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SPECIAL ANNIVERSARY ISSUE

MYSTERIES OF THE MIND

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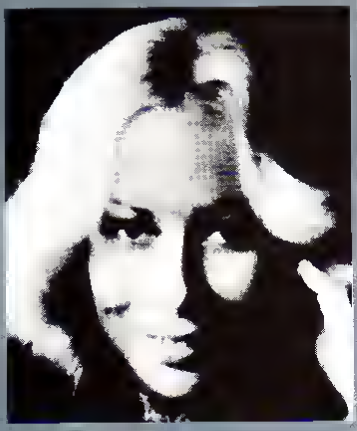
OCTOBER 1982

CONTENTS

Artist Dickran Palulian portrays a hollow android, searching the vastness of space. The cold, sterile silicon is softened by human eyes, which symbolize the evolution of mind and its epiphenomenon supermind (Courtesy of NEC Electronics USA, Inc.)



FIRST WORD

By Kathy Keeton

"A permanent U S space station could be put into orbit for only slightly more money than Americans spent on pizza in 1981"

Omni's fourth anniversary falls in the same month as the twenty-fifth anniversary of the launching of *Sputnik 1* It was October 4 1957, when the Soviet Union opened the Space Age with the first artificial satellite of Earth

October 1982 is also a notable month because, if current schedules hold the space shuttle *Columbia* will undertake its first operational flight and place two communications satellites in orbit.

The Space Age has come a long way in its first quarter-century, from its history making first satellite launch to the reusable workhorse *Columbia*

And in its much shorter span of four years *Omni* has come a long way, too, with more than 5 million readers each month two books published four highly popular *Omni Science Fiction* specials and an award winning television series to boast of

The chief reason for *Omni*'s success is of course, you—the reader You have verified the faith that Bob Guccione had when he started this magazine and have proved to a skeptical world that you are confident about the future and interested in scientific research, in the exciting prospects of space exploration robotics, genetic engineering, life extension, biotechnology and the many other areas covered in each issue

Like *Omni*'s your vision of the future is creative, optimistic and unafraid of new challenges

Paradoxically our political leadership seems to be looking backward, not forward it does not seem to understand that, by reaching for the stars, we can make life vastly better here on Earth

On July Fourth President Reagan witnessed the landing of *Columbia*'s final test mission and said in a speech to the half-million enthusiasts who had gathered at Edwards Air Force Base to see the spectacular event, "This is the historical equivalent to the driving of the golden spike that completed the first transcontinental railroad We must look aggressively to the future by demonstrating the potential of the shuttle and establishing a more permanent presence in space

Those are fine words But where are the deeds to match them?

The President has not called for a new program to build a permanent space station in Earth s orbit Without such a station, talk of 'a more permanent presence in space ' is mere rhetoric

In NASA parlance, the space station is referred to as the Space Operations Center or SOC It is the next logical step in our space program now that the shuttle appears to be well on its way to full operational status

When NASA originally proposed the shuttle program to the Nixon White House in the early 1970s, the shuttle was one third of the agency s total plan To operate economically and efficiently in space, NASA's planners reasoned we need a reusable shuttle that can carry relatively heavy loads into orbit and then come back for more We would also need a station in orbit to serve as a base, a "terminal" on the far end of the shuttle line And we would need a "space tug" that could take payloads from low orbits to higher ones, such as the geosynchronous Clarke orbit, where communications satellites operate

Neither Nixon, Ford, nor Carter would fund the entire integrated program So NASA tackled the first, and hardest part the shuttle

Now we should be working on the second step SOC The station would serve as a base in orbit for long-term scientific and industrial experiments biomedical research, military observations and communications, astronomical studies and much more.

Very sophisticated probes of the planets and comets could be assembled at the SOC, then ferried into orbit in components by the shuttle Complex satellites could be checked out at the SOC, and the station could even serve as a base for satellite repair and maintenance crews

According to Major General James Abrahamson director of the shuttle program space-oriented industries already represent a $20-billion-per-year market in the United States The SOC will allow industrial and commercial firms to operate in space on a more permanent basis to build new products in zero gravity, to create new jobs (on Earth) and strengthen the American economy

Still we do not have a decision to go ahead with the SOC Senator Harrison H Schmitt believes part of the reason is that we do not have enough trained scientists or engineers in Congress or the administration to make informed effective decisions on scientific and technical questions

This is something to remember, with congressional elections coming up next month Where do the candidates in your state and your district stand on the space program? How aware are they of the need for stronger efforts in scientific research and education?

NASA and several aerospace contractors have studied various space-station ideas. James Beggs, NASAs administrator has told the press that a Space Operations Center could be built for a total cost of about $9 billion and could be finished by 1988 *That cost is only slightly more than what Americans spent on pizza in 1981*

Would you give up a year's worth of pizza to see a permanent U S space station erected in orbit? If you would write to the President and let him know Send us a copy of your letter Or would you rather see your children celebrate the twenty-fifth anniversary of Russia s first space station 25 years from now?

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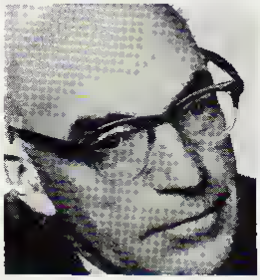

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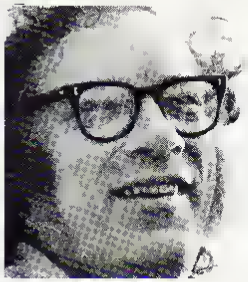

ASIMOV

NOLEN

Since its inception, *Omni* has covered numerous scientific breakthroughs and has been a celebrant of exploration. To mark our fourth anniversary we look at the uncharted landscape of the brain, in this 'Mysteries of the Mind' issue. How did self-awareness emerge from the gray matter of the cortex? Whence do ideas, dreams, and emotions spring? What is the relation between consciousness and the labyrinthine circuitry of the cerebral hemispheres? There are many unknowns, but modern science has made great strides since the nineteenth-century author Ambrose Bierce defined *mind* as "a mysterious form of matter secreted by the brain." To appreciate just how far we've come, turn to "Brain Frontiers" (page 112), a special guide to recent findings in neurophysiology, from advances in understanding the electrical language of the brain to research that may someday help paralyzed people to walk again.

On a related medical front, clinical investigators are combating Parkinson's disease and other neurological disorders in primates by transplanting healthy tissue to damaged areas of the cortex. This revolutionary treatment is the subject of an in-depth report by *Dr. William A. Nolen*, author of the best-selling autobiography *The Making of a Surgeon*. In "Brain Transplants," starting on page 28, Nolen examines the many technical and ethical obstacles that remain to be hurdled. But when and if this research pays off, Nolen expects, the benefits to mankind will be staggering.

What is the connection between body and soul, brain and mind, physical substrates and mental states? The answer is still far off, but eminent neuroscientist *Sir John Eccles* believes some important clues have surfaced. Eccles, who won a Nobel Prize in 1963 for his pioneering study of synapses (junctions between nerve cells), has been a staunch proponent of the view that an immaterial force directs neuronal processes. In "Beyond the Brain" (page 56) the Australian-born scientist discusses current efforts to track down "the ghost in the machine." If his hunch is correct, it is not a pervasive spirit, as once was thought, but is actually centered in a precise anatomical location.

Not all the experts concur with Eccles's opinion. According to another leading authority, Stanford neuropsychologist and surgeon Dr. Karl Pribram, the brain encodes information in the form of a three-dimensional energy field, roughly analogous to a hologram. Thus, consciousness cannot be pinpointed but is a direct result of the firing of billions of nerve cells in concert. In this month's Interview (page 128) the Father of the Holographic Theory of the Brain speaks to *Judith Hooper*, author of an upcoming book that will examine various cognitive models.

The rise of artificial intelligence has obscured the mind/brain debate even further. A growing body of computer specialists now insists that consciousness need not be associated with the brain at all. Something akin to awareness may emerge in silicon processors as they evolve in complexity. To assess this potential, science writer *Philip J. Hilts* visited World Computer Chess champion Belle and learned that its moves are virtually indistinguishable from those made by human chess masters. Still, "this paragon of brute, logical, mathematical force," he maintains, is anything but human in its mode of thought. To judge for yourself, turn to "Mind Machines" (page 104). A science reporter for the *Washington Post*, Hilts traces his interest in artificial intelligence to a meeting with a prominent figure in the field, John McCarthy, who is profiled in Hilts's newly published book *Scientific Temperaments*.

Science-fiction fans weaned on *Isaac Asimov*'s Foundation trilogy will not want to miss *Omni*'s exclusive excerpt (page 64) from the long-awaited sequel, *Foundation's Edge*. And *Frederik Pohl*, whom the American Association for the Advancement of Science commends "for imaginative writing with a solid foundation in science and technology," makes his *Omni* fiction debut with the satire "Farmer on the Dole" (page 118).

Finally, parapsychologists *Stephan A. Schwartz* and *Rand De Mattei* return to these pages with another experiment to test your ability to perceive distant events or locales telepathically. To participate, open to page 136. ∞

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OCTOBER

LETTERS

COMMUNICATIONS

Film Buff

Here's to Ridley Scott's attitude toward filmmaking! His belief in design as "statement" expressed in *Omni's* Film column [May 1982] made me feel better than ever about the movie industry

It's a good thing that there are still people who realize and enjoy the cinema's power to create strange imaginative worlds Scott's filmmaking is a more than welcome alternative to actor-oriented films, and he offers a promised land for potential designers and craftsmen

Joe Masset
Centereach NY

Gross Gourmet

The article "Toasted Termites" by Susan S Lang [Continuum April 1982] contains a very gross error pertaining to the "ordinary hot dog" Contrary to the article's assertion hot dogs may not contain any organ meat or meat that has not been cut from the bone

The appetites of hundreds of *Omni* readers can be restored

Raymond Markarian
National City, Calif

Susan Lang replies Omni readers may be able to re-whet their appetites for some hot dogs by knowing that "frankfurters" may indeed have only raw skeletal muscle meat Those labeled "frankfurters with by-products," however may contain hearts stomach parts livers tongues lips esophagus brains, lungs, nonlactating udders kidney back intestine jowls, butts, snouts, ears diaphragms and spleens from cattle or hogs, or both, according to animal scientist John Forrest at Purdue University

Hot dog lovers should not be too distressed though Frankfurters with "variety" meat frequently have higher nutritional value than those with skeletal meat only

Irritating Insects

In *Omni's* Antimatter article "Loch Ness Worms" [June 1982] a serious blow was dealt to insects and oligochaetes in one shot No self-respecting insect would like to be confused with a worm and no earthworm would welcome being mistaken for a lowly flatworm

Please make amends before biologists are bugged to death with complaints by irate insects and night crawlers for insulting their parentage and kin not to mention the misinformation provided to the uninformed reader

Robert Huffman
Lagro, Ind

Sharks Are First-rate

I commend your fine magazine on its fascinating interview with Eugenie Clark [June 1982], entitled "Sweet Sharks"

I found the interview conducted by John Stein very thorough and thought-provoking Clark revealed how this animal is often misunderstood and brought to my attention many facts of interest She has done a remarkable job in providing answers to the questions asked and in sharing with us her knowledge

Lillian Olari
New York NY

Subversive Character

I was astonished by the information presented by Owen Davies in "The DMSO War" [Continuum May 1982] In particular, I had never been aware of the subversive character of my possessing a copy of *The Persecuted Drug The Story of DMSO* I hereby invite the Food and Drug Administration to take a good look at my entire book collection How silly of me not to have burned them myself It only shows how desperately my fragile intellect needs the protection of the FDA's valiant cavaliers

As a matter of fact they may well find their true vocation along these lines So many new books are published each year while there are really very few new drugs

Emanuel Cooper
Lafayette, Ind

No Left Turn

I read with great interest the article by Eric Mishara entitled "Levophobia" [Mind June 1982] and I'd like to suggest a

CONTINUED ON PAGE 194

DIALOGUE

FORUM

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

Comic Comment

Bill Lee's "Creationist Comix" [June 1982] hit me squarely in the stomach.

The cartoons displayed an unexpected personal viciousness that does not belong in a publication for educated people. Mr. Lee's crude comments fell far short of attaining the label *satire* and attacked not only the creationist argument but the Jewish and Christian faiths. This was done with a heavy-handed lack of taste that I have never seen in a magazine of *Omni*'s reputation before.

Sharon Lunsford
Aledo, Tex.

Could it be that the evolutionists are adopting some of the creationist tactics? It seems to me that Bill Lee's "Creationist Comix" is no better than the cartoons depicting Darwin's head atop a monkey's body.

Roger Thrasher
Transfer, Pa.

Although I can see the humor and direction of "Creationist Comix," I must remark that more sensitivity should be exercised toward those people whose beliefs do not coincide with the views of the scientific community.

Bill Melancon
St. Martinville, La.

Michener on Sagan

Omni's fascinating report on Carl Sagan in the June issue ["The Marketing of Dr. Carl Sagan"] quotes me accurately from my *New York Times* review of Dr. Sagan's book. I did point out that many jealous scientists "dismiss him as a mere popularizer." I was reporting what others felt about Sagan. In my review I also indicated that I, among others, felt that he was one of the best things that has happened to science in a long time. His witty style, his wide knowledge, and his charismatic personality have enabled astronomers and astrophysicists to win a hearing they had not enjoyed before.

James Michener
St. Michaels, Md.

More on Sagan

As I was reading the article "The Marketing of Dr. Carl Sagan," it occurred to me that the authors [Franklynn Peterson and Judi Kesselman-Turkel] were really annoyed at the man, particularly at the sales of his book *Cosmos* and its hefty $19.95 price tag.

While I thought the article over, I happened to see a television commercial for a "Laughing Head" (a plastic head that plays a recorded belly laugh and rolls its eyes) for $19.95. Now I ask you: Wouldn't it seem that there are a lot worse ways to spend $19.95 than on *Cosmos*?

Diane Rhodes
Los Angeles, Calif.

I am quite aware that Carl Sagan is not perfect. However, I was repulsed by your vitriolic attack on him and by your attempt to discredit his valuable contribution to the advancement of science.

Whether Dr. Sagan's motives are entirely "pure" is hardly the question. In society today the promotion of Carl Sagan is objectively the promotion of a progressive trend in science, striking a blow at philistinism and metaphysics.

Wilson Pietzsch
Houston, Tex.

The Eiseley Touch

I'd like to add a touch of color to your splendid Loren Eiseley self-portrait [June 1982].

When I was writing a feature about my alma mater (the University of Pennsylvania) for *Holiday* magazine, I had a fascinating interview with Dr. Eiseley. We discussed many of the student/faculty problems, and at one point I asked him whether he had any particular goal when he was teaching.

He said, "Well, once I was lecturing in New York, and the discussion lasted so long that I just managed to catch a very late train back to Philadelphia, practically a milk train. There were only two in the empty car, I and a drunk across the aisle, obviously sleeping it off. When the conductor came through, he woke the drunk, who didn't have a ticket, but he pulled out a bill, poked it at the conductor, and said, 'Gimme a ticket to wherever it is.'"

Eiseley smiled. "And that's my goal. I try to give students a ticket to wherever it is."

Alfred Bester
Ottsville, Pa.

Laser Communications

In the article "Sun Guns" [May 1982] authors Jeff Hecht and Dick Teresi suggest an imaginative scheme for using lasers in communications. The idea, mistakenly attributed to me, was to communicate still video images of *Voyager* quality toward Barnard's star as a possible means of contacting some extraterrestrial civilization.

The attribution may have arisen from a talk I have given several times involving the use of laser links on automated spacecraft to transmit images of, not toward, the Barnard star system and any associated planets. Under realistic assumptions, one could communicate *Voyager*-quality images to Earth at approximately *Voyager* data rates by using solid-state pulsed-laser arrays. This would involve pulse position modulation, with erasure-fill-in block coding to account for missed pulses.

One should not underestimate the possible use of spacecraft to explore nearby stellar systems. Such a challenge goes far beyond that of merely communicating. However, overcoming any such challenge could provide a unifying scientific and technological theme for the next millennium.

Edward Posner
California Institute of Technology
Pasadena, Calif.

LIFE AT THE RIFT

EARTH

By Yvonne Baskin

Swells of liquid sapphire rolled under *Lulu*'s twin pontoons thrusting the huge catamaran upward in the morning sun. In the center of the deck, the tiny submarine *Alvin* nestled in its cradle. I stood by its side, trying to picture a bustling world beneath the bright, foamless blue. But it was a surreal vision, too incongruous to hold.

