what causes the jump in diastolic pressure, but he suspects that it involves the increased muscular effort required "to keep someone upright on an examining table without back support."

Taking blood pressure with patients sitting on examining tables almost doubled the number of people classified with high blood pressure in Cushman's study; those patients, he adds, did not actually suffer from hypertension.

How should blood pressure be taken? Cushman suggests using a quiet room because even talking can make pressure jump. And the arm should rest at heart level, because a hanging arm will goose up pressure, too. In most cases, a doctor or nurse should take measurements on three different visits before drawing conclusions, because blood pressure varies throughout the day and even seasonally.

—Paul McCarthy

ON THE RADIO

You're listening to the radio, and that song comes on, the one you've loved for years. But you don't know its title or who sings it—because radio disc jockeys often neglect to mention those details. New York City inventor David Alwadish must have had this experience himself, because he has patented a radio transmission system that sends such information, in computer code, over an unused part of a station's bandwidth. A decoder in a specially designed radio receiver converts the code, and *"Let It Be" by the Beatles* or even an advertiser's toll-free phone number lights up the receiver's display panel. Listeners can even store the information on a memory card and print it out later.

While Alwadish talks with radio stations and receiver manufacturers about his invention, the National Association of Broadcasters (NAB) and the Electronic Industries Association (EIA) are promoting a similar European technology called Radio Broadcast Data Service (RBDS). According to Ken Springer, an NAB engineer, RBDS transmits information that allows the radio to identify a type of music or information. "Punch a button on the receiver number panel—G7 for country music, for example—and the receiver seeks out the stations broadcasting that code," Springer says. When a station fades, RBDS car receivers use the codes to seek out new stations playing the type of music you've been listening to. And punch in the code for a traffic alert, and the system switches from a cassette to the radio when a report airs.

The NAB and the EIA are working together to develop code standards, and Springer thinks that RBDS receivers might include some of Alwadish's ideas and make it to the U.S. market in two or three years.

—Francesca Lunzer Kritz

THE FASTEST PHYSICAL ACTION YET RECORDED OF ANY ANIMAL IS THE WING-BEAT OF THE COMMON MIDGE. THIS TINY INSECT NORMALLY CAN BEAT ITS WINGS AT A RATE OF 133,000 TIMES PER MINUTE.

"The antiquity of time is the youth of the world."

—Francis Bacon

IS THE ANSWER BLOWING THE WIND?

Mexico City's air pollution problems are almost as legendary as its Aztec heritage. In March, smog levels in the capital set a new record—four times the international health standard. Residents are tiring of "emergency measures" such as driving bans that are fast becoming the norm. In response, city officials have seized upon a novel solution—run that dirty air out of town.

Mexican scientists have proposed erecting 100 giant fans to send the pollution beyond the mountains encircling the city. The fans, they say, will propel air skyward with enough force to break up the persistent thermal inversions that set in each winter. The city's mayor has approved small-scale testing of the concept.

Local environmentalists have attacked the plan, claiming that it's easier and more effective to control pollution at the source. Jim Brock, a chemical engineer at the University of Texas, agrees. Twenty years ago, he says, a similar proposal called for drilling holes in the San Gabriel mountains and blowing Los Angeles' pollution through them into the desert. "Calculations showed that it would take all the power the state generated just to run the blowers." Although estimates for building the Mexico City project run about $100 million, Brock figures "it would take several hundred million dollars *per hour* just to run the fans."

The blame for the immense cost of cleaning up the atmosphere lies with the laws of thermodynamics. "It's extremely difficult to move dirty air out and clean air in unless nature does it for us," Brock says. "In Mexico City, unfortunately, nature doesn't do that."

—Steve Nadis

Can wind clean up polluted Mexico City?

PAIN, PAIN, GO AWAY

Arthritis afflicts the joints of millions of people—most as they grow older, some throughout life—inflicting intense pain. And until now, there simply hasn't been much the medical community could do about it. Relief from the pain may be on the way in the form of Microdose Therapy, a treatment developed at the University of North Dakota and now in clinical applications at the university's Inflammation Institute in Grand Forks.

Professor Virgil Stenberg pioneered the new treatment. "The results we're getting are far superior to any other treatment in the world," he says.

Stenberg's new treatment is the fruition of more than two decades of research that began when doctors told his wife, Helen, that she had rheumatoid arthritis. Stenberg had little success in his research until 1983, when he read a book about hormones that provided the missing piece to the puzzle.

When the body's tissues become inflamed, the human adrenal gland releases "big pulses" of cortisone, a massive dose as much as three times greater than the small amount normally present in the bloodstream, Stenberg says. After the pulse of cortisone fights the inflammation, the body returns to its normal cortisone level within about seven hours.

However, Stenberg says, "people with arthritis can't produce the big pulse of cortisone anymore." Furthermore, injecting patients with large amounts of cortisone to simulate the body's natural reaction to pain is out of the question. Prolonged exposure to high doses of the hormone produces undesirable side effects.

Microdose Therapy replaces cortisone with its synthetic cousin, prednisone. Over a span of days, patients receive an oral dose of prednisone, which within hours begins to relieve the inflammation and restore mobility.

At the Inflammation Institute, 60 percent of patients treated with Microdose Therapy experienced a greater than 75 percent reduction in their pain. As an added bonus, the treatment, according to Stenberg, costs significantly less than normal arthritis treatment.—Tom R. Kovach

CONTINUUM

THE THOROUGHLY MODERN MATCH

In 1827, the first friction matches, then known as lucifers, came on the market. Now, to make them environment friendly, British researchers have virtually reinvented them.

Sulfur has always been essential to matches. Without it, a match would simply fizz like a firework sparkler and give off a nasty odor. The snag is that sulfur in the atmosphere causes acid rain—and researchers calculate that matches in the United Kingdom alone release more than 100 tons of sulfur dioxide each year. In all safety matches produced by Bryant & May of High Wycombe, England, the country's leading match maker, sulfur has been replaced by ferrophosphorus, a combination of phosphorus and iron used to make high-grade, low-alloy steel. It increases the combustion temperature of the match head, producing a readily ignitable phosphorus vapor.

To stabilize the glue binding all the components of a match head, the firm used zinc oxide. But this polluted rivers, spurring the manufacturer to supplant it with limestone.

Potassium dichromate, a red crystalline salt prepared from chrome iron ore, "acted as a sensitizer," says technical director Mike Cox. "Without it, you'd have had to use more force to get a light. The trouble is that it can cause ulcers and, in cases of intense exposure, rot the nasal cavity. By incorporating more air into the match-head composition, we've found a way of making matches burn just as brightly without it."—Ivor Smullen

A clean burn. Making the humble match safe for the environment

FILL 'ER UP—WITH TEN KILOWATT-HOURS

In just six years, strict clean-air regulations will force droves of electric cars to hit the streets of California, New York, Massachusetts, and possibly other northeastern states. While electric cars emit far less pollutants than conventional automobiles, they usually run on energy supplied by polluting power plants. To increase the cars' clean-air benefits, some of the electricity to run them must come from sunlight. Part of the answer may be solar-energy installations at parking lots for recharging car batteries.

The "solar carport," the first such facility in the United States, will open this month at the South Coast Air Quality Management District (AQMD) headquarters in Diamond Bar, California. A 2,100-square-foot array of solar cells has been mounted above a section of the headquarters parking lot. Five parking spaces now have plugs that carry electricity produced by the solar cells to the car batteries. Excess electricity will go back into the normal power grid.

Air-quality officials hope that this demonstration will spur the construction of similar structures at shopping centers and office parks. "Some folks get nervous about the prospect of not having enough power to get back home," explains Nick Patapoff, project manager for Southern California Edison, which built the AQMD carport. "This will extend the range and usability of electric cars."

An estimated 200,000 electric vehicles will roam California's roads by the year 2000. "Systems such as this could provide 10 percent of the electricity for these vehicles," Patapoff says. "And fortunately, the solar carport occupies just a small fraction of the space already available at business and shopping-center parking lots."

—Steve Nadis

CONTINUUM

CALL BEFORE YOU VOTE

If you're torn between voting for George Bush or Bill Clinton and want to know more about how they stand on issues, Project Vote Smart can probably provide the answers you need.

Run by the Center for National Independence in Politics, Project Vote Smart offers a voters' hotline that provides information on the voting records, campaign contributors, issue positions, and backgrounds of all candidates for governor, Congress, and the U.S. presidency. In addition, operators have access to performance evaluations on the candidates given by about 60 different special-interest groups.

The project's nearly 200 volunteers manning the phones are trained to respond impartially to callers. If an operator supplies information on a candidate's environmental record, for example, the operator must not make judgments, even at the caller's request, about whether the record is good or bad, says Renee Harber, assistant director of the Center's public-information department.

The factual information dispensed by Project Vote Smart comes from impartial sources: the voting records and biographical information from the *Congressional Quarterly*, the finance data from the Center for Responsive Politics, which gets its data from the Federal Election Commission. The project's staff also sent candidates a questionnaire earlier this year to assemble their positions on various issues. Some candidates have filled them out; among those who had declined to reply at press time were Bush and Clinton.

Richard Kimball, the Center's director and a former Senate candidate, started Project Vote Smart a few years ago with the Center's sterling and amazingly diverse list of supporters, including famed conservative Barry Goldwater and equally famed liberal George McGovern. Fed up with the way political campaigns try to manipulate voters with slick commercials and pamphlets, Kimball wants to "put control back in the hands of the voters," Harber explains.

To maintain its nonpartisan stand, the Center only accepts contributions from its 20,000 members and grants from nonpolitical foundations.

You can reach Project Vote Smart at (800) 786-6885. By calling (900) 786-6885, you can order the project's *Voter's Self-Defense Manual*, which offers information on your state's Congressional delegation; the call costs $3.50. You can order the manual for only $2.50 by sending a check to Project Vote Smart, 129 NW Fourth Street, #204, Corvallis, Oregon 97330. Center members receive the manual free of charge; to join, send a check for $35.00 (students may join for $15.00) to the address above. —Erin Murphy

A DIVINE NEW WAY TO EXERCISE

Walking on water used to be a privilege reserved for a chosen few. But an Orange, California, physician has changed all that.

Bored with jogging, Alan W. Nayes thought walking on water might have some aerobic value. To test his notion, he invented Aquashoes, which are six-foot-long fiberglass shoes that resemble cross-country skis. The hollow cores of the $200 contraptions provide enough buoyancy to float a 200-pound man, Nayes says. The key to the whole thing lies in ten flaps hanging at an 80-degree angle, attached to the bottom of each shoe.

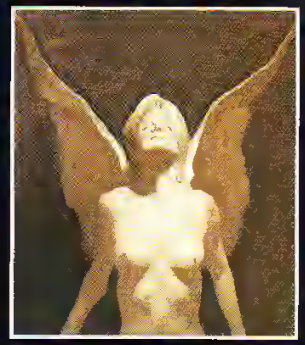
Push one leg forward, and water pressure forces the flaps backward, folding them up parallel to the bottom of the Aquashoe. The flaps on the other shoe, meanwhile, remain almost vertical, steadying the wearer in the water.

Someone well-practiced in the art of Aquashoeing, Nayes says, can glide along at a rather heady 3.5 miles an hour.

Nayes has tested two prototypes, one for people weighing about 165 pounds and the other for people over 200 pounds. "If you weigh much more than that," he says, "you better find some other way to burn off calories," because you'll probably sink.

—George Nobbe

In northern Japan, on certain days in July and September, the dead children "cross the valley." In West Africa, the Ijaw of Nigeria build houses over the buried dead, believing they continue to dwell among the living.



VISIONS OF THE AFTERDEATH

AN EXCLUSIVE OMNI SURVEY

"I think the afterdeath has become our next frontier," says Sukie Miller, psychotherapist and director of the Death and Dying II Project (DDII), a cross-cultural research study on people's beliefs, attitudes, and feelings about the afterdeath. "'What becomes of me after I die?' is one of the most profound human questions," Miller says, "one that people are afraid to voice and sometimes even ashamed to ask." Every culture throughout the history of the world, however, has had an afterdeath system—some cultures have rich, complex conceptions, images, and even maps of the journey—and every major religion has a theology of the afterdeath.

In the first phase of this project, DDII researchers are amassing information on the rituals, myths, scriptures or writings, oral traditions, art forms, and "afterdeath maps" in a dozen cultures around the world including the EGUN, an ancestral cult on the Brazilian island of Itaparika; the cultures Yoruba, Igbo, and Ijaw in Nigeria, as well as the Fon of the Republic of Benin. Researchers are also establishing an afterdeath image library. To date, they have assembled 500 images. Each image is cross-referenced to its country of origin, religious background, date of creation, and current location. Additional projects are to be conducted in China, Russia, Bali, India, Japan—and the United States.

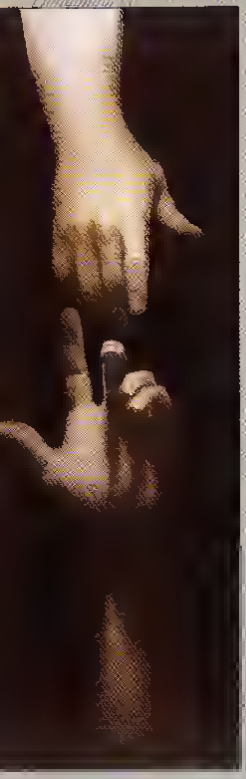
And that's where you, the *Omni* reader, enter, representing, we hope, part of an American "cohort." On the following pages are eight grids covering different aspects of the afterdeath from the preparation for the afterdeath to the environment of the afterdeath. Each grid contains a set of questions, the majority of which require a simple response: Yes/No/Don't know. For some questions, however, you are asked to clarify your response (a blank space is provided).

The questions you are asked to answer have been answered by healers, shamans, kings, diviners, peasants, and professionals—men and women living in small rural villages and in large industrial centers. Some questions are deliberately vague, providing you with the opportunity to tap into ideas that you may not be conscious you are carrying around. If you are religious, you will, of course, answer the questions according to your beliefs about the afterdeath. If you consider the "afterdeath" a religious issue, and you don't identify with any religious tradition, we encourage you to take the survey and note your mental and emotional reactions. In answering the questions, be spontaneous and imaginative. Some of your responses may not even fit into your theoretical or religious framework.

Thinking about the afterdeath may not be "fun"; however, Death and Dying II is the only known research project that is documenting relatively inaccessible beliefs on the subject. Your responses will help researchers who are establishing the field of the afterdeath. As you answer the questions, you may become clearer about what you believe. For those of you whose beliefs in the afterdeath are firm but not clear, self-examination may lead to clarity. "While we will never know in any objective sense the truth of the afterdeath beliefs," Miller says, "considering them carefully is very useful—even in the most painful moments of life."

Who will benefit from this research? A wide range of health-care professionals including hospice workers, doctors, the clergy, and psychologists. Curriculum designers who work with the very young have expressed interest in the survey. One museum is considering developing a show using the Image Library and utilizing virtual reality. "We can't imagine all the potential uses for the data," Miller says.

When you have completed the survey, return it to Omni, 324 W. Wendover Avenue, Suite 205, Greensboro, NC 27408. Mark "DDII" on the envelope. If you want to contribute to the image library, send either photographs or copies of art along with your survey. On the back, include the size of the original, date of composition, title, and where the original hangs. *Do not* send original art. Once the data from this survey has been collected, *Omni* will report back to you on the findings and compare and contrast the afterdeath systems from the various cultures that have been studied.



Today, the grids are being completed in four countries: Brazil, Nigeria, the Republic of Benin, and the United States. Within these countries, eight cultures with thirteen "subcultures" are being studied.

GRID ONE: What's the Afterdeath All About?

1. Do you think of the afterdeath as a journey? Yes ____ No ____ Don't know ____
2. How long is the journey? _____ Don't know ____
3. How far is the journey? _____ Don't know ____
4. Are you transformed by the journey? Yes ____ No ____ Don't know ____
5. Does the individual benefit from the journey? Yes ____ No ____ Don't know ____
6. Does the community benefit from the journey? Yes ____ No ____ Don't know ____
7. Does humanity benefit from the journey? Yes ____ No ____ Don't know ____
8. Is the goal of the journey a return to this life? Yes ____ No ____ Don't know ____
9. Is the goal of the journey to begin another life? Yes ____ No ____ Don't know ____
10. Is the goal of the journey eternal bliss? Yes ____ No ____ Don't know ____
11. Is the goal of the journey "rest"? Yes ____ No ____ Don't know ____
12. Is there a "waiting space" or "resting place" on first arrival?
    Yes ____ No ____ Don't know ____
13. If it isn't a journey, is the afterdeath seen as a specific place?
    Yes ____ No ____ Don't know ____
14. If it isn't a journey, is the afterdeath seen as a specific condition?
    Yes ____ No ____ Don't know ____
15. Do you review your former life? Yes ____ No ____ Don't know ____
16. Do you experience light? Yes ____ No ____ Peace? Yes ____ No ____
    Terror? Yes ____ No ____ Tests (obstacles)? Yes ____ No ____
17. Is there a guide or guides on the journey? Yes ____ No ____ Don't know ____
18. Is the journey or the destination emphasized in your view?
    Yes ____ No ____ Don't know ____

Comments _____

GRID TWO: Who Tells You About the Afterdeath?

1. When do you learn about the afterdeath? Youth? Yes ____ No ____
   Middle age? Yes ____ No ____ Right before death? Yes ____ No ____
2. Who taught you about the afterdeath? Church? Yes ____ No ____
   Parents? Yes ____ No ____ Society? Yes ____ No ____
   In the form of myths? Yes ____ No ____
3. Do you have a primary image for death? Yes ____ No ____ Don't know ____
   Image _____
4. Do you have a primary image for the afterdeath? Yes ____ No ____ Don't know ____
   Image _____
5. Do you have an image of a guide of the afterdeath? Yes ____ No ____ Don't know ____
   Image _____
6. Is there literature that describes your view? Yes ____ No ____ Don't know ____
   Title _____
7. Does art exist representing your view? Yes ____ No ____ Don't know ____
   Examples _____
8. Does your belief system claim knowledge that is secret?
   Yes ____ No ____ Don't know ____
9. Does your belief system have a set of symbols? Yes ____ No ____ Don't know ____
   Examples _____

Comments _____

"Our inability to engage with death not only as grieving and loss but also as poetry, art, ritual, and journey seems to increase our fears and insecurities, all of which contribute to, if not create, illness itself," Miller says.

GRID THREE: How Do You Prepare for the Afterdeath?

1 Should you prepare for the afterdeath? Yes _____ No _____ Don't know _____

2 Does everything you do in life prepare you for the afterdeath?
Yes _____ No _____ Don't know _____

3 Are certain periods in life more important for preparation?
Yes _____ No _____ Don't know _____
Periods _____

4 Check which of the following prepare you for the afterdeath?
Relationships _____ Vocation _____ Finances _____ Sexuality _____
Beliefs _____ Past lives _____ Behavior _____

Comments _____

GRID FOUR: Defining the Afterdeath

1 Is the afterdeath fixed? _____ or flexible? _____ Don't know _____

2 Can those still alive affect your experience of the afterdeath?
Yes _____ No _____ Don't know _____

3 Is the afterdeath defined by how you lived? Yes _____ No _____ Don't know _____

4 Is the afterdeath defined at the moment of death? Yes _____ No _____ Don't know _____

5 Is the afterdeath defined by the rituals at the time of death?
Yes _____ No _____ Don't know _____

6 Is the afterdeath defined by rituals after death? Yes _____ No _____ Don't know _____

7 Is the afterdeath defined by your age at the time of death?
Yes _____ No _____ Don't know _____

8 Is the afterdeath defined by the cause of death? Yes _____ No _____ Don't know _____

9 Is the afterdeath defined by your psychological state at death?
Yes _____ No _____ Don't know _____

10 Is the journey defined by the afterdeath itself? Yes _____ No _____ Don't know _____

GRID FIVE: "Lay of the Land"

1 Is there time? Yes _____ No _____ Don't know _____
Space? Yes _____ No _____ Don't know _____

2 Are there ethics? Yes _____ No _____ Don't know _____
Manners? Yes _____ No _____ Don't know _____

3 Is there good and evil? Yes _____ No _____ Don't know _____

4 Is there a hierarchical structure to the environment?
Yes _____ No _____ Don't know _____

5 Are there animals? Yes _____ No _____ Don't know _____

6 Check which of the following are present in the afterdeath?
Individuation _____ Boundarylessness _____ Creativity _____ Joy _____
Helplessness _____ Delight _____ Rage _____ Dead friends _____
Dead family _____ Sadness _____ Peace _____ Will _____ Passivity _____

7 How do you communicate in the afterdeath? _____

8 Is the afterdeath a world laden with objects? Yes _____ No _____ Don't know _____

9 What do you see in the environment? _____

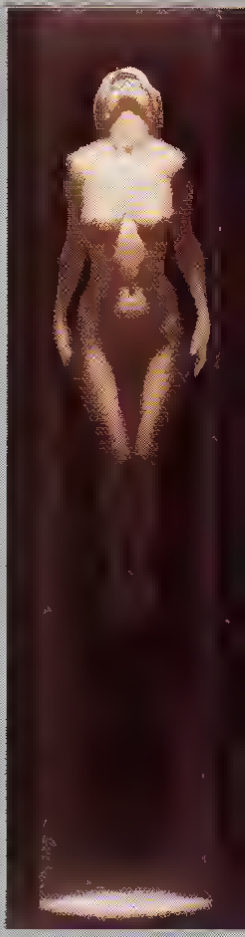
10 What do you hear? _____ What do you touch? _____

Comments _____

GRID SIX: Talk About the Traveler—If You Can

1. Assuming there is a journey, does a traveler (entity) make the journey?
   Yes ____ No ____ Don't know ____
2. What form does the traveler take? ____
3. Is there communication between the traveler and the living?
   Yes ____ No ____ Don't know ____
4. Is there a relationship between the traveler and his former self?
   Yes ____ No ____ Don't know ____
5. Is there a relationship between the traveler and his former body?
   Yes ____ No ____ Don't know ____
6. Is there a relationship between the traveler and his former community?
   Yes ____ No ____ Don't know ____
7. Are people awaiting the traveler? Yes ____ No ____ Don't know ____
8. Does the traveler remain the same throughout the journey?
   Yes ____ No ____ Don't know ____
9. Does the traveler exercise will? Yes ____ No ____ Don't know ____
10. Does the traveler have memory? Yes ____ No ____ Don't know ____
11. Does the traveler have a sense of humor? Yes ____ No ____ Don't know ____
12. Is the traveler masculine? Yes ____ No ____
13. Is the traveler feminine? Yes ____ No ____
14. On the journey, does the traveler change gender? Yes ____ No ____ Don't know ____
15. On the journey, does the traveler remain the same gender?
    Yes ____ No ____ Don't know ____
16. Does the traveler's gender become yet something else?
    Yes ____ No ____ Don't know ____
17. Does the traveler move? Yes ____ No ____ Don't know ____
18. Is the traveler able to see? Yes ____ No ____ Don't know ____
19. Is the traveler able to hear? Yes ____ No ____ Don't know ____
20. Is the traveler able to touch? Yes ____ No ____ Don't know ____
21. Is the traveler able to taste? Yes ____ No ____ Don't know ____
22. Is the traveler able to smell? Yes ____ No ____ Don't know ____
23. What is the energetic nature of the traveler? ____
24. Which of the following characteristics describes the traveler? Delight ____ Pain ____
    Passivity ____ Beauty ____ Ugliness ____ Creativity ____ Ecstasy ____
    Helplessness ____ Despair ____ Happiness ____ Terror ____ Rage ____
25. Does the traveler experience sexual desire? Yes ____ No ____ Don't know ____
26. Does the traveler travel alone? Yes ____ No ____ Don't know ____
27. Does the traveler travel in groups? Yes ____ No ____ Don't know ____
28. Are there other travelers? Yes ____ No ____ Don't know ____
29. Are these travelers divided into groups, classes, types?
    Yes ____ No ____ Don't know ____

Comments ____



"I don't believe in an afterdeath," a dying patient said. "I believe there'll be nothing. I'm too tired. If there were more, I don't think I could stand it. I count on there being nothing."

