OMNI

JUNE 1983 $2.50

HOW GOD PLAYS DICE WITH THE UNIVERSE

ROBOTS BUILT FOR DESTRUCTION

MYSTERY OBJECT IN OUR SOLAR SYSTEM

PLUS:
MOON MIRRORS, SPACE WARS, CHINA'S UFO CULT, AND BEASTS OF THE MICROWORLD

OMNI®

VOL. 5 NO. 9 JUNE 1983

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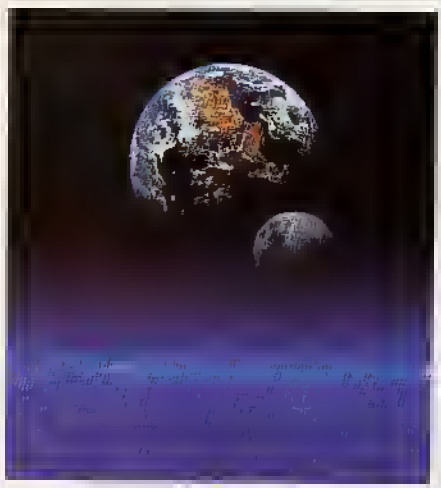

Worth a Thousand Ideas *was designed by Ken Cooper, a conceptual photographer living in Vancouver, British Columbia. A soft glow lures the beholder over the grid and into a future brewing with energy. The earth and moon await the traveler in space.*

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FIRST WORD

By Congressman Albert Gore, Jr.

"Supply-side science is a tragic, self-defeating mistake that will cripple America for years to come unless it is quickly changed."

Among the casualties of Reaganomics has been federal support for scientific research and development (R&D). In fiscal year 1983 all federal agencies, except the Department of Defense and NASA, have seen their R&D budgets slashed.

Scientific R&D is the indispensable link in a whole chain of activities that lead to technological innovation, increased productivity, and economic revitalization. The Reagan scientific program, however, ignores the importance of R&D and even the ways of science. Supply-side science is more than simply a by-product of the administration's decision to reduce overall government spending. It is a tragic, self-defeating mistake that will cripple America for years to come unless it is quickly changed.

The Reagan philosophy, as espoused by the President's science adviser, George Keyworth, and budget director, David Stockman, puts short-term economic concerns before scientific needs. When it comes to establishing research priorities, the administration blithely assumes the private sector can and will make up for cuts in government funding, but thoughtful private-sector observers know better.

The Reagan Administration now considers only two areas of research legitimate candidates for federal funding. The first is where there is "substantial prospect for significant gain to the nation but where private-sector investment is unlikely." In the abstract this sounds fine. In practice, however, these criteria have been used time and again as simply an excuse for the elimination of applied R&D programs in transportation, drastic cuts in programs for solar- and renewable-energy R&D, and the outright dismantling of NASA's successful program to transfer space technology to industry. The President has proposed ending the Department of Energy's research on industrial-energy conservation even though an administration review panel strongly underlined the need for it and questioned whether private industry would ever undertake this long-term, high-risk research on its own.

The other area still approved for federal funding is research that provides "a climate for technological innovation which encourages private-sector R&D investment." Translated, this means that any research that leads to scaling down or eliminating federal regulations is okay. But in the field of environmental controls, for example, the administration has actually been gutting the very programs intended to make government regulation more sensible. The President proposed cutting the fiscal year 1982 research budget for the Environmental Protection Agency (EPA) in half. And he vetoed the Environmental Research and Development Act of 1982, in part because it mandated that only the barest minimum of that agency's budget be reserved for long-term research.

To compound the damage caused by these supply-side cuts to federal research budgets, the administration has made perhaps the most serious mistake of all. It has cut funding for training scientists and science teachers. It takes almost a decade to train a Ph.D. scientist. Losing fellowship funds, even for a year, can mean the end of a career. Already, abrupt changes in federal support for scientific manpower training have begun to have an impact.

These are hard times—all the more reason why government investments should be well-directed. But Reaganomics as applied to science is seriously diverting our attention and resources.

Recently, for example, the President approved a plan to "privatize"—sell to private industry—this nation's orbiting fleet of weather and Earth-resources satellites. The public has invested heavily in this technology. Research on LANDSAT imaging and telecommunications technology has spun off important applications elsewhere. If selling these satellites will save the taxpayers money, as the administration claims, then we ought to consider it carefully. But we also need to think about what new research opportunities will be lost once we've auctioned them off and dismissed all the scientists and engineers who build and operate them. And while we debate whether to jettison this program and for how much, we need to remember that other nations, like France with its advanced imaging SPOT satellite, are about to overtake us technologically.

We desperately need to end this shortsightedness and rebuild the base of American technology. The money that Stockman and Keyworth feel they are saving now is being diverted largely to defense R&D, which of course has its place but has historically produced few benefits for the civilian economy in proportion to the massive expenditures that are required.

There are no guarantees in science. But we can be thankful that President Kennedy didn't balk at funding the space program because it didn't meet standard investment criteria and that we didn't refuse to form the National Institutes of Health because government computers couldn't calculate the social and medical benefits of curing cancer.

What is needed is not supply-side science but a strong commitment to an aggressive, forward-looking national science policy. I and many of my colleagues encourage the Reagan Administration to develop one. ∞

Albert Gore, Jr., Democrat from Tennessee, is chairman of the House Committee on Science and Technology's Subcommittee on Investigations and Oversight.

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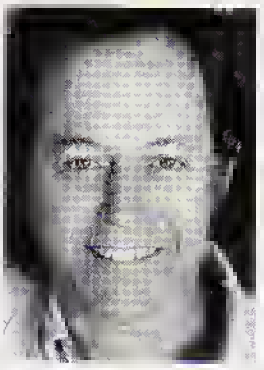
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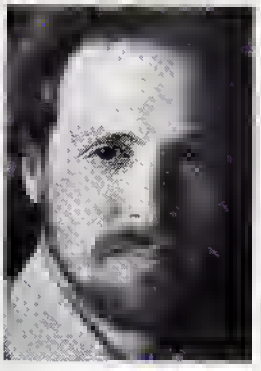
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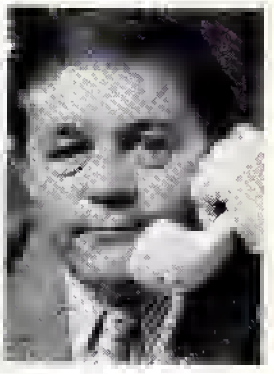

O'TOOLE

Ever been kept awake by a dripping faucet? And have you been doubly disturbed because you can never tell when the next drop is going to fall? Ever played roulette and wondered why no one has developed an instrument that can predict where the little ball will end up? What about the weather; why can't meteorologists give us accurate forecasts more than three days in advance?

These are the questions scientists pursue in one of the newest, most exciting disciplines of our age: chaotic dynamics. Scientists are learning that nature does not operate according to the clockwork precision of Newtonian physics and that, Einstein notwithstanding, God does indeed play dice with the universe. In "Connoisseurs of Chaos" (page 84), you'll meet a handful of courageous researchers who are not afraid to peer into the face of madness. They are attempting to unravel chaos, nature's method for deciding the patterns of fluid turbulence, the precise moment your heart will degenerate into arrhythmia, or whether the weekend will be fair or stormy. Contributor *Judith Hooper* took the title of the piece from a poem by Wallace Stevens. "Researchers in chaotic dynamics think, and talk, more like poets than physicists. They are people," says Hooper, "possessed by the beauty of randomness."

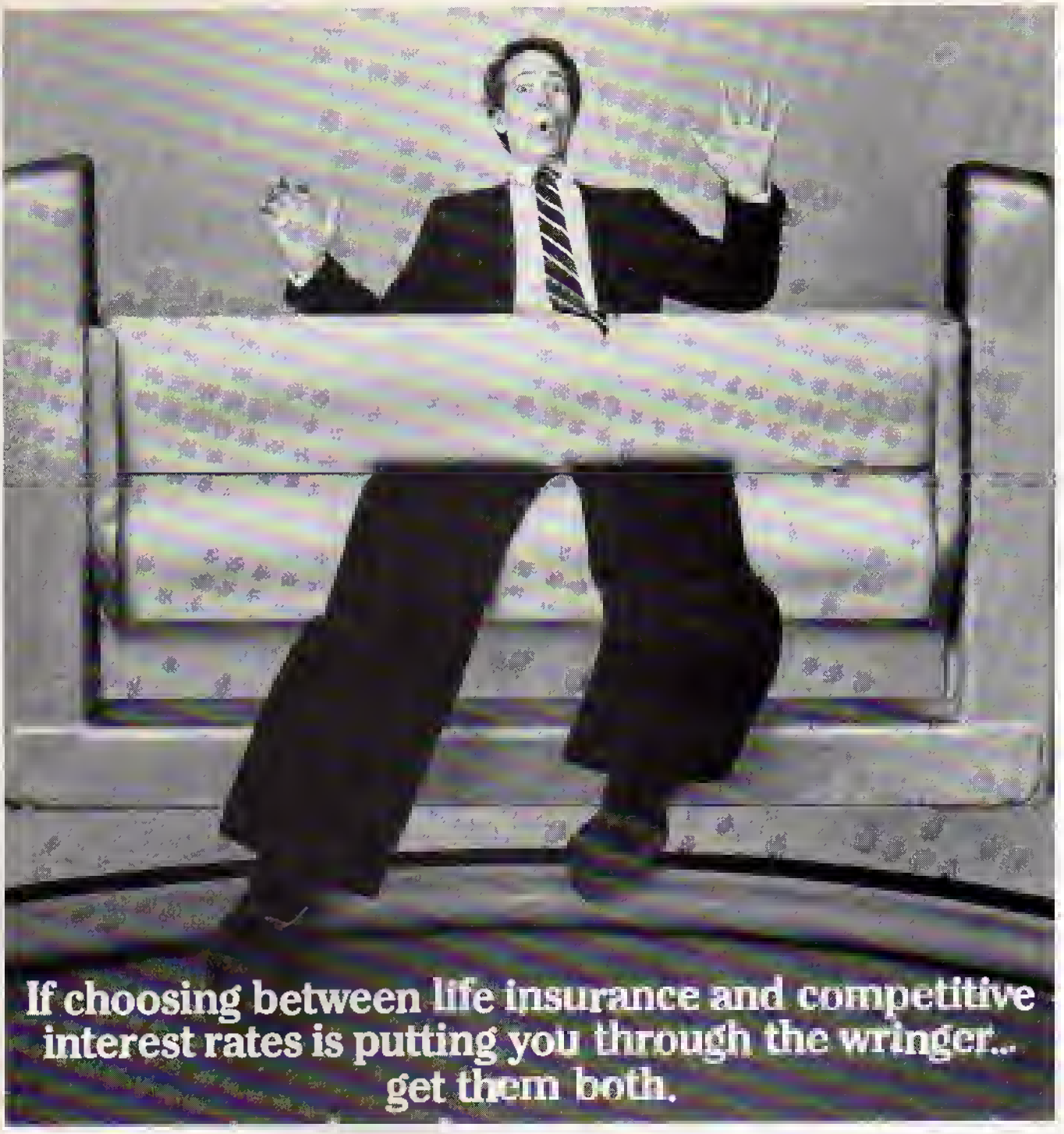
Joseph P. Allen has seen a lot of the world. Last November, aboard the space shuttle *Columbia*, he traveled 2 million miles in five days, circling the globe a total of 82 times. From this special vantage point, Allen observed the awesome three-dimensionality of Earth. The spaceship provided a breathtaking view of brush fires in Africa, lightning storms streaking across Australia's outback, and the colorful halo of the aurora borealis at each pole. After reentry, Allen recounted his rare experience to *Washington Post* space correspondent *Thomas O'Toole*. "Joe's Odyssey," Allen's lyrical description of an astronaut in flight, starts on page 60.

Through the magic of satellites hovering 22,300 miles above Earth, we will soon be able to enjoy a sophisticated new art form combining video, quadraphonic sound, computer-generated special effects, animation, and artwork—all without leaving our homes. That's one conclusion *Richard Wolkomir* draws from his inside look at Comsat, the communications-satellite company, and from some of its rivals in the contest for geostationary orbits. According to Wolkomir, a freelance writer whose specialty is high technology, we can look forward to obtaining our pay TV from two-foot dish antennas on our rooftops. We'll also have programs and information channels that cater to our special interests, and we'll enjoy transglobal conferences that are travel free. For the inside scoop about the coming communications revolution, turn to "Satellinks," on page 52.

Dr. Henry J. Heimlich is responsible for all those restaurant-wall posters of people choking. As readers may know, he is the genius behind the Heimlich maneuver—a method of rapidly disgorging food from blocked air passages. Ingenious in its simplicity, this one-step procedure has prevented thousands of deaths since it was introduced in the mid-Seventies. Yet it is only Heimlich's most publicized innovation. His other achievements include a host of lifesaving devices, such as a chest-drainage valve and a portable breathing apparatus. In this month's Interview (page 80), freelance writer *Douglas Starr* squeezes this medical inventor so he coughs up lots of wisdom about the stock market and world politics, about his plan for using computers to promote peace, and about the workings of the creative mind.

Larry Niven is best known in science-fiction circles for his Hugo- and Nebula Award-winning novel *Ringworld* and his powerful and popular collaborations, *Lucifer's Hammer* and *Oath of Fealty*. His latest contribution, "A Teardrop Falls" (page 100), is a futuristic tale of robot "berserkers," machines primed by unknown masters to destroy every living thing that crosses their path.

Omni's other fiction offering comes from *Gregg Keizer*. In "Edges," starting on page 64, Keizer tells of a post-nuclear civilization in which competitors wind-surf across salt flats and collide with mirages from earlier epochs.



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JUNE

LETTERS

COMMUNICATIONS

Granny's Song

I somehow couldn't stop the creation of this little verse after reading the story by Phoebe Hoban about the "Bionic Granny" who had eight major joints replaced in surgery [Continuum, February 1983]:

Let's offer a prayer for a Bionic Granny.
They've replaced all her parts 'cept a bionic fanny.
The surgeons said, "Madam, it's nothing so drastic.
If anything hurts, we replace it with plastic."
Other methods of health care? Don't even try it.
They might suggest vitamins, minerals, or diet!
That holistic bunch is completely demented,
This medical milestone must be prevented.

Jon Von Gunten
Burbank, CA

Record Breaker

Vernor Vinge's predictions about future intelligence [First Word, January 1983] should go down in your record books as an example of how far astray one can go with a severe case of tunnel vision. Good grief!

W. P. Williams
Seattle

A Helping Hand

Trent D. Stephens's UFO Update [Antimatter, January 1983] on alien characteristics is a thorough collection of weakly glossed-over facts combined with hyperbolic opinion.

It is paintully obvious that Stephens practices the "don't confuse me with the facts" method of speculation instead of actually investigating his topic.

A single case in point is his requirement of "humanoid arms" to fetch firewood. This ignores a rather large and, incidentally, quite intelligent exception, commonly known as the elephant. This creature, with the aid of tusks and a quite dexterous trunk, is an effective manipulator of its environment.

Let's not even mention the amazing dexterity of the octopus and the squid. Look, Ma! No hands!

James Matthews
Denton, TX

Meddling Ethnics

Judith Hooper's article "Ethnotherapy" [Mind, February 1983] has convinced me of one of two things: Either Judith Klein is almost all wrong, or I am not Jewish.

In my large, close-knit "extended family" there are many Jewish mothers straight from the "old country," but none of them are meddlesome or domineering. The only "Jewish motherly" trait they exhibit is a periodic urge to serve large amounts of Jewish food to relatives.

Roberta Gluzband
Chestnut Hill, MA

Having been bred and raised by persons of many ethnic heritages, including Irish, your article on ethnotherapy intrigued me. I liked it, but I caught a trace of bias against the Irish. Let me bring certain points up that you seem to have missed.

First, the Irish do tend to seek wedlock with other ethnic groups, yet please note that they also seek kinship with Erin. It's a two-way aisle.

Just as the Irish seek more stable families, their Jewish or Italian mates seek looser ones. Neurotics need a bit of the psychotic. Look at the English. Without their touch of Celt, they'd be like the Germans, with close family bonds.

As for the pranks of an Irish upbringing, what do you think gives the Shaws, Kennedys, and Reagans their wit and charm? It's unhealthy to be too serious.

J. P. Scribner
New Canaan, CT

Lip Service

Thanks for Derek Best's excellent article on radio drama (The Arts, February 1983), and in particular for the glowing praise of the "classical resonant voice of the narrator." I could only have been more pleased if you had mentioned the narrator's name—Ken Hiller.

Catherine Brooke
Minneapolis, MN

DIALOGUE

FORUM

In which the readers, editors, and correspondents discuss theories and speculation arising out of Omni. *Readers are encouraged to debate views and pose questions to* Omni, *the scientific community, and the science-fiction establishment. The opinions published are not necessarily those of the editors.*

Dr. Patterson's Black Box

I am a recovering addict/alcoholic with six-plus years of total abstinence from all mind-altering chemicals. My physical addictions included heroin, alcohol, methadone, and barbiturates; so I thoroughly understand the physical and emotional pain of detoxification. For the past five years I have worked as a chemical-dependency counselor, my specialty being detoxification units.

Kathleen McAuliffe's article "Brain Tuner" [January 1983] was a breath of fresh air. It's about time we started looking beyond the macho "kick it like you shot it" attitudes and the Valium/Librium substitution syndrome of the private physician. It's very refreshing to hear that addiction is being approached biochemically, intelligently, and with a new perspective. If Dr. Margaret Patterson's "little black box" does anything near what it appears to do, it may at least offer some alternative to the prevailing treatments. I applaud Dr. Patterson's efforts; we are involved in the same war.

Richard Poccia
San Mateo, CA

Future Profit Sharing

I think *Omni* has allowed its predictions to be influenced by government and company policies that are outdated and advocate industrial ideals that no longer relate to our generation ["Our Future Stock," January 1983].

Projections by the U.S. government are generally based on past trends and assumptions that other things will remain as they are, whereas in reality the coming changes in our business and social lives will be so drastic that old rules will no longer apply. Any projections will probably be off by quite a sizable percentage.

The rising cost of housing and necessities will likely force people back to group living (not only among families but also among working people away from home), rather than into smaller households. This trend will prove to be more economical and will create better communication among people. It may not continue, but I don't see people breaking into isolated groups of two or three in the near future.

New technology will not necessarily mean automatically lower prices. It will cost a great deal for the farming community to change over to a roboticized and computerized farm while having to phase out the existing machinery that will be obsolete. Unless the expenses and profits of change are managed and shared, this kind of development will drive prices up rather than down.

Unless we have a total restructuring of profit distribution and workforce, robotics and computer control in industry will mean only higher unemployment and worker frustration.

There is no doubt in my mind that the advances we see today in science and technology can lead to a better world for mankind, but only if we turn away from current trends in economics that permit a small minority of the population to benefit at the expense of others.

Warren Caruk
New York City

Pyramid Theorists

I realize that *Omni* serves as a forum for new and unconventional ideas, but Joseph Davidovits's theory that the blocks of the pyramids were cast rather than cut ["Plastic Megaliths," February 1983] crosses the line into the truly ludicrous.

As a professor of ancient history, I am constantly confronted by students with the screwball ideas of such people as Velikovsky and Von Däniken. There seems to be a great reluctance to accept that human beings could have accomplished what they have in some simple and mundane fashion. Occam's razor is discarded, and flashy explanations involving alien visitors or plastic stone are taken up instead.

Contrary to the statement of Douglas Starr, the construction of the pyramids can be satisfactorily explained in terms of the engineering skills available to the Old Kingdom Egyptians. There is debate over precisely what methods were employed but absolutely no doubt that Egyptian technology and the tremendous labor force available during the months of the Nile flood allowed the erection of the pyramids.

All new ideas deserve some attention, but this one would be more appropriate in Antimatter.

Richard Berthold
Albuquerque

The late Edward Kunkel spent his life working on the hypothesis that ancient Egyptians used a hydraulic pump to construct the pyramids.

Kunkel printed a series of five books under the title *Pharaoh's Pump* and erected over the years a model of the pump on the grounds of a local sportsmen's club.

Kunkel believed the massive slabs of stone were positioned by water displacement. He had no belief in the age-old "harness slave ramp" mechanical method of pyramid building.

Kunkel said he believed the pump lay buried beneath several tons of rock "known to millions as the interior of the Great Pyramid." He felt that the pyramids were not monuments to kings but "are the results of ancient hydraulic-engineering research."

The five-star final edition of *Pharaoh's Pump* opens with a letter Kunkel received from George Washington Carver, dated March 3, 1934. It says, in part, "Your explanation, I believe, is the solution of one of the greatest mysteries of all ages." Kunkel believed the stone blocks were floated on barges through a series of locks, and when in place, the water level would be lowered to let the block fit in the right spot.

Cathie McCullough
Lisbon, OH

CONTINUED ON PAGE 140

A BITTER FOG

EARTH

By Carol Van Strum

On a spring morning in 1975, four children went fishing in the river bordering their home in the wilderness of the central Oregon coast. The river was the pulse and breath of their young lives. They knew the nests of thrushes, sparrows, and kingfishers along its banks, the dance ground of the grouse, the tracks of the beaver, raccoon, heron, and bear on its sands, the favorite rocks of the dipper. They swam in its pools in summer and cheered the salmon up its flooded waters in winter. Log trucks and other mill traffic rumbled by on the road above their riverbank, but the river world had adapted to the noise, and the children no longer noticed it.

On this particular morning, however, a heavy tank truck crawled ponderously along the road, its engine whining in low gear. Two men perched on the back, each holding the nozzle of a thick hose that sprayed a bitter substance onto trees, brush, thistles, and ferns along the roadside. Where the road skirted the riverbank, overhanging shore and water, they directed their hoses into the water, inadvertently spraying the four children fishing down below.

The truck moved on, leaving the children gasping in a wet mist that clung to their skin and clothing. With smarting skin, tearing eyes, burning mouths, throats, and noses, they stumbled home. By nightfall, all four were sick with nausea, vomiting, cramps, headaches, diarrhea. One of the boys had an uncontrollable bloody nose.

The four children sprayed by the county road crew that June morning were my own. The river they were fishing in was Five Rivers, bordering our farm in the Siuslaw National Forest. And the substance that showered them was a herbicide, or plant poison—a quick, economical, and effective method of killing unwanted plants that encroach upon roadsides and impede the growth of timber and crops.

The children's father had run after the spray truck that morning to find out what was sprayed. The men on the truck had told him that the spray was perfectly harmless. "Just 2,4,5-T," they said. It only kills plants, and you can drink the stuff without being hurt. So we told ourselves it was all a coincidence, that we'd probably just come down with the flu or something.

It was harder to regard what happened to the river as a coincidence. The day after the spray truck came, we went back and saw that the river had changed. The leaves of alder and willow on both banks had wilted, their new growth twisted in unnatural spirals. The water had an oily scum on it. Floating or beached on the shore were dead crayfish and trout, and the sodden bodies of two merganser ducklings. Songbird nests along the shore were empty, except for one, in which a hermit thrush still sat, dead. Staring down at the dark water, we realized our sickness was no coincidence. What had happened to the river was happening inside our children's bodies.

In the next weeks, as spraying continued, we had an epidemic of deformities among the chicks, ducklings, and goslings that hatched on the farm: crossed beaks, stunted or missing wings, toes, or whole feet on backward, and stunted growth. We tried surgery on some. An operation on one gosling with club feet was partially successful. One foot healed, but the other remained twisted backward. We called our patient Lord Byron.

The dog that had been in our family for 16 years developed a large, oozing lump on his back. The vet couldn't explain it. He removed it, but within a few weeks similar lumps appeared all over the dog's body, particularly in his groin. One night his kidneys failed. He was in such pain it was out of the question to drive him 50 miles to the vet. Shooting him was a grim kindness.

My husband, Steve, spent days at the Oregon State University library reading studies on 2,4-D and 2,4,5-T, the phenoxy herbicides. The studies he found did not agree with what we'd heard from state and federal officials. The 2,4,5-T, we learned, was contaminated with dioxin, a highly toxic compound that can accumulate in the food chain. Both the

CONTINUED ON PAGE 136

Herbicides are poisoning people and wildlife throughout forests of the Pacific Northwest.

WOMB FOR HIRE

LIFE

By Gini Kopecky

Her husband had a vasectomy after their second son was born. "We wanted two children, and we were satisfied," says Mary (not her real name). Then she tuned in to the *Phil Donahue* show on a day when Donahue's guest happened to be Dr. Richard Levin, founder and president of Surrogate Parenting Associates, Inc. (SPA), of Louisville, Kentucky. The subject of the program: surrogate mothering. "I thought it was fascinating," says Mary. "I thought it was the best alternative to adoption that I had heard of yet. And it would give me a chance to do something special." Three months later Mary was on her way to Kentucky. Today she is pregnant with her fourth child, her second by artificial insemination—the second she will surrender upon its birth to the sperm-donor father and his infertile wife.

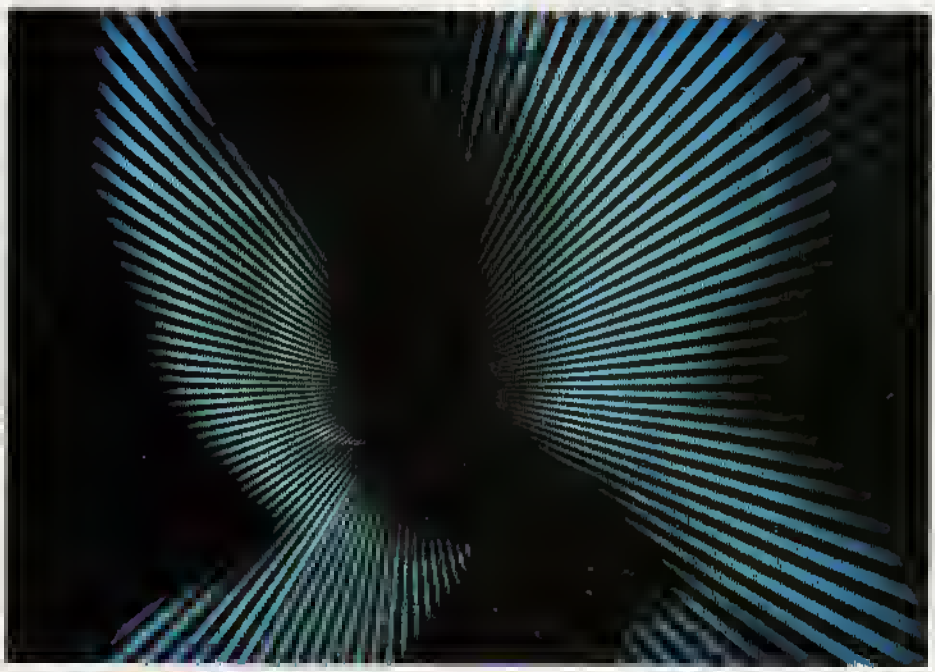
No one knows exactly how many children have been born to surrogate mothers. But whatever the number, it seems to be growing. "There's a lot of action stirring about," says Dr. Levin, who claims to have handled "hundreds" of cases since the birth of SPA's first surrogate child in November 1980. Michigan attorney Noel P. Keane, who is also well known for bringing couples and surrogates together, places the number at a more conservative "minimum of seventy-five." But he anticipates the figure may climb to 300 this year, as services proliferate to meet the needs of couples who might otherwise have turned to adoption. "Fifty percent of these people would adopt if they could," he says. "But there are no babies. That's what brought about this whole movement."

The other 50 percent may never have looked into adoption—so strong is their desire for a child that, at least partially, is biologically their own. As long as they can afford the fee, which generally ranges upward of $25,000, it is unlikely that any surrogate-parenting group will turn them away. Levin, for example, requires only that couples present a health report, a recommendation from their physician, and documentation of the wife's infertility or other medical or genetic disorder that disqualifies her from bearing children. Beyond that, he does not probe. His basic philosophy is that "people have certain intrinsic rights and the ability to procreate is one of them. You or I don't have the right to tell people that they can or cannot have a child."

He does, however, have some very definite ideas as to what type of woman makes the best surrogate mother; the first requirement is that she must already have children of her own. "Women who have never had a child cannot properly understand what we're asking of them," he says. "Such women cannot give informed consent. The psychological ramifications for them, and ultimately for us, are too risky." Levin also looks for women whom he classifies as "mothers. They're like mother bears who will kill anything that tries to hurt the baby bear. They're women with strong maternal instincts who believe that what they're doing is important for society."

So many prospective candidates have contacted SPA that Levin has had to switch from floppy-disk to hard-disk information storage. To qualify, prospects must submit to rigorous medical screening, followed by a psychiatric examination of both the surrogate and her husband. "We want to know, are they crazy? Are they stable, mature people? Do they have a sound marital unit that will not be damaged by this process?" Finally, both husband and wife are invited down to Louisville to be interviewed by Levin himself. "You develop a second sense," he says. "You know who is appropriate and who is not."

Usually, an invitation to Louisville means that Levin has already tentatively matched the surrogate with a particular infertile wife. "We use a range of weight, height, eye color, hair color, blood type, ethnic background, religious background, basic body structure, and other things a couple may ask for, if they're within reason," he says. "Some couples may want someone with athletic ability. Or they may want a woman who is artistically or musically inclined, or who has high intelligence. Don't ask me if that means anything. But if that's what they ask for,



I'll find it for them." If all parties agree to the match, a contract is signed by the surrogate and the sperm donor. She agrees to relinquish the child at birth. He agrees to assume all responsibility for the child, whatever its condition. She agrees not to smoke, drink, or take any medication without Levin's permission. He agrees to pay all her medical and travel expenses—as many monthly trips to Louisville as are required until insemination results in pregnancy or until both parties agree to call it quits.

If requested, Levin will arrange for couples and surrogates to exchange letters or speak over the telephone during the course of the pregnancy—strictly on a first-name or false-name basis. "Most surrogates do have a desire for some relationship with the parental couple," says Philip Parker, clinical instructor of psychiatry, at Michigan's Wayne State University, and author of a longitudinal pilot study on surrogate mothers who have been referred to him for consultation by Noel Keane. "It helps them to develop a feeling of empathy with the couple and to deal with their own anticipated loss." So, too, do couples seem to benefit from this contact. Patty, who gave birth to her first surrogate child one year ago, remembers, for example, her first telephone conversation with her own parental couple. "I could hear the woman crying. She said that talking to me finally made it seem real to her."

It is not until actual delivery time, however, that Levin's couples and surrogates actually meet face to face. "Of the whole thing, that's what I feared most," says Jane, speaking from the hospital where, only a few hours before, she and her husband, Joe, had witnessed the birth of their surrogate son. "I guess I was afraid I wouldn't know what to say to her. I was really worried until I met her, and then I relaxed." Indeed, in describing these meetings, couples and surrogates inevitably seem to have only the most glowing things to say about one another: "She was a fantastic person; we just liked everything about her." Or, "I couldn't have asked for a nicer, more loving couple." According to Parker, such praise from the surrogate may be motivated, in part, by her need to "idealize the parental couple," who, in turn, cannot help but idealize her. "I was the angel sent from heaven," recalls Mary. "If you ever need your ego inflated, be a surrogate mother at delivery time."

If the surrogate has no objections, couples who so desire may also be present in the delivery room to witness the birth. When Joe and Jane's son was born, first Jane, then Joe, and then the surrogate held him. "The surrogate didn't mind," says Joe. "She wanted us to bond." Says Bob, another sperm-donor father who, along with his wife, Kay, recently witnessed the birth of their infant daughter, "I've never had anything happen to me that compares. I usually don't cry, but there were tears in my eyes."

Aside, perhaps, from another brief glimpse through the nursery window before she leaves the hospital, that moment of birth is the last time the surrogate ever sees the child. "I'm sure it will be difficult," says Linda, speaking from the hospital the day before she gave birth to Joe and Jane's son. "I'm not going to walk away without a tear. But these people have waited such a long time to have a baby." Most surrogates further prepare themselves for this moment of relinquishment by reminding themselves, over and over throughout the course of the pregnancy, that "this is not my child." Says Linda, "It takes a lot of willpower. There are a few crisis times—when you're inseminated, when you find out you're pregnant, when the baby starts moving. But you just have to set it in your mind that this baby is not yours." Of her first surrogate pregnancy, Mary says, "All I could picture was delivery time and two people with the biggest smiles on their faces. I just kept picturing how happy they would be holding the baby. And I know, because I've been there myself." This doesn't mean that surrogates experience no subsequent grief reactions. According to Parker, many of them do, but so far, there hasn't been anything they couldn't handle. "There are always going to be reminders," says Patty. "Like, right now, my neighbor's baby is learning to say *Mommy* and *Daddy*, and that evokes a strange feeling. On those rare times, it bothers you. But it passes quickly."

"The Church objects to surrogate mothering because it's unnatural. Well, so was the virgin birth. Jesus may have been the first surrogate child."

How can women do it? Why do they do it? Based on personal interviews with applicants numbering "in the four-figure range," Levin offers three reasons. "First, they do it for themselves. Some women love being pregnant, and they see this as an opportunity to enjoy that reproductive experience without paying the consequences." Second, he says, they do it out of "altruism, to help someone else in a unique way, as only they are able to do." Third, and "least of the bunch," he says, is the "financial aspect"—seldom much more than $10,000, which he sees more as "a stipend, an honorarium, a little thank-you. You couldn't pay this woman what her services are worth."

Says Mary, "I know you'll hear surrogates say this over and over again; money is not the main thing." Sometimes, in fact, she is bothered by the money—$8,000 her first time around, $10,000 this time—so much so that her future goal is to serve as surrogate to a couple "who can afford to support a child but who cannot offer a fee. That is constantly on my mind." To these three reasons for becoming a surrogate, Parker would add a possible fourth: the desire to resolve through voluntary relinquishment of a surrogate child the previous, unresolved relinquishment or loss of a child to adoption or abortion. For example, he recalls one surrogate who claimed that "as a result of having some phone contact with the parental couple who accepted this child, she felt more confident about the personality of the unknown couple who accepted the newborn that she put up for adoption when she was fourteen."

Were funding available, Parker would also like to see studies conducted on the children themselves. "Nobody has followed up to find out how they are doing. Are they going to do well? Or are they going to end up in a psychiatrist's office before they start school?" He would also like to compare such family units to those in which couples have adopted—and, hence, bear no biological connection to the child—and those in which the wife conceived through artificial insemination by donor (AID). "With AID, the husband does not have a biological connection to the child, but the wife—the primary caretaker—does. Comparative studies need to be done with that in mind. How a woman feels about her own infertility, whether she sees the child as her own, or whether she sees herself as a caretaker for her husband's child will influence the way she raises that child."

Jane has put much thought into the biological question. "It might take some working on," she says. "If someone implies that he's not my child, I might have some difficulty, but I think I'll be able to handle it." Says Kay of her feelings toward her daughter, "I know I'm sharing part of her with another woman, but it's like we were sisters or something." Sisters who, if they are wise, will have no substantial future contact. Levin tells of one couple who discarded his advice that couples and surrogates never fully identify themselves to each other. "They told the surrogate who they were, where they lived. They sent her a whole album of pictures at Christmastime. Well, their baby is now a year and a half old, and the surrogate wants to come to their house and visit. They realize that they didn't allow her to cut cleanly and get on

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PLANETARY BLUES

SPACE

By Ben Bova

While NASA's space shuttles are roaring up into orbit with increasing regularity, many scientists worry that the exploration of space is coming to a halt.

That isn't as contradictory as it sounds. *Columbia*, *Challenger*, and their sister shuttles still under construction are space-going trucks; they carry payloads into low orbit around the earth, no farther. Space scientists such as Carl Sagan, Bruce Murray, and many others are grievously concerned that very few of the shuttles' payloads will be scientific equipment for the exploration of the solar system. Indeed, they point out that so much of NASA's budget has gone into developing the shuttle that space science has been fiscally strangled.

Murray unexpectedly resigned last year as head of the Jet Propulsion Laboratory, in Pasadena, California, where NASA's planetary-exploration program is planned and directed. In part, his departure resulted from dissatisfaction with the pace of the current program. "The United States [has] unilaterally abandoned world leadership in planetary exploration, one of the twentieth century's most uplifting and challenging technological and scientific enterprises," according to Murray.

For 20 years, American space probes have visited every planet known to the ancients, starting in 1962 with the *Mariner 2* flyby of Venus and culminating in 1981 with *Voyager 2*'s spectacular flight past ringed Saturn and its moons. During the U.S. bicentennial year, two *Viking* spacecraft landed on Mars and examined samples of Martian soil to determine whether life exists on the Red Planet.

None was found. And since *Voyagers 1* and *2* were launched in 1977, there has been no new life in planetary exploration. Not a single mission has been approved by Washington. Instead, several proposed missions have been stretched out and others killed outright. Among those killed, the most painful are:

- The mission to Halley's Comet, which would have flown a probe through the comet's tail. Two Russian, two Japanese, and one Western European spacecraft will go to Halley's Comet in 1986. But no American probe will.
- The International Solar Polar mission (ISP), in which the United States would have sent a spacecraft looping over a pole of the sun to study our day star in regions where it cannot be seen from Earth. ISP was to be a joint mission, with the European Space Agency sending a spacecraft around the sun's other pole. The U.S. cancellation particularly upset the Western Europeans, who were left with half a program.
- The Venus Orbiting Imaging Radar (VOIR) program, which was to place a satellite in orbit around Venus to map the surface of our sister planet with radar that can penetrate its clouds.

Louis Friedman, executive director of the Planetary Society, says that the Reagan Administration "has been nothing but negative. . . . They have not made a commitment, either in terms of policy or programs, toward having the United States continue in an active role in the exploration of outer space."

The Planetary Society is a grass-roots activist organization that was founded by Murray and Sagan to further the cause of planetary missions. "In 1981 the Reagan Administration tried to cut out planetary exploration altogether," Friedman says. "That was found to be politically unacceptable." But, he adds, the Reagan White House has "turned down all proposals to initiate new programs."

Many of the space scientists see the shuttle as the main culprit in their scenario. For years now, the shuttle has absorbed more than half of NASA's total budget, while space scientists have received from 10 to 15 percent—and only a part of that goes toward planetary programs. Moreover, several planetary-exploration missions were built around the idea of using the shuttle as their primary booster. The long delays in the shuttle schedule—it was originally supposed to be operational in 1979—have delayed shuttle-based planetary programs. Now scientists such as Friedman are worrying that the shuttle may be too expensive to use for most scientific missions; cheaper

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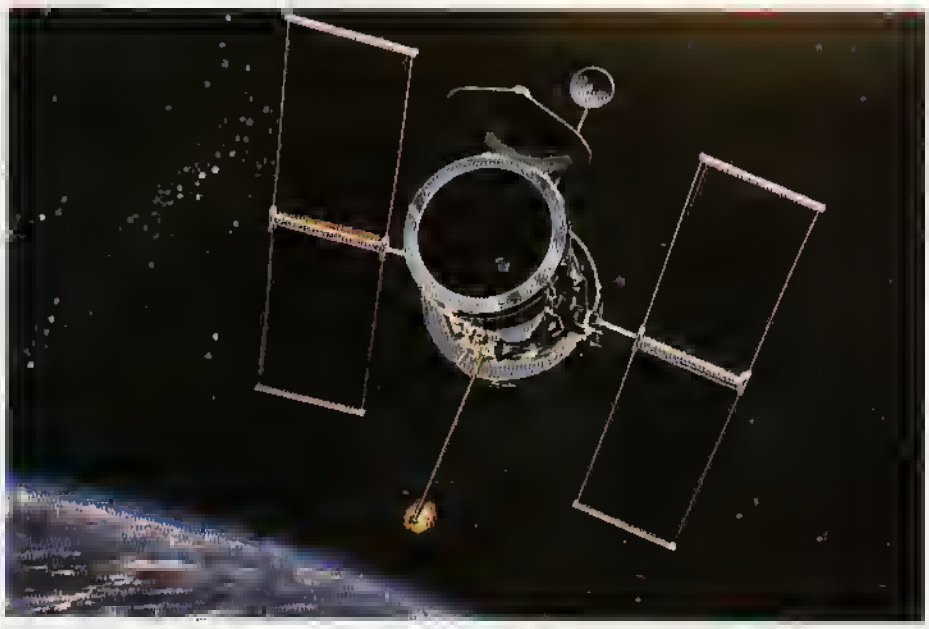

Space Telescope: Astronomers will have to fight for time to peer deep into the universe.

