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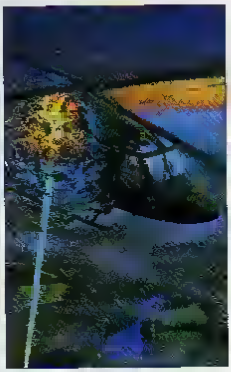

How do we reconcile the aesthetic—the intangible—with science and the tangible? The experts offer their views. Cover art by Ray Roberts. (Additional art and photo credits page 114)

FEATURES

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FIRST WORD

COLD WAR LEGACY:
Not what we did to them, but what we did to ourselves

By Susan Eisenhower

The Cold War lasted 40 years, but its impact will be felt well into the twenty-first century. Ironically, resolution of the critical social, economic, and environmental issues that have emerged as a direct or indirect result of the U.S.-Soviet standoff will most likely be stymied by the sheer size of the effort required to cope with the legacy of it.

The costs of the Cold War were considerable, both from a financial as well as a social and democratic standpoint.

Apart from the multitrillion dollars we spent and will spend to destroy our Cold War arsenals, the "aftermath" costs associated with industrial retooling, job retraining, unemployment benefits, and scientific and R&D displacement will also have wide-ranging demographic and economic effects on a weakened America.

But perhaps the part of the Cold War legacy that has received the least attention is the effect this confrontation had in changing the nature of the relationship between the American people and our government.

The nuclear age brought with it greater complexity in the technology of warfare. The development and deployment of these systems also necessitated larger and more centralized government structures. Politicians and strategists, determined to meet the perceived Soviet threat, reached a tacit agreement with the public: "These complicated topics should be left to the experts. Trust us and we will assure your national security."

Grateful to avoid having to learn what "flexible response" and "double-zero option" meant, the public effectively gave the government a blank check to do "what had to be done" to face down our superpower rival. Even at the point where common sense had been lost, most of the public went unquestionably along with any kind of military expenditures. By the time the Cold War was over, the United States had 100 times more nuclear weapons than during the Cuban Missile Crisis, and together with the Soviet Union, enough nuclear weapons to blow up the world 15 times. Elaborate and undecipherable arguments were given for the necessity of America's "overkill" capacity, and the public barely squawked.

With the onset and the institutionalization of the Cold War so came the growth of government. In 1956, for instance, the year the dark mystique of Stalinism was shattered with Nikita Khrushchev's secret speech to the 20th Party Congress, 2.86 million military personnel worked for the Defense Department and 1.4 million civilians. By 1993, years after the real Soviet threat to the United States had diminished, that figure had almost doubled.

But perhaps the most disturbing government expansion was in the burgeoning of secrecy. The CIA, NSA, DIA, NRO were all founded as highly classified agencies. Today, it is estimated that as much as $36 billion now goes into the "black budget" that portion of the federal budget that is exempt from Congressional oversight. Incredibly, that figure is now, after the Cold War is over, approximately four times what it was at the beginning of the 1980s. Downsizing these Cold War bureaucracies will require a herculean effort.

Susan Eisenhower is director of the Center for Post-Soviet Studies, based in Chevy Chase, Maryland. Her grandfather was Dwight David Eisenhower.

The greatest tragedy of the Cold War period, however, is that it induced the public to forgo their interest in the formulation of our policy. The public had no reason to demand it back until recently, when the American people finally understood that the "piper" would have to be paid for the "guns and butter" expenditures that are still on account.

Since the last genuine fiscal surplus in 1960, between federal entitlements and our massive arms buildup, the federal debt went from $630 billion dollars in 1976 to $1.4 trillion in 1982. Today we have a federal debt *four* times that size.

As the fiscal crisis in the United States looms larger, the American people may begin to look for scapegoats for the fiscal feeding frenzy of the last three decades. Military industry or the military itself will be easy targets. But they cannot be properly blamed. It has always been the military's job to provide worst-case scenarios, and it is industry's mission to make a profit and market their goods. But it is the duty of the country's leadership to say "No" and "Enough," and in this they failed us. In the final analysis, however, we elected those officials and we were the ones who relinquished our responsibilities.

In the next century, the future of the United States will depend on the American public learning the issues and asking the tough questions. If our democracy is to survive, the buck will have to stop at the ballot box.

COMMUNICATIONS

READERS' WRITES:
Getting what you deserve, shaman behind bars, and clothing the earth

Every Man for Himself

Although I find most of the articles in *Omni* stimulating and interesting, I found Tom Dworetzky's article on health care [Political Science, August 1993] to be pure hawg wash. The free-enterprise system has created the finest health care and pharmaceutical system the world has ever known. Implement Mr. Dworetzky's plan or any other like it, and the American public will receive the benefits of a second-rate health-care system and another giant government bureaucracy with its giant payroll—such as welfare, where it costs 75 cents just to flip a quarter someplace. How many of these programs can taxpayers and the GNP absorb?

Harvey Taylor
Newalla, OK

I find Mr. Dworetzky's leftist rhetoric deplorable. There is no total equality in the Constitution, implied or otherwise, nor should there be. The equality we share as citizens of this country is equality under the law. We have the same rights of life, liberty (freedom from government coercion, the right Mr. Dworetzky seeks to erode or destroy), and the right to pursue happiness. Those are our rights. There are no others, nor should there be. The Constitution does not guarantee anyone a car, a house, medical treatment, good cable-TV service, nor anything else created by humans. The rights that we possess are ours *because* we are humans, not because a document decreed them to us.

Keith and Denise Russell
Overland Park, KS

Sublime Secretions

It's a good thing Peter Gorman was in South America when he was collecting psychoactive frog secretions and snorting strange powders ["Making Magic," July 1993]. Otherwise, the Drug Enforcement Administration might have thrown him and that shaman (or should I say drug dealer?) in prison. Although the ecstatic experience of psychedelics has the potential of offering many benefits, the government condemns all forms of psychedelic experience out of hand. This not only prohibits scientific research, but oppresses those of us who wish to explore our own minds.

Pat Jordan
Clarksville, TN

All in Favor Say Baa

I read "Gardening with Wool" [Continuum] in the July 1993 issue with great interest. It seems to me that this "tip for gardeners" could hold great promise for the areas in our world that have become increasingly infertile due to soil erosion. I applaud the officials of the International Wool Secretariat for their valuable research and sincerely hope they will expand their trials from small vegetable patches and hanging baskets to places where soil erosion is tragically impacting the lives of millions of people.

Lisa Getz
Vancouver, B.C., Canada

Food Fetish

Though I'm not a huge fan of cyberpunk or car racing, the fiction piece "Grand Prix" by Simon Ings contained a perfect blend [June 1993]. I loved the way Catherine was characterized by eating prawns with "casual, sadistic gestures." Compact and very revealing.

David L. Duggins
Suffolk, U.K. **DO**

Clarification: Since the October issue was printed, Dr. Rick Strassman has withdrawn from further involvement with the Heffter Research Institute, which was mentioned on page 70 of "Finding God in the Three Pound Universe: The Neuroscience of Transcendence."

Got something to say but no time to write? Call **(900) 903-8683, ext. 70103.** Your comments will be recorded and may appear in an upcoming issue of *Omni!* The cost for the call is 95 cents per minute. You must be age 18 or older. Touch-tone phones only. Sponsored by Pure Entertainment, P.O. Box 166, Hollywood, California 90078.

DIGS

RELIGION AND FREEDOM

Artifacts indicate that African culture persisted even in slavery

By Eric Adams

More than two centuries ago in Annapolis Maryland a Black slave living in the home of a prominent Roman Catholic signer of the Declaration of Independence buried in a dark corner of a basement workshop a collection of quartz crystals, polished stones bone disks, and pierced coins

No one knows for sure the identity of the slave or why he or she buried these treasures beneath the home of Charles Carroll of Carrollton But for all the unanswered questions, this particular find could be, as one Yale University art historian calls it a "Rosetta Stone" in the study of the birth of African-American culture

The cache containing more than 20 items and covered in the dirt by a bowl with an asterisk painted inside it was discovered two years ago during a decade-long project funded by the Charles Carroll House Inc. Archaeologists and students from the University of Maryland's College Park campus, led by anthropology professor Mark P Leone are excavating sites around Annapolis, searching for clues about the daily life of both enslaved and free African Americans

"This find is so exciting because of the specificity of it," says Yale's Robert Farris Thompson who examined the artifacts last year. He recognized them as elements of African culture, indicating that such culture survived during slavery. Historians had previously assumed that White society thoroughly quashed the expression of African culture and religion by slaves.

These artifacts, buried hundreds of years ago by a Maryland slave, provide the first indications that African slaves continued to practice their native religions.

Africans in Kongo, a region in southwest Zaire and northern Angola, still use the sort of items in the cache according to Thompson. They wear the pierced coins, for example, on a string or chain, he says. Kongo parents often put them on small children as charms. "If they're characterized by chubbiness—*ntandu*—it will help them achieve thinness—*mikaso*," he explains.

The bone disks, also pierced and worn around the body represent ideas at the core of Kongo classical religion, he continues. "They have a very precise phrase to tell us why they would want to wear them: *lunda lukòngolo lwa lunga* or 'keep your circle complete.' As long as the circle is not broken, you're safe.

"All major world religions have some way of miniaturizing their religion. Right here, hidden in the soil of Annapolis, is the Kongo equivalent to a miniature crucifix, a small irreducible essence of the religion," says Thompson of the bone disks, adding that the crystals and the asterisk—a "cosmogram"—are also significant elements of Kongo religion.

Charles Carroll, whose family was among the wealthiest in Maryland, was one of the largest slave importers in Annapolis, bringing them from West Africa, including Sierra Leone. Nevertheless, Maryland still had fewer slaves than most other colonies and states, making it harder, historians had reasoned, to perpetuate many native traditions. Moreover, as the archaeological project is revealing, Blacks in Annapolis gave the appearance of living much like Whites did. Free Blacks, in particular, used Western goods purchased from the same markets Whites used.

But the Carroll House dig, besides raising very serious questions about how successful Whites were in rubbing out African culture, has also changed the way archaeologists and historians view the development of African-American culture, according to George Logan, site supervisor for the dig. The artifacts and other material turned up in the dig show that African and European cultures didn't remain separate. "It's a creolization, a process of different cultures coming together and forming a different product on its own," he says.

Understanding how individual elements of African-American history combined to create a separate and ultimately free, culture is crucial, says project leader Leone. In fact, it provided the motivation for this part of the project. "Our 'mandate' from the African-American community, whom we were collaborating with very closely on the formulation of our research, was to discover what conditions were like in freedom," Leone explains. "They said they were familiar with slavery, but they wanted to hear about freedom—their freedom and their ancestors' freedom." OO

FUNDS

ANATOMY OF A RIPOFF
How to avoid getting fleeced

By Linda Marsa

Nobody likes to get fleeced, but unfortunately, consumers get ripped off all the time: home improvements that are shoddy, the department store charges you didn't make and stalwartly refuse to pay—ruining your credit rating the unscrupulous auto mechanic who makes repairs you didn't authorize or inflates costs.

The list is endless. Under normal circumstances, a phone call conducted under ten decibels or a calm letter stating your case should get results. But if a company proves recalcitrant and ignores your complaints or offers only token compensation, resist the impulse to dynamite its offices. There are numerous consumer watchdog agencies that will gladly mediate your dispute, and sheer persistence can often grind down even the most intransigent trades people. And if all else fails, you can at least have the pleasure of hauling the SOB into the nearest court.

As a last resort, you can hire a lawyer or go to small-claims court. But you have to decide if it's worth the trouble and expense.

It's essential to keep records and establish a paper trail. That includes receipts, any kind of warranties, and documenting the complaint process with a detailed log of who you talked to, what you told them, and what took place in the conversation," advises Michael Haslet of the Consumer Information Center in Washington, DC. "That way you can refer back to that if anyone disputes your claim."

This may sound like a lot of trouble, but Haslet says the vast majority of consumer complaints are resolved with the first step—either by negotiating an equitable settlement with the person from whom you purchased the product or service or by contacting the parent corporation that makes the goods. In fact, virtually all big companies have customer-relations departments whose sole function is to rectify consumer problems. "Oftentimes," says Haslet, "they'll be happy to make amends."

If you get stonewalled, it may be time to bring in the heavy artillery. Enlist the aid of your local Better Business Bureau, your state or city department of consumer affairs, or trade associations, which often have a strict code of ethics for members and hot lines to handle consumer beefs. One of these strategies is bound to come through—the company may get so tired of fending off people pleading your case. It'll settle just to get rid of you. "If nothing else," adds Haslet, "it'll give them a bad rep in their field, which can result in lost business."

For more complicated cases, your best recourse is consumer agencies, which do have some legal clout, or trade groups for these industries, like the American Society of Travel Agents (1101 King Street, Alexandria, Virginia 22314, 703-739-2782) or the National Association of the Remodeling Industry (4301 North Fairfax Drive, Arlington, Virginia 22203, 703-276-7600).

Similarly, problems with mail order—merchandise that never arrives is one of consumers' biggest gripes—can often be resolved by the Direct Marketing Association's Mail-Order Action Line (1101 17th Street NW, Suite 705, Washington, DC 20036).

The best defense, though, is a good offense. Thoroughly investigate a product's reputation before you fork over your hard-earned dough. Read *Consumer Reports* and talk to people you trust. If you hire tradespeople to do a job, ask for references. Call the Better Business Bureau and their local trade or professional organization to check out their track record. And get as much as you can in writing, such as warranties for materials or products or contracts for remodeling jobs, which outline exactly what you expect. "If you do your homework beforehand," says Haslet, "it will save you hassles afterwards."

For more information on how to fight back, get a copy of the *Consumer's Resource Handbook* (which can be obtained gratis from the Consumer Information Center, Department 592Z, Pueblo, Colorado 81009). This handy guide will pilot you through the complaint process. It also has comprehensive listings of where to go for help: corporate customer-service contacts, professional and trade associations, and national, state, and local consumer protection groups. ∞

MUSEUMS

COLUMBUS ON DISK:
A Spanish archive goes from the shelves to the computer screen

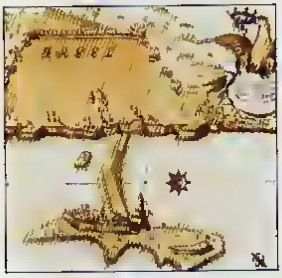
By Pat Janowski

Historians have generally pursued their research in a rather old-fashioned manner poring over scraps of fragile documents and studying ancient artifacts Now, some scholars are, in a way, catching up with the times An archival collection relating to the Spanish conquest of the Americas is being transferred to optical disk.

The Archivo de Indias in Seville Spain—mecca to historians of the Spanish conquest—holds all official documents and maps relating to early emigration, exploration, missionaries, and trade in the Americas, including Columbus's discovery of the New World. Housed in a sixteenth-century building, the chilly, dimly lit Archivo contains five and a half miles of shelving loaded down with boxes of documents "I used to take a flashlight in with me to look at manuscripts," says Harry Kelsey, a research fellow at the Huntington Library in San Marino, California

Kelsey is just one of the historians able to access the priceless material more easily because of the optical-disk project. For the past three years, 12 to 15 curators have worked full time to get the Archivo s catalogs ready for scanning onto optical disk About 250 000 pages a month are being scanned with an optical scanner that converts each page into digital data. so far. Archivo workers have scanned about 13 million pages They have roughly 75 million pages to go

The curators have already entered into a database all of the Archivo's various catalogs, allowing scholars to enter a keyword and call up all the relevant references without paging through catalog after catalog. Now as each page is scanned workers add the names, places, and subjects contained on the page to the database, expanding on catalog references that in many cases contained only the most cursory information Together, these projects—financed in part by El Corte Inglés one of Spain's premier department stores—will facilitate the work of the thousands of scholars who currently travel from all over the world to examine the Archivo's documents



Millions of voluable documents (right) and maps relating to the voyages of Christopher Columbus (below) and Spain's conquest of the Americas are being preserved on optical disk.

Researchers used the catalogs principally to determine which of the Archivo's 43,000 cardboard bundles held the documents they were after Each folder holds about 2,000 sheets which may or may not cover related subjects. Kelsey says With the optical-scanning project, the contents of each folder now fit on one optical disk.

"This project will result in a complete record of what's in the Archivo for the first time," says Bill Frank a curator at the Huntington. And the database allows quick searches for historical information For instance, a researcher consulting the database for data about a particular shipwreck would likely turn up a report citing the circumstances of the wreck, what was salvaged, and what happened to the king's share of the booty

"These are things that you'd never have found before," Frank says. "A lot of this stuff had never even been read by curators

Besides aiding with scholarly work, the optical disk project also preserves the fragile, deteriorating documents Kelsey recalls having crumbs from a document's original wax seal fall out of a folder as he looked through it Now researchers needn't shorten the materials' lives with every inquiry "I'm consulting these documents but doing them no harm," says Geoffrey Parker professor of history at Yale University "They are, after all, five hundred years old."

Last year, the Archivo sent eight optical disks from the not-yet-completed database to the United States as part of a temporary exhibition at the Huntington The disks later went on display briefly at the IBM galleries in New York City—their last scheduled visit fo any museum

After trying out the new system Parker was astonished With the database, which inventories 95 percent of the Archivo's contents, "I can get call numbers, contact the Archivo, and ask for copies of specific documents Even if I still need to go to Spain this allows me to be totally prepared so I don't have to spend fruitless time searching."

Using the disks, Parker says, can be even better than examining the original documents

"I can do things that I can't do to the original," he explains "I can remove blemishes These documents are frequently written on both sides of the page, and often the ink bleeds through from one side to another I can clean that up I can print out a perfect copy of an imperfect document I'm on a high—I've never seen anything like this."

Putting manuscript collections onto disk is the future of historical research Parker says Several archives may soon follow the Archivo's example ☐☐

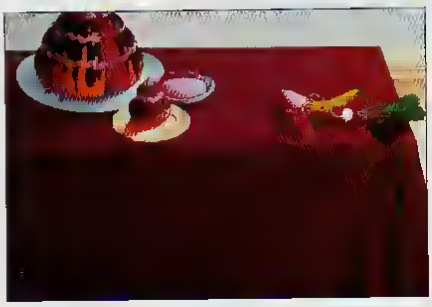
MIND

COMPULSIVE EATING, RITUAL, AND ADDICTION
Outside suggestions may trigger "pig-out" brain programs

By Douglas Stein

"I just had to have them; suddenly, I absolutely craved all those chocolate eclairs," he screamed to his diet counselor. This obese 34 year-old man could be any of millions of Americans who routinely binge and gorge on impulse—when they aren't even hungry. Studies conducted at Northeastern University by Ann Kelley, now associate professor of psychiatry at the University of Wisconsin, indicate that foods can be substances of abuse, and eating can involve cravings as intense as a drug addict's. The brain region at the center of research on addiction, the nucleus accumbens (NAC), also serves as a critical component in a system which grants various environmental cues their power to reinforce and perpetuate compulsive eating patterns.

Sensory cues eliciting compulsive eating can be within the food—its crunchiness or tartness, the environment—the lighting and music of a restaurant, or in colorful food ads.



Kelley and her student, Vaishali Bakshi, divided sated rats into two groups. One received saline injections in the NAC every 48 hours. The other group, which got morphine on the same schedule, ate progressively more and doubled their food intake after a week. The saline rats showed little change in the amount they ate. Then they gave both groups "mock injections"—that is, the needle was inserted into the brain, but nothing was injected. The morphine-sensitized rats continued to eat well beyond their pretest levels.

That injected morphine induces animals and people to overeat is an old finding. But Kelley's is the first study to show morphine-induced *conditioned* feeding and the brain areas that mediate it. The sight, maybe the feel, of the needle become sensory cues conditioning the animals to overeat long after the actual opiate was withdrawn. "With this conditioning," says Kelley, "if you don't give them food—right away—they're sniffing, digging for it. I doubt they're suddenly hungry, and yet they must eat!"

Cues associated with the morphine may provoke the animals to release opiates within the NAC and surrounding areas. And the needle may be just the tip of the iceberg. "You might need the actual cage and objects around it," she says. Kelley compares this to cocaine addicts' response when shown a video of drug paraphernalia or someone making crack. "Exposing them to drug-related cues causes addicts' blood pressure to rise, galvanic skin response, and many circulating hormone levels to change."

Situations in which people gain pleasure through foods offers a potential constellation of cues, any one of which can become a component of a craving-inducing ritual. "The reward," says Kelley, "may come to be within the social ritual, because much of what's happening there can be reinforcing." Researchers on obesity and bulimia are exploring how these cues activate cravings that overwhelm a person's ability to control appetite and why past experience is so salient in governing present behavior.

The NAC's strategic position within the brain region called the striatum may hold answers. As they're perceived, craving cues are filtered through the higher associative cortices, then channeled to the frontal areas and downward to the limbic areas where they're tied to emotions and memories. This journey moves increasingly along opioid circuits until these meaning-charged impulses reach the NAC. "The NAC serves as a limbic-motor interface," Kelley says, "between environmental cues, past experience, and the *movements* leading to eating. The NAC does this in part via activation of its opioid system."

Dysfunction of these systems may be a prime cause of excess eating. The opiate blocker, naloxone, has helped some bulimics to eat less, but not less often. Perhaps, Kelley muses, they feel less reward when they binge. A disorder of impulse control, binge eating is akin to obsessive-compulsive syndromes, which involve the striatum's failure to turn off a motor circuit. But for cue-induced food cravings, opioids are probably not controlling just movements, but also thoughts. Such cues are embedded in our surroundings and our "inner universes" as well. Almost any association connoting the rewarding value of food can tap into the widespread opioid circuits and trigger a compulsive eating "program."

Chronic drug use can alter neuronal architecture long after the drug is gone. These long-term changes may underlie behavior, bodily responses, and mental states related to foods, too, and their associations. "Many in the conditioning field," says Kelley, "believe these cravings never really go away." Possibly the "software" makes us crave our drug, and by "running the system," it perpetuates abnormalities in the "hardware." If this is the case, it's quite a cage we inhabit.

MEDICINE

CHELATION THERAPY: One of medicine's best-kept secrets?

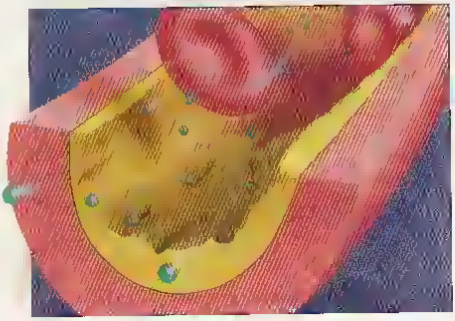
By Gary Null

For 30 years, chelation therapy has been the target of a bare knuckled attack from nearly every camp in the medical-industrial complex—professional organizations, medical journals, government regulatory boards, and the insurance industry. The reason: It provides a safe, effective, and inexpensive alternative to the drugs and surgery used to treat illnesses such as heart disease. In other words, chelation therapy threatens the viability of some powerful industries, including the multibillion-dollar-a-year cardiovascular and coronary-bypass field.

As long as the attack continues, the human price will be high indeed. Chelation therapy could be offering treatment to millions of people suffering from strokes, cardiovascular disease, Alzheimer's Disease, diabetes, and adverse reactions to environmental pollutants. In one study, people who received chelation therapy had a lower incidence of death from cancer than the general population.

By the sheer will of its practitioners—and the compelling fact that it works—chelation therapy has begun to emerge from the oppressive shadows of the medical establishment. Hundreds of thousands of people have now undergone the therapy, and thousands of scientific articles have been written about the process.

An artist's image of how chelation therapy works: EDTA molecules (the blue dots) scrape calcium (yellow) away from the arterial walls.



How does it work? In its most common application, chelation therapy overcomes the arterial clogging that leads to angina in a simple but elegant way. The synthetic amino acid EDTA is infused into the bloodstream; it then travels through the blood vessels and removes toxic heavy metals and deposits of calcium that help form plaque. As the level of plaque decreases, more blood can flow to the heart and body.

EDTA also mobilizes the calcium in soft tissues, where it should not be stored, and moves it to the bones. By acting as a calcium-channel blocker, it may reduce blood pressure by 10 to 20 points and eventually eliminate the need for medication. It also strengthens bones by increasing their calcium production, thereby providing an indirect treatment for osteoporosis.

Chelation therapy is not only safer than the conventional methods of treating such ailments, but also far more powerful. Drugs and surgery address the symptoms of a disease, while chelation therapy goes directly to its causes and reverses the damaging processes, says John Sessions, M.D., a chelation practitioner.

People with hardening of the arteries often experience an improvement of 90 percent or better from chelation therapy, according to Kirk Morgan, M.D., director of the Morgan Medical Clinic and assistant clinical professor at the University of Louisville in Kentucky. In his treatment of heart patients over the past ten years, some needed 40 treatments to improve, while others needed only 10 or 20. "There is increasing evidence," he says, "that chelation using EDTA is a relatively inexpensive, effective, safe, and even preferential but often neglected technique for medical management of cardiovascular and related diseases."

While the effects of bypass surgery are limited to heart functioning, chelation therapy enhances the entire circulatory system by cleansing vessels and organs. Serafina Corsello, a chelation practitioner in Huntington, New York, says kidney vessels often have atherosclerotic plaque that weakens the body's cleansing process before the heart shows symptoms. "By regulating the amount of EDTA and adding vitamin C to repair tissues, the little vessels of the kidneys get cleaned out," she says. "Then we can increase the amount of EDTA and ultimately clean the whole vascular system, the heart, kidneys, liver, pancreas, and brain."

People who are prone to strokes often have poor cerebral circulation, according to one large study. Chelation therapy can help prevent a stroke or lessen its effects by removing calcium and other mineral deposits from the arteries in the neck and head and helping to improve the vital blood flow.

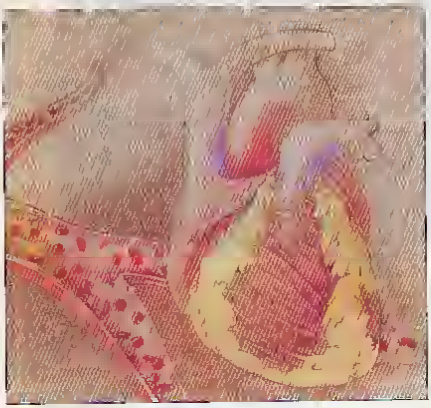
In a retrospective study of 19,000 people with peripheral vascular disease, 82.5 percent of those who received chelation therapy showed substantial improvement, says Albert J. Scarchilli, D.O., of Farmington Hills, Indiana.

"We have seen dramatic results with people who have vascular disease in the legs and who have sores from diabetes or other causes," says Michael Janson, a Cambridge physician and director of the Center for Preventive Medicine on Cape Cod. "Some of them had ulcers that weren't healing for up to a year that started to heal after chelation therapy."

In fact, diabetes responds well to chelation because the dis-

ease generally involves the arteries. The therapy may decrease the need for more insulin by opening up the insulin receptors. Pompano Beach, Florida, internist Dan C. Roehm, for example, took one patient off 60 units of insulin after only seven treatments. "I thought this was unusually good," he says.

Chelation may also be effective against a slew of other illnesses, including macular degeneration (a disease that causes blindness and that many ophthalmologists believe untreatable), scleroderma, hypertension, arthritis, Alzheimer's disease, multiple sclerosis, and high cholesterol. And yet, despite the evidence, the medical establishment has maligned chelation therapy ever since articles about the treatment first began to surface. "For several years we have been administering intravenously to patients with advanced occlusive vascular disease 3–5 grams of EDTA. An accumulative experience with several hundred patients has demonstrated that overall relief has been superior to that obtained with other methods," wrote Norman Clarke, M.D., director of research at Detroit's Providence Hospital and a pioneer in EDTA's use in treating heart and circulatory diseases, in a 1960 *American Journal of Cardiology* article. "The treatment of atherosclerotic vascular complications with chelation agent EDTA is supported by a large volume of information," he asserted.



Chelation may provide a safer, surer treatment than surgery or drugs for a variety of ills, especially heart and circulatory diseases.

Clarke's research unleashed a vigorous controversy that has continued to this day, raising serious questions. Is the controversy based on facts about chelation or on a reluctance by medical associations to endorse alternative treatments? If chelation therapy flourishes, after all, costly procedures such as bypass surgery and expensive drugs may be harder to market. "Herein lies the danger," says Corsello. "We are creating less money for the pharmaceutical industry, so why should they love us?"