For in the ocean, blue is the desert color, a sign that few creatures can subsist. Below us, beyond the reach of the sun's rays, was a mile and a half of frigid sea. The sparse life inhabiting that changeless world moves in slow motion, growing and respiring only a fraction as fast as green-water creatures closer to shore. Without sunlight to propel photosynthesis, the deep sea can sustain no plant life, so animals survive only by eating the meager organic debris drifting down from the surface.

Or so I'd always thought. But here and there in the deep ocean, somewhere back in time, life apparently took a different tack. Independent of the sun that fuels the rest of our world, an alternate life chain evolved. The earth's molten core produced hot springs that spewed hydrogen sulfide, one of the most toxic substances known. The sulfide, rich in chemical energy, formed a food supply for clouds of bacteria, and the bacteria nurtured red-blooded clams, clusters of ten-foot-long tube worms, even scurrying white crabs.

I'd arrived at this tropical site, 120 miles south of Baja California, in April 1982, with three dozen scientists, a handful of other science writers, and three ships: the *Melville*, a huge floating lab; the *New Horizon*, a somewhat smaller research vessel; and the catamaran *Lulu*, used for launching the *Alvin*. Dispatched from the Scripps Institution of Oceanography in San Diego, our expedition had been dubbed "Oasis." Our mission: to study the frenetic world created by these hot springs, or volcanic vents, deep under the sea.

Geologists studying the seafloor near the Galápagos Islands stumbled upon these unique deepwater communities in 1977. It didn't take them long to realize they'd found part of a 45,000-mile network of "spreading centers": spots where the earth literally splits at the seams as the great plates forming its crust pull apart. Seawater flowing into these seams heats rapidly, gushing back up full of valuable minerals and gas. It was the movement of the earth's crust that interested geologists, not clams and worms, but they did bring back a few bottled prizes to tantalize biologists.

When biologists finally got to the Galápagos in 1979, they found blue-water creatures thriving on hydrogen sulfide, with just a paltry supply of surface nourishment in sight. But the Galapagos were just the beginning. Now we circled a vent 21 degrees north of the equator, 2,000 miles from the Galapagos. Below us, unseen, two crustal plates moved away from each other at the rate that a fingernail grows, about 2.5 inches a year. Our only link to that uncharted region was the 25-foot *Alvin*.

The sub rocked in the water as Scripps biologist Bob Hessler folded his lanky frame into the cramped passenger compartment for an hour-and-a-half descent. Crouching on boat cushions bundled against the deep-sea chill, he and two colleagues videotaped the vent community through portholes.

That night, in the *Melville*'s library, we were able to view the sights they had seen. *Alvin*'s floodlights had picked out a black lava field with 30-foot "chimneys" gushing sulfurous 650° F water, kept from boiling only by pressure 260 times that on the surface. When a superheated plume hit icy seawater, a glitter of heavy metals rained down on the lava base. Vent water cooled so quickly that creatures just inches from the opening enjoyed pleasant temperatures of 40° F to 70° F. We could see a mass of three-inch Pompeii worms, named for the shower of ash they endure, embracing chimney walls. Foot-long clams and thickets of feathery, red-tipped tube worms basked nearby; lobsterlike crabs and white eellike fish scavenged among the tubes.

"If the vent could be sniffed," Hessler said, "the rotten-egg smell of poisonous

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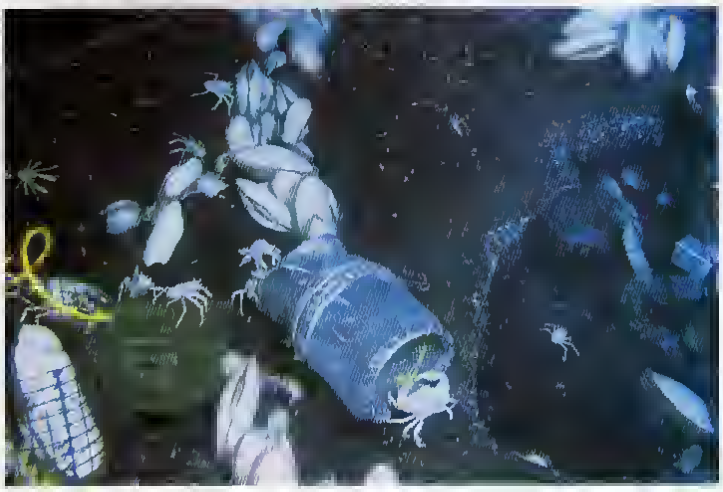

Clams, crabs, and snails bask in the warmth of a deep-sea rift at the bottom of the Pacific.

BEYOND SPUTNIK'S BOOSTER

SPACE

By James Oberg

An epochal cosmic event went unheralded sometime earlier this year. In a manner of speaking, it was the millennium.

Technically it was merely the one thousandth launching of the primary Soviet space booster. The mainstay of the Russian space program for a quarter of a century, the booster was known to its original designers as the R-7 (Rocket 7) or, affectionately, as "ol' mark seven"—in Russian, *semyorka*. Western observers call it the A-class vehicle. In any language it is *the* workhorse of spaceflight.

The launching was a fitting tribute to the first space satellite, *Sputnik 1*, which rode a *semyorka* into orbit on October 4, 1957, 25 years ago this month.

In the past quarter-century, the *semyorka* family carried 6,000 tons of payload into orbit, many times the total weight of the cargo any other type of booster has lifted. If all the rocket stages used in these missions were laid end to end, they would stretch 70 miles—nearly far enough to reach into space. Half a million tons of liquid propellants, mainly kerosene and liquid oxygen, were consumed by the booster.

The *semyorka* has seen glory and tragedy. It carried the first artificial satellite, the first moon shots, the first men (and a woman) into orbit. It is the only Soviet space booster ever to have been "man-rated" safe to carry crewmen, and it has done so for more than 100 riders. It also once killed 100 people. A balky model exploded on the launchpad in 1960 during an inspection that violated safety standards the Russians had foolishly set aside to meet a politically inspired deadline. In 1975 another *semyorka* was responsible for spaceflight history's only manned-launch abort, when an upper stage malfunctioned and dumped two cosmonauts onto a night-shrouded, snowy mountainside uncomfortably close to the Chinese border.

Even now, more than half of all Soviet space shots are atop *semyorka*-class boosters. Although that might be interpreted as a lack of real progress in Soviet space propulsion, in fact it is probably testimony to the foresight and advanced thinking of the missile's creator, Sergey Korolev. He persuaded the Kremlin leadership to finance an intercontinental ballistic missile (ICBM) program in 1955, but the missile built was clearly designed as a space booster. It never made a very efficient weapons carrier and was quickly replaced by newer ICBM designs, but it held its place as a space-transportation system without equal in the world.

A million pounds of flaming thrust pushes the *semyorka* off its concrete pad, built on an apron overlooking a deep flame pit. The 20 rocket engines are divided into five clusters of four each, with a long central core unit surrounded by four tapering strap-on stages. After two minutes, the strap-on units fall away and the core central stage carries on into space. An upper stage then pushes the payload into orbit.

That scenario has been conducted successfully more than 900 times. Several dozen more launches have fallen back from space, failures. Another two dozen *semyorkas* were expended between 1957 and 1959 during its brief weapons-test program.

The semyorka has lofted 6,000 tons of payload

But now the reign of the *semyorka* is apparently drawing to a close. Several trends are converging toward its extinction. Many standard payloads previously carried aboard *semyorkas* are now being launched aboard more modern SS-9 ICBMs, which have in turn been replaced for military use in the ICBM silos by the even more awesome SS-18 missiles. One bigger booster, the Proton, has after more than a decade of parallel service apparently reached the stage where it, too, can be trusted to carry cosmonauts. A special minishuttle is evidently being built to transport cosmonauts to and from a planned large space station later in the Eighties. That station itself is reportedly to be launched by a carrier rocket at least 12 times the size and power of the *semyorka*. With these developments on the horizon, the next ten years may witness the launching of the very last of Korolev's progeny.

The most spectacular successor is bound to be the "superbooster." Its advent had long been expected by Western observers, and rumors of an impending launching have been circulating for several years. A year ago the Pentagon officially confirmed that such a booster, with "six to seven times the payload capacity of the space shuttle," was being built. That comes out to about 200 tons in orbit, twice the payload weight lofted by the now-defunct Saturn 5, which carried Americans off the pad in the lunar missions.

Though no official word was given on possible schedules, most experts believe that a first test flight (probably with a dummy payload) could occur before the middle of next year. The booster could become operational by 1985, carrying giant 12-man space stations into low-Earth orbit as well as *Salyut*-class three-man craft into lunar orbit and, eventually, on to interplanetary trajectories.

The Russians would need a special new vehicle to take crew members up to

CONTINUED ON PAGE 169

DIETARY DISPUTE

LIFE

By Dr. Bernard Dixon

One unanticipated benefit of the last war was a steep decline of dental disease in Europe. With cooking sugar in short supply, the bacteria that erode tooth enamel were starved of nourishment, and the result was a sharp reduction in human cavities.

That unplanned experiment in preventive medicine comes vividly to mind four decades later as experts dispute just what dietary measures should be undertaken to combat another ailment, heart disease. The argument does not simply follow on the familiar theme of saturated versus polyunsaturated fats. It concerns the shape of our entire diet. And what worries some cardiovascular specialists is that the type of massive restructuring now being urged may be unrealistically draconian. Do we really want every lunch and dinner to be a serious exercise in nutritional science?

Earlier this year two experts sparked off the controversy in the columns of the international journal *The Lancet*. They were Dr. Jean Marr, of the Royal Free Hospital, London, and Professor Jeremy Morris, from the London School of Hygiene and Tropical Medicine. The target of their criticism was dietary advice that is rapidly becoming "conventional wisdom" in many countries: the notions that no more than 30 percent of total calories should come from fat and that the contribution of saturated fats (those obtained from meat and dairy products) should be reduced disproportionately to 10 percent. As Marr and Morris point out, no matter how we juggle our food constituents, it is impossible to produce a palatable diet along these lines.

Instead, these moderates advocate cutting fat intake back by half the amount hardliners have recommended. And they argue that the shortfall in saturated fat must be compensated for by extra polyunsaturates such as the oils derived from olives, soybeans, and maize. But again they feel there is no need to go overboard. "It's time to dispel those visions of the population swilling corn oil."

The crux of the argument—apart from gastronomic considerations—is whether we should all be stuck with a diet designed to protect high-risk groups. There is no simple answer. Just as many contributory factors, from a person's genetic makeup to smoking habits, influence his or her chances of someday succumbing to heart disease. So there is no black-and-white certainty concerning diet. Marr and Morris compute, from previous evidence, that their moderate advice would lead to a reduction in middle-age coronaries of some 10 to 15 percent. But the rewards for eating more draconian meals *could* be even greater, as another World War II rationing experiment demonstrates. Coronary mortalities in Europe fell as a result of the fat shortage. And atheroma, which causes blockages in arteries, was virtually nonexistent among prisoners of war.

Since they first broached the subject early this year, Marr and Morris have not been short of advice from other experts explaining how to achieve that target of 30 percent calories from fat, one third of them from saturated fat. They have come from centers like the Cleveland Clinic Foundation, in Ohio, and the Dunn Clinical Nutrition Centre, in Cambridge, England. In sum, these suggestions are that every atom of visible fat be excised from meat before it is cooked, that full-fat milk products be replaced by low-fat products, and that margarines and oils replace butter and cooking fats.

"Measures of these kinds surely should by now be standard health education and nutrition policy," Marr and Morris concede. "But carried to the extreme, such measures would also entail turning the whole population into patients."

Marr, by the way, speaks from sobering experience. She and Professor Andrew Shaper have succeeded in converting human subjects to a stringent diet in which only 37 percent of the calories are derived from fat. But their guinea pigs were "highly cooperative" civil servants, and adhering to the regimen required "considerable effort on all sides." There's still a long way to go before they achieve the austerity of the wartime kitchen. Whether they should pursue that goal at all is the fundamental question.

BETTER BABIES

mind

By Tim Whitaker

If it weren't for the sign out front—THE INSTITUTES FOR THE ACHIEVEMENT OF HUMAN POTENTIAL—it would look like just another classy estate in the lush Chestnut Hill section of Philadelphia. But behind the walls protecting this handsome stone complex is a controversial organization that claims a lofty calling: To increase the ability of all people to function in the intellectual, social, and physical realms.

Founded in 1955 as an alternative rehabilitation center for brain-injured children and stroke victims (the late Joseph P. Kennedy was probably their best-known patient), the institutes claimed to get results where others had failed. They did it, they declared, through "patterning," which they described as "visual, auditory, and tactile stimulation with increased frequency, intensity, and duration." The patients were drilled ceaselessly in exercises designed to restore their lost abilities.

The medical establishment has never endorsed founder Glenn Doman's aggressive techniques; at most, a few doctors concede that they get limited results. And physicians decry Doman's qualifications to practice sophisticated rehabilitation at all, his degree is in physical therapy. But notoriety has never hurt Doman's practice, and the publicity may have helped.

In February 1978, buoyed by a 23-year run of well-heeled clients, Doman decided to extend his brain-stimulation techniques to healthy babies. After all, if you can help people relearn speech, arithmetic, and physical skills, why not babies learning them for the first time?

Dubbing his program the Better Baby Institute (BBI), Doman now runs week-long seminars that seek to teach parents how a baby's brain grows and then offer practical methods they can use to help their infants learn "even before they walk." The cost is $450 per parent, and seating is limited to 90. The babies are not invited.

Doman's techniques convert adult language into symbols that babies can understand when they are repeated often enough. For example, a very young beby may not grasp the concept of numbers, but if he is repeatedly shown a flash card with 50 dots on it, he will soon recognize what the number 50 means. The same technique, Doman says, can be applied to playing the violin or learning a foreign language. A child will be played a tape of a violin, given the instrument, and asked to duplicate the sound.

"We all have the capacity to learn from the second day of life," says BBI director Gretchen Kerr. "Just because the children can't talk yet doesn't mean it's not in their capacity to learn. We just give them a language they can understand."

Leah Cianfrani, thirty-three, first heard about the Better Baby Institute over a Philadelphia classical-music radio station in February 1980. Her curiosity aroused, she enrolled in the week-long parenting course, sight unseen. Today she is one of the institute's staunchest advocates. "I just wish I had been taught everything in my life the way the Better Baby Institute teaches it," Cianfrani declares.

Doman and his staff claim they can turn curious parents into teachers who can instruct their very young children to read, play the violin, solve simple arithmetic problems, speak several foreign languages, identify works of art, perform gymnastic feats, and more—all without a magical wand.

"My son can do far more then the average two-and-a-half-year-old," Cianfrani asserts. "He can ingest vast quantities of information quickly. He knows most of the Impressionist painters and their works by sight. It's amazing. What's most amazing is that he thinks I'm as smart as he is," she says, "which is frustrating, because I'm not."

As soon as her child began talking, she reports, he began asking to work on some of the "bits"—the flash card techniques that are a staple of Doman's patterning repertoire. "When I first started working with him, I often thought he was bored with the flash cards. But as soon as he started talking, I realized I just wasn't going fast enough for him. I was boring him with repetition. I now go a lot faster than even the institute recommends."

Cianfrani anticipates problems when her

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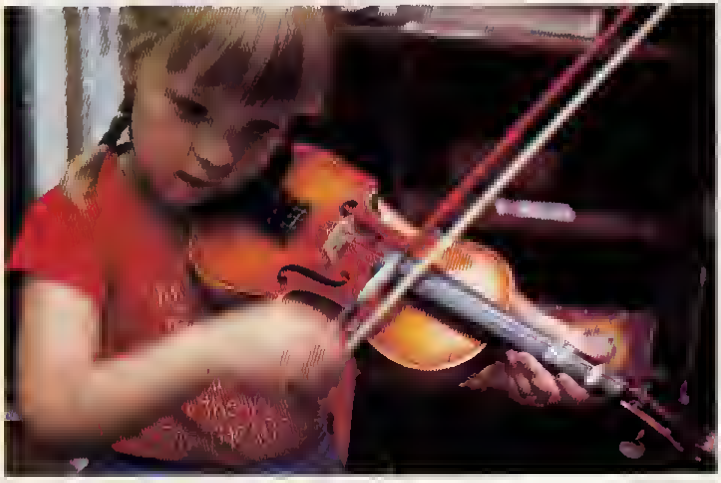


The skills of the child prodigy can be taught to almost any child. The question is: Should they be?

THE BODY

By William A. Nolen, M.D.

On the day that each of us is born we have all the brain cells that we are ever going to have. When we lose a brain cell or neuron it is gone forever. No new brain cell will replace it. It is this fact that makes us live in fear that someday a stroke, injury, infection or degenerative disease may destroy or damage a significant part of our brain.

