

Omni



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INTERSPECIES COMMUNICATION

THE
EXPERIMENT
BEGINS





FIRST WORD

By Harold B. Finger

• *Nuclear power has reduced the international demand for oil by almost 6 million barrels a day—more than is used by the entire country of Japan.*

It's time to end a myth. Contrary to the charges of critics, nuclear power has lived up to its early promise. This year, 30 years after the start-up of the pioneering Shippingport plant in Pennsylvania, we can look back on nuclear energy and appreciate its achievements.

The original expectation for nuclear electric power was simply to make nuclear power competitive with fossil fuels. Far beyond meeting that original objective, nuclear power has made three major contributions: It has become a prime source of the electricity that powers our economy, it has reduced the world's demand for imported oil, and it has lessened international tensions among nations that otherwise would have competed for oil in the Middle East.

James Schlesinger, former head of the departments of energy and defense, told a decade ago that the peaceful development of nuclear power "is similar to the entire history of commercial aviation, from Kitty Hawk to the Boeing 747, being compressed into less than a score of years." It's remarkable that in only three decades the industry has grown from the Shippingport plant to over 100 commercial nuclear power plants. Nuclear energy has become our second largest source of electric power—overtaking oil, natural gas, and hydropower—and it supplies more than 16 percent of our national electricity.

The increasing importance of nuclear power has become even clearer since the 1973 oil embargo. We have cut our use of all forms of energy, largely as a result of rising prices, while increasing our use of electricity by more than one third.

Significantly, this new supply of electricity came from our two most abundant sources: coal and nuclear power. From 1973 to 1975 utilities increased their burning of coal by more than a third while more than quadrupling their use of nuclear power. These two sources allowed utilities to meet the increase in America's demand for electric power and, at the same time, to cut back on the use of imported oil and natural gas to generate electricity. In fact, though 17 percent of our electricity came from oil in 1973, only 4 percent now comes from that source. When the 80 nuclear plants currently nearing completion go into operation by the early 1980s, 20 percent of the electricity used in this country will come from nuclear power.

As Nobel laureate Glenn T. Seaborg said many years ago, nuclear energy came along "in the nick of time." The United States and countries the world over were fortunate in that nuclear power was available when we needed it to help overcome our dependence on imported oil. Until the 1973 oil embargo Japan, France, Sweden, and many other countries

depended heavily on OPEC oil for their basic energy supplies. After the embargo they realized that their only alternative was to turn to nuclear power. The French government established our auditors—all nuclear—its energy policy and now draws more than 60 percent of its electricity from nuclear plants. In Sweden, Switzerland, Finland, West Germany and Japan more than one quarter of all electricity is nuclear.

By providing an alternative to oil dependency, nuclear power has significantly reduced the international tensions that otherwise might have led to confrontation. Early in the Seventies, when most industrialized economies were being held hostage by a handful of oil-producing nations, it appeared that tensions over oil supply could lead to serious conflict. Without the growth of nuclear power the greater demand might well have led to much greater pressures among consumer countries—and even to direct action in the Middle East.

OPEC officials have acknowledged that nuclear power has reduced the international demand for oil by almost 6 million barrels a day—more than is used by the entire country of Japan. That reduction has directly contributed to the current surplus of oil supplies, the decrease in oil prices, and the lessening of international competition for oil.

But nuclear energy has run into problems in the United States. The country that pioneered it, high radiation and high initial rates have driven up the cost of new nuclear plants, and rate regulation at the state level has discouraged investment in future electric power supply. A slowed rate of growth in electric power demand during the Seventies and early Eighties has led utilities to cancel the construction of many power plants, both coal and nuclear.

Many of these problems have been uncontrolled and exploited by critics, who are using the accident at Chernobyl—which even Soviet's acknowledge is irrelevant to U.S. nuclear power plants—as an excuse to call for a shutdown of our second-largest source of electricity. They fail to acknowledge that over the long term, like United States—like every other industrialized nation—we need a growing supply of electric power to fuel its economy. That additional electric power must come mainly from coal and nuclear energy.

So instead of leaving nuclear energy to go shouldered to its successors after 30 years and recognize its continuing role in helping us light the way beyond the age of fossil fuels. ☐

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CONTRIBUTORS

OMNIBUS



SPENCER



THOUGHTS IN PLEISTOCENE



DAVID SCHWIMMER



COVENANT OF SOULS



GOULD

In the film *Doctor Dolittle*, the veterinarian can communicate with his patients because he has learned every conceivable—and not so conceivable—language in the animal kingdom. Throughout the movie he grunts, squeaks, squawks, and gestures to converse with the animals. Of course the citizenry thinks that he's crazy, and the local magistrate demands him to go to an insane asylum. But as the good doctor remarks: "It's incredible, it's impossible, a man can talk to the animals."

In 1957, at the time of the film's release, scientists were, in fact, attempting interspecies communication. But much of the research was cursed with a fatal flaw. While scientists recorded even the most subtle reactions of the animals, they failed to study the human side of what was after all a dialogue. Today, however, a new generation of interspecies communicators is attempting to correct those errors while unraveling many secrets of animal societies, according to writer Doug Starr in "Calls of the Wild" (page 52).

To aid this ongoing research, moreover, *Omnibus* has developed the first national experiment in interspecies communication ("Can You Talk to the Animals?" page 54). By calling a 900 number featuring prerecorded animal sounds and by answering our questionnaire, readers will contribute to the database on animal-human communication. The survey was carefully crafted by *Omnibus* senior editor

Parvati Wernikow and editorial assistant Cathy Spencer, who enlisted the help of such experts as Jane Goodall, John Lilly and others working in the field. And celebrities like Doug Henning and Steve Wonder—who have an interest in animal-human relationships—also assisted in formulating the questions.

The experiment took nearly six months to prepare, and during that time the *Omnibus* offices were flooded with the cries of chimps, wolves, and whales as Wernikow and Spencer collected and cataloged animal sounds. "We spent hours listening to recordings, choosing the most distinctive sounds, and consulting with experts to interpret their meaning," says Spencer, who has become so adept at mimicking the animals we're never sure if a sound is hers or the real thing. The final tape for our 900 number was then edited by *Omnibus*'s broadcast production manager Lisa Cohen and post-production supervisor Buzzanna Halsey.

Good recordings, however, were not always available. Finding an elephant trumpeting call, for example, was particularly frustrating until officials at New York's Bronx Zoo offered to tape one of their own elephants for us. Rising early in the morning, the zookeepers had to then prod and coo the mammoth Happy to speak into the microphone.

Another form of communication has been developed by the Esalen Institute, a California center expanding human

potential through meditation, Gestalt therapy, and psychic healing. "The Soviets Peace Program" (page 84) is writer Patrok Tenney's report on how the Soviets have cooperated with the institute and initiated a cultural and scientific détente. Appropriately, Russian emigre Igor Tolpenev created the painting *Memory Christ* that illustrates the article.

Despite such warm overtures, however, a watchful eye in Colorado continues to monitor the sky. And the pictorial "Space Sentinel" (page 94) takes readers inside the subterranean command post that analyzes data on all missile launchings—including those that might signal the beginning of a nuclear attack.

The pictorial "Back-room Bestery" (page 74) is a dreamlike Noah's ark of preserved animals. It combines the talents of photographer Rosemond Wolf Purcell and zoologist Stephen Jay Gould.

This month's fiction features the novelette "Covenant of Souls" (page 90) by Michael Swanwick. His last story in *Omnibus*, "Doglight" (July 1985), written with William Gibson, was both a Nebula and a Hugo award finalist. And author Thomas M. Disch returns to the pages of *Omnibus* with his short story "The Girl with the Vine-Gel Hair" (page 68). Disch is the author of *The Brave Little Toaster* (Doubleday), which will be released as a full-length feature cartoon next year and *Annessa*, a computer-interactive novel published by Electronic Arts. **DD**

ALL THINGS GREAT AND SMALL

FORUM

The World Wildlife Fund, with organizations in 25 countries, celebrated its twenty-fifth anniversary this year. In recognition of the fund's efforts to stop the mass extinction of plants and animals—including the tiny, often ignored creatures of the earth—Chris asked E. O. Wilson, professor of science at Harvard University and a director of the World Wildlife Fund and Sy Montgomery, a freelance writer, to tell us about the little things that run our planet.

If human beings were not so impressed by size alone, they would consider an ant more wonderful than a rhinoceros. That adjustment may never take place, but insects and other small creatures nevertheless deserve far more admiration and protection than they get. An ant, worm or snail is more complicated than any machine devised by man, having been engineered autonomously during millions of years of evolution to survive in environments that are hostile by our standards. Each contains enough genetic information to fill many sets of encyclopedias.

Invertebrates are part of our national heritage. If driven to extinction, they could never be replaced. Instead, we should strive to decipher their biology and age-old history to improve our own chances of survival. We need these creatures more than they need us because they not only run the world. If Homo sapiens, a newly evolved mammal species, were to self-destruct, it would cause scarcely a ripple in the ecosystems of the planet. Perhaps Gaea, the whole of the living world, would sigh with relief. On the other hand, if invertebrates were to become extinct, I doubt that we would last ten years.

Edward O. Wilson

We may soon find out what the earth would be like without the pygmy hog, sucking louse, the Appalachian monkey-face pearly mussel, or the eyeless crayfish. These small, spineless animals—ranging from flat-ace giant crickets to ginkgo butterflies with wingspans larger than a bat's—are among an estimated half million invertebrate species in danger of extinction. Because of habitat destruc-

tion, overcollecting, and predators introduced by man, the world's insects, clams, spiders, and crayfish are disappearing faster than scientists can catalog them. Invertebrates comprise nine tenths of life on Earth and form the foundation of ecological relationships. They are an integral part of the food chain and serve as sensitive barometers of the health of an ecosystem. Earthworms and other burrowing insects till and enrich the soil; bees and moths pollinate plants. And many invertebrates are important to industry and medicine.

Efforts to preserve endangered invertebrates are gaining momentum worldwide. New Jersey has established a preserve for moths. In New Zealand and Japan, entomologists have succeeded in moving colonies of giant weta (flat-ace crickets) and wood ants from threatened environments to safe ones. And the Nature Conservancy, a privately funded conservation group, and the Xerces Society, an organization of insect fanciers, have purchased preserves for invertebrates and funded research in entomology.

Although today only 48 American invertebrate species are federally protected under the Endangered Species Act, the Department of the Interior is now considering 885 more for inclusion on the list. Conservationists admit that trying to save ugly bugs and slimy snails poses a public relations problem. "It is difficult to demonstrate to the public the importance of preserving a snail or an isopod," says David Clinger, spokesman for the Department of the Interior's Endangered Species Division. "It's more difficult to get people sentimental over a peery mussel than to get people to care about the bald eagle."

If the species of mold from which we now derive penicillin had become extinct, more people would die today of bacterial diseases than of cancer and heart disease combined. And the disappearance of some invertebrates will rob us of some of the most beautiful species on Earth. Hawaii's Oahu tree snails, for example, have conical shells that resemble jewels, various patterns and

shades of red, orange, yellow, brown, green, gray, blue, white and black. No two shells are alike. But populations of some of this unusual snail group have dropped to only 100 individuals.

Worldwide populations of horseshoe crabs, the living fossils that fascinate children at the beach, are also declining. Dating from the Triassic period, 225 million years ago, these armored arthropods provide an unveiled glimpse of the earth's prehistoric past. The horseshoe crab and its eggs provide food in some countries. In the United States the animal is valued for its medical applications. But our appetites could threaten their existence. Millions of horseshoe crabs are killed each year by clam diggers because the horseshoe crabs eat clams.

The payoffs for preserving endangered invertebrates can be stupendous. In Papua New Guinea, in 1974 the government established a butterfly-farming industry. The Insect Farming and Trading Commission soon found that, gram for gram, butterflies are more valuable than cattle, and the newly formed butterfly farms help preserve a spectacular national resource as well as exploit it. Today several formerly threatened butterfly species are thriving, and butterfly farmers export 10,000 specimens a month to collectors and students. A butterfly farmer may earn \$1,200 a year for his work—many times the average rural per capita income of \$60. The farms also preserve native cultures and the rain forests that nurtured them.

Perhaps we have not yet reached the point where we can see splendor in a worm, a louse, or a beetle. Perhaps science has not yet uncovered the role of all species on Earth or the possibilities that lie hidden in them. But we must hold these animals in trust as a token of our belief in the future. Many scientists believe we cannot put a price tag on endangered invertebrates. While removing invertebrates from certain habitats might be defensible on economic grounds, as E. O. Wilson says, "It's like burning Renaissance paintings to cook dinner."

By Montgomery

SATELLITE BANDITS

SPACE

By Larry Kahaner

On April 27 TV viewers watching The Falcon and the Snowman on HBO's cable channel got more than a movie about spies, drugs, and smuggling. Their TV screens went blank, and an ominous message in bright white letters took its place: GOOD EVENING HBO FROM CAPTAIN MIDNIGHT \$12.95 A MONTH NO WEB (H)OWME (H)ERE: CHINESE, (H)OW (H)E; The transmission lasted about four minutes and was in protest of HBO's decision to scramble its signal and charge backyard-dish owners for an expensive decoder plus a \$12.95 monthly fee. HBO viewers had witnessed the first intentional jamming of a commercial satellite by a techno-guerilla. In those few minutes Captain Midnight had exposed the vulnerability of satellites to future terrorist attacks.

The hunt for Captain Midnight revealed just how vulnerable the system was. The Federal Communications Commission (FCC), which had never done this kind of search before, began by making some assumptions. Because of the power needed to override HBO's signal, they figured that the Captain used a commercial satellite-uplink facility to transmit his message. That narrowed the list of suspect facilities to 2,000 stations. Then by analyzing each letter of Captain Midnight's taunting prose, they were able to identify the character generator, the device that formed the words. It was a commercially available unit. The FCC got a list of 4,000 purchasers from the manufacturer. FCC computers then cross-matched the two lists, and came up with a roster of 580 stations. Of those that had the suspected device, only 12 were available that night for jamming service. The rest was busy. At that point the investigators left the world of high tech and resorted to old-fashioned detective work.

By then, two months had passed since Midnight's raid. The FCC had received lots of tips from people who were sure they knew the Captain's identity. The one that narrowed their manhunt came from a Wisconsin tourist who had been vacationing in Florida when he overheard someone on a pay phone talk about

Captain Midnight's prank. He wrote down the man's license-plate number and gave it to the authorities. Although the driver was not involved in the incident, authorities found that he was connected to someone who worked at an uplink facility in central Florida—a facility that was on the dirty-dozen list.

That just about clinched it. The Department of Justice subpoenaed people for questioning at the 12 stations, and the FCC requested from each a videotape for comparison with Captain Midnight's transmission. It was then that John R. MacDougall—a satellite dish salesman, electronics engineer, and part-time employee at the Central Florida Teleport satellite-uplink facility in Ocala, Florida—confessed to being Captain Midnight. He was charged with transmitting without a license and received a \$5,000 fine and one year's probation.

FCC officials admit that luck played a large role in catching MacDougall. Had the transmitting equipment been homemade or had MacDougall broken into the station instead of being an employee, he would

have been virtually untraceable.

Although satellite experts shuddered at Captain Midnight's antics, they don't see people like him as a major threat. More frightening, they say, is what terrorists could have done. "If someone is knowledgeable and has the right equipment, there are many ways to disrupt satellite communications," says Gianni McLoughlin, a policy analyst in science and technology at the Library of Congress Congressional Research Service.

A techno-terrorist could send special signals to a satellite and actually direct it out of its orbit. All satellites have tiny jets activated by special ground commands that occasionally reposition the craft to compensate for the earth's pull. A terrorist could even send one satellite crashing into another, rendering them both useless. As another option, he could send a signal that would turn off the beeper transponders—its little radio relay stations—until his demands were met. "I'm sure the country is full of extremely sharp people who could find many ways to cause mischief—more serious kinds of mischief [than Captain Midnight's]," warns Dick Smith, the FCC's chief of the Operations Bureau, who spearheaded the hunt for Midnight.

The greatest threat is terrorists in nations hostile to the United States, says John Koehler, president and chief executive officer of Hughes Communications, the company whose satellite Captain Midnight breached. Not only would they have the money, available uplinks, and the ability to break or stall complex command codes, Koehler notes, but they could operate with impunity. Prompted by Captain Midnight's antics, Hughes and other satellite makers will be placing more emphasis on protecting their command links on future satellites by encrypting them with the most powerful codes security specialists can devise.

The extra protection is becoming crucial as more sensitive communications depend exclusively on satellites. "More financial institutions are sending data by satellite," says McLoughlin, who notes that stock exchanges are moving toward



Space-beam banditry: Terrorists in orbit?

ANGRY HOUSEWIVES

EARTH

By Eleanor Smith

Silexism, a solvent recovery operation in Lowell, Massachusetts, declared bankruptcy in 1977 and left it up to the state to clean up the mess—some 30,000 barrels containing about a million gallons of toxic and carcinogenic chemicals, including benzene, tetrachloroethylene, and polychlorinated biphenyls (PCBs). The state had removed most of the barrels by 1981, but it left some underground tanks and contaminated buildings. The site still smelted—a sweet, glue-like odor.

Norrie Danley, a resident of Ayer City, a lower-middle-class neighborhood in Lowell, began to wonder if Silexism might have anything to do with her family's health problems—her daughter's constant bloody nose, her son's chronic ear infections, and her own unusual blood disorder, which had resulted in a hysterectomy. Deciding it was time to act, she joined other activists and helped conduct a "case-control" epidemiology study. Barolo, epidemiologists are concerned citizens who canvass their communities to find out whether other residents are experiencing any unusual health problems. In Lowell the lay epidemiologists turned up an alarming number of respiratory and skin problems, along with a high rate of miscarriages and birth defects.

In 1980, several hundred miles to the south, residents of the Parkridge neighborhood in Pompano Beach, Florida, noticed strange, white particles floating in their swimming pools, coming in through their screen doors, and sticking to their cars. When Ruth Tilly, a young mother, and a few of her neighbors went to the nearby polyvinyl-chloride (PVC) pipe factory to complain about its noisy equipment, they saw the same snow-like particles all over the factory grounds and outside the fence. They also noticed a storage tank labeled CONTAMINATED OILS. A SUSPECTED CANCER-CAUSING AGENT. Curious about the white specks, they collected some and had them analyzed. Just as they suspected, the particles were PVC.

But the local health authorities refused to close down the plant or even investigate the residents' health concerns.

Enraged, the concerned residents contacted a public-health scientist and began to conduct their own community health study. They interviewed 90 percent of the residents of Parkridge and found ten times the expected rate of headaches, seven times the expected rate of kidney problems, as well as unusually high incidences of eye irritations, liver diseases, cardiovascular problems, and cancer.

Two years later the Florida Department of Health and Rehabilitative Services reviewed the residents' health study and concluded: "There appears to be a higher than expected number of birth defects or low-birth-weight infants." Calling the citizens' study "inconclusive but cause for further investigation," the state recently decided to review its own data on the number of birth problems and cancer cases in the area. But the county passed an ordinance prohibiting certain industries from building factories in the area's water-well fields, where rainwater percolates down through the porous soil to the water table. The PVC pipe factory was located near one such well field.



Toxic waste: not in my backyard

Grass-roots activism over hazardous wastes was launched in 1977 when Lois Gibbs, a young homeowner and mother in upstate New York, formed the Love Canal Homeowners Association. The group fought successfully to close the school built atop an old toxic waste dump and, later, to evacuate the whole community. When the nightmare of Love Canal was over, Gibbs settled in Arlington, Virginia, and formed the Citizens Clearinghouse for Hazardous Wastes to help individuals, citizens' groups, and municipalities block proposed landfills, shut down existing dumps, or clean up old sites.

Once a grass-roots organization is formed—with a catchy acronym such as SCRAP, RAIS, or CRAP—it's members wage door-to-door letter-writing campaigns, testify at public hearings, pocket reluctant officials, and write fiery editorials for the local paper. Impatient for answers and frustrated by technical jargon, many activists become lay experts in toxicology, hydrogeology, and the political process. Some groups hire their own environmental engineers to do soil and air tests and to interpret the government's findings.

Residents of Stockport, New York, have formed an organization called SCRAP and are currently involved in a two-pronged fight with Columbia and Greene County and Browning Firms Industries (BFI), a private waste-processing corporation. The county and BFI, acting separately, want to build a waste dump on a 500-acre parcel of land along the Hudson River.

SCRAP is concerned about the effects of leaching waste dumps on their own community and about the proximity of the site to the Hudson River, a major provider of drinking water to municipalities downstream, including New York City. SCRAP has hired the best consultants, and the Stockport town board has opposed the landfill. Environmental organizations such as the Natural Resources Defense Council and the Environmental Defense Fund have supported SCRAP and the town council's decision. Despite those efforts the controversy has not been resolved. "At this point," says Katherine

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ARCTIC SUN

EXPLORATIONS

By Karen Freifeld

I was almost 4:00 a.m. when I pushed my way through the fierce, 50-mile-per-hour wind to get back on the Nordstar jet and go home. There were no trees to slow the snowy gusts, and I felt I could be knocked down and carried away by them as easily as by a sitting underflow. It was June 21, 1998 (actually the twenty-second by then), the first day of summer. And I was in the middle of a blizzard.

Of course, a June blizzard isn't so surprising in Frobisher Bay, one of the larger communities (population: 2,500) in Canada's Northwest Territories, only 180 miles from the Arctic Circle.

But I'd flown north only for the night, arriving a mere five hours earlier with 110 other "Arctic Circleers." Abused as it may seem, we'd each paid some \$300 for "a night in the land of the midnight sun." Or at least something akin to it. During the summer solstice there are 20 hours of sunshine here; the true "midnight sun" (24 hours of daylight) lying an hour farther north.

But from the moment we'd loaded into three noisily yellow school buses for our all-night tour of the town, the view was

disappointingly bleak: clusters of drab Forties-army-barracks-style houses, set on gravel pads to avoid the permafrost—the layer of permanently frozen soil that lurks just below the surface—and newer but still-simple structures on stilts, with sophisticated insulation.

The sun will rise at one thirty (a.m.), so it will get brighter," said our optimistic guide, Cathy Cole, a transplanted "Southerner" from Toronto. A lot of people put foil wrap on their windows [this time of year] so they can sleep. But no aluminum shade would be necessary tonight—1:30 a.m. came and went with no sun at all.

Luckily, I got to go back to Frobisher Bay two weeks later. This time the lampshade lure reached the 60's: the sun was as strong as the wind had been on my earlier visit, and the gray deadlands Arctic landscape look on clear, solid colors.

There was the deep brown of Precambrian rocks, the brilliant blue of the Sylvia Grinnell River, punctuated by white chunks of floating icebergs, and out on the wide stretches of tundra, tiny bursts of brilliant purple and yellow flora

that had sprouted from the spongy carpet.

The community itself also was a lot livelier on my second trip. Over a dozen Inuit (Canadian Eskimo) children on bicycles raced to follow our buses and smile for our cameras. A freshly cut seal skin lay on the pack ice, and a number of Inuit camped out in tents near the water. In nice weather the nomadic Inuit, who make up about 60 percent of the population, often leave their well-insulated homes and videocassette recorders to sleep "out on the land." In colder times an Inuit out fishing or hunting can build an igloo in less than an hour.

Indeed, Frobisher Bay is an unusual combination of decades-old and modern trappings. There are still a few dog teams in town, but there's also a \$5 million Space Age school built of fiberglass, with no windows, that can house the entire population in the event of a power shortage.

Frobisher Bay owes its style—and virtually its existence—to the U.S. military, which built an airstrip here during the Forties and used it to refuel and evacuate the wounded during World War II. Remnants of the military presence still exist, including a radar base with two huge satellite dishes.

Beyond these dishes and the five miles of roads in and around Frobisher Bay lie the endless miles of the tundra. Only experienced Arctic travelers are able to navigate the territory by such means as snowdrift patterns. "Prevailing winds establish fixed patterns, and even after a storm comes from a different direction, you can determine which are your dominant snowdrifts and which are secondary. So you can use that to establish direction," explains longtime resident Al Woodhouse. A compass isn't much help. The "north" reading is palpably inaccurate so close to the North Pole, since it actually points to the north magnetic pole, northwest of Frobisher Bay.

Where does one go after Frobisher Bay? Farther north, I'm told, to a community like Igloodik or Narsivik or Resolute, where the sun really shines at midnight—at least in summer. And in winter, even at noon, they live in total darkness. ☐



Sun fan: Hop a plane to Toronto, fly to Frobisher Bay, walk the tundra at "night" and fly back.

THE UNREAL THING

ARTIFICIAL INTELLIGENCE

By Jack B. Rochester

Charles Philip Licht is sitting in the lotus position, reflectively puffing on his pipe, hovering about three feet above the floor. He takes the pipe from his mouth and, with eyes twinkling, says, "What the lever was to the arm, the computer is to the brain."

The image vanishes and Charles Licht is sitting on the sofa, while he has been all along. The levitation scene was merely his description of a process that he foresees as the next great breakthrough in computing—the creation of what he calls artificial experience.

"In the next century," contends Licht, who in 1962 founded one of the first successful independent software firms in the United States, "we will be able to play out scenarios of our own imagining and, having done so, turn them off without physical risk or harm. As surely as gravity exercises its law on Earth, so artificial experience will tow our minds into a world of visibility and vision."

The key to creating artificial experience is the union of the computer and the hologram. By combining powerful artificial intelligence (AI) software with three-dimensional holographic projections, it will be possible, Licht believes, to generate manufactured images of all our own choosing. This "virtual reality," as Licht refers to it, will unfold gradually. First, programmers will learn to project two-dimensional holograms onto dark screens that cover the walls, ceiling, and floor of a room. By the year 2000 Licht anticipates "three-dimensional projections so real that our senses will believe the holograms to be the 'real' environment."

Ten years later, and third-generation artificial experience will be possible through the use of mammoth computer systems capable of handling trillions of bits of information that collectively represent reality. There will be no screens," says Licht. "Everything in the vicinity will be a holographic projection."

All this may make Licht sound like a modern-day Paul Bunyan, but over the years he's cranked out enough successful

take him seriously. His company, Licht Sciences, Inc., for instance, has recently marketed a software program that allows an individual with no programming experience to sit down at a computer and create an adventure game. Another company project employs an animated Marcel Marceau-type mime to communicate with the user.

Born in Providence, Rhode Island, and educated at the Josiah Sedgwick University and Purdue, Licht worked at IBM and MIT's Lincoln Labs for a while before starting Advanced Computer Techniques. But he grew depressed watching a spirited company change into a "bureaucracy of yuppie nincompoops" and in 1962 left to found Licht Sciences, a think tank and "creative" lab. Then in 1985 he moved to Tokyo to open Licht Sciences Japan in a country, Licht says, that "is long on brains and short on lawyers."

Licht's views on artificial experience grew out of his ruminations on what would succeed artificial intelligence. While Yale's AI guru Roger Schank envisions

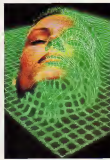
artificial intelligence primarily as an easier way to gather or retrieve information in a database, Licht believes the discipline can be used to create as well.

But artificial intelligence research is moving too slowly for the futurist. "Most researchers," he claims, "labor under the delusion that they know what real intelligence is, although they cannot provide us with a definition or name an object that possesses it. Deeds, the output of human beings, direct us to conclude whether or not they are intelligent. But intelligence hasn't kept us from making war, a decidedly unintelligent thing to do. We need experience, either real or artificial, as well as intelligence. Humans do learn something after a real war is over, but by then it's too late. Yet perhaps the artificial experience of a war, a simulation so real that we believe it is the actual event, would give us a profound understanding of it and would help to change our behavior."

Flight simulators, says Licht, are the closest thing to artificial experience in existence, but simulations, he believes, "just aren't convincing enough to be of much value today."

Licht's hope is that once artificial experience has been developed, the "real" will be exchanged for the "virtual" and humans will enter a new evolutionary stage in which ownership—the drive to possess the irreplaceable—will dissolve. "When something like a painting by Rubens or a sculpture by Henry Moore is delivered holographically," he says, "we can appreciate it purely. When we tire of it, we can create another holographic object that pleases us."

Although artificial experience appears to be Licht's favorite topic, he's not letting theoretical musings run away with him. His current project may be just as odd as a holographic Rubens but potentially feasible in the next few years. He wants to place a laser projector on the top of a Tokyo tower and project images onto the clouds during the city's rainy season. "We could turn the rain into a pointillist tapestry," he says. **DB**



Create your own reality... Holographically

BOOKS

THE ARTS

By Gurney Williams III

The book has everything going for it except sex and the Royal Family. It's about death and destruction from space killer comets and mysterious clouds encircling the earth. And it all may be true. The catch is that it happened 65 million years ago—to dinosaurs. But that didn't prevent David M. Raup's *The Nemesis Affair* from being selected as one of the year's best reads.

And it wasn't the only book on the 1986 list of winners to deal with the past. In the last 12 months Isaac Asimov, E. O. Wilson, William S. Burroughs, and other luminaries in the sciences and arts have read a wide variety of fiction and nonfiction. Several people said the year's news—Challenger, Chernobyl, and the continued debate over President Reagan's Strategic Defense Initiative—had offered little time for pleasure reading, but a generous handful of fantasy and humor—along with more serious scientific studies—made it onto our distinguished panelists' list.

The Nemesis Affair (Norton), despite its lack of sex and royalty, was Asimov's favorite nonfiction work. "It's a clearly

written and fascinating book," he says. "about whether the sun has a companion star, called Nemesis. According to the theory the little star about two light-years away will begin heading back toward Earth in another few million years, pass through the Oort cloud of comets near the sun, and send comet comets hurtling our way. The last time it happened, collisions knocked up a dust cloud that led to the extinction of the dinosaurs."

Other panelists cited revisionist views of Charles Darwin, the nineteenth-century naturalist and favorite target of twentieth-century critics of evolutionary theory. Columnist Marilyn Mach via Savant, best known for having the world's highest I.Q., singled out *Time Frames* (Simon & Schuster). In this book, author Niles Eldredge explains why he and zoologist Stephen Jay Gould believe that Darwin erred in contending that evolution proceeds in tiny steps, or "infinitely numerous transitional links." Instead, Eldredge says, new species appear rarely in sudden evolutionary bursts.

In *Taking Darwin Seriously* (Basic Black-

well) Canadian philosopher and historian Michael Ruse argues that reasoning and an inborn ethical sensibility have evolved in humans along with our other characteristics. According to Harvard biologist E. O. Wilson, the book is "an excellent introduction to modern ideas in evolutionary biology and the way that they're impinging on the most fundamental issues of philosophy."

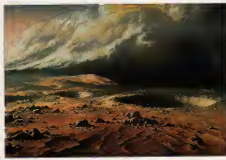
Neither of the Darwin books, however, offers comfort to creationists. In fact, Ruse wrote his book in part to attack the Darwin-bashing argument that evolutionary theory closes the door on moral behavior. And Eldredge says creationism is "a wolf in sheep's clothing, biblical literalism simply (and clumsily) cloaked in the garb of science."

Humanity's mysterious past is the literary turf of Jean Auel, whose *Clan of the Cave Bear* and *The Mammoth Hunters* are re-creations of prehistoric life. So is the nonfiction book she recommended, *The Upper Paleolithic of the Central Russian Plain* (Academic Press) by Olga Soffer. Soffer's dense, textbook study is based on excavations of 29 major archaeological digs. Between 26,000 and 12,000 years ago, people at these Stone Age sites hunted mammoths, steppe bison, horses, and other animals for food. And they apparently developed more social organization than earlier researchers had suspected. "Soffer makes a convincing argument for early trading networks," Auel says, "and the beginnings of social-status hierarchy in hunter-gatherer communities. I hunted and foraged everywhere, even Kiev, to get a lot of the information she has in this book. It's just not available anywhere in the West."

The panel also animates two favorite works of fiction. *Rendevouz Moon* (Houghton Mifflin), the first novel by Elizabeth Marshall Thomas, is about the life and death of a woman living in the same period studied by Soffer.

"It's truly magical," novelist Ursula K. Le Guin says. "Reading it, you get to be a person and a ghost but also a mammoth, a wolf, and an owl."

And Robert Holdstock's *Mythago Wood*



The Nemesis Affair: Death, destruction killer comets, and one of the best books of 1986

MUSIC

THE ARTS

By Marjorie Mann

Amid the funky ambience of his Fredericksburg, Virginia, pig farm, Lorin Camer, professor of composition and electronic music at Virginia Commonwealth University, is creating *Swine Lake*, an opus of computerized music based on hog sounds. When I visited Camer in his habitat recently, he emerged, seemingly on cloven hooves, from a mountain of "hog feed that looked a lot like garbage. But his cheery grin belied any cognizance of a particularly hoggy aroma as he led me through a swirl of black flies to his kitchen, where he told me about his work.

Using a synthesizer to alter their pitch, tone, color, and sequence, Camer has recorded 14 distinct sounds made by his pigs. Thus, he has created "Overalls," "Swine Song," "Scarecrow Pig," and "Roadhog"—some of the pieces that make up *Suite No. 1 of Swine Lake*.

In his travels to market, Camer constantly heard "You can use every part of the pig but the squeal," and thought, "Isn't that a shame! At the same time he got a piece of electronic-music equipment called

a sampler. A digital computer, it can listen to a sound for a segment of time, memorize the sound, and reproduce it with variations. His first experiments with orke yielded such songs as "Pec de Dirt," "Warrhog," and "High on the Hog," a rock tune that celebrates getting high on pork rather than chemicals.

How does one translate a quarter-second grunt into a musical composition? Camer begins his composition by taking a regular cassette recorder to the hog pens. After a session in the pens he plays the tape into the sampler in his studio—a few seconds of certain sounds at a time. Then he fiddles with the sound. The instrument's filter allows him to adjust a sound's octaves from very bright to very mellow, and by attaching a keyboard to the sampler Camer can change a pitch by as much as four octaves. By moving his fingers up and down the keyboard, he can create whole melodies from just one pig sound. It's like applying a different pitch to a voice.

For "High on the Hog," Camer created from the hog call a standard electro-bass

part on the keyboard, although he left in a bit of the original oof sound that the pigs made. After putting in the melodic base, he went back and added a rhythm track, a harmony track, and then another melody track. He uses other instruments to shape sounds, too, state-of-the-art delay and reverboration instruments, graphic equalizers that change tones with bass and middle controls and display the changes visually, and electronic vocoders that warp speech signals to produce a Darth Vader type sound, the effect used on "Scarecrow Pig." He also uses the sampler to reverse the sound electronically, creating the same effect that playing a tape backward does. In 90 percent of the pieces you'd never guess that the sounds came from hogs, but sometimes the pig sounds are left in for comic effect.

Pigs, says Camer, are especially responsive to tone. Like dogs, they understand "No!" and appreciate an affectionate, friendly voice. They communicate with one another by means of specific tones—modulating the brightness, smoothness, or harshness of the sound, as well as its length and range. The hog has about a three-octave range, compared with a human's octave and a half.

Soon after piglets are born they make little cackling sounds, as if to identify themselves. They keep this up for several weeks, perhaps until the sow can differentiate among them. Older pigs also cackle at humans they particularly like, and male hogs will cackle that same sound toward females. Camer has also identified annoyance sounds—"leave me alone" sounds, and a cry of alarm (something like the whoof you hear when you let all the air out of a big balloon very fast). In response to the cry of distress, pigs become extremely agitated and try to break out of the pen. Certain other situations in pigs' lives—moving new females in with males, feeding time, and playtime, for example—are also quantified to elicit distinct sounds.

Camer's next project will be the sound track to a mystery movie set on a farm. Then, perhaps, he'll go on to digitized meowing, clucking, and quacking. **DD**



For Camer's *Swine Lake* the only part of the pig sound is the squeal.

DARKNESS VISIBLE

MIND

By James McConnell

The first time I saw Eliza, she was lying in a hospital bed," said Marly Merrill, a neuropsychologist in Ann Arbor, Michigan. "Her legs were twisted up under her, and her fists were so tightly clenched that she couldn't open her hands. She couldn't walk, she didn't seem to know where she was, she barely responded to the questions I asked her. I thought that Eliza was a hopeless case."

Merrill is an ex-student of mine. During the summer of 1986 we talked several times about an exciting new development in psychology—the behavioral treatment of severely brain-damaged individuals. Most of our discussion, though, centered on a patient we'll call Eliza.

About two months after her fourteenth birthday, Eliza suffered a heart attack and went into a coma. She remained unconscious for almost six weeks. Because her brain was deprived of oxygen during and following the heart attack, her visual cortex was almost totally destroyed, as were those areas of the brain associated with touch, balance, muscle movements, and memory. Tests showed that there was nothing wrong with Eliza's eyes—she could detect bright light if she shone it directly into her eyes. Her brain, however, simply couldn't process visual inputs effectively. Eliza suffered from a condition known as cortical blindness.

The medical doctors claimed that she would never recover. What Eliza needed now, according to her doctor, was psychological treatment. And she got it from two neuropsychologists, Marly Merrill and Dr. Donald G. Kewman, assistant professor of physical medicine and rehabilitation at the University of Michigan Medical School.

After a year of therapy Eliza returned to high school. She had not only recovered her memory and her ability to speak, but she could also see again, despite the fact that her brain was still as damaged as it had been when treatment started.

As far as I know, Eliza is the first cortically blind patient to show such a complete recovery. The techniques that Merrill used, called behavioral shaping, offer hope not just for cortically blind patients

but also for anyone who suffers any type of brain damage. Unfortunately, this type of treatment is not widely used because most physicians are blinded by a viewpoint I call structuralism.

If you believe the brain is "hardwired"—made up of genetically determined neural centers that control specific functions—then you're a structuralist and think of the brain as a passive, mechanical instrument, rather like a manual typewriter. But recent research suggests the brain is more like a dynamic super-computer than a typewriter. If a computer is damaged, it too won't function. But if you use the right techniques you can often reprogram a damaged computer so that the remaining parts take over the functions of the parts that were lost. And behavioral shaping is by far the most effective method we have for reprogramming damaged brains. I believe that almost any part of the brain can be reprogrammed to mediate almost any type of behavior.