Indeed, mainstream medicine promotes the use of dangerous drugs and invasive surgery instead of chelation therapy. For example, doctors encourage arthritis patients to use steroid medications, which cause ulcers, osteoporosis, and immune dysfunction, even though they merely eliminate symptoms.

The detractors, for their part, like to portray chelation therapy as a dangerous procedure. Clearly, however, the hazardous treatments are the more conventional ones, such as coronary bypass surgery. The mortality rate for bypass surgery is about 5 percent a year, and a large percentage of bypass patients may even require additional operations.

"Doctors do not realize that there are phenomenal risks to even the smallest surgical procedures when you're trying to remove or strip off this cemented type of plaque (from blood vessels)," says Chris Calapai, D.O., a member of the American College of Nutrition and professor of family practice at New York College of Osteopathic Medicine. "When you compare the risks from surgery to the absolutely nil possibilities of having adverse reactions from chelation, it almost boggles the mind as to why doctors are constantly pushing for all these surgical modalities before trying something like chelation."

The most enduring myth about chelation is that it damages the kidneys, but studies show it actually improves kidney function. Sessions, for example, has worked with dialysis patients whose kidneys initially functioned at only 5 percent of their capacity. After treatment, he says, "they were able to cut down on their dialysis from three or four times a week to one or two times."

In recent years, chelation has begun to win a few rounds of its own. A precedent-setting state Supreme Court decision in Florida supported a doctor's right to use chelation. In addition, the Food and Drug Administration finally gave the go-ahead to two clinical trials of chelation therapy at the Walter Reed Army Hospital and the Letterman Hospital. Those studies were put on hold when funding dried up (and a pharmaceutical-company backer pulled its promised support), but as more and more people turn to alternative treatments, and evidence mounts of chelation's effectiveness, another source of funding may come forward to complete the studies. If the findings are positive, EDTA may be approved for more uses, and insurance companies would begin to cover the procedure, making chelation therapy available to millions of Americans.

And it wouldn't be a moment too soon. ∞

ELECTRONIC UNIVERSE

DOWN WITH DINOS

Some exciting alternatives to *Jurassic* mania

By Gregg Keizer

I've had it up to here with dinosaurs. *Jurassic Park*'s computer-animated creatures may have been the stars of the show, but if I can't get them to appear inside a PC or videogame with the same realism I saw on the silver screen, I'll take a rain check. I'll settle for fish or aliens or spaceships instead.

El-Fish, another title from the company that specializes in offbeat software—*SimLife*, *SimAnt*, SimSomething-or-other—is the current substitute for thunder lizards on my PC. A combination aquarium builder and fish breeder, *El-Fish* is not only great fun, but great to just watch. These fish look almost as real as those children-stalking *Velociraptors*.

Building a virtual aquarium in *El-Fish* is a lot like a visit to the pet store. You can populate it with all kinds of junk, pick the background, set the color of the pebble-strewn bottom, and add plants and coral and rocks. But this package's real entertainment comes from building fish. Like Maxis' *SimLife*, *El-Fish* lets you play a bit with genetics, though in this case, the gene splicing is almost hidden. Here you simply select two species of fish, then ask the program to combine them for you. Not only do you get to pick from the possible iterations, but you can also tell the program to quickly step the creatures through multiple generations for some ultrafast evolution.

With Maxis' *El-Fish*, you can mix and match fish species, create new ones, and custom design an electronic aquarium.

Once you've got your fish, though, you need to make them move. *El-Fish*'s animation is superb—among the best you'll see on a PC—but to get that look, your computer has to do some hard work. On a run-of-the-mill 386-based PC, *El-Fish* can take several hours to generate the images necessary to animate a single fish. On a more powerful 486, that time is cut to mere minutes.

The wait is worth it, even if you have to keep your PC running overnight. *El-Fish*'s creatures move naturally, especially when they swim in three dimensions, not two. It might not be quite as much fun as watching lawyer-munching dinosaurs, but it's close.

If scrutinizing sea creatures isn't combative enough, you might want to try *Space Hulk*, an Electronic Arts science-fiction game that features an almost familiar plot. This PC strategy title may be based on a board game, but it owes more than a nod to the first two episodes of the *Alien* film trilogy.

You run squads of Space Marines through a series of huge spaceships, ferreting out aliens that look like the beetle-browed creatures that Sigourney Weaver and Tom Skerritt faced on the *Nostromo*. Screens show the point of view of each Marine; weapons range from bladed gloves to explosive-tipped assault guns, and movement-sensitive radars pinpoint the nasty Genestealers. The action is fast and fierce, with ambush a constant problem. Reminiscent of the ground-breaking *Wolfenstein 3-D* in places, you give orders to your men, move them through corridors, and conduct missions that put *Alien* to shame. Where else but a game would you destroy your own men to keep them from falling into enemy hands? *Space Hulk* is top-notch science-fiction entertainment on the PC.

A lot less intense but still enjoyable, Accolade's *WarpSpeed*, a shoot-'em-up videogame set in space, is a nice diversion from fish and foul-smelling aliens. Available for the Sega Genesis or Super Nintendo systems, *WarpSpeed*'s cockpit perspective looks like LucasArts' *X-Wing* on the PC. You stare out the front screen of your ship and blast the enemy vessels that come into your line of fire. Long-range scanners plot the position of the enemy ships, and your fighter carries blasters, cannons, and missiles. No thinking here; just quick reflexes and steady fingers on the control pad. And not a *Tyrannosaurus rex* in sight. ∞

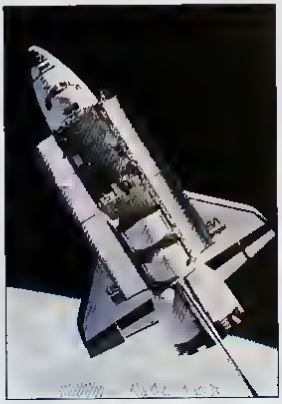
SPACE

THE CUSTOMER IS ALWAYS RIGHT.
NASA asks the public what it wants from its space program

By Leonard David

Information is the currency of democracy,' consumer activist Ralph Nader once said

NASA pumps some $15 billion a year through its bureaucracy For that kind of cash, you'd think the taxpayer would have some control over where the space agency's nose cone is headed But all too often, that hasn't been the case No less an authority than NASA administrator Daniel Goldin recently voiced the opinion that "we were losing sight of our customers It seems clear that our ultimate customers are the citizens of the United States—the people who pay our way—so we decided to go on the road and talk to our customers '



Shuttle diplomacy: NASA went to its customers—U.S. taxpayers—to ask their opinion about programs like the space shuttle, at right, and the agency got quite an earful.

Last November and December, Goldin took part in a series of six 'town meetings" held by NASA at North Carolina State University in Raleigh, the University of Hartford in Connecticut Indiana University and Purdue University at Indianapolis, California State University–Dominguez Hills in Carson, California the University of South Florida in Tampa and the University of Washington in Seattle At each locale, citizens had the opportunity to express their opinions over open microphones and in written testimony

NASA chose the sites primarily for their relative distance from the agency's major facilities, according to Douglas Isbell, a NASA special assistant for communications and coproject leader for the town-hall gatherings

Each of the four-hour meetings began with short discourses on NASA's past, present and future and then the microphones opened up Those stepping up to the mike—usually 40 to 50 people per meeting—got two minutes of air time Others crammed their thoughts into a comment box hauled from town to town

All told, more than 4,000 people showed up Hundreds more mailed in letters and postcards expressing their views

In large measure, the town meetings served as congregations for the space faithful Analysts found that about half of those taking part in the meetings claimed affiliation with the aerospace community 12 percent were university students, teachers, and researchers, and the remaining 38 percent identified themselves as interested citizens.

"I've been a taxpayer for thirty years and this was the first time any government body or agency ever came to me to ask for my opinion on how that money should be spent " wrote David Skinnon of Meriden, Connecticut

The main point that emerged from NASA s encounter with its constituents is rather disquieting While participants in the town meetings showed interest in all aspects of the agency and its programs, many declared that the public doesn't really know what it does in the first place

"I would like to see NASA do more 'marketing" of how important space exploration has been and will always be toward our development as a technology-dependent planet,' said Don Crawley at the Raleigh meeting

Some participants suggested that NASA use public and cable television, computer bulletin boards and networks, and promotions with fast-food restaurants—even sponsor the halftime show at the Super Bowl—to better communicate with the public.

"I recommend that NASA's logo be on every can, box or product that has evolved from NASA s programs it pays to advertise,' wrote Suzanne Ridley of Long Beach, California.

According to Isbell, of primary concern to the participants is monitoring and protecting the earth's environment—from incoming asteroids as well as global warming Citizens also called for NASA to better supply educators and students of all ages and social backgrounds with science materials

In addition, the agency should take up some of the slack in national research and development funding, particularly as the U S defense budget declines, they said And in every town participants told NASA that it should cooperate with the former Soviet Union to procure hardware and services more cheaply

And naturally, many participants repeated what Americans have been saying since John Glenn orbited the Earth "People asked when they could go into space and didn't want to be too old to go when the chance came,' Isbell says

What will NASA do with the feedback it got from its customers? ' The new NASA is going to have a different set of priorities ' based on what the agency heard at the meetings, Goldin told reporters in April He considers the forums a rousing success and wants to hold more soon

STYLE

SEARCHING FOR SUSTAINABILITY
The Body Shop tries Living Water waste treatment

By Kyle Roderick

With more than 900 stores that peddle some 400 skin and hair-care products worldwide, the Body Shop international has been pioneering "green' business practices with no-frills packaging and in-store environmental campaigns since its 1976 inception. Anita Roddick, the company's founder, introduced a refill system in the first Body Shop in Brighton, England, and although the concept is imitated by other cosmetic companies today, Roddick's Shop continues setting new "eco-nomic" precedents.

Now, fittingly, the Body Shop is the first international skin- and hair-care company to tackle one of the industry's chief environmental challenges: successfully treating raw factory waste on site with an experimental, ecologically sustainable system. Adjacent to the Body Shop's factory and ultrafiltration plant on the Sussex Coast of England, the treatment system incorporates water aquatic plants, bacteria, and microbial ecologies that live in a small greenhouse about 43 by 20 feet.

The Body Shop, known for its eco-friendly products, is testing a new, more natural system to turn waste into an ecologically sound system.

While waterfalls aerate the waters, sculpted Flowform basins also bring much needed oxygen to the system by producing rhythmical flows such as those found in rivers. Lush green plants with purple and yellow flowers cleverly hide the engineering inside the ponds, including recirculating pumps. There are three distinct ecological zones in the system and each contains 12,000 liters of water. These microhabitats work together to adapt to the waste stream and treat the waste product, which stays in the system for about 28 days.

"The aim was to create complex food webs in each zone that would consume the factory effluent as a food source," say Jane and David Shields, the scientists who designed the so-called Living Water Treatment System. (The effluent, or waste, consists of plant oils, fats, and clay that are byproducts of the Body Shop's grooming products, as well as cleaners used in the factory.) In the Living Water system, plants form a symbiotic relationship with bacterial, microbial, and invertebrate life to break down the waste.

Based in Edinburgh, Scotland, the Shields operate Living Water, a firm specializing in creating ecological treatment systems for industrial effluents, agricultural waste, leachate from landfills, and sewage from households, hotels, and small communities. Living Water installed the Body Shop system in 1991 and has been monitoring it since it began operating in 1992.

Like all cosmetic companies, the Body Shop produces liquid effluents that have a chemical oxygen demand (COD) calculated at a certain value. (COD could lead to low oxygen in the water; the higher the COD in the water, the less likely that it will be able to sustain bacteria, plants, and other life.) The Body Shop's weekly COD of 3,470 milligrams per liter of water equates to an annual burden of about 20 tons of COD on the public sewerage system.

According to Dr. David Wheeler, general manager of environmental affairs for the Body Shop International, a filtration plant first removes about 90 percent of the organic load from the effluent. "Filters physically remove the ingredients with high molecular weights, greatly reducing the amount of organic material going to the sewer," he says. The cleaner liquid then goes to the sewer and the concentrated sludge is taken away by tanker for secondary treatment and disposal.

Living Water handles about 5 percent of the untreated effluent. "Although our effluent already meets the legal standard for COD," Wheeler says, "our ideal would be to emit negligible COD to fit in with the Body Shop's corporate policy of moving beyond conventional environmental management and toward sustainability. We know the system works and if we make it bigger, it could handle far more."

Toward that end, the Body Shop plans to enlarge the facility and collaborate with scientists at Portsmouth University to study the treatment system. With any luck, other cosmetic companies will take the Body Shop's lead. But dealing with factory waste will be a formidable task indeed.

"The economic rules are rigged against sustainability," laments Wheeler. "It's going to cost us money. But we're committed to becoming self-sufficient. Living Water will be the polishing system that helps make the water as pure as possible." ∞

OMNI ONLINE

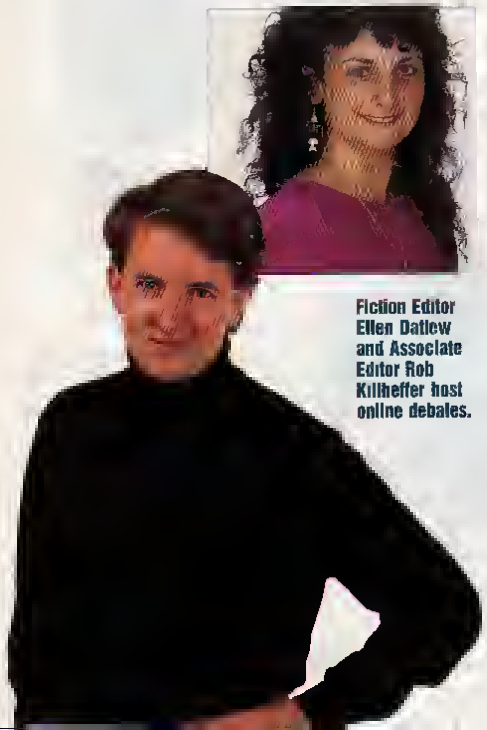
UP AND RUNNING

Omni Magazine Online is the place for shaping the future

By Keith Ferrell

By now those of you with computers and modems may have tried our new service Omni Magazine Online available via America Online We hope you have—our aim has been to create an electronic environment that extends and enhances the *Omni* experience offering you opportunities to interact with our editors and experts in various fields, and most importantly with each other

We think we've succeeded As I write this, we're only a couple of weeks away from fully launching the service, deep in the process of beta testing various features and sections adding new items lining up a host of resources and preparing for our debut



Fiction Editor Ellen Datlow and Associate Editor Rob Killheffer host online debates.

Thaf debut as planned now, will take place over Labor Day weekend with live reports from the World Science Fiction Convention in San Francisco The reports will be filed online by Fiction Editor Ellen Datlow, Associate Editor Rob Killheffer and myself Perhaps you joined us for a discussion of science fiction's big event

Or maybe you logged on a little later in September to talk with Rob about his "Consciousness Wars' feature in the October *Omni*. There are few topics in science more provocative and controversial than the nature of consciousness Rob captured that controversy brilliantly in his magazine piece and his online discussion of the article promised to be one of the hot events of Omni Magazine Online's first month

And those are just some of the events we have planned for Omni Online's firsf month The reality will be even richer

But *Omni* and Omni Magazine Online are about the future, so let's glance at some of the events we have planned for the present and for the months ahead

For this issue, we're creating special sections of Omni Online where you can record your opinions about, for example, future military challenges and missions as described in Ben Bova's feature, "Future War Future Peace."

Perhaps more dramatically, we're taking the opportunity Omni Online offers to extend the life of a feature that was actually created online "Bordercrossings," by Janet Stites, came into being on the Internet, a telecommunications network linking universities and institutions, companies, and services such as America Online Janet gathered a panel and launched an E-mail debate on the relationship between fhe sciences and the humanities Their debate, as you can see this month, is fascinating and provocative

We feel sure that your insights are equally fascinating, so we're turning the debate over to you Log on to Omni Magazine Online and check out the Space/Cyberspace Computers of the Future message board Open the Bordercrossings folder Read the question Janet posed to our experts; then add your thoughts You'll be able to watch the debafe take on new life, gather new insights, continue to grow and expand in the weeks and months fo come

And it will grow The debate as published here was distilled from reams of entries and annotations Next month we'll post the whole Bordercrossings file which will doubfless spur even more comment and controversy We're looking forward to it

In next month's pages, we'll be taking a look at the Nostradamus phenomenon, from both scientific and historical points of view and you can bet that the online commentary will be just as lively as the magazine's coverage of this always-provocative topic We're looking forward to your comments on this subject

Farther ahead, we'll be announcing the winner of our cryonics contest and exploring with author Charles Platt some of the ramifications of the cryonics movemenf This is sure to be one of the most hotly debated online topics of the year

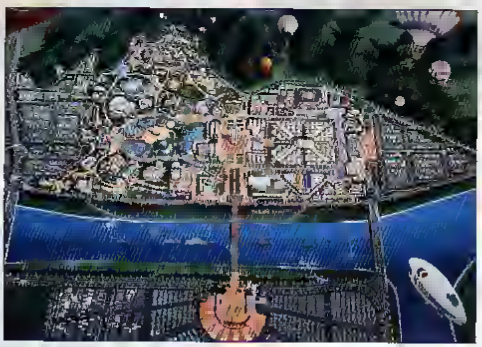
And don't neglect our regular online features The worlds of Continuum and Antimatter are yours at the click of a mouse button See what's happening in Ellen Datlow's Science Fiction/Fantasy World Tease your brain with a visit to Scot Morris's GameRoom Or check out what's scheduled for upcoming issues And more We look forward to meeting you in one of the many sections of Omni Magazine Online

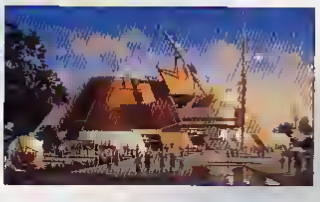
CONTINUUM

KOREAN EXPO AND SCIENCE TOWN:

A peek into the future? Plus, let's move Venus a little bit that way, and how pot scrubbers keep cows' stomachs full, if not clean

"The expo will be a venue for educating the nation—for the future," says Myung Oh, chairman of the Taejon International Exposition, which opened August 7 in South Korea. "It will contribute to the internationalization of the Korean people, elevate the standards of our way of thinking, and educate and encourage them to become involved in science and technology." In other words, the primary audience of the expo *is* the Korean people.





General plan of the Taejan Expo (above); Starquest Povilion (left)

At this time, 112 countries have agreed to participate in the 93-day expo (it closes November 7), sponsoring displays and special events on the main theme, "The Challenge of a New Road to Development," and two subthemes, one related to science and technology and the other to the environment. For example, exhibits will include a Recycling Pavilion constructed of some 50,000 glass bottles from all over the world and a Recycling Greenhouse that demonstrates how to grow food using fertilizer from food wastes. Korean government agencies and private companies ranging from Hyundai to Daewoo will also be represented.

In keeping with the environmental theme, experimental six-passenger electric cars will ferry VIPs, the elderly and handicapped, and lost children around the 232-acre site. A fleet of 21 exhaust-free electric scooters will collect the expo's garbage, and two sleek solar cars that look more like spacecraft than Earthcraft will ply the site, mostly giving rides to children. All of these vehicles as well as a Maglev (magnetically levitated) train were developed by a combination of government and privately sponsored research.

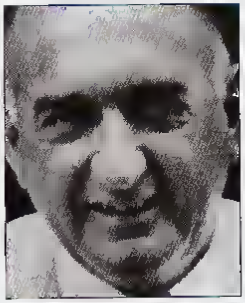
Not by coincidence, many of Korea's most important research institutions are located at Taedok Science Town, right across the road from the expo site. Imagine a town in which the United States has located the National Institutes of Health, NASA, the National Bureau of Standards, a couple dozen of the most important corporate research institutes, a university, and housing and shopping for more than 50,000 scientists, other employees, and their families. That would be the equivalent of Taedok, a city within the city of Taejon. Created in the 1970s, Korea's premier scientific and technical complex is the cradle of accomplishments, including development of the country's first satellites, the switching system that modernized Korea's telephone network, and numerous advances in semiconductor technology.

When visitors seek information on expo events and displays at the computer monitors that dot the site, they'll also be able to learn about Taedok's research efforts and sign up for a shuttle-bus tour to some of the institutes, where displays and audiovisual shows will demonstrate everything from the therapeutic properties of ginseng, to converting a written message in Korean to a voice message in English. Visitors who are interested may even request visits to labs and meetings with the scientists.

For all of its accomplishments, however, South Korea is still classified by the World Bank as a "developing" country (the first to host an international expo), and its annual per-capita income equivalent of $4,400 in the United States has a long way to go to reach that of neighboring Japan at $23,730. Only time will tell if Korea's investment in this expo can create the momentum to propel the country into a more prosperous and productive future.

Like any other international exposition, Taejon will be a hybrid of carnival and culture as well as science and technology. Will this turn out to be the magic mix that inspires children to devote their lives to science and technology, and adults, government agencies, and corporations to redouble their current efforts? P. Chungmoo Auh, president of the Korean Institute of Energy Research and of the Korean Solar Energy Society, is one scientist who thinks so. "After all," he says, "it is the scientifically minded ordinary people who will make the future of our country."—*ELLEN HOFFMAN*

CONTINUUM



Statistics indicate that Shoeless Joe Jackson played fair in 1919

IN DEFENSE OF SHOELESS JOE

The story of Shoeless Joe Jackson and the Black Sox scandal has fascinated baseball fans for most of this century, receiving unprecedented attention in the last few years through the film *Eight Men Out* and W. P. Kinsella's novel named after the left fielder—the basis for the movie *Field of Dreams*. As the legend goes, Jackson and his Chicago White Sox teammates tanked the 1919 World Series to the Cincinnati Reds, prompting an anguished young fan to cry, "Say it ain't so, Joe!" Now statistician Jay Bennett claims that at least as far as Jackson himself was concerned, it probably wasn't so.

Jackson's boosters point out that Shoeless Joe hit .375 during that Series, almost 20 points better than his already awesome lifetime average of .356. Jackson's detractors argue that he didn't get his hits in the clutch. Bennett, who works for Bellcore in New Jersey, has attacked that assertion with a statistical system called Player Game Percentage (PGP), which he developed eight years ago with statistician John Flueck of the University of Nevada at Las Vegas.

PGP takes into account the circumstances as well as the results of a player's at-bats, drawing a distribution curve that gives a real picture not just of how often a player hits, but when. "PGP," Bennett declares, "is specifically geared to address the Shoeless Joe question."

So what's the answer? Jackson's PGP score during the 1919 Series was actually 68 percent higher than that of a typical .375 hitter—which, everyone will agree, is an outstanding hitter, indeed. In other words, during the Series, Jackson hit even better than he might have been expected to—especially in the clutch.

"The guy got a raw deal," Bennett concludes. "He should be in the Hall of Fame."—Bill Lawren

TRAVELING AT THE SPEED OF THE FASTEST ELEVATOR IN THE EMPIRE STATE BUILDING, IT WOULD TAKE A BIT MORE THAN 30 MINUTES TO REACH THE BOTTOM OF THE MARIANA TRENCH

PASS THE POT SCRUBBERS

Recently, a few butchers in the Midwest have cut open the stomachs of cattle and discovered pot scrubbers inside. The steers haven't accidentally gobbled up the kitchen garbage. Rather, farmers have deliberately fed the pot scrubbers to the beasts in an effort to decrease their appetite for costly, bulky hay.

While cattle may prefer hay, given their druthers, it actually isn't very nutritious for steers in feed lots being fattened up for hamburgers and steaks. But cattle need hay for the roughage required by the first of their four stomachs. Feeding them only high-powered corn grain gives them ulcers.

Aware of this dilemma, Steve Loerch of the Ohio Agriculture Research and Development Center at Ohio State University in Wooster, Ohio, hit on an idea. "I saw research in which sheep fed on liquid diets developed the same stomach problems, but when the researcher put pot scrubbers in, it took care of the problem."

Loerch wrapped each of six Tuffy pot scrubbers in digestible masking tape and fed them to steers. They opened up inside the first stomach and remained there, replacing much of the need for hay fiber. The pot-scrubber solution saves about $50 per animal during the five months they live in feed lots.

Some farmers have read about his pot-scrubber technique and are using it, Loerch says. He's not sure how many, because he holds no patent on its use, but several reports of surprised workers at slaughterhouses have come back to him.

Maybe humans will use it to replace chocolate-cake cravings someday.

—Ben Barber

PUTTING VENUS IN ITS PLACE

When we last heard from Alexander Abian, he wanted to blow up the moon to change the Earth's orbit. Now he's set his sights on Venus. Abian, a professor of mathematics at Iowa State University in Ames, thinks we should try to change Venus's orbit to create what he calls a "born-again Earth" that can one day comfortably support humankind.

Often referred to as the earth's "twin planet" because of similarities in size, mass, and substance, Venus is almost ideal for duplicating Earthlike conditions. The main sticking point is its orbit. While Earth stays about 93 million miles away from the sun, Venus orbits within a paltry 65 million miles, which helps to make its average surface temperature a very inhospitable 900° F.

Scenarios that involve installing machinery on Venus and other planets to facilitate future habitation won't work, Abian insists. "You can't create life-sustaining conditions without changing the orbit," he says. By making Venus's orbit similar to Earth's, life-sustaining ecology will evolve automatically.

And just how does Abian propose we change Venus's orbit? "We can shoot it with rockets," he says. "Just hit it to change its trajectory." Even if our well-intentioned nudge sets it awry, "the chances of it colliding with Earth are nil."

We've got to realize "that the present solar system's setup is not the only possible scenario," he says. "It's not even very satisfactory. Our solar system is corrupt because of the inexorable and relentless cycles of epidemics and ecological disaster, and we've been brainwashed not to question whether nature has created the best possible setup."

—Peter Callahan

Let's send a rocket to Venus—not to explore the planet but to blast it into a new, more Earthlike orbit

'The best thing about the future is that it comes only one day at a time.'
—Abraham Lincoln

HEALING THE HEALERS

More than a third of the U.S. physicians practicing today say that if given the chance to do it all over again, they would not go to medical school. Gigi Hirsch knows this malaise firsthand. After finishing her residency in internal medicine, she worked in a hospital emergency room for four years and experienced some burnout. While just in her early thirties, she seriously considered retirement. "For the first time in my career, I realized I needed career-development assistance; but there were no resources available to me," she recalls. She went back to school for a three-year residency in psychiatry with one goal in mind: to "help doctors find more satisfaction in their professional lives."

On July 17, 1992, she founded the Center for Physician Development, affiliated with Beth Israel Hospital in Boston, a teaching hospital of Harvard Medical School, and its department of psychiatry. Hirsch intends to raise awareness about changes and issues within the profession and how they affect doctors as a first step toward improving the U.S. health-care system.

In addition to pursuing research on preventing physician burnout, her Center provides education, career counseling, support groups, and therapy. "By coming in and talking about the things that are causing problems in their professional lives, physicians will be helping to change themselves and the future practice of medicine," Hirsch says. —Steve Nadis

THE PARACHUTE WAS INVENTED MORE THAN A CENTURY BEFORE THE AIRPLANE.

CONTINUUM

LETTERS SHOW SUPPORT FOR SPACE PROGRAM

Last year, the space-advocacy group Spacecause and 11 other organizations sponsored a letter-writing contest designed to spotlight both the crucial importance of the space program to the United States and the danger that it faces in Washington. The contest, which included both children's and adults' divisions, required participants to write letters to their U.S. representatives and U.S. senators in support of some aspect of the space program.

Spacecause recently selected the contest winners, each of whom receive a free session at the U.S. Space Camp in Huntsville, Alabama, generously donated by that organization. In addition, the one letter judged best overall will be published in the magazines and newsletters of the sponsoring organizations, which have a combined circulation of more than 2 million: the American Institute of Aeronautics and Astronautics, *Analog*, *Final Frontier*, the International Association of Machinists and Aerospace Workers, *Isaac Asimov's Science Fiction Magazine*, *NASA Tech Briefs*, the National Space Society, *Omni*, Spacecause, Spacepac, *Space Station News*, and the U.S. Space Foundation.