THE CHIRON MYSTERY

STARS

By Charles Kowal

It is a natural human tendency to try to classify the objects in the world around us. But once in a while nature produces a freak that simply will not fit into any known category. One such freak is Chiron.

Chiron is a mysterious object that travels in our solar system between the orbits of Saturn and Uranus. When I discovered this unique object in 1977, scientists were disturbed as well as excited; each tried to squeeze Chiron into his own favorite pigeonhole—with little success. Most astronomers labeled it either an asteroid or a comet, depending on their specialties. Some speculated that it might be an escaped satellite of Saturn, Uranus, or Neptune, or a new species of space objects. The news media heralded it as a "possible tenth planet." The debate continues today.

Much of this confusion arises from the nature of Chiron itself. Because it is rather faint, it is difficult to study in detail. Nevertheless, as astronomers continue to observe it, they have gradually learned a few things. Using infrared techniques, astronomers at the Mauna Kea Observatory, in Hawaii, determined that Chiron is 300 to 400 kilometers in diameter. Its surface is dark and covered with either dust or rocks, a makeup similar to the surfaces of some asteroids.

Though we know very little about Chiron's physical properties, we know its orbit quite well. This is because Chiron has been photographed repeatedly since the nineteenth century. Images of it have been detected on photographs taken as early as 1895, but it wasn't until 1977 that anyone noticed it was there.

This long series of inadvertent observations lets us compute its precise orbit. We now know, for example, that its period of revolution around the sun is 50.7 years. With this information we can compute Chiron's orbit back as far as the third millennium B.C. Every few thousand years Chiron passes extremely close to Saturn. These close passes drastically affect Chiron's orbit, making it unstable. Because its present orbit is so unstable, Chiron could not possibly have remained where it now is since the beginning of the solar system; it must have come from somewhere else. This is the fascinating mystery about it: Where did it come from? What is it?

Though Chiron is similar in size and surface composition to some of the larger asteroids, it probably is not one of them. Almost all of the asteroids lie in a belt between the orbits of Mars and Jupiter, and even the most eccentric pass through the belt during some part of their orbit. Chiron never goes anywhere near the asteroid belt. Therefore, this indicates that it almost certainly originated in a different part of the solar system.

Other astronomers have mentioned that Chiron's orbit would not be unusual for a comet. This observation is of little value, since comets can be found almost anywhere. Furthermore, comets are typically 100 times smaller than Chiron. Even the magnificent Halley's Comet is less than 10 kilometers in diameter.

If Chiron is not related to asteroids or comets, the only other objects it resembles are some of the satellites of the planets. In fact, Chiron does resemble Phoebe, Saturn's outermost satellite, in both size and physical makeup. It seems at least possible that Chiron could be an escaped satellite of Saturn itself, or perhaps of Uranus or Neptune.

But it is not that easy to rip a satellite from its planet. It would take the gravitational influence of some massive body—something on the scale of Neptune—passing close by to do this. Could this body still be out there somewhere in the solar system?

Right now Chiron is almost as far away from the sun as the planet Uranus, but by 1995 its eccentric orbit will bring it *much* closer. At that time it will be much brighter and much easier to study. Then we should be able to learn much more about its physical nature and perhaps even about its origin. Until then, however, Chiron will have to sit in a pigeonhole all by itself, a freak of nature. ∞

Asteroids in orbit: Is the mystery object Chiron one of them, or is it something stranger?

Charles Kowal is an astronomer at the California Institute of Technology who, in addition to having first sighted Chiron, is credited with the discovery of various sky objects—from supernovas to moons orbiting other planets.

THE ARTS

By Douglas Stein

At a recent group show—*A History of Androgyny in Art*—at Long Island's Hofstra University, Nancy Burson exhibited one work. The piece, entitled simply "Androgyny," was a computer-generated photographic composite of six male and six female head shots. Although it measured only 9" × 7" and was inconspicuously placed within the installation, it consistently drew large crowds of highly vocal viewers. The magnetism of the portrait seemed to grow from an unsettling feeling: Though one initially encountered an overall femaleness of expression, the lingering effect was of a characteristically masculine obduracy and intensity—and a disconcerting sense of ruthless indifference.

At the opening a youthful couple standing in front of the piece were heatedly engaged in their own compressed version of *Scenes from a Marriage*. The gesticulating man would not believe the image he was looking at was an equal melding of the 12 preliminary snapshots displayed to the left of the composite. He insisted that Burson had stacked the deck in favor of the female. But his partner reacted to the portrait's subliminal maleness. On the surface she saw a female, but underneath she perceived a male.

New York City artist Nancy Burson developed her computerized "facial warping and stretching system" in 1978, and at that time it constituted a major breakthrough in computer-graphics technique. It was one of the first occasions when a computer interacted substantially with a live image, or a photographic representation of what Burson calls a "real-world object."

In 1981 Burson was awarded a patent for her process. Subsequently the program has grown to include approximately 11,000 lines of software, and it has many applications. The way it basically works is this: A television camera scans the given image into a computer; about one second later the image becomes digital information—that is, it is transformed into tiny electronic segments called pixels. The resolution Burson uses is roughly 65 percent finer than a standard television image.

The actual "averaging" of the individual faces to an overall common size and the "warping" of the particular features of each face to fit that acquired average are done on two AED (Advanced Electronic Design) frame buffers, and they utilize two separate menus. What differentiates Burson's innovation from previous composites, which are essentially photo montages, is her intricately programmed use of grid systems to achieve the exact "on-top-of-it-ness" of each set of eyes, each nose, mouth, cheekbones, and so on. Since in the human face only the eyes—center to center—tend to be most nearly aligned, the process begins there and proceeds to "warp out" or "warp down" to precisely align each of the other features. Treating faces as so much living toffee, Burson is engaged in a kind of intimate geometry, a Cartesian cartography of the face. Given her range of choices and commands in these programs and the necessity of properly sequencing them, she finds the technical expertise of computer scientists Richard Carling and David Kramlich indispensable in the fabrication of her work.

The most striking quality of the "Androgyny" composite is the overt predominance of the feminine. A close look at the preliminary photos only heightens this surprising phenomenon. These snapshots were randomly taken by college students and were selected from hundreds for their extreme heterogeneity, their structural and expressionistic dissimilarity to one another. One notes how decidedly masculine the male photos are—even how masculine a few of the female are—and yet how overtly female is the whole. Burson admits to being baffled by these results. She points out, however, the common tendency among adults when seeing a small child for the first time is to perceive it as a girl.

"Portrait of Baby William" is a more lighthearted treatment of the female-as-basic-unit theme. An equal fusing of the faces of Prince Charles and Princess Di, the offspring of this experiment is what

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Face of destructive power: In this composite of nuclear warheads, Brezhnev predominates.

THE ARTS

By Mitch Tuchman

Richard Marquand sat on the knee, if not in the lap, of American luxury and professed his astonishment at being part of "all this." Catamarans drifted across the man-made lagoon whose waters splashed upon the redwood deck of his rented San Francisco Bay Area villa. He had been with Martin Luther King, Jr., in Selma, Alabama, in 1965. Now he was with George Lucas in suburban San Rafael.

The wage he would earn as director of *Return of the Jedi*, the third *Star Wars* movie, he described first as "pleasant. I will be able to educate my children," he said, "and despite Maggie Thatcher, I will be able to be an old man without freezing on the street corner." And then it became "outrageous. With the kind of money you're talking about in this business, you could build a hospital in Namibia. Still, one's not going to turn it down if it's offered."

That he had been Lucas's choice at all had baffled film-industry observers. For *The Empire Strikes Back* and *Raiders of the Lost Ark*, Lucas had chosen Irwin Kershner and Steven Spielberg, well-known, experienced, American filmmakers. Marquand, by contrast, is relatively unknown, inexperienced as a director of feature films, and British. His first two movies, *The Legacy* and *Birth of the Beatles*, were unprepossessing, and his third, *Eye of the Needle*, was as yet unreleased at the time of Lucas's announcement in May 1981.

Asked to explain the procedure that culminated in the choice of Marquand, Lucas replied, "The search for a director was extremely difficult. We looked for about nine months. We needed someone who was confident of himself, friendly, and had a sense of humor. That combined with the fact that we needed a director who was technically very proficient, because it's an extremely difficult movie to make. We had to get someone who wasn't going to be above the material, who had a genuine enthusiasm for the project, for what *Star Wars* was.

"I interviewed a lot of directors. I saw a lot of films. We made up long lists of all those who could possibly do it," paring those lists by stages to 20, to 4, and then to 2, "both extremely good directors, both good for the project." It was a rough cut of *Eye of the Needle* that eventually tipped the balance in Marquand's favor. "In the process of seeing a lot of movies," Lucas recalled, "that one just jumped out."

For Lucas, Marquand's motivation seemed perfectly clear: "He liked *Star Wars*. He wanted to work with me. Finally, it's a very good career move for him: He will be catapulted into the top directors' [category], and his salary will skyrocket." Yet, Marquand himself seemed curiously ambivalent about this and other elements as he recounted his entertainment career. From reluctant college thespian to back-of-the-camera superstar, his aspirations and achievements confronted him, and he sought the proper attitude to assume. Having once marched with civil-rights hero King for equality of opportunity, he was too sensible to ignore, or condone, the inequality of opportunity that had favored him, the son, brother, and former son-in-law of elected officials in Britain. No goal seemed unattainable; he rejected those that fell too easily within his grasp.

It was in documentary films that he made his first memorable achievement: *In Search of the Nile*. Part documentary, part drama, it won him an Emmy in 1971. In 1978 his first chance to direct a feature turned out to be a dreary chiller, *The Legacy* ("I took the script and started to read it, and my heart sank"). His second, *Birth of the Beatles* (1980), was less about music than about relationships among musicians—a key point. His third, *Eye of the Needle* (1981), was by far a more accomplished work. Another British director considered for the job saw the Ken Follett novel as a straight espionage story, but Marquand insisted that "this is not a World War Two story; this is a relationship film," and to emphasize his point he doubled (from 24 to 48 hours) the length of the affair between the German spy (Donald Sutherland) and the desperately lonely woman (Kate Nelligan) on the remote Scottish island.

Return of the Jedi, more than either

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Return of the Jedi, *more than* Star Wars *or* The Empire Strikes Back, *is a film about relationships.*

BOOKS

THE ARTS

By Jerry Pournelle

Space war! It's no longer just science fiction. The ability to operate in space may well be the determining factor in future conflicts. It's no secret that during the Falkland Islands confrontation the United Kingdom had the use of U.S. satellite observations of the Argentine air, sea, and land forces. Modern satellite photos can show individual ships as well as troops in foxholes. Satellite photographs of Soviet forces stationed along the Chinese border have greatly aided our negotiations with the People's Republic.

Even now the United States relies heavily on space systems for military command, control, communications, and intelligence, along with navigation and weather information. Of course the Soviet Union realizes this; the first Soviet antisatellite weapons (ASAT) were tested in 1968, and the Soviets have been improving them ever since. Consequently, any conflict involving the Soviets, no matter how limited or controlled, must be planned considering the possibility that Soviet ASATs may be used against our satellites. Meanwhile the United States has also developed antisatellite capabilities. Although it is not a shooting war, the space war has already begun.

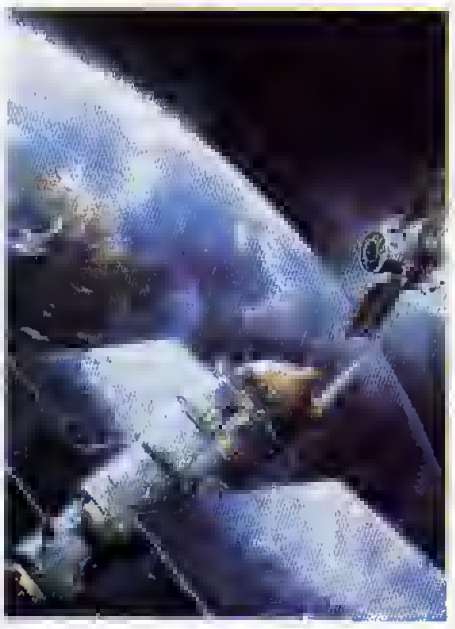
G. Harry Stine has given us both an overview and an introduction to this new kind of war in *Confrontation in Space* (Prentice-Hall, 1982). Stine, a professional engineer working in the space program, and a popular science-fiction writer, explains not only the physics of space war but also military doctrines and rules of engagement. He concludes that a confrontation in space is inevitable; the only question is, who will win?

Science writer David Ritchie presents a different view in *Spacewar* (Atheneum, 1982). Ritchie does not believe in space war (although you would never guess that from the book's cover blurbs), but he is afraid that military space systems will bring about nuclear war by accident. He is also concerned with the vulnerability of space systems. His advice is simple: Keep military systems out of space. He doesn't tell us how to impose this restriction on the Soviets, but he suggests:

"Perhaps the vulnerability of our space systems offers the best hope for limiting the spread of weapons into space. If a space platform costs billions of dollars and can be knocked apart like a house of cards for little more than pocket money by anyone with access to simple rocket technology, then the generals and admirals here and abroad may decide that wars in space are a quixotic enterprise after all."

It is not necessary that space military systems be that vulnerable. Certainly they can be attacked, but they can also be defended. However, Ritchie doesn't believe space weapons systems can ever be adequately defended, or that large-scale laser systems can be used for antiballistic missile defenses.

His book is also incomplete, since there is no discussion of the antisubmarine warfare (ASW) capabilities of space systems or the danger that ASW (both space-borne and air- /sea-based) poses to the submarine leg of the U.S. strategic deterrent Triad. But if the seas become essentially transparent, both the United States and the Soviet Union become increasingly vulnerable to a nuclear Pearl Harbor—and the evidence piles up that submarines *can* be detected and tracked from space.



Space will be tomorrow's battlefield.

A much better book is *War In Space*, by James Canan (Harper & Row, 1982). Canan, former Washington reporter for *Business Week*, examines not only space-deployable systems such as lasers and particle-beam weapons but high-technology weapons systems in general. His assessment of the personalities of the people working on the development of these weapons is invaluable for understanding the current situation. Although he, like Ritchie, deplores the spread of warfare into space, Canan concludes that it is inescapable.

An even more detailed—although slightly less readable—account of the history and technology of space war is David Baker's *The Shape of Wars to Come* (Stein and Day, 1982). Baker, a space scientist and mission planner, looks further into the future than even science-fiction-writer Stine, discussing the possible use of radiation weapons for mass destruction.

In 1970 Stefan Possony and I concluded in *The Strategy of Technology* that technological warfare was the decisive conflict of the twentieth century. Technological war could be bloodless war; if a side gets sufficiently far behind, it may be impossible to catch up.

Space systems can also lead to political stability. If both the United States and the USSR had absolutely reliable early warning of ICBM attack, it is unlikely that either side would launch any missile.

Space weapons offer grounds for comfort as well as fear. Stine argues that laser battle stations in space will be a powerful influence for peace and that a *defensive* arms race makes far more sense than our present doctrine of Mutually Assured Destruction (MAD).

The technological war remains the decisive war of the century. Few as yet realize that space war has become its most important theater.

ARTIFICIAL INTELLIGENCE

By Anthony Liversidge

Recently a computer on Wall Street took a long, hard look at a hill of beans. And based on the computer's performance in predicting the future of the soybean market, designers of the system are now certain that artificial intelligence can make money grow like a beanstalk.

According to Manhattan's Raden Research Group, their computer spewed out its forecast for an 18-month period based on an analysis of five years' worth of data on soybeans. It was only a test. But Raden's thirty-seven-year-old president, Dave Aronson, says the computer would have generated up to three times the profit of technical models currently used by traders. Aronson is confident that the program will enable a computer to examine any financial market and to develop sound and profitable investment strategies. "The model seems to anticipate trends," Aronson says. "Technical analysts usually recognize a trend only after it appears."

For all their fast moves in money matters, the pin-striped professionals of Wall Street have so far been slow to embrace the computer as a partner in making investment decisions. Brokers have used hardware and software mainly for data transmission and calculations. But with the continued success of Raden's program and others like it, money managers and financial institutions may soon be buying and selling according to trading strategies produced by their computers, not merely their own intuition and experience.

"We can now give the computer general historical data of a market," Aronson says, "and let it tell us what to look for. It will build its own model."

Raden's methods of computerized pattern recognition resemble those that have already proved helpful in medical diagnosis, weather prediction, and oil-field exploration. Once loaded with the Raden program, called PRISM (Pattern Recognition Information Synthesis Modeling), the computer is fed many of the variables involved in determining the way, say, soybean prices move. Having analyzed how the market works, the computer makes its prediction and then suggests what action to take.

PRISM goes beyond current statistical methods used by Wall Street forecasters. As Aronson points out, conventional techniques depend on human understanding of market forces. Analysts using these techniques load the computer with a model of these human concepts, rather than allowing it to work out fresh principles. Traditional methods are like "baking a strawberry shortcake from a recipe," Aronson explains. "You are provided with the recipe, and you just follow the directions, using the ingredients you are told to use."

PRISM, however, is like "putting many possible ingredients on the table and combining them in a variety of ways until the result is close to the idea of strawberry cake that the cook has in mind"—or something better than the cook ever dreamed of. PRISM works by accepting up to 500 different variables that money managers, traders, and other experts suggest may have a bearing on trends in a particular market. By analyzing historical data, PRISM draws correlations too complex for a human to detect. Then it packages the data into a model of the way the market works. It keeps the design of the model as simple as possible, however, using only the variables it finds most important.

Raden now plans to apply the program on behalf of its first client, a meat corporation interested in the cattle market. Already signed up, the company will pay $30,000 and a monthly retainer, dependent upon the quality of the results, for the privilege of having the electronic seer's advice.

Computerized pattern recognition has proved successful in other areas. Another consulting company, Entropy Ltd., has established a good track record in forecasting weather, the breakdown rate of nuclear-reactor cores, and the life expectancies of individual heart and cancer patients. Entropy's president, Ron

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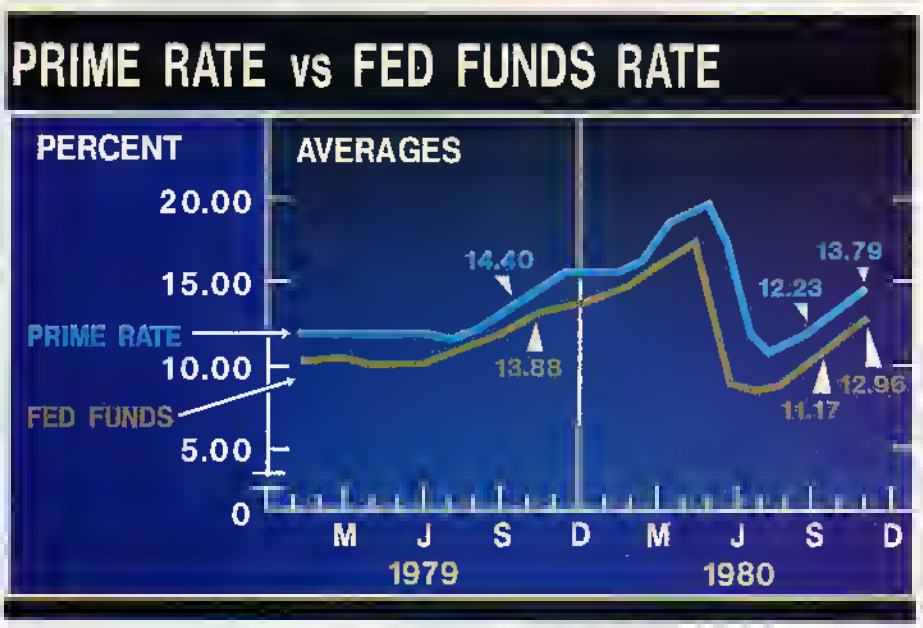


New computer system analyzes up to 500 market variables to build a moneymaking model.

CONTINUUM

ROMANS IN RIO?

Since the mid-Sixties, fishermen had been bringing up old pottery fragments from the bottom of Guanabara Bay, 15 kilometers from the port of Rio de Janeiro. Then, in 1976, diver Jose Roberto Texeira salvaged two intact amphorae, tall storage vases of the sort used throughout ancient Europe. They created a sensation in the Brazilian press, and the government promptly confiscated them. Texeira, understandably miffed, refused to tell where he had found them.

There the matter stood until 1982, when archaeologist Robert Marx convinced Texeira of the importance of his discovery. Marx, an underwater archaeologist with an International reputation, got permission to dive in Guanabara Bay. The amphorae had been found in deep and heavily polluted water near a penal colony. Working with professor emeritus Harold E. Edgerton, of MIT, Marx found thousands of pottery fragments and more than 200 necks, all from identical amphorae. He identified them as Roman, from the second century B.C.

How did the amphorae get to Brazil? Using profiling sonar, Marx and Edgerton located a wooden structure, presumably an ancient vessel, in the muddy bottom of the bay, underneath the wreck of a sixteenth-century ship. Before Marx could dive for the remains, trouble started. No one in Brazil liked the idea that the amphorae were Roman.

There is still dispute over which of two claimants was the first European to discover Brazil. Pedro Alvares Cabral, a friend of Vasco da Gama, was sent on an expedition to the East Indies by King Manuel I, of Portugal. Sailing in 1500, Cabral went far off his course to the west, reaching the coast of Brazil, which he claimed for Portugal, before turning east for Madagascar, Mozambique, and the Indian coast. His claim is recognized in Brazil and Portugal. The Spanish, however, consider the discovery to have been made by Vicente Yáñez Pinzón, who commanded the *Nina* on Columbus's first voyage to the New World. In 1499 Pinzón sailed from Spain with his own command, reaching the coast of Brazil in January 1500 and discovering the mouth of the Amazon. Irrespective of these claims, the land went to Portugal on the basis of the Treaty of Tordesillas in 1494, which divided the non-European world between Spain and Portugal at a point 370 leagues west of the Cape Verde Islands.

Marx's identification of the amphorae as Roman prompted some highly emotional responses. Local Brazilian experts, who had positively identified the amphorae as Greek or Phoenician, refused to budge from their positions, considering Marx a cheap sensation seeker. The local press had their own views. They found "experts" who claimed that the vases must have been left by King Solomon on one of his less publicized voyages. Others even cited the amphorae as proof of a visit by the ten lost tribes of Israel. Marx's claim for the Romans was obviously not well received.

There were international repercussions as well. The governments of Spain and Portugal, with their long-standing vested interests in Pinzón and Cabral, objected strenuously to the idea that a shipload of Romans had been the first in the New World. They accused Marx of being an agent of the Italian government, sent out to drum up publicity for Rome. They even accused Marx of bringing the amphorae over from Europe himself and planting them in Guanabara Bay. Under pressure from all sides, the Brazilian government refused to let Marx continue diving.

Recent work by professor Elizabeth Will, of the University of Massachusetts at Amherst, and other experts have confirmed that the amphorae are second-century-B.C. Roman, probably manufactured at Knouss, on the coast of western Morocco. Marx believes that finding remains of the ship that carried the artifacts is crucial to establishing how they got to Brazil. He suggests that a Roman ship from North Africa might have been caught in a storm and blown across the Atlantic Ocean. In the last century alone, over 600 forced crossings of the Atlantic were recorded. Roman wrecks have been found in the Azores. From Africa to Brazil is the narrowest passage across the Atlantic. Modern sailing ships often make the journey in 18 days.

If a Roman ship had been blown across, was anyone alive when it reached Brazil's coast? Marx points out that there is little chance an unmanned ship could get through the winding, reef-laden entrance of Guanabara Bay to its present location.

Through the offices of the National Geographic Society and others, the Brazilian government has finally agreed to let Marx resume diving in January 1984. Tune in next year to learn whether Romans were sunbathing on Copacabana Beach in the second century B.C.—*ROBERT SHECKLEY*

CONTINUUM

HIGH-TECH VETS

Ranger's doctors diagnosed leukemia last year. So they gave him injections of a new immune-boosting drug, protein fibronectic, and now the cancer is in remission. Ranger, a German shepherd, is a patient at New York City's Animal Medical Center, and his glitzy experimental treatment isn't yet available to his owners.

Remember the veterinary Dark Ages when being "put to sleep" was the only remedy for serious pet illnesses? Well, now if your dog suffers from an ulcerated cornea, Seattle's Animal Eye Clinic will outfit him with protective contact lenses. If your cat has a brain tumor, neurosurgeon Douglas Purse, of New York's Animal Medical Center, will remove it microsurgically for $1,500. And Beverly Hills, California, veterinarian Anthony Shipp will treat your pet's cancer with cryosurgery (freezing).

These days, Spot and Puss in Boots consult specialists. They go about their business with cardiac pacemakers ($650, at the Animal Medical Center) in their chests—and travel to distant veterinary centers for coronary bypasses, artificial hip replacements, cosmetic surgery, or orthodontia. High-tech echocardiography and nuclear scans probe their organs, and state-of-the-art chemotherapy halts their diseases.

"People want the best for their pets," notes Dr. Shipp, "and they're willing to pay for it."

—Eric Mishara

"We fancy men are individuals; so are pumpkins. But every pumpkin in the field goes through every point of pumpkin history."

—Ralph Waldo Emerson

If Rover's bite is worse than his bark, consider orthodontia. The new-age pet is denied none of modern medicine's miracles.

Male hormones make the woman. High levels of testosterone and other androgens underlie female sex drive and erotic pleasure.

SEXY HORMONES

What makes men sexy? male hormones. What makes *women* sexy? Answer: male hormones.

If your answer to the second question was estrogen, the principal female sex hormone, you're in good company. But researchers from the University of Pennsylvania and the Marriage Council of Philadelphia have found that male hormones—produced by a woman's ovaries and adrenal glands—equal more joy of sex for females.

Women with high androgen (male hormone) levels make love more often and enjoy it more, according to just-completed research by Harold Persky and his Philadelphia team. Female hormones apparently have no such aphrodisiac properties.

The androgen theory of female sex drive has circulated in psychoendocrinology circles for years, but only recently have scientists measured precise hormonal levels in the blood. Persky and his colleagues took a series of blood samples from 11 young married women and 19 postmenopausal women and found a strong link between androgens and intercourse frequency as well as subjective reports of fulfillment.

The younger women also reported more lovemaking and more overall gratification than their middle-aged counterparts, perhaps because, after menopause, the ovaries manufacture less testosterone and other androgens.

Do women's male hormone levels rise in response to more and better sex, or does it work the other way around? Could women with flagging libidos get a lift from doses of testosterone? "That's the big question," says Persky. "How hormones influence sexuality remains one of the gray areas of science."

—Charles Craig

"Four be the things I'd been better without: love, curiosity, freckles, and doubt."

—Dorothy Parker

DIRTY DESIRE

Pregnant women have been warned in recent years to steer clear of just about everything from coffee to aspirin. Now there's another warning from scientists: If you're a mother-to-be, don't eat dirt.

According to a recent National Academy of Sciences report, an alarming number of expectant mothers regularly snack on dirt and other nonfood substances—including burned matches, mothballs, cigarette ashes, toilet-bowl air fresheners, even tire inner tubes. The practice is called pica—Latin for magpie, a bird famous for eating everything in sight.

The syndrome is most common in the southern United States, explains nutritionist Carolyn Lackey, of the University of North Carolina. Up to 49 percent of the pregnant women in some poor, rural, mostly black areas regularly eat clay or laundry starch. But the cravings cross racial and economic lines.

According to Lackey, women with pica may suffer toxemia as well as intestinal blockage. One woman died after clay—which she had eaten by the pan-ful—backed up in her system and punctured her colon. For others, pica simply displaces food and vital nutrients. Most of the time, however, the syndrome doesn't harm the fetus.

No one knows exactly what causes pica. Researchers have linked it to iron deficiency and anemia, but anemia may be merely an effect. Other causes may be cultural. In some regions visitors bring expectant mothers boxes filled with clay instead of baby clothes.

The cure? As soon as the woman delivers, the craving stops.

—Maura Lerner

No matter how delicious that mud pie may look, don't eat it if you're pregnant. Dirt binges can be bad for expectant mothers.

To some people, words are more than sounds, emotions more than feelings. To a synesthete, either can become physical sights.

AZURE WORDS, MINT TRIANGLES

One sultry afternoon, a young woman orders a vanilla ice-cream cone, and the street vendor replies gruffly, "No vanilla, only tutti-frutti." Nothing weird there. But the woman, who is not psychotic or stoned on LSD, "sees" black cinders and coal spew from the short-tempered vendor's mouth.

Her visions are part of a rare condition called synesthesia, says neurologist Richard Cytowic, president of Capitol Neurology Laboratories, in Washington, D.C. Don't expect to hear the word on future telethons, though. The strange sensory cross talk that is synesthesia—wherein sounds are "seen" and colors "heard"—is not a disease.

"It's like a bonus," notes Cytowic. "Your senses give you more than you bargained for."

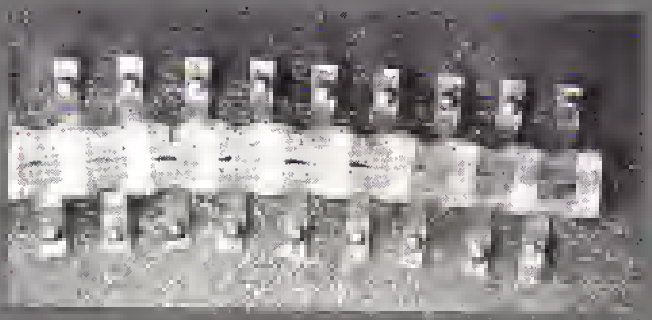
In its commonest form, he explains, synesthesia is "colored-hearing," with sounds evoking colors or images. When nineteenth-century French poet Arthur Rimbaud wrote about the precise hues of *A*, *E*, and *U*, for instance, he may have been expressing his synesthetic sense. But after studying the syndrome for years, Cytowic has also discovered unique cases: One man can even "feel" every flavor as a distinct geometric shape pressed against his face or hands.

To learn the syndrome's cause, Cytowic recently conducted a series of cerebral blood-flow tests. Monitoring patients in mid-synesthesia, he traced the greatest blood flow—and brain activity—to the limbic system, the brain's emotional center. "We were surprised," he confides. "We expected to see this activity in the cerebral cortex, which governs thinking, imagination, and daydreaming. The limbic system determines life-and-death responses beyond our control.

"All we can say now is that synesthetic people aren't normal or abnormal, just charmingly different."

—Kathrine Jason

CONTINUUM



Good-bye stitches: Dr. Sheehan's zipper consists of two plastic strips, each attached with razor-sharp stainless-steel pins.

SURGICAL ZIPPERS

The final stage of any surgical operation is the "close," and for years this has been accomplished seamstress-style, with a simple needle and thread. More recently, surgeons have used staples, with better holding power, but the patient is still left with a "railroad-track" scar once the staples are removed.

Now orthopedic surgeon Joseph Sheehan, of Oak Park, Illinois, has a new solution: a plastic zipper.

To close an incision, Sheehan uses surgical adhesive to position two plastic strips on opposite sides of the wound. Each strip contains a row of razor-sharp stainless-steel pins, which are pushed gently into the skin. Finally, a plastic sleeve is placed over one end of the apparatus and pulled along to the other end, zipping up the wound.

Because the pins are well anchored and numerous, they distribute the pulling forces better, resulting in a fast, stable closure, Sheehan contends. And the sharp pins slide into the skin without ripping it. The result: an unobtrusive hairline scar.

Sheehan's invention, dubbed Dermizip, is now manufactured by Kells Medical, Inc., of Burr Ridge, Illinois. It's already being used by several physicians in foreign countries, and FDA approval is expected soon.—Rick Boling

LONE-GUN REDUX

Recent acoustical evidence is giving new support to the theory that John F. Kennedy was assassinated by a lone gunman.

In late 1978 taped evidence cast doubt on the notion that a single assassin killed President Kennedy. After studying police transmissions recorded on November 22, 1963, a team of acoustics experts told the House Select Committee on Assassinations that the odds were 20 to 1 in favor of the theory that at least two guns had been fired. Conspiracy theorists took heart.

Now a new review of the police tapes by the Committee on Ballistic Acoustics, established by the National Research Council, has reversed that conclusion. The sounds the original experts attributed to a second gunshot weren't shots at all, opines the committee: They were recorded *after* the president was hit.

None of this might have happened without the finely trained ear of private citizen Steve Barber, a Mansfield, Ohio, musician. He listened to cassette copies of two tape recordings, each one made from a different area of the Kennedy motorcade. The first tape contained the sounds that had long been interpreted as a series of gunshots; the second tape, which was closer to Kennedy himself, contained only conversation.

Barber realized that some of the muffled talk on tape one matched up perfectly with the somewhat clearer conversations on tape two. The match-up gave scientists a new reference point, making it possible to determine just *when* the so-called gunshot sounds occurred.

Sure enough, analysis revealed that the lone-gunman scenario was probably the most accurate one after all. "The cross-talk match-up establishes irrefutably that what the original acoustics researchers identified as a gunshot took place one minute *after* the assassination," reports committee member Paul Horowitz, of Harvard. "The 'gunshots' were just noises—nobody knows of what."

Both Barber and Horowitz note that the new study does not rule out the possibility of a conspiracy. "You'd have to go back in a time machine to prove what really happened," says Horowitz. "We confined ourselves to commenting on the acoustic evidence. And that evidence just doesn't support a two-gun theory."—Sherry Baker

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"Every man has the right to utter what he thinks truth, and every other man has the right to knock him down for it."

—Samuel Johnson

John F. Kennedy's final motorcade in Dallas: A new analysis of police tapes lends support to the classic one-gunman theory.

HEAVY ELEMENT

Fighting odds of 100 trillion to one, a team of West German physicists has created the most massive element known.

For ten days physicists at the Society of Heavy Ion Research fired a beam of high-speed iron atoms at a thin metal foil of bismuth. Their object? Element 109, containing 109 protons and 109 electrons. To create it, iron and bismuth atoms had to fuse, an event that calculations predicted would happen once in 100 trillion collisions.

Until now the heaviest known element was number 107. Element 108 is still uncreated.

The researchers were about to give up when they witnessed the creation of a single atom of the new element. It existed for only five thousandths of a second but was unmistakably there.

Finding an atom of element 109 among the millions of atoms spawned by the experiment was "like finding a grain of sand in a whole trainload," says one physicist. Element 109 probably won't have any practical applications, unlike the artificially created, bomb-making element plutonium. But the techniques that led to its creation could produce other heavier, more stable elements with unforeseen uses. —Paul Raeburn

Finding 109 was like pinpointing a single grain of sand.

CHICKEN I.Q. TEST

Chickens may not be total birdbrains after all. According to experiments at Exeter University, in England, this common domestic fowl can even recognize photos of its friends.

To test chicken I.Q., researcher Catriona Ryan showed pictures of three different chickens, taken from a variety of angles, to a group of male bantams. To develop their photographic memories, the birds were shown the slides ten times each, until they could differentiate between them.

Then, to see whether the birds had digested the material, Ryan showed them views of each of the old birds as well as slides of another, previously unseen, chicken. The result: The bantams almost always selected the familiar chicken models by pecking a key, receiving a reward of food.

Unfortunately, no one has yet found a use for this new information.

—Phoebe Hoban

"Every advance in civilization has been denounced as unnatural while it was recent."

—Bertrand Russell

Bug eats bug: Unlike this straightforward mantis, the devious assassin bug cons prey by disguising itself as a termite nest.

ASSASSIN BUG

Elizabeth McMahan, a zoologist at the University of North Carolina, was watching a termite nest in Costa Rica one day, when part of the nest started to walk. It moved to the termites' hole and snatched the first termite that emerged.

The walking nest, McMahan soon discovered, was really a species of assassin bug that feeds on termites. The inch-long executioner had used a natural glue to attach pieces of the nest to its body for camouflage before making its grab.

And that was only the beginning. Piercing the termite's outer skeleton with its ramrod lower jaw, it promptly sucked the victim's guts out. Then the assassin bug went fishing. Picking up the mostly intact carcass in its front legs, it returned to the mouth of the hole and dangled the body over the edge, wiggling it like a worm on a lure. Since termites eat their dead, another termite immediately clamped on to the bait, only to be yanked up and treated just as badly as its brother. The greedy killer repeated this act 30 times before being sated.

Since that day, McMahan has seen the assassin bug in action several times. Her conclusion: The creature's different stratagems represent an outstanding example of the use of tools by insects. The bug's behavior seems so premeditated, in fact, that McMahan believes we may have been selling insects short for years.—Mark Teich

"There are more animals living in the scum on the teeth in a man's mouth than there are men in a whole kingdom."

—Anton van Leeuwenhoek

CONTINUUM

NEW TYLENOL THREAT

When seven Chicagoans died last year after taking cyanide-laced capsules of Extra-Strength Tylenol, the maker, Johnson & Johnson, withdrew the product from the market. The popular pain reliever was later reintroduced in triple-sealed packages, and consumers could once again take Tylenol without concern.

According to many physicians and pharmacists, however, consumers *should* be concerned—not about poison but about acetaminophen, the primary ingredient of Tylenol and several other nonaspirin pain relievers. Although acetaminophen does not cause the gastrointestinal bleeding produced by aspirin, it can be toxic in large doses.

Biochemist David W. Martin, Jr., of the University of California Medical Center, says, "An acetaminophen overdose is much harder to treat than an aspirin overdose. It creates toxins in almost every major organ. At very high doses, the liver, pancreas, and kidneys, especially, just sort of turn to slush." Such damage is irreversible.

What constitutes a toxic dose? That varies from one person to another, but according to Ken Liska, author of *Drugs and the Human Body*, "double the recommended dose is getting up near the toxic range." Liska, who holds a doctorate in pharmaceutical chemistry, cautions that taking even the recommended dose daily for an extended period might be risky. Fortunately, he adds, if tissue damage occurs with doses less than those generally considered toxic, it is usually reversible.

—David Dreier

The latest Tylenol scare isn't poisonous sabotage; the aspirin substitute's own ingredients are highly toxic in large doses.

Rainbow trout eggs being stripped from a mature female: When exposed to a powerful electromagnet, they turn superfertile.