GRID SEVEN: Proving the Afterdeath Exists

1 Do you have evidence supporting your view? Yes _____ No _____
2 Was the evidence given orally? Yes _____ No _____
3 Did you see the evidence? Yes _____ No _____
4 Is the evidence experiential? Yes _____ No _____
5 Is the evidence technological? Yes _____ No _____
6 Is the evidence in any way material? Yes _____ No _____
7 Is the evidence in written form? Yes _____ No _____
8 Do you think the evidence helps explain everyday events?
Yes _____ No _____ Don't know _____
9 Do you think the evidence depends on a collaboration between the living and the dead?
Yes _____ No _____ Don't know _____
10 Do you have to be in an altered state to understand the evidence? Yes _____ No _____
11 Do you need an interpreter to understand the evidence? Yes _____ No _____
12 Has the evidence been predicted before death? Yes _____ No _____ Don't know _____
13 Is the evidence replicable? Yes _____ No _____
14 Is the evidence reliable? Yes _____ No _____
15 Is the evidence nonverifiable? Yes _____ No _____
Comments _____

GRID EIGHT: The Return Trip

1 Is there a return to this life? Yes _____ No _____ Don't know _____
2 Is it random (accidental)? Yes _____ No _____ Don't know _____
3 Is it determined (fixed)? Yes _____ No _____ Don't know _____
4 Is it determined by the journey itself? Yes _____ No _____ Don't know _____
5 Is it determined by accumulated lives? Yes _____ No _____ Don't know _____
6 Is it determined by willful intent? Yes _____ No _____ Don't know _____
7 Is it determined by the traveler? Yes _____ No _____ Don't know _____
8 If there is a return, when is the time set for the return? Check one
Before the journey _____ During the journey _____ After the journey _____
9 What aspects of the returned life are predetermined? Check
Mother _____ Parents _____ Country _____ Family position _____ DNA _____
10 Are aspects of the next life determined before conception? Yes _____ No _____
11 Are aspects of the next life determined at conception?
Yes _____ No _____ Don't know _____
12 Are aspects of the next life determined at 4 months? Yes _____ No _____ Don't know _____
13 Are aspects of the next life determined at birth? Yes _____ No _____ Don't know _____
Comments _____

PERSONAL DATA

Age _____ Sex _____ Zip Code _____
Level of Education _____
Religion Raised In _____
Practicing Religion _____
Occupation _____
Income Level Below $15,000 _____ $15–25,000 _____
$25–45,000 _____ Above $45,000 _____

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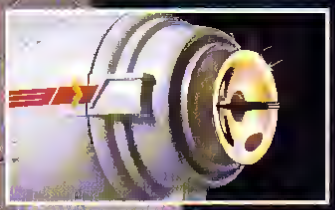

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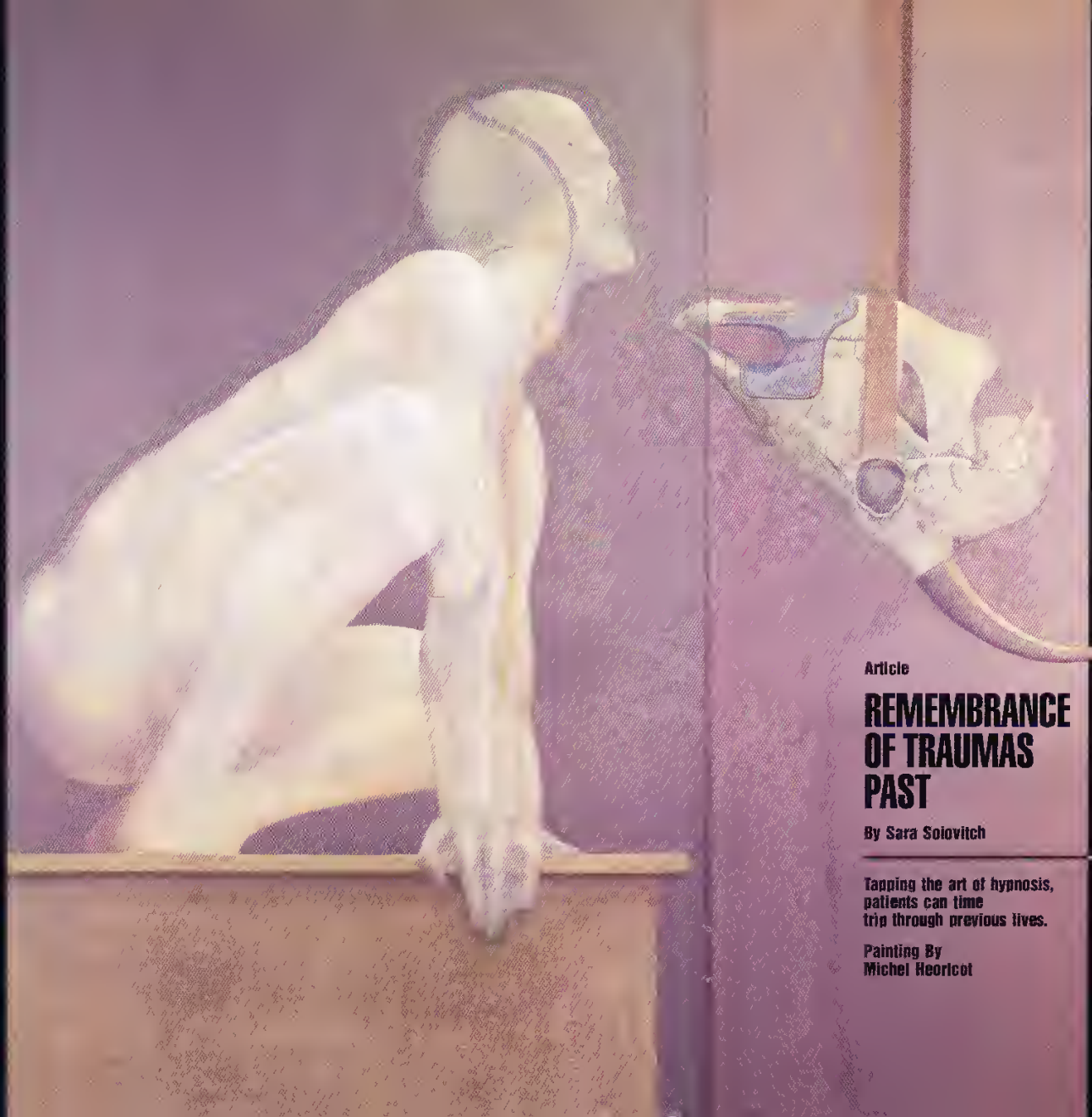


Lifting the shroud of centuries: From the squalor of medieval Europe to the grandeur of ancient Rome, your past lives and loves and unjust deaths may live on as rolling memories of the soul.

Article

REMEMBRANCE OF TRAUMAS PAST

By Sara Solovitch

Tapping the art of hypnosis, patients can time trip through previous lives.

Painting By Michel Heoricot

If Jan's eyes were open, she would see an overcast Miami sky. But her sharp blue eyes are shut tight, and the soothing voice of psychiatrist and hypnotist Brian Weiss guides her through a different sort of scene. Traveling down a deep, dark set of stairs, Jan enters a wondrous garden full of flowers and shade trees. Weiss tells Jan to look down at her feet. Is she wearing sandals? Animal skins? Clearly, he is not referring to the professionally dressed woman sitting zoned out before him in a red blazer, navy-blue trousers, a white blouse, and red patent-leather pumps. Jan opens her mouth to speak, but nothing comes out. Then, slowly, haltingly, she begins to recount a story of life as a man in ancient Greece.

"I see columns," she says, her voice almost a whisper. A faint smile crosses her face as she recognizes the woman she knows in this lifetime as Lydia: "Her name is Claudia and we have a son . . . We're married. I want to say my son's name is Cyrus . . . I'm a soldier. I die in battle sometime. I mean, I don't live my life out with her. . . ."

Impatient, Weiss instructs her to fast-forward to the time of death. "I'm stabbed in battle," Jan blurts out. "It's hand-to-hand. He's so close, the soldier who kills me! I can see him. I'm looking in his eyes."

Whoa! Is this the next step in the evolution of psychoanalysis? Sigmund Freud taught us to look back to early childhood, Otto Rank returned us to the womb. And now a small but growing number of therapists are taking us back even farther. Through hypnosis and guided meditations, they regress their patients to past lives and death experiences whose traumas, they claim, live on as "memories of the soul." It works like this. A man with persistent neck pains sees himself guillotined in eighteenth-century France. And voilà! His neck pain disappears. Dismissed by critics as a gross misuse of hypnosis, past-life therapy is being hailed by some as a fast and effective treatment for migraines, arthritis, phobias, asthma, insomnia, anxiety, and other problems. Its practitioners claim they can accomplish in hours what often takes years to uncover in traditional psychoanalysis.

And their assertions, right or wrong, are grounded in the millennia-old art of hypnosis. Credited with helping patients tap their own healing powers, hypnosis can, according to advocates, aid in the release of endorphins (neurochemicals that relieve pain), fight infection, and widen blood vessels. According to another theory, it alters awareness so that the brain no longer reacts to pain or nausea. There is even speculation that hypnosis may open a direct line to the limbic system, the brain's repository of emotion and memory.

Past-life therapists say hypnosis is so penetrating, it can even peel away lives like the layers of an onion, revealing levels of existence of which patients are not generally aware. While past lives "revealed" through hypnosis would seem to presuppose a belief in reincarnation, however, some of past-life therapy's strongest advocates stop short of conversion. Instead, say many past-life therapists, their

patients' so-called past lives are generated through the special power of hypnosis; the past-life memories themselves are powerful metaphors of the unconscious, helpful to past-life therapy in the same way that traditional dreams shed light on buried thoughts and psychosis during traditional psychotherapy and analysis.

"It's valuable material, which is what I point out to patients when they ask me, 'Is it real, or did I imagine it?'" says Garrett Oppenheim, a certified psychotherapist in Tappan, New York. "The material is just as valuable in therapy either way. You can take it literally or metaphorically. It comes from their unconscious. It has a certain reality for them, and it has a reality therapeutically because it expresses their problems and needs."

The most famous hypnotic regression case of all time, of course, had nothing to do with therapy. It was about reincarnation, plain and simple. Bridey Murphy was the nineteenth-century Irish woman who emerged whenever a Denver housewife named Virginia Tighe was hypnotized by candlelight back in the early 1950s. Tighe's descriptions of life in early-nineteenth-century Cork, Ireland, were hailed for their vivid and seemingly accurate details. When Morey Bernstein, Tighe's neighbor and amateur hypnotist, wrote an account of their sessions, his famous book, *The Search for Bridey Murphy*, provoked a worldwide debate about reincarnation.

It also attracted some of past-life therapy's first practitioners. Those early therapists went on to form the California-based Association for Past-Life Research and Therapies (APRT), an international organization with some 700 members. The field, as represented by APRT, is not particularly strong on "quality control," according to some of its critics. After all, hypnotherapy does not require a license in California—the state that many past-life therapists call home. And APRT's membership roster includes several astrologers, New Age channelers, and one doorman.

But Brian Weiss's credentials are impeccable. A *magna cum laude* graduate of Columbia University and Yale Medical School, he is as traditionally trained and left-brained as any medical doctor in the United States. Until July 1990, he was chairman of psychiatry at Mount Sinai Medical Center in Miami, where he enjoyed a national reputation as a psychopharmacologist.

But that's Weiss's past life.

Once, he would have found such testimony as Jan's hard to swallow. Like the story about her past life as a frail servant girl in a long-ago Middle Eastern country. Doomed to a hopeless existence, Jan saw herself riding in a wagon filled with wet straw. It overturned and she died, trapped and suffocating beneath the straw. After reliving this episode on Weiss's white leather sofa, her chronic asthma dissipated. For the first time in years, she can sleep through the night without waking up gasping for air.

Weiss, 48, recounts this story and others like it without batting an eye. Indeed, he says that his own wife, Carole, was once a medieval European man fatally clubbed in the left temple. This insight, garnered during hypnosis, delivered instant relief from premenstrual migraine headaches that have plagued her for years.

Weiss's transformation began one day in 1980 when a young woman walked into his office on the referral of another physician. "Catherine" suffered from a host of fears and phobias that left her sleepless, always on guard against the next panic attack. Eighteen months of intensive and traditional psychotherapy failed to bring any significant results. Though Catherine seemed to understand the roots of her anxieties, she showed no improvement. In frustration, Weiss finally decided to hypnotize her.

Regressed to the age of 5, she recalled having nearly drowned in a swimming pool. Regressed to age 3, she recalled a long-forgotten night in a darkened bedroom when she was sexually molested by her drunken father. Regressed to age 2, she remembered nothing. And then, Weiss asked her to "go back to the time from which your symptoms arise." Suddenly, the floodgate to 86 different past lives opened.

Catherine remembered drowning in a flood in 1863 B.C., having her throat slashed as a young boy in the Netherlands in 1473, and dying from a waterborne epidemic in eighteenth-century Spain. Her therapy, described in Weiss's much-publicized book *Many Lives, Many Masters*, amazed the psychiatrist. Especially after one session when she announced that her lifelong fear of drowning had disappeared. And with each subsequent session, with each new "memory," another anxiety bit the dust.

But it was the "message" delivered by this patient, says Weiss, that changed his life. After a while, he notes, she began speaking to him in a husky voice later identified as that of a *Master* or *highly evolved soul*. "Your father is here, and your son, who is a small child," the husky-voiced Cather-

"A distinct advantage of not having developed technology is not having to put up the outdoor Christmas lights each year."

ine told Weiss issuing forth, he insists on topics she could never have known on her own "Your father says you will know him because his name is Avrom, and your daughter is named after him. Also, his death was due to his heart. Your son's heart was also important, for it was backward, like a chicken's. He made a great sacrifice for you out of his love. He wanted to show you that medicine could only go so far, that its scope is very limited."

Catherine had zeroed in on a couple of remarkable aspects of Weiss's family history. Yes, his father, Alvin, was a religious Jew who, as Weiss writes, was far better suited to his Hebrew name of Avrom. And yes, Alvin had died of heart disease, and Weiss's daughter, Amy, had been named for him. But even more significantly, Catherine had identified the single greatest tragedy of Weiss's life: the death of his first-born son, Adam, 11 years earlier. The baby's heart had, indeed, been turned around backward, like a chicken's. And when open-heart surgery failed to save his child's life, Weiss reacted by deciding against a career in internal medicine in favor of psychiatry. As Catherine said, he had become convinced that modern medicine, with all its advanced technology, could "only go so far."

To this specialist in brain chemistry, the information offered by his patient, a mere layperson, was earth-shattering. 'A hand had reached down and irreversibly altered the course of my life," he says. "My mind was indeed now open to the possibility, even the probability, that Catherine's utterances were real."

Today, Weiss talks before conventions of Japanese businessmen, hospital nurses, past-life therapists. He has a waiting list of 1,000 patients from around the world, all of them eager to be hypnotized by this latest hero of the New Age. In 1991, he organized a four-day workshop on past-life therapy that drew cardiologists, internists, psychiatrists, and other medical professionals from up and down the East Coast to Miami. Ever since the publication of his book in 1988, Weiss has been bombarded with calls and letters from doctors admitting that they, too, have been experimenting in this field, secretly, behind their closed doors.

Weiss wants to throw open those closed doors.

Last year, with Weiss's encouragement, another credentialed colleague —Spring Lake, New Jersey, psychiatrist Robert Jarmon—stepped out of the closet to take some heat. One of Jarmon's patients, an otherwise rational and successful businessman, habitually became psychotic and paranoid around the time of the full moon. Under hypnosis, the man spoke, in the first person, as an American Army officer during World War II. Caught behind enemy lines, he was interrogated and taken to a river by German soldiers. With the full moon reflecting in the water, he was shot in the head and killed. During an EEG workup, the patient was shown to have a scar-like lesion in the area of his left brain—the same area, according to Jarmon, where the Army officer was supposedly shot in 1944, four years before the businessman was even born.

And there was more. Under hypnosis, the patient recalled the name of the soldier and the small Minnesota town where he had grown up and attended college. Armed with this information, the patient's wife called the school's alumni office. She told a secretary that she was trying to look up an old relative. And, after some searching, the secretary confirmed that yes, the man had graduated college in 1939.

"Just because somebody says something or imagines something doesn't mean it really happened," says Jarmon. "But what I always fall back to is this: Is the patient getting better?" In this case, he says, the answer is a definite yes. After more than 20 years of anguish and paranoid behavior during the full phase of the moon, the problem suddenly stopped; two follow-up EEGs were both read as normal.

Jarmon's first past-life patient, described for his peers in the *Medical Hypnoanalysis Journal*, was a thirtyish woman who sought him out for help in losing weight. "Two months into the sessions," Jarmon reports, "she developed painful swelling and tenderness in the region of her right ovary. 'Anna' had stopped menstruating, and, though she insisted she could not possibly be pregnant, her gynecologist suspected an ectopic pregnancy. As it turned out, Anna wasn't pregnant. Instead, under hypnosis, she claimed to be Elizabeth, a 19-year-old woman in medieval Europe whose baby was 'out of place.'

"The priest in attendance at her bedside would not permit the physician to perform an abortion to save the woman's life," Jarmon explains, "and Elizabeth finally weakened and died." The patient, Anna, meanwhile, described Elizabeth's soul floating out of her body. As she did so, notes Jarmon, "her pulse and breathing became extremely faint, and I immediately brought her out of hypnosis." Anna, who never remembers what goes on in trance, said, 'Well, you finally did it. Thank you. My pain is all

gone.' Later that night she called me to say that her menses had returned."

Another therapist who regularly taps the techniques of past-life regression therapy is Springfield, Missouri, neurosurgeon and psychologist C. Norman Shealy. Though Shealy views past-life memories as little more than "mirror images" of real life, he calls the technique "the single most effective psychotherapy tool I know." It is the job of the psychotherapist, Shealy believes, to "trick" the subconscious into behaving. And past-life therapy does just that. "As symbolic stories created by the subconscious, past lives help patients gain insight into problems," Shealy says. "It is a lot easier to say, 'John Doe in 1600 did so and so,' than, 'I did it in 1969.' It takes blame and guilt away."

To make the point, Shealy cites one of his earliest cases, involving a woman with a spinal-cord injury that had paralyzed her. The woman had come to Shealy seeking relief from the intense pain that seemed to follow her so-called "accident." The woman, it turned out, had no memory of the event that crippled her and believed she had accidentally shot herself while cleaning her husband's gun. Under hypnosis, however, she gave an entirely different explanation. She said she had been Anne Boleyn. And her story was convincing—right up to its historical denouement of her beheading under the order of her husband, Henry VIII.

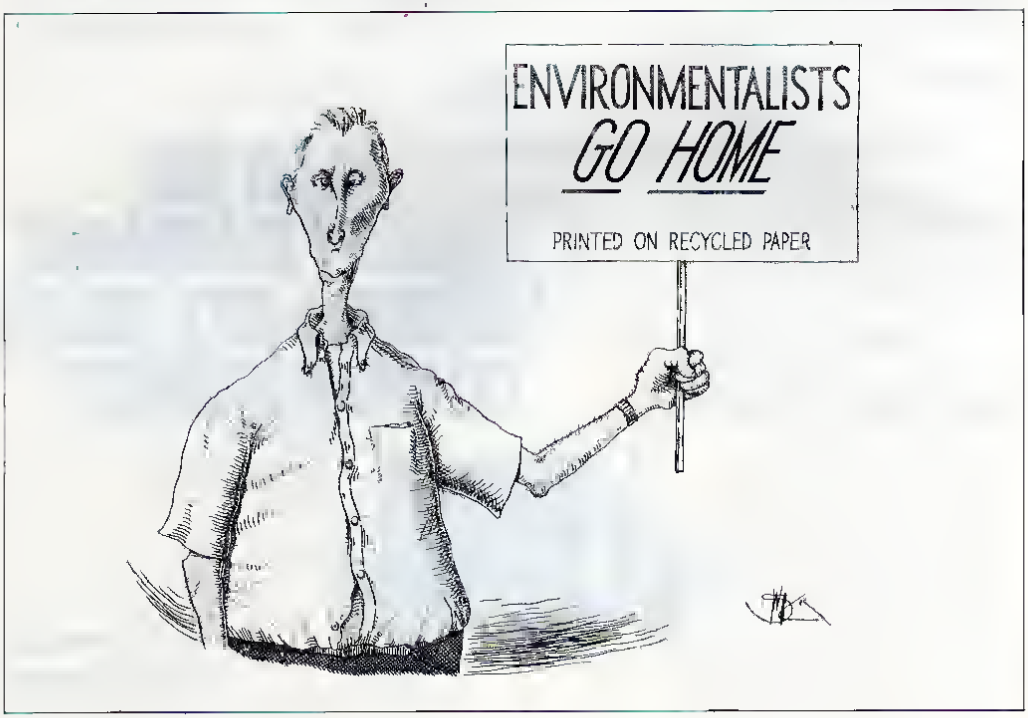
As soon as he brought her out of hypnosis, Shealy confronted the patient with his interpretation of her "memory." He told her that her husband had shot her or, at the very least, that was what she believed. She immediately recalled a violent argument with her husband before everything went black. The pain subsequently subsided and the woman ultimately obtained a divorce, though no legal charges were ever brought.