Adam Gulley, 11, of Cleveland Heights, Ohio, won both the children's division and the overall prize. On September 23, he wrote to Representative Louis Stokes:

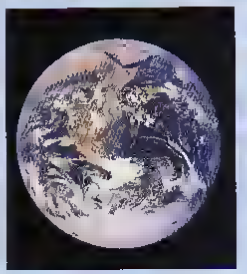
May I ask you to support Space Station Freedom? It could serve as a laboratory for learning how to use the microgravity of space making possible the materials which would help us all.

Maybe we could even discover new ways of improving parts on cars. I'm sure you remember that before the space program we didn't have very long mileage tires for cars. Now we do. Satellites help us talk to people and watch TV all over the world. If it wasn't for the space program, we wouldn't have these technologies.

Freedom *could help us answer many questions and problems. We may find cures for terrible diseases that scare us such as AIDS, cancer, leukemia, and Alzheimer's.*

It has been estimated that the Space Station Freedom program will employ more than 70,000 people in at least 40 states. These jobs will contribute new ideas, new knowledge, and new products to our economy. Perhaps even I will be among those employed because of Space Station Freedom. I hope to do something in the field of space someday. But I still have a lot of studying to do.

So please, Mr. Stokes, support Space Station Freedom.—Adam Gulley



In a letter-writing contest cosponsored by *Omni*, participants asked their senators and representatives to support the U.S. space program.

The 1992 elections sent a large number of individuals to Congress who don't favor space exploration in general and the space-station program in particular. The Clinton administration, while supportive of a space station, will not fight as tenaciously for the program as the Bush administration did. The recent station redesign efforts have weakened the pro-station coalition and have strengthened the Congressional critics' reasons for canceling the entire program.

You may want to contact your elected officials to express your support for the space station. Address letters to: Representative (name), Washington, DC 20515; and/or Senator (name), Washington, DC 20510. You can speak to your elected officials by phoning (202) 224-3121 and asking for your representative or senator.

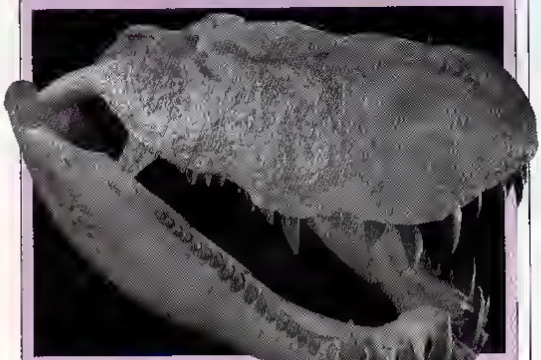
CONTINUUM

THE BIGGEST CARNIVORE OF ALL?

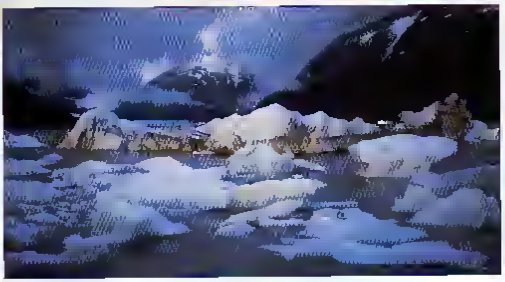
Millions of years after dinosaurs ceased to exist, the most massive carnivore of all time still roamed the Amazon basin in South America. According to paleontologist Carl D. Frailey and Kenneth E. Campbell of the Natural History Museum of Los Angeles County, the monstrous survivor was *Purussaurus*, an ancient genus of alligator whose members stretched 40 feet long, stood eight feet tall, and weighed 10 to 12 tons. "They were bigger than *Tyrannosaurus rex*," Frailey says.

A few years ago, Frailey, a professor at Johnson County Community College in Overland Park, Kansas, uncovered a fossilized skull of *Purussaurus* while excavating a site along the border of Peru and Brazil. "The skull was really thick and heavy, and the eyes were well protected, which is typical of all alligators," Frailey explains. Like other alligators, Frailey thinks, this giant fed on turtles and land mammals living around the huge lake that once covered the central part of the Amazon basin.

Frailey's fossil discovery indicates that the enormous reptiles persisted until as recently as 8 million years ago. Although paleontologists disagree as to the cause of the giant alligators' eventual extinction, Frailey suspects it has something to do with the disappearance of the lake ecosystem in which *Purussaurus* lived. "Movements in the Andes may have drained the lake," he explains. "When that happened, the specialized animals—including *Purussaurus*—that had adapted to that environment died out."—Jane Bosveld



Big mouth: Animals that met Purussaurus didn't live to tell about it.



Hot ice: Glaciers on top of tropical mountains are shrinking much faster than normal, possibly due to global warming.

THE GREENHOUSE GETS TO THE GLACIERS

New evidence for global warming has emerged from the peaks of tropical mountains. Researcher Lonny G. Thompson, a glaciologist from Ohio State University, traveled to Peru to measure the recession of glaciers on top of the Andes. He found that a snowcap there has the highest level of isotopic enrichment in 500 years, an ominous sign of global warming.

"Temperatures overall have increased by one degree centigrade since 1976," Thompson says.

By analyzing oxygen isotopes buried for centuries in ice, scientists can decipher how the glaciers have changed over time. In recent years, the ice has melted so rapidly that it no longer holds these ancient isotopes. According to Thompson, the ice on top of the Andes' Mt. Quelccaya has melted at a rate of 14 meters per year over the past decade. "Since 1983, 16.6 million cubic meters have been lost," he says.

Some mountains in Africa also show signs of recession. According to a letter published in *Nature*, Mt. Kenya lost 40 percent of its snowcap between 1963 and 1987, far exceeding previously recorded shrinkage.

Snowcaps in Tibet and the former Soviet Union also show signs of rapid recession. One site displayed isotopic enrichment unsurpassed in 12,000 years.—Andrew M. Thorpe

THE MANTIS SHRIMP IS STRONG ENOUGH TO PUNCH A HOLE THROUGH A GLASS JAR.

"The fascination of shooting as a sport depends almost wholly on whether you are at the right or wrong end of the gun."
—P. G. Wodehouse

BORDERCROSSINGS

A CONVERSATION IN CYBERSPACE

STANDING BETWEEN TWO WORLDS, A SCIENTIST, A NOVELIST, AND A SCHOLAR CLOSE THE CULTURAL GAP THAT SEPARATES SCIENCE AND LITERATURE

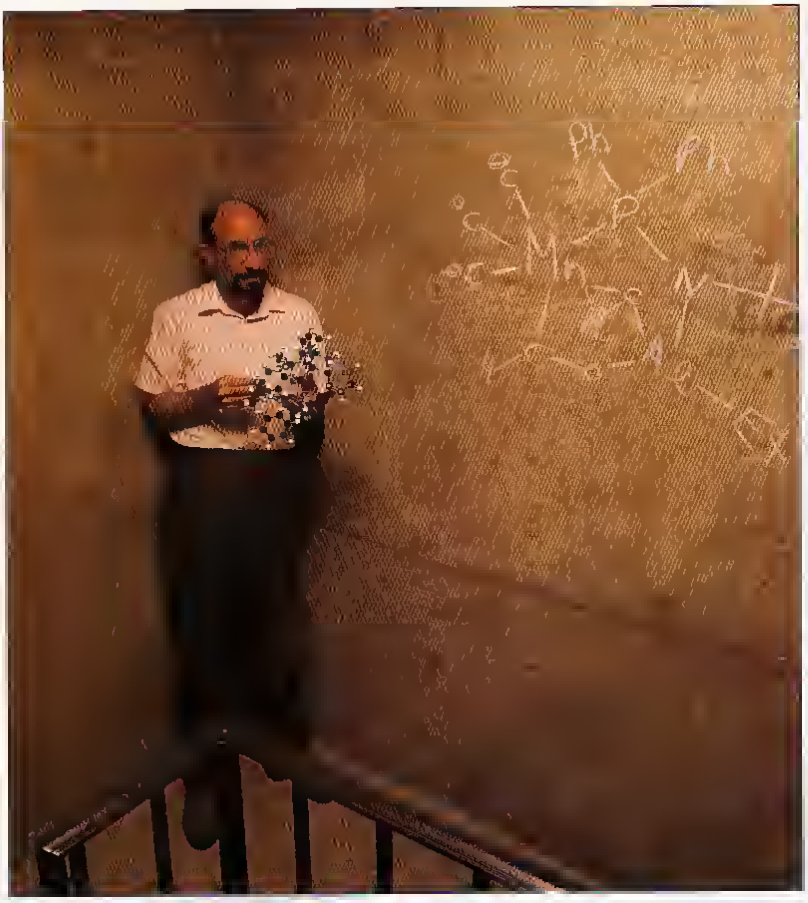
Science is not about control, says Stuart Ressler, a molecular biologist in Richard Powers' third novel, *The Gold Bug Variations*. "It is about cultivating a perpetual condition of wonder in the face of something that forever grows one step richer and subtler than our latest theory about it. It is about reverence, not mastery."

Is the character who utters these words talking about science or art? Isn't he mixing his categories, describing the scientific enterprise with words like wonder and reverence, words we use to describe a sunset or a Van Gogh painting? In fact, Ressler is out of step with those who believe that science is cold and abstract, art is warm and forgiving. There are those who separate science and art into two dominions, two hemispheres, two cultures. Science is truth; art is fiction.

C. P. Snow in his famous 1959 Rede Lecture on the need for educational reform was the first to recognize the emergence of "two cultures." For Snow, the significance of the cultural divide between science and art was immense. "I believe the intellectual life of the whole of Western society is increasingly being split into two polar groups," he said. While science, sometimes arrogantly, claimed a special license for dispensing the truth, art, sometimes contemptuously, smirked in the face of scientific discoveries, content to cultivate an art of pure aesthetics.

Snow worried that not only the intellectual community, but the general population as well, would be ill prepared to understand the coming revolution wrought by advancements in electronics. Partial education, one that concentrates on the values of one discipline at the expense of the other, could not possibly cope with the complex moral, social, and political issues that attend radical change. "Closing the gap between our cultures," he argued, "is a necessity in the most abstract intellectual sense as well as in the most practical. When those two senses have grown apart, then no society is going to be able to think with wisdom. For the sake of intellectual life . . . for the sake of Western society living precariously rich among the poor, for the sake of the poor who needn't be poor if there is intelligence in the world, it is obligatory for us . . . to look at our education with fresh eyes."

ARTICLE BY JANET STITES • PHOTOGRAPHS BY TOM ZIMBEROFF



RICHARD POWERS (OPENING PAGE) IS AUTHOR OF FOUR NOVELS, INCLUDING *THE GOLD BUG VARIATIONS*. HIS MOST RECENT NOVEL, *OPERATION WANDERING SOUL*, WAS PUBLISHED IN MAY. JAY LABINGER (LEFT) TEACHES CHEMISTRY AT THE CALIFORNIA INSTITUTE OF TECHNOLOGY

It was a conversation with Powers, whose *Gold Bug Variations* uses the strands of the DNA molecule to weave together two love stories and set them dancing to Bach's "Goldberg Variations," that led me to the idea of bringing together representatives of the two cultures. But how to do it? Sitting one night on a North Carolina porch, the medium came to me, apropos to the topic and astonishingly simple: a place where language meets science and technology: electronic mail.

Serving as moderator, I organized an E-mail panel with a writer, a scientist, and a scholar. The generally media-shy Powers agreed to participate, and I found a scientist, California Institute of Technology chemistry professor Jay Labinger, who had reviewed *The Gold Bug Variations* in Caltech's journal *Engineering & Science*. Labinger hadn't used E-mail much but was enticed by the idea. For a scholar, I turned to N. Katherine Hayles, president of the Society for Science and Literature, English professor at UCLA, and author of two books.

Powers, Labinger, and Hayles had never met but immediately began to call each other by first names, establishing a familiarity that seemed antithetical to the impersonal medium. My intent was to have the panelists discuss specific questions about the two cultures. Had they seen the boundaries soften between science and literature? How had scientific theories such as quantum mechanics influenced literature? Has the science of chaos figured in contemporary fiction? I underestimated their enthusiasm and the allure of E-mail. Following the first question, the panelists revolted, and all I could do was observe the mutiny.

The format was informal, responses written at leisure. A flurry of messages would be followed by days of silence. Twice, systems went down. Every message offered new ideas to explore, or raised another question. Powers suggested that there weren't two cultures, but "hopelessly many." A molecular geneticist for

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—JEANE DIXON

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A LEADING CRITIC ON HOW LITERATURE IS INFORMED BY CHAOTICS, N. KATHERINE HAYLES' BOOKS INCLUDE *CHAOS BOUND: ORDERLY DISORDER IN CONTEMPORARY LITERATURE AND SCIENCE*. SHE IS WORKING ON A STUDY OF CYBERNETICS, VIRTUAL REALITY, AND LITERATURE.

example, probably has as much trouble talking to a theoretical astrophysicist as a literary critic has talking to a political historian. Hayles asserted that to say something in other words is to say something different. Labinger bemoaned that everything he said seemed to have been said before.

Surprisingly, the participants were more interested in looking for similarities between scientists and writers than differences. Hayles pointed out that the value of chaos theory was that it offered new ways to think and write about literature, while Labinger proposed that its value may be its impact on how scientists approach science. For Powers, chaos theory gives the writer the motive to write, because in it, the individual counts a lot, and a small seed of words can still create a stir.

Browsing through the library, Labinger found an essay by Lewis Thomas, a physician and a writer, he thought gave a particularly good reason to come down against the two cultures. The essay, titled "On Matters of Doubt," was from the collection *Late Night Thoughts on Listening to Mahler's Ninth Symphony*. "To do this, I must try to show that there is in fact a solid middle ground to stand on, a shared common earth beneath the feet of all the humanists and all the scientists, a single underlying view of the world that drives all scholars, whatever their discipline—whether history or structuralist criticism or linguistics or quantum chromodynamics or astrophysics or molecular genetics. There is, I think, such a shared view of the world. It is called bewilderment."

Bewilderment is what we felt at the success of our experiment. We had provided an arena in which the two cultures could meet, had come to understand that science is not just a metaphor for fiction, but itself proceeds metaphorically. We had agreed that the world is not a linear equation, big changes come from small initial differences. But initial differences, as in those between the sciences and human-

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TWO CULTURES: A READER'S GUIDE

THE BUTTERFLY EFFECT (SENSITIVE DEPENDENCE ON INITIAL CONDITIONS) A discovery by meteorologist Edward Lorenz that demonstrates how a slight alteration in the initial conditions of a weather system affects major alterations in the behavior of the system A butterfly flapping its wings over Tokyo causes hurricanes in Miami

CHAOS (NONLINEAR DYNAMICS) A scientific theory that looks at complex systems such as weather or stock markets by mapping various patterns within the system Rather than reducing the system to its component parts (watching only the market activity of IBM), chaos examines the system as a whole, tracking repetitions and variations that occur on different levels within the system (global markets, daily closing figures, rate of exchange). Chaos has radically altered what constitutes meaningful phenomena in scientific study

EINSTEIN'S SPECIAL THEORY OF RELATIVITY The famous equation $E=mc^2$ says that light travels at a constant rate of speed that is independent of its source and that time and space are not absolute or independent phenomena. Relativity argues that there are many frames of reference from which absolute motion or rest may be determined and that no one point of reference is superior to any other

EMERGENCE As we move from lower-level structures such as the neuromapping of the brain into high-level structures such as consciousness, certain properties will emerge that can't be explained even by the most rigorous exploration of data at the lower level. Consciousness may be produced by a series of chemical events but it is not determined by them Emergence is a process in which the articulation of the phenomenon is as instructive as observation of the phenomenon itself.

EMPIRICISM. Experience obtained by sensory perception is the only accurate source of knowledge Gravity exists because we directly experience the effects of gravity

EPISTEMOLOGY The study of how we know the world around us, how we determine the nature of reality To what extent, for example, does intuition, logical analysis, or sense sensation play a part in determining what we think?

GÖDEL'S INCOMPLETENESS THEOREM. Revolutionized our concept of mathematics as a language of pure logic Like any language, it is coherent only within the system it seeks to describe. No system can stand outside of itself, perch above the laws of its own operation in order to see the whole at work—no system can ever completely describe itself Math can never exhaust the possibilities of its own language

LAPLACIAN DREAM Influenced by the Newtonian idea that given approximate knowledge of a system, we can predict the approximate behavior of that system, Pierre Simon de Laplace, an eighteenth-century mathematician, claimed that had he been standing with God at the moment of creation, he could have predicted the entire future of the universe

MANDELBROT SET Commonly referred to as the most complicated mathematical object in the universe, the set is a fractal which displays infinite and varied detail It is an example of how complexity can be generated by a simple act.

OBJECTIVISM External reality exists and can be ascertained through a detached and logical consideration of facts Gravity exists because it can be verified by scientific experiments

PARADIGM A concept used by Thomas Kuhn to explain how and why scientific revolutions occur Radical discoveries in science, he argues, produce radical shifts all across the cultural terrain Newtonian physics, for example, is based on the assumption that physical laws are logical, consistent, and predictable, given sufficient data In addition to revolutionizing science Newton's ideas changed the way historians and artists and sailors saw the world

In this century, a new paradigm has emerged Randomness, not certainty is increasingly accepted as the natural state of the physical world

POSITIVISM A limited doctrine developed by Auguste Comte around 1830 which holds that the only reliable source of knowledge is that which is obtained by the direct observation of the material world Through scientific experiments, we can explain how gravity works, but we can never explain why gravity exists

POSTMODERNISM. A descriptive term that has for the past two decades been used to describe everything from cartoons to war As a reaction to intellectual traditions that attempt to explain the world using universal concepts such as Freudian models of the personality Marxist theories of economics, or the cause-and-effect explanations used by historians, postmodernism sees life in the late twentieth century as a series of disconnected events, a smorgasbord of narratives or discourses that compete for attention No one system of thought can ever account for the infinite diversity of modern life Science, for instance, does not offer a better or more accurate description of reality than fiction, only a different one

PRIVILEGED Based on the assumption that words derive their meaning in part from their association with opposite terms (such as good/evil reason/instinct, intellect/emotion), a privileged term is one that for cultural reasons is judged to be superior Reason is better than instinct

QUANTUM MECHANICS and HEISENBERG'S UNCERTAINTY PRINCIPLE Both challenge the notion that scientific investigation can discern all properties of a system. Quantum deals with the fundamental instability of subatomic particles Heisenberg proposed that we can never know with complete certainty both the position of a particle and its movement at the same time. At best, knowledge is founded upon the principles of probability, not certainty

CONTINUED ON PAGE 114

ities, may only be a matter of perception. We had crossed the barriers of our professional disciplines and found some much-needed common ground. We had become a little wiser, as C. P. Snow hoped we would. And all we had to do was sit back, listen and cultivate, in Ressler's words, "a perpetual condition of wonder." What could be simpler?

3 NOV
From: IN%"@inis.uncg.edu" (OMNI)
In the now famous Rede Lecture delivered at Cambridge in 1959, C. P. Snow proposed what's come to be known as the "two culture" theory. Do you believe there are "two cultures," one of science and one of humanities?

4 NOV
From: IN%"@XHMEIA.Caltech.Edu" (Labinger)
Whether or not Snow's proposal was valid 30-odd years ago, it may be less so today. There certainly appears to be much greater awareness of scientific themes and issues represented in non-scientific writing, both serious and mass market. Whether this indicates a real integration of the "two cultures" or simply superficial name dropping where the significance of the scientific reference is limited to placing the action into context, or even just to showing off the author's erudition, is not so clear. If the requirement for scientific literacy is a complete and deep understanding of, say, the Second Law of Thermodynamics (an example Snow used), perhaps many nonscientific authors would fall short.

One issue that I find particularly troubling as a scientist is not whether the number of cultures is two or one, but whether science is thriving as a culture at all. There has been a growing tendency to equate science with technology and to demand that scientists turn their efforts toward applied problems with short-term promise. Is this a "cultural" issue? I was really struck by a recent article in *Chemical and Engineering News*, the weekly news journal of the American Chemical Society. In discussing the trends toward targeted, technology-oriented R&D, a former Presidential science adviser was quoted as saying that science is currently undergoing a "paradigmatic shift." That phrase is associated with science historian Thomas Kuhn, referring to scientific revolutions—an elegant illustration of the cultural side of science. I found its use in this context strangely upsetting. Not only are we going to downgrade science as a culture, but we'll add insult to injury by ripping off a phrase intended to describe cultural changes and use it to refer instead to cultural collapse. (Talk about intellectual inflation. Paradigms ain't even worth 20 cents these days.)

From a strictly practical point of view, there are strong arguments against overemphasizing applied research—if all we do now is try to exploit the basic discoveries of the last *x* years, what will we have to work on *x* years from now? However, I think the implicit assault on the cultural side of science is fundamentally even more dangerous. For years I have been hearing pundits in my own field tell me that chemistry is a "mature science." That seems reminiscent of the state of physics toward the end of the nineteenth century, when all that was left to do was "add the next decimal place." To start thinking of science as just a box of tools whose basic forms have been perfected and whose major importance is what we can make with them would be much the same as dismissing the importance of literature and art. (Aren't there enough books and paintings out there already?) Either would be a dramatic demonstration of our complete stagnation as a society. I think it's more than a coincidence that we see increasing pressure on funding for both truly basic scientific research and arts and humanities at the same time.

I seem to have digressed a bit. Perhaps, though, this leads me back to an argument for one culture, whose goal is basically to understand how the world works, a quest that encompasses both humanistic as well as scientific aspects—to use a distinction that the two-culturist might make.

I don't think there is much fundamental difference between the way we seek to gain understanding of scientific and humanistic matters; perhaps this says nothing more than that scientists and nonscientists minds work pretty much the same. It may be noteworthy that, along with the perceived increased scientific content of nonscientific writing, there seems to be an increase in attention to the human side of scientific research. The American Chemical Society has recently instituted a major series of monographs titled *Profiles, Pathways, and Dreams: Autobiographies of Eminent Chemists*. This increased interest in the personal aspects of science and the lives of scientists probably began with Watson's *The Double Helix*, and it may be making too much of it to cite it as evidence for "homoculturalization" (how's that for a neologism?) rather than a somewhat elevated version of *Lifestyles of the Rich and Famous*. If there are or have been two cultures, I think they are progressing toward convergence.

4 NOV
From: IN%"@iris uncg edu" (OMNI).
What role has literature played in influencing cultural trends?

4 NOV
From: IN%"@XHMEIA.Caltech.edu" (Labinger)
My daughter has a poster with mock final-exam questions, one of them for philosophy, runs something like, "Discuss the Universe. Be concise." This question reminds me of that: more than a little. I really don't know how to answer it at this point in our electronic conversation. For now, I say that culture represents the quest to understand the World (capital W). Or, as Rick quoted Wallace Stevens in *Gold Bug*, "Life consists of propositions about life." To gain that understanding, to decide on the validity of those propositions, requires as much data as we can possibly acquire and process—far more than we can get from first-hand experience. Literature is just one—although in many ways the best—of the available sources for that data.

5 NOV
From: IN%"@assistant.beckman.uiuc.edu" [Powers]
Two cultures? The answer to that one depends a lot on the gauge you set on "culture." At fine magnifications, we probably want to talk not about two cultures but about hopelessly many. As far as common cultural currency, a molecular geneticist probably has as much trouble talking to a theoretical astrophysicist as a poststructuralist literary critic has talking to a political historian. In fact, scientist friends of mine have complained to me that they sometimes have trouble following more than half of the articles in technical journals devoted to their own discipline. So where do you set your focus? About halfway up, I still see a rather formidable barrier to mutual intelligibility. As Jay rightly points out, many scientists and most humanists lack a deep understanding of the Second Law (which may, for the faint hearted, be a good thing). And of those who do have a complete grasp on it, few again will be readily conversant in Chaucer or Milton, let alone the texts these dead white males took for granted. It's a funny kind of formulation, because the population at large may be neither particularly positivist/empirical nor especially literary/artistic.

There are as many philosophical alignments as there are ways of being alive. I suspect that most cultural allegiances are pragmatic hybrids of several positions. But what the question really disguises, I think, is an anxiety about wheth-

er some kind of profound and fundamental split has opened up in the way we look at the world at the lowest magnification. Whether knowing the world from one angle precludes seeing it from the other. Whether empiricism or experimentalism is somehow inimical to whatever humanist intuitionism is supposed to be "science's" opposite. Here I am with Jay. The similarities in the ways we all attempt to solve experience are, in the wide lens, probably more important than the differences. My humanist friends all seem to be more or less well versed in the program of repeatable and testable observation if not the specifics, and I have never met a scientist who did not respond in some degree to irony, lyricism, metaphor—the whole arsenal of literary devices—even without knowing all the names of the tropes.

We choose between measurement or interpretation in describing what it means to be alive, but that is no cause to fear that society is necessarily going to fissure intractably down the length of that dichotomy. We are all, to differing extents, capable of dual citizenship, bilingual. The brain, if my layman's understanding of recent research is correct, converses in both registers.

As for the cultural variety that swarms the petris at narrower gauges, I'm all for it. "Multiculturalism" is the current buzzword for those whose job it is to decide if the world is going to make it. We can not only survive plurality—we need it.

Literature's role in culture? You're asking a person with a strong bias. I would say, at its best, literature can be a fractal map of that multiplicity, at a scale of almost one inch to the inch.

17 NOV

From: IN%"@umaxc.weeg.uiowa.edu" (Hayles)

I've thought a lot about the two-cultures divide, having found myself straddling it for quite a few years now. There are a couple of contexts in which it seems to me useful to think about two cultures. One is language. The second, related to it, is institutional—how people going into literature and chemistry, say, are trained and what kinds of assumptions they absorb more or less unconsciously from that training. In fact, I think that the "two cultures" construction has an institutional basis. Why did Snow choose literature and science as representative of different styles of thought and not, say, anthropology and home economics?

After a bit of research on the background of Snow's famous Rede Lecture, I decided it was basically because of a dramatic shift in Anglophone academic curricula. Until about 1920, what it meant to be educated was to be literate, in the sense that John Milton or Matthew Arnold would have understood the term—to know the great works of literature (including philosophy) in one's own and other languages and to be able to refer to them fluently and easily in conversation and writing.

Gentlemen knew languages and literature—or at least that was the myth. (Gentlewomen presumably knew needlepoint). Gentlemen (and certainly gentlewomen) did not necessarily know science, which until well into the nineteenth century was regarded as too technical and in some cases too grubby to be really high tone.

All this changed dramatically around the turn of the century when leading progressive institutions in America and England began to put science and mathematics, rather than Latin and literature, as the center of their curricula. By the 1950s when Snow gave his lecture, the shift had largely been accomplished and the real power in academic curricula in many institutions was scientific rather than literary. Hence it made sense for Snow to talk about the two cultures in terms of education, insisting that literati should know the Second Law no less than scientists should know Shakespeare. It is more historically correct. I think, to talk about the two cultures as an educational and institutional issue than an epistemological divide, because it's for sure that ways of thinking and knowing are as diverse as the human population, as Rick pointed out.

So what difference does it make that chemists receive a different kind of education than English majors? One of the biggest differences I see is how language is used, constructed, conceptualized, thought about or not thought about. As a result of their training, many scientists hold what I call the gift-wrap idea of language. They see language as a gift wrapping that I use to hand an idea to you. You receive the package, unwrap it, and take out the idea. In this view, the wrapping is purely instrumental, a way of getting an idea from me to you. The idea is what counts, not the wrapping. People trained in literature tend to think this view of language is completely wrong. They deeply believe that the language constitutes and does not merely express the idea. Because no two verbal formulations can ever be identical, to say something in other words is to say something different. Literary people believe that the language counts and that it is important to say something in precisely the right way. They don't trust their expression

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FUTURE WAR... FUTURE PEACE

Superpower conflict may be a thing of the past, but military confrontation will undoubtedly figure in our future. What's the best way to approach armed confrontation in the decades ahead? The approach that transforms megapower war machines into peacekeeping tools.

ARTICLE BY BEN BOVA

One of science fiction's most prescient speculators offers a scenario for a future at first bloodier and then much brighter than the present. At least we hope.

The collapse of the Soviet Union and the end of the Cold War plunged the world into 20 years of chaos and bloodshed.

By the mid 1990s, fierce wars and civil conflicts were raging in the Balkans, Southeast Asia, the Indian subcontinent, and through much of Africa. Both the former Yugoslavia and the former Soviet Union were split into warring nationalities. Serbs against Croats and Bosniens, Armenians against Azerbaijanis, Georgians against Russians.