TROUT FERTILITY

Fusion reactors and levitated trains are among the myriad future devices sure to generate high magnetic fields. With all this magnetism coming our way, the Department of Energy had one question: How will it affect people and other living things? To learn the answer, they recruited biologist John Strand, of Battelle Pacific Northwest Laboratories, in Richland, Washington.

Strand and his associate, Scott Abernethy, spent three years exposing thousands of rainbow trout egg and sperm cells to a powerful electromagnet. After the cells had been exposed, the researchers fertilized the eggs, waited seven days, and then counted the embryos. They found that, compared to normally fertilized eggs, there was a 2 to 5 percent increase in fertility when either the eggs or sperm were exposed to the magnetism. The increase ran to 5 percent when both eggs and sperm were exposed.

Strand isn't sure how the magnetism works, but he speculates that it may increase both egg permeability and sperm motility. He warns against drawing conclusions about any effects on humans, however, because the magnetism used was thousands of times stronger than people will ever be exposed to—and because you can't compare humans to trout.

Despite the inconclusive findings, some people have suggested using magnetically enhanced fertility to increase profits at commercial hatcheries. But Strand doesn't advise it: The electromagnet used to produce the slight increase in fertility cost more than $100,000.—Douglas Starr

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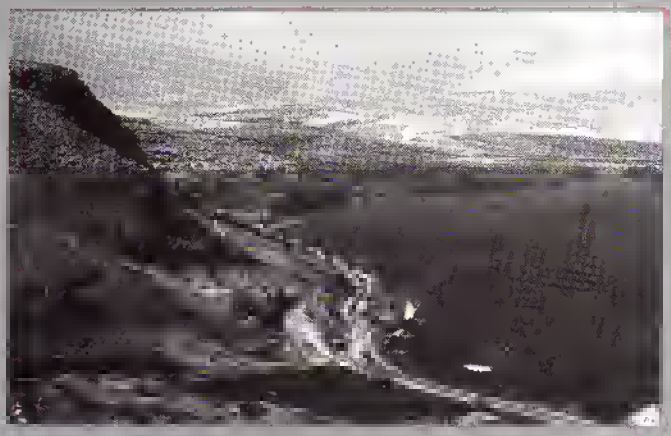
"After you've heard two eyewitness accounts of a motor accident, you begin to worry about history."

—John McNab



Sea of Galilee: New fossil evidence suggests the real Garden of Eden—the stomping ground of Homo erectus*—was here.*

ISRAELI ADAM

Was the first man on earth an Israeli? Ancient fossils and tools recently found at Ubeidiya, an archaeological site near the Sea of Galilee, suggest that the answer may be yes.

According to paleontologist Charles Repenning, who has studied the region, remnants of ancient rodents suggest that *Homo erectus*—immediate ancestor to *Homo sapiens*—existed in Israel before migrating to Africa, long regarded as the birthplace of modern man. Repenning, of the U.S. Geological Survey, in Menlo Park, California, says that the rodents, believed to have coexisted with early man, were present about 2 million years ago. This is about 500,000 years before man is supposed to have first lived in Africa. "The rodent remains," Repenning adds, "were actually found wedged in cobblestone floors that had been made by *Homo erectus*."

Repenning says that his controversial theory is buttressed by studies showing that deer, zebras, hyenas, bears, tigers, meadow mice, and lemmings—all animals assumed to have lived at the same time as *Homo erectus*—existed at Ubeidiya more than 1.5 million years ago. Moreover, he notes, scientists evacuating the site have discovered flint hand axes and limestone picks.

Nevertheless, fellow scientists, including anthropologist Helen Fisher, remain skeptical. "It's a questionable analysis," says Fisher, of the New School for Social Research, in New York City. "It's impossible to say whether man was in Israel before Africa on the basis of a single site."

—Robert Brody

"If someone says that war is necessary for revolution, one must reply that in a war the working classes die most of all."

—Nikita Khrushchev

SURVIVOR SYNDROME

When doctors learned that Ellen Stovall had Hodgkin's disease, a cancer of the lymph glands, they told her she had a 40 percent chance of living two years. That was ten years ago. Then high-dosage radiation treatments saved Stovall's life, making her one of 3 million cancer survivors in the United States today.

But like many other cancer survivors, Stovall bears troubling physical and emotional scars. For instance, the radiation that saved her life brought on menopause at age twenty-five. And Stovall lives with the knowledge that, because radiation is carcinogenic, it could eventually trigger a new onset of cancer.

Facing the pitying expressions on people's faces is another problem. For many, Stovall is a walking medical miracle—and a symbol of death.

"I'm not wearing a big C on my chest," she says, "but I may as well be."

According to Stovall, she and other survivors cope with their past by volunteering as counselors for cancer patients. The survivor is a positive alter ego for the terrified patient, she says. "We have a kinship and go through the ordeal together. I stay in touch with those who make it."

Pennsylvania radiologist Harmar Brereton, who regularly refers cancer patients to Stovall and her colleagues, agrees. "No one has more empathy with the patient," he says, "than someone who has had the same disease and overcome it."—Eric Mishara

"In time of war, the first casualty is truth."

—Boake Carter

The survivor blues: People who have won the war against cancer often need counseling for a variety of emotional aftereffects.

CONTINUUM

WART BONANZA

Warts—those horny, grotesque lumps that disfigure hands and cripple feet—are not a subject most people care to dwell on. But for a growing number of scientists, the study of warts has resulted in a research bonanza. Diligent investigators have used the hardened lesions to unravel the cell's secrets and unleash the powers of interferon.

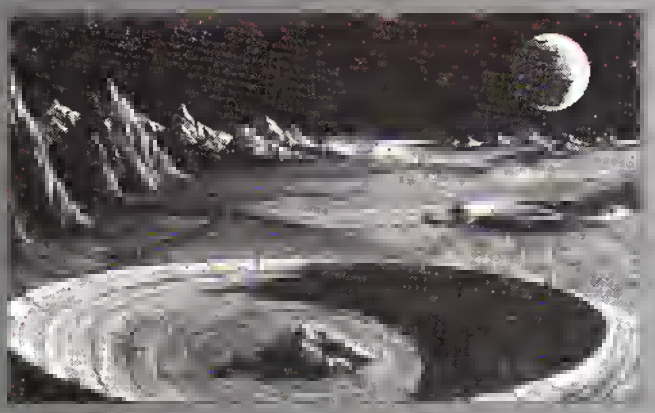
Because warts are benign tumors caused by a virus, it has been suggested that they might be good targets for interferon—a natural protein that seems to destroy tumors. To test this hypothesis, University of Pittsburgh doctors injected interferon into the arm muscles of two badly afflicted patients: no improvement. Then they injected the interferon into the warts themselves. Within weeks, the warts disappeared.

While this treatment is too painful to be practical for the average wart victim, the study suggests that interferon may work against more serious tumors.

Other researchers, meanwhile, have been studying disembodied wart cells—and finding an enigma. Warts multiplied like crazy on faces and hands but refused to grow in petri dish cultures made almost entirely of cells resembling those in the lower layers of the skin. The problem: The heart of the wart virus—its DNA core—was growing in the skin culture. But the tumor-producing protein shell was missing.

If we can learn why the shell is produced only in the top layers of human skin, says biochemist Robert LaPorta, we may gain insight into the cell's physiology. We may also be on the road to producing a wart vaccine.—Carol Truxal

The heartbreak of warts still awaits a surefire cure, but to scientists, the benign tumors are keys to the cell's secrets.



Lunar craters. Meanwhile, back on Earth, a huge basin beneath the surface of Canada may betray the imprint of a giant meteoroid.

METEORIC BIRTH OF NORTH AMERICA?

The primordial planets and their satellites were bombarded by asteroids during the birth of the solar system, some 4 billion years ago. The rugged, crater-strewn surface of the moon serves silent testimony to that ancient blitzkrieg. But because of weathering and crustal-plate movement, the constantly shifting Earth has revealed no telltale scars—until now, that is.

After studying faint variations in the force of gravity over central Canada and the northern United States, a group of geologists has discovered what may be a long-buried, 1,700-mile-wide crater basin stretching between Hudson Bay and the Great Lakes. Klaus Schulz and William Cannon, currently with the U.S. Geological Survey, and John Klasner, of Western Illinois University, speculate that the basin could have formed when a giant meteoroid the size of Delaware slammed into the earth some 4 billion years ago.

The newly revealed feature, located many miles below the barren Canadian landscape, may finally provide an answer to a long-standing geological mystery: How were the continents born? According to Schulz, if a monstrous piece of space debris created the circular basin, then it could have triggered volcanic eruptions, giving rise to North America.

"North America is probably not unique," says Schulz. So he and his colleagues are now sifting through the gravity data in hopes of positing meteoritic births for the other continents, too.

—Marcia Bartusiak

"Two great talkers will not travel far together."

—Spanish proverb

"Anybody who is any good is different from anybody else."

—Felix Frankfurter

When data rain down over the face of the earth, Comsat shapes the clouds

SATELLINKS

BY RICHARD WOLKOMIR

In a beige conference room in McLean, Virginia, five executives are sitting around a triangular oak table. TV cameras on robot arms gaze down from the side walls. On the far wall two huge video screens hang side by side. Filling the screen on the right is a document the size of a picture window. On the screen at the left is another group of high-level executives in a similar robot-equipped office, which happens to be in London.

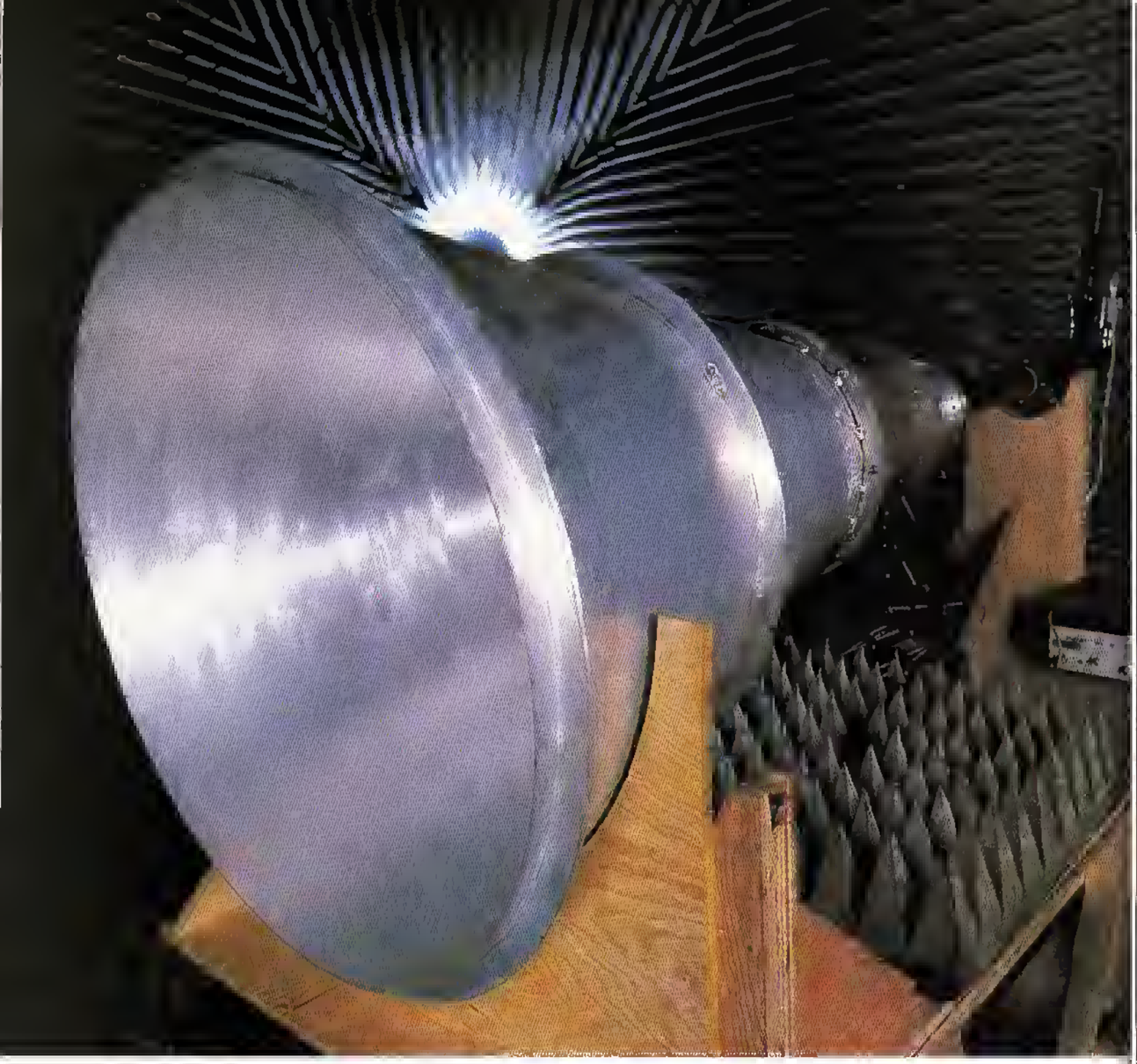
"Might we have printouts of that contract?" asks one of the Londoners, live and in color on the wall.

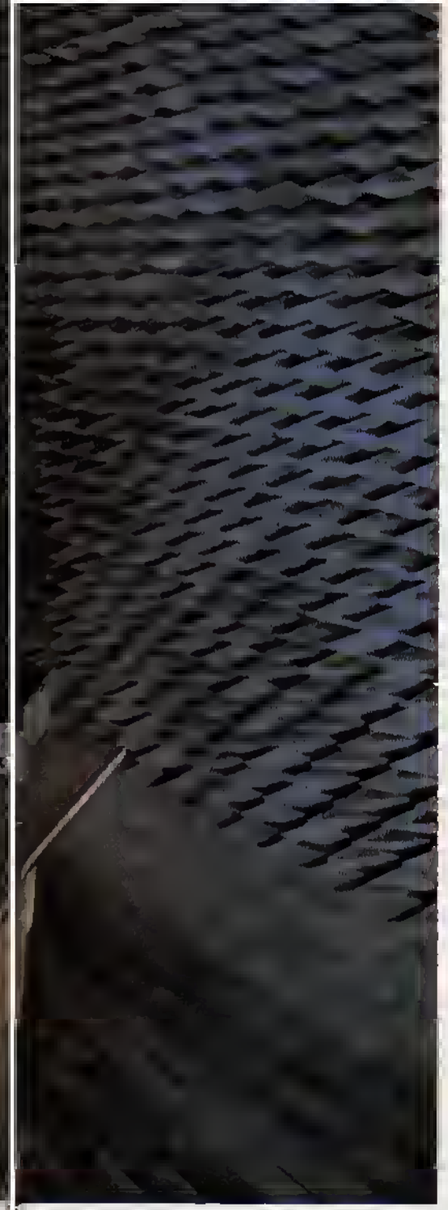
Beside the head chair in each of the rooms is a computer terminal. The woman leading the Virginia group points a finger at the video display. In London five copies of the document displayed on the big wall screen slide out of a slot in the conference table. Another transatlantic teleconference is under way.

This most sophisticated of teleconferencing setups is in the office building of Satellite Business Systems (SBS), a short drive across the Potomac from downtown Washington, D.C. A joint partnership of IBM, Aetna, and the Communications Satellite Corporation (Comsat), this fast-growing new company is dedicated to

PHOTOGRAPHS BY MALCOLM KIRK

Comsat Labs' director foresees an era of billion-dollar satellites.





the proposition that communications satellites are going to change the world.

For instance, why travel across a continent or an ocean to discuss a project if, through television and satellite links, you can stay home and do it just as well? Perhaps you can do it even better, so effective is the transmission of data out to space and back again through today's satellites.

No special lighting is needed, nor are camera operators; everything is robotically controlled from the computer terminal at the head chair. Just point your finger at the appropriate symbol on the video display (in the process penetrating an invisible infrared grid) and the system obeys your command, zooming in for close-ups, showing documents, or doing whatever you wish. A black dot in the middle of the table is the only microphone. The sound system automatically amplifies quiet speakers and dulls irrelevant noises, like a dropped ashtray's bang or participant's cough.

The price for such a room? Anywhere from $150,000 to $750,000. But because of travel savings and increased employee contacts, more and more major corporations are buying into teleconferencing. Eventually technological advances in satellites and transmission equipment may bring teleconferencing into everyone's life. And it may be spooky, according to Alfonso Fabris, who helped design the system for SBS: "Someday, instead of screens, we may have three-dimensional holograms of people sitting around the table."

Larry Weekley, public-affairs director for SBS, says the company foresees low-cost teleconferencing service for homeowners toward the end of the century. He says we also can expect "proxy vacations" via satellites and holographic video. "You'll stay in your home town but go on an African safari or tour the Louvre, seeing everything in three dimensions, hearing the sounds, smelling the smells," he says.

Meanwhile, the 4,779 artificial satellites of various types now orbiting the earth are already changing the way we do things. The radio industry is rapidly switching to satellite transmission, meaning there is less local programming, more national. Via satellites, newspapers are stepping up national and international coverage. Already such papers as *The New York Times*, *The Wall Street Journal*, and *U.S.A. Today* are transmitting copy to printing plants nationwide. To train professionals for the blossoming satellite era, New York University has begun a graduate program in interactive telecommunications. Peasants in 5,000 remote villages in India already gather daily in dusty village centers to watch satellite-beamed educational programs—everything from agricultural techniques to reading—on the communal TV. India's press has dubbed the system "the blackboard in the sky." In Detroit, Ford and General Motors are working on satellite-generated navigation systems in which a car's location will be shown by a moving dot on a dashboard-mounted video map.

Out beyond the Van Allen belts, we have opened up a rich new marketplace for the Information Society's vendors of bits, bytes, market reports, and the latest sitcoms. Outer space is now open for business.

Call it the satellite connection. Since the June 1965 orbiting of the world's first commercial communications satellite, Early Bird, the cost of transmitting information via satellite has plummeted. While the U.S. consumer price index has tripled since 1965, the charge for leasing an international satellite voice circuit has dropped substantially, from $4,200 per month in 1965 to today's $1,125. If other goods and services had deflated at the same rate, new cars would sell for about $700, a gallon of gasoline would cost approximately ten cents, and new homes would average $8,000.

Behind much of this economic white magic is technology developed at the

John V. Harrington (above, top), director of Comsat Laboratories (above), presides over sophisticated facilities including an anechoic test chamber (left), used for testing antennas and their components. Previous pages show the display screen of a computer-aided design system, used to create new microwave circuits, and the Washington, D.C., operations center of Intelsat, with a map of its international antenna network.

Clarksburg, Maryland, laboratories of Communications Satellite Corporation (Comsat). Scores of corporations—from RCA, Hughes, and Ford to AT&T—design, build, and orbit satellites. But under current federal law, Comsat is this country's sole provider of international commercial satellite communications.

In the early Sixties, when the first artificial satellites momentarily distracted Americans from their preoccupation with tailfins and hula hoops, leaders like John F. Kennedy foresaw that the era's primitive Echo I orbiter—a lightweight balloon that reflected radio signals—would spawn a powerful new industry. To make sure the U.S. thumb would be deep in that pie, Kennedy signed the 1962 Communications Satellite Act, summoning Comsat into existence. A private corporation, Comsat butts helmets with other companies in the domestic arena. But its international operations, carefully monitored by the government, are a one-company show; the alternative would be chaos.

Comsat was permitted to build Earth stations (antennas) in the United States only, but the new international ground-to-satellite-to-ground telecommunications system would require a planet bristling with dishes. So in 1964, after much missionary work—and a little shoving—from Comsat, nations around the world formed an international satellite communications organism, called Intelsat. This multinational cooperative (Comsat is the U.S. member) is the world's overseer of commercial country-to-country satellite transmissions. Thus, Comsat sired its own parent, Intelsat. And both are the progeny of an infant, the Information Society. In fact, their existence is an indicator that the planet is inching titfully toward some new form of transnational civilization, where distance means little and digitized chitchat is the primary rite.

Government agencies represent most nations in Intelsat. Private-enterprise Comsat is an anomaly. It also is the biggest bird in the nest: With each nation's Intelsat share proportionate to its use of the system, Comsat holds the jumbo slice, about 24 percent. Comsat also handles much of Intelsat's research. In fact, the technology issuing from Comsat Laboratories is one of the driving forces of the Information Society, creating satellites that are ever more potent transmitters of messages.

"We're not talking carrier pigeons and smoke signals here," says Pier Bargellini, Comsat Laboratories' Florentine-born senior scientist.

No, indeed. Bargellini and his colleagues are talking "up links" and "down links." They are talking GaAsFET, half-circuits, and megabits per second. They are talking TDMA and SS-TDMA. They are talking Flash Gordonese, and they are doing their talking in just the right setting.

The laboratories are located 30 miles from the White House, in suburban Clarksburg, Maryland. Their address is, significantly, 22,300 Comsat Drive. As Arthur C. Clarke pointed out in 1945, an artificial satellite orbiting 22,300 miles above the equator will circle Earth at a speed precisely matching the planet's rotation, in effect hovering over a single spot. Comsat officials whimsically made their laboratories' address a salute to the geosynchronous orbit, because it is that ability to hover that makes satellite communications practical. As Bargellini puts it, "A communications satellite is a twenty-two thousand three-hundred-mile-tall radio tower, with a straight-line view from New York to Baghdad."

Rounded and metal-skinned, Comsat Laboratories might be a Hollywood set for Marsport. Sculpturelike Earth stations decorate the lawn. Thrust out from the front door in a circular glass shrine, satellites fly on wires, their solar arrays extended like beetle wings. Inside the building, walking along the glassed-in passageways and ramps, the labs' 650 workers (350 of them are researchers) talk earnestly about real-time sequence simulations and supergroup transmultiplexers. Visitors almost expect them to be wearing tight-fitting uniforms emblazoned with the words SPACE PATROL. Every white corridor leads to a gigantic mural of flaming rockets and gleaming, spinning satellites.

Comsat Laboratories is a nerve center for what might be called Outer Space, Inc., the expanding network of businesses that profits by sending microwaves through the void. Its challenge is to make the orbiting "birds" longer lived and ever more powerful, because Earthlings are increasingly addicted to satellite communications. But there is only one geosynchronous equatorial orbit, and it is rapidly filling up.

"The Clarke orbit is precious. It is unique," says Bargellini.

And its space must be used with caution. Earth has not grown a dense, Saturn-like ring of electronic tin cans, circling 22,300 miles out, mainly because—to avoid signal interference—satellites need lots of elbowroom, about the distance from Boston to Washington, D.C. Geosynchronous-orbit parking slots are limited.

"The good Lord was not generous enough," laments Bargellini, contemplating the "precious" orbit's finitude. As he points out, however, engineers have been clever at making each satellite work harder, thus conserving the orbit. And given the researchers' track record, they have no reason to be daunted now.

Intelsat I, or Early Bird, launched in 1965, was the size of an office typewriter, lasted about three years, and could handle either 240 voice circuits or one TV channel. Intelsat V, today's model, spans 51 feet from wingtip to wingtip of its solar-cell arrays, is designed to last seven years, and relays an average of 12,000 voice circuits *simultaneously* with two TV channels.

Of course, today's larger rockets can orbit larger satellites. But researchers also have learned to miniaturize electronic components in such key devices as the transponders, which receive signals from Earth, amplify them, and beam them back to receiving stations. So engineers can squeeze more transponders (which means more channels) into each satellite. But this is only one of many new tricks.

For instance, early orbiters maintained their position in space by spinning, the entire satellite acting as a gyroscope. However, the antenna spun, too, twisting much of its signal wastefully into the void. With Intelsat III, in 1968, engineers introduced the "despun" antenna, which spins in a direction opposite that of the body so that it always points toward its target.

The antenna's signal, however, spread out like a flashlight beam, dimming as it widened to cover the entire visible face of the planet. To correct that, engineers developed the "spot beam" antenna, which can focus its microwave beams on smaller targets, increasing the power reaching the Earth stations.

Another new wrinkle: Instead of handling microwaves in only one frequency band, 6 GHz (gigahertz) for the Earth-to-satellite up link and 4 GHz for the down link, as earlier satellites did, the latest models also handle a second set of frequencies, 14 and 11 GHz. A third frequency range, even higher, is coming; it will handle even greater circuit capacity. Engineers have beefed up solar-cell arrays for more power. And new long-lived batteries based on nickel-hydrogen ensure that the satellites will not die when the earth eclipses the sun and cuts off radiation to the solar cells.

But satellite traffic in the United States alone is projected to grow by as much as 20 percent a year for the next decade; so engineers must soup up their orbiters even further. To make sure they are successful, Comsat Laboratories gives its researchers everything a techno-wizard might need, from the latest in digital crystal balls to the electronic equivalents of newts' eyes.

Suspended from a steel framework in one room, three stories high and as vast as an airline hangar, is a cottage-size device resembling a bathyscaphe. "That's the Thermal Vacuum Chamber, an outer-space simulator for testing satellite components in a vacuum," says Allan Galfund, chief spokesman for the laboratories, as he shows a visitor around.

"In two hours you can bring the temperature inside that thing from plus seventy degrees down to minus three hundred twenty degrees Fahrenheit."

Nearby is a tank-size Ukrainian Easter

egg, its insides bristling with foam-rubber teeth. The pyramidal teeth absorb echoes, making the carnivorous-looking egg perfect for testing antenna performance.

Elsewhere in the laboratories, Galfund points out a "Link trainer for satellites." On a computer screen, in bright brown, blue, and red, floats the image of an orbiting satellite. Engineers, practicing to control spacecraft, punch buttons—PITCH, ROLL, YAW—and watch the screen's satellite respond with pirouettes. As the satellite dances, a roar fills the room. "That's the sound of the thrusters; it gives you a feel for the length of the bursts," says Galfund.

Nearby, a satellite model, a massive 1,500-pounder, squats on the floor. Galfund presses a switch and the satellite levitates smoothly. "It's on an air bearing so you can see how it will perform in frictionless space," he says. "Give it a push." A pinkie propels the Volkswagen-size hulk as if it were dandelion fluff.

But the laboratories have more profound exhibits. In a dust-free "clean room," eerily lit by yellow lamps harmless to the photolithographic processes under way, researchers are crafting new kinds of speed-demon electronic chips. Edmund Rittner, executive director of the laboratories' physical-sciences division, adjusts a microscope. The view is unearthly, like looking down on an alien city—streetlike silver lines zigzag between glittering blue squares and iridescent green rectangles.

"It's a field-effect transistor made of gallium arsenide," explains Rittner. "Standard silicon chips are not fast enough to handle today's satellite frequencies. Now that we're adding higher-frequency transmissions, we have to develop these gallium arsenide transistors, which have a much higher electron velocity." The aim, he says, is to squeeze more transponders into each satellite. Gallium arsenide field-effect transistors (GaAsFET) also will be important to Comsat's new satellite-to-home TV system. Researchers are now learning to etch gallium arsenide chips with features down to 0.2 microns, which is skinnier than the wavelength of light itself.

Arthur C. Clarke, the satellite industry's often-invoked founding father, once pointed out that any really advanced technology would be indistinguishable from magic. If that is so, these chips will be the next satellite generation's magic wands. And the new magic word will be *TDMA*. It stands for time division multiple access, the next step in the march toward supersatellites.

According to Joseph Campanella, executive director of the laboratories' communication-technology division, the most efficient way to transmit data—anything from a video image to a telephone conversation—is in binary digital form. "And TDMA is the natural way to handle digital transmissions," he says.

TDMA sends messages as a series of microwave bursts, split seconds apart. Imagine Earth stations in Cairo, London, and New York all beaming digitized messages to each other via the same satellite. Now imagine a block of time, akin to a measure in music. Each Earth station is allotted a particular moment in the measure to beam out a burst of digitized information, a portion of the message it is transmitting. Each TDMA measure—called a frame—begins with a "reference burst" from the satellite, which signals the various stations to prepare to transmit.

Each station knows the precise interval between the reference burst and the moment the time slot in the frame opens. At the appointed time, it sends out a short "preamble" (including information needed to recover the signal at the intended receiving station), and then its burst of signal. Then it waits for the next frame to send its next burst. The bursts are so short, millionths of a second, that the transmission seems continuous to a listener.

Receivers tune to the appropriate time slot. And, according to Campanella, the system can even squeeze extra information bursts into the dead spaces in telephone conversations, not wasting a millisecond. Next, he says, will come satellites with on-board switching systems (satellite-switched time division multiple access—SS-TDMA), enabling each satellite to aim six concentrated spot beams toward stations at six different locations on Earth, switching signals among them.

"The charge for leasing a voice circuit has dropped. If other goods and services deflated at the same rate, new cars would sell for about $700."

"Ten years ago, when we started this research, people were skeptical," says Campanella, who talks in TDMA bursts himself. "But these systems will be doing very sophisticated things. I can make these bursts dance! I can make them jump from frame to frame and change their destinations on demand!"

Elsewhere in the shifting network of corporations and entrepreneurs making up Outer Space, Inc., the excitement is less over technology than over potential. There are enormous profits to be made in space. And the geosynchronous orbit has become an arena for wars that have nothing to do with the military.

"By the end of 1987 we plan to have four million subscribers, and we'll be leasing ten transponders—five channels in the eastern United States, five channels in the west," says Richard Blume, vice-president of United Satellite Communications Inc. (USCI), which is going head to head with Satellite Television Corporation (STC), a new Comsat subsidiary. USCI plans to begin broadcasts in the Northeast in September 1983. STC will begin service in 1986.

"We have the jump on Comsat," Blume boasts. "They're betting on high-powered satellites. We're putting our horsepower in the Earth stations—receivers—instead." Under current plans, USCI will offer consumers a three- to four-foot-diameter antenna (about $300 to $400) to snare signals from conventional satellites. Comsat's hopes rest on a new generation of satellites transmitting to 2.5-foot-diameter antennas and other home equipment costing a total of several hundred dollars.

Both companies are aiming to supply pay TV to rural, suburban-fringe, and high-density urban areas currently not served by cable TV. Both companies will offer movie channels, news channels, and sports. Details of their programming plans are secret, but STC says it plans to offer cultural, educational, public-affairs, and children's programming, too. Delivering all those Super Bowls and *Swan Lakes* to subscribers' rooftop antennas has required Comsat engineers to come up with new wrinkles in satellite technology.

A key to the new satellites' power will be "shaped beam antennas," which radiate microwave beams in a desired shape, wasting no energy in subscriberless areas. For instance, Comsat's first direct-broadcast satellite (DBS) will serve the Eastern time zone, with its beam's "footprint" (the geographical area it covers) roughly kidney-bean shaped, like the time zone. "Instead of providing broadcasts to fish in the Atlantic and the Caribbean, we told the signal back in and distribute it to our customers," says Ernesto Martin, STC's system-engineering director.

Instead of radiating a single beam, the satellite's antenna sends out a stream of "beamlets" that blend together. "It's a lot like the flow from your showerhead when you take a shower in the morning," says Martin. By precisely positioning the beamlets, blending them just so, the engineers can fine-tune their combined footprint. They can even vary signal intensities within the footprint. "For instance, in areas where rain might degrade the signal, we can increase the power of the beamlets," says Martin.

Eventually the satellites will provide film-sharp video, even if the images are blown up as big as a wall. More immediately they will offer stereo sound. DBS will also be able to match cable-TV services—right now with teletext (screen display of printed information, such as news or stock prices), and in the future with interactive capability (you might, for instance, vote using the system), burglar-alarm protection, and other electronic baubles. But the major impact may be somewhat more subtle.

"Because we can control what goes to

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A fledgling astronaut rides Columbia *into hushed euphoria*

JOE'S ODYSSEY

BY JOSEPH P. ALLEN
AND THOMAS O'TOOLE

Few of the 51 American astronauts who have flown in space are like Joseph P. Allen, a member of the "gang of four" crewmen who took the space shuttle Columbia *on*

PHOTOGRAPH BY JAMES McLOUGHLIN

its fifth flight around the earth last November. He was never a test pilot or even a fighter pilot, which makes Allen a member of the astronaut minority. At five feet six, Allen is the shortest of the male astronauts, an engaging nonmacho man whose nickname among the press corps that covers spaceflight is "astro-gnat."

Joe Allen is different in other ways. A native of Crawfordsville, Indiana, Allen has a Ph.D. in physics from Yale University—not your average astronaut's educational background. He is the only astronaut to leave astronaut service, then move back into it and get a flight assignment. That happened after he moved to the Nixon White House as a special space adviser and after he spent three years (1975 to 1978) heading up the congressional liaison office for NASA. He doesn't talk much about it, but Allen wasn't exactly welcomed back with open arms when he returned to astronaut duty five years ago.

Now a boyish forty-five, Allen worked hard enough and long enough to win his way back into the good graces of the men who run Houston's Johnson Space Center, earning a crew spot on Columbia's *fifth flight. It was a 2-million-mile voyage that took him and his colleagues Vance Brand, Bob Overmyer, and Bill Lenoir around the globe 82 times in five days. He and Lenoir were "mission specialists," responsible for deploying two satellites from the shuttle bay. The job gave him the freedom denied to previous shuttle crewmen: to watch the launch and landing as a passenger.*

An intelligent, eager, candid, and observant space traveler, Allen talked about his experience in rare and rich detail in a six-hour interview. Allen began the conversation by remembering how quickly he was brought back to Earth by his son, daughter, and wife, Bonnie Jo. Outside his house was a sign, WELCOME HOME, DAD, *printed by his two children. The other sign was more to the point and was handblocked by his wife:* THE LAWN NEEDS MOWING. *Here is Allen's first-person report about his flight aboard* Columbia.

The most striking thing about circling the earth aboard *Columbia* is the peacefulness of the journey, the silence that made it like being in a gondola under a hot-air balloon racing across the sky.

You can't hear the orbital maneuvering engines start up when you want to raise or lower *Columbia*'s orbit in space. The only way you know the ship is speeding up is if your computer console tells you it is—or if you hold something in front of your face and let go of it when the engines start and it comes back to you because of the sudden but gentle forward force. All you hear when the engines come on is the soft whirring of pumps and the quiet hiss of regulators. You feel there's something magical driving you because here you are, hurtling through space at 18,000 miles an hour, and there's no sound of an engine anywhere.

Even when we launched our two communications satellites out of the payload bay and into space, we didn't hear a thing. When you hear those satellites spin on the ground, and if you're in the same room, it sounds as if a subway train is about to run you over. In space there's nothing to carry sound. In space we looked at that big thing in the payload bay, seven tons of it rotating (for stability), and you couldn't hear a whisper. You couldn't even feel a vibration. We knew those satellites were spinning only because our eyes told us they were going around and our computer said they were spinning at exactly 49.9 revolutions a minute. I still can't get over that.

I still have a hard time getting over the way you see Earth in three dimensions. It's no longer a flat Earth, as it is from high-flying airplanes. It's a globe. I like the view from airplanes, but I never remember being awestruck by the view from airplanes. You are awestruck by the view from *Columbia*. You're no longer looking down at Texas where Route 10 looks just as flat from the air as it does on the road map. You can see Route 10 from *Columbia*, but now you see it curving up through the state at the same time you're looking at the gulf clear down to the Bay of Campeche, off Mexico.

You know the earth is round because you see the roundness, and then you realize there's another dimension to things because you see layers as you look down. You see clouds towering up. And you see their shadows on sunlit plains, and you see a ship's wake in the Indian Ocean and brush fires in Africa and a lightning storm walking its way across Australia. And you see the reds and the pinks of the Australian desert, and it's just like a stereoscopic view of all nature, except you're 190 miles up.

You see a lot from *Columbia* because the shuttle is a different breed from any manned spacecraft that's flown before it. *Columbia* has 11 windows, bigger than airline windows, windows that wrap around the windshield, two large overhead windows, and two large windows looking back from the cockpit. There were only three small windows in *Apollo*. *Skylab* had only one hatch window for observations. There are so many large windows in *Columbia* that there's no way you can't always see the earth, even if you're flying upside down.

One of the first things you realize is that the sky is jet-black, but the sun is so bright you never see stars in sunlight.

Night falls in space with an abruptness that takes your breath away. One moment you see the earth; the next moment you don't. I somehow pictured always knowing where the earth would be, even in darkness. Either there were going to be lights I could see on the ground, or there would be light leaking over the horizon from a soon-to-be-rising sun. Instead, I found the blackest black I ever saw. I remember as a youngster going into Mammoth Cave, in Kentucky, and being taken into a room and told, "You're going to experience the darkest dark you ever felt." And then somebody turned out all the lights. The darkness in space is just as dark. The way you find the earth in the dark is to track the stars until the stars stop. When the stars stop, that's the earth blocking their light.

It's very hard to see city lights from orbit unless you're crossing right over a large, well-lit city at night. We could see the lights of Miami and Perth and a few of the coastal Australian cities because we passed right over them. But they were the only city lights I saw. We could never see the lights of New York because it was too far north of our ground track. It's hard to spot lights to the north or south, in part because you're not certain which way is north or south.

In fact, it's harder keeping track of yourself in space than it is in an airplane. You don't know if the spacecraft is right side up or upside down. You know your direction, but that's never related to which way your nose is pointed. You can be flying tail first, wing first, or belly first and you know you're traveling east, but you have to do a deliberate mental calculation that if that's east and the earth is down there, then that over here must be north.

The sun truly "comes up like thunder," and it sets just as fast because of *Columbia*'s incredible speed. Each sunrise and sunset lasts only a few seconds. But in that time you see at least eight different bands of color come and go, from a brilliant red to the brightest and deepest blue. No sunrise or sunset is ever the same. I mean, they're not like rainbows, which have the same color combinations no matter where you are on Earth. The colors change and the width of the bands is different every time. And you see 16 sunrises and 16 sunsets every day you're in space.

Physicists tell you the colors change because different particles in the atmosphere change the way the sun's rays are bent into your eyes. I know I shouldn't say this, because it's the only argument I know for air pollution, but the most spectacular sunrises and sunsets I saw were in regions of the atmosphere over the earth where the pollution was at its worst.

Sunrises start with the faintest hints of color, quickly followed by bands that taper out like a brilliant crescent into blackness at both limbs of the horizon. Suddenly the sunball peeks over the horizon where the bands are widest, and all color disappears in an instant.

The way you look at sunrises and sunsets in space is different. At sunset you look at the limbs of the horizon first and then move your eyes toward the sun as it goes

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FICTION

EDGES

BY GREGG KEIZER

From
the corner of
my eye
I watch Marart's
death. I
have my own
rigging
to work, meters
to keep
in sight; so all
I can do
is watch him from
the corner
of my eye. I think I
see a line
fluttering where

PAINTING BY
MARCEL MAILLET

one should be taut, and he is off balance as he leans over the deck of his clipper. I feel little for him. My heart pounds wildly and I cannot forget that he tried to force me onto a cairn of rocks moments before.

My clipper is functioning perfectly, coming abeam of his again, and though my sight is drawn to the smoothness of the salt that streams beneath me, I *have* to look and watch Marart. There is nothing else I can do, even if I wished, for it would take kilometers to slow and stop my clipper. By then he would be a dwindling speck on the horizon of the Flats.