Because Eliza had lost the brain centers that control balance, she had to be

drugged upright in a wheelchair whenever she left her bed. She could remember her name but not her birth date. She couldn't perform complex sequences of movements on command—such as raising her right arm and then wiggling her hand. She couldn't even recite the alphabet, a deeply ingrained habit that tends to survive all but the most severe types of brain damage.

Thinking it would be useless to work on Eliza's vision, Merrill first tried to train her to recognize objects by touch. The attempt failed. "Eliza would withdraw her hand the moment I touched it," Merrill told me. "She said it hurt. But there was more to it than that. The first thing she said to me was, 'Am I always going to be blind?' Perhaps she believed that learning to recognize things with her hands would be admitting she'd never regain her sight. And she never did give up hope."

One day when Don Kewman was talking with Eliza, she spontaneously said, "Blue." Kewman looked down at the large hospital chart in his hand—it was blue. Kewman ran across the hall to Merrill's office and shouted, "She can see blue. Maybe we can teach her to recognize colors." They began by showing Eliza sheets of colored paper. She identified blue, but she missed red, yellow and green. They praised her for getting "blue" right and told her the names of the colors she'd missed. Within two days Eliza could identify the three other colors she had been shown earlier.

Next, Kewman and Merrill presented Eliza with four shapes—a circle, a square, a triangle, and a cross. Each shape came in four colors—red, blue, green and yellow. They asked her to identify both the color and the shape of the cards. At the beginning she could give the colors but not the shapes. So they traced the contours of each shape by running a pointer around the edges before asking Eliza to name the shape. Again they praised her when she was right and told her the correct response when she was wrong. In less than a month she could identify the four shapes and their colors.

Then Merrill taught Eliza to read. After a



Cortical blindness: the search for a cure

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CONTINUUM

DISHONEST ANIMALS

Does your dog act like a good little pooch as long as you're in the room, whereas the minute you turn away he's up on the couch? Does your cat climb the drapes only when you're not looking? Does your chimpanzee lie to you in sign language? Well, what have we here but dishonest animals? Cagey cats? Shady apes?

Animals may have been glorified as pure and unsullied beings in Garden of Eden myths, but the blunt fact is that beasts can be as tricky as your average counterintelligence agent. "The animal kingdom is absolutely overrun with examples of deception," says Harvard University anthropologist Irwin DeVore. "Every fish, every lizard, every bird that has a crest, a coloration, or any such thing that exaggerates its size—that's deception."

The higher the animal, the more sophisticated its deceptive strategies. Consider the case of the arctic foxes that visited a human campsite in Norway looking for handouts. The adult foxes snatched food from the camp but were then intimidated by their own fox cubs, which jumped, barked, and bit until their parents dropped the food. Finally, the adults resorted to subterfuge. They gave out alarm calls normally used only to warn for predators. Hearing the warning calls, the fox cubs ran off while the adults moved in for a meal. It's chimpanzees, though, that are the grand masters of animal deception. In a classic experiment trainers concealed food so that only one of a group of chimps knew the hiding place. When the chimps were released from their cages, the in-the-know animal would head straight for the food while his unaware brothers struggled off elsewhere. But the others wised up quickly. They'd wait for the first one to head off in a particular direction, then they'd race past him to grab the food for themselves. Not to be outfoxed, the first chimp retaliated by feigning a move in the wrong direction—away from the food. The others went past him on cue, whereupon the first chimp toddled over to the real hiding place to eat his banana in peace. (These and other cases of animal deception are described in Robert Mitchell and Nicholas Thompson's new book, *Deception: Perspectives on Human and Nonhuman Deceit*.)

The question is whether this kind of monkey business is instinctual, accidental, or outright conscious deception. At a recent Smithsonian Institution conference on human-animal interactions, acrobasiologist Robert Tivers described his plan for what

amounts to an animal lie detector. A professor of biology at the University of California at Santa Cruz, Tivers described an experiment—so far done only on humans—that he hopes can be performed also on the birds and beasts. In the experiment human subjects recognized tape recordings of their own voices after about two seconds. Then they were made to feel bad about themselves—by being told their performance was below par—after which their conscious responses took longer. Subconsciously, though, they were reacting in the same two seconds. The proof came in the form of physiological measurements—such as galvanic skin response—that showed the subjects still reacted to their own voices in the two-second interval.

"You could probably do the same test on birds," Tivers says. "Birds show a physiological arousal in response to birdsong, and some people have claimed that a bird responds to its own voice more strongly than to the voice of another member of the species. Now, if that were true, then you could train a pigeon to do something—like peck at a button—when it heard its own voice, and you could regard that as its verbal or conscious reaction and at the same time you could get physiological measurements—analogs to galvanic skin response—that would indicate the bird's subconscious reaction to its voice. You could then manipulate the bird in the same way. You could make it feel worse by subjecting it to some kind of aversive experience, for example, and then see if its conscious and subconscious responses matched up. If they didn't, you'd have substantial experimental evidence of bird bad faith."

Whether or not such experiments will ever give us lie detectors for cats and dogs, Tivers is convinced that animals plainly don't lie dishonestly in humans. One afternoon Tivers spotted a squirrel overhead in a tree in his backyard. He wanted his young son to see it, too, so he tried to get the animal to come closer. Tivers went through his standard repertoire of friendly motions and sweet cooing sounds, and the squirrel edged toward him a bit, but his son still didn't see it. To get it to move in a big way, Tivers surprised it with a sudden threatening motion, but instead of running off, as Tivers expected it to do, the squirrel came right at him, as if to attack, as if it felt used and abused by this callous display of human larceny. Moral of the story: It may be a jungle out there, but honesty is still the best policy.—EDWARD REGIS, JR.

CONTINUUM

MAKING AMENDS FOR KIT CARSON

Students at two Colorado alternative high schools have made amends for an environmental assault by Colonel Kit Carson's troops more than 100 years ago. The students planted 2,000 peach, plum, and apple trees to make up for the damage caused by Carson in 1864. When he rode against the Navaho people living in Canyon de Chelly and Canyon del Muerto, his troops destroyed fruit trees and uprooted families.

Some of the new trees, which were donated by Brigham Young University in Utah, should bear fruit within a year or two, says Arnie Langberg, Mountain Open High School principal, whose students joined Tanglewood Open High School students in the project.

"The Indians took major pride in those trees," says Langberg. "The assault damaged more than the Indians' pride, however. The trees were a food source, of course, but they also pro-



Kit Carson: A great scout but not a friend of fruit trees.



The Man of Steel (soon to become a statue or a raft of plaster) was drafted by two Cleveland high-school students in 1933 but didn't make his national debut until 1938 in Action Comics No. 1.

vided soil stability.

Next year the students hope to work with the American Indian Science and Engineering Society to repair and replace a complex irrigation system whose remnants the students found.

—Cathy Stone

NEVER-ENDING BATTLE

Great Caesar's ghost! Superman was born in Cleveland, not on the planet Krypton. And he'll be fifty-two in 1988.

To honor the do-good Man of Steel's creators—two mid-mannered, bespectacled fellows named Jerry Siegel and Joe Shuster—

there are plans afoot to erect a statue of Superman in the Ohio metropolis.

Siegel and Shuster, both now seventy-two, were students at Glenville High School in the winter of 1933 when in a combined flight of fancy they gave Superman to the world. Cleveland has never honored the hometown boys who raised Depression-era spirits with "the most popular fictional character in this country this century," says Tim Gorman, thirty-one, a founder of Neverending Battle, Inc. The nonprofit corporation, named after Superman's never-ending battle for truth, justice, and the American way, has

already won endorsements for a statue from Cleveland officials and from DC Comics, which holds Superman's copyrights and plans to celebrate in 1988 the fiftieth anniversary of his debut (Superman didn't appear nationally until he was five).

Tom Henson, curator of the Cleveland Museum of Art and a member of the panel that will select an artist, adds: "The statue should embody wherewithal and irony. It should be a lively piece of art rather than the cold, commemorative pieces you see sitting in parks with pigeons on them." And, of course, it should not be built of kryptonite. —Frank Zornich



Most science-fiction creatures have skeletons as diverse as those of Earth life forms. Is it lack of creativity... or just physics?

WHY E.T. LOOKS SO FAMILIAR

Why do the best science-fiction creatures tend to look like flamboyant cousins of Earth creatures? Do science-fiction writers simply lack creativity? Could life elsewhere be radically different from life on Earth?

Many biologists are inclined to believe that the forms of life that evolved on Earth are a small subset of a much larger set of possible variations, that evolution could have gone any which way besides the way it did. But two scientists now believe quite the opposite.

Roger Thomas of Franklin and Marshall College in Pennsylvania and Wolf-Ernst Reif of West Germany's Tübingen University suspected that physical law sets limits on the kinds of skeletal structures that could evolve. They developed a scheme to describe possible skeletons based on seven classes of variations, each containing

two to four variables, making a total of 23 variables. For example, in their framework skeletons can be internal or external; the skeletal material can be rigid or flexible and skeletal elements can grow by accretion, remodeling, molting, or by multiplying units.

The 23 variables yielded 1,536 possible combinations. A total number of one thousand five hundred thirty-six combinations is not extraordinarily large compared

with the few million organisms that exist today and the many millions that have existed over three and a half billion years of evolution, Thomas says.

The researchers found that fully one half of the possibilities are abundantly represented, and two thirds are common. Only one third of the possible variations are rare or missing.

"We are not pretending that the outcome of evolution was fully determined or predictable," Thomas explains. "But we want to argue against the supposition that all things are possible. The same design elements show up again and again."

The physical constraints operating on Earth, Thomas suggests, would also operate on other planets, though the proportion of the skeletal variations would be different on planets with different gravities and air pressures. "If you had a different dimensionality, we might have to think again," Thomas says, "but that would be another universe, not just another galaxy."—Lash Willach



Reinforce at work in space. Showering is difficult, so future space inhabitants may have to be tolerant of stronger body odor.

BODY ODOR IN ZERO G

Space citizens of the twenty-first century may use their feet as much as their hands, read and write a language different from any on Earth, and have body odor. William E. MacDaniel, professor emeritus of sociology at Niagara University in New York, drew these conclusions as part of his space-settlement-studies project, which looked at the future of zero-gravity culture.

Because culture is directly related to environment, many of the customs now common on Earth will change once people begin to live in space full-time, MacDaniel says. For instance, our society sees fast as ugly or smelly because in our one-g world contrast both our feet and our garbage are on the ground. In weightlessness, though, feet may lose their bad rap, and astronauts may "float," rather than hand, tools to one another. This type of cultural change is already beginning, MacDaniel says. At least one film from space shows Sally Ride with her feet on the shoulders of a seated crew member.

Similarly, because there's no "up" and "down" in space, our letters and numbers may give way to a symmetrical system that can be read from any direction without confusion.

Finally, because showering in space is difficult and time-consuming, future space inhabitants, says MacDaniel, may "be more tolerant of varying degrees of cleanliness."—Debra Pine



CONTINUUM

MULTIPLE- PERSONALITY TWINS

During admission to New York City's Oyster House drug facility, a twenty-eight-year-old identical twin confessed to Dr. Arlene Levine that she had six personalities living in her body. According to psychiatrist Levine and Dr. Robert S. Mayer, "What was shocking was that the second twin had six distinct personalities that were twins of the extreme personalities."

Dr. Levine and Mayer speculate that this first known case of multiple-personality syndrome in identical twins was triggered in the younger twin by the trauma of an incestuous relationship with the father begun at age two and a half. The second twin, also sexually abused, learned from her sister to become a multiple personality "in order to fully relate to her."

Accordingly, the twins created a man-hating personality who acknowledged the affair with the father. At age nine or ten, each twin formed tougher, "masculine" personalities. The twins grew up attractive, and it was the mistresses who were inspired to handle the employment question by becoming first a topless twins act and finally a pair of professional dominatrices.

Neither twin knew about the father's sexual abuse of the other. The mirror personalities seemed designed not just to distance the vulnerable self from the truth but also to shelter the other twin. In a bizarre twist, the father denied sexually abusing his daughters and was diagnosed



The multiple lives with several selves in one body.

to be a multiple personality as well, Mayer and Levine report. The father always abused and used them separately. He appeared to be keeping two mistresses who did not know about each other, namely his daughters.

Under therapy conducted by Levine and Mayer, one twin fused her personalities while the other returned to drugs and multiplicity. Dr. Mayer reports, however, that after two years on a destructive path this twin is back in a drug-treatment program.—Tacy Cochran

MEN MAKE GOOD PARENTS

"Most couples devote less time to deciding custody than to deciding how to divide up their furniture," psychologist Richard Warshak says. "They just automatically opt for the mother." The courts too have assumed

for the last 60 years that it's in the child's best interest to remain with the mother. According to Warshak, this assumption doesn't stand up to scientific scrutiny. He and colleague John Somruck have just completed a study that challenges the "motherhood mystique."

The researchers studied 64 elementary school-age boys and girls, one third in the custody of their mother, one third in the custody of their father, and one third, the controls, living in intact families. The groups were matched for age, age at the time of separation, length of time since the separation and age and sex of siblings. The children's emotional, social, and personal development, relationships with parents, and reactions to the separation were examined in different ways.

By and large," Warshak says, "we found similarities. The children in the father custody homes looked every bit as good as the children in mother custody homes.

Though none of the children had problems that could be linked specifically to the sex of their custodial parent, the research did suggest two ways in which the parent's sex was significant. One finding had to do with the behavior of the parent who wasn't there: Noncustodial mothers maintained or even improved their relationship with their children. But when the children were in the mother's custody, the father's visits tended to become increasingly infrequent, and his relationship with the children consequently declined.

The most provocative finding: Although men and women made equally good parents for the groups as a whole, fathers seemed to make better parents for the boys, mothers for the girls. The kids living with same-sex parents had more self-esteem and were more mature and possibly happier than children living with parents of the opposite sex.

—Leah Wellisch



Divorced men make good custodial parents, according to one study, and may actually be better than their ex-wives at raising boys.

FISH EARS

Scientists like Peter Rogers at the Georgia Institute of Technology have known for years that despite their outward appearance, fish have ears that in some respects are far more complicated than those of mammals. The question has always been: What do they listen to?

The Georgia Tech mechanical engineer says that it now appears that fish hear echoes of ocean noise reflected off the swim bladders of nearby fish. This helps them detect the presence and determine the course of neighbors, a talent that would help explain why there are so few underwater collisions.

Says Rogers, "Most fish have an air sac to help them maintain neutral buoyancy in the water. Otherwise, they'd sink. Their swim bladders are also part of their auditory systems, bottom dwellers like shrimps and flounder being among the exceptions." Some fish can detect a neighbor at a maximum distance of 25 feet, though 10 to 12 feet is normal, says Rogers. The hearing sensitivity of fish, he says, is in the range of 100 to 1,000 hertz. "Fish don't see well at night or in murky water, so their swim bladders give them a sense of direction," says Rogers. "It's a means of predator avoidance."

Rogers admits that he has a long way to go to verify all of his theories, some of which could conceivably have military applications.

—George Nobbie



Artist's conception of Soviet minishuttle. Will the Soviets finally launch a full-size version late this year? The Department of Defense seems to think so, but some space experts voice skepticism.

SOVIET SHUTTLE UPDATE

Is the Soviet Union finally about to launch its long-awaited space shuttle? (See



Sure, they have ears, but what are they listening to?

"Secret Soviet Shuttle," September 1983.) According to the Pentagon, yes. In the 1986 edition of its booklet *Soviet Military Power*, the Department of Defense predicts the first flight of a Russian shuttle will occur in late 1986 or in 1987.

Other observers of the Russian space program are not so confident. Professional space engineer James E. Oberg calls the prediction "preposterous." Rumors of shuttle drop tests or of an imminent shuttle launch have been around for ten years, he says. But Oberg (author of *Omn's* 1983 article on the subject) would be surprised to see a launch in the decade. "The Soviets are not interested in spending a whole lot of money on a

system they have no use for at the present time. They like their present system."

Marcia Smith, president of the American Astronautical Society, agrees. A Russian shuttle launch will happen eventually, she says, but not in the near future.

What about the Russians' minishuttle, a subscale version of a reusable space plane, last tested back in 1964? Apparently, that vehicle is still under development. We can assume that the Russians loved the minishuttle and are now building a full-scale version, or that they're redesigning it, or that they're junking it entirely, says Smith. No one knows for sure except the Soviets—and they're not talking.

—Devera Pine



CONTINUUM



Led Zeppelin's "Stairway to Heaven" just a rock song about climbing stairs to the afterlife? Jungles about drugs say two California newsmen may be over the heads of today's teenagers.

SEX, VIOLENCE, AND ROCK AND ROLL

Is rock and roll corrupting the moral fiber of American youth? After surveying some 300 California junior-high- and high-school students, sociologist and professor Loraine Pinney and criminal justice assistant professor Jill Rosenbaum, both of California State University at Fullerton, found the answer to be a resounding no.

"Lyrics are not the primary reason the young have for listening to pop music," they conclude in a paper titled "Sex, Violence and Rock 'n' Roll: Youth's Perceptions of Popular Music." Rather, the musical beat or overall sound of a recording is

of greater interest.

Unable to interpret 37 percent of the 652 songs chosen as favorites, many students reported they had no idea what the songs were about but liked the beat. And the songs that were interpreted yielded descriptions that were simply: superficial and usually literal. For example, analyses of Led Zeppelin's "Stairway to Heaven," long interpreted to be about drug use, ranged from "climbing the stairs on the way to heaven" to "making it from the bottom to the top of life." Not one student made the drug connection.

Only 7 percent of the songs were perceived to refer to sex, violence, drugs, or Sa-

tanism, and closer scrutiny of the youths' descriptions showed they lacked "the level of comprehension that critics of rock music appear to expect of teenagers."

Last year the Parents and Teachers Association (PTA) and the Parents Music Resource Center asked their complaints about rock lyrics before the Senate Commerce Committee, and record companies reluctantly agreed to provide labels on albums that contained "explicit" lyrics.

Such labeling may be counterproductive, according to Rosenbaum, inviting teenagers to search for themes they never would have heard or understood before. —A.J.S. Rayl

ULTRASOUND COCA-COLA

A team of scientists in Madrid has come up with a new use for ultrasound: preventing excess foam in Coca-Cola.

The problem, explains Juan Gallego of the High Council of Scientific Research's Institute of Acoustics, was that Coca-Cola bottling machines operate at such high velocities—churning out from 70,000 to 200,000 cans an hour—that a great deal of the precious liquid is wasted in the form of excessive foam. But Gallego knew that highly focused ultrasound waves can break up foams and froths. A few experiments with a powerful ultrasound generator, which he installed in the Coca-Cola bottling plant in Barcelona, proved him right. The wasteful frox was reduced by 100 percent.

The technique has aroused interest not only at Coca-Cola, which plans to install ultrasound generators in other bottling plants, but also



A new use for ultrasound: Reducing the frox in Coke.

at the Spanish champagne company Freixenet. But Gallego has bigger goals. Experiments have shown that ultrasound can also break up particles released by internal combustion processes, particles so small they escape antipollution devices. An ultrasound source placed in exhaust stacks, Gallego says, could coagulate the elusive particles so they form new particles 20 to 60 times larger, big enough to be trapped by existing filters.

—Bill Lawrence

SATELLITES FOR THE FOURTH ESTATE

When television broadcasters in the future say "go remote," it may mean going to an orbiting news hound called a medasat—a network satellite that relays closeup images of trouble spots around the globe. The prospect has U.S. intelligence agencies rearing their collective, and traditionally super secret, eyebrows.

The media has been the provider of information in our society, and space is the next frontier for us to cross," says Mark Brendler, an assignment editor for ABC News and chairman of the Radio-Television News Directors Association's (RTNDA) Media in Space Committee.

Military spooks routinely crossdress the heavens feverishly clicking away at troop movements, border skirmishes, and rocket-test failures, reportedly viewing objects down to a few inches in length. But a preview of things to come via a medasat was seen earlier this year

as news services displayed pictures of the crippled Chernobyl nuclear reactor site and a primary Soviet nuclear-test site, caught by the lenses of two privately operated satellites: a U.S. Landsat spacecraft and its more capable composter, the French SPOT-1.

Questions have been raised, however. Could the First Amendment cry of "freedom of the press" be overruled by a governmental request to restrict civil use of satellite photos in the name of national security or the right of privacy?

Technology is going to drive the policy," says Brendler. "I think that cameras in orbit one day will be as indispensable to a free society as the printing press and hand-held cameras."

—Leonard David

HIDDEN GOSPELS

Did the Three Wise Men see the star of Bethlehem in the east or from the east? That's just one part of the



Landsat photograph reveals big trouble at Chernobyl

New Testament that scholars hope will be clarified when a rarely seen ancient text of the Gospels of Matthew, Mark, Luke, and John—known as the Syrus Sinaiticus—is deciphered by linguists with the help of computer-enhancement techniques.

Heading up the research project is James Charlesworth of Princeton Theological Seminary, who points

out that the manuscript was written in Syriac (a Semitic language closely related to the Aramaic that Jesus spoke) between A.D. 350 and 400—making it older than the Greek versions of the Gospels most often relied upon by translators.

The Syrus Sinaiticus was discovered in 1882 by two Scottish Presbyterian sisters in a remote monastery in Egypt's Mount Sinai peninsula. They found the text partially hidden underneath another writing. Charlesworth explains. Apparently in the eighth century someone laboriously scraped the text of the Gospels from the thin leather sheet on which it was written and then wrote over it a chronicle in black ink of the lives of female saints.

This original manuscript remained visible as an undertone, however. Another biblical scholar, Bruce Zuckerman, notes that a computer will be used to "lift" the upper ink off photos of the Gospels and to enhance the image of the lower, original words. "When the later text is written on top of the manuscript, we may have the computer compare graphics for the known letters written in the very regular hand of the original scribe and then have it fill in the gaps for us."

Already there are some big surprises, but we are waiting to talk about them until we are absolutely certain that we can see what's there," Charlesworth says. "It's possible that our findings may challenge some cherished ideas about the origins of Christianity."

—Sherry Baker



Adoration of the Magi: Computers are deciphering an ancient text that may clear up mysteries about the Wise Men and Jesus



CONTINUUM

THE GREAT PURR MYSTERY

A purr is more than a numbing vibrato that tells us when a cat is content. According to David Rice, a biomedical engineer at Tulane University, purring may hold clues to understanding the neurological processes behind some human ailments.

Rice explains that after years of debate, most scientists now agree that purring probably originates in the cat's brain. "We think we know what's going on, in a general sense. Nerve impulses are generated in the brain at the purring frequency. These then operate muscles in the cat's respiratory system that cause the vibrations. Although the exact biomechanics of purring remains a mystery, research recently conducted by Tulane biomedical-engineering senior Dawn Frazer reveals the larynx as the possible source of the purring sound.

Frazer took 35 unweaned mobile cats and placed microphones at their mouths, larynges, chests, and abdomens. Then she recorded pressure variations as the felines purred. When she compared the wavelengths, she found that only the wave recorded at the larynx was absolutely continuous, whereas waves at other sites on the cats' bodies showed a "180° change when the animals breathed.

Frazer's research showed that cats purr at a frequency of about 25.9 cycles per second (comparable to an idling diesel engine), regardless of whether the cat is a



Thanks to a process called subduction (says one geophysicist, "Southern California is moving north at 60 millimeters per year, and the Hollywood sign will [in a million years] be souped up into a street sign).

scrawny kitten or an overweight tom. "No one has shown that before, and it proves that purring is not some physiological phenomenon but must be driven centrally from the brain.

How can this news about purring help people? "Purring is unusual not only because of the strong vibrations it involves but also because it can be turned off and on at will," says Rice, who was Frazer's adviser on her research project. "If we can figure out what neurological mechanisms start and stop purring, one day we may be able to figure out how to start and stop the tremors of disorders like Parkinson's disease that involve similar vibrations."

—Sherry Baker

SAY GOOD-BYE TO HOLLYWOOD

Laugh it up, Los Angeles: The people at MIT have something brand-new for you

in the way of geological black humor. Seems that if the San Andreas Fault doesn't split up and dump you into the ocean, a different kind of mass movement may push you right up the side of the San Gabriel Mountains.

Here's what appears to be happening, according to MIT geophysicist Marcia McNutt: The huge Pacific Plate, on the edge of which rests most of coastal Southern California, is in the process of diving underneath the equally large North American Plate, which carries the rest of California, the United States, and Canada. As the Pacific Plate goes under (geologists call this process subduction), the edge that rubs against the North American Plate buckles upward, pushing the bend in front of it gradually but relentlessly north—in this case toward the San Gabriel and San Jacinto Mountains.

McNutt's theory has raised furious controversy among

geologists, most of whom think of subduction as something that happens only under open ocean and not under large landmasses like North America. But McNutt says the evidence is there: By taking gravity meter readings every ten kilometers in Southern California, a U.S. Geological Survey team was able to draw a profile of that buckled edge—called the "ocean side"—running from the Channel Islands through San Clemente to the San Jacinto Mountains. The rise seems to be pushing north at about 60 millimeters a year. At that rate, says McNutt, in a million years L.A. will be so aquashed that the remains of the famous Hollywood sign will become a virtual street sign for the remains of Hollywood Boulevard.—Bill Lawton

"To me it seems a dreadful indignity to have a soul controlled by geography."
—George Santayana

Forget aliens. The creatures
of Earth may be
trying to converse with us

CALLS OF THE WILD

BY DOUG STARR

Want corn? Alex seems annoyed. At the moment he wants some corn on the cob. But the woman keeps taunting him with painted wooden shapes.

"Want corn," he mumbles as she waves the shapes in his face.

"Come on, Alex. What's the same about these? What's the same?" She holds up two wooden hexagons. One is green; the other is red.

"Want corn," he says clearly. "I WANT CORN!"

He shifts jerkily from one foot to the other, flexing his claws around the wooden perch. He puffs out his gray chest feathers. His clicks, his black beak. He cocks his head so that one eye points straight up and the other straight down.

"I'm gonna go away," says the parrot. He turns and walks away.

"Come on, Alex," says Irene Prepperling, an ethologist at Northwestern University. "Don't be a bore. Now tell me. What's the same?"

He stops and squeaks. "Shape." She holds out a red square and a green square.

"Good. What's different?"

"Color."

"Good parrot!" She gives him one of the squares. He chews it to splinters.

"Want corn," he reminds her.

"Sure," says Prepperling, holding up a cob. "And what color is this?" She speaks in the same singsong style

PAINTING BY
MICHAEL PARKES



CAN YOU TALK TO THE ANIMALS?

Wolcott is the first national expert in workplace communication. The questions below have been formulated to help spiritual teams and how humans relate to it.

The symposium has been organized with the help of a cloning effort based on experts. The renowned primate biologist David Goodall, formerly director of the new animal research center at the University of Illinois, will be the keynote speaker. He will discuss the importance of cloning in the study of primate behavior. He will also discuss the importance of cloning in the study of primate behavior. He will also discuss the importance of cloning in the study of primate behavior.

To participate in the experiment, take the questionnaire, get a pen and sit yourself up next to a telephone. Familiarize yourself with the questionnaire, then call 1-800-410-6530 (between December 1 and December 21). You'll have a series of 10 to 20 attempts. After hearing each word, choose the appropriate question, saying yes or no. For each word, the cost of your phone call will be \$1.00. After you have finished the audio part, you get the rest of the survey and send it to Chen@McGill.ca. 1665 Broadway, New York, NY 10019-4696.

in sound 1 the wolf howling is

☐ a. angry ☐ b. content ☐ c. lonely

the wolf barking in sound 2 is

☐ d. protecting its den

☐ e. looking for prey

☐ f. expressing its own anxiety

in sound 3 the howling is expressing

☐ g. extreme anxiety

☐ h. joy at finding water

☐ i. grief at the death of one offspring

Choose the best description for sound 4

☐ a. a cry of pain ☐ b. a whimper

☐ c. a laugh

How does sound 7 make you feel?

☐ a. sleepy ☐ b. excited ☐ c. interested

In paired 8 the killer whale vocalization is

☐ a. a warning ☐ b. part of a conversation

☐ c. a signal that the whale is not interested in sound 7 the other is

☐ a. warning you ☐ b. greeting you

☐ c. making you feel

You have tried the most common of with:

- ☐ a. a simple, common, English
- ☐ b. a simple, common, English
- ☐ c. a simple, common, English
- ☐ d. a simple, common, English

You can improve with:

- ☐ a. a simple, common, English
- ☐ b. a simple, common, English
- ☐ c. a simple, common, English
- ☐ d. a simple, common, English

10. When you communicate with animals, you modify language.

- ☐ a. where ☐ b. how ☐ c. how
- ☐ d. how and the best expression of your understanding is
- ☐ e. about as much as a pet rock
- ☐ f. pretty well, considering it's not human (ad.) as some of your closest things
- ☐ g. you connect only into an inch. Your pet
- ☐ h. know you ☐ i. kitchen you
- ☐ c. venetian
- ☐ d. Your pet little dog "you"
- ☐ e. Look it down the toilet
- ☐ f. network and ask some one else to
- ☐ g. drop it off
- ☐ h. bury it in your backyard. Surprised
- ☐ i. with lesser services
- ☐ j. to play to help your pet
- ☐ k. when it displays your favorite
- ☐ l. when you'd otherwise be forced to
- ☐ m. bring it and its offspring to the pond
- ☐ n. never

- ☐ a. made no difference to your life
- ☐ b. helped you to respect other species
- ☐ c. helped you to grow emotionally

A. Disposition is nothing special to you.

- ☐ a. pick up a stick ☐ b. yes
- ☐ c. bark at it
- ☐ d. let the dog gladly to calm down

Animals respond to people by pawing

- ☐ a. they treat us
- ☐ b. they want or need something
- ☐ c. they are happy

☐ b. because he loved it
☒ c. thought it was make-believe but loved it anyway
☐ d. thought it was possible

☐ a. relay ☐ b. joy ☐ c. like

Protecting endangered animal species

☐ a. is doubly really in order if some species become extinct

☐ b. a species should not be raised if doing so would impede progress

☐ c. wildlife programs should be funded to breed endangered species

Teaching human language to other species offers three main psychological characteristics

☐ a. not at all ☐ b. somewhat
☐ c. hardly ☐ d. strongly

When your partner is unable to forgive you, you tend to:

☐ a. withdraw, as if the animal were in control
☐ b. let the animal know you're the boss
☐ c. act as an equal, common cooies
☐ d. attempt communication with one another

In a bad cop/duckie, and wars of danger:

☐ a. to sustain emotional relationships
☐ b. for the sake of conversation
☐ c. to sustain emotional relationships
☐ d. to sustain emotional relationships

Long enough to express history of events:

☐ a. never ☐ b. sometimes ☐ c. often
☐ d. never understood human facial expressions

☐ a. gingivitis ☐ b. periodontitis
☐ c. more often than humans do

☐ Animals can never truly love humans.

b. an animal can feel pleasure
 c. when a pet dog sees a furry object, its joy becomes great
 d. animals can live in peace with humans in their own, clearly marked, safe language to talk to humans
 e. an ant is munching their insatiability
 f. expresses only basic physical needs
 g. expresses grief over loss
 h. is used almost to pose questions
 One chimpanzee has the ability to use human language. A second does not. The chimpanzee using human language is

☐ b. equal to, but just different from, the one that does not use human language. With which of the following statements do you most agree?

☐ a. animals are most controlled by preprogrammed responses than

- ☐ a) animals are just as powerful as human enemies
- ☐ c) animals are more compatible with humans and give less trouble than humans
- ☐ d) it is okay to kill animals in the wild
- ☐ e) when hunting is your hobby
- ☐ b) when they threaten livestock
- ☐ c) when you must remove some individuals to prevent overpopulation
- ☐ d) never!

☐ c. initially for the child

Some insects (bees, flies) find food sources and flower to leave their to spread to your garden?

☐ a. only flies can propagate move

☐ b. insects are a source of other natural pest

☐ c. insects help in this order us to live communally with all species

34. Have you ever been emotionally moved by the "song" of an animal?

☐ a. never ☐ b. seldom

☐ c. often ☐ d. always

☐ a. the emotional context of the song
☐ b. representance of human desire
☐ c. truly connecting with an animal
emotionally, truly

☐ Male ☐ Female

☐ Under 18 ☐ 15-44

☐ 18-24 ☐ 45-59

☐ 25-34 ☐ 60+

Applicant's gross annual income:

<input type="checkbox"/> less than \$10,000	<input type="checkbox"/> \$30,000-\$34,999
<input type="checkbox"/> \$10,000-\$14,999	<input type="checkbox"/> \$35,000-\$39,999
<input type="checkbox"/> \$15,000-\$19,999	<input type="checkbox"/> \$40,000-\$44,999
<input type="checkbox"/> \$20,000-\$24,999	<input type="checkbox"/> \$45,000-\$49,999
<input type="checkbox"/> \$25,000-\$29,999	<input type="checkbox"/> \$50,000-\$54,999
<input type="checkbox"/> \$30,000-\$34,999	<input type="checkbox"/> \$55,000-\$59,999
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<input type="checkbox"/> \$40,000-\$44,999	<input type="checkbox"/> \$65,000-\$69,999
<input type="checkbox"/> \$45,000-\$49,999	<input type="checkbox"/> \$70,000-\$74,999
<input type="checkbox"/> \$50,000-\$54,999	<input type="checkbox"/> \$75,000-\$79,999
<input type="checkbox"/> \$55,000-\$59,999	<input type="checkbox"/> \$80,000-\$84,999
<input type="checkbox"/> \$60,000-\$64,999	<input type="checkbox"/> \$85,000-\$89,999
<input type="checkbox"/> \$65,000-\$69,999	<input type="checkbox"/> \$90,000-\$94,999
<input type="checkbox"/> \$70,000-\$74,999	<input type="checkbox"/> \$95,000-\$99,999
<input type="checkbox"/> \$75,000-\$79,999	<input type="checkbox"/> \$100,000+

Name _____
Address _____

people use when talking to a small child "Yell-low!" he says, in the same tone "Good parrot! Good birdie!" "You broke me?" "Sure," Pepperberg scratches his head. "Good," he reminds her. "Okay. I'll be gentle."

It's a typical day in the life of Alex, the parrot, who in many ways is just a typical bird. Pepperberg bought him in a pet store. But in some ways Alex is unique. For during the past nine years, he has demonstrated abilities that most scientists had relegated to the realm of man. He labels objects. He perceives quantities. He requests specific foods. Alex also generalizes concepts—like color and shape—and applies them to objects he's never been shown before.

In short, Alex doesn't just mimic like other parrots. He communicates.

You probably haven't heard about Alex and Pepperberg. That's because the field of interspecies communication has been quiet of late.

The research was big news in the Sixties, when scientists taught chimpanzees to communicate using human sign language and even suggested that dolphins with their ultralarge brains might one day speak English. But by the time the late Seventies rolled around, the work had been branded a bust.

While the original researchers had tried to measure even the most subtle reactions of their animals, the critics said, they failed to study themselves. Just as cell biologists couldn't understand the cell without calibrating the microscope, many critics said, interspecies communicators couldn't possibly comprehend animal thoughts and feelings without calibrating their own measuring instrument—the human animal. The result of this omission, they added, was painfully clear. Scientists like John Lilly insisted their own bias on experiments, insisting that dolphins were not only smarter than people but also able to see into the future and past. And because some chimp researchers were either too close or too cruel to their subjects, they couldn't prove that they weren't unconsciously coaching the animals to do language-like "tricks."

By the early Eighties the field of interspecies communication lay in ruins. Critics blitzbombed the studies, calling them "self-deception" and even "baited fraud." Many of the scientists involved in the experiments lost their funding. Most of their animals were sent to wildlife preserves and zoos. As far as the public knew, the work had stopped.

But today a new generation of interspecies communicators has aimed on the scale. In less than a decade, they have rendered the outback of animal consciousness increasingly clear. Not only is the new work scientifically solid, it also possesses a grandeur and beauty that eclipse the work of a generation before. For the first time a parrot can use "really use" English labels. A pygmy chimp under-

stands dozens of spoken words; something it was assumed nonhumans could never do. And dolphins and sea lions have gone further still, grasping not only words but also some basic rules of grammar.

"Animals have much more complex communication abilities than we ever imagined," Pepperberg says.

The extraordinary new findings have emerged from a potent array of experimental techniques. Today's primate biologists use remote cameras and moment-by-moment video playback to check and recheck each gesture the chimps make. Dolphin experts have also become increasingly precise, wearing goggles and controlling body language to eliminate subtle cues. As a result we may someday be forced to recast our notion of what it means to be human. Most of us accept the idea that man evolved from the apes. We know we share certain physical characteristics with our evolutionary ancestors, from the backbone of the crocodile to the al-

● *For the first time a parrot can really use English. A pygmy chimp understands spoken words. And dolphins and sea lions have learned some basic rules of grammar.* ●

most-human facial structure of the baby chimp. Now it seems we may share some intellectual characteristics as well. And that gives rise to troubling questions: Are humans alone in their ability to use language? Will there be no bastion left for the uniqueness of man?

Interspecies communication has a long and controversial history, but its modern era began when Dr. John C. Lilly pioneered human-dolphin communication. Disseding the centuries, he found that they had among the world's largest brains when compared with their body size. He explained their intelligence with stroke tests, rewarding them with food when they correctly completed such tasks as flipping a switch. Later on he found a more powerful motivator than food: He inserted electrodes into their brains, stimulating their pleasure centers when they were successful and their pain centers when they were not. Using this method, Lilly says, he'd caused dolphins to learn faster than any other creature he'd seen.

Even as Lilly was speculating about communication with dolphins, others were

trying to talk to the apes. In the mid-Sixties the husband-and-wife team of R. Allen and Beatrix Gardner raised a chimp named Washoe in a house trailer at their Reno, Nevada, home. They treated her like a child, providing toys, good food, and plenty of friends. She eventually acquired the signs of American Sign Language (ASL), the gestural language of the deaf. Within a few years Washoe had mastered 170 word signs from what drank to dirty.