The Russians were particularly worried about the Moslem nations along their southern border and the influence of Moslem fundamentalism from nearby Iran.

In Southeast Asia, Cambodian factions such as the Khmer Rouge fueled a long-lasting civil conflict that triggered an undeclared war between China and Vietnam. In Latin America, major nations such as Brazil and Argentina suffered continued economic convulsions that led to military takeovers of their governments.

Long and painful civil wars continued in the villages and jungles of Guatemala, Honduras, and El Salvador, pitting rag-tag "people's armies" against government troops.

Much of Africa, meanwhile, was collapsing in famine and drought, while one-party governments battled insurgents for power—and food. South Africa's shaky attempts to move to multiracial government teetered on the brink of genocidal war.

And in the Middle East, one effort after another to negotiate peace between Israel and its Arab neighbors collapsed while the Palestinian resistance to Israeli occupation of the West Bank and Gaza Strip escalated into guerrilla warfare.

As early as 1992, many political observers were demanding that the United Nations create a fully armed International Peacekeeping Force aimed at stopping aggression and enforcing the peace.

U.N. peacekeeping efforts were nothing new, even in the 1990s. During 1950–1953, a U.N. army defended South Korea against invasion from its northern neighbor. In 1991, a U.N.-directed coalition freed Kuwait after it had been invaded by Iraq. However, both of these operations were composed predominantly of American military personnel, who bore the brunt of the fighting and the casualties.

Peacekeeping in its true sense—attempts to prevent warfare and bloodshed—was less successful. Even well into the 1990s, U.N. "peacekeepers" were only permitted to operate as referees standing between two belligerent parties, and only after the warring factions had agreed to allow the U.N. troops to separate them.

They were lightly armed, only for self-defense. If and when the belligerents decided to renew their fighting, the U.N. peacekeepers were forced to flee. Or die. In Cambodia, for example, Khmer Rouge attacks on the blue-helmeted peacekeepers forced the United Nations to withdraw its token force altogether.

Terrorism reached the United States with the bombing of the World Trade Center in early 1993. Other terrorist attacks, from organizations as diverse as the Irish Republican Army to the more rabid ecological radicals, peppered American airports, trains, and amusement parks such as Disney World.

The United States and the other industrialized nations did not immediately support the

idea of a well-armed, highly mobile International Peacekeeping Force. The reaction in America and Europe was to utilize existing military alliances such as NATO to intervene in regional conflicts such as the Serbian-Bosnian bloodbath. Thus came the NATO fiasco in the Balkans in the later 1990s.

What troubled the United States and Europe was the spread of ballistic-missile technology to the Third World.

During the Iran-Iraq war of 1980–1988, both sides fired ballistic missiles. Though the missile warheads contained "only" high explosives, this was the harbinger of worse to come. After Iraq's humiliation in the 1991 Persian Gulf War, U.N. inspectors verified that Iraq was developing both nuclear and poison-gas (chemical) warheads and improving the range and accuracy of its ballistic missiles.

By the mid 1990s, no fewer than 16 Asian, African, and Latin American nations either possessed or were working to develop nuclear, chemical, or biological weapons. Israel, India, Pakistan, and South Africa admitted to having nuclear capability. In 1993, North Korea quit the Nuclear Nonproliferation Treaty and began selling weapons-grade enriched uranium to Iraq, Iran, Syria, Egypt, Libya, Argentina, Brazil, and others.

And despite treaties banning chemical-warfare-weapons development, two Russian scientists disclosed in 1993 that Moscow was pursuing research on sophisticated new binary nerve gases. Both received long prison sentences.

The United States, China, North Korea, and several European nations were all selling ballistic-missile technology worldwide, often under the guise of exporting knowledge and hardware for space exploration. In a very real, and ultimately tragic, sense, the United States was selling its potential enemies the means for attacking its own cities.

As early as 1983, the United States and its NATO allies had begun work on defenses against ballistic missiles, the Strategic Defense Initiative, dubbed Star Wars by the news media. Once the Soviet Union broke apart, however, Washington slowed work on SDI in the belief that the missile threat to the American homeland had evaporated.

But although the Russians were dismantling most of their nuclear-armed missiles, Ukraine, Kazakhstan, and several other nations that had been part of the Soviet Union refused to give up their missiles—missiles with the range to reach the United States.

Meanwhile, the situation in the former Yugoslavia escalated into full-scale religious war: Christians against Moslems.

NATO's first attempt to control Ser-

bian aggression was to enforce a "no fly zone" over predominantly Moslem sections of Bosnia. This had little effect on the slaughter taking place on the ground. Little by little, NATO was drawn deeper into the nightmare.

NATO planes were shot down. Pilots and crewmen were murdered or held hostage. Rescue missions were attempted, with ground troops attacking by helicopter. Within a year, a sizable NATO ground force—including significant American units—had established an enclave in Bosnia. But the fighting continued with no end in sight.

At the same time, Turkey became embroiled in the simmering war between Armenia and Azerbaijan in the former Soviet Union, while Greece moved to help the Macedonians who had declared their independence from Yugoslavia and were threatened by Serbian invasion. Serbia claimed that Greece wanted to annex Macedonia to itself. Turkey insisted that it could no longer sit by idly while Armenian Christians were slaughtering Azeri Moslems.

The Armenians, remembering slaughters generations earlier, appealed for Russia's help against the Turks.

Both Turkey and Greece were NATO members. Both ignored the efforts of their fellow NATO members to negotiate peaceful settlements. Russia threatened to intervene on behalf of the Armenians. If Russia attacked Turkey, the other NATO nations—including the United States—were bound by treaty to fight on Turkey's side.

Nuclear war was imminent.

It came, but to everyone's shock it happened in the subcontinent of India.

Massive religious riots had been rocking India for more than a decade, pitting Hindu against Moslem (although Sikhs and other ethnic groups within India also contributed to the mounting violence). The rioting escalated into a full-scale battle in the Rajasthan city of Jaipur. After several days of bloody street fighting, the Indian government called on the army to restore order.

The government of Pakistan warned that if the Indian army fired on the Moslems of Jaipur, Pakistan would declare war. Fearing a nuclear strike, India launched four nuclear-armed ballistic missiles at Islamabad in an attempt to decapitate the Pakistani government.

Two of the missiles reached Islamabad, instantly killing nearly a quarter million Pakistanis. That night, Pakistani air-force jets, coming in at wave-top level off the ocean, destroyed most of Bombay in a nuclear suicide attack.

The world held its breath. Nearly 4 million people had been killed in less than 12 hours. Two and a half million more would die within weeks from radiation poisoning, injuries, disease or starvation. Clouds of deadly radioactive fallout drifted across the world.

It was the Russians who took the first step toward sanity. In an emergency meeting of the U.N. Security Council, the Russian representative called for the United Nations to warn both India and Pakistan that they had overstepped the bounds of civilized behavior and any further warfare between them would be met by the full military force of all the United Nations' members.

"We can no longer permit nations to resort to violence in settling their disputes," said the Russian delegate. "If they attempt to do so, force must be met by overwhelming force."

The Security Council voted unanimously to establish a "peace patrol" to prevent further attacks between the two nations. This was the first step toward the creation of the International Peacekeeping Force.

The peace patrol included a massive naval task force centered on four American aircraft carriers. A motley army drawn from more than a dozen nations occupied the border area between Pakistan and India. While neither American nor Russian troops were deployed, U.S. Marines and Russian airborne troops backed up the U.N. border units.

Critics argued that this show of force did nothing to solve the Hindu-Moslem conflicts that had triggered the nuclear exchange. The U.N. secretary-

general countered. 'Our task is not to govern India; it is to prevent war.'

But the rioting had stopped, shocked into paralysis by the horror of Islamabad and Bombay.

Thus was born the International Peacekeeping Force of the twenty-first century: an elite, highly mobile, specialized force armed with the highest technology the world could produce.

It would have come to nothing, however, if the industrialized nations continued their deadly trade in armaments.

To her everlasting credit, it was the president of the United States who proposed a global halt to arms exports. 'We must stop building and exporting the weapons of death,' she said in a televised speech. 'The time has come to turn our swords into plowshares.'

The U.S. government instituted a massive program to convert its armaments industry into peaceful uses such as space exploration, transportation, information services, and even—surprisingly—new entertainment media such as virtual reality. Weapons were still developed and manufactured, but at a much lower level than before. Weapons exports virtually ceased.

Gradually, under heavy pressure from the United States and the United Nations, the nations of Europe, Asia, and Latin America joined the worldwide arms embargo movement. The effort to convert the arms industry to more useful pursuits resulted in a flowering of global transportation and information systems and an expansion of international space exploration and development, including the global network of Solar Power Satellites.

The various national armaments corporations had linked themselves into multinational combinations for many decades. Much diminished now, they still continued to develop high-tech weaponry for their national armed services—and for the new, growing International Peacekeeping Force.

The IPF consisted of a permanent cadre of highly trained personnel who formed a global quick-reaction force. This was backed up by units from the member nations of the United Nations, as needed. Thus the IPF's quick-reaction force was often enough to stop a local war in its opening stages. If not, heavier units of troops, ships, and planes were loaned to the United Nations for the duration of the emergency, under Security Council direction, much as was done in the Persian Gulf War of 1991.

Though small, the basic IPF cadre was highly mobile and thoroughly professional. And it was armed with the highest technology the world's industries could produce.

The eyes and ears of the IPF was a network of orbiting surveillance satellites that could spot troop movements, arms buildups, and even monitor electronic communications anywhere in the world. Dubbed 'peacesats,' the surveillance satellites also carried command-and-control electronics systems that relayed U.N. communications around the world virtually instantly.

To the greatest degree possible, the IPF depended on standoff weapons: small, inexpensive, "smart" missiles that could find and destroy the tanks, planes, artillery pieces, bunkers, and other paraphernalia of aggressors. Often guided by lasers and directed from orbit, these standoff weapons allowed the IPF to fight battles with minimum exposure and risk to their own personnel.

The world's research laboratories also began to produce nonlethal weapons, beginning with simple copper filaments that could short out a city's electrical distribution systems.

Electronic jammers capable of disrupting military communications became a mainstay. 'Defeat their communications and you defeat their attack,' was central to the IPF credo.

Nontoxic gas, optical flash devices that temporarily blinded attacking soldiers, and other nonlethal weaponry became an increasingly important part of the IPF's arsenal.

The goal of the IPF became *warfare suppression*. Its very existence helped to induce belligerent national leaders to the conference table rather than the battlefield. When armed strife broke out, the IPF struck swiftly to stop the fighting as quickly as possible.

The IPF's central operational doctrine was to destroy weapons rather than kill people. The standoff missiles went from 'smart' to 'clever' to 'brilliant.' A single small missile could locate and destroy an expensive tank or airplane with almost a one-to-one efficiency. Troops learned that it was unhealthy to be near these targets. The economics of warfare shifted decidedly in favor of the defense.

Politically, the IPF was structured so that no nation was asked to disarm itself. Indeed, the IPF depended on contingents from national armies, navies, and air forces to reinforce its own cadre, when necessary.

Gradually, however, nations began to shrink their defense establishments. Governments, especially in the democracies, came under increasing pressure from their people to reduce their outlays for the military. As national armies be-

came smaller, the IPF's task of keeping the peace became easier.

Not that is was ever truly easy. One of the IPF's earliest tests came when Kazakhstan and Russia massed troops on their mutual border. Both nations had nuclear-armed ballistic missiles with the range to reach any city in the world. The crisis was averted by frantic diplomacy, backed by the IPF's destruction of both sides' surveillance and communications satellites, which effectively blinded their generals.

Immediately afterward, Russia and the United States began a cooperative program to build full-scale SDI defenses in orbit. The system was eventually turned over to the IPF so that now SDI satellites protected every nation on Earth against ballistic-missile attack from anywhere.

The central problem of the twentieth century, as far as international relations was concerned, had been that there was very little international law and even less enforcement of international law. Nations always had the option of going to war to gain what they wanted rather than to the World Court.

The IPF removed that option, or at least greatly reduced its attractiveness. The IPF provided a much-needed enforcement arm. Increasingly, as the years wore on, international disputes were settled by the World Court. On those occasions when nations—or subnational groups—resorted to arms, the IPF suppressed the fighting and the issue went to the World Court afterward.

The greatest threat came with the Second Cuban Missile Crisis. When post-Castro Cuba began to arm itself with ballistic missiles, the United States threatened to invade the island and remove both the missiles and the Cuban government. An IPF peace patrol of ships and planes was sent to the waters between Florida and Cuba, with orders to prevent an American invasion. The United Nations demanded that Cuba disarm under IPF supervision.

Many in the United States insisted that America ignore the IPF, resign from the United Nations, and take over Cuba. But cooler heads prevailed. Faced with virtually global disapproval, the United States backed down as gracefully as it could. The Cubans allowed IPF inspectors to remove their missiles. Peace returned to the Caribbean.

Both the U.N. General Assembly and U.N. Security Council have continued to work very diligently to keep the IPF as small as possible, consistent with its task of suppressing warfare. There is the continuing fear that an international military organization could somehow turn into a global dictatorship. By keeping the IPF small and maintaining national military establishments, this fear of a global coup d'état has remained little more than a background worry.

Like the military establishments of the United States and other Western democracies, the IPF was originally created as a nonpolitical organization. And it has remained so. New recruits are trained in the nonpolitical doctrine of the IPF as hard as they are trained to operate the military hardware they employ.

As the second decade of the twenty-first century begins, the world looks forward to an era of peace. The trillions of dollars once spent by national governments on armaments are now being spent on food production, education, housing, and scientific research. The *causes* of war and terrorism are being slowly but steadily removed from the global stage.

Carved above the main entrance of the IPF headquarters is a Biblical prophecy: *Nation shall not lift up sword against nation, neither shall they learn war anymore.*

After the bloodiest century in history, the peoples of the world are slowly, but steadily, making their way toward that new era. DQ

"Greetings! We have come with solutions to all the world's problems."

THE ULTIMATE IN ARTIFICIAL INTELLIGENCE—YOUR OWN!

SOULS IN SILICON

BY FREDERIK POHL & HANS MORAVEC • PAINTING BY MICHEL HENRICOT

It is the year 20-something—we don't know the exact date yet, but figure 20 to 50 years from today—and your doctor has just given you some really bad news. That nasty little pain in your lower abdomen turns out be serious. The doctor explains to you with great tact and kindness that, although medicine can now fix almost everything that can go wrong with the human body, there remain one or two really ferocious ailments that cannot be cured. You won't be in pain, he says. You won't even be bedridden, except at the very end—but the fact is that you have just six months left to live.

Naturally you don't enjoy hearing that. It comes at a particularly bad time, you think, because now that you're approaching 90, you've just begun thinking seriously about how you're going to enjoy your retirement years. Then the doctor clears his throat and says: 'Of course, there is an alternative.'

That gets your attention right away. 'Alternative?" you say. 'You mean I don't have to die in six months after all?'

The doctor purses his lips professionally precise. 'That isn't exactly what I mean,' he says. 'Your body is certainly going to die. There's nothing we can do about that, but that death doesn't have to be, well, *fatal*. You're a possible candidate for a mind transplant.'

So a couple of weeks later you're undergoing tests in the best surgical hospital in your area. You're surprised to find out that most of the tests aren't medical. They're psychological, and they test things like your memory retention, your reflex speed, even your IQ. The CEO of your company comes by your hospital room with a dozen roses. There is a small flask of her best 1990 Scotch hidden among the flowers, and when the nurses aren't looking, she shares a last drink with you. "You'll be back in the office in two weeks,' she predicts. And then one morning they wake you up, give you a tranquilizer, slide you onto a gurney and wheel you down to the operating room.

They don't put you to sleep, only make you a little drowsy so you can drift off to sleep if you want to. They do anesthetize your entire scalp, because the skin of your head is sensitive to pain, but the real cutting-and-splicing operation is going to be done on your brain, which has no nerve endings to feel pain. They've fixed it so that you can watch the whole thing on a TV monitor if you want to. (You're not at all sure you want to, but every once in a while you sneak a look.) You already have a good idea of what they're going to do, because the surgeons and the computer people have gone over it with you, with a model of the brain. You're a little impressed with the number of people in that operating room, all concentrated on you—two brain surgeons, an anesthesiologist, four nurses . . . and five computer experts. That's a lot of highly trained specialists to be working on you, you think, but you can't help feeling a little lonely in that crowd.

DO YOU WANT TO LIVE FOREVER? LIVE ANOTHER 25 YEARS OR SO AND YOU PROBABLY CAN. YOU'LL BE PART MACHINE, BUT YOU'LL BE MOSTLY YOU.

What they do to you doesn't hurt. You feel a kind of gently pushing this way and that as they lift a flap of scalp to expose the skull, and you definitely feel the vibration as they cut the bone and lift it away. You stop looking into the monitor at that point. You close your eyes and try to concentrate on thinking about your wife and kids, all waiting in one of the hospital's lounges, along with a couple of people from your company. Maybe you even do drift off to sleep.

And while you're doing that you know the surgeons are exposing that tough lump of meat in the midsection of the brain that is called the "corpus callosum." You even know what the corpus callosum is because they've told you that its half a billion fibers operate as conduits, passing information back and forth between the two halves of your brain.

Then the surgeons step back and the computer people take over. They don't touch any scalpels themselves. They operate micromanipulators which gently slide a *very* dense and fine comb into the corpus callosum. The comb has some hundred thousand tines, and each tine has a hundred thousand connections. The tines slip elastically into the space between the fibers, until each fiber has made a contact with one or more of the connections. It's a mammoth job, but it is done nondestructively. The whole thing takes only about eight hours.

And then they bandage you up and wheel you back to your own room, and you really do go to sleep.

When you wake, you don't even have a headache—you're full of selective analgesics—and the doctor's there grinning at you. 'Congratulations,' he says. 'Welcome to immortality.'

Of course, that's science fiction—today. (But nuclear power spaceships, television, and robots were also science fiction—once—and now they're all over the place.)

The idea of storing human intelligence in some kind of machine is pretty old stuff in science fiction, almost as old as science-fiction magazines themselves. One of the earliest writers to use the notion was Neil R. Jones, who published his short story "The Jameson Satellite" in 1931. It told of a college professor named Jameson who, learning that he was soon to die, decided he would like something better than the usual funeral and burial. Like all college professors, Jameson was of course very rich. (When college professors read this story this is generally the point at which they start laughing uncontrollably.) So he took some of his money and built a spaceship in his backyard. When the professor did at last die, his executor loaded his corpse into the spaceship and fired it off into low Earth orbit. There Jameson remained, frozen solid, for a long time—40 million years—until some wandering aliens called Zoromes discovered it and decided to recruit the professor into their band. So they surgically removed the brain from the frozen corpse, thawed it out and implanted it in a robot machine that resembled a breadbox with tentacular metal arms and legs. Then, renamed 21MM392 by his new Zorome friends, the professor went on to have endless adventures in space.

There were plenty of other such stories, but almost all of them assumed you would have to store the physical organic human brain in some kind of machine. That seems pretty unlikely as a really long-range solution to the problem of immortality, since, sadly, the human brain is by its organic nature subject to rather rapid decay (as well as being afflicted with the steady deterioration that costs each one of us a few thousand brain cells dead or decrepit each day). When computers came along, they offered a more hopeful place to store intelligence.

We don't have any computers today that can come anywhere close to the capacities of the human brain—a typical late twentieth-century computer has roughly the "brainpower" of a housefly—but the things keep getting better, and they do it very fast. Between the early days of this century, when the first mechanical adding machines began to be useful, and the arrival of electric calculators during the World War II era, machine computation increased a thousandfold in speed and capacity. Then electronic machines came along, so that between 1940 and 1980 there was an additional millionfold improvement as vacuum tubes and then transistors took over. Since then, with accelerating miniaturization and the use of advanced integrated circuits, the curve continues to steepen, while future computers—using such techniques as quantum devices, diamond semiconductors, increasing miniaturization down to the atomic scale—suggest that computing power will continue to grow at its historical rate or better for an indefinite time into the future.

The human brain, with its 100 billion neurons and roughly 100 trillion connections, requires a lot of computing power to be sure, but not more than computers early in the next century should provide.

Given the probable existence of such hypercomputers within the lifetimes of many of us now alive, how do we go about getting all the memory, speed, and flexibility of a human mind into the machine?

That's where the corpus callosum comes in. Suppose that a neural comb like the one we have described is slipped into it and connected to an external computer. At first that computer does nothing but pass the brain's traffic from one hemisphere to the other and eavesdrop on it. It retains what it learns. Over time, it constructs a model of what goes on in your brain. More than that, the computer can put enough signal on each connection point to overwhelm the normal traffic if it needs to, so that, when the model is nearly complete, the computer begins to insert its own messages into the flow. The computer becomes an auxiliary brain, then, when the original organic brain begins to deteriorate, the computer smoothly assumes its functions.

And when the brain at last dies, as all organic things must, your mind is complete and functioning—in the computer. Optical, auditory, chemotactic, and other sensors let you know what is happening in your environment; speech synthesizers and graphics programs let you communicate with others in the "real" world; and you live on, though your body has died.

So here you are, a couple of months after you've had your operation.

It's now the Labor Day weekend. You've spent most of the summer "convalescing"—not really convalescing in the usual sense, because the operation didn't leave you particularly damaged, but getting used to this new companion in your mind.

You have to wear this portable com-

"Please allow some time in my schedule for grieving."

puter all the time of course. By 20-something the thing is made with quantum-effect devices a hundredth the size of the microchips of the 1990s, so it isn't particularly large or heavy. Still, it's got to be able to hold a lot of information in its data file, so it's as big as say a 1990s laptop.

That doesn't mean it has to *look* like a laptop. The engineers have built the whole thing into a sort of helmet which covers your entire head. Although your children are now in their fifties and sixties, they still remember the old movies they saw in their kindergarten days, their affectionate name for you is "Darth Vader." The helmet does cramp your style a little. You can't swim while you're wearing the helmet, and it's not a good idea to ski or play football—but at your age you've pretty nearly decided to give up the more violent sports anyway. Apart from that, you can do anything you ever did.

No, that's not true. Actually you can do a great deal *more* than you ever did—with your mind, at least—because the companion in the helmet is actually helping out your memory. Baseball? When you and your great-granddaughter watch the Tokyo Mets playing the Vladivostok Dodgers you astonish her by remembering the batting averages of every Mets catcher since 1960. It's all in the data file. Cooking? If your wife thinks of making the chicken-and-wine dish you once had in Paris for dinner, she doesn't have to look up the recipe. You could recite it for her, if you chose—actually, you probably just go ahead and make the dish, though eating any of it when it's done is a little trickier. Business? When you go back to work, your entire corporate financial dossier for the last 50 years is right there in your memory, and you can tell off the top of your head which divisions pulled their weight and which have generally underperformed . . . and even why.

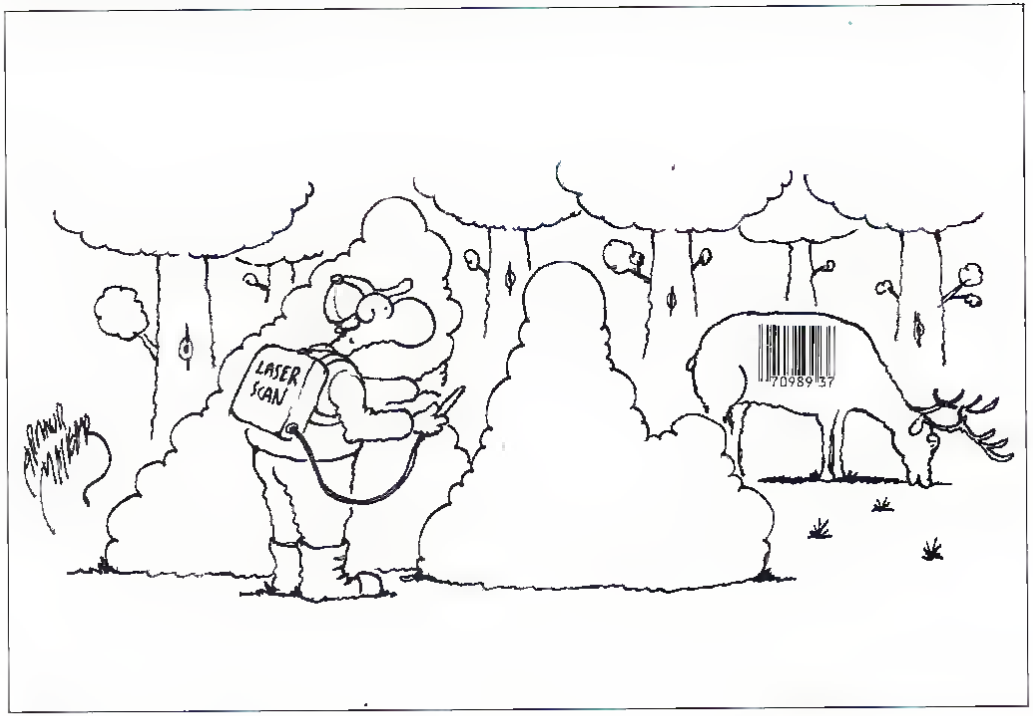
Remember that all this time the computer that sits on your head isn't only teaching you; it's also *learning* you. It learns who your friends are, and what experiences you shared together, and what they mean to you. It learns what music you like to hear, and what sorts of books you like to read, and what plays and films you enjoy. It learns everything you know about your own life, from the first three-year-old birthday party (when you didn't, after all, get the Super Nintendo you had your heart set on) to the last disagreement you had with your wife . . . and how pleasingly you made up afterward. It remembers everything you remember. Likes everything you like, worries about everything that worries you. . . .

It *is* you. And when that demon in your belly at last makes the body you have occupied all these years useless, and the couple of pounds of wetware in your skull has to die . . . *you* live on in the machine.

Do you really call that living, you ask?

Well, what *do* you call living? Is Stephen Hawking alive, for instance?

Hawking is generally acknowledged to be the world's greatest living theoretical physicist, but his body has been all but dead for many years. He is a victim of the disease called ALS—Lou Gehrig's disease—and he cannot even feed himself; worse, a complication a few years ago cost him his voice. But that does not keep Hawking from being a great scientist and a loved human being. It does not prevent him from traveling, or even from lecturing in public, though to be sure he must use a speech synthesizer for the purpose. Since the synthesizer is American made and Hawking is very English, he apologizes for its American accent—but it is still Stephen Hawking speaking. And you, with your advanced hardware and sophisticated software of the next century, can certainly do better than that. You will be able to speak in



your own voice—or to sing—sing as well as you ever did, and if you like much better than ever with the voice of any opera star who ever lived.

But at least Hawking does have a body you argue, although admittedly one in bad repair. When he is speaking through his voice synthesizer people can *see* him, anyway. You won't have even that much, right? Wrong! The mere lack of a body won't keep your friends from seeing you—just as you were, or as much handsomer as you wish. (Push back that receding hairline, smooth out those wrinkles—why not?) All you need for the purpose is a TV monitor. You can be the one who controls the image it shows, and that image can be you, made up out of the data bits your computer mind will generate for you. By then, the image will probably be in 3-D as well. Possibly it could be even physically present as a sort of puppet operated by your computer mind so that it can be touched and embraced.

Well, that's all well enough for your friends, you say, but what about yourself? Can you *feel*? you ask. Can you hear and see and smell? Can you perceive heat and cold? Can you feel the sensation of pain, or the touch of a lover's gentle caress?

Of course you can. It is not your brain that feels or sees any of those things, you know. Your brain can't. It doesn't have the necessary equipment. The brain is blind, deaf, and without sensation. All the brain knows is what the sensory organs of the body tell it, and your machine-stored mind can have all the sensory organs you like: video eyes, microphone ears, transducer sensory to convey the physical sensation of touching. Indeed, that could be only the beginning for you. The machine brain can be equipped with far better sensors than the standard accessory package that comes with the human body, for there are better designs on the market. The human eye, for example, cannot see infrared or ultraviolet (but video cameras can); the ear misses the bat's shrill squeak and the low frequency sounds of nature (but microphones do not); there is no human sense that can pick up radio waves direct, but machines do it all the time—why not be in yourself your own TV set, pocket radio, or even radar?