That makes sense, since information garnered during hypnosis has generally been ruled inadmissible as legal evidence in most courtrooms throughout the country. This reflects mounting evidence that hypnosis cannot be relied upon to enhance memory. In fact, some studies have suggested that hypnosis may actually make memory more susceptible to distortion.

"Hypnosis can put people in a very suggestible state," says Elizabeth Loftus, a University of Washington psychologist who specializes in memory distortion. "I don't think there's anything particularly mystical about this." In fact, several studies have found that patients who say they recall past lives are more easily hypnotizable than subjects who fail to report past lives. One implication, explains Loftus, is that anyone capable of remembering a past life may be highly suggestible. And it is well-accepted knowledge that the power of suggestion is often sufficient for people who want to get well.

"The rationale is not important as long as the patient has faith in the therapist," adds Nicholas Spanos, a psychology professor at Carleton University in Ottawa, Ontario. "That holds true whether you're talking about a witch doctor or a Freudian psychiatrist. If the therapist is a psychoanalyst, the patient will say, 'Now I know it's because I wanted to sleep with my mother.' It doesn't matter what the explanation is. Every person requires meaning in their life, and past-life therapy is one kind of explanation."

Writing recently in the *Journal of Personality and Social Psychology*, Spanos says that past-life memories are really "expectation-induced fantasies." In other words, he explains, past-life regressions are directly influenced by the hypnotist's bias and the subject's own interests and concerns. Spanos's explanation goes a long way toward accounting for why a person with an interest in Florentine art is likely to construct, un-



der hypnosis, a minutely detailed life in Renaissance Italy.

But Spanos' study goes further revealing gross inaccuracies in the historical veracity of past-life memories. 'For instance,' he notes, in one case, a patient who relived life as Julius Caesar "stated that it was A.D. 50 and that he was emperor of Rome. Caesar, however, died in 44 B.C. and was never crowned emperor. Moreover, the convention of dating years as either B.C. or A.D. did not begin until several centuries after A.D. 50. Similarly, one past-life reporter claimed to live in the state of Mississippi in 1780, long before Mississippi became a state. Another claimed to live in Germany in 1866, before Germany became a country."

According to Spanos, even the supposedly air-tight story of Bridey Murphy comes apart under the careful investigative eye. Murphy supposedly walked the streets of Ireland back in 1806. Yet soon after Tighe's revelations were published, it was found that Tighe had once lived with an aunt of Scottish-Irish descent who often regaled her niece with stories about the Old Country. Further investigation found that a certain Bridie Murphy Corkell had once lived across the street from Tighe in Chicago.

Had Tighe deliberately misled Bernstein? Nobody suggests any such thing. Rather the consensus is that Bridey Murphy provides a classic case of cryptoamnesia, a phenomenon first described by the nineteenth-century Swiss psychologist-philosopher-physician, Theodore Flournoy. According to his theory, the human mind is like a library filled with years and years worth of overheard conversations, pictures, newspaper stories, television shows, books, and songs. Nothing is ever lost; everything seen or heard remains on file. Though consciously forgotten, these bits and pieces of information and experience can later form the basis of fully blown fantasies that emerge, under hypnosis, as personal "memories."

"I think the memories are real," says Weiss, "but it doesn't really matter because people get better. To me, it ties in with a lot of the mind-body work going on now. It's related to the new field of psychoneuroimmunology, in which patients can marshal the immune system to fight cancers and other types of disease with the mind. When the mind changes and the mood changes, physical illnesses often get better, too."

Weiss now relies on hypnosis for almost all of his patients, even those *not* involved in past-life regression. "I like doing memory work in that state," he explains. "It's much faster, it goes deeper, it bypasses the usual filters. Things have the intensity of the emotion. Memories are enhanced."

"This isn't a court of law," Weiss adds. "We don't have to prove that every single detail is correct. If there's a degree of accuracy, that's what's important. It's like, if you went back and remembered a trip to the zoo. What difference would it make if there were three polar bears there and you only saw two in your memory?"

So maybe Jan's wife in Ancient Greece wasn't named Claudia. And maybe Jan didn't die in hand-to-hand combat. *Maybe* the only time she's seen Greece is in the pages of *National Geographic*. But upon her return to modern Miami one recent gray morning, she brought back a lesson that, ultimately, had little to do with reincarnation. In all her past lives, Weiss pointed out, she was the one who always died first, leaving her mate behind. This time, she told the psychiatrist, she was committed to the new relationship she had begun. She wasn't going to repeat the pattern of a lifetime—and maybe many lifetimes—by running away (or dying) when things got sticky. This time, she was going to stick around. ∞

SECRETS OF THE CYBERCULTURE

Computer cowboys roam the techno-underground seeking information—or just wreaking havoc

ARTICLE BY A. J. S. RAYL

Something's happening here. What it is ain't exactly clear. There's a punk with a computer over there, tellin' me I got to beware.

It's a time-warp scene in some weird science-fiction story as I head down Telegraph Avenue just outside the Berkeley campus. The smell of patchouli wafts through the air, overwhelming other scents of burning incense. The driving beat of the Doors' "Break on Through" pulsates from a record store—a fitting soundtrack to the movie surrounding me. Sidewalk merchants are hawking everything from tie-dyed T-shirts to turquoise jewelry. Me? I'm on a mission—to meet my connection in the counterculture. It seems conspicuously like the Sixties. But familiar sights, sounds, and vibes aside, things have changed. After all, this is the Nineties. Abbie Hoffman is dead. And no one is attempting to levitate the Pentagon anymore.

But if you thought the revolution was over, think again—and read on. These days, a new breed of young politicized radicals, known as cyberpunks, roam a techno-underground. Inspired and fueled in part by ideas emerging from science fiction literature, these cyberpunks are computer cowboys riding the trails of cyberspace—a nether world of bitstreams and databases inside computer networks—circumventing software barriers in search of information and services or sometimes just to wreak a little mischievous havoc. They've got the equipment and, they say, the technical knowhow to slip into virtually any computer system and affect changes with global ramifications. With the tap of a key, they claim, they could effectively cripple the economy or shut down communications systems the world over. If that is true, then cyberpunks hold the potential for becoming the most powerful countercultural force ever.

The government has taken them seriously. It has launched at least two major operations, one in 1990 called Operation Sundevil, to quash the movement. The problem: The consensus in the computer community is these government agents know considerably less about the technology than the computer experts and the cyberpunks, a charge govern-

PAINTINGS BY PAOLA PIGLIA

ment officials deny. As Secret Service Special Agent John F. Lewis put it, "There are some very talented individuals who are unfortunately misdirecting their energies. But to say they're leaps and bounds ahead of law enforcement personnel isn't true." Still, so far their efforts have seemed dubious at best, serving more to fan the flames of the sociopolitical fire now raging over the control of and individual rights in the electronic frontier.

I duck into a coffeehouse and manage, with relative ease, to spot my connection—one of the hackers for whom the word *cyberpunk* was created. He's tall and slender, wearing black jeans and sporting a pair of John Lennon specs. He has a boyish, almost baby face, which belies the brain power it so handsomely covers. His eyes are intense, at times piercing. Overall, he appears every bit the intellectual anarchist for which the Berkeley scene is perfect.

POP CYBERCULTURE

In the last decade, cyberpunk has seeped from the techno-underground and the pages of science fiction into pop culture—movies, music, comic books, magazines, games, and art. Says cyberpunk writer Bruce Sterling, "The same thing that created us within science fiction created the hackers within the computer community, the musicians within music, and the artists in the art world. We are all products of the same bohemian dynamic."

When did it begin? Ridley Scott's 1980 movie *Bladerunner*, the penultimate cyberpunk film, is one starting point—although the movie, based on Philip K. Dick's novel *Do Androids Dream of Electric Sheep?* actually predates the cyberpunk wave in literature. Other films—such as *Tron*, *Videodrome*, *Brazil*, *The Terminator* and *Robocop*—also project a cyberpunk vision, while TV's first foray into the genre was *Max Headroom*.

Musically, cyberpunk is a politically edged mutation of the technology-based, alternative-rock industrial genre. Infused with the sound of European electronics, it's a seriously aggressive brand of razor-edged rock that jolts you with anti–George Jetson views of the future. While such cyberpunk bands as Ministry and Skinny Puppy are slowly merging into the American rock consciousness, most cyberpunk bands have European roots—including Front 242 (Belgium), Laibach (Yugoslavia), and Can (Germany)—and remain relegated to the cult underground.

According to Paul Barker of Ministry, technology and attitude are the music's defining characteristics. "The technology comes from synthesizers and samplers," he says. "In terms of the attitude, there is a nihilistic vein that comes from the fact that kids are being weaned and spoon-fed on MTV with really banal music. Cyberpunk is the backlash to Bon Jovi and Guns 'N' Roses." While cyberpunk represents the backlash in rock-'n'-roll, it just may turn the performance art scene upside down. The works of San Francisco's Survival Research Laboratories are the classic example. These 'great primordial cyberpunks'—as William Gibson calls them, took the Disney concept of animatronics down a decidely darker path, where creation is only as important as the ultimate destruction.

Headed by Mark Pauline, SRL appropriates various technological devices and industrial-type machinery and creates weird machines and "organic robots" made of dead animals and spare parts, and then turns them loose—in parking lots or under the Brooklyn Bridge. The machines battle each other to a smoking, fiery, explosive, and blood-spurting 'death' accompanied by prerecorded "soundtracks." Also heating up the cyberpunk scene: Seiko Makami, a Japanese "trash assemblage performance artist" who solders sculptures from broken computer boards.

Visualizing cyber culture also challenged comics author Scott Rockwell, who in 1988 wrote *Cyberpunk* for Innovation Comics. "In reading cyberpunk novels and stories, I never could get a perfectly clear picture of what was going on in cyberspace," Rockwell says. "I wanted to take some of the concepts into the primarily visual medium of comics to explore the visual side of the matrix." Meanwhile, Mike Saenz created the first Macintosh-generated computer comic book, called *Shatter*.

Computer games, however, are the obvious medium for cyber stuff. Numerous games have hit the market, including Interplay Productions' *Neuromancer*, based on Gibson's novel. The role-playing *Cyberpunk 2020*, from R. Talsorian Games, has proven so successful that the company is now peddling a Cyberpunk Master Series. Dungeons & Dragons–meisters I.C.E. released *Cyberspace* in 1989 as part of its science-fiction series. And now there's even a collection of electronic essays known as "Beyond Cyberpunk!" for those players who are "Mac"-enabled.

While many pop culture entrepreneurs no doubt view cyberpunk as the latest catch phrase or marketing gimmick with which to lure the rebel faction of new consumers, its genesis was grass roots. "The movement bubbled up from the streets—ideas, concepts, and works," says Howard Rheingold, editor of *Whole Earth Review*, one of several hardcopy magazines covering the cyber scene.

Now that it's finding its way into pop culture, the trick will be to separate what's real from marketed phoniness."—A. J. S. Rayl

Cyber visions: *Bladerunner*, *Robocop II*, and Belgium's cyberpunk band, Front 242.

"ONCE YOU HAVE ACCESS TO THE SYSTEM," SAYS SYNERGY, "YOU BEGIN TO CLEARLY SEE THE BARS OF THE PRISON WE LIVE IN."

camouflage. He's known in the techno-underground as Michael Synergy.

Twelve years ago, Synergy was your basic computer nerd. He spent his time exploring cyberspace, staging his own quiet protests by going where he wanted, when he wanted. Synergy became so adept at infiltrating systems that he's become a legend. Today he remains something of an icon in the techno-underground.

Synergy evolved—as did cyberpunk—from the late Seventies' hacker community. "There were a lot of us playing with the phone systems, and then slowly we began to find our ways into other networks," says Synergy, as he takes a sip of tea, adjusts his Lennon specs, and leans back in his chair. "My whole reason for breaking into systems way back then was to become educated. At that time there wasn't a C-compiler on microcomputers, so I broke into Bell Labs just to learn C." Most hackers used their talents then, Synergy says, simply to learn. For the most part, the original hacker crew was apolitical—more interested in the machines than in the politics.

As they began traversing software barriers into the secured systems of major corporations, government, and military-industrial complexes, however, that began to change. They gleaned a lot of inside, top-secret information on just about everything, including covert military operations. At the age of 14, Synergy, now in his late twenties, managed to slip into a supposedly secure top-secret computer network run by the intelligence community and the Department of Defense. The DOD took him out of cyber circulation and brought him into their circle. He worked for nearly three years conducting "penetration testing and security design" for the National Security Agency, Secret Service, and FBI, as well as the DOD.

Consequently, Synergy became politicized. "It used to be really hard to find things out, but nowadays systems are so well networked together, if you know which machine to talk to in the intelligence community, it's fairly simple to break in," he says. "The work I did for different government agencies gave me an inside view, and that strengthened my opinions. It made me very political and very antigovernment. Once you have access to the system, you begin to clearly see the bars of the prison we live in."

While Synergy was being politicized, writers on the science-fiction front were at work writing about such youthful electronic frontier outlaws. They projected them into dark, desolate, not-so-distant futures where technology both rules and runs amok, and set them in adventures in cyberspace where data serves as the landscape and territories are traversed mathematically, not geographically or physically.

The term *cyberpunk* was brainstormed back in 1980 by Bruce Bethke as the title for a short story he'd written about a computer-hacker gang—bored suburban kids out to raise hell. Bethke had been hanging around, playing keyboards on the periphery of the punk New Wave music scene while working for Radio Shack. "I wanted a word that grokked these punk attitudes and the technologies," he says. The story, which was published in the magazine *Amazing* in 1983, remained obscure—but the title took seed, first in the science-fiction community and then in the media at large.

Robert Morris' worm made a big mess.

The success of William Gibson's first novel, *Neuromancer*, published in 1984, actually launched the cyberpunk wave in science-fiction literature and put the word *cyberpunk* on the map of the collective public consciousness. Set in a future urban dystopia, the novel centers on Case, a software cowboy for hire. Burned by Japanese microbionics experts who bonded tiny sacs of a wartime Russian mycotoxin to his artery walls, Case is suffering a slow death. He finds a man who can cure him, provided, of course, that he is able to penetrate a highly secured computer system and acquire the key information. In order to get inside the various systems, Case links his brain directly to the computer, or, in the terminology of the novel, "jacks in to the net."

While the word *cyberpunk* never appears in the *Neuromancer* text, it was the catch phrase that reviewers used to define his book and the new genre that suddenly seemed to be everywhere. Other cyberpunk-oriented works by such writers as Bruce Sterling (*Schismatrix, Islands in the Net*), Pat Cadigan (*Mindplayers, Pretty Boy Crossover*), and John Shirley (*Eclipse, Corona*) captured SF fans.

Gibson, whose own early influences were such "subversive" rock-'n'-rollers as Lou Reed/Velvet Underground and Steely Dan, had been watching the punk-music scene with a certain enthusiasm. In fact, he says, the rebelliousness of punk served as the inspiration, and his own boredom as the fuel that motivated him to begin work on *Neuromancer* and numerous other cyberpunk short stories (many first published in *Omni*). Gibson wrote two more cyberpunk-oriented novels—*Count Zero* and *Mona Lisa Overdrive*—and garnered acclaim as the godfather of cyberpunk. It's not a title, however, that he's assumed.

"It's really just an accident in history," says the author, whose roots go back to the counterculture of the Sixties. Gibson actually knew very little about computers and high technology. He pounded out his cyberpunk works on a 1938 manual typewriter while listening to early Bruce Springsteen albums. "I didn't set out to start a movement, but for whatever reason," he says, "those books of mine have become a rallying point."

Co-cyber writer Sterling agrees that Gibson was in the right place at the right time. "To some extent, people always credit the messengers," says Sterling, whose first nonfiction work, *Hacker Crackdown*, about the government's efforts to stop hackers, was published this fall. "We write books for a purpose—not just to be cute. Science fiction is about making up weird ideas and throwing them out there. And now all that stuff we were writing about *is* out there—loose in the world."

SONY

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What happened when cyberpunk science fiction hit was a case of life imitating art. 'Suddenly, the concept of cyberspace took hold and inspired the real hackers, and they began to redirect their efforts in the technical arena. It gave us a vision of the technology's potential," says Synergy. "Most computer enthusiasts and a lot of the hackers are very technical, but not very in touch with the world at large. The difference is cyberpunks are very technologically capable but at the same time very worldly, connected to reality and what's going on in the culture."

In essence, the cyberpunks are to the hackers as yippies were to hippies—political, savvy, worldly versions of the alternative culture. They don't hang out in places but in cyberspaces communing, often anonymously, on computer bulletin-board systems or through "zines"—electronic magazines. While there are several hardcopy magazines devoted to things cyberpunk—the most popular being *Mondo 2000*—cyberpunks do their real business in the net.

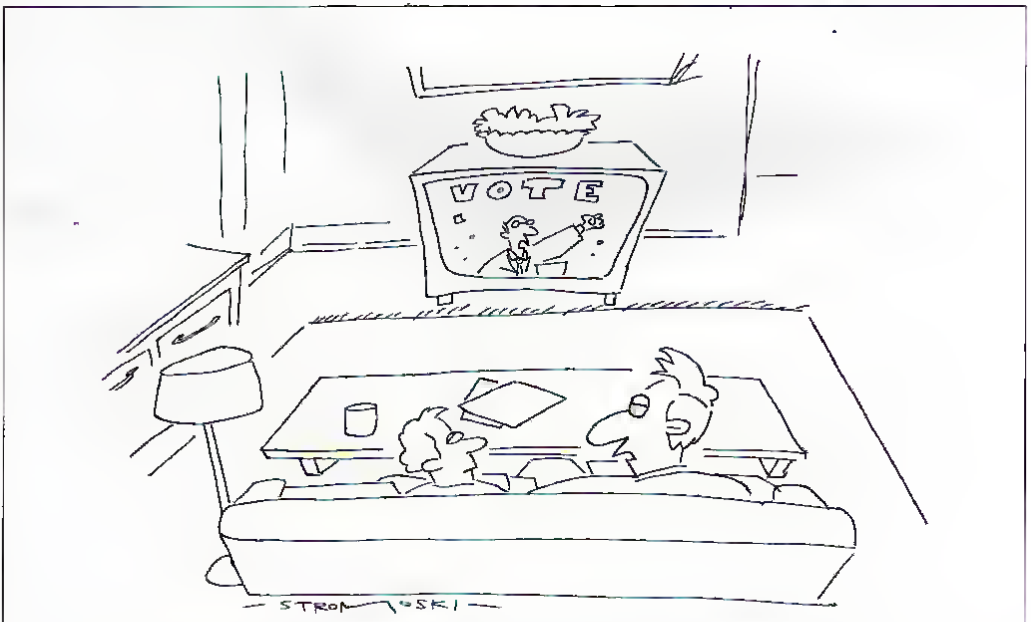
"Listen to these titles—*Anarchy 'N' Explosives, Bootlegger, Cult of the Dead Cow Files, Freaker's Bureau International, National Security Anarchists, Phuckin Phield Phreakers, Rebel's Riting Guild*, and *TAP (Technological Advancement Party) Online*, which is actually the resurrection of Abbie Hoffman's old magazine," says Sterling, leafing through a compilation of computer sources recently sent to him.

The vast majority of bulletin-board systems and zines, however, are legal and aboveboard. In 1985, the *Whole Earth Review* created the *Whole Earth Lectronic Link*, known as the WELL. "While this electronic medium existed, there was no publicly available community," says founder Howard Rheingold. "The purpose was to create a public utility to enable people to build a community and do business online." Current WELL members include computer and communications pioneers as well as SF authors like Sterling, and, of course, cyberpunks. Such above-ground efforts signify that cyberpunk is emerging in pop culture, assuming meaning as a lifestyle, a way of thinking and, hence, a movement whose numbers—at least in terms of subscribers to the mindset—are beginning to grow.

Central to the cyberpunk viewpoint is the belief that governments—nation states—are giving way to multinational corporations—global states. These entities are located not so much in one geographical location but throughout the world via global networks on the electronic frontier.

In this electronic landscape, cyberpunks see a future where those who have information will be separated from those who don't. By disseminating information—be it corporate plans or top-secret government operations—they believe they can take on self-assumed roles that range from benign sociopolitical watchdogs capable of averting global oppression to anarchists retaliating against corporate greed by wreaking havoc on computer systems—or as electronic terrorists ready, willing, and able to take out an enemy simply by shutting down systems.

It comes as no surprise then that the government is up in arms. In Secret Service and FBI circles—the government agencies charged with computer law enforcement—the term *cyberpunk* has almost come to mean computer criminal. And cases like the 1988 Internet "worm" have undoubtedly fed the crackdown fever. Created by 25-year-old Robert Morris, the worm shut down some 6,500 computers and caused an estimated $150,000 to $200 million worth of damages to computer systems nationwide. Because his defense attorneys were able to prove the destruction was unintentional, Morris was sentenced to a $10,000 fine and 400 com-



"You know son, in politics, when all is said and done, a lot more is said than done."

munity service hours.

Since then, there have been several instances of what the hackers claim are government attempts to suppress the cyberpunk media. Steve Jackson Games is a case in point. Secret Service agents raided this small Austin-based games manufacturer—publishers of fantasy-role-playing and board games—in March 1990. They seized computers and a stack of software disks and ransacked the company's warehouse. Some materials seized in the raid, including the game *GURPS Cyberpunk*, have yet to be released, and Jackson has filed a civil suit against the government as a result.

Spurred by this incident, the computer community rallied, holding a meeting on the WELL in late spring 1990. Mitch Kapor, creator of *Lotus 1-2-3*, Apple cofounder Steve Wozniak, Sun Microsystems pioneer John Gilmore, and computer enthusiast and Grateful Dead songwriter John Perry Barlow formed the Electronic Frontier Foundation to protect freedom of speech and expression in cyberspace.

With the recent arrests of numerous hackers for illegal entry and data possession, the battles over control of the electronic frontier and hackers' rights are now being waged in court. One critical issue is whether information belongs to a given corporation or government or whether it belongs to the world. For those who are relaying information through computer networks and zines, there is also the question of First Amendment rights, or Hackers' Rights. How free is a free press in the electronic medium? This debate over intellectual freedom isn't entirely benign. The access to knowledge, like freedom, is risky when absolute.