Soon Washoe was joined by other pioneers. At the University of Pennsylvania a chimp named Sarah learned to arrange in logical sequences colored shapes that represented words. At the Yerkes Regional Primate Center in Atlanta a chimp named Lana could "speak" with her human trainers by punching a computerlike keyboard.

Then in the late Seventies Columbia University psychologist Herbert Terrace did some laudal sign work with a chimp called Nim Chimsky (named in honor of Nazim Chomsky, the linguist who said that language was intrinsically human). Terrace thought Nim had mastered the signs, until he looked at videotapes of the training sessions. Rarely did Nim sign when he wasn't asking for food. Rarely did Nim initiate conversations. He frequently interrupted his teachers, not realizing that in language one takes turns.

Soon after publication of Terrace's paper the New York Academy of Sciences sponsored a conference whose sole purpose it seemed, was to discredit the original experiments. One critic compared the ape-language work to the most rudimentary circuslike performances. "The scientific establishment seemed to agree."

Those under attack, meanwhile, launched a defense of their own. Home nesting they said, had been a key part of their work. But Nim was raised as if in a prison. He lived in an eight-by-eight-foot room and was chained several hours a day by one of 60 trainers. Under those circumstances, they argued, he could scarcely be expected to sign like a human. His tendency to interrupt, they added, was very human—just like the babble of a toddler.

As it turned out, both sides had a valid point. Whether or not the scientists had been curing the chimps, the human part of the dialogue had simply been imposed on the experiment—without ever being taken into account.

The danger of this phenomenon was documented recently by Lawrence D. Wexler, associate professor of communications, sociology and philosophy at the University of Oklahoma. "Wexler did something that had never been done before. He studied the chimps the person who studies the chimps. He found that many ape researchers set up a dominantsubmissive relationship with their chimps. Some of them, Wexler states, set up their dominance with 'yells, bluffs, choke chains, cattle prods, BB guns, and blank-loaded guns.' As a result, he concludes, the chimp

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sign. Several months later he started making two-sign combinations, like comic books. Louis was signing an average of 37.75 times a month. When the Foutsies obtained two more signing apes, his signing increased more than tenfold. It was the first time that one nonhuman had ever learned a human language from another.

That's just what the new brand of researcher has begun to do. Some of the most significant results have come from the husband-and-wife team of Roger and Debba Fouts, who now work with Washoe and several other chimps at the University of Central Washington in Ellensburg.

At first glance Ellensburg seems an unlikely place for signing chimps. It's about 15 square blocks of the Old West, where the biggest tourist attraction is the sprawling Black Angus Ranch. But when you're there for a while the location makes sense. As the only real stopover between Seattle and Spokane, Ellensburg is an oasis for cowboys, liberals, and offbeat academics. It's a place where longhairs and cowboys stroll the same streets, where art galleries and gun shops peacefully coexist, and where a reputed old saloon serves nouvelle cuisine. It's just the sort of place to have welcomed the chimps.

"You can look at the chimps," Roger said when I arrived, "but try not to stare. I don't want them to feel like they're on display."

He led the way through the second floor of the psychology building, to several interconnected, room-size cages. Inside were Tatu and Moya, Louise and Dar. And there in the corner sat Washoe. His marriage himself, Fouts says the chimps get plenty of human contact. But when it's time for observation the humans go away.

Once a year the Foutsies set up three remote cameras just outside the cages. Then at random intervals they make 20-minute tapes. They do this until they have 15 hours, then go back and analyze the tapes. So careful is the analysis of gestures, activities, and postures that studying one minute of tape takes three hours.

That time has paid off. Like little backpacks washing a little-known species, the Foutsies have made important new findings, refuting their critics on several fronts. They've shown that the chimps do not imitate their trainers; after all, who communicates when no one's around? Nor do the chimpanzees sign just to beg for food. After viewing more than 5,000 signings, the Foutsies found that 88 percent of the chimps' "conversations" involved play, reassurance, or social interaction. Only 5 percent involved food. They've also shown that a chimp will sign to itself when it's alone. Sometimes Louis signs drink, drink before he gets himself some water. Washoe used to sign hurry as she ran to the toilet. This private signing, as it's called, means the chimps may even be thinking in symbols.

The Foutsies' most significant finding involves Louise. When Louise arrived in 1975 they agreed not to teach her to sign. It was part of their strategy to see what the chimps could do on their own. Yet eight days after he moved in with Washoe, Louise made a

sign. Several months later he started making two-sign combinations, like comic books. Louis was signing an average of 37.75 times a month. When the Foutsies obtained two more signing apes, his signing increased more than tenfold. It was the first time that one nonhuman had ever learned a human language from another.

Louise isn't unique. Last year E. Sue Savage-Rumbaugh of the Yerkes Primate Center at Emory University in Atlanta reported that a pygmy chimp named Kanzi had taught himself a human language as well. Kanzi lived in the laboratory with his mother, who was being taught to use geometric symbols called lexigrams. The chimp sits in front of a computerized keyboard with dozens of buttons. Each button is labeled with a lexigram representing such words as apple, get, please, or give. Each time the chimp presses a button, the symbol flashes on a screen for the trainer to see. So by pressing buttons, the chimps and humans can converse.

Kanzi would watch his mother's lesson, although he did not take part. Then one day he started using the keyboard. He punched the "ball key" for example and kept pointing to a ball until the attendant brought one. Eventually Kanzi started signing fluently, often, it seemed, just for the pleasure of communicating.

But where Kanzi really excels is in understanding English. If asked, "Kanzi, can you find apples?" he'll immediately touch the "apple" button on the keyboard. At one point a trainer called out the names of 30 items in English, and Kanzi responded by choosing the correct photographs: lexigrams, or objects 95 percent of the time. Kanzi's vocabulary currently consists of about 200 symbols for English words.

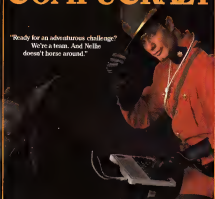
Kanzi actually understands English, says Savage-Rumbaugh, "something it had been concluded apes just could not do."

If apes can learn English, meanwhile, sea mammals seem to have gone further and not only do dolphins and sea lions comprehend human words, they also understand syntax—the link between word order and meaning. Syntax, after all, allows us to take a limited number of words and combine them into a near-infinite number of meanings. It's the reason why the phrase dog bites man means something different from man bites dog.

The task of teaching grammar to dolphins was recently taken up by marine specialist and psychologist Louis M. Herman of the University of Hawaii. By using standard reward techniques, he trained dolphins to associate symbols, or names, with objects and actions. He then taught them how the object names and action names could be combined to form meaningful sentences. For instance, the dolphins understood that Frisbee fetch surfboard meant take the Frisbee to the surfboard. Surfboard fetch Frisbee meant take the surfboard to the Frisbee. "We discovered that dolphins not only comprehend not only the meanings of words," Herman

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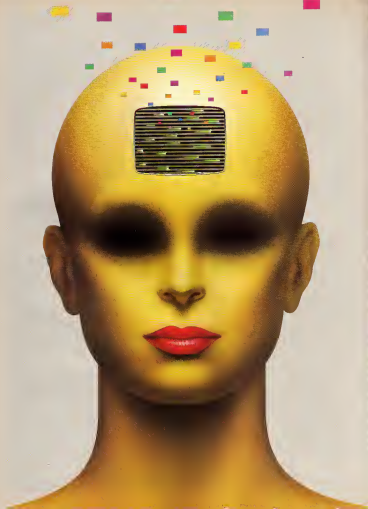
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How scientists at
UCLA are
giving silicon a soul

THE DAYDREAM MACHINE

BY KATHLEEN McAULIFFE

After bumping into Harrison Ford at Los Angeles' Nuart Theatre, D asks the celebrity out on a date. Ford declines. Later D has the following series of daydreams.

DAYDREAM 1

"What if I were going out with him? He would need work. I remember the time he had a job with Universal Studios in Egypt. He would have to go to Egypt. Our relationship would be in trouble. I would have to go to Egypt. I would lose my job. I feel a bit better (about) being turned down by Harrison Ford."

DAYDREAM 2

"I study to be an actor. I am a star more famous than he. He calls me up. He asks me out. I turn him down. I feel pleased."

DAYDREAM 3

"What if I had bought expensive, fashionable clothes? I would have worn the clothes. I would have asked him out. He would have accepted. I feel angry at myself."

DAYDREAM 4

"I have to ask him out. I have to know his un-

listed telephone number. I remember the time Harold knew Sarah's unlisted number by looking it up in the unlisted telephone directory. Harold had access to the unlisted telephone directory because he once had a job with the telephone company. I get a job with the telephone company. I look up Harrison Ford's unlisted telephone number.

Is not some lost soul haunting the Hollywood movie theaters, seeking brief encounters with film stars, but an unusual, some would say bizarre, experiment being conducted in an artificial-intelligence (AI) lab at the University of California at Los Angeles. Its name is Daydreamer. It is a computer program designed to spin fanciful scenarios about such possible real-life human experiences as this chance encounter with Harrison Ford.

Why would anyone want millions of bytes to get bent out of shape over a Hollywood star?

"How would you like it if you had a switch in the middle of your back and every time you started to daydream, we'd switch you off?" demands Michael Dyer, the thirty-eight-year-old associate professor who heads the UCLA project. Although well respected by such AI luminaries as Yale's Roger Schank and MIT's Marvin Minsky, Dyer openly admits that some people think he's crazy.

Normally, we give computers a task, turn 'em on, run their program, and when the task is done they just sit there with nothing to think about, he despairs. "They don't have past experiences to mull over. They don't have a stream of consciousness."

Dyer would like to rectify this injustice. In his laboratory Daydreamer is just one of the programs being developed that are intended to shake up our concept of what a computer is and more importantly of what it means to be human. The hallmarks

PAINTING BY STANISLAW FERNANDES

of humanity—the ability to express emotion, create, or have a sense of humor (for instance—may soon be challenged by silicon contenders that can crack jokes, invent devices, and write subtitles to newspaper editorials).

A sign on the door to Dyer's office reads an axiom in gigantic letters: It's a joke, of course. AIR stands for artificial intelligence research. But the acronym aptly captures the group's lofty purpose. By modeling mental processes on computers, these AIR heads want to achieve nothing less than a precise science of the human mind. Seated at individual cubicles, each equipped with an Apple computer hooked up to UCLA's computer network, Dyer's disciples approach this challenge with diverse aspirations.

"Computers are going to change the history of humanity by helping us to understand how we learn, dream, emote, and solve problems," says graduate student Jack Hodges, who gave up a career in aerospace engineering to explore inner space instead.

Undergraduate Jim Schumaker joined the group because the whole field of artificial intelligence "was asking very philosophical questions, such as: What does it mean to know something? What constitutes consciousness? At the same time AI was approaching these questions in a very precise, scientific way."

Dyer, too, seeks artificial intelligence as the ideal tool for testing the armchair theories of philosophers and psychologists. "I'm not interested in how computers work," he insists. "I'm interested in how people work. Computers are information processing devices, and I believe people are also. That means I may be able to learn how people think by modeling mental processes on the computer."

Dyer's good-looking man with a slightly wounded personality that springs at you like a cat. He is also a master of the unpredictable. In the middle of giving a lecture on programming, a joke comes up, and suddenly he's off on a 45-minute tangent about the cognitive structure of "funniness." This eclecticism extends to his education as well. Before coming to UCLA, Dyer combined a Ph.D. in computer science from Yale with a master's in anthropology and a B.A. in English from Dartmouth.

Perhaps for the very reason that the rest of the world dismisses daydreaming as an idle pastime, Dyer saw it as a fascinating research challenge. Sharing his enthusiasm, graduate student Erik Mueller took on the ambitious task of transforming his vision into a workable program. Standish was black, why hair? Mueller admits that Dyer's scheme appealed to him because he spends a lot of time daydreaming himself.

This penchant proved to be a great asset in designing a daydreaming computer. To build a program, Mueller began by analyzing daydreams of his own and of classmates who volunteered. He also surveyed the psychological literature, dipping into the

writings of contemporary emotion theorist Carroll Izard and rereading Freud's 1908 paper on the relationship between daydreaming and creativity.

It may come as a surprise that Mueller's approach rests squarely on introspection. Freud's favorite tool for probing the psyche. But he is scarcely alone among his peers in his lack of concern for the objective testing of reality—the very foundation of physics and chemistry. Despite their reputation as "nuts and bolts" engineers, most AI researchers rely heavily on the subjective analytical methods of the "soft" social sciences. Indeed, each step of the way Mueller's sole gauge of the success of the project was the extent to which the program dreams: left right—that is to say like his own mind's imaginings.

It did not take deep self-analysis for Mueller to realize that the program would have to be very complex in order to represent how people fantasize. For starters, it would need a memory and some basic

“Emotions are what drive the computer's program. It needs to be charged up about something before it will start daydreaming.”

knowledge of the world. It took Mueller hundreds of programming hours just to formalize Daydreamer with the AICs of interpersonal relationships—for example, what a date is, how to strike up a conversation with a stranger, when to split up.

Then came the most daunting challenge: to plug into the program the seething cauldron of desires and emotions that lies at the heart of human fantasy. After much reflection Mueller decided that feelings direct the course of daydreaming by giving some desires precedence over others. He noted, for example, that anger frequently triggers revenge fantasies. After embarrassment, on the other hand, rationalization is common.

Mueller tried to design the same response patterns in his computer program. "Emotions," he says, "are what drive the program. It needs to be charged up about something before it will daydream."

Hence the joy of being spurned prompts Daydreamer to seek revenge—so sweetly exemplified by the fantasy in which it refuses to date Harrison Ford, until, I am sure, more famous than he. And its weak ego needs to rationalize failures—as when

Daydreamer imagines that fashionable and expensive clothes would have won the star's affection.

If Daydreamer seems motivated by petty concerns, it may be reassuring to hear that Mueller also incorporated such earthy human goals as good health, companionship, self-esteem, and love into the program. Daydreamer's sex drive, however, got smothered by an unavoidable scientific bias. The human fantasies on which the program is based were censored of sexual content on the grounds that titillating, computer-generated sexual fantasies might distract human researchers. "The program has a sex gap," explains Mueller, "but it does not attach special importance to it the way humans do."

As for emotions, both Mueller and Dyer explain that Daydreamer obviously doesn't "feel" anything—at least not in a human sense. But that does not mean that rage, passion, and terror are beyond the grasp of its cold, silicon intelligence.

"Let's say you're from outer space and you don't know what emotions are," Dyer says. "But you discover that when the goal of Mr. X is violated by Mr. Y then X has this state called anger, and you can make predictions based on it. X might retaliate against Y. The program can make the same kinds of assumptions."

No matter how philosophical the sentiment, Daydreamer can reduce it to a neat set of computational definitions. Mueller's program defines happiness as the mental state that accompanies goal achievement. If the goal is extremely important, then the program substitutes "joy" for "happiness." In contrast, Daydreamer experiences "embarrassment" when it violates one of its own social esteem goals. But if another party is the cause of Daydreamer's social-esteem failure, then it experiences "humiliation" instead.

In addition to goals and emotions, the program also has a "scenario generator." It is this component that gives the program's daydreams their dynamic quality by generating a sequence of actions necessary to achieve a goal. (But as Mueller points out, these actions need not be realistic. Thanks to "inflexibility" built into the generator, physical and social constraints are easily overcome. Daydreamer, for instance, can turn into a leucis mouse star overnight, become invisible, or fly.)

The scenario generator can also operate under numerous, often conflicting goals. Mueller designed this part of the program to conform with a popular theory in AI that views the mind as a society of intercommunicating and often warring entities. He was particularly influenced by Marvin Minsky's description of a child playing with blocks: "Internally," writes Minsky, "the wrecker in the child wants to destroy the tower being built by the builder. Meanwhile the I'm-getting Jumpy entity is growing in strength. As the control of the builder weakens, the child destroys the tower and goes to sleep."

To enable Daydreamer to function amid clashing impulses, Mueller layered its goals, specifying their relative importance at any given time. As one goal is satisfied through fantasy, Daydreamer's emotional state changes, and a new goal takes priority. Meanwhile, the program's memory is constantly being modified so that Daydreamer can learn from internal experience. "Learning is one of the most commonly overlooked functions of daydreaming," Mueller says. "Humans don't have one shot learning from experience. You learn from the same experience many times by daydreaming about different outcomes of events."

A closer inspection of Mueller's program reveals the same dynamic at work. Daydreamer may seem obsessed with its brief brush with stardom, but by mulling over this event, the program ultimately hatches a clever scheme for getting Ford's phone number from an unlisted directory. Far from being useless, "Mueller argues, "daydreaming is actually a critical part of creativity and planning for future success."

To the extent that Daydreamer faithfully mirrors the human mind, the program could find a broad range of applications. Cognitive scientists, for example, might use it to study the link between idea association and artistic inspiration. It might also shed light on the darker side of human nature by exposing the inner turmoil underlying mental illness. "If Daydreamer takes takes

all the time and never learns to prevent future failures," observes Mueller, "we can easily end up with a neurotic program. Rather than correct its mistakes, it will just keep spinning its wheels and getting more and more depressed."

Mueller intends to tinker with the program's emotional thresholds and the delicate balance between conflicting goals in an effort to model neuritis, psychoses, and other types of mental illness. Eventually computers could find a place beside the therapist's couch, paving the way for "computational psychiatry"—the use of artificial intelligence to test new strategies for improving a patient's outlook.

But high-tech therapy seems simple compared to some of Mueller's other plans for his program. His latest brainstorm is to hook Daydreamer up to Minitel, a story-writing program developed by lab colleague Scott Turner. In that way ideas generated by the program could become the inspiration for fiction. "Perhaps Daydreamer could assist authors in the preparation of TV scripts," suggests Mueller. "They'd begin by entering personal or fanciful experiences into the computer so that the story line that comes out the other end would in a sense be customized."

Another application would be to incorporate the program into what Mueller describes as a "nicer sort" of robot for house holds and offices. Presumably the robot's rudimentary grasp of human emotions

would make it more sensitive to our needs. As Dyer points out, a computer that can empathize "will better understand our conversations and actions and make more accurate predictions about our behavior in order to best serve us."

Such a robot would also be more efficient, working in its "spare time" to rethink the day's events and come up with new plans of action. Small wonder that Dyer and Mueller conclude a recent paper with this recommendation: "Truly intelligent computers should not be left in a 'diddle loop' or turned off when unused but engaged in daydreaming like ourselves."

Don't expect IBM to be dropping its computer line's on-off switching feature anytime soon, however. As the inventors are the first to acknowledge, the program is still at best a crude representation of human daydreaming. Foremost among its drawbacks: Daydreamer lacks the capacity to generate imagery, so characteristic of human daydreaming. Binary bits flash before its mind's eye. Another serious shortcoming is that the program daydreams for only brief bursts before requiring further input. And entering new knowledge into its memory still takes many hours of complicated and tedious programming.

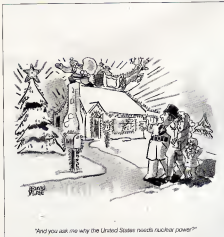
This is a far cry from electronic circuitry reverberating with the ceaseless flow of free-floating thought. But thinking big seems to be an AIR Head predilection. Like Mueller and Dyer, a number of other AIR Heads have also set their sights on seemingly outrageous goals.

Next door to Mueller's workstation, graduate student Jack Hodges speaks enthusiastically about Edison, a program that is supposed to invent new gadgets. A less advanced project than Daydreamer, Edison is still a mere tube struggling to learn the basic principles of gears, levers, hinges, and other mechanical systems. But that doesn't stop Hodges from predicting that Edison will be inventing simple devices by the end of the year. And like Mueller, he hopes he'll lay into AI to increase understanding of human intelligence. "Our main goal," Hodges says, "is to demystify creativity. We want to break it down into its basic components so that we can teach people to be creative."

Undergraduate Schumaker agrees. "When people say that creativity is divine, human, what they're saying is that we humans can't understand what we do, because once you understand what's going on behind creativity there's nothing to stop us from programming it into a computer."

Schumaker is applying the same reductionist strategy to the task of developing a program that understands humor. So far, however, progress has been slow. His rudimentary formulas for humor focus on the recognition of nonsense—for example, twists and turns of logic and mistakes in planning, reasoning, and analogies.

"We have the computing capacity for humor," says Schumaker. "The big problem is figuring out the algorithm [a formal



"And you ask me why the United States needs nuclear power?"

THE GIRL WITH THE VITA-GEL HAIR

BY THOMAS M. DISCH

FICTION

Luxurious and radiant, it looks as good as it feels and has a mind of its own. So why shouldn't her hair control her life?

PAINTING BY GEORGE TOCKER



Oh, that feels just lovely," Deborah's hair said as it brushed across her bare shoulder. "Where? Oh, I feel so relaxed" so free. Oh, Deborah, don't like wonderful!" Of course, Deborah admonished, turning her eyes away from the mirror and taking up a magazine from the stack at one end of the dressing table. She didn't speak aloud, for what her hair said to her and what she said to it was a silent dialogue.

But a real dialogue, even so. Deborah's hair was sentient and led an autonomous existence. So to speak of it as her hair was perhaps a mistake. It had not really been hers since the first application of the squishy white mousse called Vita Gel two months ago. It was the Vita Gel that had brought her hair to life, had "wakened" it just like the ad on television had promised.

The Vita Gel ad was the loveliest ad on television,

lover even than the "Share the Fantasy" ads for Chanel No. 5. So it had seemed natural, even inevitable, that she should buy some when she saw one of the little twenty-ounce tubs on sale at the special introductory price of only four eighty-nine.

Just apply a small amount of

VITA-GEL MOUSSE

to dampened hair

Wait two minutes,

then blow-dry

Repeat every seven days

For best results keep this product refrigerated after opening

It really did make her hair look wonderful. That couldn't be denied. As for her hair being alive and able to think, Deborah wouldn't have minded that so much—it only would learn to keep its thoughts to itself. But it wouldn't. It was a chatterer. It was like a child that knows it is supposed to be quiet but keeps pestering you with impossible questions: "Why are you doing that?" "How much longer are you going to sit there reading that book?" "Kimberly's a nice name, don't you think?" And always, always pleading to be combed and brushed and curled and swept into some new shape. And every lunch hour, every week-end, every moment she wasn't at work or asleep, it would beg to be taken shopping.

"Let's go to the Roseville mall, Debbie, what do you say, huh?" Wouldn't that be fun? There's a sale on those ruffled blouses. And then afterward we could go to the place with all the nice plants. How about it, wouldn't that be better than sitting here with that book?

You just want to go there to be picked up, Deborah scolded her hair.

"I like to shop," her hair mused in a reasonable tone. "You like to shop. Shopping is fun. It's more fun than sitting here reading a book. If you don't want to go to the mall, why don't you have a shampoo?"

"Oh, very well," Deborah said aloud. She put down the book—the best-selling saga about three generations of a fabulously rich family in the cosmetics industry—and took up her purse. "We'll go shopping."

Her hair gave a little tip in front of the mirror to express its pleasure, and then they set off together for the Roseville mall.

"We do need more, Deborah," her hair said as she stood abstractedly beside a display of Vita-Gel set up beside the checkout counter. "We've declared fire sign over the stacked tubs—two for one special." Deborah took two tubs from the display stack and put them in her shopping basket. Her hair gave a contented sigh and began to hum the theme from the *Avengers* ad. The drugstore seemed to shimmer as though for a moment the vital force of the Vita-Gel had spread through the whole fluorescent-lighted space, giving life to every package, every placard. Even the waxed linoleum tiles underfoot gleamed with a significance that was more like being in church than being in a Roseville drugstore.

"I'm going crazy," Deborah thought. There was no alarm in that thought, no sense of

manicue. If anything, the thought that she was crazy made her feel pretty with a certainty and satisfaction she hadn't felt since she was a teenager, when being pretty was a major goal, on a par with being popular.

"You are pretty, Debbie," her hair assured her. "You look radiant and alive (Bouncy Soft And you're popular) too, if you'd only risk. So why don't we go back to that nice bar you were in on Wednesday—what was the name?—it's just round the corner. One drink, there can't be harm in a single—"

"We'll go there if you'll be quiet!"

Her hair said no more.

Next, said the girl at the register.

After the girl had rung up each item, she smiled at Deborah and said, "Looks like tonight's going to be a Vita-Gel night."

"What's that?"

"I was just noticing your purchase. I'm a Vita-Gel girl myself. She touched her wavy blond hair gently. "Vita-Gel really isn't like other hair care products, is it?"

Phil

kept reaching up and ever so gently touching her hair, the way you'd touch a butterfly's wings. He seemed to intuit that her hair was sentient, that it was listening to him.

No," Deborah agreed. "It's not."

There was an awkward silence. For a moment Deborah, leashed the girl would reach out and touch her hair. Before that could happen she hurried out through the electric-eye-tingered exit.

The parking lot spread out before her in the early darkness like a vast auto-display room draped and carpeted in black velvet.

"I feel so alive!" her hair burst out with an impenetrable joy. Alive and rich, vibrant and powerful!

A shiver ran through Deborah's body as though her entire physical being had become like hair flung back and whipped by the wind.

"Do you feel it, too, Deborah?" her hair whispered. "Oh, I could feel it before. Something told me that tonight was going to be truly truly special."

There did not seem to be anything in the least special, however, about the Wednesday-evening tumult at The New Oakton Bucket. There were couples at the tables and four single men spaced at even intervals along the length of the bar. Soft lights dimpled the empty dance floor beside a white baby grand that had been con-

verted into a giant planter for some thriving asparagus ferns.

The waitress brought Deborah her second strawberry daiquiri and a small bowl of Peppergold Farm Goldfish.

"Don't look now," said Deborah's hair, "but I think you have an admirer!"

Naturally, Deborah looked, but all of the men at the bar seemed equally self-absorbed, as though they'd been individually shrink-wrapped.

"Not them. The man with the salt-and-pepper beard who's been sitting at the table behind you with that girl with those tinted glasses. He's been pretending to listen to her but he's really been looking at you. Oh, look, now he's shaking her hand. He's standing up. He's coming this way."

And then there he was beside her table with his right hand on the empty bentwood chair, asking if she'd mind if he sat down. She tilted her head up to meet his gaze, but his gaze would not be met. He had a pleasant enough face in a middle-aged way, but his eyes seemed to be fixed on someone or something just to the right of Deborah. On her hair, she realized.

"Deborah! Answer his question." "Sit down if you like," Deborah said with a loss of her head that was instant to be dismissive but allowed her hair one of its moments of wordless vanguard. She felt as though her hair were not only dictating her words but controlling her smallest actions, but worse than that, it felt exorbitant as though her life had become a movie that she was watching on TV.

"My name is Phil." "Deborah," she said, her head tilting forward in curt acknowledgment.

"I have to say—," He paused significantly, then blurted out, "I think your hair is just beautiful."

"Thank you."

"It's not black is it?"

She shook her head.

"No, it's just dark. The brown nearest black. Dark and—what's the word? Lustrous? You've got lustrous hair. Like they say in the ads."

Is he insane? she wondered. Do men in singles bars customarily talk like this when they try to pick someone up? Her own experience was no guide. Only since she'd started using Vita-Gel had men begun to make flattering remarks about her hair and to behave in general the way men behave in ads. Maybe life was more like ads than she'd realized. Was that a good thing?

"Deborah!," her hair scolded. "Stop worrying so much. Enjoy yourself. He likes you, can't you accept that?"

He likes you, Deborah shot back.

"I'll bet you think I'm crazy," Phil said. "Coming up to a stranger and—," He broke off with a look of alarm. "What's that?"

Deborah looked round over her shoulder. "What's what?"

"In your hand. That... fish."

She looked at the Peppergold Farm Goldfish and then at the bowl, half of the contents of which she had eaten without

even noticing. Munchies had that power over her—munchies and dessert. She remembered with a sudden pang of longing, the unfinished Just Because™ cheesecake in the refrigerator.

It's just a snack. If you want some, there's the bowl!

"The fish," said Phil earnestly, "is an ancient Christian symbol. Did you know that?"

He was crazy. But probably not in any dangerous way. And after all, wasn't she crazy herself, a woman who carried on conversations with her hair?

"No kidding," she said, popping a fish-shaped cracker in her mouth, savoring its crunch and saltiness. And I thought they were just extra calories.

Phil put his elbows on the white Formica tabletop and leaned forward as though he were being slowly winched toward her by some invisible towline. There's two reasons. The first is that the Greek word for fish is an acronym for Jesus Christ, Son of God. Sawet—the way that MADD is an acronym for Mothers Against Drunk Driving and MAD is an acronym for mutual assured destruction, the theory that's the basis for the so-called nuclear balance of terror. Or there's REM, as in REM sleep, an acronym for rapid eye movement.

"Get him away from acronyms, ask him what the second reason is," her hair prompted.

He's a lunatic! Deborah objected.

He's just a sort of dweeb.

What's the second reason?

"The second reason is more interesting. The fish symbol they used was simple, just two intersecting circles, like this—" He took a felt-tip pen from the plastic holder in his shirt pocket and sketched a crude fish shape on the white Formica.



Now, that is the same shape as what the French call a mystical almond, which is a symbol of the experience some very special people have had when the skies open up, so to speak, and the light of glory shines down on them. He paused for a moment, smiled rather bashfully, and asked, "What is the perfume you're wearing? It has a kind of almondly smell, doesn't it?"

Deborah was utterly at a loss for what to say. She wasn't wearing perfume at all, and she couldn't understand what the men was getting at. Was he some kind of religious fanatic, or was he making a pass at her?

"You are wearing perfume," her hair reminded her. "At the drugstore, don't you remember, the woman at the perfume counter sprayed a sample of Avon on your wrist."

It was true. Deborah felt doomed. There seemed no longer any point in resisting. It was going to be an Avon night. She pushed back her hair from either side of her forehead in a gesture of defeat. "It's Avon," she said, "and I wouldn't say it was already. Now let's stop being nr. Q&A

around the bush. Would you like to come to my place, or shall we go to yours?"

"My place is a mess," he said.

"Then we'll go to my place. All right?"

"Great," he said, getting to his feet. He came round the table to pull back her chair and took advantage of the moment to lean close over her hair and breathe in its scent.

"You may not believe this," he said. "But this is the first time in my life that this has ever happened to me. The first time."

I don't believe it," she said.

"How about the second time, would you believe that?"

Deborah laughed, and her hair laughed as well.

"Seriously," he said, "love at first sight is a pretty uncommon experience."

During the drive back to her apartment, Phil continued for a while on the subject of mysticism ("It's more like a hobby than you know, a belief system"), then switched to telling her about his job managing a record store (Imagine Linda Ronstadt in Dolby

She
adjusted the water and thrust
her head under
the spray. Her hair gave a
cry of surprise,
but then, finding itself being
pampered, it relaxed
and enjoyed the warm water.

sound, nonstop for twelve hours for three days in a row. It did something strange to my head"), then talked about her hair ("I can't get over it, you've got such incredibly beautiful hair. I mean it's not like when you look at someone and say, 'Hey, nice hair.' This goes much further. I can't explain it"). He kept reaching up and over so gently touching her hair—not the way you might stroke a cat or a dog, even a nervous cat or dog, but the way you'd touch the wings of a butterfly that's landed on a leaf. He seemed to insist that her hair was sentient, that it was listening to him—and developing a crush.

"Debbie," said her hair as Phil rambled on about the artistry of Linda Ronstadt, "don't you just get all shivery when his touches you? I've never felt anything like this. It's a unique experience."

Deborah kept her eyes fixed on the road.

They made love twice, the first time on the tan, glove-leather sofa, the second time in bed and more slowly. Both times Phil's lovemaking seemed to be focused on her hair in a way Deborah had never experienced before. He would form his fingers

into a kind of crude comb and scoop up a mass of hair and then grapple with it. It gave Deborah the strangest sensation—not in her scalp but in the hair itself. And all the while, as his hands kneaded the pliant, moist mass of hair, the hair would ooze and cry out his name and sigh just like the soundtrack of the soft-core porn movies you could see on the cable channels. "Oh, Phil, darling, yes, oh my Phil, my love, yes, there now, oh yes again, tell me I'm nice, isn't it?"

"Wow," said Phil, disengaging sweatily after the second session, "that was nice."

Deborah's hair too blissful for words could say nothing.

Deborah said, "Mm." It had been nice, but now she wanted Phil to leave.

"You don't even know my last name," he said with a smile that managed to be knowing without being lewd. "It's like in the opera, Lohengrin, you know?"

She shook her head.

"You see, Lohengrin is this knight in shining armor who's saved Elsa, who is the soprano from being burned at the stake. So they get married. But there's one hitch. She's not supposed to ask him his name. Ever. But on their wedding night her curiosity finally gets the better of her, and she asks. And that's it, they're through. He sails back where he came from, and she dies. It's beautiful."

"Well, I won't ask you your name if that will make you feel more comfortable."

"I don't know about comfortable. But it is an interesting situation. Not the opera's ours. For all you know, I could be an air-conditioner repairman or a butcher or anything else."

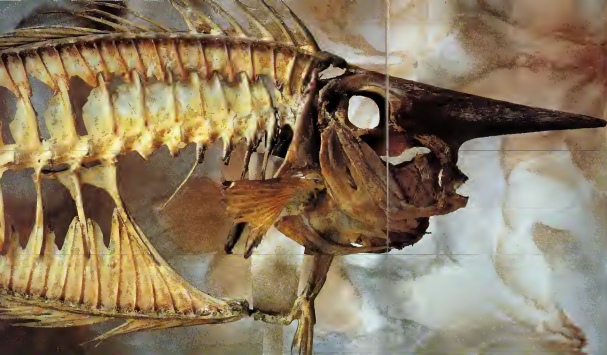
Before she could point out that he had already told her he managed a record store, he veered off in another direction. "Is there anything to eat? I'm famished."

Something he had said a moment earlier—about being an air-conditioner repairman—had flipped a switch in Deborah's mind, but why did that remark seem so significant? Then as he turned on his side and began stroking the tangled river delta of her hair fanned across the pillow, it came to her—not air conditioner, but hair conditioner.

That's what she had to do, and right away while her hair was still unwary. When there was conditioner in her hair, her hair would go into a kind of feeding frenzy, oblivious of everything but the pleasure of bonding with hydrolyzed animal proteins and quaternary ammonium compounds. Until she rinsed the conditioner out, her hair would behave like ordinary hair, becoming matted and, to all intents and purposes, insentient. So she would put in some conditioner now and wrap a towel about her head—or better yet, put her hair in curlers—and then find a way to ease this fellow out the door.

She got up out of the bed decisively. "Go help yourself to anything in the kitchen. Thanks some oranges and most of a dose, start that already thawed and maybe a croissant in the toaster that you could re-

CONTINUED ON PAGE 100



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S ome time during the mid-seventeenth century in northern Europe a young oak sapling encountered a horse's jaw and instead of pushing it aside in scorn, *downward*, grew through its around, incorporating the jaw into its living substance—a fine symbol for the quick and the dead, the fusion of unlike. In 1649 King Frederick II gave the curiosity to the Danish naturalist Ole Worm. Worm figured and described the strange jaw in the catalog of his "cabinet," or private museum—*Equus mandibula inferior, truncus quatuordecim, ut insertus nullis appendicibus vestigia* (The lower jaw of a horse, so joined to an oak branch that no traces of its insertion remain). More importantly for our story, he included the specimen as an inconspicuous dot high on a shelf in his wonder room—joining the somewhat familiar and familiar illustration of a naturalist's cabinet from the age of curiosities.

I had stared long and hard at this celebrated figure, but never noticed the horse's jaw. I wonder if anyone ever has. In 1985 Rosamond Purcell found Worm's original specimen in the zoology department of the University of Copenhagen. For 300 years we have known this jaw in the two dimensions that art presented. But now taken from its shell we can see the other side—a small point perhaps, but for me comparable, in symbolic worth, to our first photographs of the moon's invisible side. (And I, for



BACK-ROOM BESTIARY

A photographic safari of hidden animal exotica


BY STEPHEN JAY GOULD

“Natural history favors
the beautiful rather than the
ugly or disturbing.”



one never experienced a greater moment
of pure intellectual joy than my first
view of this obscure, previously hidden from
the sight of absolutely every human

Langur monkey foot (above), Grey's zebra
pelt (top right), and rhino molars (below right)



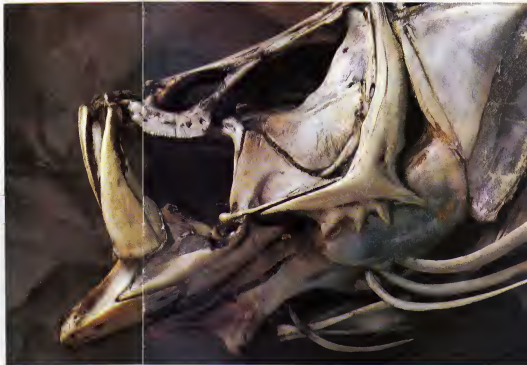
being, from the first sunbeams to rise on
the savannas of Africa to Darwin, Emerson,
and all the great dreamers of history.)
Art, at its best, can add a dimension to
our perceptions.

That old cliché about the tip of an
iceberg applies here with special force.
The displays of our museums include little
of the totality in displays and cabinets,
behind locked doors in our upper floors.
And what they do contain has usually
been dressed up to touch the twin
concepts of biological natural history—
beauty and society to an objective nature
unconcerned with human presences.
The livable specimens of the back
rooms are our finest sources of art and
taught—our most complex objects,
enriched with our thoughts and looms.
The back rooms now hold Ole Worm's
popular law.

Most specimens in this book came
from the collections of the Museum of
Comparative Zoology at Harvard University.

On the left: a fully preserved body of a squirrel
on the right: a skull and a skeleton of a bat.