It's possible, though, that adding new senses might not be a good idea. The brain you were born with had to work hard in order to learn how to interpret all those sensory inputs. There is some evidence that, after a certain point, new kinds of sensory inputs can be emotionally damaging. Young people who have their sight restored at maturity, after having been blind from birth, find the experience disorienting; Dr. Jerome Lettvin of MIT has found that many such people commit suicide.

Of course, your machine brain isn't bound by the same rules as your old organic one. Very possibly a few extra programs could be written in, or a little extra hardware added to your system, and you could then easily enough deal with senses that would allow you to "see" and "feel" anything that any instrument can detect.

All right, you say at last, but that's still not *living*. What about eating? What about the taste of a fine wine? For that matter, what about the buzz you get from a six-pack? And then you get right down to the question that's really on your mind: What about *sex*?

The answer: Don't worry. No problem at all.

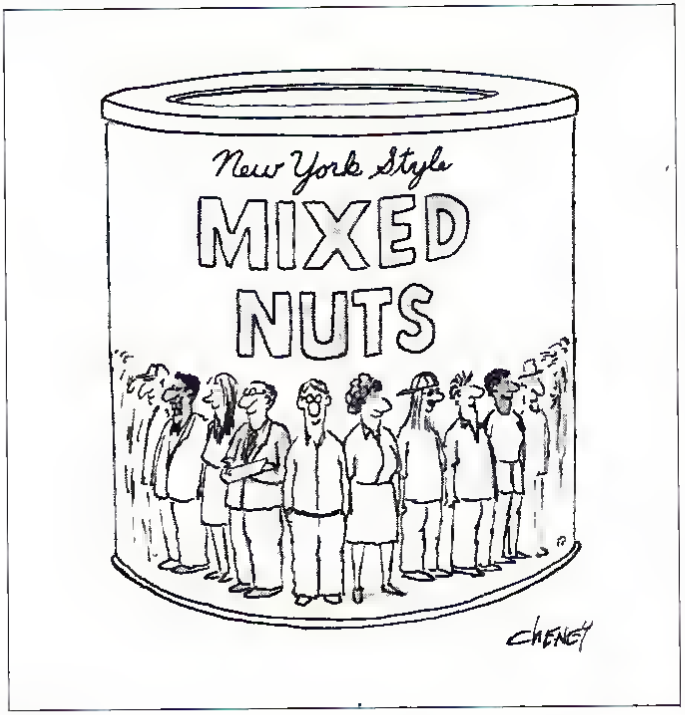
Well, no *theoretical* problem, anyway. Remember the main point. Everything you experience is experienced in the brain. It is the brain that interprets all those sensory inputs, including the pleasures of love-making. Once the eavesdropper in your corpus callosum learns how your brain works, it is only a step or two to reach the point where it can create for you any array of sensual inputs you like, not just sex. Not even just very good sex. *Incredible* sex without such penalties as AIDS or unwanted pregnancy or even the wrath of a jealous lover, since all of it takes place in your mind.

You don't even have to give up your present mate, either. The technical problems of love-making between some collection of data bits stored in a Cray-100 (or whatever) and your flesh-and-blood nearest and dearest are daunting, but that's only temporary. If you are determined to be monogamous you can arrange with your nearest and dearest to join you in machine storage when the times comes. That may not be quick. Your devotion may require a good deal of patience, but then you've got all of eternity.

At least, you have eternity as long as you go on paying your utility bills.

Well, how much "science" is in this particular piece of science fiction?

Quite a lot, actually. That isn't to say that this is something you can count on by the year 2001. It may take longer. It may take *much* longer, because some pretty daunting technical problems are involved. Brain anatomists will tell you that there are important sections of the brain—for instance, the brainstem and the cerebellum—not directly reached by the corpus callosum, perhaps more



connections must be made than we have outlined. Then there is the tricky question of hooking nerves to wires. Nerve impulses are at least partly electrical in nature, but they are also at least partly chemical. It isn't just a matter of taking a soldering iron to the nerve endings in the brain and joining them to an equal number of copper wires. Some sort of interface will be needed, and no one can now say what form it will have to take.

So the mind-transplant procedure has a long way to go to become a mature technology. How long, exactly? Perhaps about as long, say, as computers themselves had to wait in 1945, at the time of the huge, clumsy vacuum-tube things like ENIAC, or as nuclear energy had in 1938, when Hahn and Strassmann first split the uranium atom. But science goes faster these days—largely because of the computer itself, which makes scientists effectively a good deal smarter than their unaided native brains would allow. If the mind-transplant procedure can be done at all, as seems at least theoretically plausible, it is at least a good gambling bet that something like it will be real within the next few computer generations.

By the time you've been back on the job for a few years, you've become fully accustomed to your new existence. You find it's pretty neat; you even wonder why your flesh-and-blood friends put off joining you.

For one thing, you will have a lot more spare time than you ever had before. Your mental life won't be held to the 55-mph speed limit of an organic brain any more. Computer functions go far faster than organic synapses; you can do in seconds what takes your meat friends hours to accomplish.

Fortunately, you're not alone in machine storage. You have machine-stored colleagues and friends to talk with, and relate to, and do things with; they move as fast as you do, and actually you find your "living" colleagues just a little slow and dull.

And the things you do with peers are really a lot of fun. Travel? Why, you can enjoy a simulated Campari on the synthesized Champs Élysees or experience the thrills of skin diving on what your senses tell you is the Great Barrier Reef whenever you like.

You know how this works in advance. When you were a child, you remember, you saw Hollywood films filled with such spectacles as the great spaceships of the Empire and the collapse of cities in earthquakes and nuclear wars. You were aware even then that things had never really happened, but were computer-generated images put together by special-effects firms like George Lucas's Industrial Light & Magic. The same techniques, now brought to perfection, can provide you with any 'surround' you like for your adventures, as real to you as any weekend on the Jersey shore was when you were still in your body of flesh. For that matter, you're not limited to dull reality. You can choose to invent your own fantasy world (Barsoom, or Middle Earth, or the *Arabian Nights*', or the Heechee Universe), and the computer will build it around you, complete with food, drink, and companionship. And you have plenty of time for all this sort of fun. Not only do you do things fast, but you never have to waste any time in sleep.

And, of course, you are better at your job than even your best ever was—better than any flesh-and-blood person ever could be.

For that reason, you're not really surprised when your CEO calls you in just before your one hundredth birthday. She tells you that the compulsory retirement rule has been repealed for machine-stored intelligences.

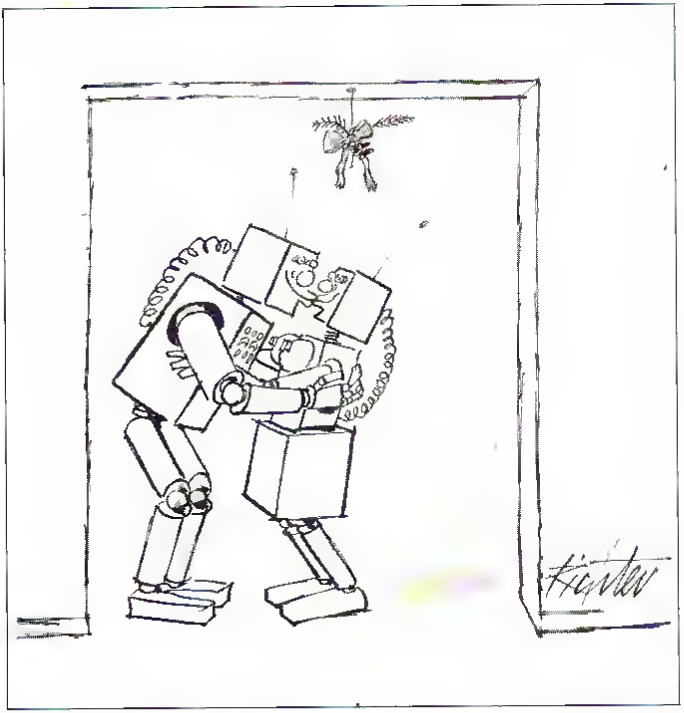
You knew that was coming. When you look at her with your video eyes you feel a little compassion. She's definitely beginning to show her age, and you wish you had been able to persuade her to take the next step to join you.

But, although you like her and sympathize with her, you turn her down.

You've had other offers, you explain. The most interesting has come from NASA. They have a great need for someone like you—several someones like you—for some of the exciting, new long-range space missions they're planning.

After all, living human beings make a lot of trouble for spaceship designers. Flesh-and-blood people need food and air and water; they need to be kept warm (but not too hot!) and shielded from the radiation of solar flares. Worst of all, they sometimes get sick, and it just isn't feasible to include physicians and dentists on a normal space mission. On the other hand, it is certainly worthwhile to try to have the presence of a human being to make the on-the-spot decisions, take care of the unexpected glitches, interpret what is discovered. And in you and your kind they have the perfect astronauts.

So, with regret, you tell your CEO that you'll be leaving the company to start training for your new job, which will be investigating the frozen surface of the planet Pluto. And there you are, with a whole new career, and a whole new life . . . and you're still a youth hardly out of your first century! ◻◻



FICTION
BY JOYCE CAROL OATES

THANKSGIVING

Father spoke quietly
"We'll do the shopping for your mother, the turkey and
all You know she isn't feeling well."
At once I asked, "What's wrong with her?"
I thought I knew Probably. It had been three days now.
But the question was what any
father would have expected of any daughter of thirteen.
My voice too was a thirteen-year-old's
A scrawny sort of voice, drawling, skeptical.

ILLUSTRATIONS
BY JOEL PETER JOHNSON

Father seemed not to hear. Hitched up his trousers, rattled the keys to the pickup as a man does who likes the feel of keys, the noisy rattle. "We'll just do it. We'll surprise her. Then it will be done." He counted on his fingers, smiling. "Thanksgiving is on Thursday, day after tomorrow. We'll surprise her so she can get started early." Yet there was a vagueness in his pebble-colored eyes that moved upon me scarcely seeing me, as if, standing before him, a long-legged skinny girl all elbows and knees and pimples gritty as sand scattered across her forehead, I was no more to him than the horizon of scrub pine a short distance away or the weather-worn fake-beige-brick asphalt siding on our house.

Father nodded, grim and pleased. "Yes. She'll see."

With a sigh he climbed up into the truck on the driver's side, and I climbed up into the truck on the passenger's side. It was just getting dark when he turned on the ignition. You needed to make a quick escape from our place, before the dogs rushed out yammering to be taken along—and sure enough, hearing us slam the truck doors, there came running Foxy, Tiki, Buck, hounds with some terrier blood in them, barking and whining after us. Foxy was my favorite, the one who loved me best, hardly more than a year old but long-bodied and showing her ribs, big wet staring eyes like I'd broken her heart going away without her, but what the hell, you have to go to school without the damn dogs and sometimes to church and sure enough you want to go to town without people smiling at you behind your back, figuring you as a country hick with dogs trailing after. "Go on back!" I yelled at the dogs, but they only yapped and fussed louder, running right alongside the pickup as Father took it out the drive tossing up gravel in our wake. What a racket! I hoped Mother would not hear.

I was feeling guilty, seeing Foxy left behind, so I poked Father, and asked, "Why don't we take them along, in the back?" and Father said, in a voice like he was talking to some fool, "We're going grocery shopping for your mother, where's your sense?"

Now we were out on the road, and Father had the gas pedal pressed down flat. The fenders of the old truck rattled. That weird high vibration started in the dashboard like a cricket none of us could ever find to stop it.

For the longest time, the dogs ran after us, Buck in the lead, and Foxy second. Long ears flailing, tongues out like it was warm weather and not an almost-freezing November day. A strange feeling came over me, hearing the dogs barking like that—loud and anxious as they'd bark if they thought we were never coming back. Like I wanted to laugh, but to cry, too. Like when you're tickled so hard it begins to hurt and whoever's doing it, tickling you, doesn't know the difference.

Not that I was tickled any more, that old. I don't guess I'd been tickled in years.

The dogs fell farther and farther behind, till I couldn't see them any more in the rear-view mirror. Their barking faded, too. Still Father was driving hard. The damn road was so rutted, my teeth rattled in my head. I knew better, though, than to tell Father to slow down, or even switch on his headlights. (Which he did anyway, a few minutes later.) There was a mix of smells about him—tobacco and beer and that harsh-smelling steel-gray soap he used to get the worst of the grease off his hands. And another smell, too, I couldn't name.

Father was saying, like I'd been arguing with him, "Your mother is a good woman. She'll pull out of this."

I didn't like that kind of talk. The age I was, you don't want to hear adults talk about other adults to you. So I made some kind of low, impatient mumble. Not that Father heard, anyway—he wasn't listening.

It was eleven miles to town and once we got on the paved highway Father kept the speedometer needle right at sixty miles per hour. Still, it seemed to take us a long time. Why would it take such a long time? I'd come out without my jacket, just wearing jeans and a plaid wool shirt and boots, so I was shivering. The sky was on fire, behind the foothills and the mountains in the west. We had to drive over the long shaky bridge across the Yewville River that used to scare me so when I was little, I'd shut my eyes tight until we were on solid land. Except now I wouldn't let myself shut my eyes. I was too old for such cowardice.

For the longest time, the dogs ran after us, Buck in the lead, and Foxy second. With long ears flailing, tongues out like it was warm.

I think I knew that something was going to happen. In town, maybe. Or when we returned home.

Father drove straight down the middle of the high wrought-iron vibrating old bridge. Lucky no one was coming in the left lane. I could hear him mumbling to himself, like thinking aloud. "—Coupons? In the drawer? Jesus. Forgot to look." I didn't say a word because it made me mad, either of them talking to themselves in my presence. Like somebody picking his nose not seeing you're there.

(And I knew what Father was talking about, too. Mother kept shopping coupons in a kitchen drawer; she'd never go to the A&P without taking a batch of them along in her purse. Claimed she'd saved hundreds of dollars over the years—! What I'd come to think was, grown-up women liked to fuss clipping coupons out of the newspaper ads or shoving their hands up to the elbows in some giant box of detergent or dog chow to fish out a coupon worth twelve cents. You figure it.)

For Thanksgiving, though, there'd be a lot of food coupons. 'Big savings' on the turkey, plus all the extras. But this year there was nobody in our house to take the time to notice them, let alone cut them out of the ads and file them away.)

Driving to town is driving downhill, mainly. Into the valley. Out of the foothills where it always seemed colder. On the far side of the river Yewville looked squeezed in, steep streets dropping down to the river, flat-looking, almost vertical, at a distance. I was starting to get that nervous feeling I'd get sometimes when we came to town, and I guessed I wasn't dressed right, or didn't look right—my face, my snarly-frizzy hair. Father made a wrong turn off the bridge ramp

before I could stop him so we had to drive through a neighborhood that didn't look familiar, tall narrow row houses built to the sidewalk, some of them boarded up and empty, and not much traffic on the street, here and there, old rusted tireless hulks of cars at the curbs. There was a thickness to the air as of smoke, and a smell of scorch. All that remained of the fiery sunset was a thin crescent in the west, very far away. The night coming on so fast made me shiver more. And there was the A&P but—what had happened? The smell of smoke and scorch was strong here: you could see that the front of the store was blackened and the plate-glass windows that ran the length of it had plywood inserts here and there. The posters advertising special bargains BACON BANANAS TURKEY CRANBERRY MIX EGGS PORTER HOUSE STEAK had begun to peel off the glass and the building itself looked smaller, not as high, as if the roof was sinking in. But there was movement inside. Lights were on, flickering and not very bright, but they were on, and people were inside, shopping.

Father whistled through his teeth. "Well, hell." But pulled into the parking lot. "We'll do it, and get it done." There were only five or six cars in the lot, which looked different from what I remembered—more like raw earth, with weeds growing in cracks, tall thistles. Beyond the parking lot there wasn't anything familiar, no other buildings or houses, just dark. I whispered, "I don't want to go in there, I'm afraid," but Father already had his door open, so I opened mine, too, and jumped down. The smell of smoke and burn was so strong here my nostrils pinched and tears came into my eyes. There was another smell beneath it—wet earth, decomposing matter, garbage.

Grimly, grinning, Father said, "We'll have Thanksgiving like always. Nothing will change that."

The automatic doors were not operating, so we had to open the ENTER door by hand, which took some effort. Inside, cold damp air rushed at us—a smell as of the inside of a refrigerator that hadn't been cleaned in a long time. I stifled an impulse to gag. Father sniffed cautiously. "Well, hell!" he murmured again, as if it was a joke. The rear of the store was darkened, but there were lighted areas near the front where a few shoppers, most of them women, were pushing carts. Of the eight check-out counters, only two were open. The cashiers were women who looked familiar but they appeared older than I'd remembered, white-lipped and frowning.

"Here we go!" Father said with a broad forced smile, extricating a cart from a snarl of carts. "We'll do this in record time."

One of the cart's wheels stuck every few rotations but Father pushed it hard and impatiently in the direction of the brightest-lit part of the store, which happened to be the fresh produce section where Mother always shopped first. How it was changed, though!—most of the bins and counters were bare, and some of them were broken. The aisles were partly blocked by mounds of decaying debris and plywood crates. There were puddles on the floor. Flies buzzed groggily. A flush-faced man in a soiled white uniform, a porkpie hat jaunty on his head declaring, in red letters BARGAIN HOLIDAY BUYS! was snatching heads of lettuce out of a crate and dumping them in a bin so carelessly that some of the heads fell onto the filthy floor at his feet.

> "A plump-faced woman with bright orange lipstick and trembling hands was reaching for one of the last good pumpkins but I snatched it away."

Father pushed our cockeyed cart over to this man, and asked him what the hell had happened here, a fire?—but the man just smiled at him without looking at him, a quick angry smile. "No sir!" he said, shaking his head. "Business as usual!"

Rebutted, Father pushed the cart on. I could see his face reddening.

Of all things, a man hates to be treated rudely by another man in the presence of one of his children.

Father asked me how many people Mother would be cooking for on Thanksgiving, and between us we tried to count. Was it eight? Eleven? Fifteen? I remembered, or thought I remembered, that Mother's older sister was coming this year with her family (husband, five children), but Father said no, they were *not* invited. Father said that Uncle Ryan would be sure to show up like every year, but I told him no, didn't he remember, Uncle Ryan was dead.

Father blinked, and drew his hand over his stubbly jaw, and laughed, his face reddening still more. "Jesus. I guess so."

So we counted, using all our fingers, but couldn't decide. Father said we would have to buy food for the largest number, then, in case they all showed up. Mother would be so upset if something went wrong.

Mother always shopped with a list neatly written in pencil. She'd keep it in plain view in her hand, sending me around the store getting items, up and down the aisles while she followed more slowly behind, getting the rest, examining prices. It was important to examine prices, she said, because they changed from week to week. Some items were on special, and marked down; others were marked up. But a bargain was not a bargain if it was spoiled or rotten, or just on the brink of being so. Suddenly, with no warning, Father gripped my arm. "Did you bring the list?" he asked. I told him no and he pushed at me as a child might do. "Why didn't you!" he said.

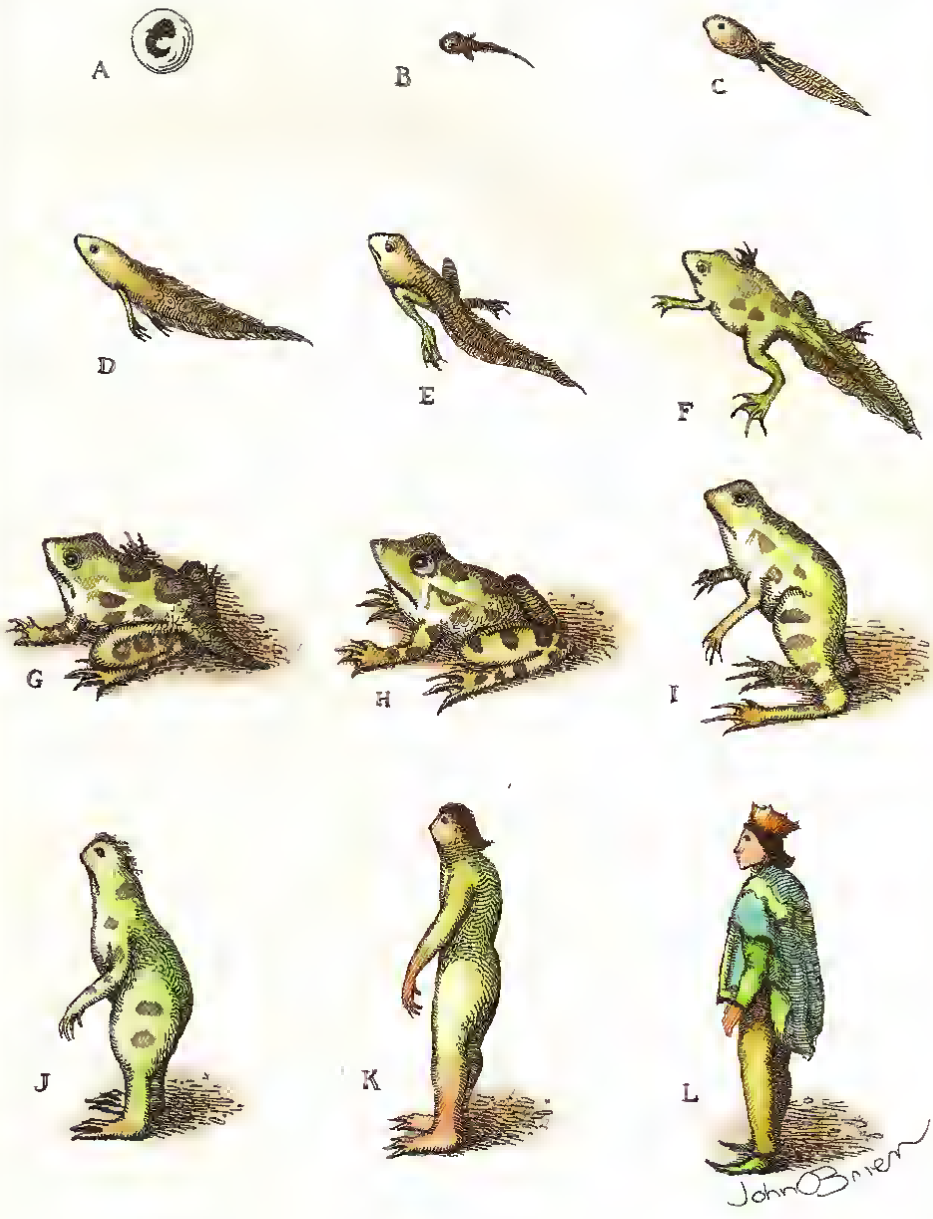
Father's face in the flickering light was oily, smudged. As if, despite the cold, he was sweating inside his clothes.

"I never saw any list," I said, meanly. "I don't know about any damn list."

We had to get lettuce, though, if Mother was going to make a green salad. We had to get potatoes to be mashed, and yams to be baked, and cranberries for the sauce, and a pumpkin for pie, and apples for applesauce; we had to get carrots, lima beans, celery. But the best heads of lettuce I could find were wilted and brown and looked as if insects had been chewing them. "Put them in the cart, and let's get a move on," Father said, wiping his mouth on his sleeve. "I'll tell her it's the goddamned best we could do." Then he sent me running around, slipping on the wet, puddled floor, trying to find a dozen decent potatoes in a bin of mostly blackened ones, a pumpkin that wasn't soft and beginning to stink, apples that weren't wizened and wormy.

A plump-faced woman with bright orange lipstick and trembling hands was reaching for one of the last good pumpkins but I slipped in under her arm and snatched it away. Open-mouthed, the woman turned to stare at me. Did she know me? Did she know Mother? I pretended not to notice, and hauled the pumpkin to our cart.

The rear of the fresh-produce section was blocked off because part of the floor had collapsed, so we had to turn around and retrace our route. Father cursed the grocery cart, which was sticking worse. What else did Mother need? Vinegar, flour, cooking oil, sug-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John O'Brien

ar salt? Bread tor the turkey stuffing? I shut my eyes tight trying to envision our kitchen the inside of the refrigerator that needed cleaning, the cupboard shelves where ants scurried in the dark They were empty weren t they, or nearly—it had been many days since Mother had shopped last But the quavering lights of the A&P were distracting A sound of dripping close by And Father speaking to me his voice loud '—This aisle? Anything? We need—' His breath was expelled in short steaming pants He squinted into the semidarkness where the way was partly blocked by stacks of cartons spilling cans and packages

I told Father 'I don't want to ' and Father told me, 'Mother is counting on you girl,' and I heard myself sobbing an angry-ugly sound "Mother is counting on *you*" But he gave me a nudge and off I went slip-sliding on the floor where water lay in pools two or three inches deep My breath was steaming, too I groped quickly for things on the shelves anything we might need Mother would want canned applesauce since we wouldn't be bringing her fresh apples yes and maybe creamed corn, too, maybe canned spinach? Beets? Pineapple? Green beans? And there on a nearly empty shelf were cans of tuna fish, bloated and leaking giving off a powerful stink—maybe I should take a few of these too for next week? And a big can of Campbell s pork and beans—that Father loved

"Hurry up! What s wrong! We haven t got all night" Father was calling at me through cupped hands, from the far end of the aisle I gathered up the canned goods as best as I could hugging them to my chest but some fell, I had to stoop to pick them up out of the smelly water "Goddamn you girl! I said hurry *up!*" I could hear the tear in Father's voice, that I had never heard before

Shivering I ran back to Father and dropped the cans in the cart, and we pushed forward

The next aisle was darkened and partly blocked by loosely strung twine — there was a gaping hole in the floor about the size of a full-grown horse Overhead part of the ceiling was missing, too You could look up into the interior of the roof at the exposed girders Rust-colored drops of water fell from the girders, heavy as buckshot Here were fairly well-stocked shelves of detergent, dish-washing soap, toilet cleanser, aerosol insect sprays, ant traps A woman in a green windbreaker was reaching beyond the blocked-off area to try to get a box of something, teetering on the edge of the hole, but her reach wasn t long enough she had to give up I hoped that Father wouldn't make me go down that aisle but, yes he was pointing he was determined—'She'll want soap I guess for dishes, laundry, go on'—so I knew I hadn't any choice I slid along sideways as best I could around the edge of the hole, one foot and then the other trying to make myself skinnier than I was not daring to breathe The rust-colored drops fell in my hair, on my face and hands *Don t look down Don t* I leaned over as far as I could stretching my arm, my fingers reaching for a box of detergent There was regular, economy, giant jumbo jumbo-giant, I took the economy because it was closest at hand and not too heavy Though it *was* heavy

I managed to get a box of dish washing soap too and made my way back

> "Father cursed me and slapped me again, on the mouth this time I rocked back on my heels and tasted blood."

to Father who stood leaning against the cart, pressing a hand against his chest where he'd opened his jacket. I was clumsy dropping the detergent in to the cart so it broke, and a fine silvery acid-smelling powder spilled out onto the lettuce Father cursed me and cuffed me so hard on the side of the head my ear rang and I wondered if my eardrum had broken Tears flooded into my eyes but I'd be damned if I'd cry

I wiped my face on my shirt sleeve and whispered, "She doesn t want any of this shit You know what she wants"

Father slapped me again, on the mouth this time I rocked back on my heels and tasted blood "*You're* the little shit," he said furious

Father gave the cockeyed cart an angry push, and it lurched forward on three wheels, the fourth wheel was permanently stuck I wiped my face again and followed after thinking what choice did I have, Mother *was* counting on me, maybe If she was counting on anyone at all

Next was flour sugar salt And next, bakery products where the shelves were mainly empty but on the floor, a few loaves of bread were lying, soggy from the wet Father grunted in resignation and we picked them up and dropped them in the cart

Next then was the dairy-products section where a strong smell of spoiled milk and rancid butter prevailed Father stared at pools of milk underfoot his mouth worked, but he couldn t speak I held my nose and plunged in gathering up whatever I could find that wasn't spoiled, or anyway wasn t spoiled too badly Mother would need milk yes and cream yes and butter and lard And eggs We didn t raise chickens any longer a chicken-flu had carried them all away the previous winter, so we needed eggs yes but I couldn t find a carton of one dozen eggs that was whole I squatted on my haunches breathing in little steamy spurts examining eggs taking a good egg, or anyway what looked like a good egg, from one carton and putting it in another I wanted at least twelve and this took time and Father was standing a few yards away so nervous waiting I could hear him talking to himself but not his actual words I hoped Father was not praying It would have made me disgusted to hear The age I was you don t want to hear any adult let alone our father yes and your mother maybe most of all your mother praying aloud to God to help them because you know, when you hear such a prayer there won t be any help

Next to the dairy products was the frozen-food section where it looked as if some giant had smashed things down under his boot The insides of the refrigerating units were exposed and twisted and gave off an ammonia-like stink A young mother fattish, tears on her cheeks three small children in tow, was searching through mounds of frozen-food packages ice cream packages while the children fretted and bawled The cartons of ice cream were mainly melted, flat The frozen-food dinners must have been thawed Yet the young mother was stooped over the packages fussing and picking among them, sobbing quietly I wondered should I look too—we all liked ice cream and the freezer at home was empty The ice-cream cartons lay in pools of melted ice cream amid something black that seemed to be quivering and seething like rippling oil I went to look closer, nudged a quart of raspberry ripple ice cream with my toot and saw underneath a shiny scuttling of cockroaches The young mother panting, snatched up a carton of chocolate-chip ice cream, shaking off

THE LUMMI UMBILICAL CORD.