Sadly, once brain cells have been injured or destroyed, there is no way to repair the damage. The brain cannot regenerate lost cells as the bone marrow can; it can't repair itself as an ulcerated stomach can; it can't be sacrificed with impunity, as the gall bladder or the appendix can; nor can we repair it, as we can the heart. Until very recently the challenge of mending the brain has seemed insoluble.

Now, however, a new approach has been developed. Instead of attempting to heal damaged brain cells, researchers have decided to replace them with new cells that can take over their functions. Previously this procedure had been successful only in lower animals, rats in particular, but some researchers plan to begin work on monkeys, our closest relatives, very soon. And in Stockholm, Sweden, the first experimental transplant of cells into the human brain took place only a few months ago. We are entering a very exciting period in the history of brain repair.

Brain mending may heal an impressive list of conditions. These include Parkinson's disease, Alzheimer's disease (a form of senile dementia), diabetes insipidus (about which, more later), epilepsy, paralyses following stroke, and perhaps even blindness or deafness attributable to brain damage. If we once learn to replace injured brain cells with healthy ones, the possible applications are virtually endless.

To take a closer look at brain mending, I recently flew to Rochester, New York, to spend a day with Don Gash, associate professor of anatomy and brain research at the University of Rochester School of Medicine and Dentistry. Dr. Gash, Richard Wyatt and his associates at the National Institutes of Health, and Anders Bjorklund and Alf Stenevi at the University of Lund, in Sweden, are among the leading neuroscientists working on brain repair.

Gash, who received a Ph.D. in both anatomy and biology from Dartmouth in 1975, teaches anatomy to freshman medical students for two months of the year; for most of the other months he does research. Over breakfast, I asked how he had happened to get interested in brain mending.

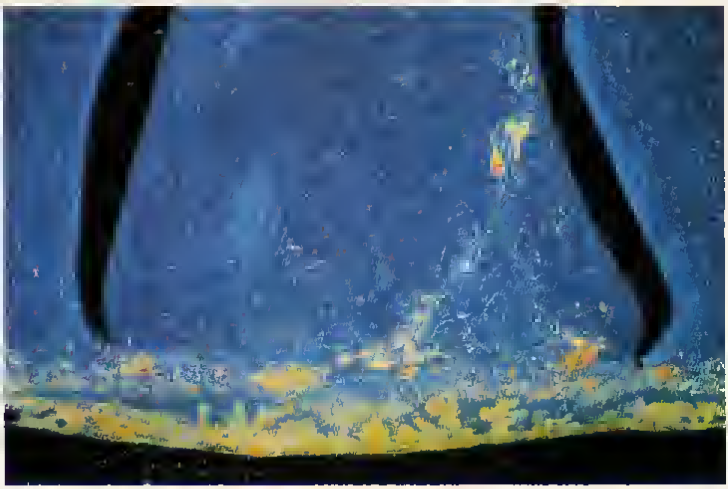
"I had been interested in the idea of brain research even before I came to Rochester in 1976," he replied, "but what actually got me started was a paper in which Anders Bjorklund said that it was possible to transplant fetal brain tissue into young adults.

"I knew that Celia Sladek [a coworker with Gash in brain research] had some Brattleboro rats. So I borrowed four animals from her and transplanted brain tissue. Two of the transplants worked. I've been at it ever since." (The photograph on this page shows one of Gash's transplants.)

The Brattleboro rat, Gash explained, lacks a special type of brain cell, the vasopressin neuron, named for a hormone it secretes. Vasopressin neurons are ordinarily found in two small areas at the base of the brain known as the supraoptic nuclei. Vasopressin is stored in the pituitary gland.

An animal that lacks vasopressin develops a disease called diabetes insipidus. The animal—rat or human—loses the ability to concentrate urine. A rat with diabetes insipidus drinks its weight in water each day; a human thus afflicted may drink and excrete as much as ten gallons a day.

Hope of treating this and other disorders rests on a unique advantage that simplifies brain-transplant surgery. The brain is often called a "privileged organ." Evidence has existed for 50 years that the brain is immunologically tolerant: transplants there are rejected, if at all, at a much slower rate than at other body sites. This is true even of grafts from



Transplanted nerve cells lie between the two dark lines; the host brain lies outside the lines.

unrelated donors and from other species—an important point when one considers possible sources of donor brain

It's difficult to emphasize adequately the importance of the brain's privileged status. In a kidney transplant, for example, it's necessary to match the donor and recipient genetically; usually a living relative—brother or sister—makes the best donor, but, with the exception of identical twins, the genetic match is never perfect.

Because of this, the recipient must take medication to reduce his or her immunity. The recipient must stay on these drugs indefinitely or run the risk that his immune system will destroy the transplanted organ. Eventually, though perhaps not for 10 or 15 years, most organs will be rejected.

In brain transplants, however, no effort has been made to match the rats genetically—donors and recipients have been of different strains—yet no drugs have been required to prevent rejection. If this tolerance is found in human patients—and the evidence so far suggests that it will be—the greatest obstacle to organ transplants will be insignificant in brain mending.

What Gash does is to take from normal rat fetuses—the fetuses of Wistar-Lewis rats, a standard lab animal used in many experiments—small segments of brain containing supraoptic nuclei, rich in vasopressin cells. These tiny pieces of brain tissue are then injected into the brains of five-day-old Brattleboro rats. The young Brattleboro rats are then followed for about 30 days to see how many develop diabetes insipidus, and their brains are examined to see how many vasopressin cells they contain.

On the day I visited his laboratory, Gash operated on two groups of rats. In the morning he did ten transplants, using 19-day-old fetuses—about two days before birth—as donors. In the afternoon the donors were five-day-old rats. In both experiments the recipients were five-day-old Brattleboro rats.

It was delicate work. The brain of a 19-day rat fetus is about three fourths the diameter of a thumbnail and perhaps half an inch thick. The portion containing the supraoptic nuclei is barely visible to the naked eye. Gash operates with eye-surgery instruments while peering through a microscope. His assistant, lab technician Leslie Dick, injected the tiny pieces of brain tissue into the five-day-old Brattleboro rats which she first anesthetized with ether.

Gash and Dick were trying to determine what age donor is best. Gash suspects that younger donors are better, because the less mature tissue requires less oxygen and is more likely to survive while it links to the blood vessels in the recipient's brain.

In most animals, the transplanted tissue survives, healthy vasopressin cells are found in 90 percent of the transplanted rats. Yet only about one rat in four is cured of diabetes insipidus. I asked Gash about this discrepancy.

"We think it's because of the attachments the vasopressin cells make," he answered. "To cure diabetes insipidus they must hook up with a part of the host brain called the median eminence. If they don't, even if they survive, they evidently don't cure diabetes insipidus.

"That doesn't mean the transplants aren't useful, however. There's some evidence that vasopressin cells play a critical role in memory and learning as well as in urine concentration. We're now trying to determine what effect our transplants have on our rats' learning processes, but it's a lot more difficult to measure than is urine output."

I later read a report of a study of vasopressin's effect on learning and memory. The report says that "memory disorders are a frequent complaint in aging people." A gross understatement. The investigators did a study of men from fifty to sixty-five years of age. In tests of attention, concentration, immediate memory, learning, and recognition, the patients who received vasopressin performed significantly better than those who received placebos. The investigators considered these results encouraging and proposed more extensive testing.

"One of the big drug companies is doing mass testing in Europe right now," Gash remarked. "At the moment it seems as if the effect is erratic; some patients are helped, some aren't. There's a lot of work yet to be done."

When Gash had finished operating and the rats had recovered from the ether and were back with their mothers, I asked him what the practical human applications of such work might be. He cited three.

"There's diabetes insipidus, of course," he said. "It's a rare disease and can already be treated with vasopressin, which is easily manufactured. Still, if vasopressin neuron transplants were feasible, that would be another way to treat it. And if the apparent relationship of vasopressin to memory and learning stands up, that will widen the application enormously.

"Then there's Alzheimer's disease. Estimates are that at least six percent of the twenty-five million people over sixty-five have senile dementia of the Alzheimer type. Personally, I think that's a low estimate.

"There is evidence that the problem lies in a part of the brain called the nucleus basilis. Ordinarily it is rich in cholinergic neurons, which produce the chemical acetylcholine. In patients with Alzheimer's disease, most of these cells are lost. If it's the loss of these nerves that causes the problem, we might ease Alzheimer's disease and senile dementia by transplanting cells from the nucleus basilis.

"A third condition," Gash continued, "is Parkinson's disease. Right now it seems likely that this will be the first human disorder to be treated by brain transplantation. Parkinson's disease is caused by a loss of cells that produce dopamine from the substantia nigra of the brain. Richard Wyatt and Anders Bjorklund have both created Parkinson's disease by damaging special areas in the brains of rats, and they corrected the disease by transplanting brain tissue from fetuses.

"Cells from the adrenal gland [next to the kidneys] also produce dopamine, and it's possible that they can be used to correct Parkinson's disease," he added.

Within a few weeks after I met with Gash, the first such transplant was in fact

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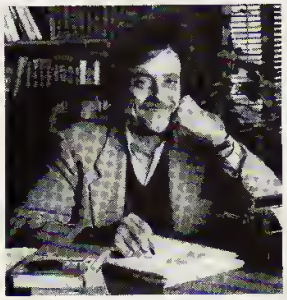
Scanning electron micrograph reveals surface features of cells growing in a transplant recipient

How to write with style

By Kurt Vonnegut



International Paper asked Kurt Vonnegut, author of such novels as "Slaughterhouse-Five," "Jailbird" and "Cat's Cradle," to tell you how to put your style and personality into everything you write

Newspaper reporters and technical writers are trained to reveal almost nothing about themselves in their writings. This makes them freaks in the world of writers, since almost all of the other ink-stained wretches in that world reveal a lot about themselves to readers. We call these revelations, accidental and intentional, elements of style.

These revelations tell us as readers what sort of person it is with whom we are spending time. Does the writer sound ignorant or informed, stupid or bright, crooked or honest, humorless or playful – ? And on and on.

Why should you examine your writing style with the idea of improving it? Do so as a mark of respect for your readers, whatever you're writing. If you scribble your thoughts any which way, your readers will surely feel that you care nothing about them. They will mark you down as an egomaniac or a chowderhead – or, worse, they will stop reading you.

The most damning revelation you can make about yourself is that you do not know what is interesting and what is not. Don't you yourself like or dislike writers mainly for what they choose to show you or make you think about? Did you ever admire an empty-headed writer for his or her mastery of the language? No.

So your own winning style must begin with ideas in your head.

1. Find a subject you care about

Find a subject you care about and which you in your heart feel others should care about. It is this genuine caring, and not your games with language, which will be the most compelling and seductive element in your style.

I am not urging you to write a novel, by the way – although I would not be sorry if you wrote one, provided you genuinely cared about something. A petition to the mayor about a pothole in front of your house or a love letter to the girl next door will do.

2. Do not ramble, though

I won't ramble on about that.

3. Keep it simple

As for your use of language: Remember that two great masters of language, William Shakespeare and James Joyce, wrote sentences which were almost childlike when their subjects were most profound. "To be or not to be?" asks Shakespeare's Hamlet. The longest word is three letters long. Joyce, when he was frisky, could put together a sentence as intricate and as glittering as a necklace for Cleopatra, but my favorite sentence in his short story "Eveline" is this one: "She was tired." At that point in the story, no other words could break the heart of a reader as those three words do.

Simplicity of language is not only reputable, but perhaps even sacred. The *Bible* opens with a sentence well within the writing skills of a lively fourteen-year-old: "In the beginning God created the heaven and the earth."

4. Have the guts to cut

It may be that you, too, are capable of making necklaces for Cleopatra, so to speak. But your eloquence should be the servant of the ideas in your head. Your rule might be this: If a sentence, no matter how excellent, does not illuminate your subject in some new and useful way, scratch it out.

5. Sound like yourself

The writing style which is most natural for you is bound to echo the speech you heard when a child. English was the novelist Joseph Conrad's third language, and much that seems piquant in his use of English was no doubt colored by his first language, which was Polish. And lucky indeed is the writer who has grown up in Ireland, for the English spoken there is so amusing and musical. I myself grew up in Indianapolis, where common speech sounds like a band saw cutting galvanized tin, and employs a vocabulary as unornamental as a monkey wrench.

"Keep it simple. Shakespeare did, with Hamlet's famous soliloquy."

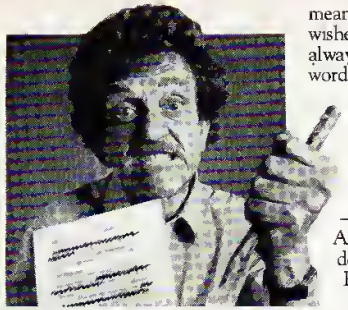
In some of the more remote hollows of Appalachia, children still grow up hearing songs and locutions of Elizabethan times. Yes, and many Americans grow up hearing a language other than English, or an English dialect a majority of Americans cannot understand.

All these varieties of speech are beautiful, just as the varieties of butterflies are beautiful. No matter what your first language, you should treasure it all your life. If it happens not to be standard English, and if it shows itself when you write standard English, the result is usually delightful, like a very pretty girl with one eye that is green and one that is blue.

I myself find that I trust my own writing most, and others seem to trust it most, too, when I sound most like a person from Indianapolis, which is what I am. What alternatives do I have? The one most vehemently recommended by teachers has no doubt been pressed on you, as well: to write like cultivated Englishmen of a century or more ago.

6. Say what you mean to say

I used to be exasperated by such teachers, but am no more. I understand now that all those antique essays and stories with which I was to compare my own work were not magnificent for their dated-ness or foreignness, but for saying precisely what their authors meant them to say. My teachers wished me to write accurately, always selecting the most effective words, and relating the words to one another unambiguously, rigidly, like parts of a machine. The teachers did not want to turn me into an Englishman after all. They hoped that I would become understandable – and therefore understood. And there went my dream of doing with words what Pablo Picasso did with paint or what any number of jazz idols did with music. If I broke all the rules of punctuation, had words mean whatever I wanted them to mean, and strung them together higgledy-piggledy, I would simply not be understood. So you, too, had better avoid Picasso-style or jazz-style writing, if you have something worth saying and wish to be understood.

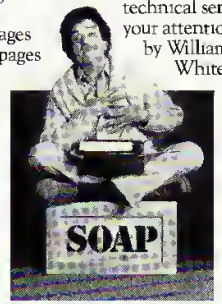


Be merciless on yourself. If a sentence does not illuminate your subject in some new and useful way, scratch it out.

Readers want our pages to look very much like pages they have seen before. Why? This is because they themselves have a tough job to do, and they need all the help they can get from us.

7. Pity the readers

They have to identify thousands of little marks on paper, and make sense of them immediately. They have to *read*, an art so difficult that most people don't really master it even after having studied it all through grade school and high school – twelve long years.



Pick a subject you care so deeply about that you'd speak on a soapbox about it."

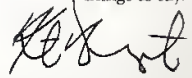
So this discussion must finally acknowledge that our stylistic options as writers are neither numerous nor glamorous, since our readers are bound to be such imperfect artists. Our audience requires us to be sympathetic and patient teachers, ever willing to simplify and clarify – whereas we would rather soar high above the crowd, singing like nightingales.

That is the bad news. The good news is that we Americans are governed under a unique Constitution, which allows us to write whatever we please without fear of punishment. So the most meaningful aspect of our styles, which is what we choose to write about, is utterly unlimited.

8. For really detailed advice

For a discussion of literary style in a narrower sense, in a more technical sense, I commend to your attention *The Elements of Style*, by William Strunk, Jr., and E.B. White (Macmillan, 1979). E.B. White is, of course, one of the most admirable literary stylists this country has so far produced.

You should realize, too, that no one would care how well or badly Mr. White expressed himself, if he did not have perfectly enchanting things to say.