Things have changed in the hacker community. The first generation of young computer enthusiasts, now in their twenties, operated from a more mature, concerned-for-the-future frame of reference. But Synergy admits danger may lie ahead with the new generation of hackers. "The new kids on the block, the new 14-year-old cast and crew, don't have a very good handle on morality, knowing what they should and shouldn't be doing with these wonderful tools they have."

Furthermore, computer technology has outmoded old forms of political power. "Anyone who was around in the Sixties is aware of the concept that all political power comes from the barrel of a gun and the power to control is the power to destroy," Synergy says. "Now, with information tools, people like me have the capability and the access—because of the way the system is structured—to shut everything down—not just locally, but globally. And, it's getting worse every day."

Interestingly, Synergy's vision of the future lies on the opposite end of the cyberpunk spectrum from Gibson's. "I think Gibson is about the most pessimistic mother fucker I've ever run into," says Synergy. "His basic premise is that science will be abused, period. I tend to be more of an optimist. If we were going to blow each other up, we'd have done it by now. And, actually having been inside and looked around, I seriously doubt whether we actually could blow ourselves up."

"Well, if you're living in South Central Los Angeles," says Gibson, "the world is a lot uglier than the world in *Neuromancer*. And, in some cases, you'd be very lucky to wind up with the *Neuromancer* future. It's hardly the most dystopian vision."

The cyberpunk future is still up for grabs—between utopia and dystopia. But indications are that the world will be one of corporate states, moving away from governments of locales to governments of multinational corporations whose increasing monopolization of information wields more and more power and control over individuals as well as nation states. The new tools for diplomacy, politics, espionage, and terrorism will be electronic ones.

While cyberpunk seems to have the potential for being the most potent, effective, bohemian force ever to take on civilization, its impact remains to be seen. One thing, however, is certain. Cyberpunk isn't just science fiction anymore. DO

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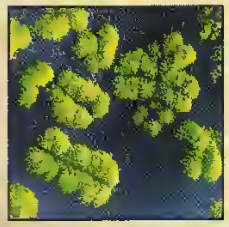
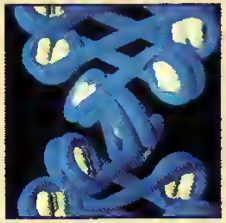





From the lab to the fields (left to right) human chromosomes, scientist inoculating citrus rootstock, simplified model of chromatin DNA, examining genetically engineered oranges for hardness, *E. coli* bacteria releasing DNA (below)

THE BLOSSOMING OF BIOTECHNOLOGY

HARVESTING MIRACLE DRUGS, BETTER PLANTS, AND LOTS OF CONFUSION

BY MARK FISCHETTI




Studying humans, plants, and animals (left to right) bacterial colonies, examining genetically improved corn, human DNA from a monocyte, preparing cancer fighting interferon DNA injected into a mouse embryo (below)

Eleven-year-old Katie of North Reading, Massachusetts, never liked running. She would quickly become exhausted and cough terribly. Inevitably, she'd have to grab for the inhaler in her pocket to help her breathe.

Katie has cystic fibrosis, an inherited disease that clogs the lungs with mucus. Until a year ago, she often fell prey to infections from bacteria that thrived in the mucus and at times, her mother had to pound her back to loosen the mucus in her lungs so she could breathe clearly. But last fall, Katie began treatment at Children's Hospital in Boston, where doctors put her on a genetically engineered enzyme called DNase. It breaks up the mucus and temporarily prevents more from collecting. Now Katie can keep up with her classmates, and she's glad. "I can run without getting tired," she says.

The wonder of biotechnology is everywhere. The gene makers have cured a little girl in Texas of an immune deficiency that would otherwise have killed her. They've engineered cotton plants that kill bugs, canola that is lower in saturated fats, and roses that last longer in the vase. "Pharmers," the newest breed of geneticists, have created animals that produce cheap pharmaceuticals in their blood and milk. Pigs are generating human hemoglobin, while sheep are producing a hormone that helps fight life-threatening emphysema.

And yet turning carefully controlled laboratory successes into widespread treatments for our hospitals, common crops for our supermarkets, and cost-effective drugs for our pharmacies is proving to be an unusually messy, complicated business.

For example, the DNase that Katie takes certainly helps but hasn't cured her or her 16-year-old sister Jennifer.

who also has cystic fibrosis. Affecting 30,000 young people in the United States, the disease is often fatal by age 30. Both girls continue to take antibiotics regularly and go to the hospital every three to five months to have their lungs cleaned out, a process that can take up to three weeks. Jennifer says she has more energy now. But the DNase also makes her voice hoarse, and occasionally she coughs up blood. Her doctors still aren't sure exactly how much DNase to give her. "It would be good if they could figure out how much I should have," Jennifer says. "If I was on a lower dose, I think it would be better."

Scientists and engineers who have strived for years in the research lab to develop treatments find that new battles take shape as treatments are transformed into effective end-products. And even when the science does prove out, numerous ethical and legal issues remain to be resolved.

As an industry, biotechnology is not really new but merely the latest stage in the commercialization of biology. The first four stages can be segmented loosely into the production of beer and wine, bread and cheese, vitamins and pharmaceuticals, and systems for sewage treatment. Today, gene teams concentrate on three distinct areas: disease therapy and diagnostics, agriculture, and pharming. Certain fundamentals cross all categories. The nuclei of plant and animal cells hold chromosomes, each made of a long, winding strand of DNA. A gene is a section of DNA; one DNA molecule can contain thousands of genes.

Genetically engineered materials hold the promise of great industrial growth. Several key discoveries formed the basis for the emerging industry. In 1974, Stanley Cohen cloned the first gene using the bacteria *E coli*, today the standard cloning "machine" found in every biotech lab. In 1982, Richard Palmiter and Ralph Brinster fiddled with human-growth hormones, making them compatible with mouse cells, once injected into mice, the hormones created the first transgenic animals—those with genes from different species. Researchers now routinely use transgenic mice to test newly engineered substances. In 1985, Kary Mullis invented the polymerase chain reaction (PCR), which enabled scientists to clone, in a few hours, huge quantities of any piece of a gene and to reconstruct a complete gene from a fragment.

Then in 1990, surgeon W. French Anderson and colleagues at the National Institutes of Health (NIH) infused a missing gene into a four-year-old girl suffering from a rare, inherited immune deficiency similar to the one that killed David, the "bubble boy," in 1984. The completely new technique ushered in the era of gene therapy. Instead of injecting needed proteins from genes grown in lab cultures, Anderson inserted corrective genes directly into the girl's body so she would produce the proteins on her own.

The Food and Drug Administration (FDA) has already approved more than 20 genetically engineered medical substances for sale. Among the most widely distributed are human insulin, cloned at Genentech and marketed by Eli Lilly and, human-growth hormone, another Genentech product. Sales of Epogen, a genetically engineered drug made by Amgen that treats anemia in kidney-dialysis patients, topped $300 million last year. More than 30 therapeutics are expected to be in human trials by the end of the year.

Yet nearly all the products simply treat diseases rather than cure them. Furthermore, some of the treatments are only marginally effective.

The battle against hepatitis is a classic case. Last year, the FDA approved the use of interferon-alpha2b for treatment of hepatitis C. One of the earliest drugs produced by biotechnologists, alpha interferon was first cloned in 1979 at Biogen. The biotechnology community hailed the FDA's recent approval as a landmark step because hepatitis C does not respond to other drugs and it infects 170,000 Americans each year. Early trials showed that 40 to 45 percent of hepatitis-C patients improved as long as they continued to receive three doses a week. But 50 percent to 75 percent of the patients relapsed once taken off the interferon. Doctors are now trying a mix of genetically engineered and natural drugs.

An actual cure for hepatitis and other diseases, however, rests with gene therapy. To treat his four-year-old patient, Anderson removed the faulty immunity cells, fitted them with a new gene, and returned them intravenously to the girl's body. Further infusions slowly built up the level of the corrected cells in her blood stream. Anderson began treating a nine-year-old girl in 1991 with equal success. Both children show no side effects.

But even this advance is not permanent. The corrected cells die in time, meaning the girls must undergo infusions every few months. Now that step 1 has worked, Anderson envisions a gene scheme that might lead to a lifelong cure. He wants to attach a corrected gene to blood stem cells, which generate fresh blood cells. The hope is that the patient will create her own new blood cells that carry the corrected gene. Anderson is awaiting FDA approval to try this procedure. He's also waiting for clearance to try gene transfer in cancer patients.

If gene therapy is the ultimate weapon against cystic fibrosis, Ronald Crystal of the National Heart, Lung, and Blood Institute, an investigator on the DNase trials, wants to lead the offensive. Cystic fibrosis results from a malfunctioning gene in cells lining the airways of the lungs. Scientists have fashioned a good gene that overrides the bad one but have run up against the problem of getting it into lung tissue. Crystal has found the solution in, of all things, a cold virus that infects the very same airways. The virus can carry the beneficial gene into the tissue. The trick is to neuter the virus so that it can't replicate once it burrows into the airways. Crystal's method works in laboratory rats. He hopes the FDA will give the OK for human trials in a year. "We're witnessing a revolution in medicine," Crystal says. "What we've got to do now is get down to the business of applying it to patients."

Part of that business is finding agents, like viruses, that can smuggle corrected genes to the proper sites in the body. But Gary Nabel, of the Howard Hughes Medical Center at the University of Michigan, has gone a step further and eliminated the vehicle altogether, this spring he became the first scientist to inject doctored DNA directly into a patient's body.

In all other gene-therapy trials to date, practitioners have had to remove cells from a patient, add the corrected gene, and return the cells to their rightful place. In June, however, Nabel injected DNA right into the tumor tissue of a 67-year-old Michigan woman suffering from metastatic melanoma, the most deadly form of skin cancer; he has since treated two other patients with injectable gene therapy. The injections are just the beginning of treatment; complete results will not be available for quite some time. The injected DNA carried several trillion copies of a maverick gene. Once the DNA grabbed a foothold in the tumor, the genes were to trigger production of a protein called HLA-B7. This protein acts as an alarm to the body's immune system, causing it to send in armies of killer T cells that doc-

tors believe can kill tumor tissue once they find the battlefield. In addition, Nabel's experiments with mice suggest that once the killer cells learn the identifying marks of the tumor tissue, they may continue to seek and destroy it throughout the body.

Injection of DNA won't render viruses and other gene vehicles obsolete, however. "No one approach will be king of the hill," Nabel predicts. "Different delivery systems will be used for different diseases."

That includes other cancers. Scientists at ImmunoGen have begun advanced trials of products that use monoclonal antibodies to target cells. A monoclonal antibody is a protein that binds to a unique marker, which may be found only on a single type of cell. ImmunoGen attaches a toxin to monoclonal antibodies to form "immunotoxins," which home in on, bind to, and destroy specific types of tumor cells. ImmunoGen has chosen to use a derivative of the plant toxin ricin, the poison used by the Soviet KGB to kill Bulgarian dissident Georgi Markov in London in 1978. ImmunoGen is testing four ricin-based immunotoxins in clinical trials for different types of cancer and has several others in development.

Scientists at Cytogen have also entered the initial stages of fighting cancer with monoclonal antibodies. Doctors are testing a Cytogen product on a handful of women with advanced ovarian cancer—those with fewer than four months to live. Three of nine patients have survived for two years now, says Thomas McKearn, president and chief scientist. He is quick to point out, however, that the women are not cured. Just the same, he says, "we are so encouraged... we are extending the trials to men with prostate cancer."

Monoclonal antibodies are also proving instrumental in diagnosing disease as well as treating it. A Cytogen product called OncoScint, which pinpoints colorectal and ovarian cancer tissue, may soon hit the market. Cytogen scientists linked the radioactive isotope indium-111 to a monoclonal antibody that latches on to the cancer cells. Scanners detect the gamma rays emitted by the indium, revealing the alien tissue. The procedure, already tested on a thousand patients, provides a much more precise mapping than other tests such as CAT scans, according to McKearn. Furthermore, the antibodies reveal cancer tissue wherever it occurs throughout the body, even in minute concentrations that other tests miss.

Even when patients have no chance for recovery, the indium test may still help improve their quality of life. "The problem with traditional diagnoses is that doctors don't know if the cancer is too far gone," he says. "Our test can show that. If a woman has only a few months to live, then why should she spend $10,000, suffer the trauma of surgery, and fill her body with drugs? She could use the money and the time to take a cruise with her family."

Like therapeutics, agricultural biotechnology teeters on the brink of broad commercialization but still has a struggle ahead of it.

The groundwork was laid in the early 1980s when researchers at Monsanto developed a safe way to kill the moth larvae that devour much of the U.S. cotton crop, according to Roger Beachy, head of plant biology at the Scripps Research Institute in La Jolla, California. Conventional efforts to eradicate the larvae and other cotton pests account for 40 percent of the insecticide used in the United States, Beachy says. The poisons damage the soil, threaten ground water, and kill wildlife. They also cost farmers lots of money.

> "The plant people at Scripps have begun to engineer crops, including tobacco and alfalfa, that can produce human materials."

A team of researchers from Monsanto conjured up a gene that causes the cotton to excrete a protein fatal to the larvae. As the insects munch the cotton, they die. The Monsanto team also created potato plants that can kill off the Colorado potato beetle, which in certain years has caused wholesale losses of the crop.

Widespread field trials across Texas, Mississippi, and the breadbasket states have been underway for five years. The bugs are dying, the plants are thriving, and the farmers use much less insecticide, Beachy says. Only one barrier to commercialization remains: regulation. But that's a tough barrier to get around. Because the techniques are considered to be pest control, they fall under the auspices of the Environmental Protection Agency. Edible plants must also pass muster at the U.S. Department of Agriculture. And if officials consider the proteins that the plants produce to be food additives, the FDA has to get involved.

For now, most scientists remain cautiously optimistic. If the regulators can cut a clear path, Beachy estimates that seeds for the engineered plants will go on sale by 1995.

Work with cotton and potatoes falls a bit short of the lofty goal that first sparked the world's interest in agricultural genetics: finding hardier strains of staples like rice and wheat to help poor countries feed their starving peoples. That nut will prove much harder to crack, Beachy says. "Developing a gene that can kill a bug is relatively straightforward," he explains. "Creating staples that can withstand drought or salt or heat is much more complex. It involves a lot of genes."

For the time being, horticulturists prepare to pursue that dream by gaining much-needed experience with commodity crops, where the market provides strong economic incentive for greater yields and healthier products. Scientists at DNA Plant Technology use biotechnology to reduce the saturated-fat content of canola used for cooking oil, to create tobacco plants that can withstand fatal frosts, and to improve the taste of tomatoes.

Now for the really wild stuff. The plant people at Scripps have begun to engineer crops that can produce human materials. Andrew Hiatt has created tobacco plants that produce human monoclonal antibodies within their leaves. His colleague Mich Hein is working with alfalfa. They propose to achieve mass production of high-value pharmaceuticals at low cost, if drug manufacturers can squeeze even a small amount of a human therapeutic from plants, then they can get huge quantities from large fields of the crop. Still unanswered, Beachy says, are whether the antibodies can be purified easily from the plant matter and whether they will act exactly like antibodies derived from lab cell cultures.

What's new for plants is old for animals. For several years now, pharmers have implanted genes in livestock so they produce human proteins for use in pharmaceuticals.

Results have come in fast and furious in the last year. At Pharmaceutical Proteins Limited (PPL) in Edinburgh, Scotland, scientists have produced sheep that carry the human protein alpha-1-antitrypsin. Used to fight emphysema, antitrypsin is traditionally extracted from human blood serum, but the process yields such small quantities that it cannot meet demand. The scientists at PPL injected the antitrypsin

gene into fertilized egg cells taken from ewes, returned the altered embryos to their mothers' wombs, and waited for birth. Now the transgenic offspring churn out the human protein in their milk at levels 15 times those produced by blood plasma, according to Martyn Breeze at PPL. Given the concentration, a modest flock of 1 000 ewes could match the entire world production of the protein. Clinical trials are still some years off, however.

For producing pharmaceuticals in volume, sheep look positively sluggish compared to cows. Growing therapeutic compounds in lab cultures generally produces only a few milligrams of useful substances per liter. Sheep and goats can produce grams of the same substances in their milk, a substantial increase. "But with a herd of cows, you're talking tons," says Robert Bremel, professor of dairy science at the University of Wisconsin, Madison.

Retrieving and implanting embryos, however, presents a bit of a surgical difficulty. That, in turn, has led pharmers of DNX to turn to swine. Pigs have two litters a year and 10 to 13 piglets a litter versus a single pregnancy and calf for a cow. DNX has poked its pigs with genes that produce human hemoglobin in the animals' blood. As an added advantage, the hemoglobin can be lyophilized, or freeze-dried, says John Logan, vice president of research at DNX. Once lyophilized, it can remain viable in powder form at room temperature for six months to a year. By contrast, human red blood cells must stay refrigerated and last no more than 42 days. Lyophilized hemoglobin, which provides a temporary blood substitute when mixed with water, would greatly aid casualty care on the battlefield, Logan says. The powder could also be kept on hand in emergency medical vehicles and in blood banks. Logan anticipates human trials in 1994.

Other biotechnology researchers have also turned to pigs. William Velander at Virginia Polytechnic Institute is working with the American Red Cross to extract genetically engineered human protein C, used as an anticoagulant from pigs' milk. If it lives up to its potential, this source of protein C will be abundant, lack the side effects seen with synthetic anticoagulants, and cost much less than protein C extracted from human plasma. Anticoagulants prevent clots in many heart-attack patients and during bloody surgeries such as hip replacements.

Anticoagulants have already stirred up some controversy. One of the first engineered drugs was recombinant t-PA, made by Genentech. Though hailed as a wonder drug, studies last year showed it was no more effective at bursting blood clots than regular medications, notably streptokinase, used widely at hospitals. The issue is price. t-PA runs around $2,200 a treatment, while streptokinase costs about $400.

The work of pharmers has drawn protest over attempts to fool with Mother Nature. Wary onlookers worry that patients who take drugs derived from animals might pick up scrapie or some other barnyard disease. Folks at the dinner table wonder if it's safe to eat potatoes with killer genes. Others fear that genetic engineers might unknowingly create freakish plants or animals that could wreak havoc on the food chain. And could a ghoulish geneticist tinker with human beings, like a modern day Dr. Frankenstein?

Leading many of the protests is Jeremy Rifkin, president of the litigious Foundation on Economic Trends and archenemy of genetically altered anything. Rifkin has initiated lawsuits to stop the open release of engineered crops, the patenting of pharm animals, and the use of human-growth hormone.

Rifkin also plays politics. In 1990, Representative John Conyers (D-Michigan) introduced the Human Genome Privacy Act, which would forbid government agencies from disclosing anyone's genetic information without consent. Conyers wants to limit the use of genetic testing by insurance companies, employers, and others who might abuse the practice. Conyers resubmitted the legislation this year. At the prompting of Rifkin's foundation and several other groups, Representative Benjamin Cardin (D-Maryland) and Senator Mark Hatfield (R-Oregon) have initiated action to institute a five-year moratorium on patenting transgenic animals—more than 160 patents are now pending—until regulations governing the process are in place. Currently, Rifkin plans to fight the possible loosening of regulations that discipline the biotechnology industry, a move recommended in February by Dan Quayle's White House Council on Competitiveness.

Commercialization of biotechnology moves so fast, Rifkin says, that regulation lags behind. "The public is nervous. They are mindful of past lessons from high-tech industries—the dumping of toxic wastes, Bhopal. They see benefits but they're leery of the risks."

Tension is mounting in other arenas, too. In April, James Watson resigned as director of NIH's human-genome project. Watson, who shares a Nobel Prize with Francis Crick for unraveling the double-helix structure of DNA in 1953, stepped down when federal officials

claimed his stock holdings in several biotechnology companies might constitute a conflict of interest.

Watson has said that he felt NIH director Bernadine Healy had finagled the situation to push him out, in part because of public disagreements between the two over whether NIH should attempt to patent gene sequences.

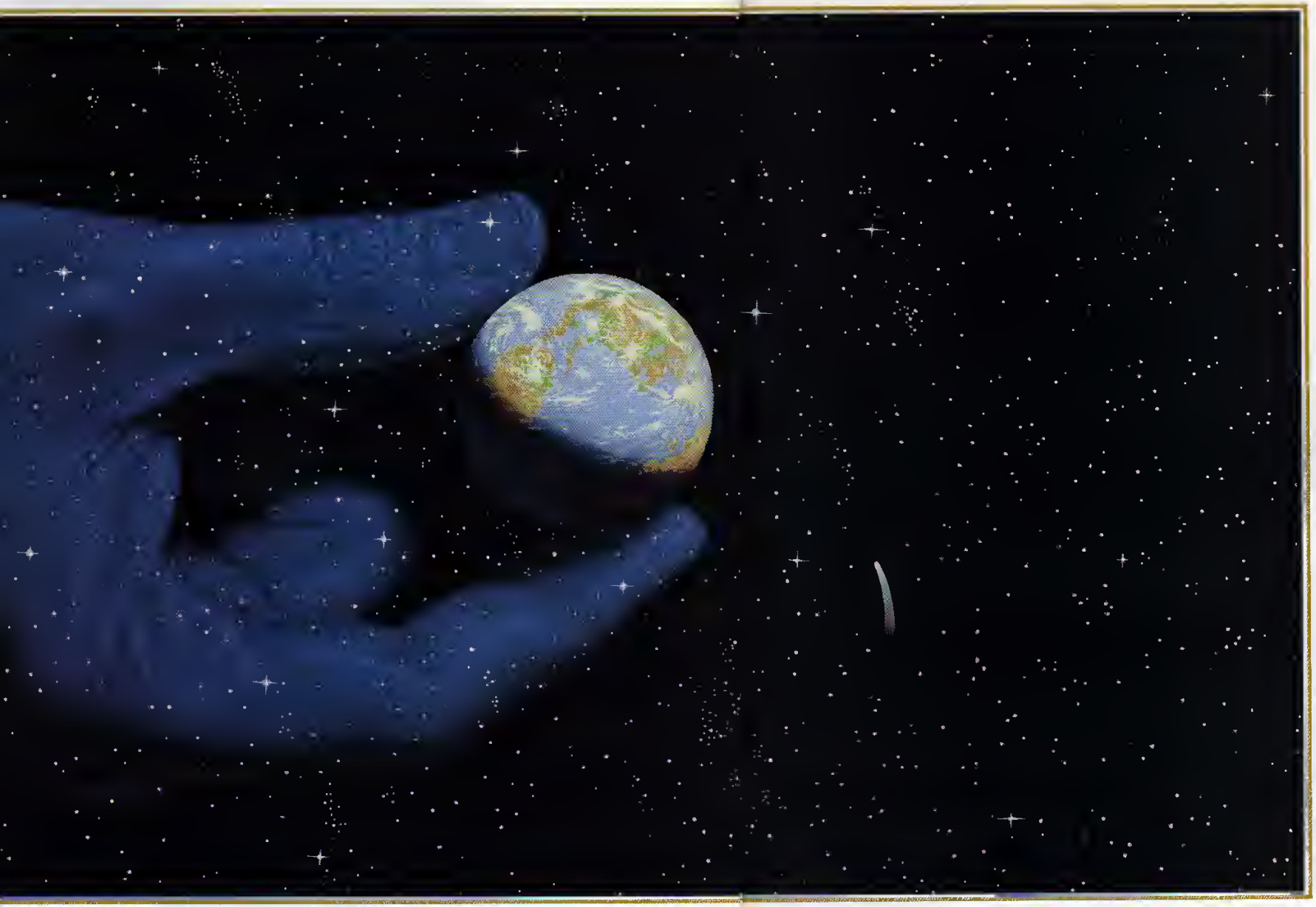
Indeed, the patent attempt has fueled a roiling, international controversy. Last year, J. Craig Venter, a scientist at NIH, applied for patents for 347 gene pieces he and his colleagues had identified as part of the human-genome project, the attempt to map the estimated 100,000 genes in the human body. In February of this year, he applied for 2,300 more. Venter and his colleagues have no idea what the gene sequences do, they've simply identified them. Healy defended the move, saying the sequences will likely prove fundamental to a healthy U.S. biotechnology industry. European governments have attacked the patent applications as preemptive.