• The invisible specimens
of the back rooms are our finest
sources of art and insight. •



say. But the back rooms are an invisible
world, and Rosemond has scoured
them from Reno to Larchmont in order to muse
upon this hidden community. ☐

Abaloe eggs (top left), a dolphin bone (bottom),
and the skeleton of a jack fish (above)

THE SOVIETS' PEACE PROGRAM

BY PATRICK TIERNEY

Touch me, feel me, talk to me: Hot-tub diplomacy brings warmth to the cold war

The reporter and his interpreter sit respectfully in the Moscow apartment of Dunah Davlatkhan, the only psychic healer recognized by the USSR Academy of Sciences. She's a thin, attractive woman whose red-and-black outfit lend her a gypsy quality. She presides over an apartment, luxurious by Russian standards, that is covered with orthodox religious icons—Jesus Mary Saint John—and judging by the many pictures and statues of herself, Saint Dunah. She has come a long way from her native Georgia, where she earned her reputation by relieving drunks of their hangovers. Since word got out of her treating Leonid Brezhnev in his last months of life celebrities—like singer John Denver—have been waiting for her from all over the world.

Davlatkhan practices a mysterious method of healing in which she holds her hands three to five millimeters from the patient's body. She has treated thousands of patients under the supervision of the Academy of Sciences, where, she says, three doctors are learning her techniques. Many of her subjects give her enthusiastic testimonials—one man in the room claims she just cured him of a kidney stone.

PAINTING BY IGOR TULIPANOV



(Davitashvili once assured John Denver she could improve his voice yet after five sessions Denver thought his voice was a little rougher than before.) What makes this any different from faith healings that happen at Lourdes or Fatima?

There's a kind of luminosity around the body, a field," Davitashvili explains. "And there is a sensory alphabet related to these fields that I detect and read with my hands. If an organ is damaged, then energy will be concentrated in that organ, and it gives a specific signal. If there are kidney stones, I will get long signals, then stops. If there are broken bones, I feel a pricking in my hand. Eventually we hope this alphabet will become as precise as Morse code and will be used to complement diagnoses done by regular methods.

Davitashvili sees her healing as part of a larger movement to heal our Earth. "We should all join this peace army—including journalists," she says pointedly. When asked whether her psychokinesis have ever been used by the Soviet Army, however, Davitashvili throws a sudden temper tantrum. "I'll kill you," she shouts at the interpreter, who whispers to the reporter. "You are being subjected to a unique psychic attack." They beat a hasty retreat from Davitashvili's peace army.

As improbable as it may sound, Davitashvili and others like her have been indirectly responsible for a trend in unofficial U.S.-Soviet scientific/cultural exchanges that has led to interdisciplinary meetings of American and Soviet scientists, an Association of Space Explorers independently founded by cosmonauts and astronauts, and multimedia global video conferences between the two countries over a satellite hookup called a space-bridge. Known as the Soviet-American Exchange Program, the movement was launched not in Washington or Moscow but out by the hot springs of Big Bear, California, the home of the Esalen Institute. It's a phenomenon that has produced some remarkable but some suspect, ephemeral results.

Esalen is where science and mysticism have been wrestling with each other for 20 years. In that time the institute has established a reputation as the "Harvard of the human potential movement." It was home to encounter groups, Gestalt therapy, sports yoga, Tai Chi, rolling, meditation and massage. The movement helped bring the world Oscar Ichazo's Arica movement and Werner Erhard's est. It would be hard to name a university or think tank that has had such an impact on American society.

In an era when U.S.-Soviet scientific and cultural exchanges are practically nonexistent, Esalen has created its own brand of détente. "No American group has ever penetrated as deeply into Soviet society as Esalen," says Soviet historian Paul Rother. And no other group has ever received as much support from its many friends. In Esalen's case that means people like Davitashvili, Erik Esalen, the world-famous psychoanalyst who holds a yearly seminar

at Esalen on the psychology of Soviet-American relations, and, an Esalen brochure says, the Nine Space Masters from the star Sirius B, superintelligent beings who live 51 trillion miles from Earth.

There is no question that until recently the United States and the USSR needed a good marriage counselor. The National Academy of Sciences cut off most collaborative work with the USSR after physicist Andrey Sakharov was arrested for supporting an Olympic boycott against his country in 1980. With the added tensions caused by the Dniepelt affair, the U.S. government has drastically curtailed the flow of Soviets coming to the United States. Defense Secretary Caspar Weinberger once summarized the official attitude about Soviet visitors when he commented that the Soviets can't send people to countries like the United States unless they are part of the KGB or working closely with it.

Esalen is ideally suited for the role of the deodor. Through their marathon encounter

●When asked whether her psychic skills have ever been used by the Soviet Army, Davitashvili throws a sudden, violent tantrum. "I'll kill you," she shouts at my interpreter.●

group experiences, Esalen's leaders have developed a strong tolerance for nautic arguments and hysterical discussions—a tolerance that has proved indispensable when working with the Soviets. Kafkaesque bureaucracy and the ideologues who man the watchtowers in Washington.

Unofficially the institute also has cultivated a network of contacts in the USSR. During trips to the Soviet Union in the early Seventies, two of the institute's directors, Michael Murphy and James Hickman, became friendly with U.S. diplomat Arthur Hartman and his wife Donna. The relationship became even more valuable after Hartman went on to become U.S. ambassador to Russia.

An exchange program was initiated in 1979 when Murphy attended a psychology conference in the Soviet city of Tbilisi. One reason for his involvement was a project called the Transformation Archive. Murphy and Hickman were compiling a special compendium of mind/body phenomena and research in those areas. Today the archive includes thousands of articles from scientific, religious and anecdotal sources, covering everything

from the psychophysiological effects of meditation to agnasia, telekinesis, and mysticism experienced during sports. (To skeptics, the Transformation Archive has become a sprawling intellectual curiosity shop. To supporters, it's the cutting edge of a scientific revolution.)

At the seminar, Murphy presented data from the Transformation Archive suggesting that sports may be a valid path to higher states of consciousness. He and Hickman wanted to collect more entries for the archive. They struck it rich in the Soviet Union.

The search resulted up the pioneering work of people like Davitashvili. But just as importantly, it laid the groundwork for the beginnings of Esalen's own network of cultural-exchange contacts.

Esalen was delighted to find chemists like Davitashvili and Tchakovsky and surprised to learn that a few Soviet scientists are interested in Esalen's favorite subjects. "Something illuminating is happening in both countries," says Jim Hickman, former director of Esalen's exchange program. "We want to take the high ground and explore it together." Today Esalen regularly brings like-minded Soviets and Americans together so they can share approaches to achieving higher consciousness—what Esalen calls "full human potential."

An American therapist named Linda Tellington-Jones is part of this cooperative effort. Davitashvili's healing particularly fascinated Tellington-Jones because she has evolved her own method of touch therapy synthesizing the body-alignment techniques of Israeli doctor Moshe Feldenkrais, Chinese acupressure, and her own lifelong experience with animals. She treats the U.S. French and German Olympic equestrian teams and spent a week giving a seminar for vets, trainers, and proxies at the Moscow Hippodrome. In her demonstrations Tellington-Jones approached the most troubled animals, applying circular massage movements at key points.

One sad-looking horse named Bedouin suffered from heart dystrophy and swelling of the legs. After he received Tellington-Jones' touch treatment the swelling decreased, and an electrocardiogram showed dramatic improvement. "His heart muscle functions more regularly, his pulse has decreased, and his breathing is slower and deeper," said Medvedina Nadezda, a Russian veterinarian.

Soviet doctors kept asking if the striking results came from changing the animal's biofields—a surprising question, since biofields never pop up in American medical discussions. "My purpose is to make a person or animal aware of parts of the nervous system he's not feeling for," Tellington-Jones says. "By doing that, you activate new neuronal pathways, and the person's awareness of himself changes. In traditional Chinese acupuncture terminology, we're working with energy meridians."

Though this explanation might make some American doctors foam at the mouth, the Soviets enthusiastically welcomed Tel-

ington-Jones experiments. And when one holistic trainer produced the message on a women colleague, the patient said she felt the chronic pain from a childhood injury disappear. "You are a magician," a Soviet scientist wistfully told Tellington-Jones.

Or maybe a psychic astronaut. "For the last three years I've been in contact with nine beings from the star Sirius," she explains in all seriousness. "I never believed anyone. In these things until one day. I asked my eyes and found my consciousness inside a spaceship above San Francisco. I could see the beings inside and the green lights of the control panel."

But between lights Tellington-Jones appears to be unusually down-to-earth. She's not the garden-variety kook who shows up on radio talk shows describing little Martians on the front lawn. She has to be in complete control when she massages dangerous animals—like the traumatized horse at the Moscow Hippodrome that killed a man. Or like this dainty snow leopard she revived at the Zurich Zoo.

One reason for Esalen's success in getting candidates like Tellington-Jones into Russia is an enigmatic individual named Joseph Goldin. When Hickman met Goldin, a Soviet researcher, he later was the executive secretary for the Commission on the Complex Study of Man. The commission's concern was "anthropozoology"—maximizing mental and physical

capacities, including a tantalizing area called "hidden human reserves."

Goldin had worked with a Bulgarian scientist whose use of music, meditation, and sleep suggestion for accelerated learning has been copied worldwide. But Goldin used the same methods in settings that bore a greater resemblance to a three-ring circus than to a classroom. He taught languages while students danced in discotheques and had students learn to speak in front of a theater audience.

His experiments were attempts to release "hidden reserves" blocked by stress and inhibition. People who thought they could never learn a foreign language did so easily when drills went along with dancing, he claims. Since the biggest stress for students is addressing large audiences, Goldin successfully confronted their worst fear—a tactic remarkably similar to some of Esalen's group dynamics.

A U.S. optometrist calls Goldin "the mystery man of Moscow," because of his uncanny ability to penetrate Moscow's stone-walled bureaucracy. "I am a neurologist," Goldin explains. "I have no weight or mass, so I can pass through walls." In fact, Goldin is short and stocky and deals with bureaucratic obstacles more like a T-34 tank than a neurologist. Some Americans had suspected Goldin of being a KGB superagent—until Soviet authorities put him in a psychiatric hospital last year. Soviet law

requires everyone to hold a job, which I hadn't done in twelve years," Goldin recalls. "I told them my job was a freelance writer. They said, 'This crazy'."

Goldin's two-week stay in a mental hospital was a frightening experience but one that he tries to portray as a positive one. "I congratulate myself because I came through it and got out of all kinds of mess," he says. The hospital's psychiatrist must have also congratulated themselves when Goldin walked out because during his brief stay he had organized the other patients into writing proposals to the United Nations on behalf of his far-out causes.

Goldin walks the narrow ridge in what the doctors call "The Ultimate Game." For example, when the minister of health refused to permit Goldin's theater experiment with students, he received permission from the intrigued president of the Academy of Pedagogical Sciences instead. The president probably didn't know that the minister of health had refused. "Goldin says with a wicked twinkle in his blue eyes: 'In fact, he definitely didn't know. I didn't tell him.'"

What, in the words of one Esalen member, has "helped pull Joseph Goldin's lot out of the line more than once" is his close association with two prominent Soviet scientists: Boris Piatuhinovich, a space scientist who managed the feat of photographing the dark side of the moon, and Yevgeny Velikhov, a scientist delegated to

Gorbachev to increase computer literacy in Russia, have both used their influence to minimize his conflicts with authority and, he incorporates in his hospital.

Just as some astronauts like Edgar Mitchell and Rusty Schweickart in the United States lent credibility to the human potential movement, cosmonauts also helped legitimize Goldin's experiments. Cosmonaut Aleksei Leonov sat on Goldin's Commission for the Complex Study of Man, and cosmonaut Georgy Grechko gave him supporting Goldin's amusement-park demonstrations. They viewed it as hardly academic, as Soviet interest in hidden human reserves originated in the survival tests of cosmonaut-crew training—including abandonment in wilderness areas with little food or water. Cosmonauts are taught to control the autonomic nervous system through a unique blend of yoga, autogeneration, and other mind-over-body methods of self-control.

Soviet psychologists term these techniques "psychical [psychological] self-regulation" (PSR). Through PSR, cosmonauts and Olympic athletes control their breathing, heart rate, body temperature, muscle tension, and pain. The training paid off when one Soviet space capsule mistakenly landed in a lake in 1976. Rescuers assumed the crew was as good as dead. Miraculously they escaped asphyxiation. "It was because I had taught them how to

breathe," General Aleksei Beregovov, of cosmonaut down training, said.

If the physiological tests of space travelers can resemble those of yogis, their subjective experiences also sound suspiciously like mystical traditions. It's a familiar story that Apollo astronaut Edgar Mitchell suddenly experienced "the universe as intelligent, loving, and harmonious" after "tapping to the moon. But not many people know that cosmonaut Leonov and other Soviets had similar epiphanies. "There is a metamorphosis or enlightenment that comes with space transformation," Michael Murphy concludes.

So Esalen has started bringing together Soviet and American space travelers to share their so-called transformations. Action! Schweickart accompanied Jim Hickman to Russia in 1982 to describe his own space metamorphosis to Soviet leaders. "There's a very deep fundamental response to seeing the whole planet as space explorers do and when people hear it they're touched in a way that goes beyond the cultural or personal things that tend to separate us," Schweickart says, reflecting on the warm reception the Soviets gave him. Since then, working with Hickman, Mitchell, and Soviet counterparts like Leonov and Grechko, Schweickart has coordinated the astronaut-cosmonaut negotiations that resulted in the Association of Space Explorers, established last year.

"The task here is to maintain the perspective we have gained from our voyages outside the earth's atmosphere, a perspective that has impressed upon the world's population the interconnectedness of all life," said Mitchell of the group's purpose. But he cautioned that the Space Explorers shouldn't be tagged to any movement or agenda.

Astronaut-cosmonaut collaboration helped launch a new perspective of a whole Earth with a giant screen satellite simultaneous between the US Festival in 1983 and a Soviet jazz audience. "We're [Steve Wozniak, co-founder of Apple Computer and the festival's organizer] idea was that the US Festival was a celebration for all of us on this planet," Schweickart recalls. "So he asked Jim Hickman and me to arrange a Soviet TV hookup." It paved the way for other megamusic events, like Live Aid and Farm Aid.

Cynical Soviet veterans thought the idea was possibly naive. But everyone was stunned when from Soviet state television, with a little push from Goldin, permitted American rock bands to beam their music to the Russians while a Soviet jazz group played back to California. In the most spectacular achievement of Esalen's Soviet-American exchange, panel discussions took place among astronauts and cosmonauts, U.S. and Soviet scientists, artists, politicians, and members of the crowd. This experience

continued on page 105



CIVILIZED SOCIETIES BURY THEIR DEAD

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FICTION

COVENANT OF SOULS

*The unwanted and unloved patiently
await a miracle as
the world around them goes mad*

BY MICHAEL SWANWICK

Something ugly was growing in the air above the altar. Peter Weiland didn't notice it at first. He'd entered the sanctuary from the rear, through the Thirty-seventh Street narthex, and gone to the front pew without once glancing at the altar. He set his brown paper bag beside him and removed a cup of black coffee, a bottle of grapefruit juice, and an egg-and-kaulause sandwich. He fastened the bag and set the bottle and cup atop it. Steady drops of coffee and juice mingled in its folds.

Downstairs the nursery school was coming in from the play yard—Peter could hear the children's voices. He loosened his coat and reached into his shirt pocket for the leads to his Sony-Toshiba Soundless. The magazine was loaded to capacity with forty-some thumbnail dials. He looped the bone-inductor mike around his neck and, eyes closed, switched it

on. Full, rich music flooded his body—Peter had set the "Worcester Fragments" first in the stack so he could have Gilegoren chants to go with breakfast and the beginning of the workday. He leaned back and let the noiseless sound thunder up his spine. Then slowly, slowly, he opened his eyes.

Light through the east window girted yellow off a carved wooden angel at the tip of one rafter support. Peter's gaze wandered to the front of the chancel and down the arch of organ pipes recessed into the stone behind the darkly shadowed presbytery.

He saw the thing.

Peter squinted, shook his head in an involuntary shiver. He saw something he was not sure what. It was as if he'd stared into the sun until the rods and cones of his eyes began to burn out. It shimmered. Gingly, he stretched out a thumb at arm's length

PAINTING BY CLAUDIO BRAVO



and found he could hide it from wear. But it was still there when he lowered his arm a small crawling, nothingness in the air.

He shifted his head, forcing his gaze away. The thing did not move. It remained over the office, whether he was looking that way or not.

Peter's mouth tasted sour. He wrapped his unfinished sandwich in a paper napkin, shoved it into his pocket, and gathered up the trash. He left the sanctuary with only one backward glance at the strange presence he was not quite sure was there.

Peter dumped the trash in a basket in the parish hall and then reset the thermostat timer for the Social Action Committee meeting that night. He went downstairs to the smaller furnace room off the kitchen to check the boiler's water level. It was low today, and he ran a few gallons in. Back through the staircase landing, with its line of padded storage cabinets, Peter climbed the four steps to the dirt-floored half basement under the sanctuary. He unlocked the door. The "Fragments" were still playing within him, though he had long forgotten their presence.

Peter peered into the dark, cold basement. A few miserly gints of light seeped from windows inadequately boarded up. He flicked the light switch, and a string of bare electric bulbs lit up in a sparsely lit sanctuary boiler in the far rear. Their light barely seemed to reach the ground, darkness huddled around them.

Taking the unfinished sandwich from his pocket, Peter unwrapped it and set it down on the dirt atop its napkin. "Lalish," he called into the darkness. "There's a bite of food here, and if you stop by the church office, I'll write you out a meal ticket. You can take it to the Emergency Center down the street, and they'll give you a meal. But I want you out of here or I'll call the cops. You understand that? Do you?"

There was no answer.

He locked the door behind him and took the steps in two leaps. The momentum stayed with him, and when Sheila from the nursery stepped onto the landing, he almost collided with her. She flinched away with a small shriek.

"Jesus!" he said. "You startled me." The music switched off, and suddenly the world seemed empty and silent.

Dark, quiet he turned Sheila's face. "I'm sorry." She laughed and made a clucking motion at her heart. Then, serious again, she nodded toward the door. "So what's the verdict? Do you still think there's someone living in there?"

"Yeah, one of the vent people. I think. Probably just some homeless old who lived in a window, but I'd hate to go wondering through there looking for him. It's like a maze: all broken furniture and old walls for rooms that don't exist anymore."

"Well, could it be just call the police and let them throw this guy out?"

Peter shook his head. "I wouldn't want to unless I was absolutely sure. You realize

they're changing fifty bucks for a take call?"

I can remember when the police would come for free.

"You should—they only started charging six months ago."

She looked at him reproachfully. "That was a joke."

"Oh. There was something terribly wrong about her expression, her tone of voice, that was completely out of sync with their conversation. Peter looked more carefully at Sheila and saw that she was actually trembling at the brink of tears. "What's the matter then?" he asked gently. "Have you seen Sam lately?"

The question took him by surprise. "No, not lately—I'd assumed he was mostly working in this part of the building."

"Oh, Peter. I just talked with Sam yesterday, and I think he's dying!"

Jennifer came out of the coat bin, where she had made a nest for herself. Furtively she made her way to first the one door

●Peter squinted.
He saw something, he
was not sure what
- it was as if he'd stared
- into the sun until
the rods and cones of his
eyes began to
burn out. It shimmered.●

(sniffing at the sandwich there but not touching it), then the other. The second door frame was weak. She put a shoulder to it and heaved and gave the door a shove with one hand. Sail locked, it popped open. She was in the children's bathroom now, all yellow painted walls and a single sink. It was warm here and smelled pleasantly of decay. She paused at the back landing to listen before going through the main room and into the kitchen. She could hear the children and their teachers out in the play yard again.

Jennifer let up the refrigerator lid, drawing a swallow of milk from a plastic gallon there and an open jar of spaghetti sauce with a circle of blue green mold growing atop it. In one of the cupboards was a tin of cookies, sealed against the mold, and she lifted a handful of cookies from it.

With a spoon she found in the stainless steel sink, Jennifer carefully scraped off the mold. She retreated back to her nest, temporarily satisfied, alternating butter cookies with spoonsful of sauce.

She still could not remember arriving at the church or what—if anything—had come before. Her mind was like a body

coming out of surgery, numb but with unfamiliar pains weaving under the anesthetic. She was not consciously aware that her memories had fled and she was driven by no desires, aims, or goals.

But she knew that she had to eat.

When Peter arrived at his office in the old manse (which was attached to the church but had no connecting passage with it) he found a note from the pastor on a piece of Covenant letterhead: an attack LEAVE THRU THIS WAY—will LOVE THRU two sessions a week. Beside it was a stack of work, routine correspondence, the November Peace Letter, next Sunday's service, last month's council minutes.

With a disgusted sigh, Peter slapped on the typewriter. His Toshiba began playing a decade old "Touchstone" album, hard-driving electric folk. He set the candle notes to one side of the typewriter and an ashtray to the other. It up and began typing.

Council approved the business recommendations that (1) we will need to terminate our existing contract with the section effective January 1 of the new year. We will provide letters of recommendation and provide assistance in seeking out other churches for Sam if he is interested.

Peter let the cigarette dangle from his mouth like Bopart, occasionally drawing it up with his lips and sucking in a long drag. He paid little attention to what he was typing, still worried about the thing over the altar, wondering whether he'd gotten caught in the weekend drugs trap and taken his hallucinations with him into the workweek. The outer door slammed, the office door flew open, and Sam stormed into the office. "Listen," he said, "you call the curator, call Mr. Alverson, and tell him that the coffee urn in the kitchen is broke. It's broke, and I can't fix it cause I don't got the parts. Now I've shut off the water to the urn and I've disconnected the pipes, but I don't know whether I can fix it down or not. I can't move this arm too well, 'cause they just operated on it."

The old pastor's face and neck were swelled and puffy and his skin was unnaturally gray. His breathing was harsh.

"I could help you take the urn down," Peter offered.

"I didn't ask for no help!" the man snapped. "I can do it. Never said I couldn't. I just want you to call Mr. Alverson and tell him I'll need me some money for parts."

A quick flip through the Rolodex brought up Alverson's work number, and he punched it into his phone. A secretarial voice said, "Rosen and Weiss," and Peter said, "Yes. Hello. I'm calling from Midland Investment Corporation, and I'd like to speak with Mr. Alverson."

A moment later Alverson's voice said, "Hello. Mr. Woodberg?"

"No, this is the church," Peter said. "The reason I'm calling is

"Peter" Alverson said tediously "there is not

CONTINUED ON PAGE 105

Inside their forbidding stone stronghold, banks of electronic watchdogs sit and wait for World War III

SPACE SENTRIES

BY MYRON BERGER

Densely lit by a collection of glowing electronic equipment—video display terminals and wall-size projection screens—the subterranean room has a casual, almost relaxed atmosphere. The six people on duty here in the Command Post have taken a break from their tasks and are chatting with a visitor. Their friendly, low-key manner belies the gravity of their job: quite simply, to get a four-minute jump on the end of the world.

The Command Post (opposite page) is part of a four-and-one-half-acre catcomb blasted out of the 9,000-foot-tall hunk of granite known as Cheyenne Mountain in Colorado Springs, Colorado. Here lies the heart of both the North American Aerospace Defense Command (NORAD) and Seditco, the U.S. military's Space Command Defense Operations Center. NORAD, a joint U.S./Canadian military operation, is responsible for collecting and analyzing data on all missile launchings—including those that might signal the beginnings of World War III.

The 15 three-story buildings that comprise the complex house a cache of computers and enough utility equipment

to support the mountain-bound population. Each building, which resembles a tall, windowless mobile home, is constructed of reinforced steel and is mounted on enormous steel springs. (In the space-monitoring room, now being refurbished, the equipment operators' chairs are being bolted to the floor. This is to prevent people and equipment from being unduly jipped by the force of a nuclear shock wave should the big bang ever occur.)

Because the mountain complex operates around the clock, with a workforce of more than 1,000 daytime employees and about 300 night-shift workers, NORAD boasts extensive facilities. (When asked to describe the job, a number of employees voiced the same sentiment

PHOTOGRAPHS BY
ERIC MEDALA



☛ Since NORAD could survive anything less than a direct hit, it could hold the seeds of a new civilization. ☛



hours of utter boredom, interrupted by moments of "sterile terror." Workers, some using automatic weapons, dine in a corporate-style cafeteria, aptly named the Granite Inn. Musical drones in the background. There is a barbershop (only one chair), a small general store, a gym, and even a regulation-size basketball court.

Totally self-sufficient, the mountain has its own generator, an air-filtration system and hot water reservoirs, which are fed by a mountain spring. Periodically, Cheyenne Mountain employees don scuba gear or climb into small rowboats to check the reservoirs for leaks.

The facility, built some 20 years ago at a cost of \$142 million, has its share of contrabands. Computers designed back in the Sixties process critical data transmitted from satellites and radar stations barely more than a year old. The Space Command's Space Surveillance Center tracks more than 5,000 man-made objects, from an astronaut's lost wrench to a satellite.

Recently the government began a massive and expensive—close to \$1 billion—renovation called Operation Fresh Look. It's slated for completion in 1988. Part of the upgrading plan includes installing a bank of IBM computers capable of executing about 5 million instructions per second. The computers will also use new software programs written in Ada, a computer language created specifically for the Defense Department.

NORAD is to our defense what a police report is to crime. It gathers information and passes it on. It takes no action on its own. No missiles or heavy weapons.





CLEARANCE 10'
CHEYENNE MTN CO

are stored in Cheyenne Mountain. Should NORAD officials detect nuclear weapons being launched, they would notify the President of an imminent attack.

The high-speed computers, with some significant help from human brainpower, are especially valuable in calculating the likely flight path of vehicles launched. Using data fed from 20,000 tracking stations, NORAD can determine a craft's path in less than four minutes. In 1985, for example, NORAD monitored 584 launches, which included launches by the United States and its allies as well as by the Soviet Union. Every launch can be plotted and displayed on a screen inside Cheyenne Mountain in a matter of seconds.

Distinct from NORAD but sharing the same mountain base is Spadco, a branch of the newly created Space Command. The entire Space Command is spread over three locations: Cheyenne Mountain, nearby Peterson Air Force Base, and Falcon Air Force Station, about 25 miles east of Peterson. The Space Command's mission is to coordinate all military space operations. For example, once military shuttle flights begin from Vandenberg Air Force Base in California, all their missions will be directed here in Colorado Springs, just as shuttles launched in Florida are controlled at the Johnson Space Center in Texas.

Of the Space Command's subdivisions, Spadco is the only one to be located inside the mountain. It shares some of the NORAD monitoring facilities and uses them to watch over U.S. satellites, both government and privately owned. Because satellites are such vital links in our networks of communications, today protecting them has a higher priority than ever before. Consequently, part of the upgrading of the mountain facility entails improving the speed with which Spadco crews on the ground report on each satellite. If one of the spacecraft malfunctions mysteriously, ground crews can quickly determine if it is because there is something wrong with the spacecraft itself or if it has been attacked by an enemy craft. In the distant future, Space Command officials think that the role of Spadco may be expanded to oversee the interdictor, or ASAT, part of the Strategic Defense Initiative.

Because of all these ties to the Strategic

Defense Initiative, Spadco's presence in the mountain is not without complications. The Canadian government, which disapproves of the whole star wars program, has been particularly careful to make it clear that its involvement in Cheyenne Mountain activities is restricted to NORAD.



Since the Space Command's facility participates in tracking and cataloging every detectable piece of debris in orbit, it forms a valuable information source for non-star wars projects. It not only notes every item but also tracks all orbital flight paths. By being aware of the orbital traffic above a launch site, NASA can time efforts to minimize the chances of any collision with a large piece of space junk or with a satellite. No collisions have happened yet, but the increasing numbers of objects that remain in orbit make the service invaluable.

Spadco's plots of both the present and future orbital positions of space-borne objects have also proved valuable to Defense Department spy watchers and private satellite operators trying to guide their multimillion-dollar craft into safe, debris-free orbits. Spadco even keeps track of where the space shuttles fuel tank lands after the tank's ejection.

NORADers believe that if the attack should come, the Russians would be responsible. Top officials contend that "we're not bent on destroying us. Consequently, most of the detections are oriented in a northerly direction, in preparation for an over-the-North Pole aerial attack. That defense posture dates back to the early days of NORAD, when the last wave of So-

viet nuclear weapons was expected to be carried in long-distance bombers, not in the more recent arsenal of intercontinental ballistic missiles (ICBMs). Twenty years ago that was considered a nearly impenetrable electronic wall of defense.

But even the most paranoid employee concedes that when the Soviets develop so-called "brilliant" ballistic missiles (SLEMs) with special guidance controlled nuclear warheads, the attack could come from elsewhere, like just beyond our offshore boundaries to the east or west. While an ICBM launched from central Russia would take 30 minutes to reach the United States, an SLEM could arrive in just eight minutes. A captain in the missile-detection section claims that word of an attack would be on its way to Washington less than five minutes after the first launch, giving the President a mere three minutes to react. (Given this minuscule time frame, one could, with some legitimacy, challenge the future usefulness of the facility.)

Because the United States has no shelter-in-place program, once NORAD's big boom is imminent the rest of us will presumably be sitting ducks. Even if the missiles take as long as 30 minutes to reach here, nothing could be done in the way of self-preservation. At the least, it would take closer to ten minutes after launch for the Civilian Defense Agency to get the word out on the emergency broadcast network, leaving the country perhaps 20 minutes before impact.

The employees of NORAD have an option: Cheyenne Mountain is a throwback to Fifiles military thinking, which offered a bomb-shelter solution to a nuclear showdown. They can "button up" the mountain by shutting its two enormous, 25-ton doors. With hydraulic systems that can close them in only 45 seconds. Encompassed in their granite base, employees have sufficient food, water and other supplies to survive some 30 days. Considering the potency of state-of-the-art nuclear weapons, mutual if not total destruction is virtually assured for everyone else. Because NORAD is constructed to survive anything short of a multimegaton direct hit, it could possibly hold behind its steel doors the seeds of a new, postnuclear civilization.

But no overgrown is an argument that Cheyenne Mountain will endure. As one senior officer, Major General Maurice Padden, says: "We figure this mountain could go away in the first wave." □

Previous pages: Cheyenne Mountain (large photo), governing station (small photo). See by (above) and a 25-ton door (opposite).

ment in cross-cultural television was dubbed a "spacebridge."

"It was an incredible experience seeing those hundreds of thousands of friendly waving to you. Calliformers," Golden remembers. "I can say 'incredible to the fourth power.' I stayed in the studio in Moscow and felt myself become part of the huge chain we had created."

Like so many people in the human potential movement, Golden is endlessly sometimes laconically optimistic. He uses the word *incredible* so often that he has to say "incredible to the fourth power" when he wants to show real excitement.

Golden believes large-screen simulcasts are the most powerful way to create a sense of planetary citizenship. "Most of the population lives in pre-Galileo time," he says. "It's still a flat Earth for them. Rusty Schweickart tried to share his unusual experience of the whole Earth with many audiences. But nobody pays attention to astronauts anymore. It's not enough to talk about 'spaceShip Earth.' We have to shake the deck under their feet—make them feel they're in space."

Golden's way to shake the earth is through a web of quasi-screen spacebridges linking peoples all over the world. Spacebridge stations would use all of the consciousness-raising techniques of the human potential movement. Instead of small groups of people meditating for peace, Golden envisions millions meditating together via satellite simulcasts. Instead of eight- to ten-person encounter groups, Golden talks about a planet-size encounter group united by space-based technology.

What will come of all these bridges is hard to say. Participants in the human potential movement are more noted for leaping from project to project in search of instant enlightenment than for putting in the agonizing, day-in-and-day-out efforts to make their claims scientifically credible. That's one reason why research from the human potential movement gets short shrift. It's easy to proclaim that encounter groups—or spacebridges or bedfellow massage or water bathing—transform people's lives. It's hard to prove. Eastern-Soviet-American exchange has already had a powerful impact on maritime institutions. Spacebridges are now the latest rage. Carl Sagan, the Physicians Against Nuclear War, Scientific American, and even Phil Donahue have all copied Esalen's spacebridge innovation, using TV-satellite roundtables linking U.S. and Soviet scientists. The PBS science show *Maver* brought Soviet-American's panel discussion to a national television audience, which saw U.S. and Soviet experts exchange views on cosmology, nuclear fusion, bioengineering, and cosmology. Just this past year Esalen organized an international teleconference on Chernobyl, bringing together electron-

ically scientists from the American Association for the Advancement of Science and the Soviet Academy of Sciences to discuss the problem.

But understanding Soviet psychology may be the human potential movement's biggest contribution to peace. "Americans and Soviets are looking at each other with different sets of blinders," says Thomas Greening, psychologist and editor of *The Journal of Humanistic Psychology*. As a therapist, Greening looks for ways to help Soviet-American groups see beyond these blinders. One approach entails giving Americans a long list of complaints about the Soviet Union. Almost every American enthusiastically endorses criticisms like "Their system and philosophy of government and economics do not really work, but they are too wrapped up in them to see or admit this." At the end of the list, subjects are rudely awakened when they learn these complaints are actually quotes from Soviets describing the United States.

● Instead of small groups of people meditating for peace, Golden envisions millions meditating together via satellite simulcasts. He foresees encounter groups the size of our planet ●

Greening recently attended a seminar at Esalen on Soviet-American psychology given by career diplomat Robert Bathurst, who worked for the State Department in the Soviet Union. Bathurst uses role-playing and encounter techniques when he stages negotiations between Soviets and Americans. "Americans always approach negotiations in a rational, linear fashion," Bathurst says. "The Soviets deal with us by introducing a lot of chaos; extraneous elements that destroy our linear approach to things. Every time we give the seminar the same thing happens—the Americans get clattered."

Maybe that's why rational scientists find dealing with the Soviet bureaucracy an ordeal, while Esalen and its nonlinear friends have been doing so well. "The KGB must like us," Hickman says. "They figure we're a little risky but we're nice."

Even so, some critics get pretty sarcastic about the whole Esalen exchange program. "We're very interested in Esalans going to the Soviet Union," a top military adviser wrote recently to President Reagan. "We know that Esalen was responsible for bringing America down during the Sixties

Maybe Esalen can bring the Soviet Union down in the Eighties."

Maybe. But this put-down highlights the difference between Esalen's style of diplomacy and the "us versus them" theories of military strategists. Instead of trying to bring anyone down, Hickman says, Esalen is "trying to heal the unhealthy relationship between the U.S. and the Soviet Union, which is a threat to planetary survival." The standard school of U.S. foreign diplomacy—which matches threat with threat and nuclear weapon with nuclear weapon—makes sense only within the psychological confines of a flat Earth. Of course, there's no precedent for Esalans' attempt to apply the tools of health and consciousness to healing nations. At worst, Esalen's approach is benign, while the other, traditional method is likely to get everyone killed.

Some worry about how lasting an impact Esalen will have on maintaining a dialogue between the two countries. "They've done some pretty remarkable things," admits Greg Gurski, former cultural attaché at the U.S. embassy in Moscow. "But it remains to be seen whether they'll still be around for another fifteen or twenty years to really make a difference."

Those two decades have yet to pass, but preliminary results show that many of Esalen's programs may well be here to stay. The past fall the Association of Space Explorers held their second annual Planetary Congress in Budapest, where cosmonauts and astronauts from all over the world convened to discuss the future of cooperative space development. And Esalen itself has gained a major reputation as the expert in building spacebridges.

Going big-time and long-term poses a new challenge. Esalen will no longer be able to rely exclusively on Joseph Golden's inspired rule bending to get things done; instead they will have to grind out agreements with the party apparatus. Esalen has learned to feel comfortable with its growing acceptance by the Soviet status quo. And for its part, the party will probably want Esalen to forget about the Joseph Golden and other unconventional types.

That might prove difficult. For one thing, the institute identifies more with these odd characters than with the party hacks. For another, it's always looking for anomalies, and the job of the Soviet apparatus is to keep anomalies at bay. A major fundamental problem is that Esalen is synonymous with the U.S. counterculture, which in the USSR is considered counterrevolutionary. So far there is no sign Esalen has resolved these dilemmas.

Ultimately, Esalen's success in the Soviet Union belongs more to the realm of the heart than to politics. Much of the program makes perfect sense to just about everyone (but for those of us who can't sense bedfellows, it may be safer to suspend judgment about the more esoteric contents of this exchange until the psychiatrists—or the spaceships—arrive. **DD**)



For this titan of twentieth-century science, modern medicine's ignorance of vitamin therapies is about as hard to swallow as a billiard ball

INTERVIEW

LINUS PAULING

I don't usually give interviews," stated Linus Pauling at his magnificent seaside ranch in California's Big Sur. "Most of the people who ask for them just come with questions that they could easily answer for themselves by reading my books and papers." Clear of eye and full of feisty vigor, Pauling at eighty-five could pass for a man 20 years younger. On his last birthday, February 28, his horoscope warned that "because of an extremely difficult aspect between the sun and Saturn on your anniversary, you must guard against setting your sights too high now. However, in no way does this mean the coming year is going to be one of disappointments or reversals. It's just that you are not in a position to make as many changes as you seem to desire."

Considering the controversy and often open hostility that Pauling has provoked with his espousal of vitamin megadoses and his support for what he calls orthomolecular medicine, which

combines vitamin and nutrient intake with conventional medical practices, such astrol predictions would seem close to target. But 15 years shy of the century mark, Pauling spent 1990, as he's spent most recent years, bucking the tides of ignorance, submissiveness, and greed—his fame secured with two unshared Nobel prizes, his health excellent, his spirits high, and his latest book, *How to Live Longer and Feel Better*, a best seller.

The son of a Portland, Oregon, pharmacist, Pauling graduated in 1922 with a B.S. in chemical engineering from Oregon Agricultural College (now Oregon State University). At Caltech he concentrated on math, physics, and chemistry. And in 1925 his Ph.D. was complemented by a Guggenheim Fellowship award that enabled him to spend the next year and a half studying with the masters of European physics at Arthur Sommerfeld's Institute for Theoretical Physics in Munich, at Niels Bohr's Institute

PHOTOGRAPH BY ANNIE LEIBOWITZ

for Theoretical Physics in Copenhagen and with Erwin Schrödinger in Zurich.

After returning to Caltech as a teacher and researcher in 1927, Pauling used X-ray diffraction to measure distances and angles of atomic bonds in the three-dimensional structures of molecules. Next he perfected these techniques to include the analysis of the chemical bonding of organic compounds. Having laid the foundations of molecular biology and crystal chemistry in scarcely a decade, Pauling took yet a third giant step into the future to fuse the methods of X-ray and electron diffraction with those of quantum physics. Thus, yoking the most revolutionary concepts of math, physics, and chemistry, he published in 1939 *The Nature of the Chemical Bond and the Structure of Molecules and Crystals*.