THE ARTS

By Ray Bradbury

This must be an intensely personal review It can't help being such, for Anthony Boucher and 'Mick' McComas were intensely personal editors and friends of mine Also, I'm breaking one of the cardinal rules of book reviewing One is not supposed to review a book in which he himself has a story Consider the rule broken McComas and Boucher this late in time deserve a reconsideration, and a rededication by all the readers and lovers of their *Magazine of Fantasy and Science Fiction*

John W Campbell was the father of the supreme Golden Age of science-fiction writing that began in the late Thirties when he took over the editorship of *Astounding* magazine He brought an incredible variety of new talent into the field including A E Van Vogt Robert Heinlein Arthur C Clarke Isaac Asimov, and a host of others And each in his own way had a flair for science and storytelling

But there were some writers coming of age at that time who didn't quite fit the intellectual and scientific mold that Campbell insisted on for his writers We were left behind on the shore with our smaller concepts our less scientific and more human way of looking at things We were often guilty of preferring fantasy to science fiction We all knew Campbell and admired him and the work he was doing but we couldn't get hired for banth-catcher on Mars

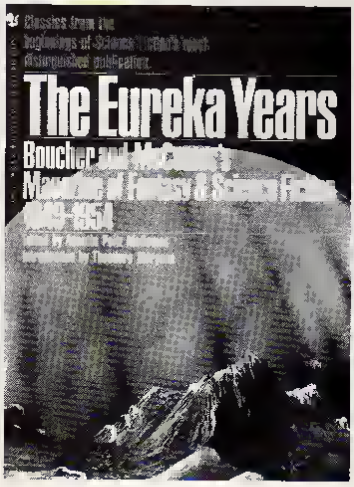
Boucher and McComas good editorial souls hired us Put up with some of us is more like it. If you read the letter exchange reprinted in *The Eureka Years* (Bantam, $3 50) a collection of notes that passed back and forth between these two editors and me you will find a very naive and untried young writer being firmly criticized but lovingly encouraged by Tony and Mick They did the same for many others

The Eureka Years then is a collection of stories that simply couldn't have been accepted and published anywhere else in America, not only in the science-fantasy world, but also in that great snobbish land of little magazines many of which were sponsored by the best universities or the richest part-time editor-publishers

In out of the cold came Philip K Dick, Richard Matheson Reginald Bretnor, and Ron Goulart Some others, like Asimov and Theodore Sturgeon could please Campbell part of the time but occasionally they wanted to speak with a more private and personal tongue McComas and Boucher gave them a small but very special hearing

The Hurkle Is a Happy Beast' by Sturgeon is a case in point It might have found a home for itself back in the days of Campbell's *Unknown Worlds* magazine But in the great noncaring nonfantasy-oriented publishing world of the Fifties it is hard to imagine any editor giving a sympathetic reading to this Lewis Carroll–oriented myth about a blue hurkle let alone believe an editor would buy it McComas and Boucher greeted this offbeat story with glad cries

In my own case The Exiles is a story of the ghosts of famous authors



Bantam collection Masterpieces remembered

(Ambrose Bierce, Edgar Allan Poe L Frank Baum, Charles Dickens among them) making a last brave stand on Mars while their final books burn and the memory of their greatness dies Imagine *that* being published in any science fiction magazine 32 years ago!

Let's face it Boucher and McComas saved a lot of lives and a lot of careers during their brief time as editors Their influence is still felt today of course in such magazines as *Omni*. The writers they encouraged, me among them survived and prevailed

At long last that empty place on your library shelf where a partial history of science fiction and fantasy was missing is now filled *The Eureka Years* drops into that place to stay to perpetuate the memory of those two brilliant gentlemen who meant so much to the science-fiction field and to pay them the honors they so richly deserve

One final totally personal note I knew McComas well but Boucher even better. Whenever I hit San Francisco Tony and Phyllis his lovely wife who sang with the San Francisco Opera Chorus, used to head for the nearest opera bar We went to drink the night away and weep and applaud Puccini and Verdi as sung by young tenors or sopranos on their way up in that sweet crazy and unappreciated world Those nights the music and the conversations that went with them remain in my recollection of them as marvelous and unforgettable For my wife and me when Anthony Boucher died most of San Francisco Oakland, and Berkeley fell over into the Bay When McComas died some time afterward the rest of their world followed Going north from Los Angeles to visit has never been the same for me since

If you read *The Eureka Years* I'm sure you will agree with Theodore Sturgeon that God did a bad script-writing job when he wrote Anthony Boucher out of our lives and then let Mick McComas follow We need them today

Many thanks to Annette Peltz McComas for bringing them back to us in this handsome literary Time Machine. ∞

THE ARTS

By Mitch Tuchman

The American housewife tidies the cots in her family's fallout shelter while her children practice "duck and cover" beneath their desks at school. "Take heart," the government admonished in a series of Cold War–era Civil Defense instructional films, "you can survive a nuclear war. Just find a hole, and make like a mole." Compiling these ignominious "antiques" in the light of later knowledge—and bigger bombs—Lance Bird and Tom Johnson conclude that there really is *No Place to Hide*.

Hollywood notwithstanding, Washington, D.C., has long been this country's film capital. Periodically movies with titles such as *One World or None* and *Public Shelter Living* are slated for retirement as obsolete. From Civil Defense offices, government archives, and a flea market Bird and Johnson rescued overlooked prints. They spliced portions together with a smidgen of network news footage and with an RKO short. *You Can Beat the Bomb*, they created their half-hour, charred-black comedy. Here is a sample from the soundtrack:

"The bomb might explode when there are no grown-ups near. Paul and Patty know this, and they always try to remember what to do if the atom bomb explodes right then."

[*A bright flash of light*]

"It's a bomb! Duck and cover!"

"Here's Tony going to his Cub Scout meeting."

[*Flash*]

"Act fast!"

"Attaboy, Tony. Crouch on the sidewalk with your hands over your head. Surely that will prevent your being incinerated in a 4000° fireball."

Here are the complacent folk of St. George, Utah. Their radios tell them that a wee bit of radiation from an atomic-bomb test in nearby Nevada is drifting their way. "Don't worry, Mom," the narrator reassures. "The kids are safe at school." Safe, but 20 years later John Wayne, Susan Hayward, Agnes Moorehead, and Pedro Armendariz, who were filming *The Conqueror* near St. George at that time, are all dead of cancer.

Nuclear Age movies: Vast indictments of the government's misplaced values

Was there something these government films were not telling us?

Other documentaries (never intended for double bills with these nonchalant spirit boosters) show government studies of structural damage during nuclear attack: plywood houses engulfed in flame, clapboard houses disintegrating, vehicles tossed about like tumbleweed.

Bird and Johnson set out in 1976 to make a feature documentary, a postwar stock-footage sequel to their Depression-era compilation, *America: Lost and Found*. The government's campaign to foster the construction, first of bomb shelters and later of fallout shelters (having admitted that the former were futile) was to have been a recurring motif. Eventually they opted for a shorter, more sharply focused film. By judicious interweaving of their found materials, they contrast the government's relentless drive to advance nuclear destructiveness with its halfhearted, intermittent, and duplicitous efforts to retard nuclear devastation. *No Place to Hide* is a profound indictment of those misplaced government values.

Brothers Kevin and Pierce Rafferty and Jayne Loader set out in the same year as Bird and Johnson to compile a feature documentary about propaganda: what it is, how it works. The challenge was to use as many entries in a voluminous catalog of government surplus films as possible: worker-motivation films, efforts of the U.S. Information Agency to promote our image abroad, bomb shelter exhortations, and similar productions. Having cut a half-hour pilot, having found it remote from their personal political concerns, having failed, furthermore, to raise funding, they, too, narrowed their focus. The military archives were the richest, the lies stored there the most blatant. Ninety minutes long, their film, *The Atomic Cafe*, shares weaponry and Civil Defense footage with *No Place to Hide* while it documents the pervasive spread of atomic imagery throughout our culture.

The magnitude of their enterprise is astonishing. One shot out of 1,000 of those screened in various archives was chosen.

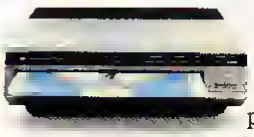
CONTINUED ON PAGE 186

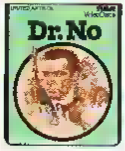
HINT #16 FROM RCA VIDEODISCS

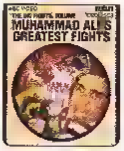
HOW TO IMPROVE YOUR SOCIAL LIFE:

If you're leaving singles bars still single, if you're getting nothing but healthy at the local health club—take heart.

With the magic of the RCA VideoDisc System, you'll have great opening lines to help you make new friends. Like, "Want me to show you my Bogart collection?" Or, "Rod Stewart? He's at my place!" Or even, "Like to come over and watch me play *Superman*?"







RCA VideoDiscs can satisfy even the most demanding women. Show *Airplane* to get things off the ground with Gloria. Use *The Godfather* to make Donna an offer she can't refuse. Mix it up with Stacey over *Stir Crazy*. Get Patty to say "yes" to *Dr. No*.

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And if you need a break from all your new-found popularity, have a night in with the boys to watch Muhammad Ali or *Dirty Harry*.

See your nearest RCA dealer now and find out just how much magic you can bring home.

What you do after that is up to you.

RCA VideoDiscs
Bring the Magic Home

THE ARTS

By Michael Schrage

Twenty-eight years old, Todd Siler is having a great deal of fun remapping the boundaries between the aesthetic and the cerebral cortex. His work ranges from classical pen-and-ink sketches to complex technological constructions. Siler's fellowship at the Center for Advanced Visual Studies at Massachusetts Institute of Technology lets him research the neurophysiological dynamics that power his Cerebreactors.

Cerebreactors are surrealistic models of the mind: depictions of the human nervous system as an organic linear accelerator, with the spinal cord as conduit and the brain as a reactor chamber, where subatomic particles tumble into energy fields that shape the pattern and substance of thought. Nuclear physics becomes neurophysiology. Cerebral fission, he says, is analytical reasoning; cerebral fusion is intuition.

The metaphor is crudely simplistic, of course, and Siler has already modified his Cerebreactors to incorporate more of the chemical processes of the brain.

The model is a mathematical equation, says Siler, who holds a Master of Science degree in visual studies from MIT. Various parts of the construction explain the workings of both systems without being either of the two. For example, the copper rods represent the amount of electrical activity; the graduated cylinders represent the chemical activities. "Just as the physicist can go to the blackboard to explain something complex, I can go to my paper."

Siler's art is as much a part of his research as it is a means of visual expression. "Todd's not asking questions that are necessarily relevant within the scientific tradition," says Professor Robert Kuhn, whose academic background is neurophysiology and psychology. "He's asking questions beyond that. The whole issue is an extremely profound one: the melding of art and science for a higher purpose. To look for the deep structural concepts of the mind."

Siler is dynamic, almost manic, in his prolific generation of images and ideas around Cerebreactors. He draws upwards of 100 sketches a week, although "some weeks," he says, "I might only read neurophysiology texts and gestate for a while."

The art itself appears as fantastical blueprints. The various parts of a Cerebreactor are carefully labeled and described. Photographs, aluminum foil, string, and plastic wrap are occasionally collaged across a canvas. The effect is a casual, textured image of something that looks as if it might exist. Cerebreactors seem to be technology and tissue all at the same time, and the little explanatory notes lend them a textbookish quality. There's no question that they are rough cuts in the process of being refined to a more precise portrayal of brain and mind.

"Since I was fourteen," Siler says, "I've always been doing projects. I did one on what makes the heart contract, by looking at the contractor vacuole of a paramecium. I loved biology. Biology was really the key, the link, for me. Art and science were opposites then. I would never mix them."

So Siler proceeded on parallel paths with his interests in science and art, but he would never let them touch. "In 1979, however, I was reading some work in neurophysiology texts on the side while doing some work in nuclear physics," he recalls. "Two of the books were lying side by side, and I noticed similarities in the fields in the brain and in fusion." This was the genesis of Cerebreactors. "Art was the language that I felt overlapped both interests," he continues. "Science is illustrative, art interpretive. I felt what I was producing—any kind of physical rendering—was scientific. Art may well be a relaxed moment of science. Art speculates, but science investigates, and I was searching for a more complete artistic/scientific paradigm."

He introduced the idea of a conceptual "mirror" as a tool to express the link between art and science as well as that between brain and mind. "Things had never been explained in terms of mirror reflection before," he says. "The mirror

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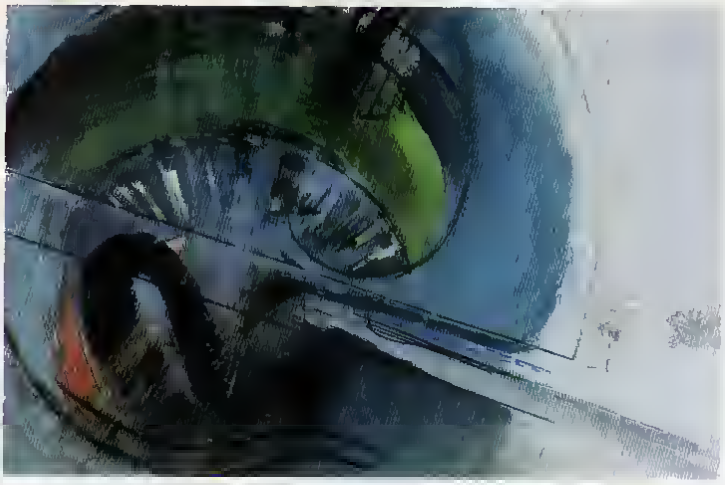


Siler's Cerebreactors: Aesthetic interrelationships between brain and nuclear-power plants

SOLAR BREEDERS

BREAKTHROUGHS

By Michael Edelhart

This autumn the Solarex Corporation, of Rockville Maryland, plans to dedicate a factory that can almost reproduce itself.

Solarex, the largest manufacturer of solar photovoltaic cells—the tiny crystalline chips that convert sunlight to electricity—broke ground last October for a 26,000-square-foot factory that will use energy produced by banks of solar cells to create new solar cells—a process in which the factory constantly replenishes itself.

Called the solar breeder by Solarex founder and president Dr. Joseph Lindmayer, fifty-three, the factory is designed to cut the high cost of creating photovoltaic cells by eliminating the plant's monthly electric bill. The solar plant won't be connected to the industrial power grid at all. The only power besides the solar-electric system will be a small diesel generator for emergencies. Lindmayer predicts that the $6 million initial cost of the plant will be recouped in ten years, while the plant will continue making solar cells for years beyond that.

The idea for the solar breeder came to Lindmayer in 1974, during the Arab oil boycott and at the height of the debate over nuclear breeder reactors. "In a nuclear breeder," Lindmayer considered, "you eventually run out of fuel. It's not a true breeder. A true breeder is one that doesn't run out of fuel." A photovoltaic plant that derived its energy from solar cells, he reasoned, would be a true breeder because it would generate its energy with the same equipment it built.

The factory's south wall, tilted 40 degrees from the vertical, receives the most direct sunlight. It is covered with 3,120 large panels, each containing 72 photovoltaic cells. These 224,640 cells cost $3 million. The other half of the factory's investment will be put into construction and outfitting.

When up and running, Solarex figures, the plant will produce 1,000 solar cells an hour, more than 2 million each year. Each generates a little less than a watt of power.

Solarex believes that photovoltaic cells with an 11- to 15-year life span can already beat utility rates for residential electricity—3 cents a solar kilowatt compared with 8 cents per utility kilowatt in Maryland. Solar cells require a large front-end outlay to buy the hardware, however, which damps their appeal.

But Lindmayer is optimistic. He is already making plans to sell 25,000-square-foot solar voltaic plants to other industries. "Just as we have prefabricated housing," he asks, "why can't we have a prefabricated industrial building with the power attached?"

Solarex photovoltaic cells gather energy from the sun to power their own reproduction

NEW PRODUCTS

The world's first one-man hot-air balloon has a Kevlar and stainless steel harness that can support up to 210 pounds. Small and light enough to stow in the trunk of a car, the Cloudhopper carries a ten-gallon propane-fuel tank that will keep it aloft for about an hour. Prices range from $5,000 to $5,500, depending on the size of the hot-air envelope (14,000, 17,000, and 21,000 cubic feet). (The Zenit Company, 4630 Arcady Avenue, Dallas, TX 75209.)

The Personal Electronic Printer EP-20 is a battery-operated portable typewriter barely larger than a pad of typing paper. It measures just 12 inches across, 8.75 inches deep, and 1.75 inches high and weighs about five pounds, so it can easily be toted in a briefcase. The typewriter, which features calculator functions, incorporates a thermal printer. It can also type on a microcassette-sized carbon ribbon. The Personal Electronic Printer will be available this fall for about $200. (Brother International Corporation, 8 Corporate Place, Piscataway, NJ 08854.)

A ten-inch-tall desktop robot from Mitsubishi Electric shuffles papers and answers the phone. Its jointed arm, with a clawlike hand capable of five different motions, is controlled by a personal computer. The RM-101 Microrobot sells for about $2,400. (Mitsubishi Electric Sales America, Inc., 3030 East Victoria St., Rancho Dominguez, CA 90221.)

EXPLORATIONS

By Norv Brasch

O'Hare Tower: United Two-thirty-six, cleared for takeoff.
Copilot: Vee one. Vee R. Vee two.
Flight engineer: Looks like we lost hydraulics—quantity and pressure.
Copilot: The gear is not up, sir. We just lost hydraulics. Do you want to declare an emergency?
Captain: Hell, may as well.