The issues will get more complex. Biotechnologists have so far confined their work on human genetics to somatic cells—those that don't affect heredity. But tampering with the germ line is the next step. Once that occurs, the gene makers can move on to enhancement engineering, the creation of people who grow taller or stronger, for example. Then comes the ultimate attempt at eugenics, the insertion of genes to alter complex human traits like intelligence and personality.

Somewhere we have to draw the line. "We have a moral mandate to cure disease and prevent suffering," W. French Anderson wrote in a recent editorial. "But it is the slippery slope leading to attempts at germ-line enhancement that causes all of us to question whether a strict prohibition might not be the safest course."

For researchers and regulators, shortcuts appear tempting. this spring, FDA chief David Kessler, after acknowledging his agency's risky approval of an experimental drug, said, "We cannot wait for all the evidence to come in when people are suffering and dying from these devastating diseases."

Managing their desperate desire to leap ahead versus their fear of an untried genetic procedure—that nether land between hope and doubt—is a struggle for the people doing the suffering, people like Katie and Jennifer and their family. "There are days when it gets frightening," their mother, Marsha, says. "And there are days when we have hope. We just don't look far ahead." ⊠



THE ENIGMA OF DISTANCE

ARTICLE BY GEORGE ZEBROWSKI

A presumptuous soul once said that God made space and time so that everything wouldn't happen in the same place at the same time. But perhaps everything is in the same place and does happen all at once. Space may be something other than the concept that developed from our common-sense notion of place, which developed into the very useful idea of absolute space, and which then, in turn, was overthrown in favor of relational theories linking space, time, and matter.

One of the earliest difficulties in thinking about distance was encountered by Zeno of Elea (born around 490 B.C.). According to Zeno's

PAINTING BY MARVIN MATTELSON

Paradox: you have to go half the distance to anywhere before you can go the whole way, and then half of the remaining distance, and then half of that, *ad infinitum*—which means you'll never arrive at any destination, and by the same token, you must pass half the time before you pass the whole time—which should prevent football games from ever ending (many football widows already feel that games go on forever). In a playful mood, one might even apply Zeno's idea of the infinite divisibility of distance to the problem of explanation. To explain anything, one must give half of it first, and then half of the remaining half, and then half of that—which suggests that all explanations may be endless.

These and other difficulties with space have led many to suspect that space and time may be only psychological states, having some basis in external physics but no literal reality without the participation of observers. Even when we try to imagine spacetime as it might be outside human psychology, we still sneak in a surreptitious human observer—ourselves imagining what spacetime would be like without us. Space is either something, or a zero field—absolute nothing between somethings, which many claim is not only impossible but incomprehensible, or space is a mental construct, built up within minds to the point where we experience it as a literal reality of three dimensions and time. An analogy would be the "sense" we develop for informational space while working at a computer. Listening to music also gives us a sense of space, which we build up out of informational cues. Reality may be a "virtual reality." Its true nature may be quite different from what we experience, just as a motion picture gives us the illusion of dimensionality on what is actually a flat surface.

We have this intuition that we can't prove—that space, distance, is malleable, even that it *should* be malleable. This wish appears in the story of the seven-league boots, in numerous science-fiction stories, and has been taken up in serious scientific journals in recent years. *Star Trek* proclaims that we will go with pride among the stars, looking out from the bridges of powerful vessels that will roll up space in front of them as if it were a rug. Space *must* be malleable, we tell ourselves as we dream of far stars.

When we try to think about distance outside the framework of well-defined physical and mathematical terms, we are taken aback by the sudden mystery, by the seeming unreality of distance on the one hand, and by our experience of its cumbersome physical character on the other. What is this thing called distance? To see what we call the space between objects as unusual, fresh, and strange, even inexplicable—that is the psychological challenge for observers: to see space with the puzzlement of a child who doesn't have the given conceptual tools with which to interpret.

In *Concepts of Space*, Max Jammer points out the irony of the founders of materialistic philosophy, the atomists, struggling with a new conception of reality, the existence of nonmaterial void, and having to be the first to say that "a thing might be real without being a body."

The answer to Zeno's Paradox is often given by saying that motion does not proceed from point to point, things go continuously, not digitally. But this description has its own strangeness, requiring that the universe be *full*, all of one piece, which suggests that everything is in one place. This undercuts all of our traditions of physical analysis (by which we take things apart into pieces in order to explain them) in favor of a grand monism in which all is one and all distinctions blur.

Let's start at the beginning, if there is such a place, and say what we think we know about distance. In reading an introductory technical book titled *What Is Distance?* by Iu. A. Shreider, I was struck by how much it is possible to discuss the varieties of distance without ever taking a stab at what distance *is*, in itself, in what may be described as the naive demand of the question. We are given *contextual* answers, based on mathematical and physical concepts that we are asked to *assume*, whose origins lie deep in our psychology, and which Einstein described as being "free creations of the human imagination, means devised for easier comprehension of our sense experience." But these means still leave us free to ask the naive, obvious question, "*What* is distance?"—and the answer leaves us with a sense of the mysterious.

Do we know anything except through the narrow angles of our senses and linguistic conceptions? The problem with understanding space is that we are embedded *in* it with no way to compare it to anything else. Zeno devised a description of the problem in his "nest of superimposed places," which regress into infinity. Since all things are in a place, that place must itself be in something, and that place is in another place, and so on. This also suggests that dimensionality is a thing inseparable from a body.

But we all feel that we know space as being different from the bodies it contains. Just reach out and wave your hand around in it, then take your hand away, and the space is still there! Space seems an irreducible intuition of our bodies, not derivable from anything else, even though it does seem to have a relative—time, which seems to tick away in one direction, whether you sit in a space or move through it.

Perhaps distances at the subatomic level might offer a clue since they hark back to the time when everything was in one place, before the Big Bang "beginning" inflated everything. Quantum-level distances are discontinuous, as we perceive them; objects jump from point to point without traveling the distance. In the conditions of the early universe, or "preuniverse," one has to say that ordinary intuitions about space and time just don't apply since there is no way to define space or time, so when our conceptions begin to apply, we can say that space and time begin at that point, which seems evasive.

The stubborn logic of naive intuition insists that even when the universe was an unshattered point, there was a place and there was some kind of metaduration. Perhaps distance (space), as we perceive it, is what you get when you shatter a unity and then inflate it so that space is what exists between the pieces that still seem to "know" each other.

Our best historical descriptions of space are 1) distance as absolute space and 2) distance as a relation. Absolute space may be thought of as what is outside the

universe into which it expands while relative space, inseparable from the objects it contains, is what you get with an expanding cosmos, in which space itself is expanding. What is outside this process may be a "superspace" that may be needed for conceptual reasons but which we can't examine. It is, in effect, our old friend, absolute space—infinite, uncreated, baffling.

Today's physics and cosmology tend to avoid discussions of absolute space and time. Experimental facts confirm relative space and time. Space can be described in the context of physics and mathematics but not explained outside of very limited terms. This leaves existence as enigmatic as ever.

Perhaps there is neither relative nor absolute space, only processes inside a dimensionless point, which *is* everything that can ever be, and always was and in which we "perceive" space and time; but there is only an eternal present, in which everything has always been *together*. This kind of speculation eliminates the need for fundamental explanations in which things are described and analyzed into pieces much as we would explain a machine by taking it apart and showing how the parts work together. Gravity's action at a distance might be nothing of the sort but more like objects being squeezed toward each other in a fluid. Existence is *full*, there is no space in the naive sense of nothingness. There just couldn't be, either physically or psychologically, because it would give us discontinuities in analysis that could never be bridged.

Fundamental explanations about the nature of reality finally seem to require an infinite, uncreated realm that did not come into being but which undergoes processes to which we are integrally joined, thus giving us a sense of time. (There seems to be no time as such.) In science as in theology, this conception provides an absolute field in which things happen. No one asks where the field came from just as no one asks who created God. The buck has to stop somewhere; somehow we either have to be able to stop asking why or accept endless whys.

In *A Brief History of Time*, Stephen Hawking has written that "if the universe is really completely self-contained, having no boundary or edge, it would have neither beginning nor end. It would simply be." This prompted Carl Sagan to comment that in Hawking's universe, there is nothing for a creator to do. With a little more imagination, one might say that if superspace (in which our universe expands and contracts) is actually infinite in all respects, then it could never have been created; it exists *necessarily* in the same way theologians insist that God exists. In such an infinite realm, space is exactly that—void, nothingness—and exists as such, but within the universes that superspace supports, space is something else, a substance wedded to matter, curved in the large, folded up in the subatomic. We will never know true void; we can only define it intellectually.

Naive realism—the notion that we see things as they are and that our intuitions are trustworthy—was once the only science of civilizations. Still the source of experimental, empirical science today, it is the view that however much we imagine and postulate, all our imaginings must rejoin the world of experience through an experiment that affirms or denies a hypothesis, or fails to affirm *or* deny, and that may violate our intuitions. Experiment (a form of organized experience) is to be accepted, however counterintuitive the result. This places a severe restriction on what modern science can deal with and is the source of common dissatisfactions with scientific answers to basic questions: the answers just don't get basic enough and stop short even when logic and imagination continue to reach out into the unknown. One may hope that the experimental method may one day find application to questions that now defy our reason.

> "We who are condemned to life in spacetime will always have to speak in terms that cannot escape their field of discussion."

Earth. Air. Fire. Water: the Greek atomists said, are all made of little hard balls—close together for dense things, far apart for lighter things like steam and fire. These hard balls were thought to be irreducible—that's just how they are (!). They were either made by God or they always existed. Space was just that—actual emptiness between things, also irreducible, incapable of being affected, bent, or shaped, taking absolute, not relative, time to cross.

Naive realism might ask today: Tell me what space is in itself, not in terms of other things. Tell me what a gluon is at bottom, or a neutrino, or a charge. Don't just give me definitions of metric spaces. And when pressed, physicists will tell you that the universe we see blown up from a point is next to nothing at all, almost a ghost, a thought . . . and they will avoid speculating about who or what may be "thinking" it and what "nothing" may be.

If Kurt Gödel was right about the Incompleteness of complex systems and that we can see the truth of statements without being able to prove them in their frame of reference, then many people have already guessed something of the nature of our universe; but to prove such guesses would require that we stand *outside*. We who are condemned to life in spacetime will always have to speak *in terms that cannot escape their field of discussion*. That is what it means to be one of the finite facets that are human minds. Physics, yoking speculation to physical experiment and observation, may be all we can have outside of pure imagining.

We would like to rip back the veil and see knowledge naked and complete, seated before us in shame and subjugation. That's how naive realism wants its knowledge: no more hide-and-seek, no more maddening infinities. Just let me know what it's all about for one moment before I die.

Remember to avoid Zeno's Paradox as applied to knowledge, *never* give half an explanation before you go the full one. Never go half the distance before you go the full distance. Always go the full distance at one shot.

What the naive realist most wants is probably best represented by what Einstein called "the thought experiment," usually a small story and probably the purest form of science fiction. A good example is the opening to "No Matter Where You Go," a story by Joel Townsley Rogers:

> I sighted the boundary of spacetime with Henley ten billion light-years from Earth. Rippled and black as volcanic glass, it loomed in front of us in a huge endless curving wall.
>
> The ship flew against it like a wind-blown midge, swirled sidelong in the terrific vacuum torrents rushing around the inside surface of the sphere. In the dark blue void behind its spider-thread of contrail the white imploding galaxies dropped away like slanting rain, vanishing far below.
>
> We were beyond the farthest lost neutrino of any creation, the first or last stroke of any time. Yet for a moment as long as all the world, the wall seemed to remain equidistant, re-

CONTINUED ON PAGE 125

FICTION BY TOM MADDOX • MISPLACED IDEALISM, BREWING RIVALRIES, A BUDDING ROMANCE, AND A DASH OF PROFESSIONAL PREJUDICE MAKE A VOLATILE COMBINATION WHEN THE TEXAS SUPERCOLLIDER MAKES ITS FIRST RUN AND THE LAWS OF PHYSICS ARE TESTED • PAINTING BY TERRY WIDENER

GRAVITY'S ANGEL

The Invisible Bicycle burned beneath me in the moonlight, its transparent wheels refracting the hard, white light into rainbow colors that played across the blacktop. Beneath the road's surface the accelerator tunnel ran, where the SSC—the Superconducting Synchroton Collider—traced a circle one hundred and sixty kilometers in circumference underneath the Texas plains.

Depending on how you feel about big science and [illegible] the SSC was either a superb new tool for researching the subatomic [illegible] physics' most outrageous boondoggle. Either way, it was a mam[illegible] subatomic partic[illegible] together as violently as [illegible] was mea[illegible] of [illegible]

volts. Those big numbers get all the press, but it's only when particles interact that experiments bear fruit. The bunches of protons want to pass through each other like ghosts, so we—the High Beta Experiment Team, my work group—had all sorts of tricks for getting more interactions. Our first full-energy shots were coming up, and when the beams collided in Experimental Area 1, we would be rewarded for years of design and experiment.

So I had thought. Now I rode a great circle above the SSC, haunted by questions about infinity, singularity—improbable manifestations even among the wonderland of quantum physics, where nothing was—*quite*—real. And more than that, I was needled and unsettled by questions about the way we—not my group but all of us, the high energy physics community—did our business. I'd always taken for granted that we were after the truth, whatever its form, whatever our feelings about it. Now even that simple assumption had collapsed, and I was left with unresolvable doubts about it all—the nature of the real, the objectivity of physics—riddles posed by an unexpected visitor.

Two nights earlier I had returned from a ride to find a woman standing in front of my house. "Hello," I said, as I walked the Invisible Bicycle up the driveway toward her. "Can I help you?"

"I'm Carol Hendrix," she said, and from the sound of her voice, she was just a little bit amused. "Are you Sax?"

"Yes," I said. And I asked, "Why didn't you tell me you were coming?" Really I was just stalling, trying to take in the fact that *this* woman was the one I'd been writing to for the past six months.

We had begun corresponding in our roles as group leaders at our respective labs, me at SSC-Texlab, her at Los Alamos, but had continued out of shared personal concerns, a mutual obsession with high-energy physics and an equally strong frustration with the way big-time science was conducted—the whole extrascientific carnival of politics and publicity that has surrounded particle accelerators from their inception.

Her letters were sometimes helter-skelter but were always interesting—reports from a powerful, disciplined intelligence working at its limits. She had the kind of mind I'd always appreciated, one comfortable with both experiment and theory. You wouldn't believe how rare that is in high-energy physics.

Women in the sciences can be hard and distant and self-protective, because they're working in a man's world and they know what that means. They tell each other the stories, true ones, about Rosalind Franklin not getting the Nobel for her x-ray work on DNA, Candace Pert not getting the Lasker for the first confirmation of opiate receptors in the brain. And so they learn the truth: In most kinds of science, there are few women, and they have to work harder and do better to get the same credit as men, and they know it. That's the way things are.

Carol Hendrix looked pale and tired, young and vulnerable—not at all what I'd expected. She was small, thin-boned, and her hair was clipped short. She wore faded blue jeans, a shirt tied at the waist, and sandals over bare feet.

"I didn't have time to get in touch with you," she said. Then she laughed, and her voice had a ragged, nervous edge to it. "No, that's not true. I didn't get in touch with you because I knew how busy you were, and you might have told me to come back later. I can't do that. We need to talk, and I need your help . . . now—before you do your first full-beam runs."

"What kind of help?" I asked. Already, it seemed, the intimacy of our letters was being transformed into instant friendship in realtime.

"I need Q system time," she said. She meant time on QUARKER, the lab's simulation and imaging system. She said, "I've got some results, but they're incomplete—I've been working with kludged programs because at Los Alamos we're not set up for your work. I've *got* to get at yours. If my simulations are accurate, you need to postpone your runs."

I looked hard at her. "Right," I said. "That's great—just what Diehl wants to hear. That you want precious system time to confirm a hypothesis that could fuck up our schedule."

"Diehl is a bureaucrat," she said. "He doesn't even understand the physics."

Yeah, I thought, *true, but so what?* Roger L. Diehl, my boss and everyone else's at the lab, also the SSC's guardian angel. He had shepherded the accelerator's mammoth budgets through a hostile Congress, mixing threat and promise, telling them strange tales about discoveries that lay just at the 200 TeV horizon. All in all, he continued the grand tradition of accelerator lab nobility: con men, politicians, visionaries, what have you. Going back to Lawrence at Berkeley, accelerator labs prospered under hard-pushing megalomaniacs whose talents lay as much in politics and PR as science, men whose labs and egos were one.

"Let's talk," I said. "Come inside, tell me your problem."

"All right," she said.

"Where are you staying?" I asked.

"I thought I'd find some place later, after we've talked."

"You can stay here. Where are your bags?"

"This is it." She pointed to the sidewalk beside her. At her feet was a soft black cotton bag.

"Come on in," I said.

> "Women in the sciences can be hard and distant and self-protective, because they're working in a man's world and they know what that means."

I figured she would be doing interesting work, unusual work—maybe even valuable work, if she'd gotten lucky. I wasn't the least bit ready for what she was up to.

We cranked up "The Thing," a recent development in imaging. It had a wall-mounted screen four feet in diameter, on it you could picture detector results from any of the SSC's runs. When it was running, the screen was a tangle of lines: the tracks of the particles, their collisions, disappearances, appearances, all the wonderland magic so characteristic of the small, violent world of particle physics, where events occur in billionths of a second, and matter appears and disappears like the Cheshire cat, leaving behind only its smile—in the form of brightly colored particle tracks across our screens.

Still, setting up and running simulations is an art, and at any accelerator lab there'll be one or two folk who have the gift. When a series of important shots is coming up, they don't get much sleep. At Los Alamos, Carol Hendrix, despite her status as group leader, was the resident wizard. At Texlab, we had Dickie Boy.

She stretched, then sat at the swing-arm desk with its keyboard and joystick module and logged on to QUARKER with the account name and passwords I gave her. Her programs were number-crunching bastards, and QUARKER's Cray back end would be time-slicing like mad to fit them in.

"Tell me what this is all about," I

said, 'So I'll know what we're looking at when this stuff runs."

Sure," she said.

While we waited for QUARKER, she drew equations and plots on my whiteboard in red, green, black, and yellow, and she explained that she was postulating the existence of a new kind of attractor that came into being in a region of maximum chaos. Its physical result an impossible region of spacetime, where an infinite number of particle events occupied a single, infinitesimal point.

Mathematically and otherwise, it is called a singularity, and in cosmology something like it is assumed to be at the center of black holes. There were all sorts of theorems about singularities, few of which I knew, none rigorously. Why would I? This stuff went with astrophysics and the gravitational forces associated with huge chunks of mass.

When she finished her explanations and turned from the whiteboard, I could see that she was wired and sleepy at once. Mostly, though, she was exultant. She felt she'd hit the jackpot. And of course she had, if any of this made sense — it couldn't, I thought.

The Thing gonged, to tell us we had our results. I pulled up a canvas-backed chair beside her as she sat at the console. "We'll walk through the simulation," she said. "If you have a question, ask."

At first there were just cartoon schematics of the detectors—line drawings of the big central detector and its surrounding EM boxes, hadron calorimeters, and gas chambers. Then the beam shots started coming, and in a small window at the top of the screen the beam parameters reeled by. Running a Monte Carlo is one hell of a lot easier than doing an actual run; you don't have the experimental uncertainties about good beam, good vacuum, reliable detector equipment; it's a simulation, so everything works right.

As we watched, the usual sorts of events occurred, particles and antiparticles playing their spear-carrying roles in this drama, banging together and sending out jets of energy that QUARKER dutifully calculated, watching the energy-conservation books the whole time, ready to signal when something happened it couldn't fit into the ledger. Complex and interesting enough in its own way, all this, but just background.

QUARKER shifted gears all of a sudden, signaling it had so many collisions it could not track them accurately. The screen turned into what we called a *hedgehog*, a bristly pattern of interactions too thick to count.

"We don't care," Carol Hendrix whispered. 'Do it." And she forced QUARKER to plunge ahead, made it speed up the pictures of events. She didn't care about the meanings of the individual events; she was looking for something global and, I thought, damned unlikely.

Events unrolled until we seemed to be in the middle of the densest particle interactions this side of the Big Bang, and I almost forgot what we were there for, because this stuff was the product of my work, showing that as promised, we would give the experimenters higher beam luminosity than they'd dreamed of having.

Then the numbers of collisions lessened, and that was the first time I believed she was on to something. Things were going backwards. The beam continued to pour in its streams of particles, but all usual interactions had ceased. Inside the beam pipes, one utterly anomalous point was absorbing all that came its way. We both sat in complete silence, watching the impossible.

> "Events unrolled until we were in the middle of the densest particle interaction this side of the Big Bang."

The screen cleared, then said:

END SIMULATION

Quantitative evaluation appears impossible employing standard assumptions. The conclusions stated do not permit unambiguous physical interpretation.

We lay in reclining chairs and watched the sky. The moon was down, and stars glittered gold against the black. Meteors cut across the horizon, particles flashing through the universe's spark chamber. We'd been drinking wine, and we were both a little high—the wine, sure, both of us drinking on empty stomachs, but more than that, the sense of discovery she had communicated to me.