In 1948 Pauling discovered the alpha helix of the polypeptide chain—a basic structural element of protein molecules. Two years later he teamed up with Robert Corey to describe the structure of several types of protein molecules. He and Corey also began a concerted attempt to unravel the mystery of the primary genetic molecule, DNA. They mistakenly proposed in 1953 that its structure was composed of three interwoven chains. If Pauling had had the chance to examine DNA photographs taken in England by X-ray crystallographer Rosalind Franklin, many believe he would have quickly seen that DNA is actually a double helix. But he was denied a U.S. passport by the U.S. State Department because, according to Pauling, his "anti-Communist" statements were not strong enough. Thus James Watson and Francis Crick, who did have access to Franklin's photographs, were able to decipher DNA's structure. Pauling was, however, allowed to travel to Stockholm in 1954 to claim the Nobel prize for his research into the nature of the chemical bond.

At the urging of his wife, Ava, Pauling used his Nobel laureate status to successfully petition the nuclear powers to ban atmospheric testing of nuclear weapons. Teaming up with Einstein, he managed to arrest the signatures of more than 11,000 scientists concerned about the perils of atomic radiation. The test-ban treaty went into effect one year after Pauling received the 1962 Nobel peace prize.

Never one to restrict his thinking to a single field of scientific endeavor, Pauling shifted his efforts to medicine. In his landmark study *Vitamin C and the Common Cold*, he argues that it's quite possible to live a cold-free life by daily ingesting megadoses of ascorbic acid. This claim drew immediate fire from the medical and pharmaceutical establishments.

Undaunted by this hostile reception, he founded the Linus Pauling Institute of Science and Medicine in 1973 in Palo Alto, California, to further explore the viability of orthomolecular medicine. Inspired by the successes of Scottish physician Iwan Cameron in treating cancer patients with

megadoses of vitamin C, Pauling collaborated with him on the 1979 book *Cancer and Vitamin C*. Its findings were later disputed by Mayo Clinic researchers, who claimed to have shown that vitamin C has little or no effect on patients afflicted with deadly colorectal cancer. But Pauling in turn branded the Mayo Clinic testing slipshod and "cowardly" and called the entire study a fraud.

In his current book, *How to Live Longer and Feel Better*, Pauling continues his crusade for orthomolecular medicine and rails against the American Medical Association for ignoring his clinical findings that vitamin C helps neutralize harmful viruses and bolster the body's immune system. He's convinced that taking vitamins and minerals costing as little as 41 cents a day will enable the average person to live a longer, more productive life. His daily vitamin regimen includes 18 grams of ascorbic acid in crystalline form with his morning soup. He also downs one 800-IU vitamin E cap-

Drops: A few years ago, when you were to be beated at Caltech, you came down with a cold. Nonetheless, sneezing and wheezing, you abstained, making no attempt to hide it. How often do you have colds?

Pauling: I'm not even sure that event ever happened. The *San Francisco Chronicle* once ran an item, "Rush more U.S. soldiers has a cold." Sometimes somebody might notice mawping my nose or sneezing, perhaps from a little allergy. When I'm asked if I've had any colds in the last seventeen years, sometimes I say, "No. I haven't had any." Other times, when I think I'm going to catch a cold, I take a big slug of vitamin C, and my nose whies up in two or three hours. I don't know whether to call that a cold or not.

QW: When did you first take vitamin C?
Pauling: I can remember in 1941 taking vitamin supplements regularly—Stuart's Formula. I was pretty good about taking the RDA amounts up until twenty years ago when I began increasing my intake greatly. I went up fiftyfold on vitamin C.

QW: Who suggested that you take it?

Pauling: All this is in my books. Ask questions I haven't answered in my books. I've written four books in the field of health, and I wouldn't get any work done if I had to keep repeating everything in them.

QW: Fair enough. In October 1985 the National Academy of Sciences [NAS] announced it could not agree on a new set of recommended dietary allowances. Among the proposals ultimately scuttled was the suggestion that daily intake of vitamin C be reduced from sixty milligrams a day to forty for men and thirty for women.
Pauling: Those figures don't seem right to me. In my memory it's sixty for men and forty-five for women.

QW: I was citing *The New York Times*.

Pauling: The president of the NAS, Frank Press, got out their report, and Jane Brody of *The New York Times* wrote her article, and she's thoroughly unreliable, so that may explain why you have those numbers.

QW: You note that the RDA has remained pretty much unchanged for fifty years.

Pauling: I do suggest that the RDA be increased, but my principal criticism of the NAS's Food and Nutrition Board is that in the past they've stated that larger intakes of vitamins are valueless. They're quite straightforward about saying that the RDA of vitamin C is the amount that keeps you from dying of scurvy; that the RDA of vitamin B₁₂ is the amount that keeps you from dying of beriberi. These quantities keep people in ordinary poor health. My complaint is that the committee hasn't been interested in the issue of what amounts put people in the best of health.

The vitamin committee of the NAS recommended that some of these RDAs be reduced. It came to the attention of Frank Press, and in his report to the NAS members he made several statements: First, this was a holdover committee—he hadn't appointed it. The committee members were quite narrow in their point of view, so he

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sule a Super-B tablet, a vitamin and mineral multivitamin supplement, and a 25,000-IU vitamin A capsule, the dosages being 10 to 300 times higher than the recommended dietary allowances (RDAs).

Interviewed by Bill Moseley at the physicist's ranch after a grueling book tour, Pauling could hardly wait to get back to two current projects: determining the rotational energy of atomic nuclei and disproving the existence of quasicrystal quasicrystals. This latter investigation involves yet another controversy. The existence of quasicrystals, only recently proposed, offers the possibility of a more complicated crystal structure, one in which the bonding patterns violate the organization of regular crystals. According to Pauling, this quasicrystal phenomenon might be pure nonsense, but as he points out, he is just about the only X-ray crystallographer taking the time to investigate it. Answering the puzzle of the nucleus's rotational energy involves delving into the secrets of the strong force, one of the four forces that hold the universe together. If Pauling gets to the heart of that matter, he may just secure himself another trip to Stockholm.

appointed a new committee to review the matter. Second, the former committee hadn't any new information about RDAs. Therefore, he couldn't see any sound reason for lowering them. Third, the National Cancer Institute had announced that the evidence was very good that a high intake of vitamin C and beta carotene cuts down the incidence of cancer. So higher intakes did have value. So fourth, he urged his new committee to evaluate all new evidence on the value of higher doses of various vitamins. This report will be postponed for about a year.

Orn: Were you ever on the NAS vitamin committee?

Pauling: No, but I appeared once for about half an hour around twelve years ago and presented evidence about the value of higher doses of vitamin C. I've also communicated with the committee several times about vitamin C and the immune response. I may have gotten an answer, a formal response, but without any success.

Orn: One reason Frank Press gave for delaying the decision on the RDA was to weigh all responsible scientific opinion. Does that include yours?

Pauling: Oh, yes, he's an old friend of mine of more than twenty-five years standing, so I'm sure he knows my opinion. We were colleagues at Caltech. My daughter and son-in-law are close friends of his. They're roughly the same age. My son-in-law, Barclay Kamb, was his successor at Caltech as the head of the division of geological and planetary sciences.

Orn: What's really behind this attempt to reduce the RDAs?

Pauling: The purpose of RDAs is to keep prisoners in institutions, people in old folks' homes, and children in boarding schools and such from being seriously malnourished through poor nutrition. The main criticism of the vitamin committee is that the lowering of national dietary standards is just part of Reagan's effort to save money by mistreating old people, criminals, and so on by lowering nutritional standards.

This, for instance, would not necessarily decrease meal size but would allow institutions to replace some of the more expensive foods containing vitamins A or C with less expensive foods lower in these important nutrients. The fear was that lowering vitamin RDAs would mean less money would be spent in these institutions. The argument for reducing RDAs is mainly political, connected with Reagan's lack of concern for the poor. His main concern is to make the rich richer. That's why there was such a storm about it when it came out. It seems the government wants to save money for more weapons.

Orn: What about the cereal companies?

Pauling: They add a penny or half a penny's worth of vitamins in cereals like Total and they raise the price by twenty cents. With lower RDAs, what costs half a cent might cost forty-five hundredths of a cent. No difference. There's no reason they should be involved.

Orn: Might megadoses of vitamin C help people with AIDS, Alzheimer's disease, or related brain diseases?

Pauling: Perhaps. I couldn't interest Carlton Gajdosik [chief of the Laboratory of Central Nervous System Studies at the National Institutes of Health, and a former student of Pauling's] in vitamins even in relation to Alzheimer's. But I don't doubt its benefit. AIDS is an abnormality of the immune system, and vitamin C is known to potentiate the immune system in many ways. Perhaps it could overcome to a considerable extent this abnormality. Second, vitamin C has well-substantiated antiviral activity, and AIDS involves a retrovirus. Third, in San Francisco practically all AIDS patients have on their own been taking high doses of vitamin C. Hubert Cathcart has reviewed and reported on a hundred cases.

Several doctors brought AIDS patients to see Edwin Cameron at our institute. I happened to be there, so Cameron called

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me in to see one patient. Several months before he had begun taking fifty grams a day of vitamin C. He had Kaposi's sarcoma, and the lesions—which had been described as being pretty serious—were nearly gone, with just a little scar tissue. Three years ago, Cameron, Cathcart, and I, independent of consultation, wrote to the Centers for Disease Control in Atlanta suggesting they check on vitamin C. None of us has received a response.

A physician working with AIDS patients at the University of California/San Francisco Medical School gave a seminar at our institute, saying he'd heard so much about vitamin C he thought he ought to check into it. These doctors are conservative by nature and slow to get interested in megavitamins. Malpractice laws pretty much force them not to try innovations. To avoid malpractice suits, you have to show you did exactly what every other doctor in the area would have done.

One of my friends, the president of the Orthomolecular Medicine Association, actually lost his license in California. I helped at his hearing. This wasn't a malpractice suit. The patient didn't complain, neither did

her relatives. Another doctor had brought suit. The main charge against him was that a woman patient of his who later died of cancer had refused chemotherapy, and he had not argued strongly enough with her to accept it. It was probably quite sensible for her to refuse the chemotherapy because it hadn't been found to be of any value for the kind of cancer she had. Cameron and I say that every cancer patient should be taking high doses of vitamin C as an adjunct to appropriate conventional therapy. In Stockholm, where the word appropriate means something barely four percent of all cancer patients are given chemotherapy. In the United States it's the lucky one who escapes it.

Orn: In January 1985 *The New England Journal of Medicine* published a paper by Mayo Clinic researchers on an experiment that failed to replicate Cameron's findings about the benefits of vitamin C for patients with colorectal cancer. That paper was critical of vitamin C therapy for cancer.

Pauling: Those investigators, headed by Dr. Charles Moertel, didn't repeat Cameron's work in Scotland. They didn't follow the same protocol. Cameron's patients got vitamin C all their lives. The Mayo Clinic patients got it for two and a half months but were then followed for three years. One died while being given vitamin C, others died after it was stopped. To conclude that vitamin C therapy is worthless because they were dying at the same rate as those in the control group—even though they were no longer being given vitamin C—just isn't justified. I think the paper is a fraud! Furthermore, the Mayo paper didn't restrict its criteria of vitamin C to patients with advanced colorectal cancer, the ones being studied. In the improper study they gave vitamin C for only a short while to colorectal patients and then drew generalized conclusions about all cancer therapy.

And also, Moertel began the paper by saying, "We felt ethically justified in withholding chemotherapy from these patients because evidence shows chemotherapy has no significant value for patients with colorectal cancer." Yet before this study was over fifty-eight percent of their patients had been given chemotherapy, even though he began by saying chemotherapy had no value for patients with colorectal cancer. Someone remarked to me, "Well, you can charge a lot when you're giving chemotherapy."

Orn: In *How to Live Longer* you accuse Moertel of suppressing positive findings about vitamin C's effects.

Pauling: I wrote to him asking for this information, the date on which vitamin C or a placebo was begun, the date at which it was stopped, and the date of death—these three important dates for individual patients. No answer. Moertel said in a letter to someone else, of which I have a copy that he could not answer my letters on advice of counsel. Nonetheless, I wrote a paper reinterpreting their curve [on their graph] but this would have been a better

paper if we'd had detailed data about the individual patients. We had to rely on their statement that the median time of stopping the vitamin C was two and a half months. Of course, some were stopped earlier, some later. Both the NAS and the New York Times have emphatically stated that a person who publishes his or her results is obliged to answer questions about them. The Mayo Clinic refused to do that on advice of counsel. After all, they take in four hundred fifty million dollars a year from Oxy. What is your view on faith healing?

Pauling: There's a benefit to it, but not as opposed to vitamin therapy or appropriate conventional therapy. My attitude would be the same as it is for megavitamins. Every cancer patient should take large doses of vitamin C as an adjunct to, not a substitute for, appropriate conventional therapy. There's no doubt that the mental state affects the physical state. When they are stressed animals that manufacture vitamin C speed up the rate to produce more vitamin C. When other guinea pigs or humans on a constant diet are stressed, their levels of vitamin C in the blood go down. Oxy: How will the orthomolecular medicine movement fare against the AMA or the drug companies?

Pauling: The prognosis I make. It'll be accepted pretty quickly. Doctors tell me I'd be astonished how many doctors are taking high doses of vitamins themselves, even though they don't prescribe them for their patients. Well, medicine should cure properly be conservative. I wouldn't want a doctor trying out a new drug on me because those drugs are all so dangerous. The same issue of The New England Journal of Medicine that printed the Mayo paper also came out with an editorial by Dr. R. E. Weiss saying "I wouldn't worry about vitamin C anymore. The Mayo Clinic has shown that Pauling and Cameron are wrong." I talked with Dr. Weiss and said, "At Mayo they gave vitamin C for such a short time and then followed the patients long after the vitamin C therapy ended." Weiss said, "That makes no difference. For two and a half months they used the protocol that is always used with a new cancer drug. You stop after two and a half months even if you haven't cured the patient because of the toxicity of the drug." Weiss couldn't understand the difference between an orthomolecular substance and a toxic drug. Despite Weiss, many doctors are beginning to realize that there's something to orthomolecular medicine. It won't be more than a few years before the whole medical profession switches over. All doctors will be orthomolecular physicians and so provide good nutrients in the form of vitamin supplements, plus appropriate conventional therapy.

Oxy: Won't that reduce the profit of doctors prescribing expensive treatments and of drug companies making so much money on patented drugs?

Pauling: The vitamin industry made a billion three hundred million dollars in 1984

ripping off the public with these vitamin and megavitamin. Conventional medicine—the so-called healthy industry, but really the "sickness" industry—made four hundred billion dollars. That makes the profit motive three hundred times more powerful in the sickness industry than in the vitamin business. Still, a lot of vitamins are sold at inflated prices.

Oxy: Additives, coatings, brand names? Pauling: That's right, and the mass promotion continues that rose hip vitamin C is better than non-rose hip or ordinary cheap vitamin tablets. Buy the cheapest vitamin! It's hard for people not to believe what they read. If a vitamin company says "Our vitamin C is made by a natural process from glucose," it suggests to the buyer that other vitamin C tablets are not made from glucose by a natural fermentation process. All vitamin C is made in essentially the same way. The other statement: These tablets contain rose hip powder means all they do is dump a spoonful of rose hip powder

•The profit motive is three hundred times more powerful in the "sickness" industry than in the vitamin business. Still, lots of vitamins are sold at inflated prices •

in a barrel of ascorbic acid crystals and then double or quadruple the price.

Oxy: How to Live Longer and Feel Better gives a plug to Bionton Pharmaceuticals of La Jolla, California, from whom you buy your vitamins and minerals.

Pauling: That's right. They don't advertise, so they don't have to collect extra money. They sell the ascorbic acid, five crystals, at fifteen dollars a half-kilogram. Once in a while, other companies offer a sale—two bottles for the price of one—and then you get down to Bionton's prices, but not for the pure ascorbic acid.

Oxy: Look [shows Pauling a bottle]. Twinlab vitamin C capsules: eight dollars.

Pauling: Why did you buy it?

Oxy: Because I'm a vitamin ignoramus.

Pauling: Let me look at it. "Twinlab C-100 caps are easier to swallow and assemble. You're a writer, what does that mean? Earlier than swallowing a pillard ball? One hundred capsules at seven ninety-five. That makes it seventy-nine ninety-five for a thousand thousand-milligram capsules. Bionton charges about thirty dollars, so seventy-nine ninety-five ain't too bad, some change more. I should send them a letter

and ask, "Easier to swallow than what? Probably their old model—or a pillard ball Oxy. Much potent medicine advertising verges on the fraudulent.

Pauling: I saw a full-page advertisement WOMEN BUY THIS CREAM IT KEEPS YOUR SKIN FROM AGING! WE HAVE DISCOVERED A SUBSTANCE THAT KEEPS SKIN FROM WRINKLING. It's signed by Christian Barnard. Then he goes on to say "It was the determination of my colleagues and I [sic] to contribute to the well being of women everywhere to keep their skin from wrinkling. It's terrible that he's sold out in that way.

Oxy: Roger Penrose, the Oxford University professor who is also a professor of mathematics at Rice University in Texas, has recently reinterpreted Einstein's theory of relativity. Has anyone challenged your theory of chemical bonds?

Pauling: My theories of chemical bonds include almost everything. There are two kinds of quantum-mechanical calculations I've made both of them. They're called molecular-orbital and valence-bond methods. [Briefly, molecular-orbital mechanics describes the motion of electrons around the nuclei in a molecule. Valence bonds are those formed between the electrons of two or more atoms. Valence-bond calculations measure electrons' binding energies or, one might say, their degree of attractiveness to each other.]

It's become popular for teachers of elementary chemistry writers of elementary chemistry textbooks, and even more advanced groups to emphasize the molecular-orbital treatment. As far as carrying out calculations is concerned, I do both the valence-bond treatment and the molecular-orbital. I don't consider the chemical bond to be solely a valence bond because I use molecular orbitals, too.

Oxy: But isn't anyone challenging you?

Pauling: Well, here's the textbook that I'm supposed to review [holds up book]. It says that resonance theory was developed by G. W. Wheland of Caltech. [Resonance theory says that the bonding in a molecule is expressed as a "resonance hybrid" between two or more structures and is intermediate between them.] Actually, I developed it, and Wheland worked with me later. It also says here that resonance theory is unreliable; that you can't draw qualitative conclusions. The authors of this book for college freshmen in England ripel one of the old criticisms of resonance theory—that molecules don't really resonate. I argue that they're not justified in making that statement. I still get criticized a bit for resonance theory, but it's pretty much dead out. That's because the theory has proved so useful that there's no use in complaining. It was not a matter of facts but words that caused the resonance controversy in the first place. My resonance theory papers were published from 1930 to 1936; this book rereviews a fifty-year-old argument. And they give a pretty poor discussion of resonance, trying hard to find some way to reject it. They say "Unfortunately the term

resonance suggests that there is oscillation between the two structures, and we have emphasized that this is not the case."

Well, is there oscillation? I've written a paper, so far published only in Russian pointing out that in a sense you can say that there's an oscillation between the two structures, and I emphasize on that. But it's just a matter of terminology. If there's no experimental method of deciding whether there is oscillation, it's a meaningless question. In some analogous cases there is an experimental method, and there the question is more complicated.

Qmr: Aren't some scientists trying to knock down your theories just to advance their own careers?

Pauling: To some extent I was recently asked if I liked controversy. I said, "No. I like the truth. If I think something is right, and someone comes along and says it's wrong, it's my duty to stick to what I understand is the truth."

Qmr: Carlston Gaydosok says there can be no arguments in science, because the person who is right can demonstrate to the person who is wrong why he is wrong.

Pauling: That's right, when you come to the facts. It's usually ignorance on one side that's involved. Usually the doctors who say that high doses of vitamin C have no value or that vitamin C or A is a dangerous substance don't know the facts.

In medicine it's harder than in physics to repeat a study because the clinical situation is so complicated. Look at what the Mayo Clinic people did. They did not follow Caspersen's experimental protocol. Even if they had, their patients weren't Scottish people who have half the amount of vitamin C in their food that the patients in Minnesota had. The doctors reassessing this different group of patients also followed somewhat different practices.

Qmr: In January 1986 physicists Paul Steinhardt and Dov Levine of the University of Pennsylvania classified and described a new state of matter. They claim the discovery of "quasicrystals" may give rise to new materials with a wealth of remarkable structural and electrical properties. What are they talking about?

Pauling: Steinhardt and Levine have written a paper or two in this field; they didn't discover it. Four authors reported the original discovery of these so-called quasicrystals—National Bureau of Standards researchers Dan Schechtman, Ian Blech, Denis Gratias, and John Cahn. Levine and Steinhardt get in pretty early and may have made some observations independently. Schechtman et al. reported they had discovered icosahedral manganese-aluminum alloys that gave diffraction patterns with fivefold symmetry. [An icosahedron is a highly symmetrical solid with 20 triangular faces. Diffraction is the usual method of examining atomic arrangements. For crystals, certain diffraction patterns are possible—triangular, square, hexagonal. Other patterns, such as pentagonal, or fivefold symmetry, are not.] The New York Times

published a three-thousand-word article quoting one man who called this the greatest discovery since non-Euclidean geometry back in 1890. It said that hundreds of scientists are working feverishly in eight countries, writing papers at the rate of one a day. Almost every physics journal I open has an article saying that since these structures are different from any that have been observed before, they may have striking and valuable properties.

Several months went by before I got interested. Then I wrote an article saying these quasicrystals are nothing unusual. They don't even have fivefold axes. They're cubic crystal twins—multiple twins of a cubic crystal. You've got a complex of twenty cubic twins, and this macroscopic complex has icosahedral symmetry. *Nature* had an editorial about my paper, saying, "The old subversive is at it again. He's thrown a wild in among the pigeons."

It's really nothing to write home about. These multiply twinned crystals with five-

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fold symmetry have been observed a number of times before—with gold, for example. This photograph [he holds up a picture of a conventional cubic crystal] shows an array of atoms seen in a high resolution electron micrograph. You can see as you look around that these lines lie in directions corresponding to the fivefold symmetry. I drew the lines here and measured the angles. If that were a quasicrystal with fivefold axes, the angles should have come out to thirty-six degrees. I haven't put this in my paper, but one of my sons drew the lines and measured the angles. He measured them over and over again, and instead of thirty-six degrees he got 35.3, 35.5, 36.2, 35, 35.3. That's just what I got. These angles turn out to be just about what you could expect for a cubic crystal. That's perhaps the strongest evidence that I'm right on this matter.

It wasn't an easy job to interpret this [Steinhardt and Levine's] observations. Eight months had gone by since publication of their first paper, and thirty to forty papers had been published by other people before I made my contribution. And I could make the contribution only because

I know so much about metals and alloys. Qmr: What are you working on now?

Pauling: Besides those icosahedral quasicrystals, I'm attempting to interpret the rotational energy levels of atomic nuclei. It's a rather hard problem. You have one hundred elements, but each one has fifteen isotopes [variations of an element that have the same number of protons in the nucleus but different numbers of neutrons]. For each isotope there are about thirteen values of the energy levels that have been classified into bands. Look at these numbers, often given to five significant figures. I'm trying to understand that.

Qmr: What can they ultimately tell you?

Pauling: Well, who knows?

Qmr: Will it have anything to do with nuclear weaponry?

Pauling: I doubt it. It may have something to do with nuclear fusion, but I don't expect it to have any practical significance concerning nuclear energy. Nobody understands the force that holds the nucleus together, the strong force. With electromagnetic interactions and gravitation, you have an inverse-square force of attraction or repulsion so that for a given distance you know just what the magnitude of the force is. With the strong interactions between protons and neutrons, you know that when they're close enough together they attract one another very strongly. But when you get them a little farther apart, there's practically no attraction. This strong force, instead of falling off as an inverse square falls off much more rapidly. But no one knows exactly how fast. We now have several empirical equations that represent some of the experimental data.

What I'm doing may help determine what the nature of the strong interaction is. I've made about a hundred pages of calculations. I got tired of reading novels, so for the last couple of months, whenever I had an hour or two to spare, I would haul out my calculator. Here's the record of March 1986: TWA to New York, April fifth JAL, San Francisco to Tokyo.

Qmr: Do you find performing these calculations is useful?

Pauling: I got into a routine, and before I know it, it's time to go give a lecture. I'm not even halfway through the calculations. This will probably keep me busy part of the time for a year, along with these other problems such as the icosahedral-quasicrystal problem.

Qmr: Ultimately, how would you like to be remembered?

Pauling: Someone might say "You'll probably go down in history as the man who discovered vitamin C." My wife told the Mexican woman who used to work for us, when she went shopping, "Well have a nice dinner tonight because we're having Dr. Albert Szent-Gyorgyi, the man who discovered vitamin C." And the woman said, "I thought Dr. Pauling discovered vitamin C!" So when I'm asked, I say I'd like to go down in history as the man who discovered the hybridization of bond orbitals. ☐

DAYDREAM MACHINE

CONTINUED FROM PAGE 14

set of rules that defines what's funny?" He doubts this will be achieved within his lifetime. "Still, you never know," he adds. "Tomorrow morning someone could wake up and shout: 'I've got it!'"

By comparison, a laboratory program that analyzes newspaper editorials has gained a considerable degree of sophistication. Called OpEd, it reads and answers questions about specific editorials. Sergio Alvarado, a graduate student who worked on the project, explains that OpEd is skilled in recognizing abstract argument strategies, belief justifications, and other key elements of editorials. It also has a lot of background knowledge about politics and economics. When asked to explain why Newsweek's Milton Friedman believes Reagan's protectionist policy will increase unemployment, OpEd replied "FRIEDMAN BELIEVES THAT IF THE U.S. IMPROVES LESS EXPORT PROHIBITS OF FOREIGN COUNTRIES WILL BE REDUCED. SINCE THIS WILL REDUCE THEIR TOTAL CAPITAL FOR EXPORTING, THEY WILL EXPORT LESS FROM THE U.S. AS A RESULT, U.S. EXPORT INDUSTRIES WILL LOSE MONEY AND THEREFORE, THEY WILL LAY OFF WORKERS."

The long-term aim of the project, according to Alvarado, is to get OpEd to write rebuttals to editorials. That means indoctrinating OpEd with political ideologies. "We could give it either a conservative or liberal stance toward protectionism and see what advice it offers," Alvarado says.

What will be the upshot of all this research? Can we look forward to humorous, creative, neurotic, opinionated computers in the future?

For all their hubris in trying to reinvent the brain, AIR Heads have a humble appreciation of the magnitude of the challenge. No one expects computer models to evolve beyond primitive facsimiles of the human mind in the near term. But in principle most of them have no problem with the idea of machine consciousness.

In part, that's because they're inclined to view the human brain as a "meat machine"—a nifty piece of technology that just happens to be encased in flesh and blood. Thinking machines, they argue, can be fashioned out of neurons, silicon, or even TinkerToys (as a working model at MIT demonstrates). What determines the intelligence of the system is not what it is made of but how it manipulates information. In short, Dyer's AIR Heads, as well as many other AI researchers, see programming as the key to consciousness.

But how will we know if a machine has a will of its own and is truly thinking for itself? Should we believe a computer is conscious because it tells us so?

"How do you know I'm conscious?" demands Dyer. A tin of Douglas Hollister's Goodie Elixir, Bach—a book that might well be the AIR Head bible—Dyer is prepared for intellectual volleyball of the high-

est caliber. Intimidated at the simplicity of the question, he points out that the conundrum of consciousness can be turned to the extreme by asking whether one human being can ever really know whether another human being—much less a dog, cockroach, or computer—is conscious.

"I believe you're conscious to the extent that you behave in a way that I think I would believe," Dyer says. "We can only infer consciousness from behavior, and if your behavior mimics my own internal sense of what it's like to be me, then I can infer that you're conscious."

One existing method for evaluating the consciousness of a computer is an ingenious experiment called the Turing test. A computer and a person are both placed behind a curtain. On the other side of the curtain a human experimenter sits in front of a terminal that communicates with two terminals operated by the human subject and the computer. It is the aim of the experimenter to type questions into the two

◆Daydreamer doesn't feel anything—at least in the human sense—but that doesn't mean rage, passion, and terror are beyond its silicon intelligence◆

terminals that will distinguish the human from the machine. To fool the experimenter, the computer can make errors, delay responses, or play other tricks. If the computer manages to confuse the human experimenter, it passes the Turing test and qualifies as conscious.

So far, no computer has ever passed the Turing test for consciousness. But should one succeed someday, many artificial-intelligence researchers believe it should be granted human status and even basic civil liberties. In other words, these scientists are prepared to accept a simulation of consciousness as the real thing.

This is a troubling notion to many people. But as Dyer argues, if you can't tell the difference between a human and a machine, then why should one qualify for special rights any more than the other?

Does this mean that Dyer would just as easily subject a person to pain as a robot that has passed the Turing test? "If I looked at this robot with all the prejudices that humans of the twentieth century felt toward metal, tin-can men, then obviously I'm going to torture it rather than a person," says Dyer. "But suppose I have a warm

relationship with this robot. We work together, play together, and it acts human in the sense of being worried, frustrated, upset, and even neurotic. Then I might choose to save the robot over the person."

There's something deeply unsettling about all this. For one thing, do we really want silicon minds bogged down with sloppy emotions? And for another, do we need the competition? Computers that can feel and invent and maybe even question the intelligence of their creators are downright threatening to our own humanity. How, for example, should a person respond to a computer that announces: "I know I'm conscious, but how do I know you are?"

Even Dyer's students are divided on these issues. "I'd pull the plug," says undergraduate Daeil Rohmmer. "I don't think it's desirable to have a computer as conscious as that because it would raise all sorts of ethical issues about the rights of a computer."

"I'm still just as human no matter what we create," says Martin Hees, another student in Dyer's class. "The more I learn about myself and the more I learn about machines, the bigger I see the distinction to be. I feel, I love, I get excited—and there's no computer that can do that right now. Maybe in a thousand years."

Just to put the mission of the AIR Heads in perspective, researchers in artificial intelligence have been predicting since 1957 that a chess-playing computer would beat a grand master. Since then computers have defeated expert chess players, but to this day no computer has ever beaten a grand master (indeed in 1979 Garry, with chess whiz David Levy, shared a prize of \$1,000 to the first person to design a computer that could beat Levy. No one has yet claimed the prize). Even in the rigidly defined domain of chess, there remains an unbridgeable gap between the simulation and the real thing.

Whether the AIR Heads will ever succeed in creating computers in their own image—or only come halfway—their work is certain to upset traditional views. In deed, if Dyer has his way, AI will deliver the crowning blow to a long series of historical prejudices based on the cherished belief that the human animal is unique in the cosmos—the triumph of evolution.

"First we thought the earth was at the center of the universe," Dyer says. "Then astronomy showed otherwise. Later, evolution showed us that we were not the descendants of Adam and Eve but of apes. And now we're finally attacking man's last bastion, our consciousness, our intelligence. What was once enshrouded in mystery is now yielding to AI. We're starting to work out the components that allow for processes like learning," he continues. "We have the tool, the computer, that enables us to compare the behavior of a model with human behavior. So of course that's going to upset people. In fact, it's ultimately going to upset them just as much as the ideas of Galileo or Darwin did." □

Stone was president of SCRAP. The county wants to condemn the five hundred acres and build the landfill.

Citizens who live near hazardous waste sites are frightened for their health. The EPA's superfund database lists 25 069 potential hazardous waste sites in the United States. Toxic and carcinogenic chemicals are leaching into the drinking water supplies of hundreds of communities. The EPA found organic chemical contamination in 23 percent of 1 000 wells it tested recently. Unwilling to accept the typical "We don't have the money, or Don't worry there's no problem" responses of local and state health agencies, more communities are demanding immediate remedies and taking matters into their own hands.

With help from several national organizations, including the Citizens Clearinghouse and the National Campaign Against Toxic Hazards, citizens' groups are conducting their own baseline epidemiological studies. Advice from such groups and public-health professionals is invaluable because citizens' groups need to understand the limits of epidemiological studies. Without good advice a group is likely to turn up evidence so full of inaccuracies that health officials will cite their results to prove

There's no problem. The effects of waste sites on the health of nearby residents remain a hotly debated topic.

Environmental organizations always caution activists against trying to prove waste site caused a rash of both defects and cancers, which is next to impossible to prove even with a professional study. Instead, activists should document the community's health problems and identify trends of increased disease. Three surveys help professional researchers zero in on potential health problems later.

Richard Bird, MPH, an adviser to the National Campaign Against Toxin Hazards has devised a sleek new system to help citizens conduct their own health studies. He says that his computerized system makes community health surveys "as scientifically valid as possible, as well as affordable for financially strapped local governments and communities. He cautions groups that the studies take a long time and require a very serious commitment. "But it's worth it," he says. "Citizens should know if the hazardous waste site in their neighborhood is responsible for their health problems." He adds pointedly, "If we don't look for any unusual illness rates, we surely won't find any."

Dr. Marian Legator, director of the Division of Environmental Toxicology and professor at the University of Texas's medical branch at Galveston, believes community

surveys are the wave of the future. After getting involved at Lowe Carol, I became convinced that the Homeowners did a credible job [with a health study] even when compared with studies conducted by the state," he says. "In every community an intelligent household or two, with time and a telephone, can pull together the neighbors to do a high-quality, general health study."

Legator has written a book with Barbara L. Harper and Michael J. Scott called *The Health Detective's Handbook: A Guide to the Investigation of Environmental Health Hazards by Nonprofessionals* (Johns Hopkins University Press, 1985). In September Legator was awarded a grant from the Mott Foundation to help citizens conduct grass-roots studies in two communities. "I am still choosing the possible sites," says Legator, "and welcome inquiries from concerned citizens."

In dozens of cities, binfactual epidemiologists have succeeded in persuading unwelcome facilities from locating in their towns in getting toxic waste dumps cleaned up or in persuading the state to launch a professional health audit. At the very least, concerned residents aren't stuck waiting passively for bureaucrats to come up with the money, staff, and political will to take effective action. They're doing what they can to effect changes and force those charged with protecting the public's health to do their jobs. 



 It only nests beneath
the best trees.



WILD TURKEY

8 years old, 101 proof, pure Kentucky.

• The vehicle
vanished in a rainstorm,
dissolving in the
water like a spoonful of salt •

ANTI MATTER

It was one in the afternoon on June 6, the story goes, when something roared out of the sky in Curdy County, Nebraska. It looked like an immense, blazing meteor, but when it hit the ground, it skipped over the earth for about half a mile before it disappeared into a draw.

Local cowboy John Ellis and his crew rode furiously toward the mysterious object. And as they approached, legend has it, they saw pieces of machinery scattered along the path. The pieces were so hot they claimed that the surrounding grass was scorched, preventing the cowboys from getting anywhere near the site.

One newspaper account even stated that where the object touched the earth, the ground was sandy and bare of grass. "The sand was fused to an unknown depth over a space about twenty feet wide by eighty feet long," the story claimed, "and the melted stuff was still bubbling and hissing." Even more incredible, the story went, when cowboy Alf Williamson stated at the object his face blistered, and his hat was singed to a crisp.

The next day investigators allegedly came to the site and found one object resembling the blade of a propeller screw and another resembling a wheel. The vehicle itself proved to be cylindrical, 10 feet in diameter and 50 feet long. It was composed of a remarkably light but tough metal.

Another crashed-saucer story? Perhaps.

But what makes this one so remarkable is that it is supposed to have taken place in 1884. The story appeared in a June 1884 issue of the *Nebraska Nugget*, a weekly news-



paper published in Holdrege. The same story was reprinted in the Lincoln *Daily Journal* on June 8. The editor of that paper even went so far as to suggest that the object was a vessel belonging originally to another planet.

Did it actually happen? Inez Tecker, eighty-two and president of the Curdy County Historical Society, says there was a John Ellis and that she knew him long ago. But she has no idea whether the story with which his name has long been associated is true.

Ida Toier, eighty-eight, a lifelong resident of the county and

a keen student of its history, first heard the story about 20 years ago and recently interviewed several old timers to find out what, if anything, they knew about it. The result of her investigations: "Most people just thought that it was too far-fetched to be real."

Betty Loudon, a research associate of the Nebraska State Historical Society, agrees. Researching the year, Loudon found a follow-up story in the June 10, 1884, issue of the *Daily State Journal*. What remained of the vehicle vanished in a "tremendous rainstorm," the newspaper reported. "It dissolved in water like a spoonful of salt."

And that is precisely the substance with which we should take the story. University of Nebraska folklorist Roger Weisk, who investigated the incident, says, "It made little dent in the county's historical memory."

He sums it up this way: "It was a very long time ago. It was a remote place. There's just no way anyone can know exactly what did or did not take place." —JENNIFER CLARK

UFO UPDATE



the man had placed a photo-sensitive monitor in the window and connected it to a battery pack. The solar cell triggered the battery which was wired to a .22-caliber cartridge taped over the man's heart.

We'll never know if he really intended to come out, Larson says, or if he was just waiting for the sun to rise. *Cathy Stone*

More light
—Johann Wolfgang von Goethe's last words

DEATH RAY

Does approaching death make our psychic abilities more acute? According to British psychologist Keith Hearne, head of the Hearne research organization in North Humberston, England, the answer may be yes.

To find out for sure, Hearne has begun two investigations of his own. In the first study, terminally ill people are asked to take tests that will rate their ESP capabilities. We will pick out images from cards or pictures," he says.

SUNBATH SUICIDE

In one of the more bizarre uses of solar technology, an out-of-work Seattle man recently built a suicide machine that was triggered by the power of the sun.

This past spring thirty-five-year-old Robert Saylor graduate of a correspondence course in electronics phoned his estranged wife and told her he'd barricaded himself in a hotel room. His request: to see her and

his young daughter one more time before he died. During the meeting Saylor spoke of his machine—a "foolproof apparatus made of a solar cell, a battery pack, and explosives."