I look up to starboard and see the shifting and dancing image we chase. I try to focus on it, but it remains blurred, a yellow stain that flickers in the heat waves. Although it is only half a kilometer away, it is on the other side of the Edge, the blackened land that seems to swallow the very light that refracts and bounces off the Flats. I cannot see an end to the darkened salt that was fused into a sort of chipped glass by the megaton bombs centuries ago. No one sails on the Edge; no one crosses the line between shimmering white and light-sucking dark. Yet an image floats above the Edge; it seems impervious. There is a pool of white underneath and around it, an oasis of contrast that moves as it moves. The image could be a simple mirage, but a mirage does not carry its own unmarked ground with it. And then I hear an odd, throaty rumble coming back to me. Mirages do not make sounds. Both Marart and I know that.

Marart has regained his balance and is hanging on to an unbroken line, which bends dangerously. But it is too late, for the blades of the fans beneath the clipper's skirting gently nick the salt. Marart's misplaced weight throws the clipper off-center and the fans dig into the crystals, leaving a worm's trail. The caresses of the fans cause the clipper to heel further and gravity tugs at him.

There is nothing Marart can do. If he falls, perhaps his suit will protect him from scraping wounds.

For a moment I think I see his face behind the thin visor of his helmet and I even imagine that he is smiling. Another mirage, perhaps, and I glance quickly to reassure myself that my clipper is sailing smoothly and the yellow blur still weaves in the distance. It paces us as we run along the Edge, half a kilometer to the east—another heat vision, like all the illusions that make up the Flats. But when I look back at Marart and his craft, several meters behind me now, the deck of his clipper is empty.

His clipper slowly drags to starboard and tips over onto its side. He is still hanging on. Then his mast reaches for the salt, brushes it, and the clipper is cartwheeling. Its plastic shell disintegrates, and the wreckage is a tangle of rigging lines, mast, and sail, all wrapped around shattered motors. And over the whine of the fans beneath my clipper and the snap of the sails above me, I imagine his screams. They are not loud, only forever, and they do not end even when my imagination's Dopplering has deepened their sounds to a low hum.

I stare past the whiteness of the Flats into the blackness of the Edge, and the mirage is still out there, flickering in the heat. I crowd on more sail, let out the jib lines, and feel the lurch as my speed increases. My clipper is close to instability, but I know I must go this fast to catch the mirage and slip into the oasis of the past that surrounds it. Marart's crumpled clipper falls farther and farther behind.

I think then of the Timing Race last year, when Marart and I watched Dannelle meet a mirage along the Edge. Her clipper flew behind the wavering image, then seemed to touch it before both flickered in the heat waves and slowly disappeared over the horizon. She had been transported into the past, the time of the machined mirages. Marart and I knew that, because we both had chased the mirages until they vanished. And when we stopped our clippers and walked from them, we knelt and touched the tracks the mirage had made in the salt. Illusions do not make tracks.

Marart has regained his balance and is hanging on to an unbroken line, which bends dangerously. But it is too late; the blades of the fans have nicked the salt.

We walked in the shallow grooves of the thing's tracks until we came upon its skeleton, still glowing as the scorched metal cooled. A hundred-meter trail of scattered debris led to its huge tail, where the pilot sat. He was burned horribly, only his face unmarked beneath the helmet we lifted.

Marart and I buried the man from the past beside his machine and said little to each other as we walked back to our clippers. The machine was fueled by a sweet-smelling liquid we lifted to our nostrils. It was huge and made of metal. There was nothing like it in all the world. There had been nothing like it for centuries. Perhaps it was jolted out of its true time when Dannelle's clipper closed on it, Marart said as we walked. Perhaps Dannelle had taken its place in the far past, he whispered. A new machine joins the past, an old one must fall out. I said nothing. Dannelle had been my lover and now she was gone—gone farther than mere death.

The search groups never found Dannelle or her clipper. Missing, the groups concluded. Marart and I knew better; we knew the mirages were real—visions of the past—and pathways into that time.

We told no one and, instead, raced to touch a mirage so that we could sail into the past. Marart had tried to kill me today to reach the mirage first.

As I blink my eyes, forcing my mind to the present, I try to focus on the mirage. But it vanishes, leaving me alone. I do not slacken my sails, though I am in the lead. Marart's death has given me this heat and thus the right to race Henna in the finals.

I adjust the rigging lines, steering for the finish banner, which vibrates vaguely in the distance. The clipper shifts slightly. The fans' whine becomes louder for a second as the skirting lifts on the high side and then I am sailing smoothly again.

There are small hillocks here and there on the Flats, as well as long ditches that cross the expanse, going and coming from nowhere. I must watch for those, because there is no way I can beat into the wind, not in a clipper. I can run only before the wind, making sure it is constantly near my back. I can sail a beam reach, perhaps ninety degrees to the wind, but that is all. If I try to come closer to the wind, I will heel over and suffer Marart's fate. There is no keel on my clipper, as there would be on a true sailboat, no resistance from the water to keep me upright. That is why we sail here, where the land is level and relatively free of obstructions.

The power for the fans that keep the deck centimeters from the salt bed is within acceptable limits and the reserve battery is fully charged. My visor snaps up and out of the way at the touch of my fingers and I let the wind tear at my eyes.

A gust of wind to starboard touches my sails as I cross the finish banner, and the frictionless clipper skitters meters to port before I can regain control. In that instant I think of Marart and I wonder who will look for his body. It will not be me. Only lovers and friends go to reclaim the dead in the caldron of the Flats. I am neither.

We crouched around the heater in the tent, watching our breath billow and rubbing our palms together in front of the red coils. I finished one beer and reached into the kitbag behind me for another.

"The front is supposed to pass tonight and a high move in tomorrow," Henna said. "Lots of southerlies for the next three days." No one spoke. "That's what the meteorologist said. What's his name, the thin one?"

"Withers," someone answered from the other side of the heater. I couldn't see a face to connect with the voice. It didn't matter; I wasn't familiar with more than a handful of the pilots this year. Henna was one of the few I knew.

"Yes, Withers. On-the-mark forecast," Henna said, an edge to her voice. "He said straight winds today, no gusts."

Someone cleared his throat and I glanced up to see Marart's brother looking at me, his dark eyes making me uncomfortable.

His name came to me slowly. Dallin, I remembered. "You were there, weren't you?" I gulped more beer and looked at my breath hanging in the air.

"Yes."

"What happened?" He was still flushed from going out to retrieve his brother's body.

"A line broke. He should have jumped, but he hung on instead," I said quickly.

"No gusts? No sudden gusts abeam?" Dallin asked.

I shook my head. I glanced up and Henna met my gaze. I shook my head again.

"I saw what made his clipper heel," Dallin said, looking over at Henna for a moment. I drained the last of my beer and reached for another. Bottles clinked together as I lengthened the row of empties. "I was behind you today, a kilometer or so back," he said, looking at me again.

Had he seen the mirage, too? Had his brother told him what they really were?

"It was the wind. You know what the Flats are like. Wind comes from nowhere. You've seen the white devils out there. One got Marart," I said, my voice too loud for the tent. If he'd been that far behind us, he might believe *I* was the cause of Marart's death. From that distance, it might appear that I rammed Marart.

"Maybe," Dallin said, his eyes hating me.

Again I wondered if Dallin knew the truth. His brother had been obsessed with speed. He had believed the machines that had raced these Flats centuries ago moved hundreds of kilometers each hour. Joining the past would allow him to race in one of those machines, he had thought. He would not have let someone else beat him to that, not even his own brother. Dallin could *not* know the truth.

It was almost silent in the tent, only the ticking of the heater coils audible as they switched on again. "Say what you're thinking," I whispered.

Dallin went on slowly, his eyes looking at me all the while. "Maybe you ran against Marart out there today. Maybe that's what made him lose control. You've said often enough how badly you want the Timing Race. Maybe enough to foul someone's clipper to take the heat."

His words hung in the chilled air. I set the beer bottle beside me, wanting to smash a jagged neck free and cut him, afraid I would if I held it a moment longer.

"Are you accusing me of murder?" He shook his head. He knew he had no proof. "File a fouling charge, then."

"No one else saw it. It would be just your word against mine."

"Why are you doing this?" I asked, the bitterness welling up in me. "I didn't harm your brother," I said, my voice tight in my throat. I could not tell him what had happened, that his brother had tried to kill *me*. Not without telling the truth of the mirages.

"I saw you out there, Paul. I saw you—"

"You saw nothing. Nothing that you could ever prove."

"You killed him, just as if you'd thrown him off his clipper yourself," Dallin said, his face reddening even more. "If you hadn't been so eager to—"

"You're more a fool than I thought," I said. "Keep your lies to yourself from now on." I pulled two beers from the kitbag and stood up. Dallin said something, but I didn't listen. Instead, I swept aside the tent flap and walked into the night.

The stars were outrageous. Every one seemed a pin through fabric, and no matter how many times I blinked, I could not make them sparkle. The air was cold and it hurt as I breathed it in.

As searingly hot as the days were here, the nights were just as bitterly cold. I hoped the water ballast in my clipper's tanks would not freeze again tonight.

Laughter reached me from somewhere far away. I turned and looked at the rows of white, bell-shaped tents that stretched into the darkness, each one lit from within. Shadows moved inside the canvas as the spectators played through the evening. The nearest spectator tent was two hundred meters away, separated from the pilots' tents by our encircling clippers.

I made it a practice never to walk into spectator territory during a Timing Race, for once they found out you were a pilot, they would pester you far into the dawn.

Timing Race We ran our clippers across the Flats for sport and the spectators flocked to watch. If they were fortunate, they would see one of us die. I thought mildly of Marart, then of Dannelle, and I wished to be out there, running along the Edge, searching for her.

The dull noise from the tent behind me rose lightly, then fell again. I didn't turn, for I knew who was standing there.

"He was only saying what first came into his mind, Paul," Henna said, shivering in the cold as she moved beside me. "He and his brother were very close. He didn't mean what he said to you."

"Yes, he did."

"I've heard stories about mirages on the Flats, Paul," Henna said. I almost said something. Did she know? "It seems every year someone sees something odd out there. Maybe Dallin saw a heat mirage," she said. I breathed easier, but her words left me uncomfortable.

"Remember three years ago? That pilot from Oregon who swore he'd seen wagons crossing the Flats?" She paused and I could hear her rhythmic breathing. "And then Dannelle last year. She said she saw a blue blur that slid across the salt, trailing pieces of itself." Henna's voice was lost in the night. "I'm sorry, Paul. I didn't mean to say her name. It's—"

"Don't worry, I don't mind."

"You still believe she's alive, don't you, Paul?" She paused and I nodded, though I was sure she couldn't see the gesture. "Are you tired? Thinking of Marart?"

"He must have made a mistake." I desperately wanted to tell her the truth, that he had tried to kill me, but I couldn't.

"And you won't? Never?" There was something akin to laughter in her tone, something I didn't like.

"Perhaps I *am* tired," I said, rubbing my hands together, hearing the sound of rough skin over calluses. It sounded so much like the noise of handling rigging lines that for a moment I thought I saw Marart's visored smile in the dark.

"The moon will be up in half an hour," Henna said, sliding her hands between mine. Her hands were warmer, but just as weathered from sailing clippers. "I know, let's go to the Edge. We haven't been there in years. Let's watch it against the moon. It'll be fun. Paul?"

I looked at her face, but in the dim light I couldn't read it. We hadn't been lovers for two years now, not since I'd met Dannelle and walked away from Henna. Then I realized her reasons didn't matter; being alone tonight was not something I wanted. "Why not?" I laughed, suddenly hugging her, feeling her warmth through the coveralls we both wore. "Race you there. Last one sets up the recharge panels." I tugged at her sleeve. "Come on, Henna."

I walked to my clipper, reached it, and touched the smooth plastic deck, straightened the rubberized skirting so that it touched the ground. My clipper was long, six meters, and narrow through the bow and stern; it only vaguely looked like the bulbous hovercrafts that lumbered along the waterways. Amidships, where the controls were clustered, it was barely wide enough to sit, perhaps kneel. The mast was up and the bright-green sail furled along the boom. Near the bow lay the spinnaker, ready to balloon when the clipper reached forty knots. The fan switches were under my fingers, and if I turned them on, the deck would lift its three centimeters.

I heard Henna behind me and she touched my arm. "No. No racing. Not tonight. Let's take the water truck instead." The electric truck was so slow, I thought; hauling our water from the mountains was all it could do. But the wind was out of the south by now, and would be again tomorrow. If we took our clippers, there would be no easy way to return, since it was difficult to beat upwind. So I nodded my head and whispered yes.

We took turns running the steering levers, giggling and shouting back and forth as we crawled across the Flats toward the Edge. For a moment I thought I saw a shape shift in the dark, but the crunch of the truck's balloon tires on the salt shattered the dream.

While Henna set up the heater and opened the food pouches she'd squirreled

away in her coverall pockets, I set up the solar panel and pointed it toward the Cedar Mountains, where the sun would first show itself in the morning. With the main battery drained, we would have to wait until it was recharged before we could head back. Luckily, the final race was not until the day after next.

We sat, huddled beside the heater, eating crackers and fruit, drinking beer I'd taken from the tent. The moon was over the mountaintops to the east and was just beginning to lose its yellowness. But we paid more attention to the blackness that swallowed the salt flats a half kilometer ahead. We sat on a small rise, dirt somewhere beneath the ever-present layer of white salt, and looked down into the Edge. The line of black marked the bombs' blast radii. What targets the bombs had searched for were long lost, but there was a stump of a city a hundred thirty kilometers to the east, the sailplane pilots said. The blackness stretched all the way to it; only the mountaintops were spared.

Though the Edge was black, there were brief shimmers of light along the border—short bursts of color, like the waves of the northern lights. At times there seemed to be only one; other times the glimmers came in pairs. But they always appeared along the border, never deep within the Edge.

I decided they were glimpses of the past, the oases I chased. If it were daytime, the oases would look like bursts of color and light. I wondered whether I would see details if we were closer. Perhaps somewhere in those gleams was Dannelle.

"You're thinking about her again, Paul?" When I said nothing, she continued, her voice quiet. "I hated her, and you. Did you know that? When she disappeared last year I was glad it happened. Not now, not anymore—but I was bitter then."

"She's out there," I said, holding Henna's hand, feeling her warmth. She shook her head. "I've told no one what we really saw . . ." I continued, letting my voice trail off into the dark.

"Today, you mean?"

"No, when Dannelle vanished." Henna shook her head again. "The destruction out there," I said, pointing to the Edge, "was unimaginable. The bombs were stronger than the sun itself. You've heard the stories. Thousands of them fell here, each one warping reality a small bit, until even space and time were changed. They fell for days. Even time rips eventually. Now there are ways into the past. Perhaps to the future, too." I said the words I'd often thought but never spoken, not even to Marart. I couldn't stop. "The strange lights on the Edge, the mirages we've all seen, are only oases of the past that are somehow visible. Imagine the power of the destruction and tell me it's not possible."

"You're insane, Paul," she said deliberately, but her accusation only made me more sure of myself. "Hallucinations, Paul. We see mirages because of the heat waves. That's all it is, the heat."

"I've touched a dead man from the past, from the time before the wars," I said. "Marart has, too. We found him in his machine after Dannelle disappeared through one of the time oases. Her presence jarred him loose, we thought."

"You believe she's down there somewhere, waiting for you? Is that why you killed Marart? To reach her before he did?" Her voice accused me of more than murder.

"He tried to keep me from the mirage and its oasis. He tried to force me onto some rocks, but he lost control. I swear it," I said, squeezing her hand tightly. "I can find her if I can catch one of the images and slip into its time oasis, just as she did. I know I can."

"You're obsessed with her, Paul. That's all." She did not believe me. I would have to take her to the dead man's strange machine and that was impossible tonight. It was too far for the truck's worn batteries.

The blackness of the fused salt, the constant flickers of color, and the moonlight

"He was dead, but somehow I was relieved. Now there was no one who knew the truth of the mirages except myself and Henna. I felt a chill in the heat of the crowd."

contrasted with one another. I could hear Henna exhale loudly. She touched me, her fingers light on my temples, as if she were trying to rub away the insanity that she thought was there.

"Dear Paul, don't torment yourself. Forget her and live your life." I didn't push away her hands, even though I saw Dannelle's face in my mind. I needed someone. That was why I'd told Henna all this. Dannelle would understand, I thought.

We made love three times that night, caressing each other with calfused hands while we waited for our interest to return. I laid aside my memories for a while. Neither of us spoke, perhaps each afraid that more words would widen the gap between us. Even so, I couldn't keep my mind on what my body was doing.

Each time she cried out, each time I shouted with pleasure, I heard the faraway sound of Marart's agonized last cries as his clipper pulled him over the salt. But in the nightmare of my passion, the salt was fused, not jagged as it was on the Flats, and it seemed to take him forever to fall silent. Sliding on a sheet of glass, forever.

I sat at the table, shielded from the others by cloudlike curtains, and drank quickly from the glass. Voices from the rest of the huge tent reached me now and again. They were spectator voices. The woman at the bar had given me a bottle and a glass and found me this table in a corner. She'd once been a pilot, she said, and understood I wanted privacy. I had smiled and tried to thank her, but she'd slipped back into the crush of spectators.

I needed to be away from the other pilots, to think; so I'd walked between the encircling clippers to spectator ground, their tents silver and noisy. A few had noticed me, but I hadn't stopped at their calls, instead pushing into this tent crowded with spectators and alcohol. As I drank to the bottom of the glass and refilled it, I kept imagining that I felt Henna's fingers on my back. It was difficult to push that image away and pull Dannelle's face into focus, but I did, and then drank again.

"They said you were here."

I looked up and saw Dallin standing beside the drifting cloth curtains. I didn't take my eyes from his, but I could tell spectators were watching.

"I didn't kill Marart. I told you what happened during the race."

"He told me everything," Dallin said, his voice dropping low. "The mirages, Dannelle. Even the man you buried out there on the Flats. I'm going to the Association, and I'm going to take them to that machine. Marart told me where it is."

"Listen to me," I said, gripping the glass tighter, feeling its solidness against my palm. "Marart tried to run me against some rocks. We were chasing a mirage and he tried to kill me. He wanted to reach it first. I didn't kill him, I told you that." Dallin reached inside his jacket and pulled out a long, thin knife.

"They'll know you were a murderer when they dig up that man out there," Dallin said. He moved to one side, brushing against the curtains, the knife pointed at my face.

I threw the heavy glass at his eyes and when he jumped to the side, I leaped over the table and pushed him to the floor. He grunted as the breath went out of him and I had my hand wrapped in his hair, trying to pull his head back too far. But then he squirmed under me and I caught a glimpse of a freed hand, the knife still in its grasp.

Its blade slashed my shirt and the skin under it, but the pain didn't come. Then I had my hand around his wrist, and still kneeling astride his chest, I pushed his arm down, the knife with it. I noticed its edge was dark with my blood.

The noise in the back of his throat grew louder, then quieted, and I looked down at my hands, both twisted around his one. His wrist was at a strange angle and the knife's haft was still in his fingers. The blade was in his chest and froth welled up around its edges.

I felt the presence of spectators behind me and heard the movement of someone's feet on the wood floor and the quiet cough of someone in a far corner. Dallin's final,

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MICROMONSTERS ON THE PROWL

PHOTOGRAPHS BY DAVID SCHARF

It is no coincidence that the tiny fruit fly pictured above looks like a jet fighter poised for takeoff. After all the damage this real monster inflicted on West Coast citrus crops, Los Angeles photographer David Scharf figured it was only fitting to paint its portrait in military colors. "In most instances, I would catch the insects myself," Scharf said

TEXT BY DAVA SOBEL

"Insect subjects survive a 5,000-volt electron-beam assault."

of his photographic subjects, "but this particular fly was lent to me by the United States Department of Agriculture. And I had to return it to them for their body count!"

Thanks to a special technique he perfected, Scharf's ants, beetles, spiders, and aphids usually live through the several-minute photo session in his scanning electron microscope. For every finished photograph, Scharf says he spends three to four days in preparations and test runs, then another two to three days, at least, to color the prints by hand. In a painstaking process that mimics the creation of cotton or silk batik, he immerses each print in as many as eight trays of toners, masking off an antenna here, a compound eye there, until his unique color combinations replace the silver on the original film. Then he dabs in finishing touches with a cotton swab. "I

"Each micrograph contains 2,000 lines of visual information."

need about ten copies of each print before I begin," says Scharf, "so I can make mistakes." He tries to stay faithful to the bugs' natural coloring wherever possible, but when confronted with something like a black fly, he freely pours in orange and blue.

Although Scharf has been creating electron-microscope photos of insects and plants since 1974, he began adding color only a year ago. The new pictures blend the forty-year-old Scharf's long experience as an amateur painter with all the photographic skill he has acquired since he took his first picture at age nine.

The yellow aphids above and their flying or crawling compatriots on these pages are previews from Scharf's forthcoming book, called *Real Monsters*, and all his insect portraits are copyright © 1983, by David Scharf, all rights reserved.

The same month
my report appeared, a doctor
choked to death
at a banquet in front of 100
other physicians. They
thought he was having a heart attack

INTERVIEW

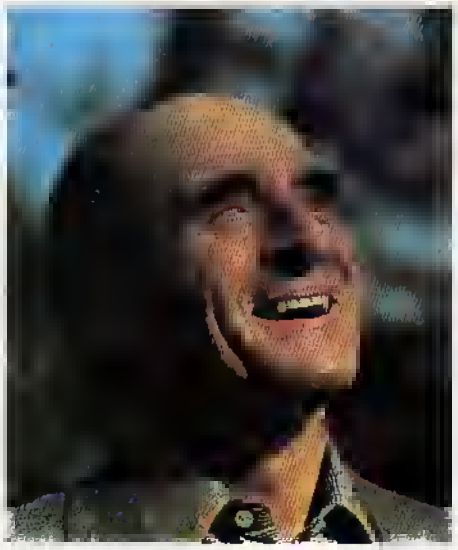
HENRY J. HEIMLICH

PHOTOGRAPHS BY DAN MORRILL

Enter almost any restaurant these days and you'll see a wall poster instructing you on how to administer a violent hug to someone who is choking on food. The hug makes a popgun of the victim's diaphragm and lungs. The morsel will likely fly from the victim's mouth and he'll sigh with relief as he can breathe once again. That lifesaving squeeze, or Heimlich maneuver, has saved thousands of lives since it was introduced in the mid-Seventies. Yet it is only the most publicized of many innovations developed by Dr. Henry J. Heimlich, an outspoken medical authority who is lately becoming more public himself.

Technically, one would call sixty-three-year-old Heimlich a chest surgeon, although medical inventor is a more appropriate term. His first recognition came in the mid-Fifties, when he developed an operation that cleverly used a flap in the stomach to replace a damaged esophagus. A decade later he developed a cheap, simple chest-drainage valve that was used during the Vietnam War to help save the lives of wounded soldiers. He has also developed new ways to teach stroke victims to swallow and, most recently, has invented a highly portable breathing apparatus that may enable thousands of people suffering from lung disease to lead more mobile lives. He is also the creator of a series of television spots, aired on ABC-TV during weekend cartoon shows, that feature a cartoon likeness of Heimlich teaching first aid to children. The spots, called *Dr. Henry's Emergency Lessons for People* (HELP), won an Emmy Award in 1980.

If there's anything that ties Heimlich's diverse projects together, it is an apparent simplicity that belies the research and thought that gave them birth. Heimlich's chest-drainage valve, for example, is simply a flattened rubber tube enclosed in a clear plastic cylinder—the prototype was a rubber "Bronx cheer" that he



"My pattern is typical of inventors: You see a problem, it annoys you, and you conceive of a cure. But I add another step: You must sell the idea. Otherwise you have wasted your time."

bought in a local five-and-ten for $1.50.

Straying from convention began early for Heimlich. The son of a prison social worker, he recalls that, "by the time I was twelve I had been through every prison in New York State." His parents were too poor to send him to summer camp; so he attended a free camp run for delinquents by his father's department. After graduation from Cornell Medical School, he joined the Navy and served in the Gobi Desert during World War II as part of an attempt by the Americans to convince Chinese warlords that American medicine made us more valuable allies than the Japanese.

Since then Heimlich has been the source of a steady stream of medical developments. He holds seven patents, has authored scores of scientific papers, and has written or contributed to ten books. He is a frequent guest on the lecture circuit and on TV, speaking about everything from first aid, to the future of medicine, to "Computers for Peace," a new peace plan he advocates. His activities have earned him a position on the advisory board of the National Peace Academy, a proposed counterpart to the nation's military academies. (The NPA now enjoys the sponsorship of almost 200 members of Congress.) Other notables on the board include Senator Mark Hatfield, of Oregon, Mayor Andrew Young, of Atlanta, and General Andrew J. Goodpaster, former superintendent of West Point.

All this public attention attracts its quota of controversy, which Heimlich only encourages with his outspoken ways. Diplomats have called his peace plan naive; critics suggest he may be less an innovator than someone who is remarkably skillful at publicizing his inventions.

To learn more about Heimlich, *Omni* contributor Douglas Starr recently followed the doctor through one of his typically frenetic days, beginning at Heimlich's office at Cincinnati's Xavier University, where he is professor of advanced clinical studies and ending at his gracious brick home overlooking the Ohio River.

Heimlich spoke in the broad strokes of a generalist, preferring overall concepts to details. Often he rushed on to the next topic without elaborating on the particulars of the last idea discussed. His skill as a lecturer is also apparent: Even when he was being combative or controversial, he expressed himself with intensity and charm. It was typical of Heimlich's schedule that, even as the discussion continued late into the evening, he was hurriedly packing to catch a plane for yet another speaking engagement, to explain Computers for Peace.

Omni: Many people have heard of the Heimlich maneuver, but few know how it was invented. How did you come up with the lifesaving squeeze?

Heimlich: I had known about choking deaths for a long time. I'd read about Tommy Dorsey and Cass Elliot, of the Mamas and the Papas, who choked to death on a sandwich. But like many people, I had always thought of choking as only an occasional happening. In the early Seventies I learned that choking was the sixth leading cause of accidental deaths, killing an estimated four thousand persons each year.

As a chest surgeon, I knew that there is twelve hundred to seventeen hundred cc [cubic centimeters] of air in the chest, plus another five hundred or so if the person has inhaled. So I took an endotracheal tube, closed off the upper end, and put it down the throat of an anesthetized dog. When I compressed the air in the dog's chest, the tube moved out of the airway. It wasn't immediately apparent where I should push. I tried pressing on the chest, but got better results by pushing up under the diaphragm. Then I had to figure out how this maneuver could be devised in such a way that people could do it very quickly and it would work. There are several positions from which you can push on the diaphragm, but it became clear that the best way would be to stand behind the victim, wrap your arms around him, and squeeze upward. That became the maneuver. I also came up with a method that works when the victim is lying unconscious on the floor. You simply press on the diaphragm with the heel of your hand.

Now, I had the concept, but how was I going to try it out? I wasn't about to tie a string to a piece of meat and put it down someone's throat. So I went ahead and published the study in a journal, *Emergency Medicine*, and asked the editors to bring it to the attention of certain people in the press. A week later I was sent a front-page story from the *Seattle Times* about a restauraleur who had read about the maneuver. One day his neighbor came running out of the house, screaming that his wife was having a heart attack. The restaurateur ran over, saw the woman unconscious, with her face literally in her mashed potatoes, and performed the maneuver. A piece of chicken popped out of her mouth, and she survived. After that, the maneuver spread like wildfire.

Omni: How many lives have been saved by the maneuver?

Heimlich: We have documented around thirty-five hundred so far, but we know there are at least six thousand, from what we hear. The maneuver saved President Reagan's life when he was choking on a peanut. Mayor Koch was saved from gagging on Chinese food, I believe. And Cher was saved by Robert Altman from choking on a vitamin pill.

In the first three months after the maneuver became known, we got reports of people's ribs being broken from the hug. That's when I devised the method of grabbing your own fist and pressing it into the victim's diaphragm, with your elbows bent outward. That relieved the pressure on the victim's lower ribs

Omni: Although the American Red Cross took a couple of years to accept your maneuver, the organization now recommends it in conjunction with their traditional solu-

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What lurks behind the wild forces of nature? Ask the

CONNOISSEURS OF CHAOS

BY JUDITH HOOPER

About 40 years ago, the late poet Wallace Stevens wrote a poem, entitled *Connoisseur of Chaos*, that unwittingly prophesied the birth of a whole new science:
A great disorder is an order. Now, A! and B are not like statuary, posed/ For a vista in the Louvre. They are things chalked/On the sidewalk so that the pensive man may see . . .

Stevens's lines run through my head as I look out the restaurant window. On the sidewalk the knapsack-laden young people drift by like a defeated army, eyeing us with the hollow gaze of Michelangelo's damned. "Only once or twice in a millennium is there a true scientific revolution, a real paradigm shift—Newtonian mechanics and the invention of calculus in the seventeenth century was the last one," my host, mathematician Ralph Abraham, notes between generous helpings of spicy Szechuan vegetables. "The current scientific revolution will synthesize the whole intellectual discourse of the species."

This is cosmic talk. And here in downtown Santa Cruz, where casualty cases of the Sixties wander the streets like possessed souls, it's hard to grasp the sense of his words. But up the hill, at the University of California, Abraham is one of a small band of scientific revolutionaries who aim to reinterpret the universe through the new science of *chaotic dynamics*. You've probably never heard of Ralph Abraham or any of the other connoisseurs of chaos, but you will. Though they work far from the public eye, in realms abstract and otherworldly, some have already begun to speak of their esoteric discipline as the science of the twenty-first century.

A few miles from the restaurant where Abraham and I lunch is a land of cool redwood groves and white-gold meadows: the University of California at Santa Cruz (UCSC). It's the sort of semibucolic, decentralized place where a handful of graduate students can abandon the straight and narrow of conventional science for the *terra nova* of theoretical physics. This universe is not inhabited by new subatomic particles born in a linear accelerator, but by macroscopic beasts just as incantatory—mathematical creatures known as "strange attractors."

Unlike quarks or gluons, the business of chaos can be seen with the naked eye and understood even by nonscientists. Why can't your chatty television weatherman predict next weekend's weather? Why can't you outwit a roulette wheel? Why does a normal, regularly beating heart suddenly go on the fritz, killing its owner? How does orderly creation rise out of the chaos of the Big Bang? How does a unique human being develop out of a cluster of common cells?

PAINTING BY FRIEDRICH HECHELMAN

The Belousov-Zhabotinsky Reaction (below) oscillates like an amusement-park ride seen by Marcel Duchamp.

The answers involve a bold new understanding of these creatures of chaos—and what we call chance. According to traditional Newtonian mechanics, if you know certain things about a system—all the forces acting on it, its position, and the velocity of its particles—you can describe, in theory, all its future states. Here is how the turn-of-the-century mathematician Jules Henri Poincaré once described the Newtonian view: "If we knew exactly the laws of nature and the situation of the universe at the initial moment, we could predict exactly the situation of that same universe at a succeeding moment." But Poincaré's own work and that of his heirs was to topple that secure assumption. Anticipating the weird world that Abraham and his colleagues now routinely confront, the French mathematician said, "These things are so bizarre that I cannot bear to contemplate them!"

A simple example: Suppose you're sitting beside a waterfall watching a cascade of white water flow regularly over jagged rocks, when suddenly a jet of cold water splashes you in the face. The rocks haven't moved, nothing has disrupted the water, and presumably no evil sprites inhabit the waterfall. So why does the water suddenly "decide" to splash you? Physicists studying fluid turbulence have wondered about this kind of thing for several hundred years, and only recently have they arrived at what they consider to be satisfying answers.

It boils down to this: Randomness, or chaos, is not merely a matter of complexity. Many physical systems, including some very simple ones, have pockets of randomness *built into* them. And that's why the most godlike scientist, wielding impossibly perfect tools, can never accurately predict the weather three days hence or mark the final destination of a ball in a spinning roulette wheel. We're condemned to live with chance, and even now some scientists cannot bear to contemplate such things.

Others, like UCSC theoretical physicist Rob Shaw, can't bear not to. While still a graduate student in late 1977, he heard about something called chaotic dynamics, a field that few physicists outside of the tiny chaos fraternity knew existed. An analog computer, a remnant of a defunct engineering department, materialized at just the right time for Shaw to try out the new equations. He dropped his nearly complete thesis on superconductivity to contemplate chaos and the crazy, seductive shapes its equations generated on his computer screen. The rage soon spread to his UCSC friends: Doyne Farmer, who set aside astrophysics; Norman Packard, who left statistical mechanics; and James Crutchfield, who changed his undergraduate studies. From these men, the Dynamical Systems Collective—colloquially dubbed the chaos cabal—was born. Abraham and the other chaos elders attended their informal conclaves to trade valuable mathematical know-how.

In a lab whose nether corner suggests a jet plane's cockpit (an elaborate assemblage of computer monitors, plugboard, electrical wires, dials, and meters takes up half the room), Shaw shows me a mundane but elegant model of chaos: an ordinary dripping faucet.

Other people tinker with car engines; Shaw builds chaotic appliances. In this case, he has constructed a water tank with a spigot dripping droplets through a ruby-colored laser beam on their way to a bucket. The intervals between drops are transmitted as pulses to the analog computer. That mathematically transforms them into spiraling video patterns in a sea-green space.

The faucet, says Shaw, is a microcosm of chaos. By Newtonian law, the spacing of the drops *ought* to be regular and predictable, but it's not. "The fascinating thing about a standard faucet," he explains, "is that even though the [water] flow is constant, the spigot doesn't move, and nothing perturbs the system, the pattern never repeats itself. It's got a random element in it."

Where does that random element come from? The same place as the waterfall's sudden, random splashes. Not from some imperceptible jiggle, as scientists had long supposed, but from the inner dynamics of the system itself. Behind the chaotic flow of turbulent fluids or the shifting cloud formations that shape the weather, to give but two examples, lies an abstract something that physicists now call a strange attractor.

Okay, so what is an attractor and what makes one strange? Suppose you put water in a pan and shake it up; after a time it will stop swirling and come to rest. That state of rest—the equilibrium state—can be described mathematically as a fixed point, which is the simplest kind of attractor. (All of the mathematics describing a system's motion are inexorably drawn toward the attractor like filings toward a magnet.)

Now imagine the periodic movement of a metronome or a pendulum swinging from left to right and back again. Geometrically speaking, this motion is said to remain within a fixed cycle forever. That is the second kind of attractor, the limit cycle. There are many different kinds of limit cycles, but they all share one characteristic: regular, predictable motion.

But the third variety, the strange attractor, is a breed apart. It is irregular, unpredictable, quirky. In a word, strange. For example, when a heated or moving fluid moves from a smooth, or laminar, flow to wild turbulence, it switches to a strange attractor. While strange attractors' geometric shapes are legion, they have

certain distinct characteristics in common.

One is an abstract structure that the Santa Cruz cabal likens to filo dough, the intricately folded pastry of baklava. "Suppose a baker puts little dots of ink on his dough," Shaw tells me. "He stretches or rolls out the dough, then folds it in half, stretching and folding it over itself again and again. Pretty soon the dots of ink could spread anywhere." Shaw and his cotheorists call this the baker's transformation. This is more than a metaphor. The mathematical models behave like the stretching and folding dough, the spreading ink dots represent the fuzziness of any initial measurements.

Similarly, mathematical points—representing such successive measurements as velocity, temperature, amplitude, or whatever—may start close together with a strange attractor and then drift ever farther apart, like the ink dots in the filo dough. So you can neither predict what something will become by looking at its initial situation, nor reconstruct its origins from its present position. With enough stretching and folding, randomness will reign. In the lingo of chaos, this phenomenon is described as "rapid divergence of nearby trajectories."

But *why* this maddening lack of precision? Well, that brings us to another chaotic-dynamics catchphrase: "sensitive dependence on initial conditions," the very thing Poincaré had pinpointed as the hidden mechanism of chance.

Why can't we foresee the entire series of physical processes that lead into the future? Because, as Poincaré observed, "A very small cause that escapes our notice determines a considerable effect that we cannot fail to see, and then we say that effect is due to chance." When you spin a roulette wheel, for example, a twitch of your finger controls the final outcome. Because of this sensitive dependence on initial conditions, tiny errors compound exponentially into colossal ones. Or take weather. Barely perceptible convection-flow events at a given moment can dictate rain, shine, sleet, or hail days later; so it's not always the weatherman's fault when the partial cloudiness he predicts becomes a downpour by next Wednesday.

Whimsical as strange attractors are, however, there's a method to their madness. Wander and loop the loop they may, but they will never fly out of their mathematical envelope of "phase space." Within the phase space, though, thickets of chaos grow. Every time you fold the chaotic filo dough back on itself, you get a minuscule gap between one layer and the next. Soon there are multitudes of gaps, and numerical fuzziness overtakes order.

Given all this, it's not hard to see why it took the Dynamical Systems Collective months to persuade their faculty advisers that strange attractors weren't *Alice in Wonderland* objects. Luckily, by 1977 or 1978 the work of the older grand masters of chaos began to infiltrate such established fields as solid-state physics. And as fate or sensitive dependence on initial conditions would have it, the young UCSC graduate students soon found themselves in the chaos mainstream. When a scientist's missed plane left an agenda gap at an international conference in 1978, Shaw was invited to talk. And Doyne Farmer once found himself addressing such chaos cognoscenti as German theoretical chemist Otto Roessler, the father of the elegantly simple "Roessler attractor," the University of Maryland's Jim Yorke, whose equations helped demystify chaos, and MIT meteorologist Edward Lorenz, the father of the Lorenz attractor—the first strange attractor ever discovered.

Back in 1963, Lorenz had been working on ways to perfect weather forecasting, when his equations turned up a startling truth: Long-range weather prediction was *impossible*. Examined mathematically, convection currents moved in a bizarre new way. This was the first strange attractor, but it went unnamed until 1971. Then mathematical physicist David Ruelle, of the Institute of Advanced Scientific Studies, near Paris, and mathematician Floris Takens, of the State University of Groningen, in Holland, set their sights on deciphering a perennial enigma: fluid turbulence.

"Why can't you outwit a roulette wheel? How does orderly creation rise from the chaos of the Big Bang? The answers involve a new understanding of the creatures of chaos."

"Before Ruelle and Takens most scientists thought fluid turbulence was just too complicated to predict," explains Farmer, who left the Santa Cruz brotherhood last year to spread the seeds of chaos to Los Alamos National Laboratories, in New Mexico. "The old idea was that when you 'force' a fluid beyond equilibrium by heating it or turning up the flow, it goes from a rest state to periodic motion—like the regular rolling patterns you see in heated french-fry grease. Then, the thinking went, you get more complicated periodic motion: doubly periodic (with two independent frequencies), triply periodic, quadruply periodic, and so on. But Ruelle and Takens discovered that after doubly periodic motion, something *totally different* occurs." That totally different something was the work of the strange attractor—which Ruelle and Takens finally named. Four years later fluid experiments by physicists Jerry Gollub, of Haverford College, in Pennsylvania, and Harry Swinney, of the University of Texas at Austin, proved what many mathematicians had predicted. The strange attractor was, indeed, a fact of nature.

Don't confuse the strange attractor's unpredictability, however, with the indeterminacy you find inside the atom. "Heisenberg's uncertainty is like magic," says Farmer. "You don't know where it comes from. In the case of strange attractors, you can look back at the mathematical model and see *exactly* where the randomness comes from." Could it be that what we call chance is something else? "I think almost everything we consider to be noisy, chaotic, or random is the working out of a dynamical system we don't understand and may never understand," muses Abraham, who spent seven months in India studying the Vedas under the gaze of a guru.