The motion, the noises, the tension, even the ensuing airsickness are real. But Flight 236 from Chicago to Cleveland has never left the ground at Denver's United Airlines Flight Training Center. The cockpit is a flight simulator, a perfect replica of a DC-8 flight deck perched on mechanical arms that pitch and roll the crew at the command of a computer. The illusion is so effective that experienced pilots often emerge drenched in sweat and utterly exhausted.

You can crash in a simulator and the only thing that's bruised is your ego, says John Ferguson, a former TWA captain who now works for the National Transportation Safety Board (NTSB). Besides being cheaper and safer than training flights, simulators give the crew an opportunity to cope with mechanical problems no one would wish to encounter in the air. At the touch of a button, the instructor can confront the crew with a variety of difficulties, everything from an engine fire to severe turbulence.

A visitor at the training center will see United's fleet of 15 simulators, lined up like a colony of huge mechanical insects. The sight of a model cockpit coughing and turning on mechanical appendages seems absurd. Yet the sensation of flight is frighteningly real to the crew inside. Electronic simulation has become so sophisticated that a pilot can be certified for advanced flying techniques without ever carrying a single passenger.

Advances in simulator technology have been matched by a dramatic improvement in airline safety. But a stubborn statistic continues to plague the industry. In the last ten years, nearly 60 percent of airline crashes have resulted, at least in part, from a poor use of human resources in the cockpit. The problem is not so much pilot error as a lack of coordination among the crew members.

The scenario has been repeated in several crashes. A mechanical problem develops in flight. The crew becomes engrossed in solving the problem and no one flies the airplane. What begins as a mishap results in disaster.

A broken indicator light sealed the fate of an Eastern Airlines Lockheed 1011. On its approach into Miami International Airport, a landing-gear light failed to illuminate. The entire crew, including the captain, attempted to troubleshoot the problem, even sending the engineer into the electronics bay to attempt an in-flight repair. Meanwhile, the plane descended from its authorized altitude of 2,000 feet, dropping perilously toward the swampland below. "We did something to our altitude!" the copilot exclaimed when he realized the deviation. Seven seconds later, the plane crashed into the Everglades, killing 101 people.

An accident in 1978, which killed ten people, taught United Airlines a similar lesson. As Flight 173 approached the Portland, Oregon, airport, the right main landing gear appeared not to be locked into position. The captain decided to circle the airport, burning his excess fuel and thereby reducing the risk of fire on touchdown. In the holding pattern, passengers were instructed to prepare for an emergency landing. But while the crew assessed the gravity of the malfunction, no one watched the fuel gauge. Just six miles short of the runway, the kerosene-starved engines flamed out. Flight 173 crashed in a Portland suburb, its landing gear locked in position all along.

In each of these cases, the accident was avoidable and the plane could have landed despite the mechanical problem. The engineer on the Portland flight expressed some passing concern over the diminishing fuel supply, but his warning fell on deaf ears. By the time the captain fully appreciated the problem, a crash was inevitable. In its accident report, the NTSB deplored the lack of

CONTINUED ON PAGE 188

The strikingly true-to-life view from inside the cockpit of a United Airlines flight simulator

CONTINUUM

Edited by Dick Teresi

ALLERGIC TO LIFE

Ten years ago physicians could find no physical cause for Harriett Molloy's pain exhaustion and depression So they called her neurotic a hypochondriac But Molloy doesn't accepf these tags, and neither does a new group of practitioners who call themselves clinical ecologists To them Molloy is like the canary in the mineshaft an ultrasensitive victim of an increasingly polluted environment

As the clinical ecologists tell it, our internal defense sysfems can'f handle the world that we've created It's not the big assaults they worry about so much, not the chemicals that everyone knows will poison us mutate our genes or cause cancer It s those little insults they believe we get from swathing ourselves in polyester or sipping disodium guanylate in our chowder those barely noticeable fumes from no-wax floors, office copiers and perfumes even common foods we eat too much of

Dr Theron G Randolph ot Chicago, a founder of clinical ecology and Molloy s physician, attributes a vast array of ills to "allergies' caused by fhese silent insults nausea, diarrhea headaches blurred vision dizziness, fatigue confusion cramps wobbly knees asthma fevers, "brain fag ' anxiety schizophrenia arthritis alcoholism Probably ninety percent of people have some kind of sensitivity—to a soap or cleaning agent that makes their eyes water or their skin itch to some food that makes them sleepy, ' says ecologist Dr Alfred Johnson of the Environmental Health Center in Dallas

In hypersensitive people the ecologists say an overload can put them over the edge Molloy dates the decline in her healfh to an injection of red dye dunng X-ray studies almost a decade ago Years of tests, drugs and psychiatric treatment brought no relief Then a psychiatrist sent her to Dr Randolph

He admitted her to his ecology cenfer ' one of half a dozen such manmade oases in the United States where fhe afflicted of several nations have come to detoxify ' Behind the double glass doors is a special world of aluminum wallpaper ceramic tile, and filtered air where floors are scrubbed with baking soda Plastics, synthetic fabrics cigarettes, cosmetics and cleaning fluids are banned Books are isolated in glass boxes and pafients reach in with gloves to turn the pages

After resting and fasting until her symptoms disappeared, Molloy was introduced fo foods and chemicals one at a time to find out which provoked symptoms For some patients, the list of apparent sensitivities calls merely for a change in diet but for Molloy it meant a change in job home and life-sfyle

At first she tried moving, with her husband and two children to a home that had natural fiber carpets and fewer chemicals "But you can f tell the neighbors not to paint the garage or come to the door wearing perfume " she says Today at fifty four she lives in a cottage in the hills east of San Diego just north of the Mexican border, an unpolluted place where at leasf a dozen other ' chemies,' as they call themselves, have taken refuge

If Molloy is convinced fhat chemicals are the source of her problems researchers in allergy and immunology are not Ecologists provoke from them the same response laetrile elicits from oncologists "More a religious cult than science is the verdict of Dr David A Mathison head of the immunology and allergy division at San Diego s Scripps Clinic and Research Foundation Dr Mathison and other researchers see the ecologists' patients as gullible people seeking external causes for their inability to cope with the world The American Academy of Allergy considers ineffective or unproven the methods used by some ecologists—urine injecfions and dropping diluted chemicals under the tongue

The ecologists' case is not aided by their inability to explain how seemingly harmless foods or faint whiffs of chemicals can wreak all this havoc Allergies In the fraditional sense, involve a detectable immune response, namely production of IgE antibodies Buf might there be some other mechanism for allergic reactions? A growing number of researchers think it s time someone took a look

"For me it s an open issue, says Dr Ted Kniker, head ot immunology and allergy at the University of Texas Health Science Center In San Antonio I have seen pafients who fit info this pattern Now he s looking for eczema patients whose symptoms seem to be caused by foods or chemicals The next step to look for the biochemical basis of their reactions

Meanwhile allergy patient Molloy faces the world when she needs to with an oxygen tank strapped to her back and a beanbag of coconut charcoal held over her nose Everybody has a theory about what's 'wrong with us she says I just try to live my life one day at a time —*YVONNE BASKIN*

CONTINUUM

WATER MUSIC

They float weightlessly, eyes closed, listening to music only they can hear. Some say the sounds put them in touch with their very souls.

These floaters are enjoying an underwater concert of music composed by Michel Redolfi, who first noticed the haunting rhythms of the sea while swimming through the Pacific.

Spurred by that fateful swim, San Diego composer Redolfi decided to see whether he could devise a new, aquatic art form based on sending underwater melodies to volunteers in submersion tanks.

He played a variety of music for his listeners and soon learned that most enjoyed medium- to high-pitched, rhythmless melodies similar to whale sounds. His test subjects said the music seemed to penetrate their bones, with sounds coming "from the center of the head no matter where in the water they were.

With this feedback in mind, Redolfi composed reams of aquatic music. And today he plays his organlike synthesizer near pools in the United States, Canada, and France. The sounds come from floating, blue vinyl speakers that have tentacles like jellyfish. Festooned with mirrors, the tentacles send light as well as sound through the heated pools.

Some listeners stay underwater for minutes at a time, Redolfi says. Others report strange prebirth or postdeath experiences. "Each century has a special architecture for listening," he adds, "whether a concert hall for an orchestra or a cathedral for an organ. The concert hall of the future may be the municipal pool. —Douglas Starr

"To restore silence is the role of objects."
—Samuel Beckett

The sounds from Michel Redolfi's synthesizer are transmitted into swimming pools through floating, tentaclelike vinyl speakers.

KRAZY GLUE CURE

Krazy Glue, the stuff that mends broken china and at least a thousand household items, is now being used by doctors to seal off abnormal, leaky blood vessels in the brain. The therapeutic Krazy Glue, developed by radiologist Charles Kerber, of the University of San Diego, is exactly like the commercial product except that its molecules have an extra carbon atom. It's just as sticky, Kerber says, but less irritating to human tissue.

The condition that Kerber treats, known as arterio venous malformation, results when fragile blood vessels with extremely thin walls clog the brain. Several hundred thousand Americans with the malformation suffer severe headaches. They live in fear of the day their vessels will burst, causing brain hemorrhage and death. Until now the only recourse was to remove the vessels with risky brain surgery.

But Kerber has done away with the need for surgery. He injects the glue into 150 centimeters of flexible silicone tubing that runs through the body's arteries from the leg to the brain. The glue flows freely through the tube, whose tip is adjacent to the damaged blood vessels and hardens upon contact. Once stopped up with glue, the vessels become harmless.

Kerber has already treated more than 100 patients with Krazy Glue and he has been successful in all but four instances. One patient died and three had strokes. Five other radiologists in this country also use the procedure. —Eric Mishara

Brain blood vessel: Thin walls can cause severe headaches.

AUTO TALK

John Phillips made headlines in 1976 when he designed a $2,000 atomic bomb for his thesis while in his junior year at Princeton University. Now he has designed a talking dash board computer for cars. The new automotive copilot developed by Phillips and his brother Dean, an electrical engineer, monitors such things as fuel level, brake performance, and keys left in the ignition. Its polite female voice, synthesized by a National Semiconductor computer chip, makes brief comments like "Please check your oil" over the radio speaker.

What's next? The Phillipses and their company, Anstotle Inc., are already planning a talking ticker (not a quotable bomb, but the world's first vocal ticker tape machine). —Phoebe Hoban

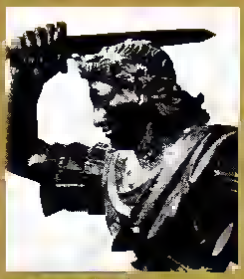
DAMASCUS STEEL

Alexander the Great is believed to have worn a sword made of Damascus steel more than three centuries before Christ was born. For Westerners though, the manufacture of these invincible carbon-steel blades, crafted by Persians, remained an elusive black art. Now metallurgists Oleg Sherby of Stanford University and Jeffrey Wadsworth from the Lockheed Corporation say they have inadvertently unlocked the secret.

Working together, the two California scientists developed a method of molding heated iron-carbon compounds to form intricate objects such as automotive gear sprockets. When cooled to room temperature, the objects were transformed into a tough carbon-steel.

The scientists thought they had hit upon a new idea until Sherby mentioned the material at a meeting of metallurgists. 'Someone in the audience stood up,' Sherby recalls, 'and said, I think you may have rediscovered how to make Damascus steel.'

Inspired by the comment, Sherby and Wadsworth decided to investigate. Examining microscopically enlarged photographs of Damascus blades in museums, the researchers observed a carbon-steel strikingly similar in structure and content to their own. Then the metallurgists discovered that the Persians had heated the blades at



Alexander the Great. His sword may have been reinvented.

relatively low temperatures—less than 1650° F—much as they themselves did. Finally, the two California researchers realized that the Persians even had a cooling technique, quenching the red-hot blade in the belly of an unfortunate slave. "They may have believed in psychoenergetics," Sherby suggests, 'and thought the strength of the living slave transmitted into the inanimate object of steel.' (Sherby and Wadsworth do not use this method.)

Although made in Persia, Damascus steel blades were actually named for the Syrian city where European travelers first saw them.

—Eric Mishara

Never argue with a man who buys ink by the barrel."
—Bill Greener

"A learned blockhead is a greater blockhead than an ignorant one."
—Benjamin Franklin

'The best thing is to sleep dead drunk on the beach.'
—Arthur Rimbaud

WATERBEDS CURE BEDSORES

Decubitus ulcers—bedsores—lead to complications that kill 60,000 Americans each year, more than are killed on the highways. Yet there is a simple way to prevent bedsores: Sleep in a waterbed.

Capillary pressure against the skin reduces local circulation when a body is resting. Normal people toss, turn, and squirm when this occurs, relieving the pressure. Long-term bedrest patients cannot do this, and even when they're moved several times a day, they often develop bedsores. The even pressure and temperature control of waterbed flotation systems can both prevent and cure these sores, according to the *American Journal of Physical Medicine*.

Unfortunately, ' says Tate Scott, of Ultratherm, a waterbed manufacturer with Food and Drug Administration (FDA) approval to make medical claims for its product, "third party reimbursers [medical insurers] won't pay for preventative care." Of the 2,500 products for bedsores, fewer than 300 are preventatives, Scott says. Treatment of bedsores, though, annually eats up 3 percent of the national health-care budget. This goes for such things as sheepskins, lotions, and hospital help to turn patients regularly.

Scott notes that several other health advantages of waterbeds are now being explored. "They're sanitary. Studies have shown they reduce infections significantly. They're being used to help burn victims, premature infants, and people with back problems."

—Allan Maurer

'You cannot endow even the best machine with initiative; the jolliest steamroller will not plant flowers.'
—Walter Lippmann

Patient on waterbed. The even pressure and temperature control of waterbed flotation systems can help prevent bedsores.

CONTINUUM

ODDS ON RESCUE

When someone is lost in the desolate Sonoran Desert of southern Arizona, the Pima County sheriff's department usually calls on more than 100 people The search effort involves ground vehicles horseback riders helicopfers and search dogs But now one more member has been added to the rescue feam—a University of Arizona mathematician armed with a specially programmed calculator

As the search progresses John Bownds uses probability theory to figure out the likelihood of finding a missing person in each particular area "It s the same as computing the odds on a certain horse at the racetrack " says Bownds These techniques are already used by the Coast Guard but my colleagues and I have adapted them to an open desert terrain, where a person could go in virtually any direction

Since the search area can cover some 4 000 square miles, the numbers that Bownds churns out on his calculator help the sheriff s department assign teams where there is the highest probability of a rescue When the probabilify of detection gets low enough the search is canceled

The mathematical search formulas have been used during half a dozen rescue efforts over the last year but Bownds cannot yet estimate how much this scientific approach actually improves the efficiency of a search 'But if our analysis saves just one more life,' he says that's enough, isn t it?"—Marcia F Bartusiak

' Trees are your best antiques '

—Alexander Smith

Desert search party A specially programmed calculator tells the searchers where there is the highest probability of rescue

Gouty mineral deposits caused by uric acid

YOUTHFUL URIC ACID

Uric acid the nitrogen-based waste product that s thrown away in our urine can cause gout If could also be a defense against can cer and aging according fo Dr Bruce Ames and colleagues at the University of California at Berkeley

Ames suspects that aging occurs when free radicals—highly reactive chemicals present in food water and air—attack proteins and other vital cell constituents When DNA within the nucleus of a cell is attacked he adds cancer may develop

But uric acid may stop this process Ames explains destroying free radicals before they harm the cell

"Uric acid could be one ot the things that enable us to live so much longer than most mammals " Ames says Humans who develop cancer late in life often retain significanf quantities of uric acid in the blood Rats which can develop malignant tumors after only two years excrete *all* their uric acid with the urine

—Owen Davies

TRACKING A MICROKILLER

One of nature's most fearsome mass killers is *Ptychodiscus brevis*, a microscopic creature that moves about by the whiplike motions of its two long flagella

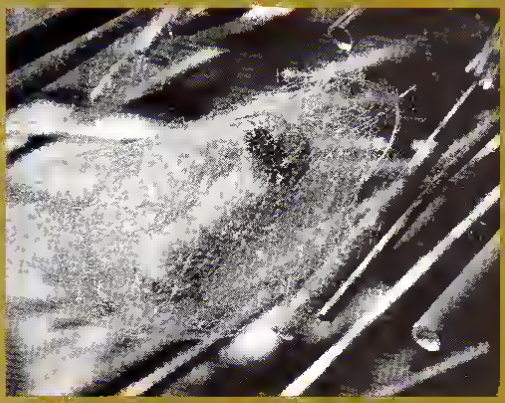
This killer alga, whose periodic appearances in the Gulf of Mexico have been given the name red tide secretes a chemical that desfroys the nervous systems of fish and shellfish Whenever the red tide blooms tens of thousands of sea animals die and wash ashore