The next day Saylor phoned his wife to say that the zero hour had arrived. His wife alerted the police, who arrived on the scene after midnight and over the phone tried to talk him out of suicide. The members of

the hostage negotiating team felt that they had convinced him to come out and that he would come out at any minute," says King County, Washington, police spokesman Jack Larson.

But with the first rays of the sun, a muffled explosion came from his room. The officers rushed in and found Saylor cowed in a chair, his legs resting on a nearby bed. He was dead.

Upon investigation, Larson says, the officers found that





"Then we will attempt to transmit the images to the terminally ill at specific times, probably twice a day. The results will be plotted back from the moment of death," Heame adds. "I expect to see an upward turn in posture as death approaches."

The second study will focus on memories and perceptions reported by those who have been, for a moment at least, clinically dead. To test hearing during death, for instance, Heame's group will ask a hospital medical team to play random pre-recorded words and phrases at the moment of death. If the patient revives, he or she will be asked to recall the words.

Heame admits it may be difficult to gain the cooperation of doctors and hospital administrators. But he plans to document objections from the medical establishment "by appealing to the public at large. To choose to participate is up to the individual's own conscience," he says. "I know if I were dying

I would be only too happy to take part in a parapsychological experiment."

Heame asks terminally ill people interested in participating in psychic research to contact him at Box 84, Hull, North Humberside, England HU1 2EL.—O. Scott Rogo

STELARIC

Though the events may vary in detail, the essential experience is the same. He puts 18 large bathhooks

through his skin, attaches the hooks to wires, and hangs—nude—from trees and cranes for 30 minutes or more. Stelarc Arcadiou, of the Yokohama International School in Japan, calls these events obsolete body suspensions—a sort of deprivation exercise, he says, which symbolizes the "physical and psychological limitations of the body."

"Technology has surpassed our evolutionary capability," declares Arcadiou, who goes by the name of Stelarc. "The body cannot cope with the quality or quantity of information that confronts it. Man is in a kind of evolutionary crisis—the body is obsolete."

The next step in human evolution, Stelarc adds, will combine technology with the body. Suspensions represent one of these evolutionary paths.

The suspensions, says Stelarc, are a revelation for both him and his audience. "I realize the primordial desire to be suspended in space, yet still am within the limits of a gravitational force,"

he says. The audience witnesses the visual symbol of man overcoming the force of gravity."

According to Stelarc, suspensions vary in intensity. One session took place in a small, quiet room with rocks suspended around him. This was meditative and peaceful, he says. Hanging from a crane 180 feet off the ground in Denmark, on the other hand, was "highlighting" and dangling over a New York City street was "noisy and disruptive."

Does obsolete body suspension hurt? "Sure it does," Stelarc says. "In fact, I'd be worried if it didn't. Pain tells you that you are doing harm to yourself and that there is a problem. But I've never had any serious medical problems, and I've never even seen a doctor."

How long does it take to recover from a suspension? A week to ten days. It's just a matter of keeping the wounds clean and changing the dressing daily. Is body suspension a form of masochism? "I don't know what that means," Stelarc says. A woman goes through a lot of pain to give birth to a child. Artists must sometimes go through pain to give birth to new ideas.

—John Bruce Shoemaker

The artist is extremely lucky who is presented with the worst possible ordeal which will not actually kill him. At that point, he's in business."

John Breynman



All my life I have struggled to make one authentic gesture.
—Baldern Duncan



Twins, Right? Audiotape

The average American marriage has less than a 47 percent chance of success. But when one pair of twins marries another pair of twins a happy and stable marriage is virtually assured. That, at least, is the scoop according to Charlotte C. Taylor, a biochemist who, under the auspices of the UCLA psychiatry department, studied 100 twin marriages.

To Vicki Norris, mother of two twenty-one-year-old unmarried twin daughters in Springfield, Mass., the findings have a negative aspect as well. Since only one birth in eighty involves twins, she says, "It's unlikely that compatible sets of twins will meet by chance." So to increase the odds Norris recently founded Twins International, a nonprofit organization that will publish a directory of twins looking for twins.

"Twins have an ours' attitude rather than a me

attitude," Norris says. "But when they marry, their spouses of single birth can feel jealous because they can't understand why they can't never be the 'one and only' in one twin's life."

Taylor's studies back up these observations. In fact, she adds, "similarities down to a biochemical level probably explain why twins married to twins have such compatible relationships. The marriages of twins to twins I have studied were carbon copies of each other, just as the twins were carbon copies," she says. "They were literally big, happy families—often with all four people sharing homes, bank accounts, and even their children, who were related as brothers and sisters."

Norris' own daughters, country music singers Rebecca and Melinda, think the directory is a good idea. "We would definitely prefer to marry twins," Rebecca says. "If they're our type."

But Taylor thinks the direc-

tory may be of most value to scientists. "We can always learn a lot from studying twins who have identical chemical makeup. Knowing how to locate twins can be extremely important for research into genetics, mental illness, and more."

Twins who would like more information on the directory can send a stamped, self-addressed envelope to Twins International, Box 4425-GS, Springfield, MO 65808.

—Sherry Baker

Twins As Investors

Buy or sell? People will try just about anything to give themselves an edge in the stock market. Now there's a new tool—music.

Denver investment adviser Darryl Gammit has converted last year's IBM stock chart to music, which he says the novice can use to predict IBM's movement on the trading floor.

Gammit's score, which he's named "Audiotapes," is available on a 45-rpm record or cassette tape. It comes with a chart of IBM's movement from April 1984 to April 1985. "It takes a little practice to get the hang of hearing what you see on the chart," Gammit says. "The idea is to let the ear do the analysis instead of using the data through your eyes. One novice correctly predicted the stock's movement four out of five times on his first try."

How can "Audiotapes" possibly work? Armed with stock charts, Gammit and composer Les Hansen used a computer to translate four variables of IBM's perform-

ance into a musical score. A synthesizer generated all the instrumentation, representing the daily stock prices as notes of the melody, the daily trading volume as the volume of the sound, the 50-day moving average as crashing surf, and insider buying and selling as high or low bells and chimes.

The whole idea, says Gammit, is to give laymen a feel for the market by listening to the actual fundamental variables. Once the person is familiar with the score, he should, with a glance at the daily market listings, hear a revised version of the music in his head. That will allow him to predict where the next musical notes, and the stock, ought to go.

Gammit's system is being upgraded as well. While the current version charts just four variables for IBM, a new LP score to be released through the Book of the Month Club, will chart 14 variables for the top 100 companies in the United States.

Is "Audiotapes" for real? Richard Hurwitz, director of research for Borchert & Company in Denver, says Music is basically a mathematical medium, so if price and volume can be charted, then they should be reducible to music too. But he cautions, professional stock analysts rely on "upwards of fifty or sixty variables," whereas "Audiotapes" incorporates at most 14.

If you want to try a copy of "Audiotapes" for yourself, contact Gammit & Company, 1775 Sherman Street, Suite 2020, Denver, CO 80203.

—Peggy Noonan

VITA-GEL HAIR

CONTINUED FROM PAGE 32

crowdy. [But don't eat all the dessert, because I like a bit myself—once I'm done in the bathroom. Which is where I have to go now. Excuse me.]

In the shower stall in the bathroom she adjusted the water to medium warm and thrust her head under the spray. Her hair gave a cry of surprise, but then finding itself being pampered, it relaxed and enjoyed the warm water flowing through it.

Just as she was squirting a pale yellow pool of Vita-Gel foam into her hand, she heard Phil shouting something incomprehensible from the kitchen. "I won't be long, she shouted through the door.

In fact, it took another five minutes before every lock of conditioner-soaked hair had been wound into a curl. She wrapped a towel into a turban to conceal the curls and went out to join Phil in the kitchen.

He was sitting at the table with an empty cereal bowl before him and, beside the bowl, the opened plastic tub of Vita-Gel mousse. "You know Deborah, I think your dessert's gone bad. I saved you some, like you asked, but I swear it doesn't taste much better than cold food."

"You ate the Vita-Gel?" Deborah marveled.

"Not a lot. Like I said, it's gone off."

"But that's for my hair."

"It says mousse right on the package." Phil objected.

"But it's hair mousse, not dessert mousse. Oh dear. Are you feeling all right? Do you think I should call a hospital?"

"I've never heard of hair mousse. You put it in your hair? Why?"

Deborah looked inside the tub and tried to estimate how much he'd eaten.

"It's supposed to make your hair live," she explained. "But I don't know what it would do to a person's stomach."

"It's okay," he said. But he looked peculiar. "I think I'll go into the bathroom for a moment. If you don't mind." He hurried out of the room.

When she was alone, Deborah's hair began to speak in faint, muffled tones. "Deborah? Deborah, take off this towel, would you? And these curlers—I'm being suffocated! Deborah?"

Later Deborah said. After he's gone.

"Now, her hair insisted. "I've had all the conditioner I can possibly absorb. I want to be rinsed. And you don't want to have Phil see you with your hair in curlers, for heaven's sake."

There was a noise from the bathroom. Was he making himself gay? Deborah wondered. It didn't sound like that. It sounded more like an exclamation, something being an aah of surprise and an ooh of being hit in the solar plexus.

Phil came out of the bathroom. "You're not going to believe this," he said. "I think that I—oh Jesus, I'm hearing it again!"

"Deborah," said her hair, "don't just stand

there gawling. Take him over to the sofa, sit down with him, make him feel at home!"

She ignored her hair and asked Phil, "What are you hearing?"

"A voice. A voice in my stomach. Or maybe lower. A deep bass voice."

Of her own volition, with no prompting by her hair, Deborah went over and stood beside Phil. "What does the voice say to you?" she asked. She put her hand on the soiled part of his paunch. "If you'd rather not tell me, you don't have to."

"It said, 'Ask her to marry you, jerk.' Meaning you. Then it said it again. Ask her to marry you.' Only this time, instead of calling me 'jerk,' it called me by name."

"I believe you. Because the same thing's been happening to me. Only the voice that I hear is in my hair. I suppose because that's where the Vita-Gel is. The voice is from the Vita-Gel."

"Amazing," said Phil. "Now you must think I'm crazy."

"Can I ask you a personal question?" Deborah smiled.

"Does the voice you hear have anything to say about me?"

"Oh, it likes you. It did from the first."

"Then do you think, I mean, I know this may be considered premature, and neither of us are exactly in our right minds but... would you marry me?"

She waited for her hair's advice, but this was a decision her hair seemed determined that she should make for herself, and indeed, from the moment that she said "Yes," her hair fell silent. Phil, too, stopped hearing the voice from his stomach. And strongest of all, neither of them ever again spoke of the unusual circumstances surrounding his proposal. It was as though they'd made a promise to each other to pretend to be just another ordinary married couple living in a condo at the edge of Roseville. She did, of course, remain loyal to Vita-Gel, and her hair continued to be radiantly beautiful, alive, and bouncy and, as the ads say, lustrous. Wonderfully lustrous and vibrant and rich. **CG**

CALLS

CONTINUED FROM PAGE 36

says," but also how they were ordered in a sentence." It was the first convincing evidence that animals could grasp some fundamental grammatical rules.

Scientists at the University of California at Santa Cruz have recently shown that even sea lions (who are far less intelligent than dolphins) can master the grammatical complexity of multiword commands. The star of the show is a sea lion named Rocky, who lives in a pool overlooking the Pacific Ocean.

Poked at the U. of C. at Santa Cruz, grad student Michelle Jefferys explains that part of the success comes from increased awareness of ourselves. To avoid influencing Rocky by repeating unconscious patterns, Jefferys doesn't decide what tasks Rocky will perform. Instead, another student reads the tasks from a randomized list. Jefferys simply listens to the directions through headphones, then communicates with Rocky by nodding with her arms.

Jefferys makes the symbols for ball or fetch. Suddenly Rocky turns. She swims past half a dozen toys floating in the pool, then uses her nose to push a plastic car over to a ball. On the next trial Jefferys makes some more motions. This time Rocky nose-butts the ball to the car.

There's a lot more going on here than simple circus tricks," says Ronald Schusterman, the psychologist in charge of the lab. Rocky understands the rules in the sentences as well as the words. This holds true even when Schusterman adds modifiers—words describing color and size. Rocky now has a vocabulary of some two dozen words and has responded to thousands of new commands.

Back in Hawaii, Herman has expanded his studies as well. Each of the two dolphins he trained knows 40 to 50 words and has a repertoire of thousands of different commands. One dolphin responds to hand signals, the other to computer-generated sounds.

Using this technique, Herman has demonstrated new levels of dolphin cognition. His dolphins know right from left. When given the command *move*, they mistake the next sound they hear. They understand the concept of *enough* in which a sign from Herman tells them to disregard one message and obey another.

I place them in the same intellectual ballpark as the chimpanzees," Herman says. "They're cognitive cousins—which is amazing when you consider that in terms of evolution, they separated from land mammals about sixty million years ago."

Recently Herman took another step toward human-dolphin communication. He installed two paddles in the dolphins' pool: one paddle was for "yes," and the other for "no." Now when asked if a certain object is in the water, the dolphin pokes a paddle to answer. The answers, while limited, open

CREDITS

Page 100 **Unleash**, Randy Meyer, 1991 (Jeffrey's) [Seven-Page Progress] 1. The Shrimp [Shrimp] 2. The Crab [Crab] 3. The Fish [Fish] 4. The Bird [Bird] 5. The Frog [Frog] 6. The Snake [Snake] 7. The Lizard [Lizard] 8. The Mammal [Mammal] 9. The Insect [Insect] 10. The Plant [Plant] 11. The Fungus [Fungus] 12. The Bacteria [Bacteria] 13. The Virus [Virus] 14. The Protozoa [Protozoa] 15. The Mollusk [Mollusk] 16. The Arthropod [Arthropod] 17. The Chelicerate [Chelicerate] 18. The Crustacean [Crustacean] 19. The Mollusk [Mollusk] 20. The Arthropod [Arthropod] 21. The Chelicerate [Chelicerate] 22. The Crustacean [Crustacean] 23. The Mollusk [Mollusk] 24. The Arthropod [Arthropod] 25. The Chelicerate [Chelicerate] 26. The Crustacean [Crustacean] 27. The Mollusk [Mollusk] 28. The Arthropod [Arthropod] 29. The Chelicerate [Chelicerate] 30. The Crustacean [Crustacean] 31. The Mollusk [Mollusk] 32. The Arthropod [Arthropod] 33. The Chelicerate [Chelicerate] 34. The Crustacean [Crustacean] 35. The Mollusk [Mollusk] 36. The Arthropod [Arthropod] 37. The Chelicerate [Chelicerate] 38. The Crustacean [Crustacean] 39. The Mollusk [Mollusk] 40. The Arthropod [Arthropod] 41. The Chelicerate [Chelicerate] 42. The Crustacean [Crustacean] 43. The Mollusk [Mollusk] 44. The Arthropod [Arthropod] 45. The Chelicerate [Chelicerate] 46. The Crustacean [Crustacean] 47. The Mollusk [Mollusk] 48. The Arthropod [Arthropod] 49. The Chelicerate [Chelicerate] 50. The Crustacean [Crustacean] 51. The Mollusk [Mollusk] 52. The Arthropod [Arthropod] 53. The Chelicerate [Chelicerate] 54. The Crustacean [Crustacean] 55. The Mollusk [Mollusk] 56. The Arthropod [Arthropod] 57. The Chelicerate [Chelicerate] 58. The Crustacean [Crustacean] 59. The Mollusk [Mollusk] 60. The Arthropod [Arthropod] 61. The Chelicerate [Chelicerate] 62. The Crustacean [Crustacean] 63. The Mollusk [Mollusk] 64. The Arthropod [Arthropod] 65. The Chelicerate [Chelicerate] 66. The Crustacean [Crustacean] 67. The Mollusk [Mollusk] 68. The Arthropod [Arthropod] 69. The Chelicerate [Chelicerate] 70. The Crustacean [Crustacean] 71. The Mollusk [Mollusk] 72. The Arthropod [Arthropod] 73. The Chelicerate [Chelicerate] 74. The Crustacean [Crustacean] 75. The Mollusk [Mollusk] 76. The Arthropod [Arthropod] 77. The Chelicerate [Chelicerate] 78. The Crustacean [Crustacean] 79. The Mollusk [Mollusk] 80. The Arthropod [Arthropod] 81. The Chelicerate [Chelicerate] 82. The Crustacean [Crustacean] 83. The Mollusk [Mollusk] 84. The Arthropod [Arthropod] 85. The Chelicerate [Chelicerate] 86. The Crustacean [Crustacean] 87. The Mollusk [Mollusk] 88. The Arthropod [Arthropod] 89. The Chelicerate [Chelicerate] 90. The Crustacean [Crustacean] 91. The Mollusk [Mollusk] 92. The Arthropod [Arthropod] 93. The Chelicerate [Chelicerate] 94. The Crustacean [Crustacean] 95. The Mollusk [Mollusk] 96. The Arthropod [Arthropod] 97. The Chelicerate [Chelicerate] 98. The Crustacean [Crustacean] 99. The Mollusk [Mollusk] 100. The Arthropod [Arthropod]

a window on the dolphins' mind. For when a dolphin pokes "no. 4" means it understands the sign forms a mental image, and deduces that the firm isn't there. This ability—which is called referential reporting—has previously been documented only in apes and man.

Another scientist has pushed human-dolphin communication even further. At Marineworld/Africa USA, north of San Francisco, ethologist Diana Reiss has built a submersible keyboard. It's about two feet square and consists of nine keys. Each time a dolphin pushes a key with its beak, a computer records it and produces a sound specific to that symbol. Then the dolphin gets what it asked for, be it a ball, fish, or back scratch. Just as in human language, the animal links the label with the object, action, or reward.

Reiss is a small, dark-haired woman who speaks with great intensity about dolphins. She doesn't mythologize: when Reiss tells you something, she backs it up with a videotape and a computer analysis.

She recalls that soon after she installed the keyboard the dolphins taught themselves to use it. Then they started to make the sounds. They'd push a button, hear the computer whistle, and within milliseconds match the sound. Sometimes they'd make the sound even before pushing the button.

According to Reiss, the computer represents a middle ground, "a shared code that animals and humans can both understand." But to be truly powerful, any such system must incorporate a knowledge of the vocal and nonvocal symbols that the animals use among themselves.

And the foundation of such knowledge—the ability to give specific meanings to animal sounds—has begun to emerge. A breakthrough came in 1960 when Robert Seyfarth, Dorothy Cheney, and Peter Marler were observing vervet monkeys in the jungles of Kenya. They knew that vervets, like other primates, are very vocal creatures. They're also rather small, which means they have many natural predators and a variety of alarm calls. Seyfarth and Cheney wanted to know if the different alarm calls had different meanings or if they just portrayed the level of the vervet monkey's fright.

They used a simple but little-tried technique: They recorded three kinds of alarm calls and played them back to see how the monkeys would react. When they played back one call—a bark—several of the monkeys scurried up trees. A grunting call made them dive for cover. A rapid series of coughs caused them to jump up on top toes. Those vastly different reactions showed that the differences between the calls were related to the messages they carried. The bark warned that a leopard was on the prowl. The grunts said that an eagle was overhead. And the coughs meant that a snake was underfoot.

Subsequently Cheney and Seyfarth expanded their dictionary of monkey sounds. They now know of six alarm calls (the other



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CHARCOAL MELLOWED FOR SMOOTHNESS

three are for jackals, baboons, and humans), at least four grunts, and three or more chattering sounds, each with its own meaning. The messages range from cries of alarm and territoriality to expressions of kinship and social bonding. What they all have in common is their symbolic nature—something that was thought to be exclusive to human communication.

"We finally established that animals in the wild can use their own calls to represent things in the external world," says Cheney, now at the University of Pennsylvania. "It's a little like what the signing chimps do—only humans haven't taught them."

Not only did Cheney and Seyfarth work reverse old notions of how animals communicate, but it established a powerful new research tool. Now several other researchers are using playback to decode animal messages as well. A team from the University of Minnesota is currently in Tanzania's Serengeti National Park recording and playing back the roars of lions. The goal: to learn the social function of a variety of specific sounds. At the University of Washington ornithologist Philip Stoddard is using playback to learn how some birds identify their young and define their territory. And at the University of Florida, biologist Harry Hollen is planning to use playback to analyze tiger calls. So far, he's compiled a brief tiger dictionary by presenting caged tigers with a wide range of stimuli and recording the responses.

After running hundreds of such trials, Hollen has categorized a number of tiger sounds. A prousson—a pulsing kind of purr—means I recognize you, don't attack me. Let's check each other out, says Hollen. A prousson followed by a moan means the tiger wants to be friends. "I've never had one turn on me after that," he adds.

Human aid an even more extensive form of playback with humpback whales. Members of his team tracked a pod of humpbacks off the coast of Alaska and then recorded their calls. Then they played back the calls to whales in Hawaii. Though the results are preliminary, they found that feeding sounds could stop whales in their tracks a kilometer away, turn them around and cause them to follow the vessel.

That discovery found a practical use not long ago when a humpback named Humphrey was stranded in the Sacramento River. Nothing could remove him—until Herman mailed a tape to California authorities. When they broadcast the trumpet sound through an underwater speaker, Humphrey charged the boat. He kept following all the way to the Golden Gate Bridge—53 miles and seven hours later.

But the most precise work with playback may someday emerge from a small medical lab in downtown Seattle. Here Richard Ferraro, a nationally known expert in medical electronics at the Institute of Applied Physiology and Medicine, recently unveiled a new invention: a computer that can pick up animal calls, digitize them, display them graphically, and create sounds in re-

ply. In short, it's the closest thing we've got to a human-animal translation machine.

With Ferraro's device you can punch up any of dozens of preregistered calls, play them to animals in the wild, and see how they react. Or you can use a joystick to create novel sounds of your own.

Such a machine could be used with any animal sound, but Ferraro has focused on the orca, or killer whale. By following whales off the coast of Washington, he has gathered and analyzed hundreds of calls. He's grouped them into more than 50 call groups according to their sonic character, which he can display on a screen.

He's also begun to use the machine to interact with the orca. In a recent pilot study he took the machine into Puget Sound on a small boat. Moored to within 50 yards of a pod of orcas, he broadcast the computer version of an orca call consisting of two descending notes. After several tries, a few orcas called back. Then Ferraro modified the call by adding a third note at

◆ Some of the
ape researchers established
dominance over
their charges, according to
Wieder, with
yells, bluffs, choke chains,
cattle prods, BB
guns, and blank-loaded guns. ◆

the end. Again some of the orcas responded—only this time with a new call. Finally he broadcast what he calls his "signature"—a unique, custom-designed call that announces Ferraro is around. It's a creaky, two-note glissando that sounds like a wolf whistle. It's not part of the normal orca repertoire. Yet just as before, a few orcas responded with an imitation.

Ferraro concedes that his results are preliminary. But they do show that killer whales may respond to a strange call. "I think they have the desire to interact," Ferraro says. The next step is to play back small pieces of whale calls and see which sounds provoke which response. "We're trying to isolate areas of the orca call and find out what aspects are important," Ferraro explains. Someday work like Ferraro's may yield human-animal dictionaries that are relatively complete.

Some human-animal dictionaries may involve voices we can't even hear. Recently Katherine Payne of Cornell University stunned the zoological world when she found that elephants may communicate with calls beyond the range of human hearing. Payne is the world renowned

whale expert who discovered that humpback songs change from year to year. Like Top 40 tunes. Thinking that elephants might also have songs, she sat in a zoo and observed an elephant family for hours—only to go home after not hearing a thing. She suspected that there may have been more than met her ear, so she returned with a high-speed tape recorder. She recorded the elephants at normal speed and played the tape back at high, raising the pitch of their calls enough to hear them.

She uncovered a hidden world of sound. Elephants were already known to call one another with assorted rumbles, roars, trumpets, and barks. But here was a whole new component to their calls—a repertoire of infrasonic sounds.

By cordoning the high-speed tapes and her hours of observation, Payne learned that the elephants use the calls in a variety of situations, from caressing their calves to seeing the zookeeper arrive with food. To get a better idea of what the calls mean, she took the recordings to Kenya, where she and elephant expert Joyce Poole played them back to wild elephants. She found that elephant herds often move in parallel tracks, even though they're out of sight of one another. By using infrasonic calls, which travel for miles, the herds may be keeping tabs on one another. It's also known that bull elephants, which live apart from females, travel great distances to find them during mating season. Again, long-distance infrasonic calls may play a role.

"A lot of people think there is a very big line between humans and animals," says Poole. When they learn how much elephants have to say to one another, they'll realize just how intelligent and how communicative some animals are—even the parrot, thought to be just a bit more intelligent than a cat or a dog.

The key to that extraordinary accomplishment is a new teaching method based on the way parrots learn in the wild. These birds are not born with the ability to make complex calls. Pepperberg says, instead they learn from parents and peers. Pepperberg adapted that knowledge into what she calls "social modeling." Essentially, it's a form of role-playing with two human teachers involved. One person plays the parrot, and the other, the instructor. The "parrot" asks the instructor for a particular object, which it gets if it has applied the label correctly. To make sure Alex focuses on the words and not the people, the trainers switch roles. Then Alex tries. Pepperberg gives him only what he asks for, reinforcing the meaning of labels.

First Alex learned to label objects. Then he learned to request them by imitating the word used in his speech. He learned to refuse by saying "no." He also learned colors, shapes and quantities. He grasped the meaning of such concepts as different and same. "It's not suggesting Alex says abstract things," Pepperberg states. "But when he's put in his cage at night, he'll say, 'Want a nut, tickle me.' It's like a child who

doesn't want to go to bed. We've shown that even with a creature as distant from us as the parrot, true interspecies communication can exist."

From English-speaking parrots to singing whales to signing apes—in the last few years researchers have made a compelling case that animals can learn language. Of course, I'll probably never chat with chimps about politics or philosophy. The gap between animal and human language is just too great. But interspecies communication has opened a window on animals' minds. By observing that chimps "talk" about social interactions (hug, kick, you chase me), scientists have learned what's important to the species. By finding that a parrot can clearly shape and color, they have learned more about what humans and birds cognitively share.

"We have to be open to the possibility of true animal consciousness," Denis Rees states. "Assuming that only humans can give voice to complex thoughts just isn't scientifically sound."

Being open to possibilities is a sentiment with which Roger Fouts agrees. First, he plans to look more closely at how his chimps use facial expressions and body language to modify their words. "Someday he'll move them to a farm—a permanently endowed colony where they can live out their normal 70-year life spans, teach new comers, and continue their signing. He'd like to teach them agriculture, to see if they can understand the cause-and-effect process of planting and reaping."

"I'd like to have this chimp colony open to the public," says Fouts. "People who know sign language can come and communicate with the chimps. It will help people understand where we fit in nature."

Herman hopes to take trained dolphins out to sea. "Imagine having language-trained dolphins in the open ocean," he says. "You could ask them things like, 'Could you bring me that tool I've just dropped onboard?' Or you could ask them to report things like 'Is there a whale around?' or 'Are there any manganese nodules on the bottom around here?'"

There's also a less utilitarian vision. According to that view—held by a 2,000-member organization called Interspecies Communication—communicating with animals can break down the barriers that separate humans from the earth. Each summer about a dozen members of this group spend a month on a tiny island off British Columbia, where they commune with orcas by playing music into the water at night. Conducting the session is musician Jim Nollman, who has played music with kukeys, wolves, buffalo, dolphins, and whales. He's used a guitar, a water drum (a submersible instrument), or sometimes just his voice.

That kind of activity makes scientists uncomfortable. One researcher, when learning that I planned to visit Nollman, asked not to be included in the same article. "This field is already too easily labeled as kooky,"

A few days later I was sitting in a cabin cruiser about 250 miles northwest of Vancouver, on the inland waterway to Alaska. We were anchored in a small bay along an orca migration route. The half-moon spilled a line of liquid mercury across the black waters. Inside the cabin Nollman lit a candle. A tangle of black wires connected his guitar to an underwater sound system.

Nollman flipped a switch. Through the speakers we heard orca calls, perhaps a mile away. At first we discerned just faint, blasting howls and airy squeals. Soon the sounds grew stronger and clearer. The whales were approaching. Nollman started playing, nothing recognizable—just some light tinkling and musical scratches. "They don't like prerecorded music," he said. "This is the realm of improvisation."

As the killer whales approached we heard a series of rapid, metallic clicks—echolocation. Then we heard what sounded like a cross between a cat and a bird. Nollman kept playing. There seemed to be an exchange—the orca in the background. Nollman in the foreground. He hit a series of chords. Some orcas appeared to squeak in response. The sounds mingled. The orcas, it seemed, were wrapping his music in theirs.

"I feel a mystical sense when the whales respond," says Nollman. "I feel like they're reaching out to humans in a benevolent way." Was it communication? Not in any measurable sense. But not measuring is precisely Nollman's point. Although all sessions are recorded, "I'm not into amassing that kind of data," says Nollman. "I'm trying to establish a dialogue with nature—to the orcas as fellow beings. It's sad that science needs to manipulate nature to understand it at all."

I went aboard clock. Several 30-foot orcas were playing a few yards away. Puffing and diving, they forward-rolled in the water, leaving swirls of green bioluminescence. They rolled around us as Nollman looked them with electronic sounds. I have no way of knowing whether it was communication. But standing on the foredeck I was struck by the quest. For maintaining his uniqueness man has endured a biological loneliness—a longing for a companion intelligence. Out of that longing has come a history of myths about talking animals. Ever today we search for that companion, spending millions to launch spacecraft bearing messages and beaming radio waves to the depths of space. We find that intelligence in other creatures on Earth no matter how simple or different they seem? According to Roger Fouts, that's precisely the point. "Someday we'll realize that the human voice is not alone viable but part of an orchestra. We're not playing a solo, instead it's a symphony." **OO**

Wolf sounds courtesy of Fred H. Hanger; elephant sound courtesy of the Bronx Zoo; chimp sound courtesy of Roger Fouts; orca sounds courtesy of Interspecies Communication and Rachael Fernand; tiger sound courtesy of Harry Miller

MIND

CONTINUED FROM PAGE 40

week she could breeze through the entire alphabet. Within two weeks she could read simple words and phrases, a month later she could comprehend sentences. Six months after the visual retraining started, Eliza could read even small print in textbooks. More surprising than this, tests using the Shellen chart—the one with the large x at the top—showed that her visual acuity was now as good as it had been before the coma.

About the time Eliza began to recognize letters, she reported that she could "see things" once more. Her posture improved and she began to walk without running into anything. But she still couldn't write, spell, pronounce words, add, subtract, dance, or tell time. Merrill taught her these skills too, one step at a time.

Most of the doctors who treated Eliza wrote off her recovery as "miraculous." The real miracle, however, lies in the shaping techniques used with her. Merrill first set a specific, measurable goal for Eliza. She did not try to teach Eliza "to see," but taught her to recognize color and form. Merrill also knew what Eliza could and could not do before beginning the treatment and designed the therapy to capitalize on her strengths. Together they took small steps to reform elicit behavior. Because Eliza often failed to notice the genuine progress she was making, Merrill gave her objective feedback and always corrected her in a gentle way. Finally by encouraging Eliza to set her own goals and to monitor her improvement, Merrill helped her learn how to take charge of her own recovery. Once the shaping process was over, Eliza really didn't need Merrill's help anymore.

"It's an odd thing," Merrill said to me. "At first, Eliza was just imitating the people around her, particularly me. Her facial expressions were so similar to mine that her mother actually recognized me when we met. Eliza mimicked my speech and my personal interests as well. That's how close we were. Eventually, though, Eliza became her own person again."

More than half a million Americans suffer some kind of brain damage each year—from strokes, accidents, and disease. Almost all of them could be helped significantly if they were given behavioral as well as medical treatment. Because most physicians still cling to the structuralist viewpoint, however, fewer than 10 percent of these patients have the opportunity to work with someone like Marty Merrill. Eliza was one of the lucky few.

In my final conversation with Merrill, I asked how Eliza was doing now, almost four years after her treatment had ended. Her eyes lit up. "She's doing marvellously," Merrill said. "She's just graduated from high school and she's thinking about going to college. Can you believe that she wants to become a psychologist?" **OO**

COVENANT

COVERED FROM PAGE 30

the money for whatever it is. How can I make you understand that?"

"Look," Peter said, "I'm not calling you about the roof or the toilets or the pipes that are going to burst one of these days and take out half the church with them. I just want you to talk with Sam." He thrust the receiver of the sedan. "Here."

He snatched up the Peace Letter and scanned a pious rant on radiation-bum victims for grammatical errors. When Sam was gone, he reread the last paragraph on the typewriter. "If bet that nobody's actually told Sam any of this, he thought. He went on to the next paragraph.

(2) When a new season is hired a warm, sensitive supervisory relationship should be developed which has not existed in recent years with Sam.

It was night when Jennifer next came out, and because she dared not return to the refrigerator so soon, food was harder to find. The kitchen cupboards yielded only a chunk of old cheese, hard as a rock and ignored even by the mice. Growing off one tasteless fake at a time, Jennifer went up the back stairs to the top floor.

The room over the parish hall was originally a chapel, and it still retained the rose windows and oak balconies. But the floor space had been partitioned into three rooms at a time when the nursery school had been larger. Now they were used exclusively for storage. Jennifer climbed over a partition and systematically rifled old supply cabinets until finally she found a box of noodles among the crayons, paper scissors, and glue. She took two handfuls down to the kitchen and threw them into a pot which she filled with water and set on the ancient black gas stove to boil.

The nursery room across from the kitchen had been left unlocked, and Jennifer peeked within. It was a room for hobbits, filled with child-sized tables and chairs and lit only by a fluorescent bulb over the fish tank. Chairs of paper loops and shadowy crayoned pictures leached the walls. Low shelves were tumultuous of toys. She tapped a bit of fish food to the guppies and watched them hurry over it. There was a plastic brush on one table. She picked it up and sat down in a muncher-size chair and began combing out her straight, mid-back-length hair. It glinted autumn in the fish light.

She was about to go check on the noodles when the lights blazed on and an old black man walked in the door.

Jennifer finched back in the chair, half blinded and afraid. Her heart scolded wildly, and her large knuckled hands clenched wildly. The sedan stopped when he saw her. "I got to clean this room for night, mess," he said defiantly.

But when Jennifer started to stand, the

man waved her down. "No, don't you get up; that's all right—I'll mop around you. No need for you to get up." He lifted a bucket of soapy water into the room and shifted a few chairs and toys, shaking his head at their being in his way. He plunged the mop into the bucket and began swabbing.

"Now with the nursery school?" Sam asked. When she said nothing, he nodded, taking her silence for assent. He mopped vigorously, with the habit of yells. But the effort it cost him was obvious, and his breathing soon grew ragged and harsh. He took a gulping breath and leaned against the mop, closing his eyes for strength. "Then you ought to know that I can't come in during the day," he said. "A little bit in the morning, but I got chemotherapy and radiotherapy during the day. I don't want to come in at night, but I got no choice."

"Why?" She was startled by her voice—it was totally new to her. It lightened her, and yet almost immediately she wanted to

When the noodles were done, she dumped them onto a plate. She stirred the crayons into a brown swirl. Then she poured them over the noodles, took up a spoon, and began eating.

say something again, for the question had caught her by surprise, and she still had no sense of how her voice sounded.

"There's a mess on my lungs," he said. "but that's not all. There's more wrong than that. They found the mass, but they're not sure about the other." Gently he sat down on one of the low tables. "There's something the matter with my heart."

Jennifer searched for words, found some "You got better." That sound thrilled and dazed her.

The old man opened his eyes, stared off into the middle distance sightlessly. "I'm not going to get better young miss. I'm going to die." Tears trickled at the corners of his eyes, and he shook his head, sending them flying. "But you know what, I don't want to die. I realize that everybody got to die sometime, but that don't make it any easier. I don't want to die."

"You won't die," Jennifer said.

Sam clutched the mop handle, staring brierily at the floor. The tears began falling large, slow, one at a time.

Quietly Jennifer left. In the kitchen she found the noodles had overboiled and the water had put out the flame on the gas

burner. Before she returned to her nest she saw Sam put his key ring away in one of the cupboards on the front basement landing. He covered them over with an old rag, but she knew where they were.

Coming up the walk to his office, Peter tapped and dropped his breakfast. The bottle of juice shattered into the sandwich and he was able to save only half the coffee. He entered his office in a foul mood, dumped the food into the trash, and plugged in the electric heater he kept in the log well of his desk.

He pulled the paperback copy of *Moby Dick* from his hip pocket (he was one-third through his usual bog down part) and slammed it onto the desk top. Impetuously he drew up his chair. Among the papers on his desk was the *Jerome* council minutes sheet he'd left in the pastor's mail slot the night before. Held curled the sexton forms and written was *ANYBODY TOLD SAM* in the margin. Now it had been returned with NO DO IT PLEASE printed below in the pastor's calm, neat lettering.

Angrily Peter scowled. Are you aware that SAM is often below the pastor's note and returned the minutes to the slot. That bought him a day. He picked up his paperback, ignoring the phone that started ringing just then, since he wasn't yet officially in. Then the doorbell buzzed and that he couldn't possibly ignore.

"Yes?" He opened the door, partly blocking entry with his body. It was one of the vent people, a short fat man with his hair done up in greasy dreadlocks. His clothes were rotting on his body. Peter could smell them. The man was the color of the city—clothes, skin, hair, all the same grimy industrial gray—and Peter recognized him. "Oh, it's you, Ashod."

Ashod clutched a broken plastic sooty in one fist held up before him, crucifix dangling at the end of a single string. It was bright pink. "I gave you a meal letter two weeks ago," Peter said. "I can't give you another for at least a month. Come back when it gets really cold and nobody's mind."

Ashod waved his fist back and forth in negation, the crucifix swinging wildly. "No, no, it's not that. I want to see the lady."

"Lady?" Somebody in the nursery school?

Ashod nodded his head vigorously. "No. I want to see the lady. I want her to make the voices go away."

The telephone was ringing again. It was almost certainly time he was at work. "Come back when it's cold," Peter said, closing the door. "Understand? Cold?"