Fiftyish, intense, with a salt-and-pepper beard and piercing dark eyes, Abraham suggests a biblical prophet turned radical professor. The mathematics of dynamical systems leads him to meditations on Oriental philosophy, the social history of the Sixties, neurobiology, and theoretical physics. He has even written a "visual mathematics" book, *Dynamics: The Geometry of Behavior*, translating the new dynamics into pictures for the layman.

That the strange-attractors people speak like poets and philosophers probably has something to do with their interdisciplinary status. Is this a branch of mathematics? theoretical physics? philosophy? All—or perhaps none—of the above. Only about 100 scientists are hard-core chaotic-dynamics theorists. They labor in different academic compartments, from physics and meteorology to physiology and chemistry. Their more straitlaced peers who aren't bewildered by what they do may be hostile.

You don't have to be a mathematician to fall under the spell of strange attractors. Computers breathe life into them, setting equations to dance forever as shifting shapes in the thousands of future states that could never be calculated by hand. Aiming a creaky school projector at a wall, Shaw shows me the movies the Dynamical Systems Collective made of its computer-generated images. "This is our local compulsion," says Shaw, as circles swell and elongate like stretched rubber on the screen, galaxies spiral into space, and delicate filigrees, spun by non-Euclidean spiders, grow increasingly ornate.

In another dreamlike film, shot in grainy, early-art-film black-and-white, subtitles announce THE BELOUSOV-ZHABOTINSKY REACTION. The movie shows chemicals pouring into a great black vat, where they are mixed by magic forces and then sent gushing out the other side. "When chemicals react, they can do one of three things," Shaw says. "They can get mixed and just sit there at equilibrium—that's a fixed-point attractor. Or their concentrations can oscillate periodically in a limit cycle. Or the oscillations can get bizarre and chaotic, as is the case with these chemicals." The

graphics of the Belousov-Zhabotinsky Reaction suggest a whirling amusement-park ride seen by Marcel Duchamp.

If you know where to look, chaotic-dynamics people tell us, the same patterns are all around. "There are only a few movies, a few dances," Abraham observes. "And everything we see around us is the working out of one of these movies."

Why do the same geometrics turn up in chemical reactions, waterfalls, and the climate? There is a deep-seated order to this strangeness, according to the seminal work of Cornell University physicist Mitchell Feigenbaum, one of the *éminences grises* of chaos. Even when dynamical systems make transitions, or bifurcations, from smoothness to chaos, certain rules and numerical values always hold. That chaos has some order to it is one of the key breakthroughs of the chaos connoisseurs.

It isn't that no one ever dared look at the face of chaos before; it's just that the old guard saw it differently. "The pre-World War Two crowd used equations for *total* randomness as a model for chaos in nature," Farmer says. "In that case randomness is simply postulated. The models work very well to describe certain things, like the statistical fluctuations in a gas in which the molecules are pretty evenly distributed.

"However," he continues, "there are many situations in nature where orderly things happen in the midst of great chaos. For those physical systems, *deterministic chaos*—with its strange-attractor structure—is the best model."

Farmer's Ph.D dissertation is aptly entitled *Order in Chaos*; its frontispiece is emblazoned with Wallace Stevens's *Connoisseur of Chaos*. The seeming paradox lures the young physicist as a Zen koan ("What is the sound of one hand clapping?") fascinates a religious expert—except mystics don't test their reality on a computer. Farmer does. Traces of Big Sky Country linger in his speech, and his everything's-cool, no-hassle counterculture manner belies one of the keenest minds in this business. Chief among his insights is, "Some systems have a 'clock' inside them that goes on keeping perfect time in the midst of very chaotic stuff."

Maybe, he speculates, evolution did not proceed wholly at random; maybe the genetic code employs some orderly clocks in the midst of wild Darwinian randomness.

"According to our current model of creation," he adds, "out of a formless, miasmic blob, the Big Bang, you eventually get very orderly structures, like biological organisms. Or think about conception: There's enormous randomness involved in sperm reaching the egg. But once you get conception, you make a human being, a highly ordered structure. Right from the beginning your life is profoundly influenced by chance events caused by sensitive dependence on initial conditions."

This theme keeps recurring in the meditations of the chaos connoisseurs.

In La Jolla, California, a semitropical paradise a half hour's drive from the Mexican border, a small, interdisciplinary chaos squad swaps secrets in physics, neurophysiology, chemistry, and psychiatry. One of their number is psychiatrist Arnold Mandell, of the University of California at San Diego (UCSD). More philosopher/seeker than mathematician, he received the chaotic-dynamics gospel a few years ago and learned the nonlinear equations of the trade. Still, the language of Jung and Freud comes more easily to him.

"Freud discovered something very profound," says the psychiatrist/neuroscientist. "When he put a person on a couch in Vienna in 1900, turned out all the lights, and told him to say whatever came into his head, there were only a few basic patterns. Out of the infinite possibilities of free association, only a few myths, like the Oedipal myth or the castration-anxiety myth, recurred again and again."

In a recent experiment at UCSD, Mandell tells me, computers recorded the paths of rats wandering at random through mazes. In time the seemingly aimless meanderings became distinct geometric shapes, unique for each animal. When the rats were given various drugs, their odysseys took on new patterns. Amphetamines produced obsessive circles, or limit cycles; LSD gave birth to fancy strange attractors.

The same principle applies to humans. Mandell thinks. If you went out for a random walk every day, certain patterns, essentially your individual signature, would emerge. "And how is it that your thoughts are in flux from moment to moment, yet have an overall stability?" he asks. "Despite the ever-changing stream of consciousness, you remain the same person with the same mind. The concept of deterministic chaos can resolve that paradox." These days Mandell wears his world view on a T-shirt: BOUNDED CHAOTIC MIXING PRODUCES STRANGE STABILITY.

In brain hardware, too, the neuroscientist probes deep order. "I've gotten the same patterns now by measuring fluctuations of enzymes that make neurotransmitters; in the receptors for those transmitters, in the shape of EEGs, and the firings of single units," he says. "However you slice it, the brain has the same abstract properties."

Think form, not content: quality, not quantity. At least that is how Alan Garfinkel, of the Crump Institute for Medical Engineering, at UCLA, sees it. "Poincaré is the father of this field," he tells me over sweet vermouth and a rum and Coke in a trendy Venice beachfront café. (My cuba libre will come in handy later as an example of chaotic mixing.) "More than half a century ago he saw that you can't get exact numerical values for many phenomena, and that even if you could, they wouldn't tell you what you wanted to know. If you're studying the motion of the earth around the sun, for instance, it's more important to know its path, or topological

"Alphabet soup, whatever that is."

shape, than the exact distances it travels. Is the orbit a closed ellipse or a very, very long curved line that doesn't close—in which case the earth might eventually spiral off into space? So Poincaré invented topology, the science of forms of motion.

"Much of the current work in chaotic dynamics exists in a never-never land of unproven mathematics," Gartinkel adds, drawing explanatory diagrams from time to time on a soggy paper napkin in front of him. "For example, there's still no *mathematical* proof for the first strange attractor discovered, the Lorenz attractor."

Like many of the chaos connoisseurs, Garfinkel is young, extraordinarily articulate, and interdisciplinary: a mathematically inclined philosopher of science who holds the improbable job of professor of kinesiology, at UCLA. Like the physicists who launched chaos at Santa Cruz and like the strange attractor itself, he came of age during the social turbulence of the late Sixties and early Seventies.

Acquaintances of his, wandering into the café's bright, mirrored atmosphere, seem puzzled by my tape recorder. "I'm being interviewed for *People* magazine," Garfinkel tells them, and a few people seem ready to believe him. Around these parts, who knows what weird fates might rocket a young scientist to pop stardom? As other habitués drift off to talk of bioenergetics therapy, parties, and films, we discuss biology. "Topology, or qualitative dynamics," he points out, "is the perfect mathematics for biology. All humans have the same form, yet we differ in the details. Why?

"I think sensitive dependence on initial conditions in the embryo is what makes us individuals," he says. "As two cells develop into zillions of cells, there is a distinct sequence of qualitative changes. You have epochs of smooth change and then—bang—qualitative change and differentiation."

This view of nature—called catastrophe theory—runs counter to the smoothly changing, continuous world described by calculus. *Nature does not make jumps*, the seventeenth-century inventor of calculus, Gottfried von Leibniz, proclaimed. "But nature *does* make jumps," Garfinkel tells me. At a certain critical value, metals snap, fluids make a sharp, qualitative leap into turbulence, chemical concentrations and animal populations turn abruptly chaotic. In biology, too, deterministic chaos prevails. What are heart fibrillations, two Montreal scientists propose, but a bifurcation from normal periodic oscillation to a fatal, chaotic one? Likewise, Garfinkel and others view schizophrenia as chaos in the brain's chemical-feedback systems.

And if you wondered why a nonphysiologist like Garfinkel is working as a professor of kinesiology, it's because he has something to say about the dyskinesias, or movement disorders. Researchers know that Parkinson's disease and Huntington's chorea ("Woody Guthrie disease") stem from specific chemical disturbances in the brain. But they hadn't noticed that the ill-

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The mystical,
mythical qualities of stone
are captured
in these haunting images

ROCKSONGS

PHOTOGRAPHS BY
DAN MORRILL

Stone coaxes the imagination in mythological directions. The Celts raised stones to mark a place where time caressed eternity. Japanese Zen masters watched them grow to enrich their minds. American Indians paid homage to the spirits within the stones. Today we turn to them to read a history of cosmic events and to mark our graves.

Ask photographer Dan Morrill about rocks and he speaks thoughtfully of them. He doesn't just think about rocks; he is bewitched by them. In his photographs of sand/skies, jeweled canyons, and sensuous strands of silicate, he plays with shapes, colors, and textures, transforming rock into the stuff of dreamworlds.

Morrill finds the greatest wealth of subjects in the American West, where the rock rises above spare, flat deserts and steppes.

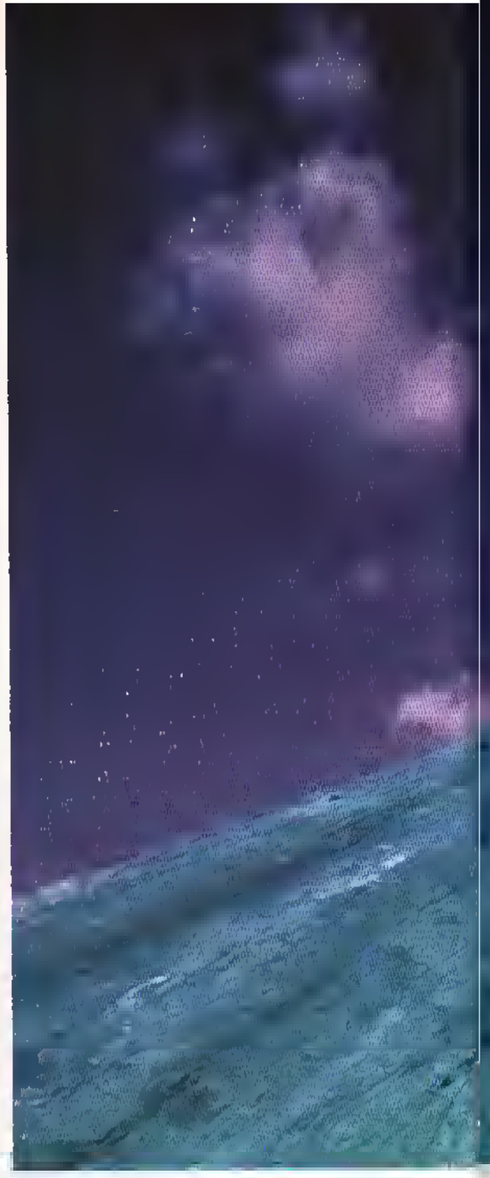
TEXT BY LEAH WALLACH

"These stones speak a kind of language to the Indians who live in this country."

It was there that his fascination with rockscapes began. It was there that Morrill, an easterner by birth, felt the enchantment of great stones and came to think of rocks as the Sioux do—as holy. "These stones speak a kind of language to the Indians who live in this country," he explains. Morrill has attempted to capture some of their commanding eloquence—to give visual expression to the language of stone.

What if, he wondered, the elements of rock language were mixed to make new environments that existed only in the mind's eye? What if a witchy moon originally photographed high over the Mississippi were made to appear in the sky above a lacy stone pillar in Utah? What if we could see these rockscapes with infrared eyes?

Morrill makes pictures of such possibilities. To accomplish this, Morrill first photographs an arresting image—a rock, a skeleton, the glowing disc of the sun—and then manipulates the background with gels and masks to create a field onto which a second image is positioned. Double exposure fuses the two images into one beautiful one.



Morrill never doctors or manufactures his images chemically. But when it comes to color, he succumbs to a slightly impure sensationalism. "Rocks have color," he points out, "but I'm giving them emotional impact." And so his rockscapes are reborn in knockout comic-book and nail-polish shades, the result of shooting with infrared filters, colored gels, using reversal chemistry, or pulling the film prematurely from its chemical bath and bombarding it with light.

The results vibrate with the energy Morrill senses within rocks and other matter. He regards his pictures as realistic illustrations of "what nature could do if it chose to." Nature, he believes, is an affair of interchangeability, a cheerful orgy of combining and recombining elements, all propelled by a kind of inner animation.

Animation? In rocks? Well, take some time to think about them for a moment the way Morrill does: "Rocks are essentially complex silicates," he points out. "And if you could take the carbon out of our system and substitute silicon, we would probably be rocks." ∞

"Nature is an affair of interchangeability, a cheerful orgy of combining elements."

SATELLINKS

CONTINUED FROM PAGE 58

each set in our system, we can offer viewers something that neither the networks nor cable can—narrowcasting," says Judith Shannon, a vice-president at Comsat's STC. "We can offer individual subscribers across the whole country the option of purchasing a variety of specialized programs, like quality science fiction or the New York City Ballet. Cable can't do that, because a cable company may have only 50,000 subscribers, with only a tiny percentage interested in any particular show of this type. But we'll have millions of viewers, making it easy to put together specialized audiences of a few hundred thousand."

Meanwhile, with nations worldwide orbiting more—and ever more potent—communications satellites of all types, society is sure to feel the impact. But exactly what that impact will be is unclear.

John V. Harrington, director of Comsat Laboratories, sees the new direct-broadcast TV satellites as a key to tomorrow's supersatellites. "As you get millions and millions of home receivers, you can talk about billion-dollar satellites, which implies enormous capabilities," he says. "On my roof I'll have a small antenna, and on my home-computer terminal I'll get the daily newspaper, new books, stock prices, weather. I'll be able to summon up whatever information I need from just about anywhere. I'll have access to the entire Library of Congress, for instance. Memory is cheap; so I'll put in my order at night, when the rates are lower, and retrieve the information from storage when I want it."

Says Campanella: "Obviously, international communications are going to be even cheaper. We'll call London with the same nonchalance we call Baltimore today, because distance will be totally collapsed."

He notes that English is already becoming the international second language. And he predicts that many workers will operate from their homes through computer terminals and satellites, living anywhere they want. When Arthur C. Clarke, for instance, finished his new novel, *2010: Odyssey Two*, he sent last-minute corrections from his home in Sri Lanka, off the southern coast of India, to Manhattan by way of Intelsat V.

"Communications are opening up frontiers, and psychologically we need them," Campanella says. "As the world becomes more unified, it may do something gutsy, like populating the moons of Jupiter."

Satellites are touching many facets of society now, even religion, with dishes sprouting outside small-town churches across the country, bringing in live sermons from big-time evangelists. An ultraorthodox Hasidic sect's rabbi has been beaming messages to congregations in London, Jerusalem, and around the United States for three years. And many other religious groups also have the satellite spirit. "We worship here when they worship there: we clap when they clap," says one Burlington, Vermont, minister of the evangelical sermons his parishioners watch via satellite. "With that ten-foot-diagonal screen, we enter right into it."

Rock groups are "teleconcerting." The pioneers were The Who; in December 1982 they presented a live concert in Toronto that reached auditoriums across North America via satellite. "The audiences reacted just as if they were at a regular concert, lighting matches and flicking their Bics," says Jack Calmes, whose Dallas-based World ShowVision Network produced the concert. He foresees satellite transmission of Broadway shows, too. And he says the technology is creating a new and complex art form.

"It will be a synthesis of sophisticated video, satellite broadcasting, quadraphonic sound, computer-generated special effects, animation, and artwork. It will be superior to live concerts," he says.

Vicky Lynn, creative consultant for the Who concert, puts it this way: "That big screen is very powerful psychologically."

But the big beat on the big screen is only an epiphenomenon of the Satellite Age. More fundamental is the inevitability with which the new telecommunications technologies will melt distance. That is why the United Nations declared 1983 "World Communications Year," aimed at developing global communications. As a U.N. announcement put it: "Next only to food, shelter, and energy on the list of vital needs for human survival, communications constitute the lifeblood of today's world and serve as constant reminders of the oneness of human destiny."

Satellites also mean increased complexity. U.N. delegates are already squabbling over direct-broadcast TV; totalitarian states are disinclined to give outsiders so straight a path to their citizens' minds. Countries like France protest the impact on their cultures of too many American sitcoms and shoot-'em-ups. Satellites could even transfer some white-collar jobs from the West to the cheaper Third World. A New York corporation already farms out word-processing and data-entry jobs via satellite to low-paid workers in Barbados.

Ushering us into this brave new world are the microwave moguls of Outer Space, Inc. Up above the atmosphere, business is booming, and a room in a downtown Washington, D.C., office building proves it.

The room is in Comsat's headquarters: Plush blue chairs face rows of computer consoles. It is a mission-control center for maneuvering private property on company business in outer space. When a newly launched satellite leaves the rocket or shuttle that lifted it to low Earth orbit, NASA transfers control to this room. From here, while Washingtonians walk by outside, engineers fire up the satellite's thrusters, unfold its solar arrays, and herd it out to geosynchronous orbit, set for business.

FICTION

A TEARDROP FALLS

BY LARRY NIVEN

The machine was a vast fortress containing no life, set by its long-dead masters to destroy anything

PAINTING BY DON BRAUTIGAN

that lived. It and many others like it were the inheritance of Earth from some war fought between unknown interstellar empires, in some time that could hardly be connected with any earthly calendar.

Men called it a berserker.

—*from* Without a Thought,
by Fred Saberhagen

Two miles up, the thick air of Harvest thinned to Earth-normal pressure. The sky was a peculiar blue, but blue. It was unbreathable still, but there was oxygen, ten percent and growing. One of the biological factories showed against white cloudscape, to nice effect, in view of a floating camera. The camera showed a tremendous rippling balloon in the shape of an inverted teardrop, blowing green bubbles from its tip. Hilary Gage watched the view with a sense of pride.

Not that he would ever want to visit Harvest. Multicolored slimes infected shallow tidal pools near the poles. Green sticky stuff floated in the primordial atmosphere. If it drifted too low it burned to ash.

Changes were exceedingly slow. Mistakes took years to manifest themselves and decades to eradicate.

Hilary Gage preferred the outer moon.

One day this planet would be a *world*. Even then Hilary Gage would not join the colonists.

Hilary Gage was a computer program.

Gage would never have volunteered for the Harvest Project unless the alternative was death: death by old age.

He was aware that other worlds were leery of advanced computers. They were too much like the berserker machines. But the tens of thousands of human worlds varied enormously among themselves, and there were places the berserkers had never reached. The extermination machines had been rumor in the Channith region since before Channith was settled. Nobody really doubted their existence, but . . .

But for some purposes, computers were indecently convenient, and some projects required artificial intelligence.

The computer wasn't really an escape. Hilary Gage must have died years ago. Perhaps his last thoughts had been of an immortal computer program.

The computer was not a new one. Its programming had included two previous personalities, who had eventually changed their minds and asked to be erased.

Gage could understand that. Entertainments were in his tiles. When he reached for them they were there, beginning to end, like vivid memories.

Chess games and some poetry could survive that, but what of a detective novel? A football game? A livey?

Gage made his own entertainment.

He had not summoned up his poem for these past ten days. He was surprised and pleased at his self-control. Perhaps now he could study it with fresh eyes?

Wrong. The entire work blinked into his mind in an instant. It was as if he had finished reading it a millisecond ago. What was normally an asset to Hilary—his flawless memory—was a hindrance now.

Over the years the poem had grown to the size of a small novel, yet his computer-mind could apprehend its totality.

It was his life's story, his only shot at immortality. It had unity and balance. The rhyme and meter, at least, were flawless, but did it have thrust?

Reading it from start to finish was more difficult than he had ever expected. He had to forget the totality, which a normal reader would not immediately sense, and proceed in linear fashion. Judge the flow . . .

"No castrato ever sang so pure—" Good, but not here. He exchanged it for a chunk of phrasing elsewhere. No word-processing program had ever been this easy! The altered emphasis caused him to fiddle further, and his description of the berserker-blasted world Perry's Footprint seemed to read with more impact now.

"He needn't call the berserker's attention to himself. Doubtless the machine could sense life. But Gage was not alive. Would the berserker destroy random machinery?"

Days and years of fear and rage. In his youth he had fought men. Channith needed to safeguard its sphere of influence.

Aliens existed somewhere and berserkers existed somewhere, but Gage had known them only through rumor, until the day he saw Perry's Footprint. The Free Gaea rebels had done well to flee to Perry's Footprint, to show him the work of the berserkers on a living world.

It was so difficult to conquer a world and so easy to destroy one. Afterward he could no longer fight men.

His superiors could have retired him. Instead he was promoted and set to investigating the defense of Channith against the berserker machines.

They must have thought of it as makework: an employment project. It was almost like being a tourist at government expense. In nearly forty years he never saw a live—an active berserker—but traveling in realms where they were more than rumor, perhaps he had learned too much about them. They came in all shapes, all sizes. Here they traveled in time. There they walked in human shapes that sprouted suddenly into guns and knives. Machines could be destroyed, but they could never be made afraid.

A day came when his own fear was everything. He couldn't make decisions. It was in the poem, *here*. Wasn't it? He couldn't *feel* it. A poet should have glands!

He wasn't sure, and he was afraid to meddle further. Mechanically it worked. As poetry it might well be too . . . mechanical.

Maybe he could get someone to read it.

His chance might come sooner than he expected. In his peripheral awareness he sensed ripplings in the 2.7-microwave background of space: the bow shock of a spacecraft approaching in c-plus from the direction of Channith. An unexpected supervisor from the homeworld? Hilary filed the altered poem and turned his attention to the signal.

Too slow! Too strong! Too far! Mass at 10^{12} grams and a tremendous power source barely able to hold it in a c-plus-excited state, even in the near-flat space between stars. It was still light-years away from Harvest, several days distant at its tormented crawl, but it occluded Channith's star, and Gage found that horrifying.

Berserker.

Its signal code might be expressed as a flash of binary bits, 100101101110, or as a moment of recognition with a description embedded, but never as a sound and never as a name.

100101101110 had three identical brains and a reflex that allowed it to act on a consensus of two. In battle it might lose one or two, and never sense a change in personality. A century ago it had been a factory, an auxiliary warcraft, and a cluster of mining machines on a metal asteroid. Now the three were a unit. At the next repair station its three brains might be installed in three different ships. It might be reprogrammed, or damaged, or wired into other machinery, or disassembled as components for something else. Such a thing could not have an independent existence. To name itself would be inane.

Perhaps it dreamed. The universe about it was a simple one, aflow with energies; it had to be monitored for deviations from the random, for order.

Order was life—or berserker.

The mass of the approaching star distorted space. When space became too curved, 100101101110 surrendered its grip on the c-plus-excited state. Its velocity fell to a tenth of lightspeed, and 100101101110 began to decelerate further.

Now it was not dreaming.

At a million kilometers, life might show as a reflection band in the green or orange or violet. At a hundred kilometers, many types of living nerve clusters would radiate their own distinctive patterns. Rarely was it necessary to come so close. Easier to pull near a star, alert for attack, and search

"A Teardrop Falls" is an excerpt from a forthcoming novel, entitled Berserker Times Seven. *The coauthors of the project, who are all prominent science-fiction writers, include the berserkers' creator, Fred Saberhagen.*

the liquid-water temperature band for the spectra of an oxygen world.

Oxygen meant life.

There.

Sometimes life would defend itself. 100101101110 had not been attacked, not yet, but life was clever.

The berserker was on hair-trigger alert while it looked about itself.

The blue pinpoint had tinier moons: a large one at a great distance and a smaller one, close enough that tides had pulled it into a teardrop shape.

The larger moon was inconveniently large, even for 100101101110.

The smaller, at 4×10^{15} grams, would be adequate. The berserker fortress moved on it, all senses alert.

Hilary Gage had no idea what to expect.

When he was younger, when he was human, he had organized Channith's defenses against berserkers. The berserkers had not come to Channith in the four hundred thirty years since Channith became a colony.

He had traveled. He had seen ravaged worlds and ruined, slagged berserkers. He had studied records made by men who had beaten the killer machines; there were no records from the losers.

Harvest had bothered him. He had asked that the monitoring station be destroyed. It wasn't that the program (Ras Singe, at that time) might revolt. Gage feared that berserkers might come to Harvest, find the monitoring station, rob the computer for components . . , and find them superior to their own machinery.

He had been laughed at. When Singe asked that his personality be erased, Gage had again asked for permission to destroy the station. He was given more make-work. Find a way to make the station safe.

He had tried. There was the Remora subprogram, but it had to be so versatile! Lung problems had interrupted his work before he was fully satisfied with it. Otherwise he had no weapons at all.

And the berserker had come.

The beast was damaged. Something had probed right through the hull—a terrific thickness of hull, no finesse here, just mass to absorb the energies of an attack. Gage wondered if it had received that wound attacking Channith. He'd know more if he could permit himself to use radar or neutrino beams, but he limited himself to passive instruments, including the telescope.

The two-hundred-year project was over. The berserker would act to exterminate every microbe in the water and air of Harvest. Gage was prepared to watch Harvest die. He toyed with the idea that when it was over, the fortress would be exhausted of weapons and energy, a sitting duck for any human warfleet.

But there were no weapons in the Harvest system.

For now Hilary Gage could only record the event for Channith's archives.

Were there still archives? Had that thing attended to Channith before it came here? There was no way to know.

What did a berserker do when the target didn't fight back? Two centuries ago Harvest had been lifeless, with a reducing atmosphere, as Earth itself had once been. Now life was taking hold. To the berserker, this ball of colored slimes was life, the enemy. It would attack. How?

He needn't call the berserker's attention to himself. Doubtless the machine could sense life, but Gage was not alive. Would it destroy random machinery? Gage was not hidden, but he didn't use much energy; solar panels were enough to keep the station running.

The berserker was landing on Teardrop.

Time passed. Gage watched. Presently the berserker's drive spewed blue flame.

The berserker wasn't wasting fuel; its drive drew its energies from the fabric of space itself.

But what was it trying to accomplish?

Then Hilary understood, in his mind and in the memory-ghost of his gut. The berserker machine was not expending its own strength. It had found its weapon in nature.

The violet star fanned forward along Teardrop's orbit. That would have been a sixty-gravity drive for the berserker alone. Attached to an asteroid three thousand times its mass, it was still slowing Teardrop by two hundredths g, hour after hour.

One hundred years of labor. He might gamble Harvest against himself—a half-terraformed world against components to repair a damaged berserker. Well?

He'd studied recordings of berserker messages before he was himself recorded. But there were better records already in the computer.

The frequencies were there and the coding: star and world locations, fuel and mass and energy reserves, damage description, danger probabilities, orders of priority of targets; some specialized language to describe esoteric weaponry as used by self-defensive life; a code that would translate into the sounds of human or alien speech; a simplified code for a brain-damaged berserker . . .

Gage discarded his original plan. He couldn't conceivably pose as a berserker. Funny, though: He felt no fear. The glands were gone, but the *habit* of fear . . . was it possible that he had lost that too?

Teardrop's orbit was constricting like a tightening noose.

Pose as something else!

Think it through. He needed more than just a voice. Pulse, breath: He had recordings. Vice-president Curly Barnes had bid him good-bye in front of a thousand news pickups *after* Gage became a recording, and it was there in his computer memory. A tough old lady, Curly, far too arrogant for a goodlife, but he'd use his own vocabulary. Hold it. What about the technician who had chatted with him while testing his reflexes? Angelo Carson was a longtime smoker, long overdue for a lungbath, and

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"Thousands of people are joining China's newest cult: a legion of witnesses with a fiery passion for UFOs."

ANTIMATTER

UFO UPDATE

Zhang Dengzhou was on sentry duty in China's remote Gansu province when he saw "an entire village enveloped in blue. I looked toward the source of light," Zhang reports, "and saw a flat oval-shaped object, its center golden-yellow and surrounded by a deep orange cloud. After two minutes it picked up speed and flew to the east. The place was restored to darkness."

In America this tale might have been received with little fanfare, one UFO sighting among tens of thousands of others. But because Zhang was Chinese, his tale was special. A member of the highly respected People's Liberation Army (PLA), he had enormous credibility; nevertheless, his fear of the authorities kept him from mentioning the story to anyone for at least a decade.

Recently many of Zhang's fellow PLA members have come forward to report UFO sightings as well. Their openness has inspired others: peasants, students, workers, teachers, even scientists. As China's repressive Cultural Revolution recedes, giving way to a greater freedom of expression, thousands of people seem to be joining China's newest cult: a legion of witnesses with a passion for UFOs.

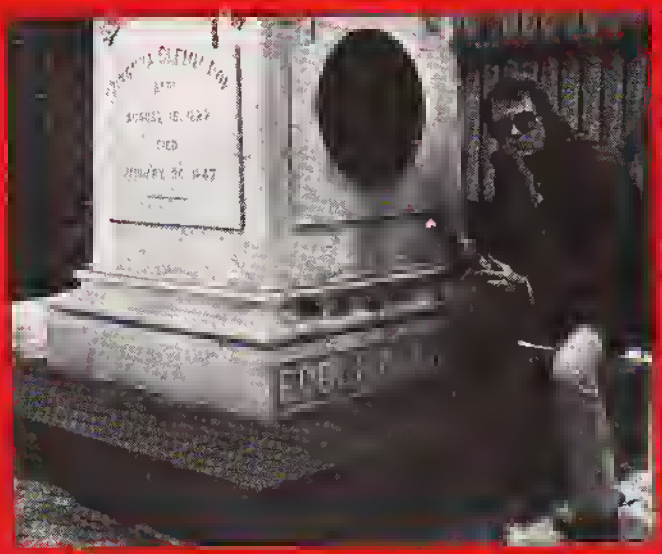
Nothing proves the earnestness of these amateur stargazers better, perhaps, than China's new *Journal of UFO Research*. Many of its reports, like Zhang's, come from the 1960s and 1970s, when talk of UFOs was considered "decadent and bourgeois." Other accounts are more contemporary. Wang Ting-yie, of Yunan province, for instance, reported a golden, cylinder-shaped object flying by his commune on April 12, 1981. And on December 21 of the same year, airport workers Wang Jian-jai and Han Feng-hsiang said they saw a "white disc suspended in the sky" high above the Peking airport.

These people and others, moreover, have begun discussing their pursuits through officially sanctioned UFO clubs all across the land. One of the country's most important groups ever was recently founded in Xinjiang province to analyze a spate of sightings along the Gobi Desert and the Soviet border.

Nonetheless, UFO research in the People's Republic remains primarily a spare-time activity that is pursued only by the novice. "The elite in the university departments of astronomy won't help us," complains one UFO buff who prefers to withhold his name. "They dismiss any discussion of extraterrestrial life as escapist Western thinking, and they have answers to explain just about every UFO sighting."

Even so, as Chinese leaders continue to emphasize free thought, UFOs may well gain wider acceptance. After all, the Chinese have always been among the world's most celestial people: They invented primitive rocketry, discovered heavenly bodies, and even developed an influential system of astrology. With more than a billion people looking skyward at night, China and her UFO watchers might soon have a lot to say.—*DANIEL BURSTEIN*

Editors' note: Daniel Burstein investigated the Chinese UFO movement during a recent trip to the People's Republic.



POE TOASTER

Every January 19 since 1949, someone has crept into Baltimore's Westminster Churchyard, placing roses and cognac on the 134-year-old grave of Edgar Allan Poe. The occasion: the great poet's birthday. This year Jeff Jerome, the curator of Poe House, decided to find out who the mysterious gift bearer was.

To stake out the writer's grave, Jerome (above) and four other Poe buffs secluded themselves in the Westminster catacombs. Then, to pass the hours, they tried to interpret (for the umpteenth time) the eerie ritual of the "Poe Toaster"—the nickname they'd given to the person who yearly toasted Poe. Why, for instance, did the phantom always leave three roses? Was it because Poe had used the word *rose* many times in his books? Or because he'd been buried with two others, his wife, Virginia, and his aunt Maria Clemm? And why did the Toaster always leave a half-empty bottle of Martell cognac, especially when the writer had supposedly been addicted to opium?

The questions poured out until 1:30 A.M., when the small troupe heard a stir. A flashlight swept across the crypts, and someone rattled the cemetery gates as the group rushed through Westminster to confront the Toaster. But only Jerome and twenty-one-year-old student Ann Byerly caught a glimpse of the culprit as he sped away.

"I saw the top of his head; he had blond or brown hair," says Byerly. "Then, all of a sudden, he darted from the grave and leaped over a cemetery wall. He was wearing a frock coat, and it was flying open as he ran. It was very dramatic."

"The man," Jerome adds, "was clutching a walking stick with a golden sphere on its end—like the one Poe carried. And before vanishing over the wall, he raised his cane high in the air and shook it at us triumphantly."

Since the stakeout, Jerome has received hundreds of letters from Baltimore residents. A note from one angry man sums up the reaction: "Hey, this stinks. We don't want to know anymore. This is a nice little mystery, and there aren't a lot of mysteries left."

Next year, Jerome promises, he'll leave the Toaster be.—Peter Rondinone

"If a man die/it is because death/has first/possessed his imagination."

—William Carlos Williams

APEMEN OF CHINA

During the rule of China's Emperor Qin—around 200 B.C.—disloyal subjects allegedly fled to the mountains rather than labor as conscripts on the Great Wall.

These people lived as primitives, legend holds, eventually devolving into hairy apemen.

It's only a myth. Yet in recent years citizens of China's mountainous Hubei province have reported encounter after encounter with seven-foot-tall wildmen covered head to toe with unruly brown hair. The anthropoids swing through the treetops, witnesses contend, eating leaves and insect larvae. One Chinese man claims to have been in peaceful contact with two of the creatures, a mother and a small child. Another says he even battled with a male brute, stabbing it in the arm.

In 1977 a team of Chinese scientists conducted an extensive survey of rare animals in Hubei province and failed to see even one wildman. But just recently two investigators from that team suggested in the Chinese journal *Hua Shi* ("Fossils") that wildmen might be descended from an extinct primate, *Gigantopithecus*, whose fossilized remains have been found throughout the province. Authors Yuan Zhenxin and Huang Wanpo assert, however, that because China's natural resources have been so abused, "it is likely that the wildman will become extinct before we can prove it exists."

—Eric Mishara

"There are laws of the universe that are still waiting to be discovered by painful research."

—E. R. Micklem

ANIMAL RESURRECTION

Folks in the quiet Dutch village of Eerbeek were going about their workaday lives last year, when they caught the stench of rotting meat. The source of the smell: the backyard of taxidermist John Roeleveld, seventy-two. Spurred by the unbearable odor, Police Sergeant John Hartgers decided to dig into the case. To his utter amazement he unearthed 250,000 animals that had been stuffed and preserved.

When questioned about the collection—including camels, kangaroos, cats, birds, crocodiles, apes, dogs, and even elephant skulls—Roeleveld was quick to explain. God had instructed him to collect two animals of every species before floodwaters arrived in June 1983. The waters would wipe out evil sinners and copulators, Roeleveld believed, leaving only him, his wife, and the animals to repopulate the world.

Hartgers points out that Roeleveld didn't trap, kill, and stuff all the animals himself. He bought specimens like the 100-year-old stuffed bear from antique shops. And he used his professional credentials to procure beasts that had died in zoos.

Nevertheless, the people of Eerbeek decided that Roeleveld could not go unpunished. Since he was too old for jail, they gave him a $500 fine. They also confiscated his collection in hopes of using it to start a new museum.

According to Hartgers, however, the punishment won't stop Roeleveld from pursuing his heavenly mission. Recently, while police were digging up animals, Roeleveld screamed from his attic window, "Take the animals. But remember, God is mightier than you. He'll make the animals return to me of their own accord!"

—Peter Rondinone

EXOTIC WEAPONS ACCESS BOOK

Do you want a pocket flamethrower? Have a yen for nonmetallic knives you can sneak through airport security? Or are you just tired of winding your own strangling wire and looking for somewhere to buy it ready-made?

If you've answered yes, we have just what you need. *Exotic Weapons: An Access Book*, by Michael Hoy. Published by Loompanics Unlimited, of Port Townsend, Washington, the volume answers the age-old question "How can I get across Central Park at night?"

Loompanics specializes in survivalist and terrorist literature—police manuals, lock-picking tutorials, even books telling how to drive getaway cars and build basement nukes. With its list of more than 500 dealers in the tools of mayhem, *Exotic Weapons* fits their line.

Most weapons, no matter how arcane, can be obtained from a variety of sources. Some 17 distributors offer the *marikqusari* and other Oriental equivalents of a bicycle chain. Two supply *calthrops*, tire-shredding spikes to be scattered in front of pursuing vehicles. Four deal in sword canes. No fewer than 27 are listed as machine-gun dealers, with 11 of those selling silencers. And 52 market tear-gas weapons of one sort or another.

"A few things should be pointed out," Hoy comments in his introduction. "First, it would not surprise me to learn that just about every weapon in this book is illegal somewhere or other. You are advised to check with your local law enforcement authorities. We are not advocating that you use any of this stuff—we just thought you would like to know about it."

What would a well-balanced citizen want with most of these devices? Hoy offers a quote from A. E. van Vogt's science-fiction novel, *The Weapons Shops of Isher*: "The right to buy arms," he says piously, "is the right to be free."

You can get a copy of *Exotic Weapons* from Loompanics Unlimited, Box 1197, Port Townsend, WA 98368.—Owen Davies

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"In my solitude/I have seen very clear things/which are not true."

—Antonio Machado

ZAPPED

Dorothy Burdick, a hospital dietitian and mother of three, was making love to her husband when she had an unusual thought. "Dorothy, you're being programmed." Then, to her husband's dismay, she burst into tears.

Burdick (a pseudonym she uses so friends won't think she's crazy) took her husband's advice and saw a psychiatrist. But when he was unable to stop the thoughts, she turned to her brother—a kind of Phantom of the Opera whose name can't be revealed, Burdick claims, because "he's working on the H-bomb at MIT." Still, he's the one who supposedly gave her the inside scoop: The U.S. government is using Burdick as part of a top-secret experiment in "zapping," or long-distance mind control.

"Some people might think that's nuts," says Burdick. "But they've forgotten our government's long history of experimenting on citizens." In 1956, for instance, the U.S. Army admitted to secretly spraying an unknown substance in New York City subway tunnels. And more recently, in December 1980, a member of the Canadian Parliament claimed that a CIA-financed psychiatrist tried to brainwash her.