Canoe makers of the Lummi tribe have a ceremony for cutting the tree, one for moving the log, several for carving it, and another that begins when the war canoe slides into the water and doesn't end until it is carried out. A ceremony forces the Lummi to consider what they're doing to the earth, how their actions will affect the next seven generations. They believe a ceremony is like an umbilical cord to Mother Earth, and only a foolish person would ever cut that cord. Please give to the American Indian College Fund and help save a culture that could save ours.

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cockroaches, with a sound of disgust, but she put the carton in her shopping cart, along with some others. She looked at me, and smiled, the kind of helpless-angry smile that means, What can you do? I grinned back at her wiping my sticky hands on my jeans. But I didn't want any of the ice cream, thank you. Father hissed impatiently, "Come on!" He was shifting his weight from one leg to the other, like he had to go to the bathroom.

So I brought the dairy things back best as I could, and put them in our cart, which was getting filled at last.

Next, the meat department. Where we had to get our Thanksgiving turkey, if we were going to have a real Thanksgiving. This section, like the frozen-foods section, seemed to have been badly damaged. The counters spilled out onto the floor in a mess of twisted metal, broken glass, and spoiling meat—I saw chicken carcasses, coils of sausage like snakes, fat-marbled steaks oozing blood. Here too the smell was overwhelming. Here too roaches were scuttling about. Yet the butcher in his white uniform stood behind the remains of a glass counter, handing over a bloody package of meat to a woman with carrot-red hair and no eyebrows, a high school friend of Mother's whose name I did not know, who made a fool of herself, thanking him so profusely. Father was the next customer, so he stepped up to the counter, asking in a loud voice where was the turkey, and the butcher smirked at him as if he'd asked a fool question, and Father said, louder yet, "Mister, we'd like a good-sized bird, twenty pounds at least. My wife—" The butcher was the store's regular butcher, familiar to me, yet changed: a tall, cadaverous man with sunken cheeks, part of his jaw missing, a single beady eye bright with derision. His uniform was filthy with blood, and he too wore a jaunty porkpie hat with red letters proclaiming BARGAIN HOLIDAY BUYS!

"Turkey's all gone," the butcher said meanly, with satisfaction, "—except what's left back in the freezer." He pointed to a wall, beyond a smashed meat counter, where there was a gaping hole, a kind of tunnel. "You want to climb in there and get it, mister, you're welcome to it." Father stared at the hole and worked his mouth but no sound came. I crouched, pinching my nostrils shut with my fingers, and tried to see inside where it was shadowy and dripping, and there were things (slabs of meat? carcasses?) lying on a glistening floor, and something, or someone, moving.

Father's face was dead-white and his eyes had shrunk in their sockets. He didn't speak, and I didn't speak, but we both knew he couldn't squeeze through a hole that size, even if he tried. Even I would have difficulty.

So I drew a breath, and I said, to Father, "Okay. I'll get the damn old turkey." Screwing up my face like a little kid to hide how frightened I was, so he needn't know.

I stepped over some debris and broken glass, got down on my hands and knees—ugh! in that smelly mess!—and poked my head inside the opening. My heart was beating so hard I couldn't get my breath, and it scared me to think that I might faint, like Mother. But at the same time I knew I wasn't the kind of girl to faint. I'm strong.

The opening was like a tunnel into a cave, how large the cave was you couldn't see because the edges dissolved out into darkness. The ceiling was low, though, only a few inches above my head. Underfoot were puddles of bloody waste, animal heads, skins, intestines, but also whole sides of beef, parts of a butchered pig, slabs of bacon, blood-stippled turkey carcasses, heads off, necks showing gristle and startlingly white raw bone. I thought that I would vomit, but I managed to control myself. There was one other shopper in here, a woman. Mother's age with steely gray hair in a bun, a good cloth coat with a fur collar and the coat's hem was trailing in the mess, but the woman didn't seem to notice. She examined one turkey, rejected it, and examined another, rejected that and examined another, finally settling upon a hefty bird which, with a look of grim triumph, she dragged back through the hole. Which left me alone in the cave, shaky, sickish but excited. I could make out only three or four turkey carcasses remaining. I tried to sniff them, wondering were they beginning to go bad? Was one of them still fresh enough to be eaten?—squatting in bloody waste to my ankles. All my life that I could remember up to then, helping Mother in the kitchen, I'd been repulsed by the sight of turkey or chicken carcasses in the sink, the scrawny, headless necks, the loose-seeming, pale-pimpled skin, the scaly, clawy feet. And the smell of them, the unmistakable smell.

> "Underfoot were puddles of bloody waste, animal heads, skins, intestines, startlingly white bone—I thought that I would vomit."

Spooning stuffing rich with spices into the bird's scooped-out body, sewing the hole shut, basting with melted fat, roasting. As dead-clammy meat turns to edible meat. As revulsion turns to appetite.

How is it possible you ask, the answer is it *is* possible.

The answer is it *is*.

The smells in the cave were so strong, I couldn't really judge which turkey was fresher than the others so I chose the biggest bird remaining, a twenty-pound bird at least, panting now, half-sobbing with effort I dragged it to the opening, shoved it through, and crawled after it myself. The lights in the store that had seemed dim before seemed now bright, and there was Father standing close by, hunched over the grocery cart waiting for me, his mouth agape, a twitchy smile at the corners of his lips. He was so surprised at something, the size of the turkey maybe, or just the fact of it, the fact that I'd done what I'd done, blinking up grinning at him, wiping my filthy hands on my jeans as I stood to my full height, he couldn't even speak at first, and was slow to help me lift the turkey into the cart.

Then, weakly, he said, "Well, *hell!*"

The store was darkening, only one cashier remained to ring up our purchases. Outside it was very dark, no moon, and a light snow falling, the first snowfall of the year. Father carried the heavier grocery bags, I carried the lighter, to the truck, where we placed them in the rear, and dragged a tarpaulin over them. Father was breathing harshly, his face still unnaturally white, so I wasn't surprised when he told me he wasn't feeling all that good and maybe shouldn't drive home. This was the first time ever I'd been a witness to any adult saying any such thing, but somehow I wasn't surprised, and when Father gave me the key to the ignition I liked the feel of it in my hand. We climbed up into the truck, Father in the passenger's seat, pressing his fist against his chest, me in the driver's seat, behind the high wheel. I was only just tall enough to see over the wheel and the hood. I'd never driven any vehicle before, but I'd watched them, him and her, over the years. So I knew how. ∞

DENNIS MUREN

INTERVIEW

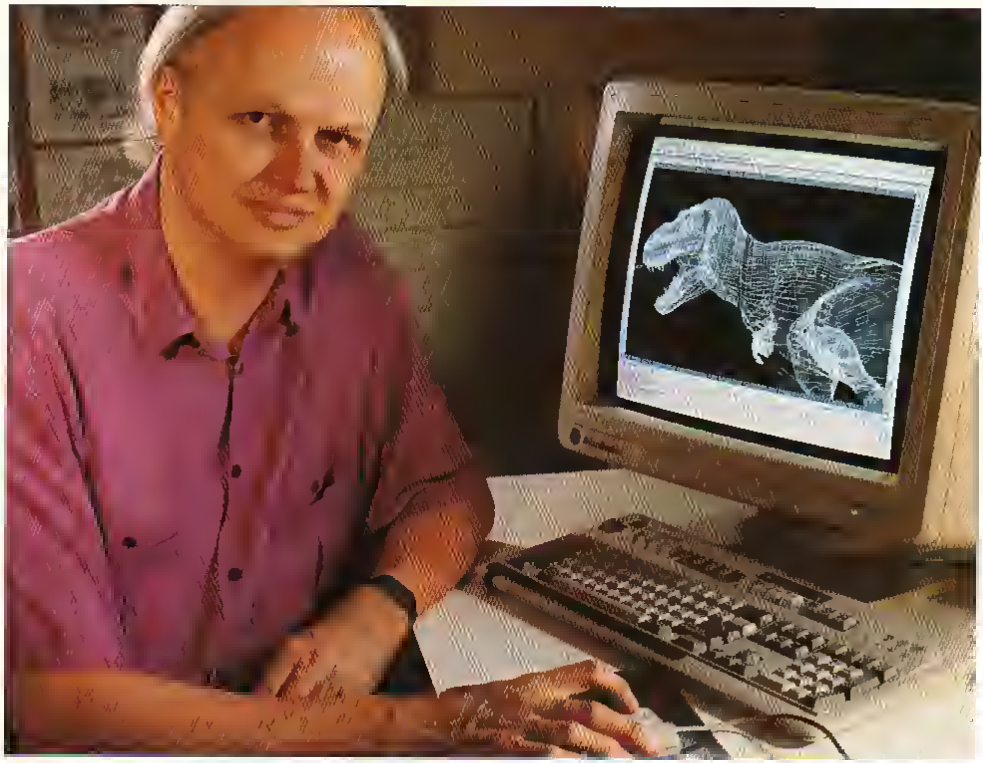
THE SENIOR VISUAL-EFFECTS SUPERVISOR OF INDUSTRIAL LIGHT & MAGIC TELLS HOW HE EXPLODED THE BOUNDARIES OF CINEMATIC ILLUSION, AND WHY.

PHOTOGRAPHS BY SEAN CASEY

Sex in the cinema sells, but seven of ten all-time box-office champs are films chockablock-buster with special effects (FX). And the mother of all FX shops is Industrial Light & Magic (ILM), the people who brought you the *Star Wars* trilogy the watery pseudopod of *The Abyss*, the melting, morting T-1000 of *Terminator 2*, and the prehistoric stars of *Jurassic Park*.

ILM is the crown jewel of LucasArts Digital Services, namesake of George Lucas, the 50-something movie magnate of San Rafael, California. And if George is King Arthur, then his Merlin is Dennis Muren, 46, senior visual-effects supervisor of ILM. Soft-spoken, lanky, and loyal, Muren has kept ILM on the cutting edge of FX technology since 1978. His current mission is to bring his talented work force up to speed on the new tools of the trade: Macintosh computers and Silicon Graphics workstations.

Born and raised in suburban Los Angeles, Muren has been making movies since he was 6. Armed with a progression of cameras, he and his boyhood friends, including Oscar-winning make-up artist Rick Baker, devised and shot homespun effects involving spaceships and dinosaurs. Muren never thought his passion wage-worthy, and to this day, despite seven Oscars for best visual effects, still fears having to get a real job!



After majoring in business at Pasadena City College and California State University, Muren freelanced as a camera operator and effects supervisor from 1969 to 1975. He helped produce several educational films and honed his skills in stop-motion photography on Pillsbury Doughboy commercials. In 1975, Muren joined up with Lucas, who was contemplating a little space film called *Star Wars*. Muren, tired of life outside the studio system, wanted in.

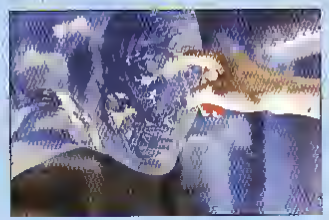
Working with effects legends John Dykstra and Richard Edlund, he learned motion-control photography, whereby the motion of cameras and models (spaceships, asteroids, and so on) can be precisely duplicated by computer-controlled servomotors. This enables filmmakers to shoot pass after pass of the same action, each pass containing a different image or element. Later, the layers of film are composited in an optical printer, and *voila!*—the *Millennium Falcon* slashes into a dog fight with the batwing fliers of the Death Star.

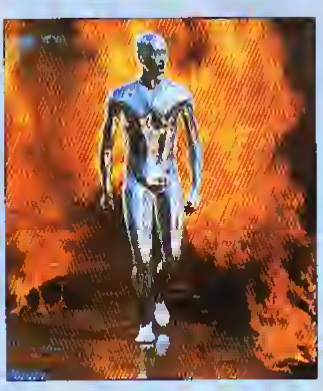
While *Star Wars*' effects were groundbreaking in 1976, Muren and company didn't feel they'd mastered motion-control technology until 1978. Then they were off and running, pushing the FX envelope with *The Empire Strikes Back*, *E.T.*, *Return of the Jedi*, *Indiana Jones and the Temple of Doom*, and some Disneyland attractions. *Young Sherlock Holmes* in 1985 marked ILM's computer graphics (CG) debut: a humble yet significant part of the movie's special effects. Three years later, the FX highlight of *Willow* was the computer-generated shape-changing or "morfing" effect. By 1989's *Ghostbusters II* and *The Abyss*, Muren knew that computer graphics were the FX wave of the future—and he needed to learn how to surf. He took a year off from ILM to teach himself the gospel according to Macintosh. "After I'd figured out *Photoshop* at home [CG software written by ILM's John Knoll], I felt it was worth either doing it or shutting up about it. *Terminator 2*," he recalls, "was the time to try it."

T2 trumpeted the arrival of the digital revolution in the FX business, winning Muren his seventh Oscar, but more important, restoring his passion for special effects. Having taken traditional effects technology as far as it could go, he needed the challenge of the new. With the record-breaking success of *Jurassic Park*, not only is the challenge met, the audience is screaming for more.

Like most effects shops I've visited, ILM is housed in nondescript buildings in an industrial park, in part, I'm sure, for economic and security reasons. But perhaps, too, to give the imagineers a blue-collar sense of their daily toil ("Hi-ho, hi-ho, it's off to *Jurassic Park* we go"). While Muren was busy making a business pitch, publicist Miles Perkins showed me around the warren of shops and offices. I was astounded by the sheer number of "the Greatest Movie Icons of the Past 20 Years" casually strewn about waiting rooms and model shops, draped from rafters, livening up the cafeteria—E.T., Darth Vader,

FX GLOSSARY





COMPOSITE: A shot produced by two or more separately filmed elements that have been optically combined.

OPTICAL PRINTER: A device in which all the film elements are composited into a single image.

MATTE: A painted background composited and filmed with characters and action.

STOP-MOTION ANIMATION: A method for creating the illusion that an object can move of its own accord. This is achieved by focusing the camera on the object, exposing one frame, moving the object a short distance, exposing another frame, and so on.

GO-MOTION: A refinement of stop-motion in which animated miniatures are subjected to electronic control that permits them to be in motion while the camera shutter is open, thus creating a natural blur of motion.

RAY HARRYHAUSEN: The master of stop-motion, in movies such as *The 7th Voyage of Sinbad*, *Jason and the Argonauts*, and *It Came From Beneath the Sea*.

MOTION CONTROL: A system that permits the camera to be programmed to repeat elaborate moves with great precision.

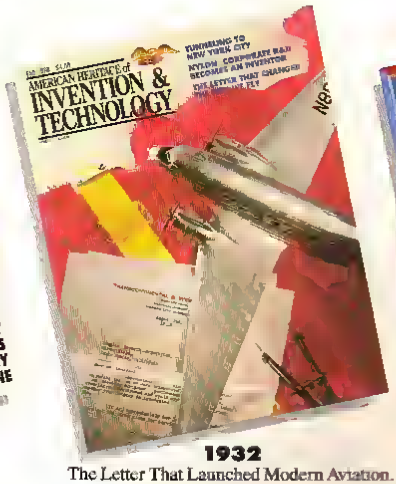
INPUT SCANNER: A device for digitizing photographs specifically, one for creating digital images, pictures represented numerically to allow processing by computer.

LASER SCANNER: A device for digitizing objects or persons topographically to create accurate three-dimensional models in digital space.

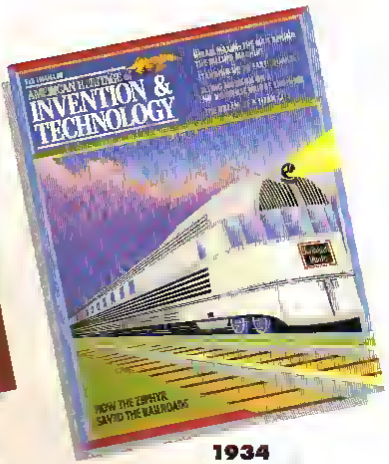
ROTOSCOPE: A technique in which individual frames, characters, or elements of a movie are blown up and traced one at a time onto animation cels.

COME BACK TO THE FUTURE

1874
World's "First Word Processor"

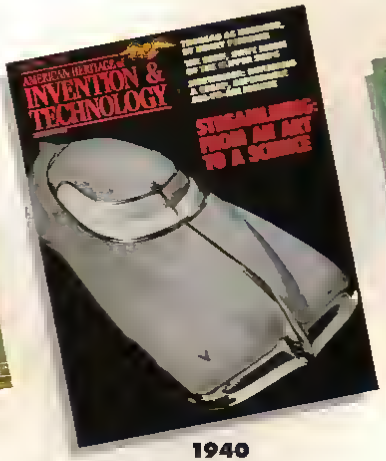


1932
The Letter That Launched Modern Aviation.



1934
The Diesel Revolution

1939
Building the Hydroelectric Future



1940
Rolling Ahead to Tomorrow.

1949
Time for the Atom.

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C-3PO, the "Rocketeer" zeppelin, Hook's hook, even the mechanical head of Howard the Duck!

—Bill Moseley

Editor's note: No stranger to filmland, interviewer Moseley can be seen in such classics as Chain Saw Massacre II, Crash and Burn, *and* White Fang *and is embarking on a rock-n-roll career as "Onions the Scarecrow" in Buckethead's debut LP.*

Omni: Most film work is in Los Angeles. Does being up here in San Rafael limit your business?

Muren: For a lot of our work people don't need to come up here. Setting up a direct fiber-optic link, I can show Steven Spielberg in L.A. our dailies on video by shuttling the tape of our shot back and forth with a pointer at the screen, talking to him live. Ninety-five percent of his comments to us are from watching video. In five years, when everyone gets linked, there may not be any point in someone going from Burbank into Hollywood, let alone San Rafael. With teleconferencing you can bring people together who are 8,000 miles apart or on different floors of the same building.

Being in a visual medium, we can do much of that work over fiber-optic lines. When Steven was in Poland doing *Schindler's List*, we bounced signals off a few satellites because we needed a quick response from him on our work for *Jurassic Park*. He sees it with a half-second delay—we're using the same technology as CNN. In this business, when you're describing images, characters and emotions, words fail. It's best to start with an image we can both see simultaneously. If Steven says this part doesn't work, we can isolate that half second. If he says something in one frame doesn't work, we can go in there with the pointer and see what he's talking about.

There are TV monitors at each end of the fiber-optic line, plus I've got a tape deck with a little mouse attached, the cursor on the screen. Steven's there, we're here, and there's a tiny picture of us in the bottom of the frame. Steven sees our faces below the image. That makes for more of a relationship between us. It's not just a voice and a video being shuttled back and forth. Now Steven wants a camera on him so we can see his expression when he sees our stuff.

Omni: Was it harder creating dinosaurs for *Jurassic Park* than the liquid metal T-1000 robots in *Terminator 2*?

Muren: When we started *Jurassic*, I looked at other companies' CG work and nothing came even close to what we needed. I didn't know if we could do it. Early on, Steven planned to do many of the effects with the full-sized mechanical dinosaurs Stan Winston made. But there are limitations to the amount of motion you can get with big machines. If they did move like real dinosaurs, you'd see them all over the place. They'd be used to walk over freeways and pick up crippled cars. Those machines haven't been built because, being so heavy, they'd tear themselves apart. They're dangerous.

Steven wanted traditional effects for the shots that were impossible with full-sized dinosaurs. For shots of running animals, shots where you see the whole animal, shots where the animal's performance is too much for ten puppeteers to act in sync, he expected to use stop-motion [actually go-motion] with rubber animals. Such shots are very hard with robotic characters, but you can do

> "If big machines moved like real dinosaurs, they'd walk over freeways and rescue crippled cars. They'd be so heavy, they'd tear themselves apart. They're dangerous."

them with one stop-motion animator working on each shot for a day. Part of the brilliance of Ray Harryhausen's work—which is my inspiration—is for all the staccato movement of his stop-motion effects, his creatures all have a sense of being. The performance, the pantomime, is what grabbed me more than the technical polish. Without that performance, it's just moving figures you don't care about.

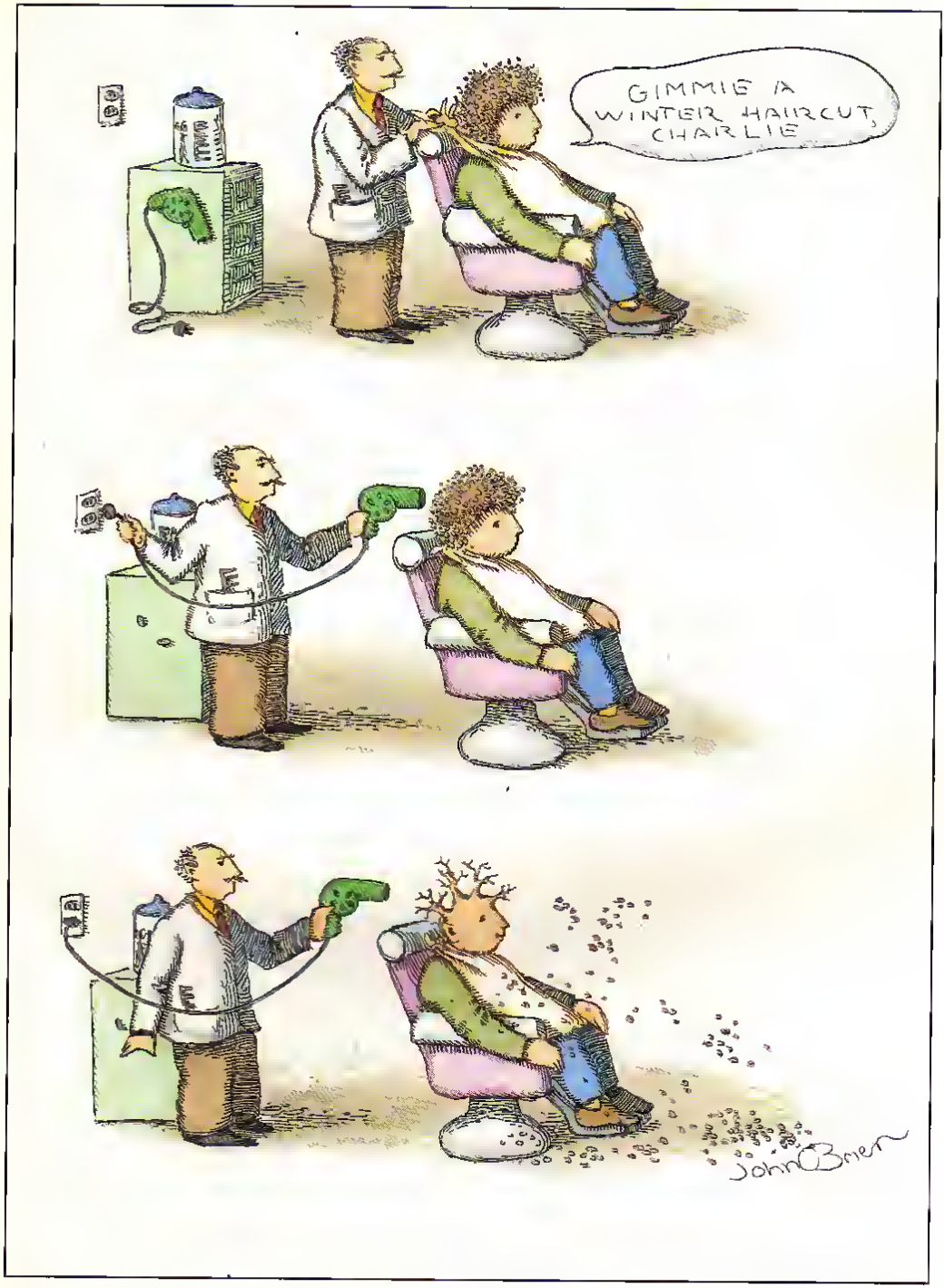
Steven wanted stampede or herd scenes but didn't know how to make them look any better than the old *Lost World*. Well, one thing our computers can do well is replicate images. In one test, we made a skeleton of a gallimimus dinosaur, then eight copies, then we shrunk the skeleton down and made babies. Altogether we had 11: eight adults, three babies. We took a photograph from a book, digitized it, and used it for background. In an animation—run—cycle, we put in one animal. It was just a skeleton at this point, not even a skinned animal. We replicated the animal for each cycle, then staggered the cycles. We rendered the animation from the perspective of the picture in the book: a view looking down on a valley. A second picture from another book looked out over a prairie similar to the area in the first picture. So we rendered the same action; this one bit of animation replicated it over all these cycles, viewed it two different times from two different places, and combined it with the backgrounds on videotape. It looked great, the motions were fluid. And Steven went nuts over our demonstrations.

We wanted to know if we could do something with the *Tyrannosaurus*. We did a little test with it and this time going from videotape up to film. All this time I'm wondering, where's the wall in this technology? The wall has got to be here somewhere. I hadn't found it yet. But I'd never seen this stuff on screen. No one had ever done this before. I was very cautious about claiming success. We shot an "empty plate" on Lucas Valley Road with a Nikon still camera and then computerized this background and added a computer generated *T. rex* walking down the road. It looked great and everybody went nuts. Amblin [Amblin Entertainment, Spielberg's production company] gave us some money to finish the *T. rex* and make it look real. The show jumped from stop- and go-motion to computer graphics plus the full-sized dinosaur models. The older technology went out; the new technology came in.

Omni: Are the full-sized dinosaurs the reality that sells the computer graphics?

Muren: Yes. Some model makers think that they're going to be out of business soon thanks to computer graphics. That's crazy. It's still 70 percent models, 30 percent CG. The advantage of a full-sized head over a computer-generated one is that it gives you eight different camera angles, eight shots in one day. You also want full-sized props for actors to interact with.

What does infringe on model makers' territory is performance. You can do a better performance with CG where one person defines what the performance is. He doesn't have to do it in realtime or on a set with a director and crew of 150 people waiting for him. It all comes down to performance. Without performance, the focus of the animal can't look real. It shouldn't look like it's an accident, like the head was sheeted, like you put these little pieces together. Then you may have a story, but not a performance. The relationship between model makers and CG people is a partnership. What was so exciting on *JP* was how well we managed to get a performance out of a computer, which


GIMMIE A WINTER HAIRCUT, CHARLIE
John Boren

hasn't the slightest idea how to perform. People were doing it.

Everyone in the film business is currently going nuts over computers. What distinguishes the good from the great computer-graphics people might be in the code of the software they write, the skill of the guy moving his mouse, what menus to bring up, how to use this incredibly complicated software/hardware combination. There's a new breed of artist now. They've had a few years to learn the tools of the trade, and that skill shows up on *Jurassic Park*.

Omni: When you recruit, do you look for computer jocks with an artistic bent or artists who use computers?

Muren: Both. We've gotten most of our hotshot programmers and technical directors from Siggraph, the computer-graphics conference held every year. Animators are a different story. You can find people who call themselves animators, but they're really only accustomed to moving logos around, products around table tops. Don't get me wrong; that's an important form of animation. You can use it for flying spaceships around, but it wasn't the character animation we needed for *Jurassic*. We were trying to create life, with all its complexity and subtlety of motion—68 body parts moving in synchrony.

We recruited a really good cartoon animator who'd worked on the *Duck Tales* TV series. He had a background in computers and was a stop-motion animator. We look for the intent. A person already comes with the intent and needs to learn the tool. The other group are guys who know the tool but have to learn how the animal should move. It's difficult for the noncomputer people to figure out the software; it'll get easier over time. Right now, there's such a growth in the perceived need for these people that many companies are opening up. A lot of raiding's going on, yet I'm not so sure this market is as big as people think—certainly not in films. There is some new business at theme parks, but everybody's thinking multimedia's going to explode.