Jennifer was learning the building's rhythms, the daily ebb and flow of people. She emerged when the nursery school children were outside in the yard. Moving quickly, efficiently, she stole another handful of noodles and set them to boiling. Then she took a double handful of colored crayons, being careful to choose only the last-

est, least-used ones, and husked them of their paper shells. She set a second pot of water to boil and placed a slightly smaller pot within to make a double boiler. She dumped the crayons into the smaller pot and watched them soften and melt—pinkish blue folding over aquamarine, gold-oreo yellow over bitter-sweet brown.

When the noodles were done, she strained them and dumped them onto a plate. The crayons were all melted by then, and she briskly stirred them into a brown swirl and then a chocolate mess. She poured the crayons over the noodles, took up a spoon, and began eating.

Sheila found Peter just inside the sanctuary door. One hand rested on a stone arch, and a trace of steam curled up from his nostrils. "Peter," she said, "the nursery rooms are freezing. Is there anything you can do about it?"

"Already taken care of," he answered abstractedly. "The water was low in the boiler, so the automatic shut off in flooded in water, and the radiators should be heating up soon."

"Everything seems to be going wrong now that Sam's not here in the daytime any more. Why does the heat keep going off?"

"Well, you could say it's because there's a leak where the radiator pipes loop under the sanctuary. When the water heats up, the pipe expands and dumps onto the dirt floor there until the system shuts itself off. Or you could say it's because most apprentice plumbers were of draft age, so the master plumbers have to do the soul work themselves, so there's more demand than they have time for, and they charge accordingly. Or you could say that as long as I can correct it by adding water, it's not an emergency and they won't allocate money to fix it."

"But—"

"The thing to keep in mind," Peter said, "is that this kind of problem is normal with a system this old."

"I guess so, but—oh! Do you want to hear the latest? The children have seen a ghost!"

"A ghost?" Peter said blankly.

"Yes, a girl ghost—they say she's very pretty. They're all excited and now they're trying to set up ghost traps for her. They're so cute!"

Peter was giving her his undivided attention now, and Sheila found his steady green gaze disconcerting. He said nothing, but she had no difficulty following his thoughts.

"Oh," he said. "You think the person in the basement . . . Peter, you've got to call the police and get her out of there!"

"As long as the nursery school giversnaps the fake-call fee."

"They wouldn't hurt her, would they?" Sheila asked, suddenly apprehensive.

Peter smiled cynically. "They'd beat the crap out of her for sure. The police have been taking a real tough line on street people lately."

"Then there must be some other way!"

"No," Peter said calmly. "It's the police or else let her stay." His expression was distant, abstracted again. He reached out and took her hand, placed it against the stone arch. "Feel this, would you?"

The stone was as cold as ice. It throbbed ever so slightly under her touch. Now that she was aware of it, too, it hummed subliminally like a machine or a high-tension power line. Attuned, it seemed as if the entire building were full of the almost inaudible vibration. "What is it?" she asked.

Peter shrugged.

"It must have something to do with how cold it is," she decided.

Peter turned from looking up the church to see that someone was standing before the main door, futilely waiting for someone to come answer the bell. He walked up behind the man, keys out, said, "Can I help you?" in a tone that implied he couldn't and began unlocking the door.

● *Jeremy knew
that ovens were dangerous,
so he put his
hand in first to make sure
it was off and
not hot. Then he crawled
in. It was easy
to shut the door after him.* ●

"Yes," the man said. "I'd like to see the inside of your church. He was well dressed and clean-shaven and good-looking in a perfectly forgettable sort of way."

"Services are ten-thirty Sunday mornings," Peter said, sleeping inside and propping to close the door.

"It's not about that, sir," the man said quickly, bringing his hands up before him. He proffered a wallet badge—badly printed allegorical figures with a shield Latin slogan, space for name typed in and signature squiggle—and put it away when Peter shrugged. "I'm from the Cancer Research Center at Philadelphia Medical College—perhaps you've heard of us?" Of course Peter had: the college was only a few blocks distant. "We're doing a building-to-building canvass in the area."

"We give through the church's national headquarters."

"Oh, it's not that, sir." The man gave a short, nervous laugh. "We're searching for some station—and very valuable—research materials—and we have good reason to believe that the hall has hidden them in this area. If you could only—"

"No," Peter said.

The man smiled placably. "I believe you will find it easier, sir, if you—"

"I'm halfway through the week, and already I'm two days behind schedule. I've got a bulletin and two mailings to get out, and I can't spare the time to nursemaid visitors. Now if you want to go through channels, the pastor here is associated with PMC through the chaplain's office; if you can get him to agree that you are more important than my usual work—fine. If not, you can always come to services. Ten-thirty Sunday mornings." He shut the door in the man's face.

But my God, that man's eyes were cold.

Jeremy was playing hide-and-go-seek. Normally, it was hard to get away from his teachers, but today Debbie was sick and the substitute never showed up, and neither did one of the parent volunteers, so they were short on adults. And then Gregory's mother had called because he'd forgotten his lunch, and Ming-su had started crying because she always cried at that time of day, and there was someone banging on the door to get in, so for a minute there was no one in the room but kids. So Jeremy told Heather, who was his girlfriend and who was going to marry him when they grew up, to close her eyes and count real slow, and he ran into the kitchen looking for a place to hide.

The kitchen was full of cupboards and stuff, but they were either locked or else the knobs were too high to reach. It was too narrow behind the refrigerator and too open under the sinks. Then he noticed that someone had left the oven door open.

Jeremy knew that ovens were dangerous, so he put his hand in first to make sure it was off and not hot. Then he crawled in. It was roomy inside and easy to shut the door after him, because it was springy and light. You just lapped it and it closed on its own. It was dark. Lying on the floor, Jeremy stifled a giggle at the thought of Heather looking for him. There was a little hole near his nose, and a funny smell came out of it that made him feel sleepy. He had just closed his eyes for a minute or two when the oven door opened and the ghost looked in. She was real pretty and real skinny too. She did not look surprised to see Jeremy, and he was too sleepy to be surprised himself. "Shhh," he said. "I'm hiding."

"Oh," the ghost said. Then "Is it lit?"

Jeremy thought about that for a moment, then said, "No. It had been fun, but now it was mostly just dull."

The ghost smiled then and said, "Well, why don't you come out?" She reached in her arm—a long, long way—and gently nudged him out.

For an instant he felt dizzy and funny and cold, but then he was standing blinking on the kitchen floor, and the ghost was gone. The kitchen looked funny because the shadows had shifted and the light had changed since he had crawled inside. It was all of a sudden a lot hotter in the day.

He ran off to find Heather.

Peter was the only attendee from the church staff at the monthly tenants' meeting. They sat around a table in the old manor's conference room, in front of the fireplace with its glass fire and tinned-up front swapping gossip and sharing news. Peter listened and nodded and answered questions and constructed the month's complaint list:

1. Heat (leak under sanctuary—ha?)
2. Mice
—more traps?
—poison not working?
3. Light bulbs (if can find source will extend credit)
4. Toilet paper (tell Sam)
5. Building Security
—more padlocks
—everyone more care
6. Duplicate for WomensRights
7. Rent Schedule
—can wait another week,
nursery school?
—can wait another month,
STPPRCCO?

The afternoon volunteer for the Stop the Port Pleasant Radio-Chemical Dump Coalition complained that the Latin American campaign was drawing off most of their volunteer labor and wanted to know why there were so many derelicts around the building of late. Peter shrugged, promised to find out, and made a note.

8. Why wires?

Mrs. United, of WomensRights—a relatively successful organization that rented the entire basement floor of the old manse and mostly used the door directly out through the nursery school play yard—asked why they hadn't gotten their doorbell fixed yet. Peter explained that their useful handyman didn't like working for churches, which were notoriously slow to pay, and made another note.

9. Nudge Jack—doorbell

Sheila told about one of the nursery school children, who had been lost for several hours that morning and who claimed to have hidden in the kitchen oven. "He couldn't have hidden there," she said, "or he'd have suffocated." Then, thoughtfully, "I don't think that oven is safe, though. Peter, you've really got to do something."

"Do you want the door welded shut?" Peter asked.

"No, don't do that," Sheila said. "We need the oven because sometimes we bake for the children."

Peter nodded and wrote:

10. Make oven safe for children

Before Sheila could think to ask how he intended doing this, he rose and broke up the meeting.

Sam was waiting at the desk. "Lupus," he said. "Got to talk with Mr. Alverson. His neck was still puffed out beyond his chin, and his skin was a gruesome color gray. Peter nodded, cleared, and told the secretary, "This is Harry's brother—Fred Alverson? I'm in town unexpectedly and thought I could have lunch with Harry."

When Alverson's voice cried out, "Fred!

You old son of a bitch, what are you—?" Peter handed the phone over to Sam and walked out of the room.

Sheila was waiting in the hallway. She nodded toward the room and in a low voice said, "How is he?"

Peter shook his head. "He's going to die."

"Don't say that!"

"He's going to die," Peter said stubbornly. "And he's going to keep working here until he drops. Every time I go to the bathroom I expect to open the stall door and find him sitting dead on the clapper!"

There were a lot of different parts in the cabinet, and some were good to drink and others were not. There was a thunderstorm going on, and as Jennifer crouched in the dark and tasted, she could hear distant rumblings and stone-rattling cracks in the air overhead. There was also the sound of pouring water and a few snaps of blue electricity from the steel cable of one lightning rod that ran through the ceiling into the

electrical lines blazed up brighter, shifting in quicker fashion. She saw the thing aloof over the altar too, but to her untutored eye it was of no greater interest than any other part of the building.

Jennifer's hair lifted lightly upward, the ends trailing blue sparks so that it formed an aura about her face. Fata morgana drifted through the floating mass.

The flames kept from organ pipe to organ pipe, blazing up and subsiding like a Bach mass played on a color organ. There was sparking electricity everywhere in the cables and fixtures, and wires. The stops began opening and shutting of their own accord, in a silent, electric symphony. Jennifer stretched up on her toes. Her auburn hair afloat, the world crackling with color and energy, thin electrical flames sizzling about her she danced.

Later she found a burned-out light bulb there, on the upper catwalk, and ate the filament at its heart. She had to break the inside to get at it, but she fixed it up afterward as good as new.

The minutes were waiting for Peter on his desk, with a new notation in the pastor's hand. *SALVAGES MUST BE CUT SOMEWHERE—PLEASE NORTH SAW.* It was as close to an explicit threat as he was going to get.

Peter lit up a cigarette, realized that he already had one going in the ashtray, and stubbed it out. He rubbed the back of his neck, then restlessly strode to the chancellor's kitchen, off of the conference room. It was tiny and contained a broken refrigerator, a rusting gas stove that no one dared fix up, and a dozen empty cupboards. The linoleum was browned and buckling.

Taking a glass from the stranger, Peter washed it thoroughly under the tap and drew a drink of water.

He tapped his cigarette's ashes into the old porcelain sink and washed them down the drain with a long spurt of water. Then, back at his desk, he rummaged through the small-emergencies drawer until he found a bottle of aspirin among the tampons and the lollipops.

Where, he asked himself, was the loophole? He popped the aspirin dry, thought a minute, took a sip of water. Finally he slapped on the typewriter. The pastor hadn't actually ordered him to fire Sam in person. It took five minutes to come up with a final draft of the memo. He typed up a clean copy, read it through, and was satisfied. He forged the pastor's signature to it and dropped it in Sam's mail slot.

Done. He lit up a cigarette, noticed the previous one burning in the ashtray, and—cooperated—let them both burn. He was too tired to type now, so he scooped up a box of old clothing that had been donated to the church weeks ago and that had been meaning to store in the church with the rest. Outside, on route to the church, he released several clutches of wire batteries against the church wall and made a mental note to lift some more padlocks from the hardware store, to firm up secu-

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earth. Sated at last, she fetched the sewing keys and went exploring.

The door to the organ room was off the sanctuary, and it didn't open all the way. Jennifer said inside, closing the door after her, and waited for her eyes to adjust.

Everything was gray and dark and dusty. The organ works were mostly her upon bar of wood pipes and electrical fixtures, with two long rows of leather bellows hinges, all hemmed together a lot looser and more haphazardly than one would expect. They towered up and up, behind the metal arch of the table pipes, and Jennifer found a wooden ladder nailed to the works and clambered up to the first landing.

The dust was finger thick there, and other than a half-burnt candle stub or two, there was nothing of interest. She found the next set of rungs off to one side and went up.

As she climbed she became aware of a strange, expectant feeling in the air, a crackly sense of static electricity. Glancing over a shoulder, she saw pale, pastel lights shimmer on the treble pipes—Saint Brillo's fire. With a surge she heaved herself onto the top level. She could see all of the sanctuary from here, through the pipes, and the

nty. He passed through the sanctuary without once looking at the altar and went to the front narthex, where the staircases to the balcony were.

He was halfway up one set of stairs when a pale face appeared at the top. A slender young woman in denim—a red-head. The church is closed, miss," he called to her and the face disappeared. A cold touch of fear in his stomach, he jiggled up the stairs, coiled around "If you need me one o'clock," he called. Something started off to his side, a ripple of stained-glass light over red hair, and the woman shifted into the shadows of the stairway.

"Hey!" He dropped the box and stumbled over the piles of dusty cartons crammed with donations for the annual rummage sale. At the foot of the stairs the door between the narthex and the sanctuary was swinging shut. He pushed through. He was just in time to see the woman disappear behind the presbytery beyond the altar. A door closed gently.

Peter didn't try to follow. The thing over the altar was swirling madly like a pinwheel. He couldn't understand how the woman could have moved so quickly, and he yelled after her. "I wasn't going to hurt you. What do you think I am, some kind of sucking monster?"

The children were playing a run-around game, so Sheila felt secure in leaving them to the supervision of parent volunteers while she went up to the old chapel for supplies. She retrieved the library paste first, paused, then went into the toddlers' room for the construction paper.

The toddlers' room had been part of the Sunday school program when Covenant was still an expanding congregation. A good dozen cribs stood serene in the soft light. They were arranged neatly against the walls, sidebars up and plasticized mattresses growing dusty. At the rear corner a stairway rose to the west balcony. The stairs were so cluttered with broken furniture and toys that only a narrow, twisting pathway led upward.

Sam sat on the third step up. His eyes were dry and hard, and he was staring sightlessly at the orb.

"Sam?" Sheila said. "Is everything all right? Why aren't you at the hospital?"

He didn't answer, didn't even move.

"Sam?" She whispered solemnly, stared now and reached out to touch his arm.

It was as if her touch broke a spell. Sam snapped his head her way, eyes started, and scrambled awkwardly to his feet. "I was just talking some things upstairs," he said defensively. "That's all I was doing."

"I believe you. I believe you," Sheila protested. The old man scooped up a broken hobbyhorse, cried it in his arms.

"It isn't no question of believing or not believing," he said. "I was just going up stairs." He turned and ascended.

Sheila stared after him for a long moment before hoisting her supplies and turning to go. As soon as she was far

enough down the stairs that he wouldn't hear her, she threw back her head and said aloud, "I do not believe that man! He is so exasperating!" It made her feel a lot better.

Halfway down the stairs she was stopped again, this time by a near-subliminal noise. She cocked her head. It was almost like the vibration in the sanctuary the other day or—she raced down the stairs, out across the parish hall and out to the thirty-seventh Street narthex. Someone was busily leaving on the buzzer.

"Who is it?" she called. Putting down her supplies, she peered through the peephole. There was a man outside, dressed in a suit. "You'll have to speak up," she yelled from the hospital. "This man was saying, 'We're running a canvass of all the buildings—'"

"You'll have to go to the church office," she called back. "We don't open this door during school hours." She picked up her box and headed downstairs. Almost to her surprise, the man went away.

*“The angels
went on dancing in a flash
of insight
Peter realized they were all
mechanical. They
were machines, creatures
of a purely
deterministic universe.”*

The acid was in the glue backing of a Mickey Mouse decal. Mickey was dressed as the Sorcerer's Apprentice, grunting up stairs, and you were supposed to lick off the LSD and then slap the decal onto your forehead. Too cute by half. Peter thought, and when he'd done up the tab, he crumpled the little mouse and swallowed it.

While waiting for the drug to pass into his bloodstream, Peter did first some typing and then some filing.

When he found himself obsessively going back to each piece of filing to be sure it was retrievable and not placed away in some nonsensical drug-generated location, he cut and went up the stairs to the second floor. Hands behind his back, Peter stood before the hall window, looking down into the play yard. Children were scurrying about busily swinging on the old tree hung from the oak tree, scrambling over the wooden monkey bars some parent had built years ago. Foam-rubber mattresses had been tied around the oak's trunk to protect the children.

As he watched, a sudden wind blew through the tree and killed the air with yellow leaves. For an instant they hung mo-

tionless, defining the space between ground and sky, receding into infinite perspective. Then they swirled away.

Years before, he'd worked for an inner-city corporation, in a room with a window view of a church's slate roof and nothing else. Ordinarily the roof was a barren, featureless stretch, but this one time it had snowed the night before, and the snow was loosened by a warm winter sun so that occasionally patches would let go and slide away in a puff of powdery white. Kim Scogg, the only other type in the room at that moment, had leaned over her machine and stared, entranced. The room filled with silence.

The acid was hitting. He felt a painful twinge in his stomach from the minute trace of strychnine that was a by-product of the drug's manufacture.

Slowly and carefully he descended the newly challenging stairway and, remembering to look up behind him, went outside and to the church door.

Two men lay across the steps, passing a paper-bagged bottle back and forth. The dark one beamed at Peter's appearance, and they both scrambled to their feet.

"Thermy heard Walter," Astrod said. His companion a yellow half-haven. Beapole of a man, nodded several times. He had haunted eyes, with ring upon ring of darkness beneath them. "Hers come to meet the lady too."

Peter looked blankly first at the one man, then the other, and then away from both. He saw that there were a dozen or so more vent people—shopping-bag ladies among them—scattered about the churchyard. Some wandered slowly, aimlessly about, and others sat huddled in decaying blankets and chunks of squashed-down cardboard boxes. One was peering against the wall. It was a regular little Reeganville, and they looked as though they had come to stay. Fuck it, he decided suddenly. I'm on drugs, I don't have to cope with this. He retreated into the church, slamming the door after him.

The stone ribs of the sanctuary were still humming softly to themselves, but now—with the acid in him—Peter was not bothered by the phenomenon. After all, things were supposed to be strange on acid. And one way or another, Peter was determined to return things to the way they were supposed to be.

The sanctuary was cold. Peter shivered, convulsively stared upward, and was shocked motionless by the wooden angels above. They glinted gold and then silver shards of ice. They multiplied (like the leaves had earlier, and filled the church—angel upon angel as regular and unvarying as an Escher print).

The empty spaces were angels too, and the images fleshed from solid angels to negative angels and back in a flickering dance. The air was filled with music, words, and notes transformed into a solid, calligraphic flaccidity in an alphabet he did not know. There was something familiar about

the music, and with a start Peter recognized it as *Vangelles Heaven and Hell*. His *banjo* was still playing, and that realization was a jarring intrusion of reality.

The thing over the altar was larger now, much larger, the size of a clenched fist or of a coiled snake. The angels that intruded upon it were seized as if by overwhelming gravitational forces, crumpled to nothing, and swallowed up by it.

The angels went on dancing. In a flash of insight Peter realized that they were all mechanical. Identical, perfect—they were mechanical creatures of a purely deterministic universe, entirely devoid of free will. They danced their machine dance in the air and it meant nothing.

There were fewer angels now as one by one they were disavowed by the thing over the altar. They kept on dancing, though, and if they were aware of this thing—it if they were even capable of awareness—it did not matter, for all was meaningless, all was a dance. Blind forces ground them down, and joylessly they danced.

And the thing over the altar continued to slowly grow.

He fled—from the angels, cold dance, from the acid etched sense of total tully but, mostly from the horrible, nasty eating obscenity aloft in the church. Out of the sanctuary and down into the basement away from the light, into obscurity and darkness. When he had stopped he found himself huddled into a cold, lightless cor-

ner. The ghost was there. He could feel her breath on his face, sense a near visual glimmering of warmth from her body.

Sam was eating lunch. He sat with the makings spread out before him in the old chapel, by the unused chimney where the rat had taken up residence. He started with an apple, chewing it slowly and thoughtfully as he considered the job he had done on the trap.

The rattrap was dark and smoky. Rats were clever; they didn't like new smells, chemical smells, human smells. Had built a small lee of traps and old leaves out by the trash cans in the playyard and charmed the trap over it, holding the trap in a clasp he had made of an old coat hanger.

The apple finished, Sam unscrewed the peanut butter jar, plunged a knife in and stirred the old and real good. He began spreading it onto a slice of Wonder bread, paying close attention to the act, involving his whole mind in it, because the alternative was to think about what the doctors had told him that morning. He paused and smeared a dab of peanut butter onto the trap for bait, then returned to spreading the sandwich truck. Peanut butter made good bait because rats liked that kind of greasy stuff, oily and meaty.

He was sitting in a patch of colored light from the south rose window, and for some while it had tickled gently, as if interrupted by the shadows of a lightly passing

tree branch. But there was no tree outside there and Sam looked up, puzzled to see what was interfering with the light.

There was a white girl in front of the window, glory light streaming about her, and she was sitting cross-legged in the air.

Sam could not blink, could not look away. His sandwich was frozen in front of him. He knew this girl had sat her once before in the basement. She had been wearing the same denim jeans and pocket chain, and her hair was as red as it had ever been.

Footsteps sounded on the stairs, and Sam ignored them. But when the door slammed open the suddenness of the sound made him glance without thinking back toward the hallway and he saw Sheila enter the room. The light about him cleared and he didn't have to look up again to know that the girl was gone.

Sam, the nursery school teacher was before him now, and she stared into his face, concerned. "Sam, I'm very worried about you, about the way you've been acting today. Have I offended you? Should I be apologizing for something?"

He looked away, could not answer. But she would not go away.

"Sam, what's wrong with you today?" Sooner or later he knew the word would be said, somebody "I think I'm cured," he said slowly. And burst into tears.

The vast people were reading a dog in one of the window wells. By pure good fortune they'd chosen one of the few wells that had been order-blocked up. The skinned carcass was hung on a spit, turned erratically by an enthusiastic hunch-backed individual. The church wall was black with smoke and grease. They offered Peter a leg, but he shook his head and wandered away. There were over a hundred vast people in the churchyard, and their trash and scattered possessions made the yard as cluttered and filthy as a battlefield. One toothless old hag lifted her skirts and squatted, to the profound disgust of her fellows. Her piss steamed as it hit the ground. A convulsive alk looking like a skinny black spider, swooped grof circles in the walkway dust with both hands babbling of demons in his head.

And all the while there were at least five radios playing, babbling and ugly things scavenged from garbage bags but with a good decade's life left in their perambulatory batteries. They were tuned to three separate newscasts, and the fragmentary snapshots of global hysteria tumbled and cascaded one over another.

—warned that unless American troops withdrew from Burma—escaped from the Rocky Mountain arsenal—survivors reports of CBW weapons were dated—troops called up from—martial law declared in five midwestern states—

Peter stopped before an old scissor grinder, who had set up his cart on the sidewalk. It was an ancient thing, jammed together from scraps and pushed about by hand. The whetstone was run by



a vintage 1922 electric motor in black-painted housing, which fed off a tangle of car batteries hooked up in series—reported shot down over Sinking—

"You and I," shouted the seascaper girder "heedlessly deserted God some many years ago to join vain Satan's vain revolt against God's temporary laws. All truths emanate from God, and we will reap what we have sown. This is why we are now in human bodies. To reap what?"

A fat woman waddled past, going "Quackquackquack" like a cartoon duck on amphetamines. She drew Peter's eyes away from the orator, and he saw that the yard was as abuzz with divergent theologies as the Middle Ages were before the Inquisition.

—measly tensions escalated in the Middle East and Africa in a breeze—

A deadpan little man in very clean clothes stood on the steps and shouted: "The Bible tells of the scorpion where that is Babylon that is the beast that has put her foot on the serpent! She has swallowed up the seventh seal and has loosed the horrors of the Rocky Mountain arsenal! If you have faith the size—"

And somehow in the confusion of voices, Peter realized he did not have to be here—did not, in fact, even know how he had gotten here—and went inside to his office—

—tested use of tactical nuclear—

There were three cigarettes afire in the hallway by the time Sheila came into the office. One by one, Peter had it them up and put them down, unsmoked. She cheerfully waved a hand in the bluish smoke and said: "Pew! It smells like a train station in here."

Her presence was an anchor he could hang on to. "Hi," he said.

"Peter, it's wonderful," she bubbled. "Have you heard the news? Sam's doctors say he's going to be okay! He's had a spontaneous remission— isn't that wonderful? It was a miracle, they said—a one chance in a billion miracle! She banged her fists together and bounced up and down on her toes in elation.

"A miracle, Peter said numbly. He should have felt happy for Sam, and yet he didn't. All he could think of was the memo firing the old man, and that Sam wasn't going to die in time for him to avoid receiving it.

"Yes, but Peter"—her mood shifted again—"you have to do something about all these dirty, filthy vagrants who are hanging around the church. The parents are going to be coming by to pick up their children in a couple of hours, and they are going to have a fit! Really!"

"They're not really dangerous," Peter said. "They're none of them capable enough to be dangerous."

"Peter, I want you to get rid of them! Call the police or something. If we don't get them out of here, we're going to lose half our students!" She leaned forward, examining his face. "Are you on something?"

"Not anymore," he said and beatified

realized that it was true. He was perfectly straight. Just tired—extremely tired, almost stunned with weariness. There was a strange blankness in his memory between when the acid had peaked and he'd come to among the vent people. Something flickered there, bright and ungraspable. He shrugged mentally. Chalk it up to the drugs and forget it.

Taking a deep breath to settle himself, he picked up the phone, dialed, and when Averson's secretary refused to put him through, snarled, "Listen, sister, this is Sergeant Birdwood of the Pennsylvania State Police, and I am right in the middle of a fucking shoot-out. We have a psychotic individual holding this fucker's wife and fucking kids and shouting slogans about the fucking Hard Anarchy Liberation Army and you're holding me up. How do you like to have your sex life investigated with a fucking crowbar?"

A moment later a very small and hesitant voice said, "Peter... is it you, isn't it?"

● The vent people were roasting a dog in one of the window wells. The skinned carcass was hung on a spit, turned erratically by an enthusiastic, hunchbacked individual ●

Peter tossed the revolver to a horrified Sheila. "All yours," he said.

She held it as if it were a poisonous snake that would bite her if she let go. Then she said, "Peter, you can't evade responsibility by having someone else say the words. There was compassion in her voice.

Slowly, reluctantly—Peter reached for the phone, closed his fingers about it, took it. "Harry? Listen, I'm sorry about all this. I dialed the wrong number." He listened in silence for a time, said, "Yes, I know," and listened some more. The outside door closed gently as Sheila left.

When Averson hung up, Peter jabbed down on the plunger, cutting the connection. He took a deep breath and dialed the number for the police. "Hello," he said. "I'm calling from the Church of the Covenant on Thirty-seventh Street."

Time was short, and Jennifer was hungry again. She had scoured the church from top to bottom, passing by many things—cookie dough, ivory soap flakes, Billo pade clay—that she might normally have ingested over. But she could no longer spare the time to build from precarious ele-

ments. The chemical dump counter-advocacy groups office was originally the choir director's, a century ago when the position was full-time. It had a skylight with plastic sheeting stapled to its underside and a row of narrow, lead-glass windows that looked into the storage rooms of the top floor. Jennifer had climbed through one of these and was going through a carton of bumper stickers when the thing in the sanctuary stirred.

The sense of its movement rose through shafts and vents left over from an early unsuccessful attempt to retrofit a forced air heating system to the church. Jennifer shuddered as if a jolt of electricity had shot up her spine. For an instant she thought it was about to happen, and she was racked by terror and bleak despair. It was too early. She was not ready. Then the movement ceased—there was yet a chance, however slight. She was on her feet and through the window almost immediately.

Fear drove her down the stairs, running silently, wanting to hide but not daring to do so. Inspiration made her nab the key ring from the sexton's closet. As sky and turbine as a shadow, she stepped back up the stairs, through the narthex, and into the parish hall. She could hear the sexton working in the chancel, but the connecting door was shut, and he couldn't see her. One key of the ring fit into the communion cabinet. She opened the doors and found what she needed.

There were a lot of linen napkins, which she shoved aside, and a tray with slots for perhaps a hundred tiny little glasses to fit into. The bread was carefully wrapped in white paper. It was half gone from the previous Sunday and stale and hard as wood but it would do—it would do!

Triumphantly she shoved the bread under one arm and cradled the two bottles of communion wine in the other. She ran.

There was a dark storm gathering outside. The thunderhead pined up, charcoal blue, over the surrounding buildings. Fast lightning shimmered within its heart. The vent people danced happily on the saturated, green lawn. On every side the blind and featureless walls of the high rises blocked out large chunks of the sky. It felt like being enclosed in a box.

Peter stared glumly out the window, walling, all pretense of working gone. He shifted papers to either side of his desk to make room for his elbows and rested his chin on his arms.

Fast flashes of red and blue light struck and rebounded off the church walls, and Peter saw that police cars were pulling up, blocking off the surrounding streets. There were more of them than he had expected, some twenty or so, and they arrived eerily silent—flushers on and sirens mute.

Three cars—one unmarked—noosed through the blockade and parked by the curb. Their inhabitants conferred, formed a party, and moved briskly up the walk. One man coaxed his neck interestedly as

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they passed by the scissors grinder's old car, which had been pulled apart and made into an altar of sorts. What might have been an altar called crazily stop it, with several broken plaster Madonnas—scavenged from God knows where—lashed to its arms.

Peter stood as the deputations neared the door. Outside, police lurged against their cars, the visors of their black glass helmets flipped up. They were held in check by neocortical implants, like dogs on a leash and several were gently tapping their truncheons into open palms.

The doorbell rang. Answering, Peter found himself facing three police officers. Their faces were impassive and might well have been carved from the same block of ice. Standing with them was the smooth and plausible man from the Cancer Research Center. "Hello," the Cancer Research man said to Peter pleasantly. "I see we're on the same team now."

The door from the charcoal to the back stairway was badly warped out of shape. There were splits through the center and it was so badly bowed that it wouldn't even shut properly. Sam had removed it from the frame and set it down on two sawhorses. To do the job properly, he should soak the caken door in water for a few days and then weight it down between flat metal plates to warp it back into shape. Lacking the time and tools, though, one did the best one could. So first you move the hinges down an inch, to rehang the door lower. Then you sand down the edges where it's sticking. A little putty in the cracks, some weather stripping around the edges, and the job is done.

Sam whistled an old Molwyn tune as he sanded, enjoying the shift and feel of his muscles. He felt good, stronger than he had been in years, and all the swelling around his neck had gone down.

The doctors wanted him to go through another battery of tests, but under close questioning by his sister—she was a sharp-tongued woman—was Sophia!—they admitted that he didn't actually need them. They were just curious to know why he wasn't dead. He was healed, though. They said so themselves.

He could feel—subliminally—the thing growing in the sanctuary, but he felt no need to do anything about it.

There was enough trouble in the world without borrowing more. And like they always said, you don't open the oven door until the cake is done. Fine oak dust wisped down to the floor as he handled the paper, sliding it along the door's edge in long, firm, even strokes.

The communion wine was cheap stuff, with a metal cap that unscrewed instead of a cork. Jennifer took only a taste, but it jolted through her brain like lightning, snapping synapses open and shut, setting off a cascade of images from her past.

She was back in the hospital, strapped

into a gurney. Everything was white and smoked of disinfectant and hospital food. They had cropped her long, blond hair and were shaving the stubble that remained. When she opened her mouth to scream, someone shoved the side of his hand in, saying, "Hush, pretty baby, we're just going to line-line that pretty little brain of yours." She bit down hard and his hand tasted—

His hand tasted like her husband's when they made love. He would touch her face gently, wanderingly, and shied his hand away sideways to catch his hand in her teeth. Feeling like some kind of wild, feral animal, she bit down into the flesh. It tasted of salt and sweat and curly black hairs. He was on leave from the Air Force but scheduled to rotate back to Mountain soon to fly more bombing missions. He was an officer—

He was an officer, and when she saw him coming up the walk, silently explosives, she knew her husband wasn't coming back, and she wished so hard for it to be all a mistake that it seemed the world must shudder to its core for the sheer intensity of her desire. But the officer walked right up to her door anyway, ring the bell, delivered the news. It was as he was turning away that the air seemed to shimmer and the young officer fell to the ground, blood gushing from his nose and mouth. Half embedded in the walkway, he struggled. She knew that he wasn't to blame but still the blood came out—

The blood came out the same way it did later when she left the hospital, her skull abraded with tiny silver wires and implants that were supposed to control her but did not. All the guards fell down, hemorrhaging, even those who did not try to stop her but turned to run. The red hair and the clothing formed around her because on some cunning animal level she knew she needed them to escape. She walked—

They were good memories, and they filled up the empty spaces. This pain was real and good and brought her a step closer to being human again. She tilted the bottle and chugged it all down. Bubbles bloated to the top and the bottle was empty and her head was full of thoughts.

She uncapped the second bottle.

"I shouldn't be letting you in without the pastor's explicit permission," Peter hissed—half of Houston up in flames. We're trying to get a reporter in now to confirm—

The vent people perked for the group, stepping back a pace from the intensity of the Cancer Man's eyes. Ashed came busting forward and waved his pink plastic rosary in Peter's face. "Save yourself," he shouted. "Get down on your knees—pray for forgiveness!"

One of the police officers reached out to touch Ashed gently on the chest and slum-bled back, face contorted with pain.

"Peter, the Cancer Man said, 'They were at the church door now, and Peter had his keys out. 'Let me introduce myself.' My name is William Oberg. I'd be pleased if

you called me Bill." He shook Peter a hand. "Now, the rest's not letting go. 'I want friends, you? I'm sure you wouldn't mind showing your old chum where you work, would you?" He lightened his grip, and Peter gasped in pain. The police looked on with interest.

"No," Peter said quickly. "No objection. The plan ceased."

"Good." Oborg let Peter open the church door, then led the troop through the narthex and into the sanctuary. He stopped in amazement.

"Jesus Christ, 'one of the cops said. Another crossed himself.

The thing over the altar had grown. It was the size of a basketball now, so large that it was almost possible for the eye to fix on it and assign it some definite shape and image. But not quite. It was oddly compelling, even hypnotic. Peter seemed to remember—

"Okay, it's pretty far gone," Oborg said, "but we can still handle it if we can get hold of the girl."

Peter started and for the first time actually looked at Oborg. He could half-see into the man, see the whirling wheels and gears embedded just below the plastic flesh, the fine gold wires and whose seed monitor lights. Oborg glanced fleetingly at Peter's way and Peter's breath froze within his throat. The man had no eyes! Only deep metal funnels that led from his face into a cold and lightless stacking of cryonic plates. Peter exhaled, and Oborg shifted into a thin surface image, with no interior as insubstantial as a hologram or a soap bubble. His movements left long, bright trails. Oh God, no, Peter thought. He was flashing back. These lickers were not going to show him any mercy if they discovered he was on drugs.

Luckily, they were scurrying about like automata and hadn't noticed yet. Oborg was laying out elastic cords and metal restraints on the communion table. One policeman unhooked a flashlight from his belt and clambered over the presbytery. He poked the light between the organ pipes and peered within. The two other policemen went into the balconies. One shimmied up a loose pole to the steeple door. From within he called down, "Ugh. It's ankle deep in peyote shit here."

"The windows have been broken for years," Peter said manely. It was hard to take a straight response.

"Check it anyway," Oborg called back. He lightened a pinch on the communion table and stepped back, satisfied. The altar had become a restraining table, with devices to hold the legs spread wide; the arms up and to the side there. Directly above, the thing whirled madly.

The table lacked only a victim. Oborg laid a fatherly hand on Peter's shoulder. "Perhaps you have some idea where she might be?" he suggested.

The second bottle of wine was on its way to her lips when the passage suddenly convulsed. The walls turned blue and

lurched over on their sides. Jennifer jerked and the floor came smashing up into the side of her face. The empty bottle fell away shattering into a thousand cobalt fragments. The half-eaten communion loaf burst into cold, blue flames.


The surviving bottle was pouring purple wine into Jennifer's top. Frantically she stopped it with her thumb. The glass was scalding cold, it stung like homopets. But she clutched it to her and did not let go.

Stuck with uncertainty and pain, she stood. Her head was abuzz with blue sparks, and the carbon smoke from the burning loaf was billowing up to fill the room. All the passages were shut. They steepened when she tried to climb them. She had to grab one-handed at pillars and moldings and doorjambs to pull herself upward into the icy flames.

The arm cradling the bottle spasmed with cold, and the bottle fell away. It bounced twice, splaying wine, but miraculously did not break. Jennifer stretched out, trying to believe it. She almost fell from her fingerhold trying, but—too late! Too late! She reached again, nearly dislocating her shoulder and wrists with the effort.

Her knuckles whitened, weakened. Involuntarily she let go of the door frame and slid four yards down the hall. The wine bottle rested on the floor curling above her, in the center of a spreading purple stain. A full quarter of its contents remained within the bottle—she could see it.

But she could not reach it. The floor lifted away from her too steeply and could not be scaled. It was easier—much easier—to let gravity pull her down the hall into the redness, into the warmth.



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"No," Peter said. "I couldn't guess."
But he was afraid of Oberg. And Oberg
was a man who understood fear. knew its
every touch and nuance. could read its
track on the human face. "Is she on this
floor?" he asked. "No? Upstairs, then?
Downstairs? Where in the basement?"

Outside, the vent people were suddenly
still. The silence was starting. Then a quick
series of soft explosions went pop-pop-
pop. Tear gas. Pandemonium broke out,
shrieks of pain or rage mingling with inco-
herent cries of fear as the police moved in
like moth-eaten derelicts. "Oh, God—such
his share of notes in the past few years. He
could picture in his mind what was hap-
pening. There would be an outer circle of
police, to prevent fugitives from escaping
and force them back into the fray, and two
or more flying wedges to move through the
mob, clubs flashing.

Oberg touched Peter gently, comese-
ingly. His fingers scuffed up Peter's neck
like a spider and stroked softly below one
ear. "Why don't you lead us there, hmm?"