The zapping technique used on Burdick, though, is even more sophisticated: A laser telescope at a nearby Air Force station, the Cape Cod dietitian declares in her new book, *Such Things Are Known*, is scanning her house and analyzing the electrical impulses in her brain with a computer.

"In fact," she says, "I'm sure that the computer can decode my brain impulses just as telegraphers decode Morse code. For example, *dot/dot/dot/dash/dash/dash/dot/dot/dot* in Morse code means 'SOS, or help.' Likewise, scientists have found that *dot, dot* in my head means 'Dorothy.' Now that they know the code, they're shooting dots into my head and programming my thoughts. I mean why else would I wake up every morning to a chorus of voices chanting obscenities? There's just one logical answer: They're zapping me!"

To fend off the ominous laser, Burdick (pictured at left) now wears a coat with tin cans tied around it. She also wears a peaked hat filled with marbles.

—Peter Rondinone

MOONDAY

Young Christian Marchal was gazing at the dazzling night sky some 30 years ago, when he had a brainstorm: By placing mirrors on the moon, he could reflect enough light back to Earth to turn night into day. Now a scientist at France's National Office of Aerospace Study and Research, Marchal says he's making that vision a reality.

To create the lunar mirrors, Marchal is currently coating Kapton (a plastic used in space suits) with an ultrathin metal surface. Right now his work is experimental, but once the ideal mirror has been built, he predicts, it will be mass-produced and shipped to the moon by shuttle. On the moon, he adds, robots will arrange the mirrors to reflect the light of the sun.

Light reflected back to Earth, Marchal explains, will depend on the area covered by mirrors. About 772 square miles of mirrors, for instance, would provide the light of streetlamps. And with 77,220 square miles of mirrors, Marchal's ultimate goal, the moon would glow like a giant bulb, providing the entire planet with the light of a sunrise or sunset. (During the new moon, of course, we would receive no light at all.)

According to Marchal, his so-called moonday will enable people in tropical climates to work at night, slashing energy costs worldwide. And, he says, there will be few ecological repercussions, with 77,220 square miles of mirrors increasing Earth temperatures by a mere 5 percent.

What about all those night owls who thrive on dark, romantic, candlelit evenings? "They'll adapt," Marchal says. "Men never have trouble adjusting to better conditions."

—Kathrine Jason

"Technology . . . the knack of so arranging the world that we don't have to experience it."

—Max Frisch

CHAOS

CONTINUED FROM PAGE 91

nesses have distinctive geometries. "Looking at them as shapes of motion, you notice an interesting thing," Garfinkel tells me. "Parkinson's disease, with its tremors and muscular rigidity, is a kind of hyperstability. The spasmodic, Saint Vitus's dance-like activity characteristic of Huntington's chorea is just the opposite: hyperinstability." Physicists have learned that coupled mechanical oscillators—a turntable that drives a metronome, for instance—may sometimes shift spontaneously into non-periodic motion. The brain's interconnected chemical-feedback loops may do the same thing, Garfinkel theorizes. The result may be motor chaos.

A great disorder is an order. . . .

"Chaos is *not* disorder," asserts Garfinkel. "It is a higher form of order." He recites some of the virtues of chaos for me: It's nature's mixer, nature's homogenizer. Chaos mixes the rum and Coke molecules in your cuba libre, and it transports heat to all regions of a boiling fluid.

And while biological chaos sometimes makes for pathology—Parkinson's disease, schizophrenia—it can also be useful. Garfinkel is enamored of something called slime mold, to which he has devoted a long, fascinating paper. The green slime that coats the surface of stagnant ponds is one of nature's most splendid examples of "emergent order," an idea that very much intrigues the chaos crowd.

"When I first saw it, I said, 'Alan, stop what you're doing; this is the most beautiful thing in the world,' " he recalls.

"The [slime mold] creature has two life phases. In the first, it's a single-celled amoeba that crawls around, leading its own little life. But when deprived of food—bacteria—it undergoes a radical transformation. By pulsing a messenger chemical called cyclic AMP, it signals to the other amoebas, and they all cluster into colonies of ten thousand cells. Then the cells undergo differentiation to become *one animal.*

"The front part becomes a head; the back, a stalk. Then the body becomes spores covered with hard cases. The spores break away, their cases crack open, and out come individual amoebas, completing the life cycle."

An equation describes this process. The patterns the slime mold forms are its solution. The equation apparently has a self-organizing property built into it. It's the same one underlying the Belousov-Zhabotinsky Reaction, and some suspect it's at the heart of embryonic cell differentiation—turning a single zygote into an animal composed of variegated organs and tissues.

What's more, societies may self-organize in the manner of slime mold. It so happens that fireflies flash and crickets chirp in concert. Human females living together fall into the same ovulatory rhythm. Social insects cooperate like a single organism, and individual, chaotic human beings form societies, nations, kingdoms, and economic structures.

Slime mold, Garfinkel proposes, is a model for the emergence of social systems. Why is it people agree to observe laws and conventions, such as driving on the right side of the road? How does one explain altruism, the sacrifice an individual makes to a group?

"The total state of the system will move to a certain attractor—say, cooperation—even if the individual doesn't consciously intend that," says Garfinkel.

The dance of randomness shaping itself into patterns is called emergent order. It fascinates Nobel physicist Ilya Prigogine (see Interview, May 1983), who sees it in termite colonies and the human body; just as it fascinates Doyne Farmer, who sees it in the cosmos; Alan Garfinkel, who sees it in the slime mold and society; and others in the chaos vanguard, including, perhaps, Wallace Stevens, who saw it everywhere: *The squirming facts exceed the squamous mind, / If one may say so. And yet relation appears, / A small relation expanding like the shade / Of a cloud on sand, a shape on the side of a hill. . . .* ∞

SPACE

CONTINUED FROM PAGE 24

throwaway boosters, like *Atlas-Centaur*, *Titan*, or *Delta*, would be more economical.

"The decline of American space science," Friedman maintains, "can be traced to NASA's concentration, in an era of shrinking funding, on massive single projects such as the shuttle."

Hans Mark, deputy director of NASA, sees the situation very differently. He contends that there might not have been *any* planetary-exploration program if it had not been for the major NASA thrusts, such as Apollo and the space shuttle. "The large programs carry along the smaller ones," Mark says. He admits, though, that the shuttle's delays and cost have hurt the space sciences. "An overrun in something as big as the shuttle can crowd out the exploratory programs."

Planetary-exploration programs such as Viking and Voyager get the lion's share of publicity about space science. But NASA has many other scientific programs. Most of these projects are small satellites that carry out astronomical studies from orbit around the earth, above the atmosphere that filters out most of the ultraviolet and other forms of energy radiated by the sun and stars. Two much larger missions are coming up in the middle of the decade: the Space Telescope and *Galileo*.

The Space Telescope is a 94-inch astronomical telescope, one of the largest anywhere; it will be lofted into orbit by the shuttle. Once above the atmosphere, untroubled by weather, the day/night cycle, or civilization's lights and smog, the Space Telescope will be able to peer deeper into the starry universe than any ground-based telescope can. It may even be able to see whether there are planets circling any of the nearest stars, something that has been suspected but never proved.

"The Space Telescope could be very significant to planetary science," Friedman acknowledges, "but it's going to be hard to get a lot of time on it." Astronomers will be fighting for every possible moment of the telescope's observational time. "It's certainly not going to do what a mission to Jupiter would do," he adds.

Galileo is a mission to Jupiter. It will place a spacecraft in orbit around the giant planet and send a probe into Jupiter's swirling, ammonia-laced clouds. Originally scheduled to be launched in 1982, *Galileo* was delayed at first by the delays in the shuttle, and then by funding decisions in the Carter and Reagan administrations that threatened to eliminate the program. It was saved, but it is the only major planetary exploration planned for the Eighties.

Mark admits that NASA's decision in the early Seventies to make the shuttle its basic booster and to phase out such expendable boosters as *Delta* and *Atlas-Centaur* left the space agency with hardly any booster capacity at all when the shuttle encountered its years-long delays. This in turn meant that there were no available boosters for planetary missions between the launch of the Voyager missions in 1977 and the eventual success of the shuttle.

"But it is my opinion," Mark says, "and a controversial opinion, too, that even though the shuttle is now working, they [the planetary scientists] are still talking about comparatively small, 3,000-pound spacecraft." He sees no advantage in sending copies of *Voyager* or *Pioneer* spacecraft to the planets to duplicate the results of earlier missions.

"I'd like to think about more ambitious missions," Mark says, "such as a Mars Sample Return," in which a spacecraft launched from the shuttle would bring samples of Martian soil and gases back to Earth for detailed study.

Friedman strongly disagrees. "Sure, a Mars Sample Return, a Ganymede Lander, or a Venus Rover would all do well with the space shuttle. But there's a whole host of relatively modest missions that can be done with the *Atlas-Centaur*, the *Titan*, even with the *Delta*, that have been waiting in the wings for many years without getting approved. The VOIR did not need the shuttle. The *Galileo* mission originally did not need the shuttle. Certainly comet missions do not need the shuttle."

"The point I want to make," Mark insists, "is that you can always claim you can do good science with smaller missions, but it doesn't lead to breakthroughs." He stresses again that this was his view, not a statement of official NASA policy.

With a budget in excess of $6 billion for the current fiscal year and at least a modest increase expected for fiscal year 1984, it would seem that there should be plenty of money to make everyone happy. But space missions are expensive, and more than half of NASA's money still goes into the shuttle, leaving roughly 15 percent, a little over $1 billion, for all the space-science programs.

Everyone involved in the space program, from NASA administrator James Beggs to the dues-paying enthusiasts of the Planetary Society, wants to continue the exploration of space. Some scientists, like Friedman, want to launch modest, specialized space laboratories, orbiters of the moon and Mars, and flights to asteroids that swing close to the earth. Others, like Mark, insist that, for better or worse, there would be no planetary-science program at all if it were not for the major NASA initiatives, such as the shuttle.

"The public would not support a planetary-exploration program that costs billions of dollars," Mark believes, "if it were not associated with other space efforts."

NASA's space-sciences budget amounts to roughly 10 percent of what the American people spend on video games annually. If the question were put to a vote, would the American taxpayer be willing to pay that billion dollars every year to expand the exploration of the planets?

ODYSSEY

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down. There's no way you can look directly at the sun except when it starts to set.

Being an astronaut isn't all watching the sun rise and set every 90 minutes. I remember the practice-launch countdown, which we did on one of Florida's hottest days of the year. We rode in a van to the launchpad, and the van's air conditioning broke down. Not a good start. By the time launch day arrived, the van's air conditioning was fixed. Trouble was, it was so cold that morning we never used it. That wasn't the only thing that went wrong. When we got to the pad, we didn't have the Velcro holders for our cue cards on what to do if the launch is aborted. Those cue cards are the owner's manual. They tell each crewman what to do if the shuttle loses an engine and we have to land at some strange field in Africa or, even more frightening, turn that 100-ton spaceliner around and land back at the Cape, having jettisoned our external tank that's full of liquid hydrogen, our solid rocket engines, and all our extra fuel from our internal tanks.

Not to worry. Our cue-card holders were driven to the pad in a private car.

I told myself and my friends I'd believe I was riding *Columbia* when I heard its solid rockets light. Well, I believed it when the solids lit. Your whole soul knows when the solids light. You have your helmet on tight and you can hear the communications okay, but your body knows you're right in the middle of a sound chamber. Your whole self is shaking and you know you're on the front end of the world's most powerful afterburner, going straight up.

You're on a rough road and you're accelerating rapidly and the sky is becoming less blue. But you don't say much. The discipline of the launch is not to say anything at all. There is a cadence that the capsule communicator (capcom) in Mission Control, in Houston, uses. You hang on his cadence. He has a set of calls that should come at precise times and be the same each time. So if he starts to vary that cadence you know you have a problem.

His cadence is so much of a litany that on the first shuttle launch, the capcom, Dan Brandenstein, wore a tie that had the eight or ten calls he makes written upside down so he could look down and not flub his calls. "Go at throttle up." Then, "You're go at one minute," and so on. And that's what we heard on the air-to-ground the whole time. It didn't change one beat through the first five shuttle launches, and that's good because it meant no problems.

Believe me, you worry about problems. Inside the first two minutes, we got a caution-and-warning alarm. That can be very frightening. They call it DPDT, a change in pressure as a function of time, which could have meant we had a leak in the cabin. If we did, it meant we were going straight up into a vacuum and losing our life support.

"DPDT," Bill Lenoir called out. "Ignore it." What happens is, the cabin structure expands like a hot-air balloon on the way up so that the cabin pressure drops just enough to set off that alarm, which may be too sensitive an alarm system in the first place. But it could have been a leak and here's the alarm crying "wolf, wolf" and it doesn't have a second time it can cry wolf. And here's Bill Lenoir saying, "DPDT, ignore it." I know it gave him pause, but he sounded as if there was nothing to worry about. Of course there wasn't. But a leak in the cabin could have meant disaster.

The noise suddenly stops when the solids burn themselves out. We're now running on the three main liquid-hydrogen engines, and they are the most smoothly running pieces of machinery I've ever been around. It's like being driven by an electric motor that has a kind of hum to it. They don't make noise and they don't vibrate. There's nothing rocketlike about them. The solids are a rocket man's dream, making loud crackles and pops, but the liquid engines are so quiet you don't even hear them when they shut down.

"You see clouds' shadows on sunlit plains, and you see a ship's wake in the Indian Ocean and brush fires in Africa and a lightning storm walking its way across Australia."

When the engines shut down, I unbuckled myself from my seat and I was floating. I knew we were in orbit. We had to do an orbital-maneuvering-system (OMS) burn to get into a higher orbit. But before we even did the burn I floated upstairs—from middeck, below the flight deck—to look over the guys' shoulders. I looked out the window and couldn't believe it. The sun was streaming in, and you could look right down at the Atlantic Ocean. I looked at the three of them doing the countdown for the OMS burn and I thought, How in the world can you do that? Look *outside*. Of course, I had a special luxury through launch. I was strictly an observer riding into space.

Your first day in orbit, you're like a baby deer on ice. Your feet are going out from under you. You're banging into everything, and you think you need to move around like Superman with your arms held out in front of you. Then there's something that tells you that you have to go feetfirst or headfirst because scuba divers travel like that, and space is like an undersea world with a dreamlike quality where things seem to move more slowly.

In the beginning, you push off to go to the other side of the spacecraft and you push off inaccurately and wind up not going where you want to go. Once you're on your way, you can't stop until you get to the other side. You could be headed for a wall where things are held there by Velcro. Of course, you put a hand out to stop yourself, but you do it awkwardly and bump all the Velcroed things off the wall. They tumble in all directions; so you have to collect them and stick them back where they were. But your feet always kick something else loose and you have to chase that down, too.

You adapt to being weightless by getting over the curiosity of it, by trying different ways to move around, realizing little by little that all it takes to get from one place to another is a gentle push. You don't have to reorient your body. You don't have to do anything but push. Now, it can't be a push that causes you to tumble. The physicists will bore you to tears saying you've got to push through your center of mass. But you can do it with one finger. If you do it right you just float over and put out your hand to stop yourself.

One other weird thing about weightlessness: There's no such thing as right side up and upside down. There's a ceiling. There's a floor. There are walls. But sometimes it's convenient up there to have your feet on the ceiling with your head toward the floor, but your head never says the floor is the ceiling. You're upside down, but you don't feel different. If you go to sleep upside down, you'll want to wake up knowing you're still upside down.

Eating is a little strange in a weightless environment, though there's no difference between eating a sandwich here and eating a sandwich up there. Except that when a crumb breaks loose, you can't put it down anywhere, and when your sandwich drips ketchup down here you ruin a pair of pants, but the ketchup doesn't drip up there. It runs over and just sticks to the bun. It doesn't go anywhere. Drinking in orbit is quite different. You have to drink everything through a straw. The straw has a clip on it so that when you take your mouth away you can clip it; the liquid just doesn't keep coming out. I remember I liberated from an orange-juice container a glob of orange juice that was about as big as a coffee cup. It was in front of me, and I moved it around as if it had come to life. Liquids come to life in zero gravity. I even wound up doing some experiments the night before we came home. I stayed up half the night and did things like causing a hemisphere of fluid to vibrate by tweaking it, jostling it with a straw, and just blowing on it. You get the strangest vibrations. I'd like to take a minnow up there, because you could literally have a glob of fluid with a straw and there the minnow would be, looking very surprised. Like a fish out of water, so to speak.

Being weightless does have its prob-

lems, though. I'm talking about what the media have called spacesickness. I observed four people firsthand, myself included. Two had sporadic trouble adapting to weightlessness. One spit up his food on two occasions and the other was out of sorts all of one day. Some doctors have said spacesickness is like seasickness. I disagree. The way I understand it, seasickness is a disturbance of the inner ear that makes people violently ill and incapacitated. Neither of our two crewmembers had inner-ear disturbance. Far as I know, spacesickness is nothing more than a third cousin to seasickness.

What causes spacesickness? I don't think anybody knows, but I think we have some clues. None of the shuttle astronauts who suffered space malaise experienced it down in the middeck, where there are no windows. Maybe that means it has something to do with what the eyes see, looking out the big windows on the flight deck. I don't want to make too much of this, but in one case one of our crew was putting up the sunshades to go to sleep and he regurgitated when he looked up and saw the earth in a place he didn't expect it. In another instance, he was taking the sunshades down and had the same problem.

One reason I think some people get to feeling bad in the shuttle is that there's more room to move around. The more you move, the more you might feel woozy if you're predisposed to it. That's no criticism of the machine, though.

Let me illustrate the beauty of this machine with the way it handles, something every car owner will understand. We flew *Columbia* with the nose pointed at the sun and tipped up 10° for a thermal test, which put all but the top part of the tail in shadow. You could count the exact number of tiles on the tail that were in the sun. I don't know how many times we went around the earth holding that position, but it was at least five times, and at the end of the fifth revolution you could still count the same number of tiles in the sun. How it could be so steady was awe-inspiring.

Getting ready to come home was kind of strange, almost the opposite of getting ready to leave the earth. You put on a pressurized flight suit to handle the reentry g forces, which is like wearing a boa constrictor from just below your stomach on down. The suits are inflated and they squeeze you to keep blood from pooling in your legs so that you don't black out. We put on our helmets and our harnesses and then we put on boots just in case we made a belly landing and had to jump out our escape hatch 12 feet to the ground. We also took salt pills with 22 to 32 ounces of liquid, which was something new on shuttle flights. The doctors have been telling us to get as much liquid as possible in our bodies at reentry to better tolerate it, for reasons nobody fully understands.

One thing is sure about reentry. You know it's not a drill. The flying procedure at reentry is to slow *Columbia* by 200 miles an hour, just enough to reshape the orbit so the low part of the orbit comes down and touches the uppermost reaches of the atmosphere. Thin as it is, the air up there is still thick enough to slow *Columbia* enough to start to bring it all the way down. You feel yourself coming down first in the seat of your pants. Then, you look at your instruments, and the needle that measures g force—a needle that's been sitting as though it were painted on the dial at zero—moves forward ever so slightly.

All of a sudden you begin to hear the sound. Until now, *Columbia* has been a silent ship, but now there is a roar that builds and builds and builds. It's the rush of air, and as thin as that air might be, it's reverberating all around the vehicle. The next thing you're aware of is a color on the window. It starts out with just a faint tint of rose-red that gets brighter and then changes to a whiter red and then an orange-pink and ultimately a white that flickers around the windows; it is the fiery heat of reentry. It's like being inside a neon light bulb.

Our pilot was Vance Brand, who took over the controls when we were 40,000 feet above the earth and moving at three times the speed of sound. It's a good idea to let the pilot take over at that altitude instead of a lower altitude, because if somebody's going to land it he ought to get some practice to see how the machine responds. Boy, did it respond. We came out of an overcast, dropped right down through the clouds at 15,000 feet, and those clouds could have come right down to the runway because there was the runway dead ahead. Not an inch to the right, not an inch to the left. As I said, a beautiful machine ∞

INTELLIGENCE

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Christensen, reports that he tried the technique on gold-bullion prices and scored high. "We were sixty-eight to seventy percent correct in predicting market movement one day ahead," he says.

Other experts in the prediction business are cautious about whether Raden might have discovered the alchemic touchstone. "Most of what is important in finance is nonnumeric—political events, trade barriers, people's perceptions," says Gene Pettinelli, of American Research and Development, a Boston research firm with an interest in artificial intelligence. "You cannot capture all the important data relating to, say, soybean moves."

Raden, however, is forging ahead. There are plans to have PRISM produce a number of other models by the end of this year, one of them predicting the course of the Dow-Jones average. An investment fund is "down the line," says Aronson. How profitable might a good PRISM-produced model be, once up and running?

"You could be talking several hundred percent a year," Aronson believes. "If it works, we'll be very rich."

NEW WARES: HARD AND SOFT

With more than 45 portables already on the market or announced, the pick-up-and-go computer market shows little sign of cooling. Latest in this field is the PC 8201, an almost-entry from giant Nippon Electric Company (NEC). On sale in Japan since January, the four-pound superportable offers 16K of working memory and 32K of ROM (read-only memory), expandable to 128K ROM. With an eight-line, 40-character display, the device manages to make do with four AA penlight batteries. In Japan the PC 8201 sells for 138,000 yen—roughly $675. NEC has dangled it before eager dealers here but has yet to confirm that it will actually be marketed in the United States. (NEC Information Systems, 5 Militia Drive, Lexington, MA 02173.)

To the hundreds of software producers churning out programs, add Scholastic, Inc., publishers of classroom magazines for school-age children. The company's first four titles, aimed at children ages eight to fourteen, are *Turtle Tracks*, a programming tutorial using color graphics; *Square Pairs*, designed to teach basic learning skills; *Your Computer*, an introduction to computer technology; and *Electronic Party*, an entertainment program that, the company claims, "makes every day seem like a party." Produced under the name Wizware, the programs can be bought for the Apple II Plus and IIe, Atari 400 and 800, TI 99/4A, and VIC 20 computers. The company also announced a new line of software, available by subscription, which includes interactive adventure stories whose plots are partially determined by young computer users. (Scholastic, Inc., 730 Broadway, New York, NY 10003.)

The decade-long research program that five years ago produced Texas Instruments' *Speak & Spell* now offers us the Voice Management System (VMS). Built around a high-powered microcomputer designed for signal processing, the unit works with TI's new Professional Computer. After hearing the user's pronunciation three or four times, it can recognize spoken words with an accuracy of more than 99 percent. Likely uses include computerized dictation and telephone answering. In previews of the system at the San Francisco Computer Faire, TI representatives called out crisp commands to make circles appear on a screen, move around, and fill with different colors. Graphics capability is probably a precursor of computer-aided-design gear that will enable architects, engineers, and others to work by chatting with their machines. The price for the TI unit, which is due on the market this month, has not yet been set. The company notes that the processing chip alone is more than $300; so the VMS will probably be a "costly option" for the $2,600 computer. (Texas Instruments, Box 53, Lubbock, TX 79408.) ∞

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Burson calls "dumb genetics." An equally valid description, however, would be "the heir apparent in drag." Burson's first "Nuclear Powers" composite—Reagan, Brezhnev, Mitterrand, Thatcher, Trudeau, Deng, and Gandhi—reveals the strengths of the Oriental and the female faces.

Fascinated by the face of destructive power, Burson created a "Second Nuclear Powers" composite. This one omits India and Canada, and combines the five remaining faces in proportion to the number of nuclear warheads each country is capable of mobilizing. Burson cites the Nuclear Weapons Freeze Council as her source, informing us that in 1982 the United States had 9,500 warheads: the USSR, 7,700; France, 64; Britain, 64; China, 80. "The composite," she continues, "is essentially sixty percent Reagan and forty percent Brezhnev." Although in actuality the United States has the greater number of warheads, in the composite it is Brezhnev that dominates, his formidable bony facial structure and eyebrows as stark and forbidding as the Carpathians. One wonders who would come up on top if Burson were to replace Brezhnev with Andropov.

The other political pictorials include the "Ideal Candidate," a composite of the last five American presidents, and the "Liberal/Conservative" composites in the form of a diptych, or two complementary portraits. The conservative composite pits the faces of Alexander Haig, George Wallace, William Buckley, Robert Byrd, and John Connally against one another. The faces of Frank Church, Ted Kennedy, Gary Hart, Mo Udall, and Walter Mondale vie for supremacy in the liberal composite. "The conservative face turned out to be more 'nerd-like,' " Burson comments.

Recently, on a Walter Cronkite special, CBS aired Burson's "Big Brother" composite, in ominous celebration of 1984. A fusion of Khomeini, Hitler, Stalin, Mussolini, and Mao, the portrait, Burson thinks, "turned out to be a pretty benign face, not fearsome at all." Perhaps the great dictator would indeed turn out to be the incarnation of Hannah Arendt's "banality of evil."

"The Persistence of Glamour," an ironic homage to a legendary Salvador Dali painting, is another diptych, contrasting female movie stars of the past—Bette Davis, Marilyn Monroe, Grace Kelly, Sophia Loren, and Audrey Hepburn—with more contemporary beauty queens—Jane Fonda, Diane Keaton, Jacqueline Bisset, Meryl Streep, and Brooke Shields.

During the past few years, Burson has been exploring the commercial application of her patent. The strongest market is the burgeoning plastic- and reconstructive-surgery industry. Burson and her collaborators have incorporated increasingly complex technology into overall programming of the composite process to enable people to see what they would look like after surgery. One might walk into a plastic surgeon's office and request to see oneself with a slightly trimmer nose, a more pronounced chin, and so on. Since all manner of body parts are now being reconstructed, one can imagine this technique expanded far beyond facial composites.

Today methods of showing a patient the probable results of an operation are quite primitive and require that the plastic surgeon draw the proposed improvement directly over a Polaroid or other photograph. Burson's innovation allows the patient to compare a much greater range of surgical options in a much shorter time. Quicker, easier, and more persuasively accurate, this method is infinitely less dependent on the surgeon's skill as an artist. Since Burson's process is a computerized system for aging a face well beyond its present appearance, as well as giving it a Fountain of Youth excursion back to a younger time, the client will have the option of projecting his surgical changes 20 or even 30 years into the future. Generally, though, surgeons will use the process to show patients how much younger they will look after their faces are lifted or shifted. Burson is working on an arrangement covering the manufacture of computers specifically designed for doctors' use. She has hired a consultant to assist her negotiations with a number of major corporations.

However Burson manages to market her patent, it is clear that she will continue to work primarily as an artist. She regards her composites as the first significant development in portraiture in many years. Yet her method is that of a scientist: Research is done, data assembled, technology applied. Whatever personal beliefs and perspectives she holds, Burson says, have nothing to do with the finished images we're perceiving. Her stance is objective; she insists that none of her value judgments about, say, the nature of political power, the mores of beauty, or male and female roles are being offered. "I'm nonpartisan," she maintains. "I'm just trying to see what comes out. I'm really very apolitical."

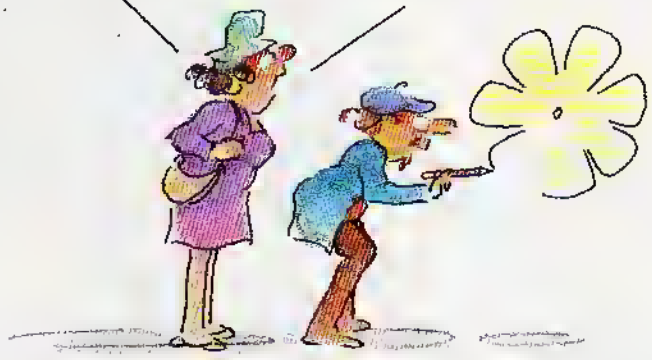
Burson's work can be viewed within a tradition stemming from Marcel Duchamp and Man Ray, in their suggestion that "anything is art" as long as the artist isolates it in an aesthetic context or format. Her art, which aspires to bring the computer into the gallery, is avowedly theatrical. Like Jean Cocteau, she employs modern technology to enable us to pass through the mirror of our dreams and cultural myths.

What's ahead for Burson? Certainly more computer-generated composites: an animal synthesis; a portrait of the Osmonds; a pictorial "saga" of a famous family; a children's book in which young children can draw the "shape of their feelings"; a "healing project"; and most cryptically, "a machine so fantastic and expensive I doubt I'll ever see it in my lifetime."

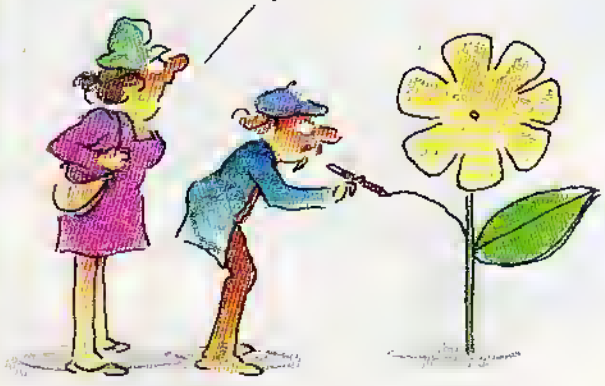
The Artist

You've got to be kidding

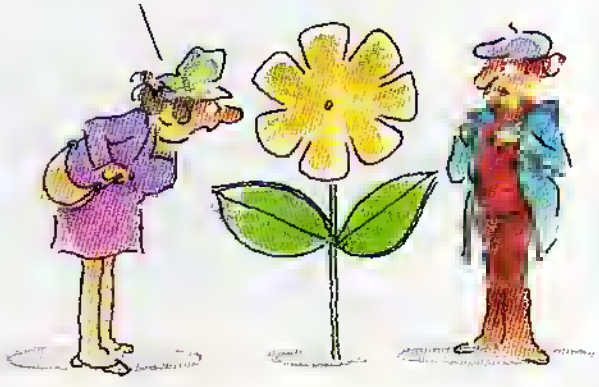
Where did you learn to draw?

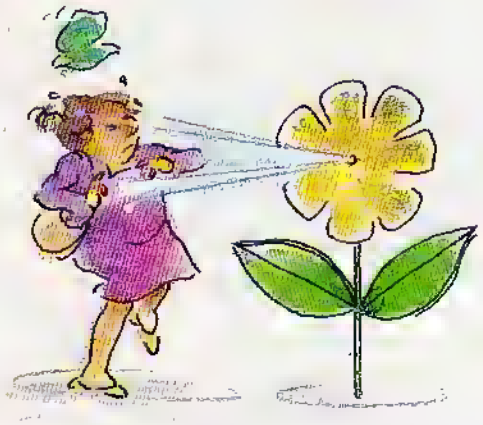


I have been in horticulture all my life —



and I have never seen a flower that looked so ...





I love their expression when they realize it's plastic

EDGES

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gentle exhalation seemed much louder.

He was dead, but somehow I was relieved. Now no one knew the truth of the mirages except myself and Henna. Yet as I took my hands from the still-warm one of Dallin, I felt a chill in the heat of the crowded tent and heard Henna's voice in my mind. She had warned me of insanity, told me to forget my obsession, and I had paid her no mind. A man was dead because I would not forget, and Henna could accuse me of one more thing: murder.

"We cannot race tomorrow. We'll have to call it off, Paul. You see that, don't you?"

I looked up at Henna, glanced down at my beer, and shook my head. There had been silence in the tent since I walked in. No one bothered to ask me about the Association's inquiry, not that it mattered. I would lie to the pilots, just as I had lied to the Association. I don't know why he attacked me, I had said, unable to tell them I was glad Dallin was dead.

"Two pilots dead, Paul. The spectators love you, did you know that? You give them exactly what they want," Henna said when I didn't answer.

"The Association cleared me."

"They know everything, do they?" she asked, staring at me.

"The Timing Race isn't canceled," I said, louder now.

"What did Dallin say to you?" she asked. "What did you and Dallin talk about?"

She knew without my having to say it. She believed my theories of the Edge now, that was plain.

"You buried a man out there, you're sure of it?" People stared at Henna, but no one spoke, not even to ask questions. "It wasn't a woman you two buried to hide an accident? You said Marart wanted speed. Could that really have been you, Paul? Perhaps Dannelle isn't what you're searching for. Perhaps you *know* where she is."

Everyone waited for an answer to her confusing questions and it was hard not to explode in denial. I stood and slipped through the tent flap, leaving it open behind me as I walked into the night.

I made my way to the clippers, found mine in the darkness, and touched it with one hand. The spectator tents glowed in the near distance.

"Paul, I'm sorry." It was Henna. I'd known she'd follow me. I moved my hand to indicate a place by the clipper's deck and she leaned against it.

"I didn't kill Dannelle," I said. "She's still alive somewhere, somewhen. Both Marart and I believed that."

"I was just frightened of what you'd become, Paul," she said, taking the beer from my hand and drinking deeply.

"I killed Dallin to keep him from telling the Association of the mirages."

"I know, Paul."

"You don't hate me? You must. I'm a murderer, Henna."

"I want to believe what you say about time and the Edge, but I can't," Henna said softly. "Not completely."

"It's true, Henna. Tomorrow you'll see that it's true. We can both touch the mirage and slip into the past. We can both go back."

"So we can both be with her, Paul? You left me for her, don't you remember?" She paused, drank beer again. My mouth was dry, but I wanted to stay clear. "Would you chase mirages for me, Paul? If it was I who vanished, would you be so obsessed?"

I thought of Dannelle and for the first time in a year, I could not see her face. I inhaled quickly and heard my breath rattle in my throat. I looked up and saw Henna smile, her teeth points in the light. Dannelle's clipper, its sails dark-blue, I could see, but not her face. Henna's kept coming into focus.

"You loved me once, Paul. In the past," she said and smiled again. "You can love me again. I'm here now. Dannelle's not."

The temptation was strong—so strong. I remembered Henna's touch as we'd lain under the night sky beside the Edge, the time oases gleaming in the distance. She was alive and warm; Dannelle was only that centuries down the line of time.

"Let's go to the Edge again tonight," she said. "We can forget all this." It was as if she wanted to make love to me in front of Dannelle's memory—or ghost. It depended on what she believed.

I wanted Henna then, more than I'd ever wanted anyone. Her touch, her warmth, her soft words, even her callused hands. But somehow I managed to stand and push myself away from my clipper.

"No, Henna. I'm going out on the Flats tomorrow to find another mirage."

My rejection showed on her face. "You'll not forget her. You'll not call off the race. Tomorrow, then. And Paul," she said, so softly that I thought for a moment it was only the wind on my clipper's sail, "stay away from me—now, and in the race. I want the past now, too, Paul. Keep out of my way. Understand?"

She stood and walked into the darkness and I could think only of her face where Dannelle's was supposed to be.

I crouched next to my clipper, rolling the skirting down so that it touched the ground, making sure there were no gaps where the air could push through. The mast was already up and the rigging lines snapped into place. Fabric rippled above me as the bright-green sails moved in the wind. When I turned on the fans and the deck lifted three centimeters, I would let the sail fill with wind and the clock would start.

I looked at the salt beneath my knees. It was smashed flat here from the constant footsteps, but if one went out into the caldron of the Flats, where there were no prints, it would crunch marvelously, sounding like shells underfoot. And it would glitter. It was difficult to see that when the clipper was reaching for sixty-five knots, but impossible to miss now. It was painful to look at.

"Are you set?" a voice behind me asked as I stood and stretched my legs. My coverall was white from the salt. I turned and saw Harmon, the Association timer. He held his timepiece close to his stomach, in both hands, as if it would leap from his grasp.

"Almost. Two more lines to check."

"Whenever you're ready, board your car and give me the signal." I nodded slightly. Like everyone from the Association, he called my clipper a car. Habit from long ago, I suppose.

I squinted into the sun and saw Henna's clipper fifty meters away, its sails a deep rust. Even that short distance away, it seemed suspended in midair, the shimmering heat waves below it, the hazy sky above. She was sitting in her cockpit, ready to start.

Gently, slowly, I crawled upon the deck of my clipper, careful not to snag any of the rigging lines with my feet. I maneuvered around the fan-intake vent and settled into the shallow cockpit. As soon as I had flipped the switches that engaged the fans, I pulled the mainsheet lines and heard the snap of the sail's fabric. The battery meters went down and I could hear the whine of the blades as the deck rose. The wind shoved the clipper aside, but I pulled the boom over and corrected. Harmon had started his timepiece by now, I knew, and I set course for the mirage of the Edge, seeing Henna's clipper from the corner of my eye, moving as I moved.

"The wind shoved the clipper aside, but I pulled the boom and corrected. Harmon had started his timepiece by now, I knew, and I set course for the mirage of the Edge."

I kneel on the deck of my clipper, yanking desperately on the mainsheet lines, trying to pull them and spill the sails. In the distance, beyond the sails I so achingly stare at, I think I see the finish banner, its length distorted by the heat waves. Another kilometer and I will be safe.

Henna is still bearing down on me, her course pointed to an imaginary spot of collision. She, too, is pulling on rigging lines, readjusting hers as I readjust mine. It is as if there is a band between us that allows us to separate only so far and that tugs us together when it wants.

It has been a tight race. Several times we ran alongside each other, our decks only meters apart. I did not brush against her speeding clipper, nor did I see one of the mirages.

But now Henna is trying to kill me with her clipper. I cannot be sure, of course, but I think my rejection hurt her deeper than she would admit to me. She has not spoken to me since she walked away from my clipper and me last night. She must have planned this then. I glance toward her and see that she is still aiming her clipper at me. It cannot be accidental, this course. Why now, I wonder as I try to steer to starboard and toward the Edge? Why not in the middle of the Flats, where there were no witnesses?

Against the mountains in the far distance of the Edge, I see a blur that is ditferent from the perpetual line of ground mirage. It dances and floats on the breeze at my back, though it is coming toward me, I realize, running directly into the wind. Every time I blink, it shifts shape and position. I rub my fingers at the corners of my eyes, but the blur remains. I realize that Henna is not trying to kill me. She only saw the mirage before I did and is heading for it.

I cannot take my eyes from it, not even to watch my instruments, because as I look, it grows larger. Then, all in one long moment, I can make it out. It is yellow, only a shade or two darker than the salt it carries beneath it as it crosses the blackened Edge. Long nosed, with dark wheels that rise half the height of the machine, its snout points toward me. No, toward Henna. It heads for her. As it becomes clearer in the hazy reflection from the salt, I hear its engine roaring and spitting sound in all directions. Then I see the pilot. He is all but invisible, hidden by the bulk of the machine so that only his head and neck can be seen. His machine is across the Edge now and on white salt, covering the kilometer between the Edge and us quickly.

I release the rigging lines to cover my ears against the sounds. How can he stand it? He must be insane from the pounding.

I hesitate, not knowing what to do. Do I force Henna to one side, as Marart tried to do to me, causing her to disappear in shards of plastic as Marart did? Or do I let her live, and lose my chance to join Dannelle's time? I cannot make up my mind, for although I've wanted Dannelle for so long, I cannot recall her face. Instead I seem to feel in the warm air that tears at my lips Henna's even warmer hands on my naked back as we lie on the salt at the Edge.

My thoughts are fused, just as the salt lies fused to the east. I do nothing, and that becomes my decision.

The mirage flickers one last time to the side and seems to touch her clipper, the distortion of its lines merging with her sails for a fraction of a second.