Now after a decade of searching a team of scientists from four American universities has isolated and identified the deadly poison of *Ptychodiscus*—a single molecule called brevetoxin B According fo Koji Nakanishi a Columbia University chemist and head of the research effort the molecule is composed of 11 Hula-Hoop like rings strung together to form a sort of ladder Brevetoxin he says "is unlike any organic molecule yet observed

The scientists have already learned that brevetoxin damages nerves by causing unusually large amounts of sodium to pass through nerve-cell membranes This information they say, will help them control the lethal organism

Nakanishi adds that *Ptychodiscus brevis* is just one of many microorganisms that cause red tide around the world

—Marcia F Bartusiak



Silkworm spinning cocoon around its body Low level radiation helps it make more silk and benefits other animals as well

HELPFUL RADIATION

When it comes to radiation, the popular notion is that every dose is an overdose Not so, says biochemist and nutritionist Thomas Luckey, of the University of Missouri He maintains that low doses of radiation are actually *beneficial* to living things

To support his controversial theory Luckey has compiled a book of data from more than 1 200 scientific papers on low-level radiation His findings? Low-level radiation causes insects and rodents to grow faster, silkworms to produce more silk and seeds to sprout more quickly It also enhances wound healing antibody production fertility, and longevity in plants and animals alike Luckey says that the data indicate that just the right amount of radiation—somewhere between 10 and 100 times background levels but way below levels known to be harmful—puts an organism on the alert, triggering the body's defenses to ' help ward off many types of dangers including infection and higher doses of radiation

Luckey also believes there is a level of radiation that is essential for survival To find if he wants to raise mice in a chamber that will shield them from background radiation produced by cosmic rays and the earth itself

—Carol A Johmann

"The first thing every child learns is that he is not the entire universe "

—Robert Silverberg

"Progress isn't always for the best Smoke signals never got an Indian out of bed at 3 A M to answer a wrong number '

—Mack McGinnis

CONTACT LENS SOLUTION

Some 80 percent of the people who try contact lenses eventually give them up The major reason giant papillary conjunctivitis (GPC), a condition marked by itchy eyes and large pimples inside the eyelid Now University of Washington chemists Buddy Ratner and Tom Horbett may have found the cause of GPC and a way to treat If

The two theorized that proteins in tears were being chemically altered by the polymer plastics in contact lenses the body was then attacking the proteins as if they were foreign substances They first tested their theory by developing an artificial tears solution and exposing it to several different plastics—standard ones used for hard or soft contacts as well as a series made from mixtures of the two

The researchers found that all plastics absorbed the proteins to one degree or another A second series of tests with commercially available lenses showed the contacts "differed in their protein absorption by as much as a factor of 300 " And different contact lenses absorbed different percentages of different proteins

That most commercial contacts affect tear proteins seems certain Which protein is the GPC culprit is still unknown But the researchers do have a solution to GPC a new plastic that absorbs less tear protein than any on the market today—Joel Davis

"Between the great things that we cannot do, the danger is that we shall do nothing "

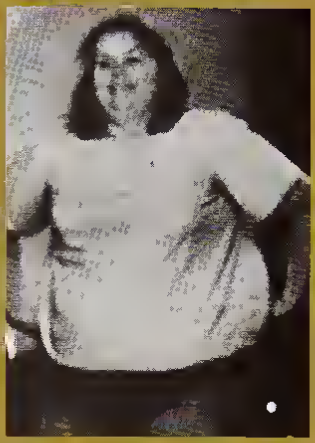
—Adolph Monod

"The struggle for knowledge has a pleasure in it like that of wrestling with a fine woman '

—Lord Halifax

Many people who try contact lenses give them up because of itchy eyes Researchers say a new plastic may solve the problem

CONTINUUM



Before and after Subliminal dieter Wendy LaCour weighed 265 pounds in September 1979, but lost 115 pounds by January 1980

SUBLIMINAL DIET

Remember those stories about the drive-in movie theaters that boosted popcorn sales subliminally by flashing EAT on the screen? Now there s a diet program that uses the same principle to deliver the message EAT LESS

Hal Becker the engineer who invented the subliminal anticrime device modestly called Dr Becker's Black Box ('Don't steal we ll catch you ' it whispered), has applied his background in psychology engineering and subliminal communication to a weight reduction program

The audio-cassette version of the program consists of Dr Becker and his secretary Wendy LaCour, lecturing on food self-image and eating habits While the advice is solid stuff Mom probably told you most of it years ago Eat three meals a day chew food thoroughly eat a high-protein breakfast It is delivered against a background of soft rock or easy-listening music

On the opposite side "key word" messages are subliminally delivered "Eat less "Think thin ' and so on Becker recommends listening to the cassette once a day Both Becker and LaCour whose fat/thin before and after pictures appear on the cassette jacket claim to have lost hundreds of pounds on the program —Allan Maurer

' The best road to progress is freedom's road
—John F Kennedy

' May you live all the days of your life '
—Jonathan Swift

BEST FOOT FORWARD

The middle-aged woman arrived at the offices of Drs Edwin Probber and Ira Weisenthal with a troublesome abnormality of the foot—a small bony spur in the heel that made walking painful

In the past podiatrists have sent such patients to the hospital for major surgery including the slicing open of the heel with incisions up to eight inches long to remove the spur But Probber and Weisenthal were able to correct the woman s problem within a matter of hours at much less expense right in their own Floral Park New York examining rooms

First the woman s foot was scrubbed and numbed with a local anesthetic Then Weisenthal made a small puncture in the side of her heel and pulverized the spur with a sterilized drill like a dentist s—a procedure invented by Probber The resulting paste was squeezed out through the puncture Finally the tiny puncture was covered with a medicated bandage and the woman walked out of the office hours later

So far the two doctors have performed thousands of these operations called percutaneous surgery Because of their success in removing both spurs and bunions the podiatrists now teach the technique to foot specialists across the country

Visiting podiatrists are often surprised that Probber and Weisenthal conduct the entire operation while dressed in business suits ' But Probber explains ' the opening through which we work is so small that there is almost no opportunity for pathogens to contact exposed tissue Gowning and gloving only cause unnecessary patient anxiety and expense

—Marcia F Bartusiak

"Look before you leap but look ahead, not behind '
—Peter Ustinov

"In every man of genius a new strange force is brought into the world "
—Havelock Ellis

Podiatrist anesthetizes woman s foot before inserting a sterilized drill to pulverize spur Recovery time is a matter of hours

JAWS

Athletes wearing jaw repositioning mouthpieces to increase their strength might as well spit them out new research suggests

On the other hand these same mandibular ortho pedic repositioning appli- ances (MORAs) may help some people get rid of headaches

MORAs were originally developed to help accident victims in need of jaw realignment, but they quickly caught on with health and fitness aficionados

In the first double-blind test of the MORAs at Arizona State University s Human Performance Laboratory 'We found no increase in strength or endurance in the muscle groups tested, ' Dr Lee Burkett reports

MORAs do have other proven uses, however and Dr Burkett's collab orator on the project Dr Allan Bernstein a dentist, thinks more research is needed Some head and neck ailments disappear when people wear them ' Dr Bernstein says "and patients often ask whether it has anything to do with strength One said I never hit a tennis ball so hard, and another said he'd never had such high bowling scores Also in the study all the people who reported having headaches improved That might be a clue

Bernstein is continuing his research on more se lected subjects to see whether there is any validity to claims of increased strength —Allan Maurer

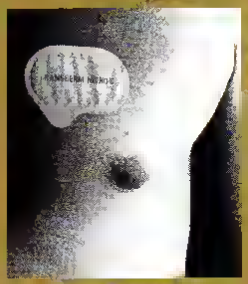
ANGINA PATCH

For those who suffer from angina pectoris climbing stairs running even a brisk walk can keep oxygen from the heart and inflict stabbing chest pain But now angina sufferers can step up their physical activities without suffering thanks to an adhesive patch called Transderm-Nitro The patch, worn on the chest allows continuous absorption of nitroglycerin through the skin

Nitroglycerin has long been used to expand the coronary arteries and relieve angina pain explains Dr Virgil Place, of ALZA Corporation, maker of the patch

A standard pill under the tongue "moves a big blast of nitroglycerin into the bloodstream within a minute ' he says but the effect is short-lived—15 to 20 minutes Chronic blasts of nitro on the other hand result in rapid heartbeat and splitting headaches

Transderm-Nitro, however delivers a steady dose that eliminates "blast ef- fects —Yvonne Baskin



Patch delivers nitroglycerin directly through the skin

Coffee drinkers often prefer their brew early in the morning as an instant pick-me up but it may be the worst time of day for caffeine

COFFEE BLUES

A good, strong, well- brewed cup of morning cof- fee may give you an instant lift but afterward it will make your body think it s in another time zone

Coffee tea, and a whole laundry list of other drugs and stimuli' can reset the body s circadian clock say researchers at the Argonne National Labora tory, in Chicago ' The circadian clock—that's the one that wakes you before the alarm clock in the morning—has biochemi- cal underpinnings, ' says Dr Charles Ehret

' Enzymes that control its twenty four hour cycle come and go at particular times he says These open up pathways for a natural adrenaline lift in the morning and sleep induc- ing hormones at night

When the clock is con- stantly reset "the lovely circadian rhythm flattens out This can cause dys chronism, which may cause depression mild insomnia and drowsiness

The best time to drink coffee or other caffeinated beverages is at British tea time or midafternoon ' Ehret asserts

During this physically neutral time Ehret notes, you can "intentionally reinforce your natural circadian rhythm Drinking a cup of coffee then may "rein in maverick cells going their own way and put them back in the circadian herd

Drinking coffee in the morning, however causes a "phase-delay Later per haps the next day your body will it you're on the East Coast think it s in San Francisco

—Allan Maurer

CONTINUUM

FAT VACUUM

A Beverly Hills plastic surgeon is offering a novel treatment to overweight patients. He literally vacuums away oversize bottoms and double chins with a suction device.

Dr. Norman Martin, of the Beverly Hills Medical Center, first injects a saline solution into fat deposits. The fat absorbs the solution, and temporarily loosens. Then a tiny incision is made in the skin, and the blunt metal suction tip of a vacuum is inserted through it to suck the fat away.

"In conventional surgery it costs between five thousand and seven thousand dollars to dissect and remove fat from the thighs, and the incisions are as long as fourteen inches," Martin explains. "With the vacuum procedure the surgical fee is normally twenty-five hundred dollars, the incisions are half an inch in length, and we usually handle what pain there is with Tylenol."

Martin, who has employed the new surgery on more than 200 patients during the past 12 months, expects it to become popular in the United States. He says the surgery is used only to remove fat deposits resistant to weight reduction through drugs, diet, and exercise.

—Eric Mishara

"There is nothing new except what has been forgotten."

—Attributed to Marie Antoinette's milliner

SWITCHED-ON STRADIVARIUS

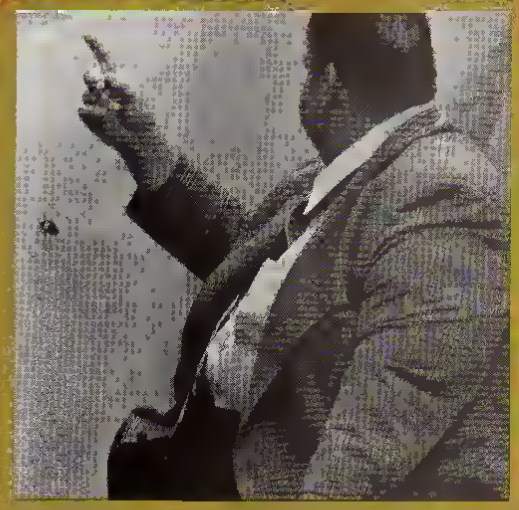
If he were resurrected and subjected to a blindfold test, even Antonio Stradivari might have a difficult time distinguishing between the sound of a new electronic violin built at the University of California in San Diego and one of his own instruments.

When Stradivari died in 1737, he took his design secrets to the grave. For the last several centuries instrument makers have experimented unsuccessfully with different combinations of wood, oil, and varnish in an attempt to duplicate the unique Stradivarius sound. Now Max Mathews, a sound engineer from Bell Laboratories, believes he has solved the problem electronically. Working with California music professor F. Richard Moore and virtuoso violinist Janos Negyesy, Mathews has built a skeletal metal instrument that he claims synthesizes the tones of a Stradivarius.

The electronic violin has microphone pickups that amplify the sound of each string, and integrated circuits simulate the resonance of an acoustic violin. When it is produced, the violin could sell for under $1,000—compared to $300,000 for a Stradivarius. —Phoebe Hoban

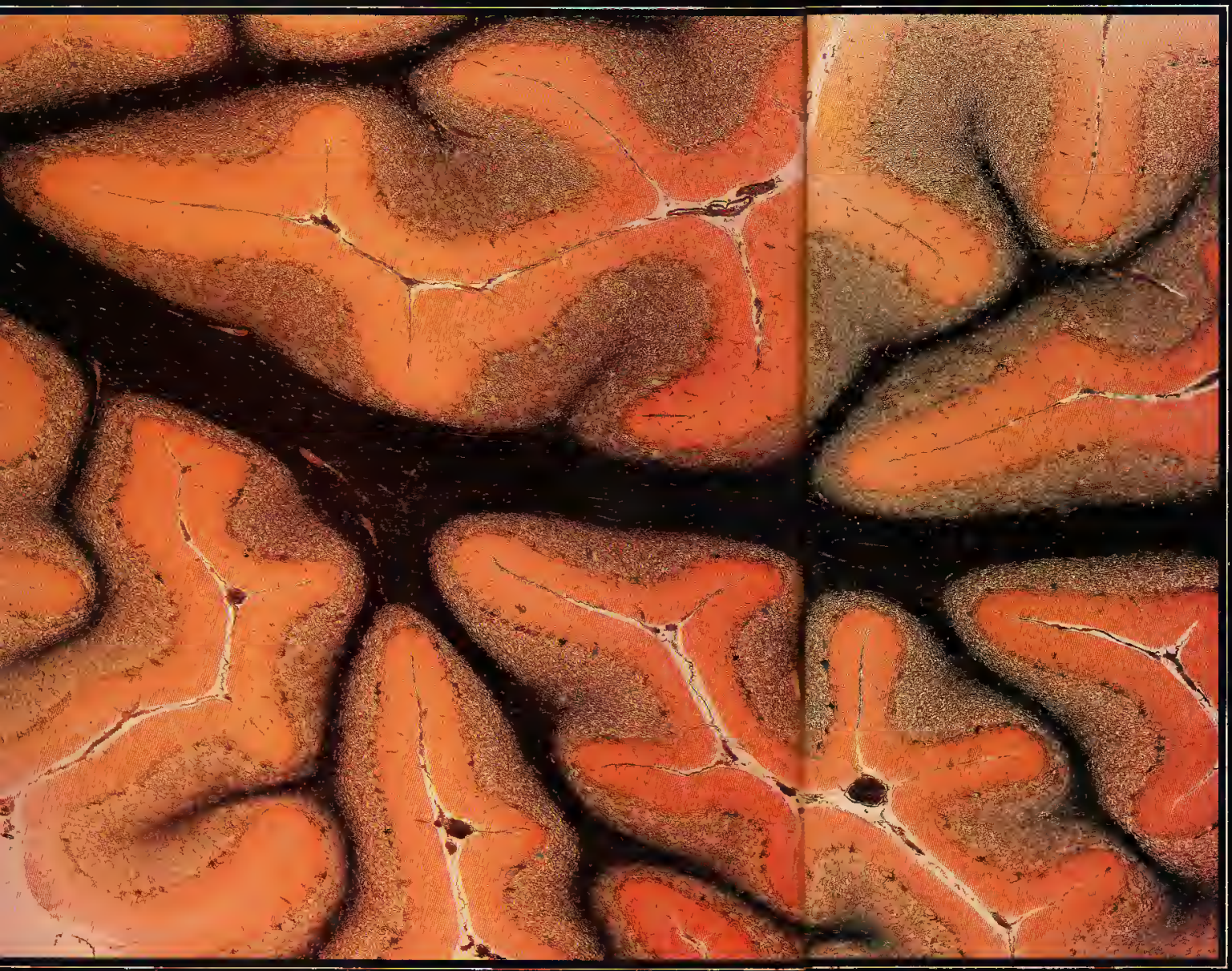
"I'm just a collection of mirrors reflecting what everyone else expects of me."