Omni: What is this "wall" you mentioned anticipating in *JP* and *T2*?

Muren: It hasn't happened. Going into *JP* we didn't know if we could move the skin over the dinosaurs' bones without tearing it apart when they moved, like computer skin has in the past. Remember, you're dealing with geometry that can't quite figure out where it's supposed to be, so you get errors like tears. It's not magic, where one thing works for every shot; it's on a shot-by-shot basis. A human being is deciding how that dinosaur should move. We don't have it automated, because then we'd have to create the intelligence to figure out what body parts should slide where. We didn't have the horsepower or start-up time to get into moving animals and skin, the "smart model" approach. My background is in filmmaking. I'm used to going frame-by-frame and fixing things, taking my way through the shot if I have to. We deal with little pieces of time. Getting through our three-and-a-half seconds, that's all that matters, one shot.

Omni: The shots are so brief because you want to stay ahead of the audience, wow 'em before they can figure it out?

Muren: Sure. It's a cumulative whole. You recall a sequence from a movie as being one shot when it wasn't. It was made up of a lot of little pieces. I remember the opening of *Bonnie and Clyde* as one long, continuous shot when Bonnie comes down a series of stairs and first sees Clyde. When I saw it again, I realized that it was 23 cuts! It was way overcut because they were trying for style. It's amazing what your mind can do to fill in that stuff.

> "As a kid, Ray Harryhausen's work thrilled me, because for all the staccato movement of his stop-motion effects, his creatures all have performance, have a sense of being."

So many effects sequences are made that way because there's no other way. Now, when you do the T-1000 going through the [prison] bars with no cuts, everybody gasps. No one has ever seen anything like it before. The opening shot of the spaceship going over in *Star Wars* is a minute and a half. *JP* has shots of people walking up to a giant dinosaur in broad daylight that run over 20 seconds. No cuts. And the camera is dollying along, too. Every so-called "rule of effects" is out the window. I like to push things.

Omni: How did you get started in the effects business?

Muren: I saw Ray Harryhausen movies and *King Kong*, every release of American International Pictures in the Fifties. When I was 6, I got a still camera and began shooting dinosaurs and spaceships. At 10, I used a little Keystone eight-millimeter camera to shoot movies, moving things through the frame in stop-motion. I had to push it to stop every three frames. The film would come out all jerky, but it was still exciting. Next I moved up to an eight-millimeter that you could view through the lens, no more parallax problems. It actually shot one frame of film at a time, a breakthrough. And it could rewind!

When I was 14, my parents bought me a 16-millimeter Bolex for $600. Their encouragement was very important in helping me get where I am today. My parents didn't know what I was doing. I didn't know what I was doing. This was in Los Angeles. There was no community, just three or four kids going to each other's houses and shooting film—not trying to tell a story or anything, just these screwy effects. I didn't think it would amount to anything.

In the Fifties, all the major studios except for Fox and Disney closed their effects departments. And Fox and Disney had strict rules about what you could and couldn't do. I did it all, so I never thought they would be places I'd work. I didn't think of effects as a career. I still don't; it's more like a hobby.

Omni: How do you classify yourself?

Muren: Others see me as a visionary. I don't. I see myself as a worker. I push the technology, but I also push the vision within the context of the director's vision. I don't feel the need to own 100 percent of the concept. If I did, then I'd need to hire someone to do what I do, and I want to do that.

Omni: How did you hook up with George Lucas?

Muren: I saw his documentary, *The Rain People*, years ago at the Academy in L.A. where Francis Coppola talked a little about George. I'd seen *American Graffiti* and *THX 1138*, which I thought was a great film. I'd done a couple of space films in 16 millimeter and some commercials. I didn't want to join up with the union, but all the big shows were union shows. I heard that George was going to produce this space film [*Star Wars*]. At that time, three effects films had come out: *Island at the Top of the World*, *Earthquake*, and *Towering Inferno*. I really wanted to be on the inside, to see what these big Hollywood shows were like. If I didn't like it, I'd get out.

John Dykstra was doing the effects on *Star Wars*. Either he or Doug Trumbull came up with the idea of the motion-control system, to vary the speed on all cameras with stepper motors. The stepper motor is a machine tool that moves mils [1/1000th inch]. In movies, you can use it to move cameras. The motor has a shaft that moves an exact amount by

CONTINUED ON PAGE 114

ANTIMATTER

UFO UPDATE:
UFO refuseniks: Alien abductees are fighting back—and winning

Here's the scenario: You wake up in the middle of the night with the vague feeling that something is wrong. You try to move, but can't, and are shocked to find two gray humanoids at the side of your bed. UFO researchers would say an abduction is in progress. Should you—could you—resist? According to some students of abduction, it's up to you.

Ann Druffel, a California investigator and coauthor of *Tujunga Canyon Contacts,* says she has begun a catalog of cases in which people resisted and now has nine techniques for those who, when faced with alien peril, want to fight back. "Some bedroom abductions begin with a high-pitched sound signaling the abductors' approach, followed by bodily paralysis," Druffel explains. "Once you recognize the signs, you might gear yourself up for thwarting alien attack."

The first technique, mental struggle, seems deceptively obvious, notes Druffel, but for those without a sense of inner strength, it may fail. The prospective "abductee" can figuratively "put his or her foot down" and mentally "just say no." As the abductee continues to mentally resist, the person will be able to move some body part, according to Druffel. "Move a finger or even a toe," she says, "and the shrill sound and the paralysis will vanish and the entities will disappear."

UFO refuseniks may also learn to issue a loud, reverberating "tone" from the head, shoulders, and neck. One woman, Druffel reports, was already aboard an alien craft when she decided to take this tack. "When she made her sound, the creature looked confused, wrapped her in a white light, and shot her back to her bedroom," Druffel states.

Meanwhile, in another case studied by Druffel, a man claimed he'd developed "intuitive perception" while in Vietnam. It gave him a heightened awareness of danger prior to attacks, he said, and with enemies of alien stripe, that came in handy. "He was able to sense they were coming," says Druffel, "and immediately engaged them in a mental struggle that drove them off."

For those with a strong religious bent, Druffel suggests "appeals to religious personages, regardless of faith." One woman, for example, appealed to the archangel Michael and fended off the aliens in seconds.

Yet to some students of abduction, total resistance is a dream. David Jacobs, professor of history at Temple University and author of *Secret Life,* a book on the abduction phenomenon, says that "resisting abduction completely is impossible." In fact, Jacobs has found after working intensively with some 85 abductees, "the best anyone could do was impede things a little. Some people struggled, others walked more slowly or fell to the floor and had to be carried. I have one woman who spit in the alien's face. Still," adds Jacobs, "I encourage abductees to try resistance because it provides a greater sense of ego strength."

Another skeptic when it comes to the notion that mere humans can fight the aliens off is Budd Hopkins, author of *Intruders.* While Hopkins won't say resistance is impossible, and, in fact, encourages such effort, he notes that "I've encountered too many instances where people consciously thought they had resisted, but when the cases were probed more deeply, through hypnosis, it turned out that they had not."

Druffel, however, finds that residual psychological trauma is often displayed by people reporting an abduction, and people who resist successfully are not as prone to the trauma. Druffel advises abductees who feel that their rights are being violated to at least try resistance. —*PAUL McCARTHY*

ANTIMATTER

SUFFERING FOR ART

If the notion of a 12-step recovery program for artists addicted to the muse sounds strange, think again. According to one anonymous member of the New York City–based A.R.T.S. Anonymous, "The Van Gogh concept, that art is the result of sickness or that disturbance equals creativity, is not popular. Yet some people are so compulsive about their art that they can't function in ordinary life. And they need help."

Enter a bold new group called Artists Recovering Through the Twelve Steps, or A.R.T.S., Anonymous. Adapted from Alcoholics Anonymous specifically for artists of all types, from painters and singers to writers, the organization starts each meeting with the classic 12-step line, "Hi, my name is John (or Jane, or Jo) and I'm an artist."

According to member Pam T., some artists attending the meetings have become so disturbed or immersed in the muse that "they cannot focus on their nine-to-five job, pay their bills, or interact with other people." Instead, she says, the muse has turned into a consuming, destructive monkey on the back that sends the artist into a headlong, downward tailspin. For Pam, on the other hand, meetings simply provide a network of support. "You get to interact with a group of peers," she says.

The support of the group, notes one participant, has helped him become a creative, responsible professional.

Before joining the program, he states, "I didn't feel safe drawing a building. Now I've completed a mystery novel."

To reach A.R.T.S. Anonymous, just call its worldwide hotline number: (212) 969-0144.

—Joseph Baneth Allen

UFO MUSEUMS

Most people come in contact with the world of UFOlogy only through books and magazines. But recently, some of the field's most impressive artifacts have been put on display.

At the Outa Limits UFO Enigma Museum in Roswell, New Mexico, for instance, visitors can see a re-creation of the alleged—and notorious—saucer crash of 1947, complete with an eight-foot-long UFO and soft, sculptured aliens. The museum displays the major UFO events of each decade since the 1940s, states owner John Price, and boasts a space-program exhibit as well. For the shopper, there are UFO books, T-shirts, and bumper stickers. Admission is a buck.

Also in Roswell, the International UFO Museum and Research Center has the backing of the city council itself. According to Walter Haut, president, the museum is centered around a 40-foot, ten-panel Plexiglas display of UFO phenomena and events. It also features a UFO library, an auditorium, and a gift shop.

Finally, another UFO museum has set up shop in Orlando, Florida, the exhibition capital of the world. James Greenen,

director of the International UFO Center and Museum, says his facility already has a gift shop along with a UFO photo and document display.

Business at all three museums has been brisk. Price, of the Outa Limits in Roswell, for instance, sees more than 400 visitors a month. Greenen says his museum draws 600 to 700 a month. Haut, of Roswell's Research Center, reports more than 15,000 tourists a month.

—Paul McCarthy

surgery or merely use sleight of hand to trick people, just as other so-called psychic surgeons have done in the past? One perspective comes from neuropsychologist Norman Don of the School of Public Health at the University of Illinois at Chicago, who filmed Rios in action. "I'm one hundred percent certain that Rios was cutting people open," Don says. "I personally watched him perform and videotaped a large variety of operations, including eye, brain, and breast surgery. Rios used a woodworking drill with a four-inch-diameter serrated blade, as well as other surgical tools. Blood would go all over the place. We brought some tumors that we saw him remove to a pathologist. They were real human tumors."

"I WATCHED HIM PERFORM EYE, BRAIN, AND BREAST SURGERY. BLOOD WENT ALL OVER THE PLACE AND I COULD HAVE PUT MY HANDS IN THE WOUNDS."

REVENGE OF THE KILLER BEES

Those who believe in the adage "It's not nice to fool with Mother Nature" may cite a recent example to bolster their position: Reputed spiritual healer Antonio Rios, who seemed routinely to supersede the laws of biology from his base in Palmelo, Brazil, was stung to death by a swarm of African killer bees. His challenge to nature: Purportedly performing hundreds of surgical procedures without antiseptics or anesthesia, using instruments like the circular saw.

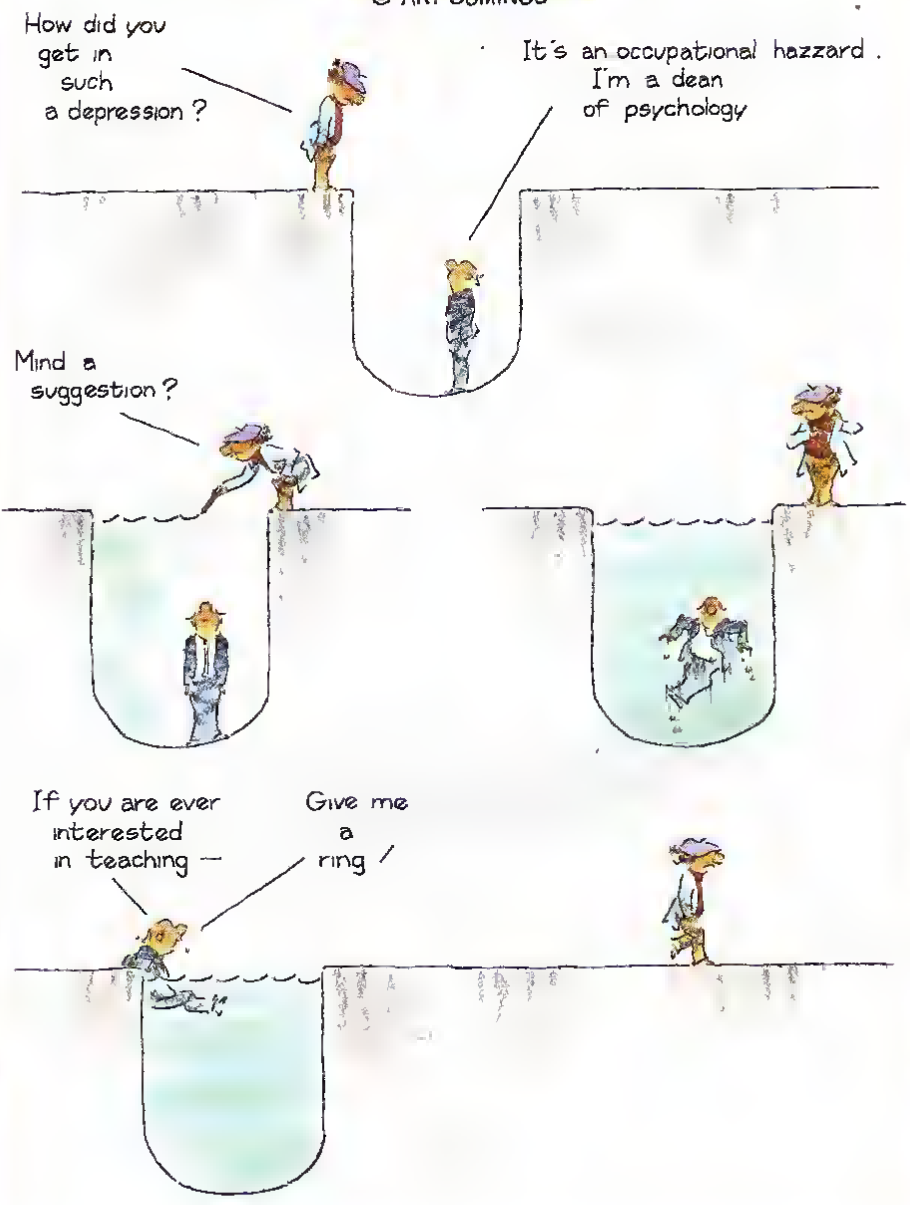
Did Rios perform real

Does Don think the surgery performed by Rios led to paranormal results? "Rios claimed a spirit was working through him," Don notes. "I say the whole thing was unusual. Patients seemed to experience no pain, and the infection rate was virtually nonexistent. Some very far-out things happen in trance states, but it's possible Rios was doing something more."

According to physician Wallace Sampson, a member of the California Council Against Health Fraud, however, Rios was doing less. "Even those with scientific titles can be fooled by people using sleight-of-hand techniques and visual tricks," Sampson says.

Another take on the topic comes from Patrice Keane, executive director of the American Society for Psychical Research. Keane, who witnessed psychic surgery in South America some years ago, says, "There is rarely adequate medical assessment prior to the so-called surgery or adequate follow-up afterward to determine whether any improvement has occurred."—Keith Harary

The Artist



BORDERCROSSINGS

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to improvisation.

One of the really fruitful ways to bring the two cultures together is to see what kind of purchase the literary view of language can have in understanding the constitutive role that discourse plays in scientific theories, heuristics, and experiments. Metaphors, for example, guide thought as well as express it: laying down a (largely unconscious) linkage of associations that determines how the cable car of cognition will move. (This metaphor, for example, clunks along and makes me want to jump off it as soon as possible.) Rhetorical protocols are more than just protocols—they are formulations that determine what can be said as well as how it can be said.

When I read in a scientific journal the phrase, "It was determined that . . ." the person who did the determining fades into nonexistence, and I am left with the claim presented as if it were a fact of nature. By contrast, I still remember the first time I read the phrase in a scholarly article, "I want to show that . . ." It sent a shiver down my spine. Wants to?!! The expression not only constitutes a person, but a person *with desire*, whose particular cultural and psychological formation materially affects what she *wants to* say.

Literature's role in culture? I don't think I can improve on Sir Philip Sidney—to give pleasure and to instruct. To give pleasure in all kinds of ways as varied as the human imagination can make it. To instruct the culture in where it has been, where it is now, where it is going, other places it might visit or envision or bring into being. The two functions are of course not mutually exclusive, since instruction always takes better when it's fun.

17 NOV
From: IN%"@inis.uncg.edu" (OMNI)
How have scientific theories—the Newtonian clock, the theory of relativity, quantum mechanics, nonlinearity (chaos), molecular biology—influenced literature?

17 NOV
From: IN%"@assistant.beckman.uiuc.edu" (Powers)
I had such a good time reading and thinking about both Jay's and Kate's responses that I would like to move that we kick around these ideas, getting back to the next round of questions if and when they seem appropriate. In short, a revolt of the interviewees. What does everyone think about letting this be a little more free form (truer to the E-mail medium) and leaving it to the editor to pick up the pieces?

17 NOV
From: IN%"@XHMEIA.Caltech.Edu" (Labinger)
I'm certainly in favor of free form. I've written something on the Newtonian question and will be happy to distribute it now, save it for later, or throw it in the electronic wastebasket—whatever everyone prefers.

Response to Kate's first E-mail. The point about language as a possible dividing line between two cultures is well taken. Scientists—those who do it rather than think about it—tend to believe that the matters they deal with are basically "true" in some manner that transcends how they are spoken about. Such a viewpoint would seem to imply that scientific truths are somehow "privileged" (to use a word I seem to keep seeing in this field) over all others and that there should be some ideal language that would express these truths precisely, which all actual language can only hope to approximate. Much of what I have read of recent philosophy of science and literature/science looks

upon this position as quite wrongheaded and argues that scientific 'understanding' is in fact intimately bound up with language, conventions, assumptions—even though its practitioners can remain blissfully oblivious to such issues and still function. This would seem to constitute a case for differentiating between the two cultures operationally but perhaps not fundamentally.

My gut feeling is that the language barrier is important but not as important as the similarities that both Rick and I spoke for in the first go-round. On the other hand, that feeling may be just another consequence of my scientific upbringing. If I'm conditioned to think that the way I describe an idea is much less important than the idea itself, then I suppose I would naturally and subconsciously tend to downgrade the significance of the fact that someone else may think the description is equally important (or perhaps more accurately, *is* the idea). I seem to be trapped in cultural quicksand here. Anybody got a rope?

18 NOV
From "IN%"@umaxc.weeg.uiowa.edu" [Haylas]
The quicksand you have discovered, I would like to suggest, is not really quicksand but an empowering reflexivity. It's empowering because it is about positionality. Somehow the idea got started, sometime in the seventeenth century, that we know the world because we are separated from it. Objectivism led to some scientific advances but also to a profound alienation about which many writers and philosophers have meditated. What if we started from the opposite premise that we know the world because we are connected to it? Then to discover that one's views have been shaped in conscious and unconscious ways by one's experiences, culture, history, and traditions (including disciplinary traditions) is to discover that one has a position from which to interact with the world.

The more we can learn about the positions we occupy, the more we learn about why our interactions with the world have the characteristic shape and flavor they do. Quantum mechanics showed this in one way by indicating that how an experiment was set up would affect whether subatomic phenomena manifested themselves as waves or particles. Chaos theory showed it in another way by emphasizing the importance of scale. Benjamin Whorf showed positionality in yet another sense, by relating the structures of languages to the kinds of thoughts that can be articulated within them. And postmodern theorists like Donna Haraway (*Primate Visions*) and Steven Shapin and Simon Schaffer (*Leviathan and the Air Pump*) have demonstrated that gender, class, and race affect what kinds of questions are asked as well as what evidence is considered persuasive in answering them. Knowledge, like power, does not exist in a vacuum. It always comes into being through a community of knowers who determine what counts as knowledge at a given time and place.

I don't mean to suggest that all knowledge is relative. I am, in fact, among those diehard realists among the humanities who think that there is an external reality. But maybe external reality is not the right phrase, since that implies a world already constructed as a reality. More accurate, to my mind, is "unmediated flux." Surely our picture of reality is affected at all levels, even before conscious perception begins, by the species-specific sensory apparatus and perceptual processing that we bring to it. The world comes into existence for us as human beings, there's no other way we could possibly know it. Other species—my dog, for example—bring the unmediated flux into existence for themselves in very different ways. So my position includes not only my culture, language, history, but also my species. This does not necessarily imply relativism, however, for the unmediated flux impinges on me, and I process it in ways that are meaningful for me. What results is an interaction between my position and the flux. To experience this interaction is what I call "riding the cusp." It's from riding the cusp, I think, that all our knowledge of the world comes. That's what I mean by saying that we know the world because we are connected to it. The result is a much less alienated vision of the world, and also a truer vision of the world, since it acknowledges that positionality is always already affecting the picture we see. It surely affects fundamental questions about the nature of the scientific enterprise as "objective" and the literary enterprise as "subjective," providing a very powerful common ground from which to think literature and science together. So much for the soapbox. I tend to get passionate about these questions. I would love to hear what you think about these ideas.

> "I have never met a scientist who did not respond in some degree to irony, lyricism, metaphor—the whole arsenal of literary devices."

18 NOV
From "IN%"@XHMEIA.Caltech.Edu" [Labinger]
I need to start with a disclaimer. I'm pretty much a neophyte in this field. I particularly don't feel equipped to discuss in any detail the history of influence of specific scientific themes on literature.

First, I'd like to look at the list of theories. The Newtonian universe is the only one that dates back significantly before the beginning of this century. I think that a couple of theories/concepts from the nineteenth century—entropy and evolution—should be added. They seem to me to have been at least as important in their influence on literature as the Newtonian clock or the theory of relativity.

Another concept, really more mathematical/philosophical than scientific, is self-reference. This is not a new concept (in literature or elsewhere), but it takes on vastly increased importance in this century, stemming perhaps mainly from its crucial rôle in Godel's incompleteness theorem, and this appears to be true of its role in contemporary literature as well.

I think we need to distinguish between different modes or levels of influence. The most superficial is what I called in my first response "name dropping," often just for the author to let us know how up-to-date he or she is. Next, perhaps, is the use of scientific metaphors, where a scientific concept may be called upon to help explain human behavior. Finally, the scientific concept may appear to be intimately woven into the basic fabric of the literary work.

While these seem to represent a hierarchy of increasing direct influence (and one might go on to infer, increasingly sophisticated understanding of science by the literary author), that need not be true. The appearance of scientific themes or concepts in literature may not be the results of any direct influence or conscious intent at all. This point is made very clearly by Kate in the preface and first chapter of her book *Chaos Bound*, with a number of examples showing how themes of chaos theory appear in literature contemporaneously with, or even preceding, their widespread dissemination in scientific, and

popularized scientific, writing, pretty much ruling out the possibility that direct influence is involved.

One could say the same about the first few decades of this century. The developments of relativity and quantum mechanics overthrew Newtonian mechanics completely changing the conceptions of causality and fixed reference points in the clockwork universe. At the same time, trends in literature and the arts (surrealism, abstraction, atonality) seem to be progressing along parallel lines. Again, little if any of this can be attributed to influence (in either direction); both instead must be representations of the Zeitgeist.

19 NOV

From: IN%"@umaxc.weeg.uiowa.edu" (Hayles)

I'm glad Jay brought up the question of influence. I think a much more powerful concept than influence is the idea of positionality that we were discussing earlier. The trouble with influence is that it is usually constructed as a one-way street (Einstein influences James Joyce; science influences literature) and a flat street at that, without much or any sense of the multiple dimensions that positionality entails. When we are ready to give up the illusion that we can achieve a "God's-eye view" of the universe, then we are led to wonder how our position not just affects (a wimpy word if I ever saw one) but actively *constructs* what we see. Only part of my position, for example, is constituted by the fact that I started life as a chemist and then switched to the literary camp. Probably a larger part of it derives from my position as a woman in male-dominated institutions, and a larger part still from being a human being in the late-twentieth-century technoculture we call America. Depending on what layers or aspects of this position I want to address, I could be seen as having more in common with scientific folk than literati (if we are talking about the Second Law of Thermodynamics), female undergraduates than male full professors (if we are talking about the amazing longevity of sexist practices), or reality hackers than Shakespeare scholars (if we are talking about electronic bulletin boards rather then the Globe Theater). All of us are fragmented composite beings with complex fractal boundaries between the various strata which are, moreover, not at all separated into watertight compartments. Our parts leak, they flow, they become turbulent or congeal, and all of these highly nonlinear interactions, taken as wholes that are constantly changing and rearranging themselves comprise our positions at any given moment.

19 NOV

From: IN%"@assistant.beckman.uiuc.edu" (Powers)

"To say something in other words is to say something different." Even to quote Kate is already to give her a kind of Heraclitean twist. The same, only different. That's the oxymoron at the heart of *Gold Bug*. There, as here, I see the two/five billion cultures debate as a variant on the astonishing oxymoron of variation. The genetic code may be universal across life, but each time you write it into a new genome, the whole postulate changes.

Does putting an "empirical" observation into other words change the nature or the observation? Perhaps it does not change that part of the component tied to the "unmediated flux." But it must certainly change the valence of the observation as it makes its way in the marketplace of human exchange.

> "Because no two verbal formulations can ever be identical, to say something in other words is to say something different, language does count."

I couldn't agree more that Snow's terms bias the discussion and that it's very useful to look at the issue in terms of the production and generation of ideas. To "see what kind of purchase the literary view of language can have in understanding the constitutive role that discourse plays in scientific theories, heuristics, and experiments," as Kate says (and as I now say differently, if verbatim). We are in search of that common term at the varying heart of theory making about the world and our position in it (which may come to the same thing, in different terms).

The common denominator between disciplines should be awe at our ability to say anything at all about where we find ourselves. Scientific and humanist wonder also share a common basis in symbolic manipulation. Whether measuring or interpreting, we use one level of the polysemous symbol-parfait to cast light on another. Now it may well be that one "culture" sees the inescapable symbolic go-between as a wall while the other sees it as a bridge. One may find metaphor a minor handicap while the other may consider it not only the means of but the subject under eternal investigation. Either way, framing a proposition and testing it are never separate acts.

What makes things interesting is that, when we do science, the metaphors that we employ in empirical examination produce and consolidate other metaphors. The stuff of the observation itself becomes the metaphorical scaffold with which we organize and position ourselves for the next observation. (There is, as Kate/Whitehead points out, truly no independent mode of existence.) This interplay of theory and observation feeds back and forth across the two-culture divide as well. That's why so many eighteenth- and nineteenth-century novels can be seen (but only in retrospect) as colored by Newtonian clockwork while so many contemporary novels are preoccupied with recursion and complexity.

"Give me a lever long enough and a place to stand and I can move the world." I always thought the planet-long lever was the easy part. It's that request for a place away from *this* place that gets tricky. It gets infinitely harder to know a thing when knowing and stating (de facto acts of separation) already alter the thing. Even a heightened knowledge of how our positionality impinges upon "knowing" is philosophically problematic (a deep recursion lurking in that process). Perhaps the knot is at least side-steppable if we admit literature as a form of knowledge? Fiction may, in any case, be one of the only ways into a knowledge of positionality as it is condemned to partake of the metaphorical process it inevitably describes. The novel is one of those things that must be what it purports to *be* about. It rides the cusp by building it, re-creating it in both emblem and essence. And as such it is definitely one resonant metaphor for the whole metaphorical process at stake here.

Yes, I believe in something "unmediated" out there as well, but I am condemned to mediated means of manipulating or understanding it. The map may not be the place, but we have only the map with which to move about in the place. Maps, rather constantly changing or perhaps I need to say varying. Both sides of the two-culture split may right now be coming to richer appreciations of how navigation and cartography are inseparable parts of the same journey. Symbolic understanding is both active and responsive, both empirical and imagined.

One of the rondo refrains of *Gold Bug*, repeated throughout the book scores of times, each time the same, only different, is the Mechanicals' question from *Midsummer Night's Dream*: 'How do you get moonlight into a chamber?' The answer is: You dress someone up as the moon.