My hands are still off the rigging lines and Henna is pulling away from me, her course altered, the hard shape of her clipper shimmering in the reflected heat. She does not disappear, but I am sure she has

slipped through the oasis of time and is even now in the past. I can still see her, of course, as I can see all the images from the past here on the Flats.

I try to follow her clipper, but as we near the Edge, my batteries register zero and I coast to a stop, my deck grinding in the sail as the sails still pull with the wind. She continues, the line of blue reflection widening beneath her keel. As I blink away the sweat from my eyes, her image flickers and finally vanishes in the heat waves rising from the blackened salt of the Edge.

The ground crews come toward me in the electric trucks. They will want to know what happened to Henna and I will have to tell them the truth. I know they will not believe me, just as Henna at first refused to listen. She is in the past now, but I am no closer to the face I cannot recall.

I sit in the darkness and wait for dawn. The sail moves above me, the boom slides back and forth in its peculiar way, and I imagine I can hear my own heart beating.

Everyone from the Timing Race—the pilots, the spectators, even the Association—has long since left the Flats.

But I've stayed, living in a tent near this mountain spring, using the long days to sail my clipper along the Edge.

I tried to tell them what had happened, but they only looked at me quietly and said they'd consider banning me from the Timing Race next season. I don't care, really, for I can search as well on my own.

I believe I know why Henna had tried for the mirage and the past. I first thought it was because she wanted to see if I'd look for her, as I'd looked for Dannelle. But then I remembered her last words to me. She'd wanted to join the past, too, she'd said. Now I believe she went down the line of time to find Dannelle. Perhaps to kill her, as I'd killed Dallin. Perhaps to tell her that it was Henna I loved, to shatter her memories of me.

I sail the Edge every day, searching for both of them and the past. In my mind, they have merged into one; Henna's face flickers in my dreams, but I still remember Dannelle's name. It doesn't really matter which one I find first. They are simply two particles of the same desire.

The sun slips over the mountain behind me and I feel its warmth drive away the chill of the desert night. As soon as the batteries are recharged, I will switch on the fans and pull the sails tight.

Perhaps today I will see one of their full-rigged clippers soaring above the fused ground of the Edge.

And when I find one of their mirages, I will sail alongside it to join its oasis of time. I will slip into the past, cross my own edge of desire, and relive my love. I will find one of them eventually. And in the blooming heat of the early morning, I shudder, feel the chill of anticipation, and smile as I look down into the mirage-haven of the Edge. Such destruction, and yet such beauty, she'd said, and she had been right. ∞

TEARDROP

CONTINUED FROM PAGE 105

the deep rasp in his lungs was perfect!

He focused his maser and let the raspy breathing play while he thought. Anything else? Would it expect a picture? Best do without. Remember to cut the breathing while you talk. *After* the inhale.

"This is goodlife speaking for the fortress moon. The fortress moon has been damaged," he rasped.

The fan of light from Teardrop didn't waver, and answer came there none.

The records were old—older than Gage the man, far older than Gage in his present state. Other minds had run this computer system, twice before. Holstein and Ras Singe had been elderly men, exemplary citizens, who chose this over simple death. Both had eventually asked to be wiped. Gage had been a computer for only eighteen years. Could he be using an obsolete programming language?

Ridiculous. No code would be obsolete. Some berserkers did not see a repair station in centuries. They would *have* to communicate somehow, or was this life thinking? There were certainly repair stations. But many berserker machines might simply fight until they wore out or were destroyed. The military forces of Channith had never been sure.

Try again. Don't get too emotional. This isn't a soap. Goodlife—human servants of the berserkers—would be trained to suppress their emotions, wouldn't they? And maybe he couldn't take it well enough anyway. "This is goodlife. The fortress moon—" *nice phrase, that,* "is damaged. All transmitting devices were destroyed in battle with . . . Albion." *Exhale, inhale*—"The fortress moon has stored vital information regarding Albion's defenses."

Albion was a spur-of-the-moment inspiration. His imagination picked a yellow dwarf star, behind him as he looked toward Channith, with a family of four dead planets. The berserker had come from Channith; how would it know? Halt Angelo's breath on the intake: "Life-support systems damaged. Goodlife is dying." He thought to add, *please answer,* but he didn't. Goodlife would never beg, would he? And Gage had his pride.

He sent again. "I am—" *Gasp.* "Goodlife is dying. Fortress moon is mute. Sending equipment damaged, motors damaged, life-support system damaged. Wandering fortress must take information from fortress moon computer system directly." *Exhale, listen to that wheeze—the poor bastard must be dying—inhale:* "If wandering fortress needs information not stored, it must bring oxygen for goodlife."

That, he thought, had the right touch: begging without begging.

Gage's receiver spoke. "Will complete present mission and rendezvous."

Gage raged, and said, "Understood." That was death for Harvest. Hell, it *might* have worked! But a berserker's priorities

were fixed, and goodlife wouldn't argue.

Was it fooled? If not, he'd just thrown away anything he might learn ot the berserker. Channith would never see it, and Gage woufd be dead—slagged or possibly dismembered.

When the light of the fortress's drive dimmed almost to nothing, Teardrop glowed of itself: ft was brushing Harvest's atmosphere. Cameras whirled in the shock wave and died one by one. A last camera showed a white glare shading to violet . . . gone.

The fortress surged ahead of Teardrop, swung around the curve of Harvest, and moved toward the outer moon—toward Gage. fts drive was powerful. It could be here in six hours, Gage thought. He sent heavy, irregufar breathing, Angelo's raspy breath, with interruptions. "Uh. Uh? Goodlife is dying. Goodfife is . . . is dead. Fortress moon has stored information . . . self-defending fife . . . locus is Albion, coordinates—" followed by silence.

Teardrop was on the far side of Harvest now, but the glow of it made a ring of white flame around the planet. The glow flared and began to die. Gage watched the shock wave rip through the atmosphere. The planet's crust parted, exposing lava; the ocean rolled to close the gap. Almost suddenly, Harvest was a white pearl. The planet's oceans would be water vapor before this day ended.

The berserker sent the message, "Goodlife. Answer or be punished. Give coordinates for Albion."

Gage left the carrier beam on. The berserker would sense no fife in the lunar base. Poor goodlife, faithful to the last.

100101101110 had its own views regarding goodlife. Experience showed that goodlife was true to its origins: It tended to go wrong, to turn dangerous. It would have been destroyed when convenient, but that would not be needed now.

Machinery and records were another matter. As the berserker drew near the moon, its telescopes picked up detaifs of the trapped machine. ft saw lunar soil heaped over a dome.

fts senses peered inside.

Machinery occupied most of what it could see. There was little room for a life-support system: a box of a room, stored air, and tubes through which robot or goodlife could crawl to repair damage; no more. That was certainly reassuring, but the design details were unfamiliar.

Hypothesis: The trapped berserker had used fife-begotten components for its repairs. There was no sign of a drive; no sign of abandoned wreckage.

Hypothesis: One of these craters was a crash site; the cripple had moved its brain and whatever else survived into an existing installation built by life.

Anything vafuable in the goodlife's memory was now lost, but perhaps the fortress moon's memory was intact. It would know all of the patterns of fife in this vicinity. Its knowledge of technology used by local self-defensive fife might prove to be even more valuable.

Hypothesis: ft was a trap. There was no fortress moon, only a human voice. The berserker moved in with shields and drive ready. The closer it came, the faster it could dodge beyond the horizon, but it saw nothing resembling weaponry. In any case, the berserker had been allowed to destroy a planet. Surely there was nothing here that could threaten it.

It remained ready nonetheless.

At a hundred kilometers the berserker's senses found no life. Nor at fifty.

The berserker landed next to the heap of lunar earth that goodlife had called fortress moon. Berserkers did not indulge in rescue operations.

What was usefuf in the ruined berserker would become part of the intact one. So reach out with a cable and find the brain.

It had landed, and still the fear didn't come. Gage had seen wrecks, but never an intact berserker sitting alongside him. Gage dared not use any kind of beam scanner. He felt free, however, to use his passive sensors, his eyes.

"It was a trap. There was no fortress moon, only a human voice. The berserker moved in with shields and drive, but it saw nothing resembling weaponry."

He watched a tractor detach itselt from the berserker and come toward him, trailing cable.

It was like a dream: no tear, no rage. Hate, yes, but fike an abstraction of hate, along with an abstract thirst for vengeance, which felt ridiculous, as it had always felt a bit ridiculous. Hating a berserker was like hating a malfunctioning air conditioner.

Then the probe entered his mind.

The thought patterns were strange. Here they were sharp and basic; here they were compfex and blurred. Was this an ofder model with obsolete data patterns? Or had the brain been damaged or the patterns scrambled? Signaf for a memory dump; see what can be retrieved.

Gage feft the contact, the feedback, as his own thoughts. What foflowed was not under his control. Reflex tofd him to fight! Horror had risen in his mind, impulses utterly forbidden by custom, by education, by all the ways in which he had learned to be human. It might have felt like rape; how was a man to tell?

He wanted to scream. But he triggered the Remora program and felt it take hold, and he sensed the berserker's reaction to Gage within the berserker.

He screamed in triumph. "I lied! I am not goodlife! What I am—"

Plasma moving at relativistic vefocities smashed deep into Gage.

The link was cut, his senses went blind and deaf. The following blow smashed his brain and he was gone.

Something was wrong. One of the berserker's brain complexes was sick, dying; it was changing, becoming monstrous. The berserker felt evil within itself, and it reacted. The plasma cannon blasted the fortress moon, then immediatefy swung around to face backward. It would fire through its own hull to destroy the sick brain, before it was too late.

It was too late. Reflex: Three brains had to consult before any major action could be taken. If one had been damaged, the view of the others would prevail.

Three brains consulted, and the weapon swung away.

What I am is Hilary Gage. I fought berserkers during my life, but you I wifl let live. Let me tell you what I've done to you. I didn't really expect to have an audience. Triple-redundant brains? We use that ourselves, sometimes.

I am the opposite of goodlife. I'm your mechanical enemy, the recording of Hilary Gage. f've been running a terraforming project; you've killed it, and now you'll have to pay for that.

It feefs like I'm swearing vengeance on my air conditioner. Well, if my air conditioner betrayed me, why not?

There was always the chance that Harvest might attract a berserker. I was recorded in tandem with what we called a Remora program: a program to copy *me* into another machine. I wasn't sure it would interface with unfamiliar equipment. You solved that one yourself, because you have to interface with thousands of years of changes in berserker design.

f'm glad they gave me conscious control of Remora. Two ot your brains are *me* now, but f've feft the third brain intact. You can give me the data I need to run this heap of junk. You're in sorry shape, aren't you? Channith must have done you some damage. Did you come trom Channith?

God curse you. You'll be sorry. You're barely in shape to reach the nearest berserker repair base, and we shouldn't have any trouble getting in. Where is it?

Ah. Fine.

We're on our way. I'm going to read a poem into your memory; I don't want it to get lost. Relax and enjoy it, death machine. You might enjoy it at that. Do you like spilfed bfood? I lived a bloody life.

INTERVIEW

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tion to choking—sharp blows to the back to dislodge the offending object. You, on the other hand, characterize the backslap as "murder." Why?

Heimlich: All the articles I'm aware of warn against slapping a choking victim on the back. The reason is, Newton's law: For every action, there is an equal and opposite reaction. If you hit a person on the back, the object is driven in deeper. Recently Richard L. Day and his colleagues at Yale did a very exacting study, showing that if you hit someone on the back, a lodged object is driven in further by a force of three g's. Similarly, if you use your fingers to retrieve the object, you only push it in deeper. And if you hold the victim upside down, he could die if the object has gotten below the slit in the vocal chords and then falls up against them.

The Red Cross made the mistake of recommending backslaps several decades ago, and they stuck with it. When the maneuver came out they fought it for two years. Later, their consulting physicians issued reports that claimed you can get adequate pressure with the backslap, statements which in my opinion are highly *inadequate*. Then in 1979 the National Academy of Sciences, which advises the Red Cross, admitted they could not supply any references for using the backslap. Yet the Red Cross still claims that they get their directions from the NAS.

Now they say to hit the victim on the back four times, then do four "abdominal thrusts"—I won't let them use my name in connection with the maneuver—and then go through seventeen pages of steps. Can you imagine some poor mother going through that when her child is choking? It's totally ridiculous.

Omni: Several inventors have come out with accessories for the maneuver. One, for example, invented a rubber sphere to push against the victim's diaphragm while applying the hug. Would you suggest a person buy one?

Heimlich: The whole idea of gadgets is wrong, because you don't know where you're going to be when someone starts choking. You have four minutes to save a life, and you don't have time to look for a piece of equipment.

Omni: How did your life change after you developed the maneuver?

Heimlich: All of a sudden I became a public figure. I was on television frequently. I was interviewed by newspapers and radio stations from all over the country. I got massive amounts of mail from doctors and first-aid practitioners who wanted to know about this development. At the same time my newfound fame enhanced the possibilities of getting grants for future work involving the portable oxygen supply and a heat treatment of cancer. It also gave me greater access to other scientists. I spent a day with Buckminster Fuller, for example; I wanted to meet him just because he is such a great man. It even got me access to senators and congressmen, who had never heard of me before. All this has given me the opportunity to work toward my most important project—Computers for Peace.

Omni: Since going public, you've used the medium of television very effectively. What role do you foresee for television in medical education?

Heimlich: I see TV as a way of teaching people to diagnose, prevent, and treat illness. Whatever television's defects, there's an awful lot of information going out over television to more people than ever before. For example, almost every comedy show I've ever heard of has demonstrated the Heimlich maneuver. But I take exception with most medical programs I see on the air. They show an artificial heart or a CAT scan, which looks very dramatic and costs a million dollars. I want to teach about headaches, colds, or chest pains—real down-to-earth medical problems. That's why I did the HELP project on ABC. I'm currently working with a producer to do a series of one hundred twenty spots, ninety seconds each, to air on daytime news programs throughout the country. In one, I go through a diagnosis of appendicitis and explain how to treat it so it doesn't burst. I covered all that in ninety seconds.

Omni: One of your television appearances made some skeptics wonder how responsibly you've used that medium. Is it true that, on one show, you had sixty percent of the viewers convinced that they were having a stroke?

Heimlich: That was a marvelous experiment. QUBE [a system that enables viewers to respond to televised questions] had begun operation in Cincinnati. I was asked to do a special show called *Self-Diagnosis for Preventive Medicine*. The topic was strokes, and I told viewers I was going to list some symptoms: blurred vision, dizziness, headaches, and occasional thickness of speech, among others. These are symptoms that can indicate what we call small strokes, which can later lead to a bigger, serious stroke.

Then I said, "If you have four or more of these symptoms, signal us." That's when the sixty percent response came in. I told the viewers, "Don't be alarmed, because in most cases these symptoms do not indicate a serious stroke. But it's worth checking out, particularly if you're over forty-five years old. Your doctor can do a very simple, ultrasonic, noninvasive test to determine whether you have a blockage in one of the arteries of the neck. If such a blockage is found, you can have it operated on and removed quite simply, thereby preventing a stroke."

Omni: What became of the sixty percent who signaled in?

Heimlich: The network won't release the numbers; so there's no way to really check up on what occurred. But those who followed my advice and went to the doctor

either would have been saved from having a stroke or would have found that their symptoms were unrelated. Even those who don't have the symptoms should know what the symptoms are so they can help themselves and others.

Now, you may say that a little knowledge is a dangerous thing, but I argue that good, adequate knowledge is useful. I realized the importance of this when I developed the Heimlich maneuver. The same month my report first appeared in the journal, a thirty-eight-year-old doctor choked to death at a medical banquet in front of more than one hundred other physicians. They thought he was having a heart attack. So what good is learning the maneuver if you don't know the symptoms of choking? I had to break down the symptoms. If a person can't speak or breathe and then turns blue—especially if he is around food—ask him if he is choking. If he replies by putting his hand to his throat or confirms the diagnosis in any other way, treat him with the maneuver.

If you can do this for choking, then why not for other medical conditions? If you learn the preliminary symptoms for stroke, you can go to the doctor to prevent the stroke that may otherwise come weeks later.

What good does it do if you're brought into the emergency room half paralyzed, and the doctor asks, "Did he complain of blurred vision?" And the family says, "Yes, for six months." You have to know what the symptoms mean.

Omni: And you actually believe these things can be taught on television?

Heimlich: I can do more toward saving lives in three minutes on television than I could do all my life in the operating room. When I was doing esophagus surgery, every operation took six or eight hours. If you invent something like the chest-drainage valve, you can save hundreds of lives—it's out there working for you. But if I can describe the Heimlich maneuver for three minutes on television and that information is heard by twenty million people, thousands of people are going to choke and be saved, even when I'm not around.

Omni: One of your favorite lecture topics is the future of medicine. What changes do you foresee in the decades ahead?

Heimlich: I see an ever-increasing use of engineering in medicine—including artificial organs. Engineering companies are equipped to develop new mechanical devices that a doctor could never think of or develop himself. I also see an increasing use of biological engineering and possibly a decrease in the use of chemicals in favor of natural hormones and enzymes. I hope there would also be an increased emphasis on preventive measures as well, particularly through better nutrition, exercise, and methods of relieving stress.

Omni: What is the significance of the world's first artificial-heart implant?

Heimlich: The first thing we must recognize is that this artificial heart is very primitive. But with the proper amount of scientific input and money, it will be possible to pro-

duce the same device with an internal source of power. I've seen this stepwise development in medicine many times over the years I've been in the field.

The operation also shows that the transplants being done today are gap-fillers until the right machine comes along. I'm talking about machines that will improve the quality of life, not extend death. Look at what's happening. Cancer will be cured in ten, fifteen, or twenty years. Arteriosclerosis is going to disappear with better diet, hormones, and chemicals. People will live longer. Organs will wear out. Because artificial organs are made of plastics, you don't have a rejection phenomenon; so you don't have to administer debilitating cytotoxic drugs and radiation, nor do you have to wait for the right person to sutter brain death in order for the right organs to become available. Furthermore, artificial organs can be manufactured and kept on the shelf in sterile packages, much as pacemakers and Dacron blood vessels are produced today. When you need them, you just take them off the shelf and insert them.

Omni: Which artificial organs do you think will be developed first?

Heimlich: Artificial hearts, lungs, and kidneys will be available for implantation in humans in a few years. The functions of each of these organs are already being carried out by machines that rest on a table. Kidney transplants will be a thing of the past. We already have an artificial kidney in the dialysis machine. It will eventually be brought down to the size of a cigarette pack. I don't have to tell you about the trend toward miniaturization—how, ten years ago, a computer would fill a room.

The artificial pancreas is also very close to realization. The pancreas provides insulin to utilize body sugar; so if you don't have a working pancreas, you must first have a reservoir of insulin in the body. Last year doctors at the University of New Mexico developed a tiny reservoir and electric insulin pump that can be implanted near the diabetic's abdomen. It automatically dispenses preprogrammed amounts of insulin. At the same time doctors at the Joselin Diabetes Foundation and Harvard Medical School, in Boston, are working on an implantable device that monitors glucose levels. It's only a matter of time before these two devices are combined to produce an implantable artificial pancreas that responds to the body's needs.

You can take it a step further now that the Food and Drug Administration has approved the biosynthetic insulin that Eli Lilly developed through genetic engineering. What you have now are cells that make human insulin. It is conceivable that such cells could be implanted in a container in the body and that they would produce insulin. The ultimate achievement would be to have them act as artificial pancreas cells—reacting to the sugar in the blood and adjusting their own insulin production.

Omni: With all this medical engineering, what will become of the family doctor?

Heimlich: The doctor will have to become more scientific. He'll use computers to help him with his diagnoses. With computerized diagnosis, you'll still have to use your brain. The computer expands your mind; it doesn't replace it.

Several years ago, when I was director of surgery at Jewish Hospital, in Cincinnati, Dr. Edward A. Patrick, of Purdue University, pitted a computer against a doctor in an experiment to diagnose persons with chest pains who came into our emergency room. Dr. Patrick separated the possible diagnoses into three categories: coronary, or heart attack; angina, which is a more chronic situation; or "other." The experiment models a common emergency-room situation, in which you're trying to make immediate decisions. If the diagnosis is a coronary, there's an emergency situation, and the patient has to stay. If it's angina, he can be discharged. If it's "other," you've got to look further.

First, Patrick had the computer calculate the minimal amount of information it needed to come up with a diagnosis. It determined that thirteen pieces of information—including blood tests, the patient's age and heart rate, plus four electrocardiograms—were all it needed. The doctors were allowed to use all the lab tests they wanted, plus the physical examination and patients' histories. After sampling one hundred two persons, Patrick found that the doctors had guessed correctly in fifty percent of the cases and the computer had scored correctly in eighty-seven percent. Coronary care now costs one thousand dollars or more per day. So if you can determine more quickly what a patient needs, you will save substantial amounts of money.

"The Heimlich maneuver saved Reagan's life when he was choking on a peanut. Mayor Koch was saved from gagging on Chinese food. Cher was saved by Robert Altman."

I understand that Patrick has installed his system in eleven hospitals, but that so far it's being used only in pilot projects. Many hospitals already have computers, but they're generally used to calculate bills and decide where to put patients. Even the computers in doctors' offices are used only to manage office accounts.

Omni: Many people say that medicine will become far less personal as a result of all this expensive machinery. Doctors are already pooling their resources in large, professional emergency rooms and clinics. Does this mean the end of long-term personal care?

Heimlich: I think there always will be a need for close contact between patient and physician, but we are getting away from the personal aspects of medicine. It's far more efficient to have several doctors working together in a commercial way. The equipment they can afford is much better. The large commercial emergency rooms and clinics we're seeing around the country are open twenty-four hours a day on a walk-in basis. The doctors have the advantage of working reasonable hours, and the patient has the advantage of knowing someone will always be there. People will always prefer to have a doctor's personal attention. But you can go to places like the Mayo Clinic, where people are treated by uniformly good doctors and can keep seeing the same doctor if they prefer.

I'm afraid the business of having "your doctor," however, is going to be a luxury. Holding hands is fine, but medicine is moving too fast. Now you have professional handholders, if you will—nurses for death and dying, counselors for mastectomies and ileostomies [operations in which the bladder is replaced by an external plastic bag]. The doctor is running; he doesn't have the time to sit down and study what to do about death and dying. If we can unload that responsibility from the doctor and still have the patient treated adequately, while improving diagnoses, the patient will be much better off.

Omni: You've said that all your work has directed you toward helping ever-larger numbers of people—from individuals you've personally operated on, to the thousands who have been saved by the Heimlich maneuver. Now you're proposing a peace plan to help save the world. How did you, as a doctor, become involved with a peace plan?

Heimlich: As the maneuver became popular, I made more and more speeches in which I spoke first about the maneuver and then about medicine and surgery of the future. I'd tell audiences how the artificial kidney and heart were nearly within our grasp—if only our engineers and scientists were free to devote their time to those developments. Unfortunately, too much of our money is going to the military. It got to the point where I was asking, "What good is saving lives in the first place if we're all going to be wiped out in a nuclear war?"

And so, as with my other inventions, I began by looking at the problem simply: Why are the United States and the Soviet Union heading toward war? The reason used to be that we were capitalists and they were Communists. But the United States now supports so many Communist nations that this explanation doesn't hold true anymore. The answer is economic competition. We're still competing in the old-fashioned way for world markets and resources. The powerful nations have al-

ways tried to control large portions of the world. The solution to this global problem was Computers for Peace.

Omni: What is Computers for Peace?

Heimlich: Computers for Peace uses the principles of trade and self-interest—or greed—to show that the benefits of trade among hostile nations are so great that it would be against national self-interest to go to war. Trading to prevent war is not a new idea per se, but in my plan the use of computers becomes all-important. Never before could we say, "The USSR produces this; if we sold that, what effects would it have on both countries?" Now we can be quite accurate in regard to those trends. Computers let us project trade needs for one year, five years, or one hundred years down the line—not only for the United States and the USSR, but for the entire world.

Every country in the world today is affected by what other countries do. A country like Ecuador, for example, can no longer determine its economic future solely on the basis of oil supplies, because the world is cutting down on the size of cars. If man were more attuned to foresight instead of to the needs of the moment, peace would occur without computers. Computers provide us with objective information and the ability to project and analyze alternatives. I propose much more international planning and cooperation, and that can be done with computers. With proper planning the United States and the USSR can have the greatest potential for trade in the history of the world. Were we to trade with the Soviets, unemployment in this country would diminish, our factories would open, and our farmers would prosper.

Omni: How could your plan affect current Soviet-American relations?

Heimlich: I'd use it in the negotiations about the Soviet gas pipeline, which for a long time was opposed by the United States. Reagan lifted the sanctions against the pipeline, but not before those sanctions seriously hurt American business. I recently met with the heads of the Caterpillar Company, in Peoria, Illinois, and learned that they lost a ninety-million-dollar sale of two hundred tractors to the Soviets. The Japanese moved in. That project also would have guaranteed a steady spare-parts business for years to come.

Once the pipeline is completed, the Soviets will be taking in billions of dollars in hard currency, while here in the United States we'll have increasing unemployment. Now, how can the United States expand its economy? Europe and Japan don't want to buy any more from us, and the developing countries can't pay. The best country to whom we can sell is the Soviet Union. And remember: Every dollar the Soviets spend buying wheat from us is a dollar they can't spend on arms.

Omni: As you describe it, the plan sounds practical. Yet such notables as former Secretary of State Dean Rusk say your plan is naive. Various other experts have said that the plan is mere gimmickry.

Heimlich: Dean Rusk told *The Wall Street Journal* that the trouble with my concept is that people do not always act reasonably and in their self-interest. I agree; people have not acted in their own self-interest. I'm saying that it's time for people to do so. As for my naiveté, each thing I've introduced throughout my career has been very simple—first looked upon by experts as being naive, then gaining credibility. At the same time it's true that I don't understand diplomacy. How is it possible, after all, that for hundreds of years the most brilliant diplomatic minds have been unable to avert war? The answer is that politicians simply have not caught up with science.

Omni: You're assuming that all wars are fought over economics and, hence, can have an economic cure. But many wars are fought for other reasons. The wars in the Falklands and the Middle East were fought over land and national pride.

Heimlich: The Falklands had very much to do with economics: The Argentine economy was falling apart; so the Argentinians attacked. As for the war in the Middle East, let's consider the causes we have been taught: racial, religious, nationalistic, cultural, traditional. Then Sadat goes to Jerusalem because the 1973 war had deci-

mated his country's economy. He speaks for one hour, and all the causes I just listed disappear. Do you really think noneconomic factors caused the Middle East wars? The Israelis were an economic threat to the area because they had democracy and affluence. The Palestinian problem didn't have to occur. Had the Palestinians been given some economic advantage following the original land partition, most of the problems in the Middle East would be over. And the unrest in Northern Ireland is not caused by religious differences, but by the fact that ten percent of the population has kept ninety percent economically depressed. War is caused by economics—period.

Omni: Aren't there more immediate ways of avoiding nuclear war? What is your position on the nuclear freeze?

Heimlich: Some sort of disarmament talks could be feasible perhaps, but what would we really be discussing? Not how to make peace, but how to fight the next war. Even if arms limitation is so successful that nuclear armaments are reduced by half, we'll still have enough weapons to destroy the earth. It's all so much crap. We can talk about weapons—nuclear and otherwise—from now until the next war comes.

Omni: How do you feel about such groups as Physicians for Social Responsibility and International Physicians for the Prevention of Nuclear War, which tell the public that a nuclear war would be a hopeless medical catastrophe?

Heimlich: It's important to get that message out, but I don't really think it will affect anything. Whether or not we have a war, both countries are destroying themselves economically with the cost of their weapons. We're directing our funds and our best scientific and engineering ability into building weapons, while countries like Japan are free to build better cars, radios, and televisions. The fact is, the physical and financial securily of our country and the world really depends on our trading with the Soviet Union.

Omni: What makes you think that the Soviets can be trusted, given their long history of aggression?

Heimlich: Let's look at their actions as compared to our own. We say, "You invaded Afghanistan, and you control the government of Poland." They say, "You invaded Korea and Vietnam, and you have controlled South America by overthrowing governments." I don't like to see any country oppressed, but we have to look at this from both sides.

We should realize that the Communist government has given the Soviet people something they never had before. Russia was invaded by the Mongols, who occupied it for six hundred years; it was occupied by France under Napoleon, and was invaded twice by Germany. During the second invasion, the Soviet Union lost twenty million people. Today they've built up armaments to the point where nobody, but nobody, is going to invade the Soviet Union. We should take advantage of that

fact and say to them, "You finally have your security; now let's talk about trade."

Omni: Isn't there a danger in trading with an adversary? We foolishly sold scrap metal to Japan before World War Two.

Heimlich: A friend of mine who owns Totes, Inc., asked me the same thing. I told him, "I don't want you to sell the Soviets weapons. I want you to sell them overshoes. You'll bring money into our country, help our balance of payments, and keep their feet warm." That he could understand.

The Computers for Peace concept worked after World War Two, incidentally, with the Marshall Plan. The plan was formed in part to deter Communism. But it also showed that if you support your enemies, they're no longer your enemies.

Omni: Are you saying, then, the appropriate strategy is to love thine enemy?

Heimlich: No. Love would be beautiful, but we're not ready for love. We're ready to make a buck. And you're not going to knock off a country that's helping you prosper.

Omni: What chance do you give your program, considering the anti-Soviet line of the current administration?

Heimlich: Right now farmers and industrialists want to sell like mad to the Soviet Union. I believe that the Republicans are more likely to act, since they represent business, and business sees a buck. Yet it's so difficult to understand the current administration—the Caspar Weinbergers of the world whose vision of peace is limited to one hundred MX missiles buried in Wyoming. Their shortsightedness is destroying our economy and our country. They're not really representing business; they represent the military and energy interests. I see hope, however, because by the very nature of their actions, they're driving people into my camp.

Omni: You say your work has been directed toward serving greater and greater numbers of people. Your critics say that, with your penchant for publicity, you're really serving Dr. Henry J. Heimlich. How do you answer these critics?

Heimlich: There have always been those in organized science who destroy an idea simply because they didn't think of it. Such associations and academies have existed for many years. They obstructed Pasteur, caused Socrates to drink hemlock, and forced Galileo to recant his discovery that the earth moves around the sun. These days people in large organizations who oppose your ideas can turn out press statements that are scientifically incorrect. There's no way I can expose what they are doing without hitting the national media.

Controversy helps in science because it exposes the facts. I don't want my work to go uncriticized. Challenging it brings out all the possible opposition to it and allows me to explain my ideas—bring them out into the open. After all, it was the Red Cross's opposition to the maneuver and the attention that opposition drew that helped make the maneuver so popular.

Omni: Yes, but aren't you also promoting yourself by attracting so much publicity? What happened to the scientific ideal of working quietly and patiently?

Heimlich: I think that if you believe in what you are doing, you don't have the moral right to withhold it from the public. If every scientist in the world knew about the anti-choking maneuver, and no laypeople did, many more people would still be choking to death. The Heimlich chest-drainage valve would not have saved lives in Vietnam if I hadn't gotten someone to manufacture it. My pattern is typical of anyone who invents: You see a problem, it annoys you, and you conceive of a cure. But I add another step: You must sell the idea. If you want to demean that by saying it's P.R., then it's P.R. But it's necessary; otherwise you've wasted your time.

I also think my work draws attention because what I have to say is news. Each thing that I've proposed in my life has eventually worked out, even if it sounded wild in the beginning. I coined a saying as a result of my experiences: You're not being original if all your peers agree with what you're doing.

Omni: How does a scientist know when to go public? Should he wait until his peers have reviewed and accepted his work? Or should he feel free to discuss unproven speculation with the public?

Heimlich: My own work has been submitted to peer-review journals, out of which have come press reports. That's the ideal way, but you should not wait until you have one hundred percent agreement from your peers as to the value of your work. You'll wait until hell freezes over.

At the same time, I don't think one should speculate to the public; you must believe your results can be substantiated. Some of the organizations that depend on donations have gone public with some of their research because they wished to raise funds. I don't buy that.

Omni: Tell us about your personal plans. It's been rumored in Cincinnati that you're thinking of running for President.

Heimlich: I don't aspire to run for President. I haven't got that ambition. But I do aspire to get my peace program across. If, in the course of events, I find that running for President will be the best way to bring the plan to the public's attention and to force other candidates to speak on it, then I certainly will do that. My plan is to accomplish a certain goal that I feel is worthwhile.

In other areas, as the portable oxygen supply becomes available, I'll be asked to speak on that. I'm also working on a novel that has to do with heading toward nuclear war. I'm also making more medical films. But my biggest project will continue to be Computers for Peace.

Omni: In light of all your interests, what function do you believe a doctor should serve in society?

Heimlich: To save lives and improve the quality of life—period. ◻

"Does it bother you that I'm a mouse and that I can articulate?"

CONTINUED FROM PAGE 16

phenoxy herbicides and dioxin caused birth defects at almost immeasurably small doses, in the part-per-trillion category. Possible human defects included cleft palate, abnormal leg positions, kidney abnormalities, decreases in fetal weight, spina bifida, and other nervous-system defects. The same chemicals were used under the name agent orange in Vietnam, where they were linked to birth defects, nervous-system damage, and liver cancer.

On Christmas Day of that year, I read a news story on herbicides in forestry, quoting extensively from Professor Michael Newton, an Oregon State University scientist who summarily dismissed any suggestion that herbicides threatened wildlife or human health.

The article renewed our distress of the summer before. Those statements by an "expert" presented an incomplete, misleading picture of herbicides to a trusting public. We had always been shy about writing to newspapers, but that article was the last straw. We pulled out our boxes of studies and wrote a response, which was printed in our local county weekly.

Publication of this letter in *The Newport News-Times* had unexpected results. People phoned and wrote from all over the Siuslaw Forest: a spray-truck operator who still suffered kidney damage and skin problems six years after being forced by ill health to quit his job; a hunter accused of killing five elk, who was acquitted after autopsies showed they had died from herbicide poisoning; a farmer whose horses had gone lame and lost all their hair. Two housewives in Five Rivers, Susan Parker and Susi Gilbert—both mothers of small children—even called a meeting in the local two-room schoolhouse to discuss the details of our letter.

The meeting was attended by a large cross section of the valley population and nearby communities. And every person in the room had a tale to tell. Beekeepers had lost their bees after the spraying. A rancher had lost 23 out of 36 young heifers after the road through their pasture was sprayed. (We learned later that it was our pasture those heifers died on; it had been leased to the rancher the year before we moved there.) One woman had suffered 14 miscarriages in the years she had lived in the valley. Another told of her two miscarriages and of her son born with defective lungs and liver. The young wife of a logger had been unable to complete a pregnancy in the five years they had been married. An elderly couple told how their health suffered so badly every year during the spraying that they moved out of the valley for those weeks; they had always thought that they alone suffered such a problem.

Fishermen and hunters told of deformed fish and deer, all agreeing that the aquatic life of the river had declined drastically as the spraying continued. The crayfish, freshwater mussels, salmon, trout, and steelhead populations were but a fraction of what they were 10 or 20 years before.

Almost every family could report a case of intestinal, respiratory, or nervous-system problems. Cancer, miscarriage, and hemorrhaging (frequently resulting in hysterectomy) in women were common, as was chronic illness among children.

Having our own experiences confirmed by the reports of neighbors was gratifying, but the implications were frightening for everyone. If the herbicides were causing all these problems, what could be done?

Parker suggested we write a joint letter to the Forest Service. The letter outlined all the problems and requested the presence of Forest Service representatives at a meeting called for March 4.

But Forest Service officials did not take our health concerns seriously and refused to curtail spraying within a mile of our homes. So we formed an organization—Citizens Against Toxic Sprays, or CATS—and hired a lawyer.

On May 12, 1976, CATS filed suit to prevent the spraying, charging that the environmental-impact statement (which should have analyzed the environmental impact of the spraying) was inadequate. In early 1977 Judge Otto Skopil decided to grant an injunction: The Forest Service, he said, could not spray dioxin-contaminated herbicides in the Siuslaw Forest until it had prepared a new statement that included all the health information found to be lacking in the old one.

There was great rejoicing among CATS members and citizens of the rest of the Pacific Northwest, but most knew that the relief was only temporary. "The Forest Service will just come out with a new environmental-impact statement for next year's spray season," said resident Cathy Hankins, "stuff enough science in it for the judge to pass, and go on like they always have."

In April 1978 Hankins's prediction was confirmed. Judge Skopil, having reviewed the new impact statement, reluctantly acknowledged that it fulfilled his requirements. Triumphantly, the Forest Service loaded its helicopters for another assault on the Siuslaw.

By 1979 an Environmental Protection Agency study had found a significant correlation between spraying and human miscarriage in the Alsea River watershed, which includes Five Rivers. That finding came out just about the time a grand jury was investigating some of the nation's largest herbicide testing laboratories for fraud. On the basis of these events, the agency once again banned 2,4,5-T and silvex, another herbicide. When fall spraying continued with replacement chemicals—2,4-D, Roundup, picloram, and krenite—EPA researchers were on the scene conducting a major epidemiological study of the area. In addition to monitoring the records of hospitals, phy-

sicians, and clinics for the occurrence of miscarriages and other "health effects as may develop," they collected numerous samples for chemical analysis of wildlife, water, and soil. They also took some samples of human tissue—including a miscarried fetus and a baby born without a brain—as well as a four-eyed kitten.

Results of the study were never released. But within weeks of the spraying, more than half the pregnant women in the valley miscarried. During the next two years, only one live human birth occurred in all of Five Rivers.

Then, in January 1981, the Forest Service announced its plans to triple the acreage to be sprayed. Public response was vociferous. After enormous protest and a lawsuit, spraying throughout much of the Siuslaw was reduced, ostensibly in response to public concern. It turned out, however, that the Forest Service had *always* intended to reduce the spray area by 3,000 acres at the last minute that way it would be perceived as a humanitarian organization acting in the public interest.

Finally, on Saturday, May 30, 1981, the angry people of the Siuslaw decided to act: They destroyed a helicopter contracted by Publishers Paper Company to spray forest areas near the town of Toledo.

It could have been a scene from a movie. In a clearing on a ridge above Toledo, the helicopter has been sitting for a week, grounded by bad weather. The clearing is secluded, but the glint of metal is visible to a keen or searching eye.

Soon the helicopter's location is known up and down the coast. In the bars, cafés, laundromats—wherever people gather—it is discussed, its location noted, oblique references made to its fate. Then one Saturday afternoon, the weather clears. Over the C.B., at the taverns and cafés, the change is mentioned along with the possibility of spraying the following day.

There is no organization, no plan. It just happens. In the clearing, the helicopter sits, the light of the waning quarter moon glimmering on its plastic bubble. Inside the cockpit is an old woman. She wears a large black cape and a fur hat, pulled snugly down over her ears. She is twisting newspapers into logs, arranging them on the floor of the cockpit.

Twenty minutes later, four figures in dark clothing appear at the edge of the clearing. Their faces are blackened with mud or soot. Two of them are teen-age boys, one leading his girlfriend by the hand, the other carrying a bundle of dry sticks and twigs. With them is a woman wearing a jogging suit with a local high-school emblem on it. She carries a can of gasoline.

Soon the crowd grows. A trucker arrives with wrenches, detonation cord, and a quart of beer. Teen-agers, motorcyclists, and hikers appear, and three women from a coastal tavern arrive with more beer, another can of gas. Cigarettes are snuffed and pocketed, bottles collected. Gasoline and other flammable offerings are poured on tinder piles in and below the helicopter.