—Rollo May



Overweight people have a new ally in the battle against obesity: a vacuum device now being used to suck out fat.

The Stradivarius violin is the choice of concert-hall performers. Now a Bell Labs engineer has simulated a Stradivarius out of metal.



From the electronic creations of artificial intelligence to ethereal forays into states of consciousness, Omni's special anniversary issue explores that mystery called mind. Our quest begins with one Nobel laureate's fascinating explanation of how thoughts are turned into action

BEYOND THE BRAIN

BY SIR JOHN ECCLES

Every day of our lives we face a strange paradox. While we take it for granted our minds act on our brains—that is, by merely thinking a thought, we can direct our brains to make any movement we wish—most philosophers, psychologists, and neuroscientists say this commonsense belief is wrong. They assert, dogmatically, that because mental events like thought and planning an action are not of the material world, they cannot cause changes anywhere in that world, not even in the brain.

Those who make these statements believe that all our actions are entirely dependent on the brain, even though we have the feeling that it is thought or desire that controls our voluntary movements. What these materialists allege is that the neural events

PHOTOGRAPHS BY MANFRED KAGE

involved in any voluntary movement give us this false impression. The explanation for this is something they label an identity relationship. There is an outward movement we can see, and there is a mental event associated with it. It is not a case of one causing the other, but rather they are the same event looked at from different perspectives, inside and outside. As a result, whenever the nerve cells are firing, we perceive that we are causing it, but in fact it is merely an illusion.

These same theorists go on to claim that eventually neuroscientists will be able to identify in more and more detail the neural events behind the whole range of conscious experiences—the excitement of creativity, joy, even love. Eventually they say everything will be explained by nerve-cell activities, if not in our lifetime, in the lifetimes of generations to come. For that reason the philosopher Sir Karl Popper derisively labels this reductionist program promissory materialism, since it essentially "promises" to explain everything someday.

But don't be alarmed. I believe we should not take these dogmatic statements too seriously, because they are based on prejudice and on knowledge that is most inadequate. The reality of the action of the mind is cruelly brought home to anyone afflicted with a disease such as Parkinsonism, a nervous disease in which the person afflicted suffers from involuntary muscle tremors and a general slowing down and weakening of bodily movement. Here there is no identity relationship. Diseased individuals find great difficulty in carrying out a planned action, no matter how much they desire it. If they were so afflicted, those philosophers who speak so glibly about the simplicity of the mind/body problem would soon realize that there is an immensely complex neural machinery of the brain interposed between the intention to act and the action itself.

Let me illustrate what is involved in some planned action such as lifting a glass of wine elegantly to one's lips or making a skillful golf stroke. Simple though these motions seem, they are the outcome of events in the body's nervous system that, at a conservative estimate, involve hundreds of millions of neurons. Think of all the muscles that have to be made to contract with just the right strength and timing. A golf stroke, for example, brings into play almost all the muscles of the limbs, torso, neck and head. Years of training are necessary to learn these skills. Although an expert player may have little knowledge of how his individual muscles are performing, he knows by how he moves and how precisely he hits the ball whether his neural machinery is operating smoothly or not.

We know something of the intricacies of muscle action from scientific studies of champion shot-putters and of gymnasts performing simple exercises, but we can only imagine the subtleties of the interrelated muscle contractions that occur in the highly skilled performances of musicians, dancers, actors, athletes, and technicians manipulating delicate instruments. For each of us, life is one long symphony of movements that we have been learning since childhood and that are as unique to each of us as the writing of our signature.

I have criticized many times the theories of the promissory materialists. What I see as an alternate hypothesis is a commonsense belief originally formulated by René Descartes in the seventeenth century and updated by Karl Popper and me. It is called dualist interactionism. It holds that we live in two distinct worlds: the world of the mind and the material world, which includes the brain (the dualism), and that there is an intense interaction across this frontier between the mind and the brain (hence the interactionism).

Until recently this idea had to be assimilated with evidence that the action of the mind was diffused throughout the brain, a "ghost in the machine," but in the last four years this concept has been transformed by three scientific investigations that have identified a special area of the cerebral cortex (see opening photo) where mental events cause neural events. It was first discovered in 1943 by neurosurgeon Dr. Wilder Penfield, who named it the supplementary motor area (SMA). The SMA lies on the upper midsurface of each cerebral hemisphere immediately underneath the skull. Ever since its discovery, the SMA has had a disappointing press concerning its role in carrying out bodily movement. The reason for this was that its influences were so imprecise when compared with the brain's true motor cortex, where the areas that control specific parts of the body can be laid out on a quite precise strip map of the brain. But now, in a Cinderella-like transformation, the SMA seems destined to be cast in the role of master control of all voluntary movement.

The most remarkable studies illustrating this have been done by neurologist Dr. Niels Lassen and his colleagues at the Neurological Institute in Copenhagen. They have built a wonderful machine that measures changes in the circulation of the blood through small regions of the cerebral cortex, and, by so doing, they can measure the intensity of nerve-cell activities within it. To do this, they first inject a small amount of a radioactive tracer, 133 xenon, in solution into a patient's internal carotid artery, which carries blood to the brain. (It should be mentioned here that a tube had already been inserted to make an angiogram, an X ray of the blood vessels, for therapeutic purposes and that the patients willingly gave a few minutes of their time for the innocuous injection procedure.) Radiation from the injected cerebral hemisphere is recorded by 254 Geiger counters arranged in a helmet that the patient wears. During the injection the patient performs a learned repetitive task for 60 seconds. At

"What rubbish, Pelham. I don't use people!"

the same time the radioactive pattern of the underlying brain activity is computed for each of the 254 sites and then played out as a 15-color mosaic map of the brain showing any changes in brain activity.

The patient is asked to do a series of finger-thumb movements that requires total concentration. He has to touch his thumb to each finger in turn following a distinct pattern: two touches to the first finger, one to the second, three to the third, two to the fourth. And then he reverses the pattern: two to the fourth, three to the third, one to the second, two to the first, and so on back around again until the 60 seconds are up. Anyone who tries this will find that it is impossible to talk or even think of anything else at the same time because it requires so much concentration to get it right.

As expected, Lassen and his group have found a large increase in activity in the area of the motor cortex that controls thumb and finger movements, but there was also a large increase over the SMA. In itself this is an inconclusive result. The SMA, for example, could have been activated after the motor cortex and not before. This possibility was eliminated by a beautiful change in strategy.

The patient was asked to think of the thumb-finger movements in the correct sequence without carrying them out. There is no increased neural activity in the motor cortex, but amazingly the SMA shows almost as large an increase in activity as when the movements are being performed. These results show that, even when a person is only intending to carry out some voluntary act, his thoughts will activate neural events in the SMA and nowhere else.

This conclusion has been corroborated in experiments done by Australian neurophysiologist Dr. Robert Porter, who took recordings of the neurons of a monkey's SMA as the animal voluntarily pulled a lever to get a food reward. Porter found that probably more than a tenth of a second before the motor cortex neurons fired, the SMA cells were activated.

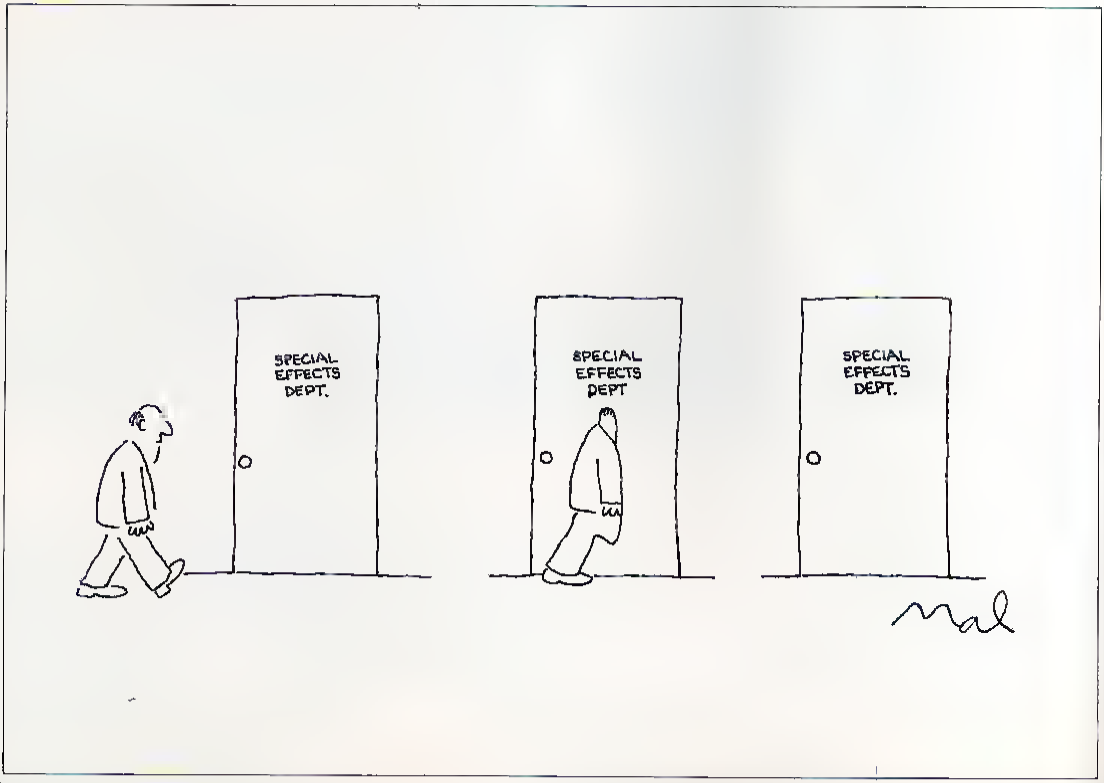
Two German neurologists, Drs. Hans Kornhuber and Luder Deecke, have confirmed this firing order with electrical signals taken from the scalps of people performing voluntary movements. The first electrical sign of nervous activity, called the readiness potential, appears in the scalp region over the SMA, and it is the largest over the SMA throughout the time period—almost a second—before the movement begins.

Most important, they have found that this readiness potential is still large in the SMA of patients afflicted with the severe akinesia, or weakness of movements, of bilateral Parkinsonism, despite the extreme feebleness of the motor act and of the readiness potential over the motor cortex. Again the mental activation of the SMA was found to precede the activity of the motor cortex, which was greatly reduced because of the severe damage to the neural pathway connecting the SMA and the motor cortex.

These experiments have shown that the mind does act on the brain and does it at a precise site in the cerebral cortex. This is only the beginning of our understanding, however. Stretching before us is an immense vista of scientific investigations that have to be done before we can give an account, even in principle, of how we perform any skilled movement. We need to understand how a thought instructs, probably in some coded manner, the neural machinery of the SMA so that the desired voluntary movement results. Also, it is assumed that in the SMA there is an inventory of all learned motor programs, as they are called, and their addresses by which they can be called forth.

Although we still have only a dim understanding of the mystery behind how a person makes any skillful move, what we know already makes the actions of the most sophisticated robot look like a failure by many orders of magnitude when compared to those of a human. It is an exciting and wonderful realization. ∞

Physiologist Sir John Eccles was awarded the 1963 Nobel Prize in Medicine and Physiology for explaining how nerve impulses are transmitted from neuron to neuron.



FICTION

FOUNDATION'S EDGE

One man's decision will change his world for the next millennium—and he doesn't even know it

BY ISAAC ASIMOV

The first Galactic Empire was falling. It had been decaying for centuries, and only one man fully realized that fact. He was Hari Seldon, the last great scientist of the First Empire, and it was he who perfected psychohistory—the science of human behavior reduced to mathematical equations.

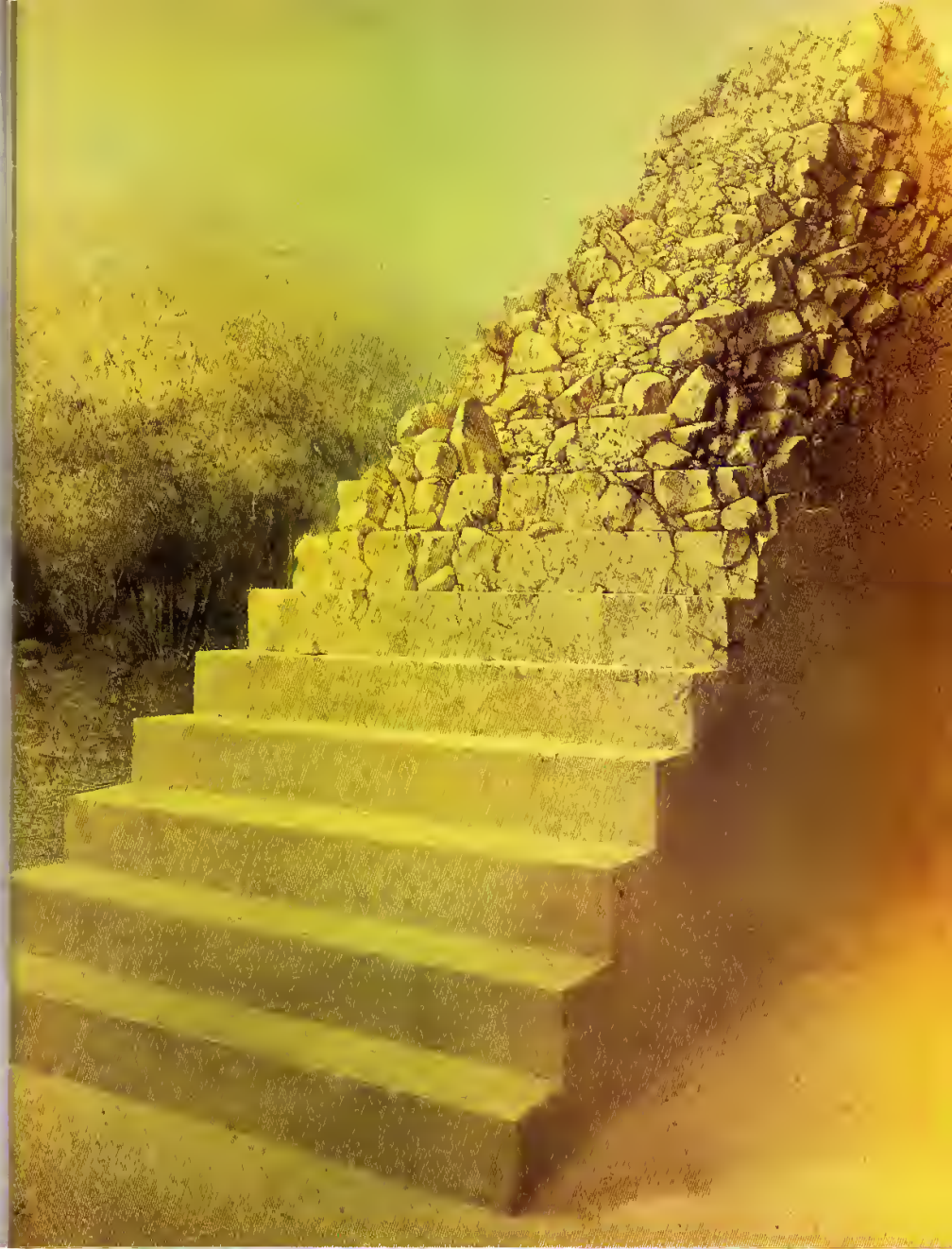
The individual human being is unpredictable, but the reactions of human mobs, Seldon found, could be treated statistically. The larger the mob, the greater the accuracy that could be achieved. And the size of the human masses that Seldon worked with was no less than the population of all the inhabited millions of worlds of the Galaxy.

Seldon's equations indicated that, left to itself, the Empire would fall and that 30,000 years of human misery would elapse before a second Empire would arise from the ruins. And yet if one could slightly adjust some of the conditions that already existed, that interregnum could be decreased to a single millennium.

To ensure this, Seldon established two colonies of scientists, which he called Foundations. With deliberate intention, he positioned them "at opposite ends of the Galaxy." The First Foundation, which centered on physical science, was organized in the full daylight of publicity. The existence of the other, the Second Foundation, a world of psychohistoric and "mentalic" scientists, was shrouded in silence.

In the Foundation trilogy the story of the first third of the interregnum is told. The First Foundation began as a small community lost in the emptiness of the outer periphery of the Galaxy. With its superior science it took over the barbarized planets that surrounded it. It faced the anarchic Warlords who broke away from the dying Empire and beat them. The First Foundation faced the remnant of the Empire itself under its last

PAINTING BY ERIC PAETZ



strong Emperor and its last strong General, and beat it

It seemed as if the Seldon Plan was going through smoothly and that nothing would prevent the Second Empire from being established on time, and with a minimum of devastation.