24 NOV
From: IN%"@XHMEIA.Caltech.Edu" (Labinger)
I want to ask Rick for a bit of clarification. I'm not sure I fully grasp the significance of your 'moonlight into a chamber' paragraph in the context of what immediately precedes it. 'Dressing someone up as the moon" seems to imply a level of artifice or manipulation that goes well beyond the role of metaphor as both you and Kate have discussed it. Kate's picture of metaphors "laying down a (largely unconscious) linkage of associations" seems quite different from disguising something as what it is obviously not, which might easily not lead to the desired effect.

I'm going to try to sum up what I think I've heard so far. We have all suggested that the two cultures are fundamentally the same and that they are fundamentally different. The obvious and probably stupid question is, are the similarities or the differences more fundamental?

The latest mailings seem to me to contain the same message—what Kate calls 'riding the cusp' and what Rick talks about in terms of "recursion." Recursion is inherently discomforting, going all the way back to basic paradoxes ('This sentence is false'). We are faced with dilemmas that we know will not be resolvable—at least in the sense of what we have been brought up to consider resolution—and yet may not feel comfortable disregarding. How do we deal with this situation?

One way is to accept it—or rather to welcome it. Another way is to "place it in brackets'—not to deny its existence or even its importance, but merely to set it aside while we get on with the business at hand. We can go back and think about it when our real job permits us some leisure time. For most scientists, questions about how we gain our knowledge of the world, how intimately it's bound up with language—they're interesting and important, but they're for the weekends, after the science is done. For humanists, such questions *are* the job, and the tension between opposing views must be at the center of their lives.

If we argue that scientific knowledge is inescapably positional, then some scientists must be at least somewhat self-deluded in that they are leaving out huge chunks of the world while going about their business. However, that's a mode with which scientists are *consciously* comfortable. Every scientific discipline involves simplification, approximation, neglect of minor perturbations. Factors that we 'know' will have insignificant effects upon the results are neglected, even though we are fully aware that they are real and can become all important in other contexts.

24 NOV
From: IN%'@assistant.beckman.uiuc.edu' (Powers)
Jay, you want clarification of my metaphor for the metaphoric process? Getting recursive . . . I use the figure in a slightly different way in *Gold Bug* (and Shakespeare uses it in a slightly different way in *Midsummer Night's Dream*), but in the context of this E-mail discussion, the point was that when you can't have the thing in itself, you make do with a constructed symbol for the thing. "Dress up" not in the sense of disguise or intent to mislead, but in the sense of approximate representation. And yes, I agree with Kate that the effect of such created symbols, once laid down, is far-ranging and often unconscious.

> "Literature's role in culture? To give pleasure and to instruct the culture in where it has been, where it is now, where it is going."

If it is indeed true that all our knowledge of the world must derive from symbolic manipulation, then we are all monocultural at base. We may become bicultural when certain investigators decide to concern themselves with the thing being represented and others decide to work with the ways of representation or the act of representation itself. Both preoccupations are to some extent problematic because of the interdependence of the elements of representation and knowledge. So we are, in fact, always left with hybrid activity: riding one cusp or the other, both depicting and being depicted—various cross-ruffing activities such as literary examinations of science or critical examinations of such literature.

I am not troubled by the reductionist assumptions behind the pure, empirical project any more than I am troubled by the nonverifiability of a good novel. But a full picture of where we have been set down will always require a parallax of both kinds of projects, and then some.

4 DEC
From: IN%'@XHMEIA.Caltech.Edu" (Labinger)
Regarding chaos and reductionism: I think there is major confusion over just what reductionism means, much of it rather politically inspired.

The basic distinction I think we need to make is between reductionism as a philosophy and as a research strategy. Take biology. Philosophically a reductionist would say that answers to "high-level' questions, such as function of an organism, may in principle be built up from the most fundamental level, namely the constituent atoms and the "rules" of quantum mechanics that tell us how atoms interact to form molecules, how molecules interact with each other to produce "supramolecular" structures as well as to give chemical reactions. The ultimate implication, I suppose, would be that conceptually one could start from the complete DNA sequence of an organism, and a big enough computer, and calculate just what the organism would look like, how it would develop, how it would function.

Opponents of reductionism in biology point out, completely correctly of course, that we don't have the slightest idea how to perform the vast majority of the steps in that conceptual integration. However, it is not clear that that is a valid objection to reductionism as a philosophy. A much more difficult argument is generated by focusing further along the chain of integration.

What we have thus is new, higher-level concepts 'emerging' as we proceed along the integration. What chaos has done, I think, is to make some of the unbridged gaps along this chain look even wider than they did before. And yet, it is still not clear that this is a fatal blow to philosophical reductionism, which would only require that these higher-level concepts be (in principle) derivable from the fundamental quantum mechanical laws. I'm sure few scientists would expect to find that the high-level concepts contradict the fundamentals—vitalism pretty much vanished from science long ago.

So the question, I guess, is whether there is an inherently unbridgeable gap in the progression to higher-level con-

cepts, and more specifically from our point of view, whether chaos creates (or reveals, more accurately) such gaps. I certainly can't answer that question. One possible argument for such a gap might come from fractal geometry. The Mandelbrot set has the property of "self similarity" in that the same structural features appear at any scale of observation. Since this self-similarity extends to infinity in both directions, larger and smaller, it would appear that there could be no reduction to "the most basic" structural elements.

However, unless everything we believe about atomic structure is wrong, self similarity does not extend indefinitely in the direction of shrinking scale. The properties of an artificial construct such as the Mandelbrot set may remain self similar to infinity, but in a "real" structure, when we approach the scale of molecular sizes, self-similarity will break down.

So for philosophical reductionism, there is no obvious impact of chaos. As a research strategy, it should be clear from purely practical considerations that it would be stupid to practice reductionism to the exclusion of all else. Even if we grant the philosophical reductionist argument, it will be a very long time before integrating up from molecules could tell us even the minutest fraction about, say, liver function that the same amount of macroscopic study would provide. On the other hand, again I don't think anybody denies that study on the molecular level is still worthwhile. Does nonlinear dynamics (chaos) then shift the priorities, place the sought-for integration so much farther off that we should refocus most of our efforts on higher level concepts?

I guess the bottom line, if there is one, is that chaos doesn't seem to me to have a major impact on reductionism, at least if one is careful about what one means by the term. It's probably clear from what I've said that I don't view chaos so much as a revolution in science, but rather as a shift in emphasis and, above all, a recognition of some thematic relationships between areas that previously appeared quite diverse. I think the same would apply to the two-culture question. It's not revolutionary in the sense that it allows for a dialogue to begin, but rather a refinement of modes of thinking and talking that perhaps will lead to better perception of connections.

14 DEC
From: IN%"@umaxc.weeg.uiowa.edu" (Hayles)
I find it almost impossible to write concisely about how chaos has influ-

enced literature, because every one of the substantive words in that prepositional phrase are problematic for me—chaos, influence, literature. Chaos theory is still new enough so that there have been relatively few texts that have explicitly referred to it in a significant way. Bruce Sterling's *Schismatrix* is one, Michael Crichton's *Jurassic Park* another, and of course *Gold Bug Variations*. Yet the ideas of chaos have had an important impact on how one reads literature, not only contemporary texts, but earlier works as well. Features important in nonlinear dynamics such as scaling, recursive symmetry and sensitive dependence on initial conditions have played important roles in literary texts for a long time, and the science of chaos has given us new ways to understand and talk about how these features can be important in literary texts. Writers whose works have been reinterpreted in these terms include William Blake (who when Newton was all the rage wrote furious epic poems insisting that nonlinearities were so important that they could not be ignored); John Ruskin, a Victorian who sought to liberate the complexities of nonlinear flows; Emerson, Thoreau, and Hawthorne, among others. Understanding more about chaos has given literary critics new and more sophisticated ways to talk about texts like Thomas Pynchon's *Gravity's Rainbow* and Stanislaw Lem's *His Master's Voice*, both texts that defeat linear modes of reading and interpretation.

Another area in which chaos has changed how literature is read is dissipative structures—entropy-producing systems that create greater order internally by producing greater disorder in their environments. A famous crux in literary criticism has been the question of where meaning resides—in the text itself, in the reader, in the relation between text and reader, or somewhere else?—for example in the culture that in a sense writes both reader and text.

Schools of criticism can be characterized according to the ways in which they answer this question. The idea of dissipative structures has proved to be very fertile in understanding how the relation between text and reader works. Arguments have been made that some texts are representations of dissipative systems, crafted precisely so as to foreground and engage the dissipative activities of the human consciousness that reads and understands them. These texts produce noise in the sense that they present the reader with messages that seem to mean something, but that also distort or otherwise complicate the processes of signification. Struggling to understand the text, the reader is forced to reorganize his thought processes at a higher level of complexity. Thus the text acts like a dissipative system that achieves internal coherence by producing greater disorder in the reader, but then the reader responds by reorganizing his understanding at the expense of still greater disorder in his environment, which is also subject to reorganization. How literally one can or should take this model of reading is still very much up for grabs; some critics want to apply it in a quite literal sense, while others see it as a metaphor for understanding "noisy" texts that is most fruitful if it is not constrained by the kind of energy balance sheets that a thermodynamic accounting would make. Whatever position one takes on the question, it is clear that chaos has stimulated new ways of thinking and writing about literature.

> "For most scientists, questions about how knowledge is bound up with language are for the weekends, after the science is done."

About reductionism. One kind of question to ask is how reality actually is. Is it susceptible to foundational analysis and description that would let macro behavior be analyzed in quantum mechanical terms? That was mostly the question that Jay concentrated on in his analysis. Another kind of perspective emerges when one assumes that "reality" is constituted through acts of description and analysis. One kind of reality comes into existence through foundational description, another kind comes into existence through what I might call "emergent description." The mode of description, in this view, cannot be separated from the kind of reality that is constituted through description. This position assumes that any reality available to human beings can never be unmediated by language and signification. To talk about reality is always already to constitute it in ways specific to the discourse system in which it is described. So the choice of discourse system is enormously important because it will have everything to do with how the reality is constituted.

One choice is foundational analysis. Such a choice implies that a certain set of metaphors will operate—metaphors such as building blocks, parts that go together to make wholes, subdivision of parts until one arrives at quantities so fundamental that they can't be divided further. Obviously these metaphors are not merely ornaments of speech. They implicitly point toward certain kinds of research strategies—for example, a research strategy that keeps trying to subdivide parts into finer and finer components in a search for the foundational part that is the 'essential building block of nature.' The foreseeable result is something like the proposal for the superconducting supercollider.

Another choice is emergent description. Here a different set of metaphors is engaged—metaphors such as wholes that are more than the sum of their parts, qualities or properties which come into existence through interactions and thus do not inhere in any of the parts, the unpredictability of such properties from extrapolation of the parts, the thresholds that, when passed, mark the transition from parts to an emerging whole. These metaphors point to different research strategies than foundational analyses; specifically, they point away from the search for fundamental particles toward synthetic perspectives that would integrate parts into emergent phenomena—for example, symmetry considerations.

Both perspectives can yield valuable insights. I'm not sure it is possible to answer in any transcendent way which perspective is better. Surely it would depend, among other factors, on the scale of the phenomena one wanted to understand and the previous contexts of understanding. In fact, a transcendent set of criteria is ruled out by the basic assumption I've been making, for such criteria would themselves also be inextricably bound up with the language used to constitute them. All this implies that the choice of perspective must necessarily be strategic and political in the broad sense of the word. What work can it do in the relevant contexts and how important is that work given all the complexities of those contexts? There are some who imply that an emergent perspective has, in the present climate, more important work to do than a reductionist perspective. Seems to me that that proposition would take a lot of unpacking—just what is that work and why is it important? Several of my colleagues are engaged in making this kind of argument right now, so the difficulty of the enterprise is evidently not discouraging people from under-

taking it. It would be worthwhile to put these folks in conversation with scientists like Jay, because their arguments are often driven by a sense of what is important for the culture in general rather than the scientific field in particular.

Both contexts need to be considered. In my view, this is perhaps the contemporary version of the two cultures divide. Is it symptomatic that in trying to come to a conclusion, I seem to have succeeded only in opening up huge new areas for discussion?

16 DEC

From: IN%"@assistant.beckman.uiuc.edu" (Powers)

I am really sitting on my hands at the moment, trying to refrain from jumping into all the new nooks and crannies that you two have opened up in your latest round of responses. These last notes on your parts strike me as having something fractal about them: rich, complex, infinitely textured at every magnification, and tightly tuned to the point of self-resemblance. No matter what fate awaits this discussion in print, I just want to say that I have benefited enormously by your ruminations, which I count as among the most lucid I have seen on the subjects, anywhere.

I will constrain myself to my assignment this time—the far less interesting question of the influence of "chaos theory" on my fiction. To some extent, all of my books have been nagged at by nonlinear dynamics. I first became conscious of the issues after reading that *Times* piece on Mitchell Feigenbaum, which must have appeared around mid 1984. The idea of sensitivity on initial conditions was one of the most invaluable metaphors for me during the creation of *Three Farmers On Their Way to a Dance* (*3F*), which was all about the discontinuity in gauges between the frames of local and global history. (A central image in *3F* is the story of how Henry Ford tried to end the First World War single-handedly.) I use for this book's epigraph the bit from Proust about how "we guess as we read, we create, everything starts from an initial mistake." Lingering in this first line is the covert image of cigarette smoke, or the turbulence of a waterfall, or better, an avalanche that begins with three farmers on a muddy road and ends with the twentieth century. But throughout the book the idea of "chaos" stays relatively hidden and defers instead to a much more "modernist" (archaic) idea that a system depends on the totality of object, observer, and receiver of observation (sitter, photographer, and audience in my metaphor).

The trope becomes more overt in *Prisoner's Dilemma* (*PD*). The theme here picks up where the first book left off. What does little have to do with big? How much difference can one vote make? Here, the epigraph is from T. E. Lawrence: "I am still puzzled as to how far the individual counts." The Butterfly Effect is mentioned by name, as are emergence and threshold phenomena. *PD*'s structure is also vaguely fractal, with nested narratives each recapitulating and extending one another at different magnifications, an attempt to mirror the kind of discrete yet continuous hierarchy that Jay talks about.

In *Gold Bug Variations*, the metaphor of nonlinear dynamics becomes the subject, and in a certain sense, the vehicle. I was struck, when reading Kate's formulation of the two-stroke cycle of reductionist versus synthetic work, by the sense of how the character Jan O'Deigh's autodidact dive into molecular genetics starts with the one motion (understanding complex systems in terms of their constituent parts) and ends in the other (an appreciation for how the ciphertext depends on the full complexity of the world, both for its "writing" as well as for its reading). "Ecology's every part—regardless of the magnification, however large the assembled spin-off or small the enzymatic trigger—carries in it some terraced, infinitely dense ecosystem, an inherited hint of the whole."

A little like the two of you, I felt I almost had a generic, layman's handle on the notion of "chaos" at one time. The ideas have gotten too complex for me now, however, even as they have simplified into general currency. (I do still find Max Planck's comment, which I use for a chapter heading in *3F*, invaluable. "The world image contains no observable magnitudes at all, all that it contains is symbols.")

I agree that the rejection of the Laplacian dream may still harbor a closet reductionist program, and hiding in the "new" formulations may be the hope that disorder is simpler than we thought. ("What could be simpler?" as the first line of *Gold Bug Variations* puts the question.) It may well be that chaos theory's lasting contribution to literature will be the creation of a place where one might once again believe in the efficacy of fiction's project—a place where "no war is inevitable until it breaks out," where the individual counts "a lot. I fancy, if he pushes the right way," where we might play the whole hypothetical piece "once more with feeling." For it seems to me that many novels get written on the naive belief that a small seed of words can still create a great stir. ∞

INTERVIEW

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increments. It might take 200 increments to rotate one complete turn. A computer can tell the motor to rotate, say, 284 turns, then go back to the start and rotate another 284 turns. Because the stepper motor repeats itself exactly, you can duplicate things over and over, and this allows you to shoot motions of models at very low camera speeds. You can both program and control the movement. There are no accidents, no gravity to deal with. As skilled as one is at visualizing what the final motion should be, here's a tool that guarantees its accuracy.

On *Star Wars*, the equipment was cumbersome and difficult to use because we never quite figured out motion control. But then when we did the TV series *Battlestar Galactica*, it was like a light bulb turning on. What a tool to be able to move three-dimensional models any way you want! On *Empire*, we went crazy with the asteroid sequence, the walker sequence, all the stuff where we now understood how to represent three-dimensional space.

Omni: The walkers [enemy battle machines with four legs] in *Empire* reminded me of Harryhausen's stop-motion magic. Did you create the walkers in homage to him?

Muren: No, we had a deadline and stop-motion's how we did it. Doing the walkers with motion control or building a robotic thing would have cost a fortune. The fact that the walkers are machines, the stop-motion effect added to their reality. We talked to Harryhausen. In fact, George even asked him if he'd like to work on the film. Ray said no. It would have been great to have had Ray come do it. But I don't remember doing anything as an homage. People read that into my work.

Because it was a technology I really understood. I knew the stop-motion animators who could do the walkers. I knew we could build big sets with painted backgrounds, scrims, baking soda for snow, and trapdoors like they had in the stop-motion film *Hansel and Gretel*. You could set up something and get your shots without it being too screwy and complicated.

Omni: Industrial Light & Magic has long been the industry leader in special effects. Might the dissemination of people and technology to other shops erode your market share?

Muren: That happened right after *Star Wars*, but in three years, most of those companies were gone. There's a feeling that the tools do the job, so after *Star Wars*, everyone was setting up motion-control equipment, optical printers, and so on. But their shots didn't look the same or they didn't deliver—and that's real serious stuff to Hollywood. When the guy with the effects company tells the producer, "We're not going to be able to deliver in time because we're having some problems," you understand problems don't you? The producer says, "No, I don't. You've been paid to deliver the job. The movie's got to be in the theaters on this date." That's what separated us from a lot of smaller companies. Also, we may be the only effects company with an art department. Because the design of effects is so important, we have about eight artists doing concepts, storyboards, and ideas full-time. Companies that think the design comes from the studio are missing an essential element. Now we've entered the digital age. ILM may temporarily lose business to new shops that buy the software, bring in managers. I say look back in three years and see who survives. Maybe if multimedia does catch on, everybody will work because there'll be more money.

Omni: How soon before today's state-of-the-art digital equipment is obsolete?

Muren: Two to three years. Filmmaking special effects is just not a business you get into to make money. The margins are too low. You've got to pay the talent. And equipment is becoming obsolete faster. We've saved a great deal of money by using the original camera we made for *Star Wars* as our main camera until the digital stuff started. We still have the original optical printer used for *The Ten Commandments*.

Omni: Do you get much commercial work following a hit effects film?

Muren: It happened with *T2*. We did the first morf shots in *Willow* in 1989, but it wasn't until the three such shots in *T2* that everybody picked up on the term as shape changing. That was followed by a deluge of commercials shape-changing characters morfing all over the place. Michael Jackson's video was all based on morfing. The marketplace got saturated.

Omni: How do you composite and manipulate computer-generated images?

Muren: We have a lot of stand-alone machines, about 130 processors we can grab onto anytime, and four or five really high-powered machines that any machine can grab onto. We might run 12 shots a night for *Jurassic*. Some of these shots would run on 65 or even 90 processors. As we're doing our rendering, we're compositing at the same time. Because we're rendering three-dimensional objects, which takes time, our processors can act in parallel. In the

READER'S GUIDE

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REALISM: External reality exists independent of our perception of it. Gravity exists whether or not I can name or understand it.

RECURSION: The looping back of a system or statement upon itself. "This statement is a sentence" demonstrates a simple recursion, while "this statement is false" suggests the kind of paradox often found in more complex examples of recursion.

SCALING: The magnification of a system itself. To learn more about the weather, we might magnify a single weather system in expectation of new data too small to register at the current level. The problem then becomes how to process the influx of rapidly increasing data.

THE SECOND LAW OF THERMODYNAMICS: Formulated during the mid nineteenth century, this law holds that although energy can neither be created nor destroyed (the First Law), not all energy within a system is available for use. As more energy is used, entropy—or the supply of unavailable energy—increases. Thus, systems will inevitably move from a state of order toward disorder, stability toward randomness, certainty toward probability.

SELF-REFERENCE: Calls attention to the instability of meaning in language. Puns, metaphors, and riddles depend upon the ambiguity of words and thereby demonstrate the futility of using language to replicate reality.

—Anna Copeland

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Correction to credits for October issue: **page 28:** Galen Rowell.

morning, when we have our dailies we've also got our composites.

Omni: Along with learning color charts, painting, etching, sculpting, isn't it imperative now for art students to learn to use computers?

Muren: Absolutely. If you want to go into effects. Anybody can create art now on a computer by buying a painter and a microchip scanner for $900. You can scan any painting and make it look like a Monet. Some people will see it as a Monet; others will say it's preposterous. Lets say the "painting" ends up in a magazine. The guy did it for $200 and puts an $800 price tag on it. Anybody can do that with a computer. Not many could do it traditionally, with oil paints. The difference between good and great in the computer shows up in performance software, in doing something like dinosaur skin. Once you get the "dino" program, everybody will be able to make dinosaurs, but they'll all look the same. What will ILM do to make their dinosaurs look better? We're not about to give that up.

Omni: What's the difference between illusion and lie?

Muren: We're not saying it's real. If we were saying these are photographs of real dinosaurs, nobody would believe it. If you say something is real when it isn't, then you're lying about it. Many people are worried that bogus images and bogus movies will start showing up, say of Clinton's secret meetings with the Japanese—*Mission Impossible* clandestine stuff. The same fears were voiced when the telephone was invented. Can I believe this voice on the other end?

We now know we can't trust a lot of what we're seeing. But changing faces is more about makeup than computer technology. Then you'd go to someone like Rick Baker. You could fake a news conference that was really, really important. They do it all the time with Big Foot. I saw some Big Foot footage 12 years ago. Rick Baker and I went down to a TV station where they had just gotten it in. Obviously bogus. The guy was wearing a suit, the cameraman's shaking the camera to make it look like it's hand-held.

People try to fake that stuff. Maybe now they can do it a bit better digitally, but I'll be able to tell the difference. I can tell UFO photos: every one of them. I've never seen one that's real! I've seen ones that look real because they're so blurred, but you dismiss those as something else. I'm supersensitive to what's real and what isn't. The unsuspecting public will buy *The Enquirer* except it will be a video version.

Omni: Why couldn't you take the president of a Third World country, compos-

OMNI

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ite him doing something untoward with a farm animal, and put that on TV?

Muren: How is that different from the front page of the *Enquirer*? It'll be a new medium, and you'll fool some of the people for a while. They'll believe their eyes until a little education goes on and they begin to realize these images are bogus. It's up to them to catch on. Don't you think this already may have happened? This is a dangerous time. A lot of computer-generated hype is going on. But it'll shake down and people will realize what's real and what isn't. We don't know what multimedia is, where it's useful. Who's to say if multimedia is full of lies? You distribute it to schools and lies pop up in it every so often.

Omni: I read that after *Jurassic Park* ILM didn't have any projects lined up.

Muren: Where did you read about that—in *Variety*?

Omni: Yes. I have it here in my briefcase somewhere.

Muren: Did you read the retraction two days later? No? Well, we're doing *Schindler's List* and *Wolf* with Jack Nicholson, Michelle Pfeiffer, Mia Farrow. We just got a major Perrier spot with a lot of computer graphics in it. We're also doing a Malaysian Airline spot, a massive thing.

Omni: What is your concept of magic?

Muren: I did it as a junior-high-school kid but quickly tired of it. Maybe because I'm attracted to spectacle, big scale of visuals; magic was too tame. The effort it took to make a tiger disappear was too much. All the paraphernalia told you it was a trick. In a movie, it's a trick but a very powerful one. Maybe it's an escape, but I respect the degree of skill it takes to be able to do that with a film.

Omni: Have you ever been disappointed with visual reality?

Muren: It's called L.A. After moving up here [to San Rafael], I was driving to work one morning in 1979. The sky was misty in a way I'd never seen before, and it formed the basis of the look of the walker sequence in *Empire*: overcast with the sun coming through, a rim light on the walkers in the opening shots where it's really spooky. I never saw anything like that in L.A. all the time I was there.

Omni: After winning seven Oscars, what's your incentive now?

Muren: The Academy Awards were never an incentive; salary was never an incentive. I'm here for the same reason now as when I got here: a yearning to fulfill a vision. I saw a wall with traditional technology. When computer graphics came out, that wall was gone. That's what keeps me going now. It's like a second honeymoon.

GAMES

ANACHRONISTIC INVENTIONS
For Competition #55, make something old new again

By Scot Morris

Not long ago, I turned on my hotel-room TV at midnight, and it blared a loud infomercial. In the dark, I pushed what I thought was the "volume down" button, but it turned out to be the "channel down" button, and the TV switched to *Yo! MTV Raps*. I had to turn on a lamp to find the right button, and the volume went down—slowly.

This experience led me to start up a new company, AnacroCo, which will introduce a new radio with just two controls: a knob at the right for tuning, and a knob at the left that has four functions—turning the power on and off and the volume up and down. AnacroCo's exclusive power/volume knob operates by the sense of touch, solving the dark-hotel-room crisis.

Our Insta-Tune knob allows you to scan an entire radio dial in a second or two. With our unique Proproceptive Feedback Sensing System, you can stop scanning instantly when you find the station you want. And our Visi-Ease Dial allows you to recall the locations of your favorite stations by visual memory, which research has found far more reliable than numerical memory.

AnacroCo's name comes from "anachronism," and we specialize in plucking ideas out of the past to improve modern life. We offer, for example, a car window that you can open or close *after* you turn off the ignition.

Sometimes the simplest of old ideas seems like the latest space-age advance. Below are seven items from our 1994 catalog. Can you tell what we're selling? (Answers follow.)

1. Lincoln medallion—bas-relief sculpture of Abraham Lincoln, "The Great Emancipator," on a disc of genuine copper. Cast by the U.S. government, it carries the inspirational motto "In God We Trust" and the patriotic word *Liberty* in raised letters. A slender 1/16-inch thick, it appears to the naked eye to be perfectly round.

We offer this unique piece for a limited time at a special price of $1. Those who order promptly will get an unexpurgated translation of *e pluribus unum*.

2. Portable hand-held word processor—writes in all languages and never needs batteries. It even performs all mathematical functions and includes a "delete" device to correct errors. $4.95

3. Solar-powered clothes drier—dries everything from lingerie to blankets, all at the same time. Does large loads or dries one item at a time using the same amount of power. Uses fusion power to save money on wash days and leaves your clothes sunshine fresh. $89.95

4. Transparent air conditioner—lets fresh breezes in with quick hand operation. Leave it fully open or fully closed, or choose one of the infinite settings in between. And unlike other air-conditioning units, this one doesn't block your view of the great outdoors. $99

The ultimate radio of the future?

5. Instant lenses—throw away your saline solution, because these lenses outlast contact lenses and can be removed instantly and even cleaned on your shirt. They fit in front of your eyes and stay in place with wires that utilize the body's natural eye-ear synergy. $89.95

6. Portable copier—instantly makes copies of handwritten lists, letters, sales receipts, and other documents. $39.95

7. When you travel to another time zone, do you avoid changing the time on your digital watch because it's such a hassle? Do you have to drag out the watch's instructions before you can "spring forward" or "fall back" an hour? Our new device incorporates Proproceptive Feedback Sensing Control to allow you to set the time on any watch with ease. $45

AnacroCo's looking for more new old-fashioned gadgets. Send us your suggestions, explaining the benefits of your device in 50 words or less. You must, of course, also tell us what it is. In a future issue, I'll highlight some of the best "improvements." The creator of the best gadget will win a 9,600-baud U.S. Robotics internal modem and a starter kit for America Online, home of Omni Magazine Online.

You may enter more than once, but each entry must be sent separately; we prefer postcards rather than letters. All entries become the property of *Omni* and cannot be returned. Entries must be received by December 15. Send to: Omni Competition #55, Retro-Breakthroughs, 324 W. Wendover Avenue, Suite 205, Greensboro, North Carolina 27408.

ANSWERS:
1. Penny
2. Pencil
3. Clothesline
4. Window
5. Glasses
6. Carbon paper
7. Winding knob


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