"Finding the order behind the visible," she said. "I've wanted to be part of that for as long as I can remember. And at Los Alamos I've gotten a taste. They offered me a job two years ago, and the offer just caught me at the right time. I had done some work I was proud of, but it was frustrating—it's easy for a woman to become a permanent post-doc. And to make things worse, I'd always worked in my husband's shadow."

"He's a physicist?"

"Yes. At Stanford, at SLAC. We've been separated since I took the job. The two things, the job and the split-up, sort of came as a package." She stopped, and the only sound was the faint roar of cars down the Interstate nearby. She said, 'Tell me what happens tomorrow."

"That depends on Diehl's reaction. I'll see him in the morning. First I'll ask to borrow our resident imaging expert. That is, if I can pry him loose. I'm figuring Diehl won't want to look at any of this stuff; he might want a report on it, if I can talk to him just right. After that, we'll see."

'Okay," she said. "Look, I'm really tired. . . ."

"I'm sorry. I should have said something." I started to get up, but she said, 'No, I'm fine. I'll see you in the morning." She waved good night and headed into the house; I'd shown her the guest room earlier and folded out the couch for her.

I lay watching the sky, my mind circling around the strangeness we'd seen earlier. I wanted to understand it all more clearly than I did, and I hoped that Dickie Boy would be a help. In particular, he might know where her simulations had gone wrong. They had to be wrong, or else . . .

I sipped at wine and wondered at the possibility that I was present at one of those moments in physics that get embalmed and placed into the history books. I suppose I was still wondering when I fell asleep.

I was jerked awake some time later by a noise like high wind through metal trees. Amber flashes of light came from the side of the house, and a piano-shaped machine rolled out on clear plastic treads, ripping chunks of sod with its aerating spikes as it came. The machine was a John Deere Yardman, apparently run amok.

I went into the house and called Grounds and Maintenance. A few minutes later a truck pulled up, and a man in dark-blue overalls got out and called the robot to him with a red-lighted control wand, then cracked an access hatch in its side. Optic fibers bloomed in the robot's interior like phosphorescent alien plants.

* * *

I awoke around eight thirty the next morning. Carol Hendrix was still in bed. I let her sleep. I left a message on Diehl's machine asking for a few minutes person-to-person, then I drank coffee and worked again through her Monte Carlos' lovely work, plausible and elegant, but almost certainly not enough to move Diehl. How could it? As she had said, he wouldn't understand it.

However, I knew who would. In the event that Dickie Boy vetted her simulations we'd take them to the Thursday Group that evening. We met weekly at Allenson's house. Every important work group at the lab was represented, and every significant problem the groups worked on was discussed there. Thursday Group was the locus of oral tradition, the place where the lab's work was revealed and its meaning decided upon. By the time experimental results saw print, they were old news to anyone who had been to Thursday Group. Usually there were ten or so people there, all men, most in their mid 30s, most of them white and the rest Chinese.

Midmorning she came in, wearing old Levis and a black tank top. "Any news?" she asked, and I told her no. She got a cup of coffee and sat next to me and watched as her simulations played.

Shortly after noon a message popped up in a window on the screen: *If you want to talk, meet me in section 27 within the next hour. Diehl.*

"Do you want me to come along?" she asked, and I said, "No way. He's a tricky bastard to handle at the best of times." I left her sitting at the console, starting the Monte Carlos up again.

I rode the Invisible Bicycle to the shuttle station at Maingate and locked it in the rack outside. Down concrete steps I went and into the cold, musty air of the tunnel. A dark-blue, bullet-shaped shuttle car sat waiting. I was the only one boarding. I told the car where I was going. "Section 27," it confirmed in its colorless voice.

The repetitive color scheme of the lattice flashed by the windows. Radiofrequency boosters were in red, superconducting dipoles in blue, quadrupoles in orange, the endless beam pipes where the straw-thin beams of protons and antiprotons would circle, were long arcs of bright green. If there were a universal symbolism of colors, these would say: *intricate, precise, expensive, technologically superb*—the primary qualities of the SSC.

About ten minutes later the car slowed to a stop. The doors slid back, and I stepped down into the tunnel. About fifty meters away, Diehl stood talking to a man wearing blue overalls with the yellow flashes of a crew chief. The man looked taut, white-faced. "So pull every goddamned dipole with that batch number and replace the smart bolts," Diehl said. They walked toward me, and the crew chief stopped at a com station and plugged in his headset, no doubt beginning the evil task Diehl had set him.

"What can I do for you, Sax?" he asked.

"I've got a visitor," I said. "From Los Alamos. And she's got some interesting simulations of our full-power shots. I think you ought to see them." He looked startled: he hadn't expected me to ask for his time—money, resources, priority, yes, but not *his time*. "Or maybe not," I said. "Maybe you should let me have Dickie Boy put her Monte Carlos on The Thing. She's got some strange stuff there, and if it works out, we need to be prepared."

> "Thursday Group was the locus of oral tradition, the place where the lab's work was revealed and its meaning decided upon."

Sax, what the fuck are you talking about? I'm tired, you know? We're in the home stretch here, on budget, on time. . . now take Hoolan—you know, who heads the Meson Group—he knows nothing about this. He knows his experiments are coming up soon, his simulations do not make shit for sense, and Dickie Boy is the one to help him. But if he is not available because you have him doing what you consider the Lord's work, Hoolan's going to be pissed, because he *cannot* understand why, in light of these approaching deadlines, he should have to come begging for assistance."

"Then maybe you should come look at what she's got."

I was playing a tricky game, using my position as group leader to put pressure on him but betting he wouldn't want to give up valuable time and maybe expose his ignorance. "I think this is really important."

He was watching the crew chief explain to six men that they would be working in the tunnel until the troublesome smart bolts had been replaced. None of them looked happy. "Jesus," Diehl said. "Take Dickie Boy if you can convince *him*."

"Thanks," I said. He looked at me like he tasted something sour. I owed him one, and one thing was sure: He'd collect when and where he wanted.

"You really like this thing, don't you?" Carol Hendrix asked as she reached up to touch one of the Invisible Bicycle's clear polystyrene tires. If hung from rubber-covered hooks just inside my front door.

"Yeah," I said. "I got it in Germany. It's just plastic, but there's something wonderful about it—almost the Platonic idea of a bicycle. There's one in the Museum of Modern Art." Hanging above her head, it seemed to glow in the soft light given off by baby spots. "I usually ride it to think."

"What do we do now?" she asked. She wasn't interested in my toy.

"We get Dickie Boy over here," I said. "If we can, I'll call him."

"New physics." I told Dickie Boy on the phone. "Nothing you've ever seen."

"Bullshit," he said.

"No bullshit. Wrong physics, maybe—that's what we want you to help with, find out if we're missing something tricky."

"Or something obvious." He had no respect for anyone's ability on The Thing but his own.

"I don't think so. I think we've got a whole set of fracks here like nothing you've ever seen."

"I've got the Meson Group on my schedule."

"I know. Diehl said I could borrow you today."

"Where do you want me?"

"Come over to my house." No way. I wanted anyone looking over our shoulders.

Dickie Boy had made his name as a post-doc at Fermilab where Diehl had recruited him when the SSC was nothing but a stack of plans, an empty tunnel, and mounds of heaped dirt. He hadn't been brought on for his good looks. He stood just over six feet tall and weighed maybe a hundred and thirty pounds; his dull, brown hair was tied into dreadlocks, he had a long, thin nose and close-set eyes and usually seemed slightly dirty. However, in his brief time at Texlab he had already made legendary forays on The Thing—the last, a tricky sequence of pion studies, lasted nearly seventy-two hours, during which time Dickie Boy had worked

CONTINUED ON PAGE 110

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INTERVIEW

Your own DNA on a compact disc? Your future health "summarized"? What we can ultimately expect of the human genome project—from the father of biotechnology

PHOTOGRAPH BY RUVEN AFANADOR

WALTER GILBERT

Not long ago, Harvard molecular biologist and lab chief Walter Gilbert met with his staff to hear how researcher Carl Fulweiler had inserted a novel gene into the first cell of a Zebra fish embryo. Fulweiler's slides showed that as the embryo developed, wherever the gene was expressed, the cells lit up like green fireflies. Since then, the Zebra fish model has proven an effective method for tracking how genes control the growth and formation of a creature as it matures—a major theme of Gilbert's lab. Today, hundreds of Zebra fish populate three rooms of aquaria in the basement of Harvard's Biological Laboratories.

Clad in a sports shirt and worn hush puppies, Gilbert listens with a typically inscrutable but genial smile as Fulweiler talks and then fields questions—some barbed with rivalry—from the audience. As the discussion gets tangled, Gilbert steps in and gently picks out valid leads, dismissing other suggestions as weak or even "a bad idea." His mind dominates the room. As everyone drifts back to their benches and computers, the mood is upbeat. Over coffee later, two postdocs did confess that Gilbert's "massive intellect is intimidating." If one is trying to cover up a weakness, they laughed, "it won't stay hidden long." Like others, however, they raved about how

supportive Gilbert is in overseeing their work. At the crest of his career, Gilbert has not let riches and renown distract him from focusing on biology's future.

"Wally" Gilbert came to biology after excelling in theoretical physics and math. The son of a Harvard economist, at age 12 he ground his own glass for telescopes and nearly blew himself up brewing hydrogen in the pantry. During his senior year in high school he boned up on nuclear physics in the Library of Congress. Graduating from Harvard in chemistry and physics, he went to Cambridge University for his Ph.D. in theoretical physics. Returning to teach at Harvard, he switched to molecular biology and in 1976 devised an accelerated way to sequence DNA, which at the time was grinding labor. The breakthrough ushered in the age of genetic engineering and won Gilbert the Nobel in 1980.

Continuing to study genes, he's focused on how they control development and why they contain long stretches of "junk" that doesn't code for protein like the genes' active parts. Gilbert named these seemingly useless sections of genes "introns," arguing that they are the structural ties that enable the "exons," to function. Genes evolved, he speculates, with introns assembling exons into progressively longer, more complex sequences. Evolution, he continues, was primarily intron-driven—a theory that others hotly dispute.

Controversy is not new to Gilbert. He outraged purists by leading the way from the research lab to the corporate boardroom. In the early Eighties he founded—and at $285,000 a year, was the chief executive of—Biogen, one of the first companies to exploit the promise of genetic engineering. Gilbert resigned from Harvard to do the job, but after four years, when Biogen was still unprofitable, he was forced out. He was welcomed back to Harvard with a new professorship, having made a fortune nonetheless. He is still a member of two Biogen boards.

His business ambition not yet subdued, when Congress was slow in funding the human genome project, Gilbert stepped in. He tried to set up a private company to publish an atlas of human DNA within a decade—and copyright the results. Even though he couldn't get backing for that enterprise, today he has a $2 million a year slice of Federal funding with his Harvard Genome Project, which aims to sequence the DNA of several bacteria. In the process, he's confident, he will speed up sequencing manyfold.

Scattered throughout the lab are the huge screens of the SUN computers brought in to do the job. Another tool is a "confocal microscope" that takes photos, layer by thin layer, of a living Zebra fish's brain. But clearly the most powerful tool remains the Gilbert mind machine.

Gilbert talks with endless patience of his experiments and other scientific topics, but he rarely makes small talk. The interview began with a reporter's nightmare—a jammed tape recorder. The machine was handed to Gilbert, and he got it going in ten seconds.—Anthony Liversidge

Omni: Why did you drop out of the National Academy review group for the genome project?

Gilbert: I tried to organize part of the genome project as a company because I thought it would be better done on an industrial scale. I think it will ultimately be done that way. I wasn't successful funding the company I tried to start, Terabase. Now I'm a cheerleader on the sidelines, participating in running a DNA sequencing project as part of the genome project.

Omni: How do you view the genome project?

Gilbert: Today we try to identify a gene and then study its properties. That is fruitful when you look at an important gene, but mostly you're looking at one that happens to be under your nose for some reason. Today you can't take a global view—can't ask what are the genes that make up the heart, the brain. The list of genes that will come out of the genome project will be the tool that turns our questions into global ones.

Omni: When will the 3.5 billion bases of the human DNA sequence be deciphered?

Gilbert: In 10 or 20 years. First we will have a genetic map, then a physical map of all the chromosomes. In five years we'll have the sequence of the first human chromosomes. In 15 years we'll have all the sequence, a list of the genes everyone has in common and those that differ among people. We know only something like a tenth of 1 percent of the sequence at the moment.

Everyone wants a hand in the outcome, a piece of the knowl-

HUMAN DNA SEQUENCED AS OF 1991:
Around 80 million bases of DNA

AS OF 1993:
About 120 million bases

IN NEXT FIVE YEARS:
300 to 500 million bases a year

GILBERT'S PARADIGM SHIFT:
"In the next stage we will have all the genes in a database and available electronically. Biologists will have to go to the computer to do research."

ON "JUNK" DNA (INTRONS):
"One man's junk is another man's treasure."

IMPORTANCE OF GENOME PROJECT:
"Listing all the human genes will change the way biology is done. Ultimately one will be able to deduce how the genes are controlled."

EVILS OF SCIENCE:
The same as the evils of society: the herd instinct and the lack of skepticism.

BIGGEST UNDERSTATEMENT:
"I'm fascinated with the molecular underpinnings."

edge. I expect the human sequence will not be done on one individual, but different countries will do different chromosomes. If you do a Japanese chromosome here, and a French, German, or American one there, it becomes an abstract human.

Omni: Are the people who are running the genome project keeping you at the bench because you wanted to start a company and do it all by yourself?

Gilbert: Could be a little of that! You can't tell what people's reactions are. I can speak my mind more freely not being deeply involved in the genome project. My view originally was that the genome project was a large effort that could be done by a company of 300 to 500 people in ten years. Now the government plans to use 3,000 people to do it in 10 to 20 years. The first step will be to set up the technology of cheap and fast sequencing. After that, it will be just a technical exercise that will be finished by companies.

Omni: Will you ever go back to the world of business?

Gilbert: I doubt it. Having come back again to the university, I am happily doing research.

Omni: Why is a common aquarium fish so popular here?

Gilbert: The Zebra fish is a vertebrate like us, but unlike mammals, you can get at the embryo which grows fast and hatches within three days. The fish lays lots of transparent eggs, so you have a lot of material to work with. One can watch everything developing: the formation of the nervous system, eyes, brain, and body.

Carl is trying to inject DNA into the fish so the foreign DNA will integrate into and destroy one of its genes so we can identify that gene's function during development. When one tries this in a mouse, it's hard to see what happens. A mouse with one defective gene looks perfectly healthy because it has two copies of each chromosome. You need several mice with that defective gene and then mate them. Then a quarter of the offspring will have two copies of the defective gene and show the mutation. But the embryo often dies in the uterus and you never see it. You can dissect the female and look at the dead embryo, but you can't follow its growth. With a fish, we can see that embryo, follow its growth, and see effects of mutations immediately.

Omni: Carl injected a piece of foreign DNA into the first embryonic cell so he could observe that DNA function to make the cell fluorescent?

Gilbert: Yes, an exciting way of doing things. The embryo starts dividing, the piece of DNA is passed to all the cells. Carl is trying to make mutations in the wiring of the nervous system, hoping to see a single neuron light up. That would suggest the foreign DNA in a gene is initially turned on only in that cell. The fluorescent substrate leaves the embryo alive so he can see the pattern of expression—and grow up that embryo into a healthy fish. If he's lucky, that embryo will pass on the newly inserted DNA to its offspring, and we'll have a line of fish with a mutation in this particular gene. We'll see the gene function and trace its effect.

Omni: What kinds of questions will that answer?

Gilbert: Issues such as how genes structure an eye? How do you put the retina together? What is the nature of genes that tell nerve cells how to connect? We know specific genes are turned on in specific cells, but we don't know to what extent this happens. To construct something as complicated as our bodies, we turn on different genes in muscles, skin, and so on to structure them. But what is the nature of a gene that activates in one nerve cell of the eye but not in the cell next to it?

The brain has a whole layer of cells in the cortex that all look the same in the microscope. But on some level they're going to be different because they participate differently in the thinking process. They may be different because the events the animal experiences makes the cells connect and fire together. That's a picture of the brain's structure by functioning. Or they may differ in what genes they express. There is a great argument over whether one structures the brain one way or another. It's a core question in neurobiology. If the connection is between axon and cell body, then the more you fire the axon, the stronger the connection. No one knows how. Maybe genes turn on and off biochemical processes that make more materials in the cell. Is the ease of turning those genes on and off the same in all nerve cells? We don't know.

Omni: Do you have a personal project in your lab?

Gilbert: Nothing separate from what everybody else is doing. The major themes are various ways to make the fish project work better and a large DNA sequencing project I've set up. We're sequencing a small, wall-less bacteria—mycoplasma—and expect about two years from now to sequence at a rate of five megabases, 5 million bases a year. That would be an entire bacterium a year, a hundred times faster than any single group now.

We should complete the sequence of the mycoplasma, this smallest free-living organism, quickly by late 1993. Then we will look at questions such as: if we have a million bases of DNA, how can we identify the 500 or so genes that make up the organism and understand what they all do? We can learn about the pattern of evolution by looking at the structure of genes and comparing the structure of proteins.

Omni: Why are you preoccupied with this line of interest?

Gilbert: In physics I worked on what particles make up other particles. In biology the similar question is how DNA makes a product. How does one gene control another? How does something you inherit from your parents determine your structure? How does DNA do it? So DNA sequencing was always exciting. The discovery of sequencing gave us the ability to look down onto the genetic material and see it. In a sense, the human genome program has the same theme. It is the ultimate answer. Nothing in the individual is more causal, more basic.

Omni: How do you fell which part of the sequence is a gene?

Gilbert: People are writing computer programs today to solve that problem. But one can tell pretty well by recognizing the splicing sequences—sequences that code for amino acids have different characteristics from those that don't. The cell recognizes the areas where DNA should be transcribed into RNA through little sequences along the DNA called *enhancers*. That we don't know how to see these features today doesn't mean we won't learn.

Omni: Why bother to sequence the whole genome if 90 percent of it doesn't code for proteins?

Gilbert: Conventional wisdom says 90 percent of DNA doesn't code for proteins. But embedded in that 90 percent are small regions that control how all the genes function and we don't know how to find those small regions without sequencing the whole thing. It's easier and cheaper to do the whole thing than to first find which 5 percent you'd want to have. The analysis, ultimately, will be very deep, layer upon layer, because almost all the DNA has some message for us to interpret.

Even the scientific community is confused about what's happening. Why do we do basic research? To learn about ourselves. In biology we've had to use simple model systems because our understanding was simple. Molecular biology used to describe just bacteria. Now we're working with the worm and fruit fly. We're about to move on to mammals using the mouse. So how does the human system work? In the future, medicine will become the center of biology. The scientific community doesn't realize this yet. We'll work with humans and human genes. We've turned this corner in the last ten years.

Omni: Will we be able to breed a superhealthy human race with sequence genetics?

Gilbert: The actual differences between people are of the order of about one change for every thousand steps along the sequence. Maybe 10 percent of our genes are slightly different. We don't know precisely which ones. We do know some places where the variation is. The idea that one can create a single subspecies that breeds true and is superhealthy and so on is an illusion. The interaction of the variation in our genes is what's responsible for lots of our attributes and vigor. That hybrid vigor requires that we receive different forms of genes from our two parents.

Omni: But don't you have to do many sequences before you know what genes we all have in common and which are variable?

Gilbert: If we do one human sequence, we can know virtually all of the 90 percent that we have in common. That one sequence will probably be compiled from many people. Then we'll look at individual genes where variation is unusually important. We know some of those places, like in the immune system. In the middle cluster there are some that are different between people, and they control transplantation. Others that are somewhat different among people are involved in whether people are subject to autoimmune disease. Both areas are studied intensively.

The differences between people are what the genetic map will be about. That knowledge will yield medicine tailored to the individual. One will first identify obvious genetic defects like cystic fibrosis. The next round of genetic mapping will show us clusters of genes for common diseases from arthritis to schizophrenia. We will be able to predict the side effects of drugs and tailor the right dose for each person.

Ultimately your doctor will have a little test kit and send off a sample of your DNA, and somebody will run your entire sequence for him. In less than 20 years, for a couple hundred dollars, you'll probably be able to take a piece of DNA from a baby and recognize every gene and whether it came from the mother or father. In the middle of the next century, say, I'll be able to take a little scrape of you and drop it into the machine and out will come the complete sequence. That will say, "Oh! You've got one of great-grandmother's

genes here and a great-grandfather's gene there. You have a whole set of medical predispositions, and we know what they are.'

Omni: So physicians will eventually just be technicians?

Gilbert: They already are. The physician used to be a counselor of the soul. He held your hand, looked at you, and said you were sick and comforted you. But he couldn't do anything for you. We already look on him as a technician with a set of tools and a computer. He's supposed to take a sample from you and run tests. If he doesn't run all the tests you are ready to sue him. Patients expect a mechanical diagnosis and a cure. So now his problem is where to get the information for that cure. We are expanding the number of assays he can do, and human genetics is part of the expansion. We'll have genetic counseling in hospitals and clinics, first for people with genetic defects, then for common diseases as they get identified.

There will be the sequence, a pile of electronic data on a disk you can put in a computer. Five or ten years from now the information will be analyzable immediately. Scientists will think about it, and companies will sell analyses. Doctors will send them a sample of the patient's serum, and they'll look for genes that predispose one to diseases: cancer, heart disease, and so on. Eventually you'll take a little DNA as assay for everything.

Omni: Won't this capacity to predict defects lead to social problems?

Gilbert: A man may have to discuss the fact he has a gene for cystic fibrosis, say, with the woman he's going to marry. The big question is, who should know that information? Just the patient? Or does society have a right to know? Today we have a problem with HIV. In my view, AIDS is not communicable enough to be a reportable disease, so HIV status should be private. Something passed on genetically is not communicable enough to be reportable, either.

Omni: Having oneself "summarized" will feel a bit weird!

Gilbert: A philosophical change will occur. A human being on a compact disc! A curious image, both true and false. True in that if you made that sequence, it would be a human being, and it is the rough essence of everybody. But that sequence won't include all the variations between people. We tend to think of ourselves as having infinite potential. But soon there will be a sharp border at which one says, 'No, humankind is a finite product of a biological system.' We are embedded in a biological world and related to the organisms around us. Biology will relate every human gene to the genes of other animals and bacteria, to this great chain of being. The human's place in the universe will be set in the scheme of evolution, the product of our biological inheritance.