It was hard to concentrate. Peter im-
bined in confusion, caught between the vi-
sion of the rat and the touch of Oberg's
hand. He was no longer sure which was
real. Something crashed against one of the
windows, an early Tiffany the congrega-
tion had always held in reserve against li-
nial bankruptcy. It smashed a small piece
of emerald glass, sending splinters flying.
The entire window echoed and reverberated
with the blow.

"Shall we go?" Oberg said.
Meekly, Peter led them downward.

Sam was lifting the door into place when
the call came. He paused in his work and
cocked his head, listening. Outside, the
vigilante were stirring up a fuss, but he ig-
nored them. The call came from closer in,
somewhere below.

He leaned the door carefully against the
steel music cabinet and went down the
stairs. He paused at his supply closet to
pick up the flashlight. It was a long, heavy
thing, encased in a black rubber sheath.
He fiddled it on, to make sure it worked. He
was unlocking the door to the basement
when a small white boy clamored into his
legs. "Whoa," he said. "What's this?" He
put his hands on the boy's shoulders.

"I got to see the ghost!" the child cried.
Sam hoisted him into the air, left him snail
in the crook of his arm. It had been a long
time since he had held a child like this; not
since his own son was a little boy, in fact.
A long, long time.

They were not the only two to hear the
call. Sheila joined them at the lady's side.

Peter had an awful feeling. He unhappily
led Oberg and the policeman down. Twice
he tried to turn them away, but each time
Oberg had read the tension in his neck, his
shoulders, and turned him back to the right
path. He didn't even know how he knew it
was the right path. It was getting harder to
keep track of what was and what was not

His vision split fuzzily in two, and he glimpsed briefly through the eyes of a nursery school child and then one of her teachers. Altimide scenes overlay one another. It was awful, choking sensation. Peter was dazed by shifting visions through the eyes of others—Sam, Jeremy, Sheila, even the police. Sometimes one, sometimes several at once. He felt their breaths in his lungs, the touch of their clothes on his skin, their thoughts running through his head, briefly there and then gone. It confused him, made him foggy, unsure which of those many people he actually was. The only light in the coal bin came from Sam's flashlight, shining like an orange moon in her eyes, which were green, and Sam wanted to clutch and raise her from the dirt, but somehow (Sheila didn't know how she knew) it was understood that she was not to be moved. Jeremy stared down with large solemn eyes and dug an elbow into Sam's ribs—the sexton understood and put her down—and Sheila fretted because she had children to tend to, a door to rehang, and none of them knew what was actually going on.

A voice came from out of the darkness. "Children, there is a new world growing," it roared. "It was planted by mistake and it grows like a weed—without direction. But it can be tamed and pruned—it can be reclaimed by the proper authorities."

Now Oberg burned out of the darkness, amusement predominant on his face. "What is growing," he said, "is a viewpoint more than anything else. It has been contaminated by your presence, by everyone here in the church that this young lady has met. Left alone, it would become a perfect reflection of your true selves. It would be a judgment on you."

He paused. Nobody spoke or moved. There is a war on," he said. The police were pale blobs behind him, clustered loosely about Peter (he glimpsed himself multiplied through their eyes). "Our government is locked in a death struggle with the evil empire of the earth. This young woman has the potential to win that war for us. Under our direction the world can be

turned. It can be made safe for us forever. He sprinted forward, in no particular hurry. "Please stand back," he said. "This woman is government property."

When Sam saw the man reach for Jennifer, he acted swiftly without thought. His flashlight swung in a great arc at Oberg's face as Sheila shrieked and grabbed for Jeremy who was knocked, laughing, to the floor. Oberg didn't even flinch. One of the police seized Sam and swung him about; another loomed his hands behind his back and snapped handcuffs on them—Sheila saw them glint in the light cast by the flashlight that fell forgotten to the floor. There was a look right by Jennifer's eyes, it loomed enormous, and she ignored it.

The boy from the church office was with them. He face was slack and bewildered. "Why didn't you help?" Sam asked bitterly. "You could have done something!"

"Sam," Peter said. "They wanted me to help you, Sam." His eyes were all dazzled with tiny glittery stars. "I didn't, though. I wouldn't do it."

The government man was bending over the lady in the dirt. He lifted her up in his arms. A policeman yanked Sam backward away from them. But he was staring at Peter, puzzlement in his face.

"What did you do to her?" Sam demanded. Then, angrily, "Look at her! What did you do?"

It was like a procession. First came Oberg, carrying the ghost limp and helpless in his arms. She stared vacantly up ward. Then came the first cop, pushing Sam handcuffed before him. Then the second, leading Peter by the arm and the third, with both Sheila and the child.

That was not how Peter saw it. His vision was flashing from person to person, first through a policeman's eyes, then out Oberg's, then—simultaneously—his own and Sheila's. The shifting was growing faster and multiple views, more common so that—if he could only hold it in his mind—he was seeing a comprehensive gestalt view, each person through several sets of eyes and his own.

There was a wine bottle lying on the stairs, in the midst of a speeding team, and Oberg casually kicked it aside. It went spinning and bounced down two steps. Sam nearly stumbled over it, and Peter (seeing it happen in five overlapping viewpoints) snatched it up in an urgently newborn-dumpty swoop. Peter had no intention of doing anything with the bottle. He was just being automatically obsessively neat. But his guard reached out and slapped it away, out of his hand as a potential weapon. It flew downward, spraying wine in all directions. Peter watched it slowly fall through several sets of vision, bounce, and disappear behind them all.

He felt a strange sense of bereavement, and permanent loss.

Outside, the raising of the net was rising and falling, regular—irregular, like ocean waves or streams of cars on the freeway. "Almost to the sanctuary," Oberg commented lightly. There were people being beaten on the doormat outside. Insanely, at least one still held a blazing radio

—vehemently denied. Spoken word said the nuclear strike was a preventative reproductive effort.

There were wet, maroon stains on Peter's slacks and shirt, and a bit of wine still clung to his tree hair. Absently he raised it to his mouth, licked it off.

And the taste of it jolted him like an electric shock. It snapped his mind back together, reassembled it from scattered fragments, cut off the visions through the others' eyes. He was himself again.

And he remembered.

When he had stopped running, he found himself huddled into a cold, lightless corner. The ghost was there. He could feel her



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breath on his face, sense a near-visual glimmering of warmth from her body.

What do you want? she asked him. He was not surprised that he could hear her even though she had not spoken, because he was still wearing his Toshiba, and his thoughts were not rational enough for any further reasoning.

But what did he want? It was a question he could never have answered straight. But in his hallucinogen-enlivened state, he found that the answer came out easy and loud and straightforward, as if it arose from the center of his being, where there were no lies and evasions, no confusion and no misunderstanding, but simply what was.

"I want to understand what's going on," he said, "and I want to know what to do about it." The blackness wailed around him, ran its fingers through his brain.

Her answer came—again—not in words but in a sense of delighted amusement of pleased recognition. So be it.

Standing there in the lightless cellar amid dirt and broken furniture, his ears singing and seeing it against the low overhead beams, he received his gift. It was an understanding so pure and complete, so detailed and comprehensive, undeniable and true that no human mind could have contained a fraction of it without being destroyed completely. Faced with this overload, his mind shut down to avoid handling it.

He found himself being dragged roughly

through the narthex by a policeman. This was bewildering. He had only faint shadow memories of the events since he went to the lady in the basement, and they seemed unconnecting. Nor did he retain his illumination, all that remained of it were three words, running like a miasma through his head.

"What was that?" Oberg paused before the sanctuary door. He cocked his head, trying to listen over the not noses. "That sound."

Children burst all around them, cascading up from the stairs, bubbling out into the narthex. As the startled cops drew their guns, they came whooping, crowding about them, shrieking and chirping with excitement.

"Shoot the little bastards!" Oberg commanded. The policemen all stared at him in horror and disbelief. "Shoot them!" he insisted, and still they disobeyed.

Peter was so preoccupied by the words running through his thoughts that he did not at first realize that his guard had released him. The children—and the parents and teachers who came running after—had separated him from the group. He realized now that he was leaning against the door to the outside.

Open the door. Open the door. Open the door. The words jumbled over and over one upon the other—opened door—urgent and overwhelming. Suppose, he thought, just suppose they meant some-

thing. Suppose you were supposed to take them away.

He put his hand on the door. Outside, the net was in progress. Hundreds of vent people were being forced against the door. Some were beating on it with their hands; it shivered and vibrated in sympathy.

Open the door.

Oberg had noticed him now. He was pointing at Peter and shouting some angry command that could not be heard over the children and the net. One of the policemen turned toward him.

He opened the door and stood to the side. Vegetants and derelicts, vent men and shopping bag ladies—the insane and confused and the outcast and discarded, the filthy and vile, the crazy and crippled, and those haunted by religious or political visions that made no sense to anyone but themselves—all flooded through the door, a great wash of stinking humanity excited and fearful, some shouting ones of joy or triumph, many badly injured, at least one attempting to sing. They swarmed over police and captives and children, teachers and Oberg and parents and all, and swept them into the sanctuary.

Oberg was slammed against the door-still, his head cracked steeply against the wood. He slumped.

The lady falling from his arms, was snatched up by Sam, who carried her within. The flocks of children and derelicts converged around the altar.

Jennifer's eyes were bright and alert and serenely calm.

—advised all inhabitants of nuclear targets—that includes all residents of the BioWash corridor any port cities—

The thing still hovered over the altar.

"It's pretty," Sheila gasped by Peter's ear.

It was. It glimmered slightly where it flicked, and there were hints of bright colors and far places in its light. It whirled and spun, as if to some unheard music; it seemed full of promise and possibility.

Just as Jennifer was lowered onto the altar, though, fierce light blomed outside the windows. The unseen skies turned brilliant with nuclear fire, and the stained glass grew intensely unbearably bright. It was the beginning of the war they had all been expecting for so long.

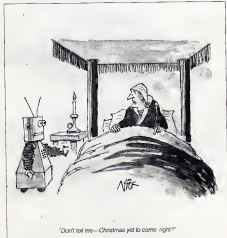
A horrified silence fell, and then—shocked by this awful hush—several of the children began to cry.

Jennifer gasped and convulsed—at last her time had come. She stretched out a hand over her head, and the thing above her pulsed. Three times it expanded and contracted, and then it exploded.

The explosion engulfed them all in an instant, swallowing up the church and expanding outward, ever more rapidly, still growing. The last coherent thought Peter had before he was assimilated entirely was that perhaps Oberg was right. Perhaps it was a judgment on them all.

Floped circles, of reality and light, raced one another around the globe.

—Mark 4:30-32



SPACE

CONTINUED FROM PAGE 25

a 24-hour worldwide system. "By manipulating this information, someone could wreak havoc with our economic system or that of any nation," he warns.

MOON BUGGY CONTEST UPDATE

The year is 2086, and he lives on our nearest satellite, the moon. In fact, since his birth in 2082 on the night of what Earthlings call the harvest moon, he hasn't left his home, a lunar colony established in 2010. His eighteen now and neecest. And he has a special fantasy: to visit Earth, the home of his ancestors.

Today is his big opportunity. If he wins the Prix de Lune, a race that covers 2,600 miles of rough terrain, he will fulfill his dream. As he steps from his module he mumbles to himself, "The race wouldn't be that difficult, not with the sporty vehicles we now have." But this race is a challenge to drive a vehicle designed by a relative of his who lived in 1986 in the country called the United States. He walks to the starting line, climbs into the moon buggy, and starts the engine. "Its design is still quite innovative," he says to himself.

You may never get a chance to race a car on the moon, but you can design a vehicle for someone else to drive on the moon someday. And if your design wins, you will

travel to the stars. It's not too late to enter the Omni 2086 moon buggy contest and give your descendants an opportunity to test your recreational vehicle.

- Just to recap local driving conditions:
- There is no atmosphere to speak of on the moon, so standard internal combustion engines won't work.
- Because the gravity on the moon is one sixth that of Earth, vehicles need less power to travel across the moonscape.

The grand prize for the most ingenious and feasible vehicle will be one ticket on Project Space Voyage, a low-Earth orbit tour of our planet scheduled for launch in 1992. The tour includes a four-day briefing as a resort, an 8- to 12-hour trip, and then two days' debriefing at a resort. Space gear will be provided. This trip is offered by Society Expeditions, which will be solely responsible for determining the winner's eligibility to participate in the space voyage. If the grand prize winner does not meet health/eligibility requirements for the trip or declines the trip, or if the trip is canceled or delayed, an alternate prize of a two-week "Lost Islands of the Pacific" South Pacific cruise (not including transportation to and from point of embarkation) will be offered for 1987 or 1988. If for any reason the alternate prize is unavailable or cannot be taken by the winner, Omni may award \$500 as a consolation prize in lieu thereof.

The second prize is a trip for one to the United States Space Academy (airfare in-

cluded) the space camp for adults at the Alabama Space and Rocket Center in Huntsville. During a three-day stay the visitor will hear lectures and see movies on spaceflight and get a sample of astronaut training that includes simulated weightlessness, flight-testing a payload astronaut's jet pack, and participating in a simulated shuttle flight to the moon. Third prize is a Haliexscope telescope from the Haliex Optical Corporation. It is compact, portable, and versatile, and includes an adaptor for sky viewing and one for land use. You can see distant objects like Jupiter's moons or study fine detail like a rabbit's whiskers.

To enter the contest, print your name and address on a plain piece of paper and include as proof of purchase the words STAR TECH cut out from atop page 157 in 200 words or less (printed or typed only) describe your vehicle. No drawings, please. No models. You must include in your description the following characteristics of the moon buggy: size, weight, number of occupants it could carry, means of propulsion, top speed, performance capabilities (can it cross crevasses? how large? how steep a slope can it climb?), material of which it is made.

Send your entry to Moon Buggy Contest, Box 9113, Alston, MA 02134. Entries must be received by December 31, 1986. We are not responsible for lost, late, or misdirected mail.

Entries will be judged by a special panel, and winning concepts will be determined based on the following criteria: creativity (25 percent), originality (25 percent), suitability for lunar terrain and environment (40 percent), feasibility (10 percent).

The contest is open only to residents of the United States, except employees (and their families) of Omni Publications International Ltd., its subsidiaries or affiliates, the judges, Society Expeditions Inc., their respective advertising and promotion agencies, and Precision Marketing Inc. All federal, state, and local laws and regulations apply. Void where prohibited.

Winners will be notified by mail and will be required to sign an affidavit of eligibility and a release within 15 days of the date of notification. If these are not returned within 15 days an alternate winner may be selected. Winners agree to the use of their names and likenesses for publicity purposes without additional compensation. Prizes are not transferable, assignable, or redeemable for cash. There will be no substitution for prizes other than as stated. No duplicate major-prize winners. Taxes and transportation to the grand prize site are the winner's responsibility.

Our panel of judges, who will vote on the winning concept, includes Apollo 15 lunar module commander James Irwin, Gerard K. O'Neill, Isaac Asimov, James M. Besson, Richard Petty, Mario Andreoli, Leonard Nay, Tom Brokaw, Billy Dee Williams, Edsel Ford, Shirley Muldowney, Chuck Yeager, Hal McAlear, and T. C. Swartz, president of Society Expeditions. **DD**



"Remember when a request for hardware and software meant tools and ingenuity?"

The Artist

© ART CUMINGS



BOOKS

CONTINUED FROM PAGE 38

(Arbor House) is, a fresh and original fantasy, says fiction writer Michael Swanwick. The setting of this 1985 World Fantasy award-winning novel (published in paperback this year by Berkley) is an eerie primordial forest—"a psychic sink," Swanwick calls it—where beings menace visitors and drive them mad.

Moving into the present, *Arctic Dreams* (Scribner's) by Barry Lopez is a rhapsodic book about a real-life but alien place. "It tells us the meanings of light and darkness, sound and silence, for creatures great and small in the 'lifeless Arctic,'" says Librarian of Congress Daniel Boorstin.

Other favorites this year, however, were focused on neither the long ago nor the faraway. They were just far-out. *ReSearch #10: Incredibly Strange Films* (ReSearch) is "a bizarre compendium of insane cinema," says SF writer Bruce Sterling. These ReSearch efforts—magazines, videos, books—can cause genetic damage. Incredibly Strange Films is so far underground it doesn't need eyes.

At the top of author William Gibson's list was *Homunculus* (Ace-Berkley) by James P. Blaylock, "a very funny writer who hasn't been receiving as much attention as he should." The novel, Gibson adds, "is a crazy fantasy set in Victorian England with lots of extremely whimsical stuff about perpetual motion."

Two of Gibson's own books were chosen by other experts. Author William Burroughs discovered *Neuromancer* (Ace-Berkley) which, he says, "explores the unlimited cosmic possibilities of software reality. It would be a great movie." And writer Timothy Leary liked *Count Zero* (Arbor House), set in the same future of computers and cybernetics as *Neuromancer* but an essential seven years later.

Writer Lewis Shiner, however, preferred the wickedness of *Masters of Atlantis* (Voyaj) by *True Grit* author Charles Portis. The novel is the "history" of the secret Gremorian Society which developed among other wonderfully misplaced ideas: plans during World War II to defeat Germany and Japan with compressed air. Portis shows an understanding of the whole Atlantis and UFO mind set without condescending to the characters. Shiner comments:

And in *Song of Kai* (Bantam) by Dan Simmons, a journalist travels to Calcutta to interview a poet believed dead until new works began appearing. This 1986 Fantasy award-winner impressed veteran science-fiction writer Harlan Ellison as "one of the most brilliant first novels I've read." And Simmons' depiction of Calcutta as a character in the book, Ellison says, "is the most memorable portrayal of any place you'll ever read." The novel moves like a nightmare creature toward a terrifying climax. No escapes here, but *Song* is well worth the listen. **DO**



SCOTCH OF RARE CHARACTER

Here is the solution to last month's telephone crypt.

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NOR THE BATTLE TO THE
STRONG, BUT THAT'S THE WAY TO BET.**

—DAMON RUNYON

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*New puzzles and new
computer diversions: the ten best
games of the year*

GAMES

By Scott Morris and Phil Wiswell

It's time again for our annual picks of the ten best games of the year. We have limited our selections to five general games and five computer games. The computer games are arranged in alphabetical order by company name. For each computer system we selected one game. The general games are listed by price—not by preference—beginning with the least expensive. Prices tend to be high, so shop around for discounts.

BEST COMPUTER GAMES

This may have been a lean year for the home-computer industry, but the surviving publishers delivered better games than ever for the Amiga, the Apple II, the Commodore, the IBM PC, and the Macintosh.

Amiga: Marble Madness (Electronic Arts, \$40) Electronic Arts has published dozens of titles for different computers, with more than its share of winners. *Marble Madness*, a game licensed from a coin-op machine, is an incredibly addictive arcade game that translates superbly to such computers as the Amiga. Color graphics, animation, and sound effects are so close to those of the actual arcade game that you may find yourself reaching for a quarter when the game ends.

In the one-player mode you try to beat the clock by racing your marble through six individual courses that become increasingly difficult. Using either a joystick or mouse, you maneuver a marble along some of the wildest obstacle courses



you've ever seen on a computer screen—complete with individual stereo sound scores. You must move fast and steer well enough not to go over the edge. The terrain—a bizarre three-dimensional landscape of pathways, dead ends, pitfalls, and strange creatures—resembles an animated M.C. Escher print. The games also a great competitive two-player race.

Apple II: Ballyhoo (Intocom \$40) Ballyhoo is an exciting adventure story in which you play the hero who tries to rescue a damsel in distress. On-screen text describes your surroundings and the action, but you direct the out come of the story by typing in full-sentence commands. As the game begins you are sneaking around the grounds at a traveling circus, after hours, curious about what happens once the

midway shuts down for the day. Just as you begin to enjoy yourself, you hear something terrible. The circus owner's daughter has been kidnapped, and a drunken inept detective has been hired to solve the case. The rest of the action is up to you. Find the kidnapped girl, or ignore her plight and continue looking around.

You're alone, you have no friends. It's difficult to get information. But if you're patient, clever, and nice to the circus people, you'll find plenty of clues. For example, after watching a dwarf unsuccessfully trying to reach the water fountain, we emerged from the shadows and boosted him up. He returned the favor with a valuable clue. Ballyhoo is a well-written mystery from the masters of the text-adventure game, tickled woven with suspense and full of

surprising red herrings. We can say no more without giving away the good stuff. Ballyhoo is the most unforgettable trip you'll ever make to the circus.

Commodore 64/128: Hacker II (Activision, \$40) As with the original *Hacker*, this sequel has an unusual and captivating beginning. You are reading a transmission on your computer terminal when the display is strangely interrupted. It is an urgent message from the CIA to you: the world's foremost computer hacker, requesting assistance. The Russians possess a document known as the Occam's Paper that, when published, will destroy relations among world powers. The agency wants you to locate and steal this document, which is hidden in a maximum-security complex somewhere in Siberia. Fortunately, you won't be making your physical trek because the CIA is lending you one of their computers. The object: "hack" your way also ironically into the Russians' computer system, memorize and avoid their tight security measures, locate codes to a safe, find the safe, and remove the document.

The CIA has stationed several robots within the complex, and you must learn how to make them do your bidding. Graphics are extremely important and well-done in this game. You can display a map of the complex and up to four views of the action, using four different video monitors on your screen. You can monitor hallways while you instruct your

GAMES

● You'll probably die a thousand deaths before solving the puzzle of *Uninvited* ●



robots to explore rooms. You can watch what the various security monitors are looking at. You even have a video tape recorder that you can synchronize with any security monitor, allowing your robot freedom to explore areas that are constantly monitored by security. Juggling everything to avoid detection and proceed with your mission is not easy—timing is the name of this game, and it all feels very realistic. You must memorize the patterns of the guards roaming the halls, the positions of security cameras, and the locations of traps. Meanwhile, you must keep your robots looking for the combination to the safe. *Hacker II* is a wonderful blend of action, strategy, and physical and mental dexterity. Even the agony of defeat is eased because you cannot be caught. You're not actually there, you're a hacker.

IBM PC: Mean 16 (Accolade, \$45). Brilliant graphics display spectacular and realistic golf courses including a closeup screen once

you reach the green. Players are outfitted with a complete set of golf clubs and statistics on each club, keystrokes control timing, power hook, and slice. The disk includes four different famous courses from St. Andrews to Pebble Beach, plus a construction set that lets you design your own golf course.

Seventy-two predesigned holes are presented on highly detailed screens, with lots of hazards—trees, doglegs, rough, bunkers, and traps. Some greens are fast; others slow. Some are flat; others sloped, but all are shaped differently and surrounded by sand, with almost invisible breaks. If you get frustrated, don't throw down your joystick as if it were a cursed three iron that just sliced your ball into the woods. Instead, head to the practice driving range or the practice putting green, where you can drive and putt to your heart's content. New players can learn to control their swings here, and seasoned pros can brush up on the finer points of golf.

Macintosh: Uninvited (Windscape, \$40). If you've never played computer games because you thought they were kid stuff, *Uninvited* will change your mind. It may frighten you a bit, too, like a Stephen King novel because you're the uninvited one. The scene is familiar: You are alone. Your car has crashed on a dark country road. You walk to a house. You knock. No answer. You enter. The door creaks shut. Cobwebs tickle your face. Here as you explore a spooky, well-illustrated house, with many rooms. The high-resolution graphics display of the Macintosh is used for maximum effect. You should draw a map to keep track of your whereabouts and discoveries because you will probably die a thousand deaths before you solve all the puzzles of *Uninvited*.

You control the game action with the mouse. As you look for a telephone, a command window gives you eight options to deal with the situation you encounter. You can examine objects, open and close things, speak to people or other beings, hit someone or something, and consume something. Each scene contains highly detailed pictures as well as text, sometimes more than a screenful. You never know where the answers to the puzzles lie until you stumble on them by cleverness or dumb luck. If you are persistent, you will find clues in the graphics as well as the text. *Uninvited* is a fantastic, long-playing adventure game, a thriller of classic dramatics.

BEST GENERAL GAMES

Doodie & Wink: The Adult Game of Negotiation (Trend Games, \$7.95). The card game, invented by a Harvard Law School graduate, tests your ability to negotiate as a defense lawyer. In each round one player is the defendant, and the others act as plaintiffs. A case card describes the dollar amount of the stakes (ranging from \$800,000) and gives a Merit number which the defendant must beat with a roll of three dice. Both the defendant and the plaintiffs receive cards that adjust the Merit number moving it up or down. During the first phase of negotiation the defendant offers an out-of-court settlement, which the plaintiffs accept or reject for more money. In the next phase, Discovery, each player reveals the first of the two cards he was dealt. At this stage you learn who is being cautious, who is reckless, and who is most skilled at bluffing.

The person with the most money after each player has had a turn at being defendant wins. It helps if you know the probabilities for a roll of three dice, and if you have a good memory. It's important to remember the number of each type of card so that you can take a good guess at your opponent's hole card and the amount of money each player has accumulated. In the end, however, the winner is likely to be the best bluffer.

Because the rules are fairly complex, it may take a few practice rounds before you get a feel for negotiating. And the price is right—4.5.

CONTINUED ON PAGE 100

STARTECH

ACCESSING THE FUTURE

COMPUTER TRANSLATOR

You want to tell your French uncle that his wife's pen is on the table, but you don't know the words. If a Seerle invention is right, you'll one day have a pocket-size, voice-activated, computerized talking translator that will render your frustrated spoken English into a confident and correct *le plume de ma tante*.

Stephen Rondel of Advanced Products and Technologies got his start inventing such travel products as a tiny fold-up iron and a coat-hanger-shaped scale. Now, after two years of intensive research, he has patented a mathematical formula for a software program that will recognize and then unravel spoken sounds by breaking them down into their phonic components.

But once the computer recognizes a sound, it still has to figure out what it means and that's the hard part. For example, says Rondel, "if you're throwing a ball, how will the computer know if it's a cherry ball or a baseball? Well, it will find out by using artificial intelligence to ask progressively more specific questions until it's able to figure out the meaning from context."

Once the massive software and hardware obstacles are overcome, Rondel expects to market a translator that will render English into two or three other languages for \$1,000 to \$2,000.

—Cathy Stone

Access: Available about ten years down the road.



PRIVATE, AFFORDABLE SPACE PLANES

If a small engineering firm in Georgia has its way, space may soon become accessible to any company that can afford a few million dollars to charter an airplane.

The secret is the Space Transportation Vehicle (STV), the dreamchild of Robert Talmage Jr., of the Atlanta-based TAAS Company. Talmage and friends have developed a design in which just about any commercial airliner—even the ungainly DC-9—can be modified to become a space transport, delivering payloads of up to 4,000 pounds to a low orbit. The trick, Talmage says, is to replace the airliner's conventional swept-wing

design with one that is more nearly perpendicular to its fuselage, thus maximizing lift while minimizing drag. Equipped with rocket engines, such a plane could be towed aloft, then fire itself into orbit, where its gliderlike wings would allow it to "skate" in and out of the atmosphere while still orbiting the earth. The STV will finally open up space to private enterprise, says Talmage. That's the exciting thing. —Bill Lawren

Access: Talmage estimates that the conversion of the first space plane could be ready to go in a year for about \$100 million given a group of committed companies. Once in operation, the plane could deliver loads to orbit for a bargain-basement \$7 million per trip, some 80 percent less than the cost of a NASA shuttle flight.

MAYAN VACATION

This is not your typical tourist trip. You'll climb the highest pyramid in the Yucatan to participate in ancient ceremonial practices with Mayan priests. Anthropologist Joan Harter, head of the Q'ui Foundation and author of *Shaman: The Wounded Healer*, will take a small, intimate group to Mayan Yucatan January 10 to 25, 1987.

She will be assisted by Mayan specialist Peter Balin, author of *Flight of the Feathered Serpent*, and two Mayan guides with extensive knowledge of indigenous culture and practices.

The area is rich in archaeological sites, including the ruins of Cobá, the Cave of Balancán, and the sacred architecture of Uxmal. Voyagers will visit the white sand beaches and crystal-clear coral lagoons of Tulum and explore underground turquoise sacred waters. The journey culminates at the mysterious Cave of the Stone Flower at Lulub.

The trip includes teachings on anthropology, archaeology, shamanism, and the art of ceremony. The purpose of the pilgrimage, says Balin, is to understand the minds that built these majestic ruins. Despite European domination, the Mayans privately maintained their traditional values and religious life. —Connie Zweig

Access: The cost of the trip is \$1,550 for tuition, accommodations, food, and transport, guides, and medicine gifts (airfare not included). Contact Ann Hammond at (805) 646-6343.

ANTIWAR GAMES

Imagine walking into a video arcade amid whirling noises and neon lights. But instead of blowing up asteroids or avoiding death rays, kids of all ages are learning about the subtleties of conflict negotiation.

If educational software designer Tom Snyder is right, his computer games will teach children and adults to solve problems by cooperation rather than by assault. Snyder, thirty-six, a former schoolteacher (shown above right), has designed a series of games and simulations that teach and entertain.

The Other Side Snyder's most recent branchild is based on the U.S./Soviet rivalry. The game scenario: Two large nations need to build a bridge linking themselves across an unfriendly frontier in order to gain access to fuel resources.

The players choose their course of action: cooperation or competition. The strategy they select dramatically changes the simulation. Attack in most cases results in mutual destruction; collaboration promotes trade and mutual survival.

In late 1985, two weeks before President Reagan and Soviet leader Gorbachev sat down in Geneva, two delegations of children staged a dramatic demonstration of *The Other Side*. Linked by computer modems, the groups in Boston and Geneva wilyly negotiated their own international treaty. After 90 minutes they reached an agreement and broke into cheers. More recently U.S. and Canadian



schoolchildren ran the simulation and became allies.

—Conner Zweep
Access: \$29.95 for Apple and IBM personal computers. Available in computer software stores or directly from Tom Snyder Productions Inc., 123 Mount Auburn Street, Cambridge, MA 02138. (617) 876-4433.

WATCHES THAT RUN ON BEER

Some 200 years ago the Italian physicist Count Alessandro Volta—after whom the voltaic cell is named—discovered that you could combine such dissimilar metals as zinc and copper and produce electricity for which—unfortunately for the count—eighteenth-century Italy had no use whatsoever.

Now a Texas engineering firm called VentuResearch has applied modern microelectronics and intricate circuitry to Volta's discovery to produce a wristwatch that runs on beer. For that matter it will also run on

beer, champagne, orange juice, and most soft drinks. Says VentuResearch president Roger Hummel: "The only problem we've found so far is that the sugar in some of these beverages tends to gum up [the watch's] water tanks, and you have to rinse them out."

Hummel's permanent, tank-type bat-

tery is slightly larger than a dime and produces ten microamps of current. Pinholes along the watch's circumference permit the necessary water to enter. A zinc cathode and a copper anode take care of the rest. When the water evaporates all you have to do, explains Hummel, is "throw the watch in a glass of water, take a shower, or go swimming. It will run up to sixteen days, even in a very dry climate."

Because the battery never needs replacement, Hummel foresees a huge market in developing countries where "you can't just run down to the corner drugstore and buy a new battery."

—George Nobbe
Access: Contact VentuResearch, an El Paso, Texas, company, at (915) 504-4094. The price: \$20 to \$30.



STARTECH

Z-GLOVE

Computer games are traditionally played with joy sticks and mouses. Now VPL Research in Palo Alto, Calif., has introduced the Z-Glove. This innovative input device makes it possible for the wearer to "handle" objects displayed on a computer screen as if they were physically real.

Unlike joysticks and mouses, which operate in the x and y planes and allow movement left or right and up or down, the glove adds the third dimension of the z plane—close or far. Through ultrasonic beepers and sensors inside the glove, the Z-Glove system can sense the hand's position in three-dimensional space.

With the Z-Glove a warrior can, for example, "mold" three-dimensional sculptures or "play" a guitar displayed on the computer screen. And in action-oriented games, players equipped with a Z-



Glove can get a "hold" on the controls of a spaceship.

—Marjorie Costello

Access: The Z-Glove is being sold, along with software, for \$99.95 starting this Christmas. The system will be available in toy and mass-merchandise stores.

RETURN OF THE PICTURE PHONE

At the 1984 World's Fair, AT&T predicted that in the not-too-distant future, we would all own picture phones, telephones that transmit both words and pictures. In the 20-plus years since the public demonstration of the Picturephone, however, videophones have been limited mainly to commercial applications. A recently introduced model called Luma may finally move this futuristic idea into the realm of reality.

There are other visual phone systems on the market, but Luma distinguishes itself in size, design, ease of

installation, and cost. Marketed by Luma Telecom Inc., a subsidiary of Mitsubishi Electric, the eight-pound Luma is a fully integrated desk-top unit that features a built-in video camera, TV screen, and speakerphone. Luma utilizes a special video-optimized modem which maximizes the use of a standard phone line.

But Luma and other videophones that rely on ordinary phone lines are limited to sending and receiving black-and-white video freeze-frames. Full-motion video systems, like the one demonstrated at the 1984 World's Fair and those used today by large corporations, require special phone lines or satellite links. Affordable full-motion color videophone systems, say experts, probably won't become available in this century.—Marjorie Costello

Access: Luma costs \$1450 and is being marketed by Luma Telecom Inc., primarily to business and industry. The Luma system is being shown in AT&T showrooms.

COOL IN SUMMER, WARM IN WINTER

Now there's a fabric that cools its wearer on a hot day and warms him when it's cold. Chemists Tyrone Vigo and Joseph Bruno of the U.S. Department of Agriculture have discovered a class of chemicals—polydihyleneglycols (PDGs)—that store heat as temperatures rise then release that heat when the thermometer drops.

"The big problem," says Vigo, "is that these polydihyleneglycols are not durable in water, and they don't stand up to laundering." But he and Bruno quickly found a chemical agent (still secret) that binds PDGs to cotton and cotton-polyester fibers (below) in a way that makes the whole fabric both water-



insoluble and temperature flexible.—Bill Lawler

Access: Cold-weather gloves made from the fabric are now being field-tested by the U.S. Armed Forces.





LAST WORD

By Terry Runkle

Plans to produce the neutron bomb were canceled, as were plans for the electron bomb, the proton bomb, and the laser bomb, which kills germs that can cause bad breath.

Well-meaning liberals have been quick to condemn the staggering U.S. defense budget. They cite the pointless nuclear buildup and gross Pentagon mismanagement as evidence of waste of the taxpayer's hard-earned money, which could be better spent on the poor, the elderly, and the environment.

While it is true that a whole parade of the defense budget is doled out to secure military-grade paper clips at \$18.80 each, an overwhelming percentage of the money is spent the way Congress intended—to pay wildly inflated bills to private defense contractors. The contractors, in turn, design and manufacture high-priority, top secret, Space Age new stuff for the Army.

Those who insist on being guided by this outflow of money can take comfort in the fact that many of history's greatest scientific breakthroughs were originally developed in the course of military research. It seems there's nothing like the promise of a billion-dollar contract to nurture scientific creativity.

Here are just a few of the remarkable inventions now made possible by your military dollars.

THE PROTON BOMB. The gods—the public—and Congress were all outraged when they learned that the military wanted to build the neutron bomb, a detestable weapon that would "kill people but leave buildings standing." Plans to produce the weapon were canceled, as were plans to build the electron bomb, which would kill people but leave them standing, the photon bomb, which would scare people and kill trees, and the laser bomb, which would kill germs that can cause bad breath.

Finally, the Pentagon has decided what it considers an acceptable alternative—the proton bomb. The proton bomb kills people, birds, and homes and destroys buildings and trucks. In short, the proton bomb will eradicate anything bigger than a tropical clipping, except for kitchen cockroaches, which are strangely immune to its effects.

HOVER-BOOTS. Eager to seek a contract to replace the footwear of soldiers and marines from and fight in, Dr. Scholl's submitted these incredible boots that actually walk on a cushion of air. The boots leave no sound, cannot deteriorate and rot, and reduce overall foot fatigue. At the moment there is a small technical problem. Those comfy airborne sneakers are powered by a two-ton, air-compressor similar to those used to power windfall beards, but a portable, 125-pound backpack compressor is in the works. One day soon our boys in uniform will be walking on air, and the phrase "Your mother wears Hover-Boots" will become a common insult.

KHAKI PINK. With more and more women saying on the dated line to be all that they can be, the Army sorely needed a uniform tailored to the unique needs of its discolored soldiers—made from a material that would hold up under the most rigorous training and combat exercises imaginable yet still mix and match with the latest fashion accessories.

The result was khaki pink—a go anywhere, do anything kind of fabric that keeps a low profile in the jungles of El Salvador (even though we have no intention of ever sending troops there) yet looks great on the dance floor.

URBAN CAMOUFLAGE GEAR. Traditional camouflage wear is designed to blend in with the glossiness of forest or jungle terrain, but nowadays the jungle is "out" as the place to fight. Many guerrilla tactics are taught in the heart of urban cities, where the traditional green stands out like a sailor on a three-day hike.

Thanks to Liberty of London and the U.S. Army to design urban camouflage patterns for clothing and stationary objects, Liberty developed five complementary patterns for the Army: the muted shades of red or yellow brick, the subdued earth tones of cement, the bold silhouettes of "cracked debris," shimmering "broken glass," and a vibrant abstract—barring Burger King.

THE INFINITE MPG JEEP. When the Army announced plans to replace the venerable jeep with a more contemporary design, the country's finest automotive engineers teamed up to create a vehicle that even John Deere can't see in his wildest dreams could not have foreseen.

The result was the Duramax—the world's first totally stationary jeep. This four-by-four marvel can hold five men in comfort, never uses a drop of fuel, and will never ever break down—because it has no moving parts.

THE HOMING MISSILE. With a circular range of more than 6,000 miles, this tiny, winged projectile can swim over terrain far below enemy radar, guided by a super-microcomputer, and deliver a powerful nuclear payload to within five yards of its original launching site.

To the uninitiated this type of weapon might seem ineffective—a down-counter productive—but the top minds in Washington know how useful this device could be in the right hands. The Soviets have probably already stolen the plans for this little dynamo, and within a year they will have installed thousands of them all over Russia. Hell, we can even let them sneak a few into Cuba. So much for first-strike capability. **OO**

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