A logger strikes a flare, bows, and hands it to the old lady. She hurls it toward the reeking helicopter. The blinding flash and deep, breathless thump of the explosion pierce the forest. The blast knocks the old lady's fur hat off and flings her to the ground. The logger yanks her toward the forest as plastic and metal erupt in a searing halo of white and orange. After a single shout of triumph, the crowd is silent, awed by the immensity of the fireball from the crumpled bit of machinery.

Like a Fourth of July crowd after the fireworks are over, the party disperses, hastening through the forest in different directions. Their footsteps fade, the sound of the last motor dwindles in the direction of the highway, and the forest is still once more.

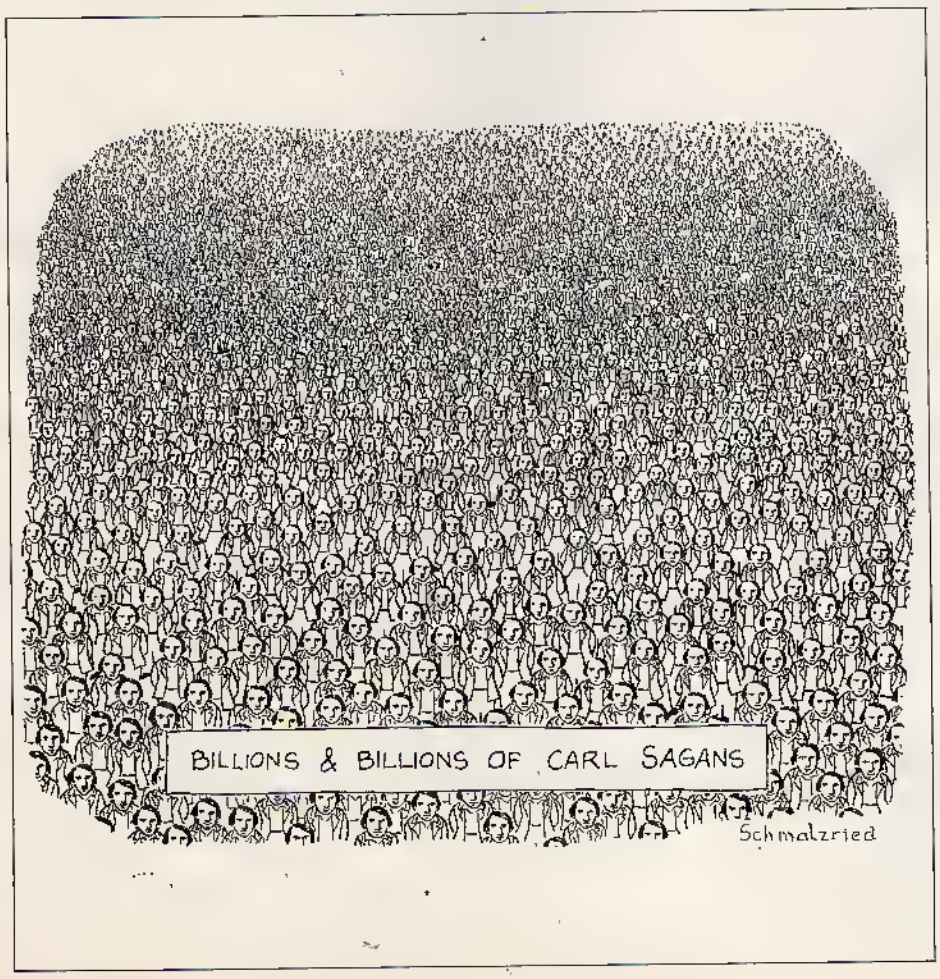
It is now March 1983. Though the FBI as well as local police investigated the copter burning, no arrests were ever made. Lawsuits over pesticides have erupted all over the Pacific Northwest, and a federal judge has halted herbicide spraying in southern Oregon because of "scientific uncertainty" about human-health effects. In the Siuslaw, spraying continues while we await a court decision on whether further research is necessary.

Birth defects, cancer, sterility, and miscarriages have deprived us of our inalienable rights to pursue a healthy life, to bear children, and to hope. Government and industry, knowing that their laboratory tests are inadequate and their registrations a sham, refuse to accept the "circumstantial" evidence of toxic effects in forest and agricultural populations, Vietnam veterans, the people of Vietnam, and anyone else who's been exposed.

Sooner or later, circumstantial evidence becomes too strong to deny. In the days when farmers sold milk directly to consumers, a purchaser had no way of telling whether the milk had been "watered," but as Thoreau suggested, finding a trout in the milk was ample reason to buy milk elsewhere. The human subjects of the forest chemical experiment are, like Thoreau's trout in the milk, a message to the nation that regulation of poisons has failed.

The answer lies not in regulation and enforcement but in returning the control of poisons to its democratic source: the people. Rachel Carson, author of *Silent Spring*, suggested the remedy: It's time for the U.S. Constitution to guarantee all citizens protection from exposure to lethal poisons.

Without such a law, violent protest might well increase. As one Siuslaw woman said, "I don't believe it's wrong to destroy machinery that kills—that's *designed* to kill—trees, children, animals, and the salmon coming in from the sea." ∞



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FORUM

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A book entitled *Born to Heal*, by Ruth Montgomery, tells the story of a six-year-old prodigy, Phil A., who once stated: "They [the Egyptians] simply made forms and filled them with sand, and mixed the hardening solution in it. Then after it solidified, they polished the top of each block to prevent deterioration or seepage, and then formed another block on top of it in the same manner."

Walter Bonnett
Winnipeg, Man., Canada

Philosophical Bureaucrats

I read with interest your article "Hospital Philosophers," by Eric Mishara, in the February 1983 issue [Continuum]. I was disturbed by the description of a case involving a badly deformed baby. The parents wanted to let the baby die, but the pediatrician disagreed. The philosopher encouraged the doctor to threaten court action against the parents. The baby was saved, and now the parents say they have learned to "love and care for" their child.

It sounds like 1984 is here already. With the government involved more and more in medical care, I submit that these "philosophers" will become more bureaucrats than anything else, and they will in turn become the pawns of higher bureaucrats whose motives will be primarily political.

If the philosopher felt the need to do some arm twisting, he should have persuaded the parents not to have more children.

Daniel Shine
Cincinnati

Fundamental Creation

Fundamentalism is apparently alive and well among the scientific fraternity espousing evolutionary theory [Interview, February 1983], as much as it is among their counterparts preaching creationism from the pulpit. Each group takes a basic tenet, claims it is the word of God (Darwin is the evolutionist's god, isn't he?), and then heaps scorn along with the threat of eternal damnation on those who dare to disagree. Each commits the cardinal sin of interpreting facts to conform to theory.

The Ernst Mayrs and the Jerry Falwells of this world are alike in many respects. Each side wants you to accept its theory of the origin of man as unvarnished fact. Each makes not-so-subtle threats should you decide to ignore it. Mayr condemns the errant one to a state of lasting stupidity, though the preachers merely threaten with visions of the pit of eternal fire.

The problem with Mayr and Falwell is that each is blinded by his own dogma. Neither can see beyond the limits of the world he has built around himself. History is replete with examples of men of science damning new theories and new discoveries that seemed to break the mold their minds had been set in at the time. Mendel's discoveries in inheritance were scorned by the Darwinists of his day. Sir Harold Spencer Jones, eminent director of the Greenwich Observatory, declared emphatically in 1957: "Man will never set foot on the moon."

With all due respect to Ernst Mayr, we are fortunate that inquisitive minds will always be unwilling to accept the dogma that some fundamentalists seem bound by.

Gilbert Lawrence
Santa Rosa, CA

Cloning and Controversy

I very much enjoyed Robert Weil's insightful profile of Dr. Landrum Shettles ["Fear and Fertility in Las Vegas," December 1982], a man whose persistent genius and abiding respect for human life never cease to inspire awe in all who know him.

I enjoyed less Weil's assertion that my account of a cloning birth (in the book *In His Image*) "was pronounced 'a fraud and a hoax' by a Philadelphia judge." It would only have been fair for Weil to add that this pronouncement was not a genuine finding of fact but a procedural sanction entered against me because I refused to publicly name sources. Later the judge acknowledged that the ruling was too prejudicial to be presented to the jury. The case, which did not directly address the truth or falsity issue but dealt with alleged misappropriation of information, was settled out of court by the other two litigants despite my challenge to continue the trial.

David Rorvik
San Francisco

I have a question in regard to the article "Fear and Fertility in Las Vegas."

Dr. Landrum Shettles states that he can create a twin male by cloning a diploid sperm cell. I thought that in a diploid sperm cell, the two individual chromosomes in each pair were identical to each other.

If this is the case, then there is a fallacy in Dr. Shettles's statement. If all pairs of chromosomes were homozygous, then the sex chromosomes would be either two Xs, a female, or two Ys, neither male nor female. The XY combination necessary for a male cannot exist in a diploid sperm cell.

Brian Korec
Manorville, NY

Dr. Landrum Shettles replies: *In that each diploid sperm cell has not undergone the usual meiotic division that would result in the haploid number, it would still have the very same chromosomal constituency as each somatic or body cell of the given individual, that is, 23 pairs of autosomes (representing the body chromosomes) and 2 sex chromosomes (an X and a Y). Consequently, if the diploid number of chromosomes from such a sperm would be used to replace the nucleus of a mature egg, then, with cleavage and development, a clone—or, we might say, a delayed twin of the donor—would result.*

"This device scientifically enhances reasoning powers, Your Highness. Just whack someone with this, and he'll see things your way."

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with her life. And now that surrogate is going to have problems making the break."

At first Joe and Jane were cautious about sharing the news of their impending parenthood with family and friends. "We waited until it was a *fait accompli*," says Joe. Only when the birth was imminent did they spread the word. "For some people it took some thinking to get used to the whole idea," says Jane, "but most people are very happy for us." Bob and Kay, on the other hand, who live in the Bible Belt, have told only one trusted friend the actual circumstances of their daughter's birth, preferring to let everyone else, including their own parents, believe she is adopted. "We feel perfectly at ease with it," says Kay, "and we probably would have told them, but we weren't sure how they would accept it. Some people frown upon it."

Most couples, however, seem to agree with Levin's advice that, when the appropriate time comes, they should tell the child the truth. Says Jane, "I'll tell him, 'I couldn't actually have you; so I asked a nice lady to carry you for me.' We don't plan to hide it from the child. It's his right to know when he is old enough to comprehend." And what if someday their son should express a desire to meet that mysterious nice lady—a meeting Levin is willing to arrange if all parties are agreeable? "I wouldn't mind at all," says Jane. Nor, it seems, would many surrogate mothers. "I'm completely open to it," says Mary, "and I let both my couples know that. Of course, you don't know what's going to happen. Someday, I may be confronted by an angry eighteen-year-old who doesn't see things the same way. But with the love these children are going to receive, I doubt they could turn out spiteful."

Once the surrogate mother has gone to court in Louisville to legally terminate her rights to the child, the new mother may initiate adoption proceedings in her home state. For her request to be granted, the court in that state must judge that her case does not conflict with the standard prohibition against "paying for the purposes of adoption." Technically, Levin explains, since the initial contract is signed only by the surrogate and the natural father, and since a father need not "adopt" his own child, no such payment has in fact taken place. Others argue that a couple is paying not for the baby but for the surrogate's services. The trick is persuading a court to see things the same way. Michigan attorney Noel Keane is currently appealing one case before the U.S. Supreme Court that essentially challenges the prohibition against payment on the grounds that it is not applicable to surrogate-mothering arrangements. In a second case, now on appeal before the Michigan Court of Appeals, he is also contesting a ruling by the same judge that, because the husband of that state's first surrogate mother "consented" to his wife's insemination, the baby must therefore be judged as belonging not to the sperm-donor father and his wife, but to the surrogate and her husband—a ruling which directly contradicts the expressed desires of all parties involved.

Levin believes that much of this legal tangle results from antiquated laws. Judges are being asked to issue rulings based on laws that were never designed to apply to "the new babies—*in vitro* fertilization and surrogate mothering. The laws aren't even good on donor insemination, which is a one-hundred-year-old procedure. It's absurd." According to Parker, legislation to update those laws is currently being considered in Alaska, California, South Carolina, and Michigan, where the first state bill to prohibit surrogate mothering has also recently been introduced. "It's a shame," says Levin. "We do need legislative control, but it doesn't become a priority until the bad cases hit the press." One such incident came to light in January 1983, when Judy Stiver, one of Keane's surrogates, gave birth to a retarded child who subsequent blood tests indicated was fathered not by sperm-donor Alexander Malahoff, but by Stiver's own husband, Ray.

Levin's determination to avoid this kind of negative outcome and attendant publicity is what makes him such a stickler for evaluation and screening. He tells, for example, of the case in which one of his own surrogates unexpectedly gave birth to twins. One was born "one hundred percent normal," but the other suffered gross abnormalities caused by intrauterine pressure due to leakage of fluid from the amniotic sac. When, despite all efforts to keep

it alive, this second twin died a few hours after its birth, the surrogate insisted that she be allowed to arrange and pay for its funeral and burial. "She wanted the natural father and his wife to be free to experience their joy and not dwell on the sad aspects of the case," says Levin. "That's the kind of outcome you can get if you structure things and screen people properly, as opposed to people running in their hour of grief [as did the Stivers and Malahoffs] to appear on the *Phil Donahue* show."

Levin worries also about the motives and reputability of some of the estimated 20 surrogate parenting groups now in existence across the country. Right now, says Parker, "anybody can set up a practice. That's part of the problem. There are no medical or legal standards of any kind. We need regulatory legislation in order to guarantee that all parties involved know what they're really getting into and to protect participants against exploitation and abuse." The question, as Levin puts it, is, "Who should lead the way?" While he acknowledges that both medicine and law are integral components in the surrogate-mothering package, "I think this should be viewed primarily as a medical procedure, regulated by medical ethics through the American Medical Association. I think people who do medicine understand life's dramas and dilemmas and can handle them more compassionately."

Others see things differently. Keane, who takes the credit for laying the groundwork for much of the regulatory legislation that he predicts will be passed this year, considers it "more of a legal than a medical issue. I had one fertility doctor tell me that doctors only get in the way."

Levin worries, however, that legislators could "nitpick until we end up with legislation that is so off the wall, we wouldn't be able to do anything." Parker, too, favors "as little intrusion on the part of society and the professionals as possible. Eventually, all the things that can go wrong will go wrong. To expect any fewer problems than occur in normal pregnancies is naive. But who are we, as a society, to prohibit people from making that choice? People who oppose surrogate mothering will always seize upon the problems and say, 'I

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told you so.' You have to distinguish scientific data from moral beliefs."

One such moral concern is that, by being free to "select" a surrogate, couples come uncomfortably close to dabbling in eugenics. Keane dismisses this notion out of hand. "If I were to choose a surrogate myself, I'd look for strong qualities—someone who is healthy, educated, attractive. Believe me, there are no eugenics involved. In most cases, all these people want is a baby." Levin, on the other hand, sees "nothing wrong with eugenics—as long as it works to benefit all of society. The goal of medicine is to improve the quality of life. The point of genetic engineering is to breed out the bad genes. So, as a concept, I don't have any problem with making a child healthier than it would otherwise have been—as long as you don't restrict access to one race or one religion. Now, you might say, 'Isn't it terrible that not everyone can afford surrogate parenting?' The question is, how far do you extend that right? Don't ask me. Ask the major theologians. I'm just a kid from Kentucky, doing the best I can with what I've got and trying to help people in between."

Then there are the other objections: Surrogate mothering dehumanizes childbirth; destroys the family unit; interferes with the will of God, who obviously meant for some women not to have children. Keane has heard every possible argument. "The Church objects to surrogate mothering because it is 'unnatural,' " he says. Well, so also, he would remind the Church, was the virgin birth. "Jesus Christ may have been the first surrogate child."

If some surrogates are sensitive to these criticisms, others, like Mary, are able to simply shrug them off. "God didn't intend for us to fly, either," she says, "but we have airplanes. He gave us brains to use." She was once accused by a woman of being coldhearted and uncaring "for being able to carry a child for nine months and then just give it away. But there are two sides to every coin. Either I'm coldhearted, or I'm warmhearted because I'm making someone else happy. People are entitled to their opinions. But they can go jump in a lake, too. Maybe if they had gone through the anxiety, the depression, the pain, the sorrow, and the emptiness of not having children themselves, they would understand a bit more."

The parental couples, of course, know where they stand on the issue. "I think it's a fantastic thing," says Kay. "To do this for us—it's just a fantastic thing." Says her husband, Bob, "We are a minority group, actually. You don't hear much about us, but we're here. It's nice that someone has done something for us. Dr. Levin is our hero." Jane recalls trying to think of a gift for the woman who bore her son—some way to express her appreciation. "But there's no gift you can give. All you can say is 'thank you.' Those are very hollow words. But you use them anyway, because there are no other words you can say."

FILM

CONTINUED FROM PAGE 34

Star Wars or *The Empire Strikes Back*, is going to have to be, like *Eye of the Needle*, a film about relationships; hence Marquand's appropriateness. Remember where we left off at the end of *Empire*? Princess Leia had just told Han Solo, "I love you," and he had replied, "I know"; so that relationship has to be resolved. Luke Skywalker had been informed that Darth Vader was his father, but he had also promised Yoda that he would return to complete his Jedi training; so those relationships have to be resolved. Yoda had told Ben, "There is another," just in case Luke "turns to the dark side." Who is this yet-unnamed Jedi warrior, and what will his (or her) relationship with Luke be?

The unreliable Lando Calrissian in the unreliable spaceship *Falcon* had just flown off at the speed of light with the ever-faithful Chewbacca at his side. The emperor was convinced that Luke had the power to destroy him. Leia was no closer to restoring her sovereignty over the galaxy, and Han had been transformed into a coffee table. All these crises have to be resolved, because none of these characters, at least as we have known them, are to return in future episodes.

To the world, Marquand had become the man who would steer a $32.5 million, 23-month intercontinental enterprise. To a handful of actors, each with a proprietary interest in a role that had brought fame and fortune, he was but the new boy on the lot. And they let him know it. In a series of meetings with Carrie Fisher (Princess Leia), Mark Hamill (Luke Skywalker), Harrison Ford (Han Solo), and Billy Dee Williams (Lando Calrissian), Marquand was told, "We are a club. We are a club of a small number of very important people, and you're now an *honorary* member."

"They all said this with a certain note of warning," Marquand remembered. " 'We hope that you fit in. Good luck.' "

Lucas was a bit of an enigma as well. Famous as a screenwriter and director, now he is neither. Since *Star Wars*' initial $250 million success, he has relegated the writing and directing of his films to hired hands ("I get to do the fun part: the creatures and the equipment, the toys and the editing. The director has to do the terrible part"). Nevertheless, Lucas is photographed at the far-flung locations of each film, and when he is absent he views the day's rushes on specially prepared videotapes. Marquand confessed, "I always had the feeling that possibly I'd find myself in a situation where I was a horse dragging this thing along and that George would hold the reins, and I would just be a cipher sitting there."

His apprehensions were unfounded. Eventually they settled into a collaborative relationship that Marquand described in terms not of cinema but of music: "George has composed this amazing nine-part symphony, and I am conducting the orchestra; it doesn't make any sense for him to step suddenly to the podium and say, 'I think I'll conduct the next six bars.' "

By Marquand's account, he impressed Lucas right off with a substantial script alteration. Lucas's one great contribution to the art of motion-picture storytelling emerged in *American Graffiti*: It is his ability to sustain half a dozen subplots simultaneously. He does it largely through deft editing. *Star Wars* is a kind of *American Graffiti* afloat. To this Marquand suggested the twist of making each character's initial entrance a misleading one. The audience is thrown off guard. No one on screen is exactly what he appears to be, "that includes," Marquand explained, "some of the characters that we've grown to hate." Darth Vader, for example, is forced in *Jedi* to acknowledge a force greater and darker than he is. "It will be as if Luke's journey finally took him to a revelation of who everybody is in the movie.

"George was very excited by the idea. He saw how tremendously dramatic it could be." The club was equally impressed. "Each one of these people and each of their characters had a definite reason for really wanting and needing to work very closely with me," Marquand said. "So, in fact, I had no trouble with the club.

"Mark was playing the character whose development was the main theme of the whole saga; therefore he realized the importance of my participation in the demonstration of that development."

What about Carrie Fisher? "I was very anxious that she should finally unfold and to a certain extent demonstrate her femininity, which is something Carrie wanted; she felt ready for that. So that was good."

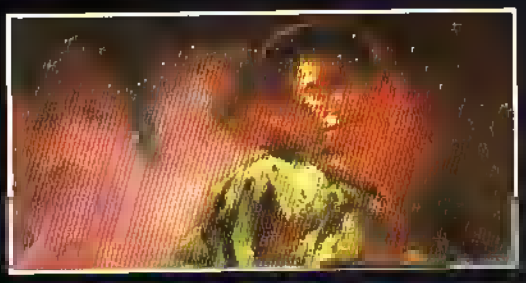
Lucas and Marquand agreed that "streetwise" Lando Calrissian needed freeing from his somewhat earthbound, black characterization; so Williams "was keen to work with [the director]." As for Han Solo, whose character undergoes the least change in this episode, "Harrison [Ford] knows that his and the movie's best interests are served if he exposes his weaknesses to the director and asks for help."

The great ticket-buying public, as the cliché goes, decides. But an abundance of screenplays tumbling around Marquand wherever he goes suggests that decisions on them matter only marginally right now. "When George said, 'He's good,' nobody was certain. Now I get this avalanche."

What else distinguishes the post-*Jedi* Marquand? "I am much more confident, and that affects my private life and my professional life. My private life is more comfortable, because I'm more comfortable with myself. In my public life I'm less willing to suffer fools gladly. I'm more certain now what can work as a movie and what can't. In the past I have sacrificed quality for the sake of budget. Now I've realized there are times when you dig in your heels and say, 'Look, guys. . . .' " In Hollywood, that's called The Force.

NEXT OMNI

FICTION

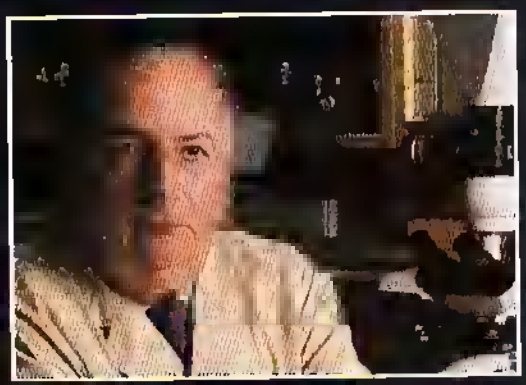


A cosmonaut struggles with his nation's bureaucracy in an attempt to save his orbiting home, in "Red Star, Winter Orbit." This story is the first collaboration of two of the hottest writers in the science-fiction field: Bruce Sterling and William Gibson. Gibson was a finalist for the 1982 Nebula Award. This is Sterling's first appearance in *Omni*. And Cherry Wilder makes her *Omni* debut with "Kaleidoscope," a story about two people swept into a different universe by a freak tropical storm.

MAWS

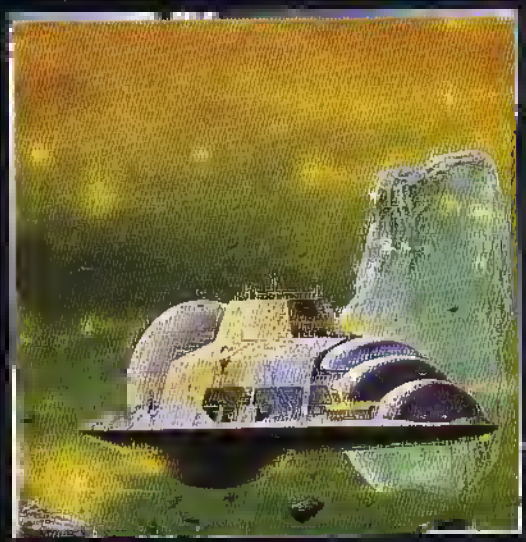
Behold the mighty marine maw. These bizarre assemblages of scales, jaws, and teeth tell stories of evolutionary adaptations as improbable as anything penned by Asimov, Heinlein, or Herbert. Some fish have kept the simple, open-and-shut traps of their ancestors, which patrolled the reefs when dinosaurs ruled the land. Other marine denizens have modernized their muzzles, evolving them into fangs, beaks, and vacuum-cleaner-like appendages. Each fish face has its own tale to tell. You can learn about them—straight from the fish's mouth—in July's special pictorial.

INTERVIEW



The only bioscience as complicated as brain research is immunology, and the most rapid progress in immunology has taken place in the last two decades. Many of these advances can be traced to one man, Baruj Benacerraf, chairman of Harvard's pathology department. In this month's Interview, this Nobel Prize-winner takes us on a tour through the immune system. He discusses widespread organ transplantation and possible treatment for such terrible autoimmune diseases as M.S., rheumatoid arthritis, and lupus, and he entertains some theories about AIDS, the immune deficiency syndrome that seems to seek out gays, Haitians, and hemophiliacs.

COSMIC DREAMS



In visionary dreams, it was a paradise of floating gardens, emerald towers, and high-domed cities. The most modest of plans in cutaway paintings from the Fifties showed dozens of khaki-clad figures at work and play inside labyrinthine chambers and tubes. But now that the planning of a real space station is a line item in NASA's budget, most of the illusion has disappeared. A report in this month's *Omni* suggests that in place of an ethereal dream, the U.S. space station is likely to be a workhorse, totally devoted to meeting the needs of science, industry, and national defense. Yet even if the station turns out to be an unmanned "utility pole" inhabited only by machines, this outpost in orbit promises to be America's best hope for leadership on the high frontier. July's *Omni* also introduces a new generation of robots able to reproduce themselves, and a new kind of self-help guide, by novelist Walker Percy, for travelers to the far reaches of the cosmos.

PHENOMENA

Hazy waves of shocking pink undulate by in this abstract study of flower petals nestled in a cuplike calyx of green leaves. Photographer R. Hamilton Smith came across this image by chance one dazzling summer afternoon while wandering through the flower garden of a friend. His eye was caught by the electric-pink hues of a group of petunias; so he decided to try to get a bee's eye view of one of the flowers. After attaching a reversing ring and a 24mm Nikkor lens to a Nikon FM body, he took a series of extreme close-ups of what, to a casual onlooker, would be just another pretty flower. Of that series, called "Petunia Wave," this photo is his favorite. He has a copy of it hanging on his office wall. "I find this combination of color and form particularly soothing to look at," Smith observes. He captured this image on Ektachrome 64 film.

GAMES

By Scot Morris

"Get it up and keep it up."
—Will Yolen, "kite-flying champion of the world" (*Who's Who*)

There was a time when adults played with kites without embarrassment. You probably know about the use of kites by Ben Franklin and early meteorologists. The kite's serious potentials have also been demonstrated in other areas:

Communication: Kites hoisted antennas for the first wireless telegraphy trials by Marconi and others.

Engineering: In 1848 a boy's kite took the first strand of the then-largest suspension bridge across treacherous Niagara gorge. He won a $10 prize.

Transportation: In 1828 George Pocock's carriage took passengers across the English countryside at speeds up to 20 miles per hour, passing horses and riders. His 113-mile trip still stands as the longest kite-powered journey ever taken.

And then there were man-carrying kites used as far back as the twelfth century in Korea. During the Boer War kites designed by Lord B.F.S. Baden-Powell (brother of the Boy Scouts' founder) carried spies with guns, telescopes, cameras, and even radio transmitters to report on enemy positions. One of the greatest man-carrying kites was the *Cygnet*, a 40-foot-wide model, made of 3,393 separate tetrahedral cells. Towed behind a steamship, the *Cygnet* safely carried Thomas E. Selfridge, lying on his stomach in the kite's center, to an altitude of over 160 feet. The kite was designed and built by Alexander Graham Bell. Ironically it was the same Lieutenant Selfridge who in 1908 became the first fatality in the history of powered flight. Selfridge met his death as a passenger; the pilot of the plane survived the crash with only a few broken bones. The pilot's name: Orville Wright.

Once the Wright brothers demonstrated the practicality of powered flight, most of this "serious" work with kites became obsolete. The kite reverted to the status of a toy, a child's plaything.

That is no longer the case. With maneuverable kites that you can really *fly* —not just hold on to—and aeronautical innovations, such as the flexible wing invented by NASA flight engineer Francis Rogallo and the parafoil designed by aeronautical engineer Domina Jalbert, kites are looking like adult's play—again.

KITES LIKE NEVER BEFORE

Kiting's growing popularity is best measured by the flurry of new world's records and the pace at which they have been set and reset.

LARGEST KITE. In March 1980 a Japanese team of 150 men launched a flat, rectangular 2,949-square-foot kite and held on to it for 15 minutes. Seven months later the largest-kite record came to the United States when students at Edmonds Community College, in Lynnwood, Washington, flew a 3,640-square-foot Jalbert paratoil (bottom left, page 153). It was anchored to a dump truck loaded with 24 tons of gravel. (A paratoil is an all-fabric kite that fills with air and assumes the shape of an airplane wing, giving it most of its lift. The inventor, Jalbert, assisted in building this kite.)

Then, in August 1981, the Dutch took the record with a 5,952-square-foot parafoil variant, with air scoops on the sides, pictured at the top of page 153. Harry Osborne, leader of the Edmonds College group, is not impressed. He intends to bring the record back to the United States this August, with another Jalbert-supervised monster kite, this one measuring 115′ × 174′—almost half an acre in area. Its 20,000 square feet will be more than triple the Dutch record.

LONGEST KITE. In March 1980 a 500-foot kite flew in Venice, California. This record jumped to 1,250 feet in April 1981 (San Francisco), 1,500 feet in November 1981 (Redondo Beach, California), and *one mile* in September 1982 (Florence, Oregon). Insiders say this record won't last the year: Both the Edmonds group and Tal Streeter and Bill Tyrrell, in New York, are planning to fly *five-mile*-long kites (or longer, depending on which team strikes first) before the summer is out.

ENDURANCE. Will Yolen's week-long flight in Fort Lauderdale in 1977 was surpassed last August by the Edmonds crew, which kept a parafoil aloft 180 hours and 17 minutes.

Some kites can fly even without wind. A handler with an educated wrist pulls the string, and the kite climbs. Then it glides slowly downward, pulling out string as it goes, until it is time for the next pull. A cycle takes about 40 seconds. The indoor record of 39 hours and 53 minutes was set in the Seattle Kingdome in February 1981. The feat overlapped two consecutive home games of the Seattle SuperSonics basketball team.

MOST KITES ON ONE LINE. Ten years ago on Ben Franklin's birthday (January 17, 1973), Will Yolen sent up 57 kites on a line—each flying independently, no kite pulling another—in Sarasota, Florida. A year later William R. Bigge, in Maryland, bumped the record to 261, an achievement that Yolen conceded was "a magnificent feat and one that will surely stand . . . for as long as the earth turns." Yolen was wrong. The current record was set in Kamakura, Japan, in 1978. The number to beat: 4,128.

ALTITUDE. This is the tricky one. At low altitudes you can judge a kite's height by triangulation—from the length of string played out and its angle to the ground. But this method becomes unreliable at record heights. Claimed altitudes exceed five miles for a single kite and seven miles for the highest kite in a train of several kites, but both calculations are questionable. The Edmonds team plans to set a definitive mark this summer with a kite carrying its own altimeter and radio transmitter. "We're going to beat thirty thousand feet," Osborne told me. "Maybe thirty-three thousand."

For more information on kite records and/or a subscription to the essential international kiting magazine (four issues for $9), write to *Kite Lines*, 7106 Camptield Road, Baltimore, MD 21207. The kite-records information above is adapted from *Kite Lines*.

KITES TO GET GOOD AT

When we were young, flying a kite was a simple experience, not a skill. You sent the kite up, it flew, and when you got bored you pulled it back in. There was no such thing as a *good* kite-flier. Maneuverable kites have changed that. To really *fly* a kite (rather than just hold its string) we recommend you try either a stunt kite or a fighter kite.

A stunt kite, which is held by two strings—one from either side—gives the maximum feeling of control. With just a few minutes' practice you can make the kite do loops and figure eights on command. Several stunters may be added behind the lead kite to form a train. The best-brands are the Rainbow (reviewed here in December 1982), Peter Powell, Triby, Skynasaur, and Hyperkite.

Fighters are single-line kites often used in head-to-head battles. The Indian fighter is the standard: Almost square in shape, with a stubby fin and no tail, it has a curved crosspiece that is delicately shaped and balanced. Pulling the string presses the crosspiece against the kite, altering the fighter's shape and flight characteristics. Hold the line steady and the kite is stable; pull in and the kite moves in the direction its nose is pointed. Give slack and the kite flutters and spins. When the kite is pointed in the direction you want it to go, pull the string and the kite follows.

The skill is hard-won, and first attempts look ludicrous. Strangers will come up and say, "Your kite needs a tail." Smile politely. Your Indian fighter doesn't need a tail. You need more practice. Learning to pull out of a spin is the first step. You'll eventually learn to tug the line just as the kite is beginning to point upward—not a moment before or after. An expert can send a fighter diving straight for the ground, then have it reverse directions within its own length and shoot back up, or pinwheel just above the hands of any spectators that may try to catch it. Some kite-fliers, after they have mastered the fighter, simply refuse to fly any other kind of kite.

Going with the wind: At top, the current largest kite, a Dutch monster parafoil filled through two vents at the sides (some say it's more balloon than kite). At left, second-largest (United States). Right: Indian fighter, its tail fin cropped in the photo. Some kiters won't fly anything else.

Kite fighting in India is a loser-lose-all business. Lines are coated with paste and broken glass. The idea is to cut your opponent's line with your own. For the defeated flier this gives new meaning to the word *bringdown*. It is said that a handful of Indian masters can perform the ultimate act of humiliation—ensnaring the rival's detached kite and reeling it in as a battle trophy.

For those of us who would hate to lose a kite just for losing a contest, there are more genteel forms of the duel. You can award points for touching an opponent's line, first from below for a set number of points, then from above for another set, and so on. Or there's the "Kiss of Death": Coat a short segment of each string with lipstick, then try to leave red marks on the white portion of your opponent's string. The scoring is messy but objective.

There has yet to be a mass-produced Indian fighter kite quite as good as the ones experts lovingly make by hand. The closest approximation, we think, is the Vic's fighter, available at most kite stores for about $8 or $9.

Of course, if you don't feel like engaging in a kite fight or setting a world's record, go fly a kite for the fun of it. As a *Wall Street Journal* headline once proclaimed: "There's no such thing as an unhappy person who's flying a kite."

LAST WORD

By Judith Hooper

"Television game-show hosts will serve as tomorrow's shrinks. New group-therapy techniques like Guess My Neurosis *and* The Hating Game *will supplant the old, tedious format."*

Sure, futurists rant and cavil about transportation, energy sources, and trips to other planets in the next millennium. But what about the things that *really* concern us—like dating technology, religion, greeting-card trends, fingernailology, and house-pet control?

Fortunately, the Institute for the Prognostication of the Paraordinary, in Citrus, California, has completed a report on just those areas. Here are some of its forecasts for the year 2000:

Technology

Telephone answering machines of tomorrow won't just take messages; they'll also be programmed to carry on boring conversations—with your mother, for example. Push a few buttons, go out for the evening, and your machine will do the rest, with such child-to-mother repartee as: "Oh, yes, I was planning to visit Grandma, eat more nourishing meals, throw out the coat with the ink stains on the pocket, change my attitude, marry someone nice tomorrow." Or "How interesting! Tell me more about the root canal." And "Okay, okay, I will," at regular intervals from the bionic conversationalist.

Dating will be transformed by computer-aided interactive video. It will spare you the embarrassment and discomfort of sharing an evening with a person who has an incompatible hairstyle or world view. Not only will you be able to select a date from videotapes of attractive people discussing their personal philosophies while lounging in hot tubs, but you'll also be able to date him or her without having to meet. Sensorama will permit you to attend a great opera together, share *coquilles St. Jacques*, or even melt into each other's arms at the evening's close, all without leaving the comfort of your home. (This is also ideal for married couples with careers in separate cities.)

Cosmetics and household products are already technologically advanced. Instead of some vapid floral essence-of-something, I now shampoo with a no-nonsense ooze labeled ESSENTIAL FATTY ACIDS, and my conditioner calls itself a BIOTECHTONIC HAIR LIBERATOR. These trends are expected to continue; so by the year 2000 qualified genetic engineers will be attending to your split ends and broken fingernails, and Nobel laureate physicists will appear on television exclaiming, "I can see my own reflection!"

Pet care will be revolutionized as high-tech market researchers will devise methods of recording your dog's salivation rate and your cat's minutest whisker quiver in response to the top 25 pet foods. Thus you will be able to avoid the sulking and those petty acts of vengeance that strain so many master/pet relationships.

Communications

Magazines are bound to change as advertisers demand increasingly more precise demographics. More extra-special interest publications will emerge, like *Joint Chiefs of Staff*, a life-style magazine only for the heads of armed forces; *Exile Life*, a travel and leisure magazine for recently deposed dictators and royalty on the run; not to mention *Executive Romance*, *Test-tube Parents Digest*, and *Spacehab Life*.

Greeting cards in the next millennium will follow trends that are already set. Cards spotted in 1983 include HAPPY BIRTHDAY TO A LOVELY GREAT-NIECE and CONGRATULATIONS TO THE ENGINEERING GRADUATE. As the number of people capable of writing a coherent paragraph dwindles, everyone will depend on greeting cards to express innermost sentiments: HAPPY BIRTHDAY TO MY DEAR LANDLORD'S COUSIN, CO-OP PURCHASE GREETINGS TO MY WIFE'S THERAPIST, or HAPPY AUDIT TO A SWEET PAL OF AN EX-ROOMMATE.

Social Trends

Psychiatry won't be quite the same in the year 2000. Because many modern patients complain that their psychiatrists are boring and not at all upbeat, television game-show hosts will serve as tomorrow's shrinks. New group-therapy techniques like *Guess My Neurosis*, *Psychopath for a Day*, and *The Hating Game* will supplant the old, tedious format.

Religion will adapt to the needs of the believer. Today we have St. Claire, the patron saint of television; St. Anthony, of lost objects; and St. Monica, patroness of anxious parents. The next millennium will have all new saints with updated job descriptions: St. Stanislaw, patron saint of software; St. Letitia, patroness of condominiums; and St. Chad, a spiritual ombudsman in charge of stray asteroids, grant proposals, or nonfossil fuels.

Even *shopping-bag ladies* will feel the forces of change in the year 2000. Since many passersby find present bag-lady monologues unintelligible, social programs will be initiated to enroll street people in the Famous Broadcasters' School to learn correct radio-announcer intonations. Thus they will be able to enunciate clearly such messages as "Rat poison, scum buckets, God's grease, I said to the ambassador."

Also, the ladies' routes around cities will be monitored by radio telemetry to avoid shopping-bag congestion in bus, subway, and train stations and to expedite delivery of the classified documents they all transport in their bags. (People don't realize that bag ladies are actually top-secret couriers.) ∞

Judith Hooper is a forward-looking freelance writer who prays to St. Chad every night.