This will be exciting for scientists but a shock for the man in the street—like finding the earth is not the center of the universe. The danger is that people may adopt an attitude of genetic determinism. 'My genes limit what I can do!' This is not particularly true. All sorts of things are connected to how one functions in the world—how one's mind functions, how determined one is to overcome genetic difficulties.

Omni: How do you know that humans vary so little?

Gilbert: Because the common ancestors of all humans converged about 200,000 years ago. We have common ancestors, and our sequences are all related. How many characteristics make up a body isn't known. There are roughly 100,000 genes, but each might have 10 or 100 different special characteristics, and the tenth of a percent variation may affect a large number of them. This will become known in the next five or so years.

Omni: How will the genome database change science?

Gilbert: The genome project involves a paradigm shift. Biology is changing to a science in which all first-level experiments will have been done and everybody will have to live with that. Today one identifies a gene, clones, sequences, makes its product, and does more experiments to understand its function. In the next stage, biologists will have to go to the computer and know that first level of information before doing something else. The scientist will form a conjecture, then turn to experiment, with the database being one of the reagents he or she uses. Some people are already on that side of the divide—computerized and thinking that way. Other scientists are completely on the first side; they see that something is happening, but they don't know what it is, and this is producing a big conflict.

The people who isolate a gene, clone and study it, and after that do another one, are suddenly going to be unemployed. All those genes will be done. The fraction of information in the database is increasing tenfold every five years. Five years from now there'll be ten times more information. That becomes overwhelming.

Omni: So gene jockeys will learn to work in virtual reality?

Gilbert: Exactly that. For a recent paper we attempted to see what the world

looked like before there was a genetic code by working with the computer in an interactive fashion. We estimated how many genetic shapes there were originally in evolution that were assembled to make genes and found a very small number—about 5,000. There is little of this kind of research as yet, but one can see the signs. I recently heard a seminar on the molecular biology of a certain protein, and that whole burst of experimental work was suggested by a computer finding.

Omni: Have you ever had a hard time because an idea of yours contradicted the current paradigm?

Gilbert: That's extremely common. One major time it happened to me was 12 years ago (and again today, because the argument is very alive right now). As we first worked out the structures of genes, we discovered DNA is broken up into exons, short coded regions, and introns, very long intervening regions not used for anything. Yet the whole region is copied from DNA to RNA before the intervening regions are spliced out. This leaves a small molecule of final RNA that corresponds just to the coding regions.

Now, bacteria don't have introns—their genes are all continuous coding regions. When all this was discovered in 1978, I and Ford Doolittle thought about how we had evolved differently from bacteria. I suggested evolution started off with tiny genes that coded for pieces of proteins and that large pieces of DNA were assembled by adding introns, like glue, to tie the exons together. That was considered an outrageous idea for a long time. But the idea gradually got accepted.

I argue that in the beginning introns were used to assemble the genes. Like other vertebrates and higher organisms, we are what we are because every now and then we make a new gene using this intron behavior. Introns speed up this process of recombination: this breakage and joining of DNA. In evolutionary time of a million years, in some individuals that DNA will break in between those two, and those broken ends will go find another end, and DNA will form a new combination of exons tied together in a new order in a new gene. So the real role of introns is the ability to make new genes. The bacteria have lost that ability and they're not evolving as rapidly anymore. They are essentially the perfect offspring of a much longer evolutionary line than ours. Ours goes quite slowly since we have a 30-year generation time. Bacteria have a 20-minute generation time, so they're far more evolved.

Omni: Biochemist Sheldon Penman of MIT flashes a picture of James Watson followed by a chimp and says, "There! All the same proteins!" suggesting introns may help determine what we are.

Gilbert: The danger with that flash is that we and the chimpanzee are about 2 percent different in sequence. There could be 2 percent difference of our proteins that are totally unrelated, and we have no idea what that would mean. We don't know if a few proteins change critical aspects of our structure. On average, each protein has about one difference in amino acid sequence between us and chimpanzee. All those minor changes may have an effect, or there may be 2,000 out of 100,000 proteins that are totally different and that have novel functions.

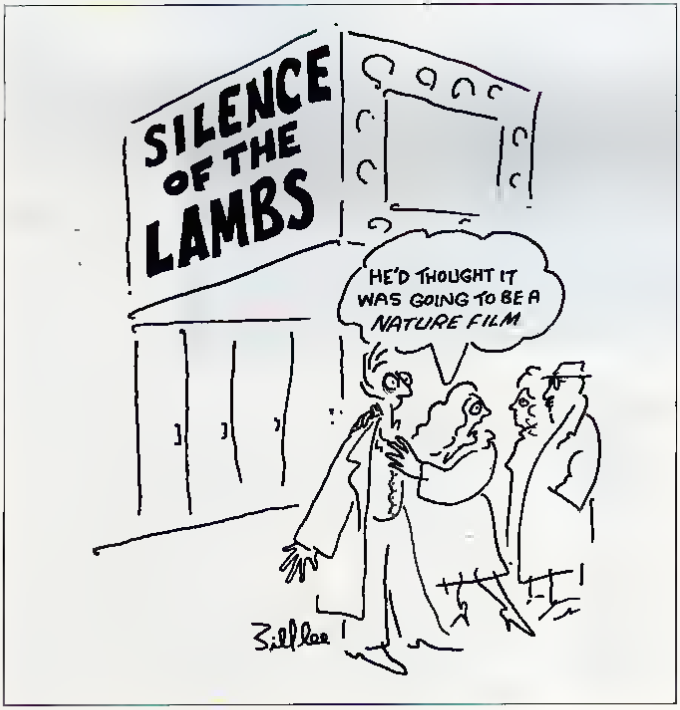
Every time someone finds a basic gene that determines some aspect of brain structure, that gene turns out to be in the brains of all mammals. If it has to do with fetal growth or the structure of the body, it turns out to be in flies and worms all over the place. Yet many aspects of structure, such as how big our brains are, are probably not a matter of how many proteins we have but how control is exerted over where and when they are made as the organism grows. What determines the shape of a limb? In the chicken wing, a gradient of retinoic acid from one side of the wing to the other sets up the digits, or bones, in the wing. If you put a pellet of retinoic acid on the other side of the wing, you get a double set of digits.

We haven't been able yet to determine in terms of genes what makes a human being a human and not another mammal. It will probably turn out to have a reasonably simple answer. Finally, we should be able to spot which of the 1,000 or 10,000 different facial types a person is from the genes.

Omni: You are perhaps the most prominent scientist who has supported Peter Duesberg of Berkeley, who argues that HIV might not cause AIDS.

Gilbert: Today one looks at AIDS very much one way, as caused by a virus. A few people try to look at it other ways, not necessarily terribly convincingly. And there is a reasonable level of scientific debate behind the scenes. The arguments for HIV as cause are not sufficient. I should not be surprised if there were a different cause. But there is a problem. If you are always reexamining your premises, you never get anywhere.

Scientists tend to be skeptical, but the weakness of the community of science is that it tends to move into preformed establishment modes that say



this is the only way of doing science, the only valid view.

Omni: Are scientists too conformist in accepting the ruling theory?

Gilbert: There's a herd-instinct problem. The virtues of science are skepticism and independence of thought. I am totally horrified when Ben Lewin, the editor of *Cell*, says science depends on trust. I feel personally insulted by that statement: it is totally untrue. Science doesn't in the slightest depend on trust. It depends completely on the belief that you can demonstrate something for yourself. I don't have to trust anybody, though I can choose to.

Omni: Surely you can't redo everybody else's experiment?

Gilbert: With everything I do, I am well advised to repeat the experiment I'm starting from. Anytime I don't, I've generally regretted it. I am perfectly serious! If I do an experiment that's too far into a novel line and don't verify the underlying step, then I'm being foolish. I may not have all the pieces. Something may have been left out of the description in the paper. I've had students waste a year because they were trying to do something where the original result wasn't valid, and they didn't check the original thing exactly.

Error is far more common than fraud, which probably comprises 1 percent or a tenth of a percent of the literature. Your most trouble with fraud is where you can't repeat the experiment easily. A medical trial where someone says, "I have tested 150 patients" is hard to repeat. The FDA does its best to look at all the records to double-check that. Cold fusion is different. Someone says they have cold fusion, and the whole world tries to repeat it.

Omni: How do you explain Pons and Fleishmann's cold fusion paper?

Gilbert: I found it utterly amazing. I use it in teaching. They were so sloppy, it was practically fraud. They claimed to get more energy out than they put in. They measure the heat input and only *calculate* output! They don't measure it! It's an observation on one side and a calculation based on estimating the energy released inside the apparatus on the other side. Terrible thing to do. So careless. I find it hard to believe any journal published it. There's hard thinking and soft thinking. Softball thinkers. You have one guy who does the experiment and another who comments. Even softer. A third person does the experiment, a technician in one lab, and both comment.

Omni: Are you religious?

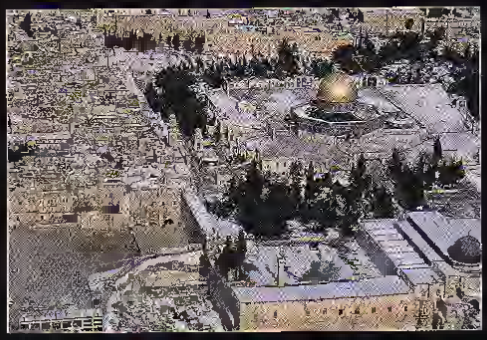
Gilbert: I have the same sense of the power and virtue of knowledge that some people get from a religious background. ∞

ANTIMATTER

ISRAEL: Land of milk, honey, and UFOs

It was the winter of 1991 when a raging storm dumped an unprecedented 18 inches of snow on Jerusalem, felling more than a thousand trees and paralyzing the City of Peace. But how could the heavenly onslaught be explained? Proponents of apocalypse said the storm augured the end of the world. Meteorologists pointed to unusual disturbances in the sun. And a few audacious spirits even suggested the tumultuous weather had somehow been caused by UFOs.

The saucer buffs were swiftly pilloried by the pragmatic Israeli press. But the extraterrestrial visitation theory was forgotten only for awhile.



Seowy shroud: Product of nature or UFOs?

On midnight of Friday, January 24, 1992, witnesses reported a mysterious, sphere-shaped object trailing a fiery tail in Safed, north of the Sea of Galilee, over Nazareth, and finally, as far south as the Red Sea and Eilat. When a local radio show carried a story on the sightings the next day, listeners called in with more reports still. Witnesses throughout the nation described a "ball of fire and a tail of glittering light about two kilometers above ground." Estimates of the object's length varied from 40 to 200 meters, including the fiery tail.

One of the first to investigate was UFOlogist Hadassah Arbel of Haifa, who received numerous reports of the mysterious object. It definitely did not fit "orthodox characterizations" of the UFO, said Arbel, since so-called "flying saucers are usually endowed with a solid, clearly defined, easily recognizable geometry. They are either cigar or saucer shaped, elliptical, or simply circular. In this case, witnesses described what they saw with words like "glittery" and "celestial."

This latest spate of sightings, Arbel adds, are just part of the phenomenon she has been investigating since 1987, when one young man from Haifa reported a glowing, boomerang-shaped object zooming across the night sky. Since then, Arbel has looked into well over 200 UFO reports from Haifa alone. According to Arbel, who by day directs the Volunteer Unit of Haifa's Social Welfare Department, the saucer sightings may have a spiritual spin. Many of the Haifa sightings, she notes, occurred on significant Jewish holidays such as Passover, Rosh Hashanah, and Shavuoth. "It is possible," she suggests, "that the UFOs are meant as some sort of sign."

Oded Regev, astrophysicist at Israel's prestigious Technion University, agrees that the sightings are a sign—that some of nature's subtle mysteries must still be solved. "The sightings can have a large number of mundane explanations," he opines. As for the latest UFO over the Holy Land, he suggests it could have been caused by "a chunk of satellite falling earthward and burning up in the atmosphere, a meteorite, or a low-flying high-performance military craft."

"Ninety percent of UFO sightings," Regev adds, "can be dismissed as natural atmospheric phenomena, optical illusions, reflections from celestial bodies, or even birds." Hadassah Arbel, meanwhile, finds vindication in the fact that even Regev admits some "ten percent of the UFOs sighted over Israel and elsewhere are unexplained."—*W. E. GUTMAN*

ANTIMATTER

VAMPIRE REALITY

A quarter of a century after reading *Dracula*, author and journalist Rosemary Ellen Guiley finally got a chance to meet a few vampires herself. In fact, more than three dozen self-styled vampires came forward to be interviewed for her new book, *Vampires Among Us* (Pocket Books), after she put out the word among vampire fan clubs, punk nightclubs, and other Gothic spots.

Though many of Guiley's subjects said they regularly drink blood, no one claimed to have come back from the dead. So they were not, strictly speaking, classic vampires. Instead, says Guiley, they were people "enamored of the vampire lifestyle" as portrayed in movies and books.

"The image of the literary vampire—as glamorous, sexy, and immortal—has superseded the vampire of folklore in their minds," Guiley says. The vampires Guiley met were generally between the ages of 18 and 28. They tended to be introverted and, as children, had often been abused. "Very often," Guiley says, "they just wanted others to look up to them or feel afraid."

Those who live the vampire life, Guiley says, usually dress in black, live with their blinds drawn, and lead secret, nocturnal lives. None of Guiley's subjects claimed to be hundreds of years old, and only half said they were bothered by garlic.

As for blood-drinking habits, Guiley notes, they varied widely form vampire to vampire. Some imbibed the red stuff once a week and some once a year, though always in very small quantities. The big change in "vampire reality," Guiley adds, comes from AIDS. To avoid disease, some vampires have opted for animal blood. Others have developed monogamous blood relationships with another like-minded vampire. Yet others have turned to a tasty substitute—a mixture of tomato and orange juice.

TO AVOID THE DANGER OF CONTAMINATED BLOOD, MODERN-DAY VAMPIRES SIP A TASTY MIX OF JUICES.

"People who believe themselves to be vampires live according to their perceptions, both conscious and unconscious, of how vampires should live," says Guiley. "Vampires exist because we believe in them. We create them with our fantasies and thoughts."

—Patrick Huyghe

Penny Price and Ron Lavin

ASTRAL LOVE

They're the epitome of a modern New Age couple. Penny Price is a producer and investigative reporter for *Geraldo*, and has her own New Age video-production company. She's produced a number of *Geraldo* shows on New Age topics, including holistic medicine, miracles, and even the outrageous segment in which Geraldo went fire-walking. Her husband, Ron Lavin, is an international seminar leader who conducts workshops on healing, intuition, and dreams.

This New Age power partnership formed in 1985 when the couple met at an American Indian workshop in Malibu. Ten dates later, they were engaged. It wasn't long after, adds Penny, that "we looked into an Indian art gallery and saw a past life we had shared in Egypt."

The duo, who now make their home in Long Beach, New York, believe theirs is "an extraordinary relationship." Says Penny, "We are independent, yet one hundred percent committed to each other." Ron credits their liaison with the growth of Penny's psychic and intuitive abilities, which, he says, "have increased about ten times." Penny, meanwhile, calls Ron "a wonderful adviser," and says "he's always right." Penny also assists Ron in his healing workshops and says she's "committed to doing whatever it takes to love Ron and help him bring his gifts to the world."

Penny and Ron intend to work together even more closely in the future "to help bring the healing spirit into the world." Ron expects to open a metaphysical institute. Penny is planning a series of video- and audiotapes on Ron's workshops.

Are there any New Age children in the stars for this cosmic couple? "Not in this lifetime," says Penny. "We're constantly nurturing the world and each other, and *all* the things we do feel like birthings, like our children."—Anita Baskin

HAPPY HUNTING GROUND

Jay Knudsen can't get hunters into heaven after death—but he *can* blast them into the "happy hunting ground." Knudsen, who heads Canuck's Sportsman's Memorials, based in Des Moines, Iowa, loads the cremated remains of deceased hunters into shotgun shells and then shoots them into favorite deer country or duck marshes. "We do the same with the ashes of favorite hunting dogs," explains Knudsen, who also puts the "cremains" of deceased fishermen into lures, deceased duck hunters into decoys, and deceased bowlers and golfers into memorial bowling balls and golf clubs.

According to Knudsen, his techniques are comparable to dropping cremated remains from airplanes or into the sea. "People have been doing that for ages," he notes. "This is just more creative. A lot of people would rather know that their loved one is in an area where he loved to hunt than sitting in an urn on the mantel." Since first advertising last fall, Knudsen has had 33 customers who paid up to several thousand dollars for the service. "The price varies," he explains, "depending on whether we have to pick up the remains and where we have to take them. Sometimes we need guides or special nonresident hunting licenses."

Robert Smith, president of the Milwaukee-based National Funeral Directors Association says he's never heard of blasting remains from guns or storing them in sports equipment. "But if it's okay with the next of kin and doesn't violate any state or local ordinances," he notes, "I suppose it's all right."—Sherry Baker

WHEN JAY KNUDSEN DIES, HIS "CREMAINS" WILL REAP A SPORTSMAN'S JUST REWARDS. "I'LL BE FISHING IN IOWA, BEAR HUNTING IN NEWFOUNDLAND, AND DEER HUNTING IN MANITOBA."

HERE'S LOOKING AT YOU

Have you ever felt as though you were being stared at behind your back, only to turn and discover that you really were? In a survey conducted by San Antonio's Mind Science Foundation, 94 percent reported this eerie experience. In a follow-up study, Mind Science researchers monitored isolated subjects being stared at via closed-circuit TV. The result? "Different physiological patterns were observed for staring versus nonstaring periods," says researcher William Braud. "The suggestion is that people may respond unconsciously to the attention of a distant person, even if there is no direct, physical link between them." Can the responses be elevated to the level of conscious awareness? "If the person under observation is not distracted by more immediate influences," says Braud, "I believe it can."

Commenting on the Mind Science results, Harvard social psychologist Robert Rosenthal states, "It remains for further research to nail down the existence and true average size of this effect."—Keith Harary

GRAVITY'S

CONTINUED FROM PAGE 88

through several shifts of physicists and finished by asking the group leader if he needed anything more.

Carol had heard about Dickie Boy, but she had her own reputation, and so when they said hello and looked each other over, I could almost hear the wheels turning, the question being posed, "Are you as good as they say?"

We went to the terminal, and Carol ran the Monte Carlos as Dickie Boy sat almost squirming with impatience to have at what she was doing. When she got out of the chair, he almost leapt into it and said, "You two go somewhere else, okay? The other room's all right; just leave me alone."

"I need to do some work at the office," I told Carol. "What about you?"

"Yeah," she said. "I should check my mail at the lab, see who's angry that I'm gone. You got another terminal with a modem?"

"In the bedroom," I said. "I'll see you two later."

At HBET I found a line of people waiting for me to talk about or approve their experimental arrangements, and so I spent the afternoon there, amid the chaos of getting the SSC ready for its first full-energy runs, scheduled for just a month away.

Carol and Dickie Boy were seated next to one another when I returned, with another variation on her Monte Carlos on the screen in front of them. "What's up?" I said, and Dickie Boy said, "This is fantastic." Carol was smiling.

"Think we can take it to Thursday Group?" I asked.

"Tough audience," Dickie Boy said.

"Is it the one that counts?" Carol asked.

"Yes, it is," I said. "If we can convince them, they'll go up against Diehl or anyone else."

"Let's do it then," she said.

"Can you do a presentation?" I asked. "Good talk, good pictures?"

"Yes," she said. "I've been getting ready to do it."

"Fine," I said. "I'll call Allenson and ask if I can take over the agenda. I don't think anyone's got anything hot working."

Bad haircuts, cheap clothes, and an attitude—that's the way I once heard a gathering of theoretical physicists described. They—*we*—consider ourselves aristocrats of the mind, working in the deepest and most challenging science there is. Getting there first with good ideas, that's the only thing that counts—under all circumstances, that was the unspoken credo.

The whole group showed up that night. The living room of Allenson's house was shabby and comfortable, with couches, chairs, and large pillows enough to hold the sixteen of us: thirteen regulars and me. Carol, and Dickie Boy. Eight Caucasians and five Orientals, three Chinese and two Japanese. Most were in their late thirties, though a few were in their middle forties. No one under thirty, no one over fifty. These were the theoretical heavyweights at the lab: men in their short-lived prime as it exists in high-energy physics. A few were drinking coffee; most just sat waiting, talking.

I gave her the simplest possible introduction. I said, "This is Carol Hendrix, who is here from Los Alamos

"Bad haircuts, cheap clothes, and an attitude—that's the way I once heard a gathering of theoretical physicists described."

where she is Simulations Group Leader. She has some very interesting simulations she would like to present to us."

Carol Hendrix knew her audience. She had gone into sexless mode as much as possible. Her face was pale and scrubbed, no makeup, and she wore baggy tan trousers and a plaid wool shirt—in short, the closest approximation she could get to what the men in front of her were wearing. From her first words, she spoke calmly and authoritatively, for they'd listen to nothing else from her, and allowed none of the passion I'd heard to animate her presentation.

She gave it all to them, dealt it out on a screen in the front of the room. The slides came up showing pretty pictures from The Thing, equation sets from QUARKER, annotations in her own hand. Each idea led straightforwardly to the one after, theory and practice brought together with casual elegance.

Leaving the last slide's **END SIMULATION** on the screen, she summarized. "We know little about the physical attributes of a singularity, in fact, its essential nature is lawless." She stopped, smiled. "Though we would anticipate its interactions with the nonsingular world of spacetime to be governed by the usual conservation laws, this may not be the case. In short, the consequences of creating a singularity are not well understood, and I would suggest that further analysis is required before any experiments are undertaken that could bring such a peculiar region of spacetime into close proximity with instruments so delicate as those in an experimental area." She paused and looked at them all, said, "I will be glad to hear your questions and comments."

This is where it will happen. I thought. Guests to Thursday Group often got taken on the roughest intellectual ride of their lives, as this group of brilliant and aggressive men probed everything they had said for truth, originality, and relevance—or the converse. I went very tense, waiting for the onslaught to begin.

"Dickie Boy," Bunford said. If this group had an alpha male, Bunford was it. He was a big man—around six-three and more than two hundred pounds—with a strong jaw, a lined face, and sunburned skin. He had elaborated the so-called Standard Model in new and interesting ways—the "semiunbound quark state" was his particular interest—and the smart money had it that he and his group could pick up a Nobel if the SSC found the interactions he was predicting. "Did you validate her simulations?" Bunford asked. Rather an oblique approach. I thought, probably in preparation for going for the throat, theoretically speaking. Carol Hendrix turned to see how Dickie Boy would answer.

"Sure," Dickie Boy said. "Very sweet, very convincing. Take for instance the series of transforms . . ."

"Fine," Bunford said. "And to Carol Hendrix: Thank you. If Dickie Boy validates your Monte Carlos, I'm sure they're well done." He paused. "The physics is interesting, too . . . though quite speculative, of course."

And he stopped there, apparently having finished.

I waited for him to go on, but he didn't—he was whispering quietly to Hong, one of his group members. And no one else was saying a word. Finally, Allenson stood from the pillow where he'd been sitting cross-legged and said, "Shall we make it an early evening tonight? I don't know about you guys, but I could use some sleep." He turned to Carol Hendrix and said, "I'd like to thank our guest for speaking to us this evening." Murmured voices

CONTINUED ON PAGE 115

GRAVITY'S

CONTINUED FROM PAGE 110

said much the same thing. "At a later time, perhaps we can discuss the implications of this work, but this week we are all very busy getting the SSC up to spec."

Carol Hendrix stood white-faced and silent as all the men got up, nodded goodbye to her, and left, some alone, others in small groups of their colleagues.

"I don't understand," I said. We were walking along one of the suburb-like loops that led from Allenson's house to mine. For the present, many of us lived in Texlab-owned housing as a matter of convenience. "They didn't even want to argue with you."

"I'm an idiot," she said. "I forgot some of the most important lessons I've ever learned. In particular, I forgot that I'm a woman, and anything I say gets filtered through that."

"Do you really think that?"

"Sax, don't be so fucking naive. Why do you think they were polite? Because I was a *visitor?*" Her voice was filled with scorn; she knew as well as I did what treatment visitors got.

"Your conclusions are radical. You can't expect them to assent right off."

"I'll grant you that, and it would have been hard to convince them of anything substantive, but I could have *begun* tonight. They dismissed me; they dismissed what I was saying. Bastards. Smug male bastards—it's no wonder they can't hear anything; they're so filled with their own importance."

We stood in front of my house. She said, "I think I'll walk around for a while, if that's all right. I don't want to talk right now."

"Sure," I said. "Go anywhere you want. In fact, I think I'll go for a bicycle ride. I'll see you later."

So moonlight flashed through the bicycle frame as I rode the berm road above the SSC, and finally I realized I had no answers to what perplexed me, and I turned around and headed back toward home.

I rode through streets of darkened homes and came to my driveway, where a light burned on a pole. walked the Invisible Bicycle up to the door, and went in to absolute silence. On a low table in the living room, I found a note:

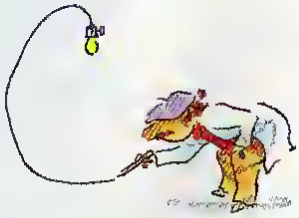
Dear Sax,

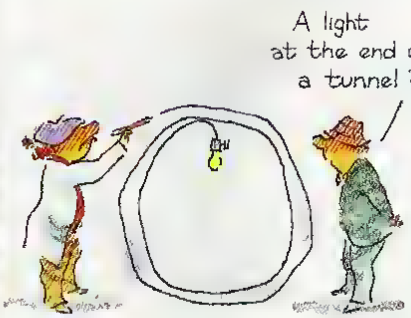
I have gone back to Los Alamos. Don't worry about me, I'm fine. I just need to think about what happened here.

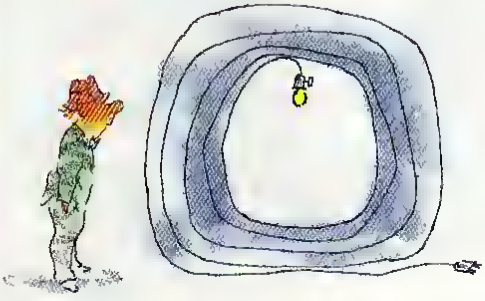
Thank you for all you've done.

Carol

The Artist







* * *

Over the next weeks, as the full-energy trials came closer, I thought often about Carol Hendrix, her singularity, and the treatment she'd gotten.

I went back to Thursday Group the next week but found I had little to say to any of them—the whole bunch seemed strutting apes obsessed with their own importance and show. If they were interested in the truth, and particularly in new, interesting truths, then why hadn't they treated Carol Hendrix with the seriousness her ideas deserved? Her ideas were strange, but important ideas always were. She was a woman, but so what? How could that matter?

All of a sudden I felt a fool. Their conversation excluded everyone not a member of the group, and their masculinity, while entirely free of conscious malice, effectively recognized only its own kind. A young, small woman simply did not exist for them as a physicist to be taken seriously.

I left early that evening and decided I would not go back.

But what I had seen at Thursday Group was everywhere at the lab. Secretaries were women, scientists and administrators were men—white men by and large, with a sprinkling of Orientals. Carol Hendrix was right. I was incredibly naive. But I understood why. As a high-energy physicist, I had been devoted to what I thought of as an unbiased search for the truth, a search that creates intense tunnel vision—because of how difficult it is, it demands absolutely everything you can bring to it, and often that isn't quite enough. Now I had awakened, and what I saw appalled and confused me.

I got one note from Carol Hendrix, apologizing for leaving so abruptly and saying that she would write again when she had gotten her thoughts straightened out. Then, five days before the first full-energy, high-beta runs, she called me at the office. "Sax," she said. "I'd like to come watch the runs. Would you mind?"

Carol leaned over me, slid her body down mine, pulled the gown over her head. She was astride me, hands at her side as she moved in rhythmic arcs. "The stars," she said. Through the window I could see points of light strobing, red- and blue-shifting through the spectrum. "Something is poking through behind them," she said. "It wants in." A sheet of blue light poured through the window, burned through us, x-raying flesh and bone. In it we were translucent, the intricate network of our nerves burning in silver fire. We were

fusing together, so close to an orgasm that would annihilate us.

I woke, got up and drank some water for my burning throat, fell back on the bed. I hung suspended between waking and sleeping as a flood of images passed across my eyes. Bright, blurred shapes vanished before I could see them clearly.

She was coming in the next day, the day before the first big runs.

She wore khaki shorts and a dark-blue T-shirt. We were sitting in my backyard again, under a moonless sky—a thousand stars above us and meteors cutting brief, silent arcs at the horizon. She sniffed at the glass of cold Chardonnay she was holding, drank, and leaned back in the reclining chair.

"I owe you an apology," she said.

"What do you mean?"

"You did everything you could to help, and I walked out on you."

"You were troubled."

"I was, but I shouldn't have treated you like one of them."

"That's okay. Apology accepted."

"Tomorrow morning, what do you think will happen?"

"Truthfully, I don't know. If we get good beam, we'll have the right conditions for your simulation."

"That's what I thought. I've gone over it and over it, worked it through time and again, had a work group tear my analysis apart. It all adds up to the same thing. My simulations are realistic, plausible . . . and unverifiable without experimental evidence. All of that's fine. What worries me is this: If I'm right, your people are going into what could be a dangerous situation, and no one has a clue about it; no one wants to hear about it, at least not from me."

"You've done everything you can."

"Maybe."

"No, I mean it. Listen." And I poured it all out to her, what I'd seen in recent weeks, how incredibly closed and self-confident our world was, unbelievably blind about its own nature, which within the community was seen as inevitable. I'm not sure how long I talked or how I sounded—I just know that the frustration and anger and amazement I had lived with for the past weeks came tumbling out in one long screed.

"Oh, Sax," she said finally. "You poor innocent." And she laughed, then laughed again, harder, and carried on laughing as I sat there embarrassed. Finally she stopped and said, "Sometimes I get so wrapped up in all of this, I forget how things really are. Thanks for reminding me. To hell with them all. I've tried, you've tried. If the SSC's turned into the world's most expensive

junk pile, it won't be our responsibility."

We talked a bit more until we had finished the bottle of wine, then she said, "When do we have to be there?"

"Seven a.m. We should leave here around six-thirty, so I guess it's time to go to bed."

She found me standing at the sliding-glass door in my bedroom, looking out onto the night. I turned and saw her in the doorway, backlit by the light from the hall behind her. "Are you all right?" I asked.

"Who knows?" she said. She came across the room to me, stood in front of me, and put her hands on my bare shoulders. She said, "Want to make love, pen pal?"

She leaned against me, and I could feel her body under the thin jersey. "Yes," I said. "I do."

Through the night we moved to the rhythms of arousal and fulfillment, making love, lying together in silence, sleeping, waking again. All the frustration, anger, anxiety, excitement we had both felt the past weeks funneled into those moments, sublimed into active, driven lust.

Shortly after five I was awakened by a sweep of amber light through the window and the sound of wind. I found the groundskeeper robot outside. It had settled onto one patch of ground, its aerating spikes flashed out of the bottom of the machine, their blind repetition chewing turf into fine mulch.

I said, "You ought to go back to the barn or wherever they keep you and just kind of relax. Keep this shit up and they'll scrap you." It stopped and sat there emitting a low-pitched hum punctuated with occasional high harmonic bursts. "That's sensible," I said. "Think it over." It decided. It crawled over to a row of stunted ornamental shrubs and began to slice them into very small pieces.

I went back inside, called the thing's keepers, and tried to go back to sleep. Instead I lay awake, thinking of what might happen that morning, until Carol turned over to me and whispered, "One more time?"

"Oh yes," I said. "One more time."

Around six-thirty we walked out of the house and ten minutes later were at Maingate shuttle station, where we went down into the tunnel with five members of a tech team. They wore orange overalls and helmets and had respirators dangling over their shoulders, protection against any accident where helium would boil from the superconducting magnets and drive the air out of the tunnel.

Harry Ling, the BC 4 supervisor, was directing people at the shuttle stop. "How's it going, Harry?" I said.

"Ask me later," he said.

At Experimental Area 1, teams were making final adjustments to their instruments and hoping no last-minute gremlins had crept in. The room was fifty meters square, dominated by the boxcar-sized composite detector. Inside it, the storage rings came together, at their intersection the protons and antiprotons would meet and transform.

Two men were levering a bulky, oblong camera—SONY in red letters on its side—into position at an external port. People picked their way through snarls of cable.

Fifty meters up the tunnel was the control room. It was on two levels: ground floor, where technicians sat in rows at their consoles, and the experiments command above, where the Responsible Person sat with his assistants and controlled the experiments.

I introduced Carol Hendrix to Paulsen, my assistant, who was crouched over his screen like a big blond bear over a honeycomb. "Hello," he said, then went on muttering into his headset—I often wondered how anyone understood him.

I said to her, "Let's find you a headset, and you can plug in to my console and watch what develops."

The next hour was taken up with the usual preparations for a run: collecting protons and antiprotons in their injector synchrotons, tuning the beams. The "experiments underway" clock had started when the first particles were fed out of the injector synchrotron and into the main rings. Now the particles would be circling in the rings at a velocity near the speed of light, their numbers building until there were enough for a sufficiently violent collision.

"I have initiated the command sequence," Diehl said on the headphones.

About a minute later a voice said, "We're getting pictures," and there was a round of sporadic clapping from the people on the ground floor. On one of the screens in front of us, QUARKER was providing near-realtime views of the collisions, which appeared as elaborate snarls of red and green, the tracks color-coded to distinguish incoming from outgoing particles. "Beautiful," the man in front of us said.

On the screen next to this one, data flickered in green type. I saw that everything was, as they say, "nominal." Then all lights in the control room went out, every screen blank, every computer dead. Under amber emergency lights everyone sat stunned.

And the world *flexed*, the wave from the singularity passing, the shape of spacetime changing. Puffs of gray dust jumped off the walls, and there were the sounds of distant explosions.

Carol jumped out of her chair and said, "Come on."

I took off my headset and followed her. We passed through the door and into the tunnel, where settling clouds of dust were refracted in yellow light. I stopped at a locker marked *Emergency* and took out two respirators—false faces in clear plastic with attached stainless steel tubes. If enough helium escaped into the tunnel, it could drive out the oxygen and suffocate anyone without breathing apparatus. "Here," I said and gave her one.

The door to the experiments room was askew. Behind us I heard loud voices and the sounds of feet pounding up the stairs to the surface. Turning sideways, I slipped through the door's opening.

Blue blue blue blue, the slightest pulse in it, then suddenly as the conjurer's dove flying from the hat, *white*, swords or crystals of it jammed together, vibrating as if uncertain, then turn-

ing as suddenly to *blue*

The composite detector unit and surrounding equipment had disappeared. Carol Hendrix had become a translucent, glowing figure that left billowing trails of color as she moved. The world was a sheet of light and a chittering of inhuman voices, high-pitched and rising.

Etched images in gold against white, flickering, the reality tape shrieking through its transports as every possible variation on this one moment unfolded, the infinitesimal multiplied by the infinite.

Sometime later, hands pulled on me, dragging me backward across rough cement to a world which did not burn like the middle of a star. My heels drummed against the floor, my back was arched, every muscle rigid.

Riding the Invisible Bicycle past Building A, I saw two men bent over the partially disassembled carcass of a groundskeeper robot. Sprays of optic fiber, red lengths of plastic tubing, and bright clusters of aluminum spikes lay in the grass beside it. One man was holding a dull-gray, half-meter cube, the container for the expert system that guided the robot and was the apparent source of its problems.

The state of things at Texlab: Big science—grandiose and masculine and self-satisfied—lay in ruins all around, shattered by its contact with an infinitely small point, the singularity.

On the steps of Building A, camera crews and reporters had gathered. They just milled aimlessly at this point, waiting for the Texlab spokesman—presumably Diehl—who would have to come out and recite a litany of disaster. Then would come the questions: *How did this happen? What does it mean?*

As I headed out the perimeter road I was passed by lines of vehicles: vans carrying tech teams, flatbed trucks loaded with massive chunks of bent metal, cars with solemn, dark-suited bureaucrats in their back seats. No shuttle rides today—the tunnel was strictly off-limits.

Near station 12 an orange quadrupole assembly lay next to the hole it had made coming out of the ground. Part of its shrouding had torn away to reveal the bright stainless steel ring that held its thousands of intertwined wires together. At other stations I passed there were stacks of lumber for shoring the tunnel, repair crews in hardhats milling near them.

Little more than an hour after the medical team had carried me out of the tunnel, I was apparently fully recovered. The rest of my morning had been

spent with me the focus of doctors, nurses, and lab techs. I had suffered an episode of *grand mal*, an epileptic fit they told me—apparently a reaction to the singularity.

Today there were fifty-six injured, one dead, two more probably to die. The collider had been destroyed, beam pipes deforming and spraying those high-energy particles all over the place—explosive quench in the lattice, it was called.

And Carol Hendrix was one of the fifty-six injured. A chunk of concrete had fallen on her. Skull fracture, assorted lacerations. *Christ*. While they were testing me at the Texlab hospital, she was being flown toward Houston in a medivac helicopter brought in by the Air National Guard. She remained in a coma, but for reasons that escaped me, her doctors were hopeful, so mine had told me.

The men she had talked to couldn't listen, simply *couldn't*. She was a woman, her approach was unusual, her conclusions weird, and despite all their protestations to the contrary, the men she had spoken to were prisoners of their contexts, their presuppositions. Their scientific objectivity didn't exist, never had.

I wondered if they felt as Oppenheimer and company had on the morning of the Trinity explosion, bright light and EM pulse, shock wave throwing those nearby to the ground . . . then they all had to confront—whatever their jubilation, awe, fear, sorrow—their part in this thing, their complicity.

At the above-ground entrance to BC 4, Texlab Security had placed on wooden sawhorses a yellow plastic ribbon with the words EXTREME DANGER repeating along its length. Several gray-uniformed men stood nearby.

"I'll keep your bicycle for you, Doctor Sax," one said as I dragged it down the steps. "No," I said, "that's all right. I'll take it with me."

Rusty iron latticework showed where chunks of the tunnel walls had fallen, brushed by an angel's wing. In the hard yellow light, the Invisible Bicycle looked cheap, a stupid toy. Which it was, just a thing of plastic and conceit.

I wheeled the bicycle around the plywood barrier in front of the experiments room door and stopped to watch the *blue white blue* which continued to some rhythm we did not understand. Robot cameras and recording instruments sat against the near wall.

Reduced to primitive magic, I hurled the Invisible Bicycle at the thing, a burnt offering. *take this, let me have her*. It slowed in midair as though moving through heavy liquid and began to deform. It seemed to turn inside out. Now the Topologically Bizarre Bicycle, no longer recognizable by shape or anything else as a human artifact, it was shot for a moment with rainbow colors, then was gone.

Unmoved, the singularity continued its transformations. Here was the angel, inscrutable as Yahweh answering Moses out of the whirlwind, "I am that I am." It promised infinite levels of discovery, an order not inexplicable but complex and deep as the night. And it promised that for every fragment of knowledge gained, for every level of understanding surmounted, there would be pain and sorrow. How puffed up we become, filled with immense pride in our knowledge, and how quickly the universe reminds us of how little we know.

In the desert it was bright and hot. One of the security guards gave me a ride back to Maingate. ∞

Omni published Tom Maddox's first short story ("The Mind Like a Strange Balloon") in June 1985. His first novel, *Halo*, has just been published in paperback by Tor Books.

DISTANCE

CONTINUED FROM PAGE 80

ceding as we fled toward it.

One longs to see *out* beyond this wall. What could one see? God lying along spacetime, contemplating it? Archytas, a Pythagorean friend of Plato, imagined going to the edge of the universe and stretching out his hand. He would feel empty space beyond the edge or some barrier would stop him either way, the edge wouldn't be much of an edge since there was always a 'beyond.' He concluded that the universe was spatially infinite.

Aristotle objected that an actual infinity was an impossible irrationality and made a peerless claim about it. He had no quarrel with any kind of infinity existing as long as it remained only potentially infinite. A sum could grow larger, a universe older, a space could expand without end, provided that the infinity was *never there all at once*.

For most of our everyday lives we live at the bottom of a well of common sense, or naive realism, which insists that what is counterintuitive can't be true, it's only the extravagance of imaginative souls, charming but foolish. But if we are ever to understand what we call "place," "distance," or "space," then we must look beyond the ideas we have built from the sensory prejudices of our bodies. Spacetime, matter are the abstractions we have made for ourselves to stand in for what more than one thinker has described as 'concrete but unimaginably complex facts.' Space and time may well be the way in which our bodies order incoming information, or spacetime may turn out to be stranger than we can imagine.

Perhaps the most stubborn example of 'common sense' about distance comes from George Bernard Shaw, whose thinking was always a delightful mixture of sophistication and naive realism. For him space could not exist in the absence of air or water, and the surface of a solid object was always the end of a space. Shaw at one time doubted that the sun could be more than a few hundred miles away. "The so-called interstellar space," he stated under cross-examination by J. B. S. Haldane, "has not the properties of ordinary space. It will not conduct sound, nor can a human being move through it. It is therefore illegitimate to measure it in miles."

It is somewhat encouraging that every claim in this statement was vulnerable to the experimental method, and has been settled. OMNI

GAMES

SILLY SCIENCE

Make up your own absurd scientific theory for our latest competition

By Scot Morris

"Lukewarm Fusion." "Survival Strategies Among Animal Crackers." "The Binary Abacus." "Dirty Dish Flow Dynamics in a Southern California Kitchen." "How Jell-O Killed the Dinosaurs."

These are some recent article titles from *The Journal of Irreproducible Results,* the oldest and best-known science-humor publication. Now in its thirty-seventh year, it has been edited since 1991 by Marc Abrahams in Cambridge, Massachusetts. He has breathed new life into this journal that has been called "the *Mad Magazine* of the Stephen Hawking set."

In one regular feature real Nobel laureates answer such questions as, "What do you look for when shopping for a lab coat?" In another, there are reviews of research published in "other research journals" such as *The Ladies' Home Journal* and *Vogue*.

One article included a proposal to preserve the Grand Canyon from further erosion by filling it with styrofoam packing puffs. "Cognomen Syndrome" presented cases in which a person's name appears to have a causal effect on his or her occupation, such as Larry Speakes, one-time spokesman for the White House, and Lord Brain, British neurologist. "We did not do any statistics," the authors wrote, "since the conclusion is obvious."

Susan Hewitt and Edward Subitzky issued "A Call for More Scientific Truth in Product Warning Labels," which included such obvious disclaimers as

WARNING: This product warps space and time in its vicinity.

PUBLIC NOTICE: Any use of this product, in any manner whatsoever, will increase the amount of disorder in the universe. Although no liability is implied herein, the consumer is warned that this process will ultimately lead to the heat death of the universe.

Last year, *JIR* announced

the winner of the First Annual Ig Nobel awards for "achievements that cannot be reproduced or shouldn't be." The awards are named for Ignatius Nobel, a distant cousin of Alfred, originator of those more famous (but less amusing) science

JIR is famous for printing visual surprises taken from photomicrographs, which are actual images seen under a microscope: a pollen grain from the common onion magnified 4,400 times (top left); two plant protoplasts (middle); and an unusual arrangement of smooth endoplasmic reticulum of mouse optic nerve (bottom left).

awards. Last year, the Ig Nobel Peace Prize went to Edward Teller, father of the hydrogen bomb, for "changing the meaning of peace as we know it." The Economics Prize went to junk-bond king

Michael Milken, "to whom the world is indebted." The Science Education Award went to Vice President Dan Quayle for "demonstrating, better than anyone else, the need for science education." At the ceremony attended by four past winners of those other Nobel awards, Marilyn vos Savant, the *Parade* magazine columnist who is listed in the *Guinness Book of Records* as having the world's highest IQ, was elected to the Posthumous Board of Governors. She received only an honorary membership, however, "because she is alive."

In the spirit of the *Journal of Irreproducible Results, Omni* announces Competition #54. The Western Hemisphere may sink into the oceans due to the accumulated weight of back issues of *National Geographic*. Automotive paint attracts supermarket shopping carts. Mobile homes attract tornadoes. The earth is flat at the poles because of the wing nuts, which can be clearly seen on any desktop model of the globe.

What we need are more theories of the type discussed here. Write your theory in 75 words or less and send it by December 15, 1992, to Omni Competition #54, Theories, Omni, 324 W. Wendover Avenue, Suite 205, Greensboro, North Carolina 27408. All competition entries become the property of *Omni*, none will be returned. *JIR* editor Marc Abrahams will assist in picking winners, which will be chosen on the basis of originality, humor, and brevity. The grand-prize winner will receive $100, and four runners-up will each receive $50. All five winners will receive free one-year subscriptions to *Omni*.

For a one-year (six-issue) subscription to *JIR*, call (800) 759-6102 or send $21 to *The Journal of Irreproducible Results*, Blackwell Scientific Publications, 238 Main Street, Cambridge, Massachusetts 02142.