But psychohistory is a statistical science. There is a chance that something will go wrong. Something did—something Hari Seldon could not have foreseen. One man, called the Mule, appeared from nowhere. He had mental powers in a Galaxy that lacked them. He could mold men's emotions and shape their minds. Armies could not, would not, fight him. The First Foundation fell, and Seldon's Plan seemed to lie in ruins.

There was left the mysterious Second Foundation, which had been caught unprepared by the sudden appearance of the Mule. Its great defense was that its location was unknown. The Mule searched for it to make his conquest of the Galaxy complete. The First Foundation's survivors looked toward it for help.

The Mule was temporarily stopped by the action of a single woman, Bayta Darell, and then permanently by the Second Foundation. Slowly they prepared to reinstate the Seldon Plan.

But now the First Foundation knew of the Second's existence. The First did not want a future in which it was overseen by the mentalists.

It is now 498 years after the First Foundation came into existence. It seems to be at the peak of its strength.

"Well," said Golan Trevize. "I've wasted a day."

"Oh?" Janov Pelorat looked up from his careful indexing. "In what way?"

Trevize spread his arms. "I didn't trust the Computer. I didn't dare to, so I checked our present position with the position we had aimed at in the Jump. The difference was not measurable. There was no detectable error."

"That's good, isn't it?"

"It's more than good. It's unbelievable. I've never heard of such a thing. I've gone through Jumps, and I've directed them, in all kinds of ways and with all kinds of devices. In school I had to work one out with a hand computer, and then I sent off a hyperrelay to check results. Naturally I couldn't send a real ship, since, aside from the expense, I could easily have placed it in the middle of a star at the other end."

"I never did anything that bad, of course," Trevize went on, "but there would always be a sizable error. There's always some error, even with experts. There's got to be, since there are so many variables. Put it this way: The geometry of space is too complicated to handle, and hyperspace compounds all those complications with a complexity of its own that we can't even pretend to understand. That's why we have to go by steps, instead of making one big Jump from here to Sayshell. The errors would grow worse with distance."

Pelorat said, "But you asserted that *this* Computer didn't make an error."

"*It* said it didn't make an error. I directed it to check our actual position with our precalculated position—what is against what was asked for. *It* said that the two were identical within its limits of measurement. I thought, What if it's lying?"

Until that moment, Pelorat had held his pointer in his hand. He now put it down and looked shaken. "Are you joking? A Computer can't lie. Unless you mean you thought it might be out of order."

"No, that's not what I thought. I thought it was *lying*. This Computer is so advanced. I can't think of it as anything but human—superhuman, maybe. Human enough to have pride, and perhaps to lie. I gave it directions—to work out a course through hyperspace to a position near the Sayshell Union. It did, and it charted a course in twenty-nine steps, which is arrogance of the worst sort."

Why arrogance?

"The error in the first Jump makes the second Jump that much less certain. The added error then makes the third Jump untrustworthy, and so on. How do you calculate twenty-nine steps all at once? The twenty-ninth could end up anywhere in the Galaxy, anywhere at all. So I directed it to make the first step only. Then we could check that before proceeding."

"The cautious approach," said Pelorat warmly. "I approve."

"Yes, but having made the first step, might the Computer not feel wounded at my having mistrusted it? Would it then be forced to salve its pride by telling me there was no error at all, when I asked it? Would it find it impossible to admit a mistake, to own up to imperfection? If that were so, we might as well not have a Computer."

Pelorat's long and gentle face saddened at this revelation. "What can we do in that case, Golan?"

"We can do what I did—waste a day. I checked the position of several of the surrounding stars by the most primitive possible method: telescopic observation, photography and manual measurement. I compared each actual position with the position expected if there had been no error. The work took me all day and wore me down to nothing."

"Yes, but what happened?"

"I found two whopping errors and checked them over and found they were in my own calculations. I corrected the calculations, then ran them through the Computer from scratch to see whether it would come up with the same answers independently. The Computer had made no errors. It may be an arrogant son-of-the-Mule, but it's got something to be arrogant about."

Pelorat exhaled a long breath. "Well, that's good."

"Yes, indeed. So I'm going to let it take the remaining twenty-eight steps."

"All at once? But—"

"Not all at once. Don't worry. I haven't become a daredevil yet. It will do them one after the other, but after each step it will check the surroundings. If it is where it is supposed to be, within tolerable limits, it can take the next step. Anytime it finds the error too great—and believe me, I didn't set the limits generously at all—it will have to stop and recalculate the remaining steps."

"When are you going to do this?"

"When? Right now. All I have to do is touch that little contact. The Computer has its instructions, and it's just waiting for me to say, 'Start.' Would *you* like to—"

"Never! It's all yours! It's your Computer. You do it."

"Very well. And it's my responsibility. I'm still trying to duck it, you see. Keep your eye on the screen."

With a remarkably steady hand, Trevize made contact.

There was a momentary pause, and then the star field changed—and again—and again. The stars spread steadily thicker and brighter over the view screen.

Pelorat was counting under his breath. At "Fifteen," there was a halt as if some piece of apparatus had jammed.

Pelorat whispered, clearly afraid that any noise might jar the mechanism fatally. "What's wrong? What's happened?"

Trevize shrugged. "I imagine it's recalculating. Some object in space is adding a perceptible bump to the general shape of the overall gravitational field. Some object not taken into account. Some uncharted dwarf star or rogue planet—"

"Dangerous?"

"Since we're still alive, it almost certainly isn't dangerous. A planet could be a hundred million kilometers away and still introduce enough of a gravitational modification to require recalculation. A dwarf star could be ten billion kilometers away, and—"

The screen shifted again, and Trevize fell silent. It shifted again—and again—

> *"They were both Foundation vessels. One was precisely like the Far Star and was undoubtedly Compor's ship. The other was larger and far more powerful."*

Finally, when Pelorat said, "Twenty-eight," there was no further motion.

Trevize consulted the Computer. "We're here," he said.

"That's only twenty-eight Jumps. You said twenty-nine."

"The recalculation at Jump Fifteen probably saved us one Jump. I can check with the Computer if you wish, but there's really no need. We're in the vicinity of Sayshell Union. The Computer says so, and I don't doubt it. If I were to orient the screen properly, we'd see a nice, bright sun, but there's no point in placing a needless strain on its screening capacity. The Sayshell Union is three and two-tenths million kilometers away from our present position, which is about as close as we want to be at a Jump conclusion. We can get there in three days—two, if we hurry."

Trevize drew a deep breath and tried to let the tension drain from his body.

"There it is," Trevize muttered.

"Gaia?" Pelorat asked, looking over Trevize's shoulder at the screen.

"Gaia's sun," said Trevize. "We can't see Gaia yet. We're still a hundred microparsecs away. Notice that it's only a star. We're not close enough for it to show as a disk. And don't stare at it directly, Janov. It's still bright enough to damage the retina. I'll throw in a filter once I'm through with my observations. Then you can stare."

"But shouldn't we get closer?"

"No!" Trevize looked up in surprise. "Not right away. After what we've heard about Gaia, why should we rush? It's one thing to have guts; it's another to be crazy. Let's wait and study it first."

"The orbit is nearly circular," Trevize said, "which means that habitability becomes a much safer bet. Yet no one's coming out to get us. We'll have to try taking a closer look."

Pelorat asked, "Why does it take so long to arrange a Jump? You're just taking little ones."

"Listen to the man. Little Jumps are harder to control than big ones. Is it easier to pick up a rock or a fine grain of sand? Besides, Gaia's sun is nearby, and space is sharply curved. That complicates the calculations even for the Computer. Even a mythologist should see that."

Pelorat grunted.

Trevize then said, "You can see the planet with the unaided eye now. Right there. See it? The period of rotation is about twenty-two Galactic hours, and the axial inclination is twelve degrees. It is practically a textbook example of a habitable planet, and it *is* life-bearing."

"How can you tell?"

"There are substantial quantities of free oxygen in the atmosphere. You can't have that without well-established vegetation."

"What about intelligent life?"

"That depends on the analysis of radio-wave radiation. Of course there could be intelligent life that has abandoned tech-

nology I suppose but that seems a very unlikely situation"

"There have been cases of that" said Pelorat

"I'll take your word for it That's your department However, it's not likely that a planet of pastoral survivors frightened off the Mule"

"Does it have a satellite?" Pelorat asked

"Yes, it does" Trevize said casually

Pelorat said in a voice that was suddenly choking, "How big?

"Can't tell for sure Perhaps a hundred kilometers across"

"Dear me" said Pelorat wistfully "I wish I had some worthier set of expletives on instant call my dear chap, but there was just that one little chance—"

"You mean, if it had a giant satellite it might be Earth itself? Look we'll wait and risk one more small Jump If we find no signs of intelligent life it should be safe to land Except of course that there will then be no reason to land will there?"

After the next Jump Trevize said in an astonished voice "That does it Janov! It's Gaia all right At least it possesses a technological civilization"

"Can you tell that from the radio waves?"

"Better than that There's a space station circling the planet"

An object was being displayed on the viewing screen To Pelorat's unaccustomed eye it didn't seem remarkable but Trevize said, "Artificial, metallic, and a radio source

"What do we do now?"

"Nothing for a while At this stage of technology, they cannot fail to detect us If after a while they do nothing I will beam a radio message at them If they still do nothing I will approach cautiously"

"What if they *do* do something?"

"It will depend on the something" If I don't like it, then I'll have to take advantage of the fact that it is very unlikely that they have anything that can match the facility with which this ship can make a Jump"

"You mean we'll leave?"

"Like a hyperspatial missile"

"But we'll leave no wiser than we were when we came"

"Not at all At the very least we'll know that Gaia exists, that it has a working technology and that it's done something to scare us"

"But Golan, please let's not be too easily scared"

"Now Janov, I know that you want nothing more in the Galaxy than to learn about Earth at any cost, but please remember that I don't share your monomania We are in an unarmed ship, and those people down there have been isolated for centuries Suppose they have never heard of the Foundation and don't know enough to be respectful of it Or suppose this *is* the Second Foundation and once we're in their grip—if they're annoyed with us—we may never be the same again"

Pelorat looked grim "If you put it that way But what do we do once we leave?"

"Simple We get back to Terminus with the news Or as near to Terminus as the old woman will allow Then we might return to Gaia again with an armed ship or an armed fleet"

They waited It had grown to be a routine They had spent far more time waiting in the approaches to Gaia than they had spent in all the flight from Terminus to Sayshell

Trevize set the Computer to automatic alarm and was even confident enough to doze in his padded chair

He awoke with a start when the alarm chimed Pelorat entered Trevize's room, just as startled He had been interrupted while shaving

"Have we received a message?" Pelorat asked

"No" said Trevize energetically "We're moving"

"Moving? Where?"

"Toward the space station"

"A voice rang out in the confines of the ship's control room, and Branno could tell it did not consist of sound waves She heard it in her mind directly"

"Why is that?"

"I don't know The motors are on and the Computer doesn't respond to me but we're moving Janov we've been seized We've come a little too close to Gaia"

The Computer on board the *Far Star* located the two ships and Trevize displayed them together on the split screen

They were both Foundation vessels One was precisely like the *Far Star* and was undoubtedly Compor's ship The other was larger and far more powerful

He turned toward the Gaian Bliss, and said to her "Well do you know what's going on? Is there anything you can now tell me?"

"Yes Do not be alarmed They will not harm you"

"Why is everyone convinced I'm sitting here all atremble with panic?" Trevize demanded petulantly

Pelorat said hastily, "Let her talk Golan Don't snap at her"

Trevize raised his arms in a gesture of impatient surrender "I promise I will not snap Speak lady"

Bliss replied "On the large ship is the ruler of your Foundation With her—"

Trevize asked in astonishment "The ruler? You mean Old Lady Branno?"

"Surely that is not her title" Bliss said her lip twitching a little in amusement "But she is a woman yes" She paused as if listening intently to the rest of the general organism of which she was part "Her name is Harlabranno"

"Has Gaia maneuvered her here too?" Trevize asked "Why?

Bliss did not answer this question She said, "With her is Lionokodell He is an important official of your world With them are four others who control the ship's weapons Do you want their names?

"No I take it that on the other ship there is one man Munn Li Compor and that he represents the Second Foundation You've brought both Foundations together, obviously Why?

"Not exactly Trev—I mean Trevize"

"Oh go ahead and say Trev I don't give a puff of comet gas"

"Not exactly Trev Compor has left that ship and has been replaced by two people One is Storgendibal an important official of the Second Foundation He is called a Speaker"

"An important official? He's got mentalic power I imagine"

"Oh yes A great deal"

"Will you be able to handle that?"

"Certainly The second person on the ship with him is Gaia"

"One of *your* people?"

"Yes Her name is Suranovivemblastiran It should be much longer but she has been away from me/us/rest so long"

"Is she capable of holding a high official of the Second Foundation?"

"It is not she It is Gaia who holds him She/I/we/all is/am/are capable of crushing him"

"Is that what she's going to do? She's going to crush him and Branno? What is this? Is Gaia going to destroy the Foundation and set up a Galactic Empire of its own? The Mule back again An even greater Mule—"

"No no Trev Do not become agitated You must not All three are in a stalemate They are waiting"

"For what?"

"For your decision"

"*What* decision? Why *me*?"

"Please Trev" said Bliss "It will soon be explained I/we/she have/has said as much as I/we/she can for now"

Mayor Branno said wearily, "It is clear I have made a mistake Liono perhaps a fatal one"

"Is this something that ought to be admitted?" Kodell muttered through motionless lips

"They know what I think It will do no further harm to say so"

Kodell said, "How could you have known Mayor? If we waited until assurance was doubly and triply and quadruply and endlessly certain we would have waited forever I wish we had not gone ourselves It

would have been well to experiment with someone else.

Branno sighed. "I wanted to give them no warning, Liono. Still, there you put the finger on the nub of my mistake. I might have waited until the shield was reasonably impenetrable. I knew there was perceptible leakage, but I could not bear to wait longer. To wipe out the leakage would have meant waiting past my term of office. I wanted it done in *my* time, and *I* wanted to be on the spot. So, like a fool, I forced myself to believe the shield was adequate. I would listen to no caution."

"We may still win out if we are patient."

"Can you give the order to fire on the other ship?"

"No. I cannot, Mayor. The thought is not something I can endure."

"Nor I. Even if you or I managed to give the order, I am certain that the men on board would not follow it. They would not be able to,' Mayor Branno said.

"Not under present circumstances, Mayor, but circumstances might change. As a matter of fact, a new actor appears on the scene."

With that, he pointed to the screen. The ship's Computer had automatically split the screen as a new ship came within its ken. The second ship appeared on the right-hand side.

"Can you magnify the image, Liono?"

"No trouble."

"Well," said Branno, studying the screen, "that's the *Far Star*, I'm sure. And I imagine Trevize and Pelorat are on board."

Then she said bitterly, "Unless they, too, have been replaced by Second Foundationers."

A voice rang out in the confines of the ship's control room, and Branno could tell it did not consist of sound waves. She heard it in her mind directly, and a glance at Kodell was sufficient to tell her that he had heard it, too.

It said, "Can you hear me, Mayor Branno? If you can, don't bother saying so. It will be enough if you think so."

Branno calmly said, "What are you?"

"I am Gaia."

The three ships were turning very slowly around the planet Gaia, as a distant three-part satellite of the planet. All three were accompanying Gaia on its endless journey about its sun.

Trevize sat watching the screen, tired of guessing what his role might be, what he had been dragged across a thousand parsecs to do.

The sound in his mind did not startle him. It was as if he had been waiting for it.

It said, "Can you hear me, Golan Trevize? If you can, don't bother saying so. It will be enough if you think it."

Trevize looked around. Pelorat, clearly startled, was looking in various directions as if trying to find a source for the voice. Bliss sat quietly, her hands spread loosely in her lap. Trevize had no doubt that she was aware of the sound.

He ignored the direction to communicate through thoughts and enunciated his words with deliberate clarity. "If I don't find out what this is about, I will do nothing I am asked to do."

"You are about to find out," the voice answered.

Novi Sura said, "You will all hear me in your mind. You are all free to respond in thought. I will arrange it so that all of you can hear one another. We are all close enough so that at the normal light-speed of the spatial mentalic field, there will be no inconvenient delays. To begin with, we are all here by arrangement."

"In what manner?" Branno asked.

"Not by mental tampering," said Novi. "Gaia has interfered with no one's mind. It is not our way. We merely took advantage of your ambition. Mayor Branno wanted to establish a Second Empire at once. Speaker Gendibal wanted to be First Speaker. It was enough to encourage these desires and to ride the wind, selectively and with sound judgment."

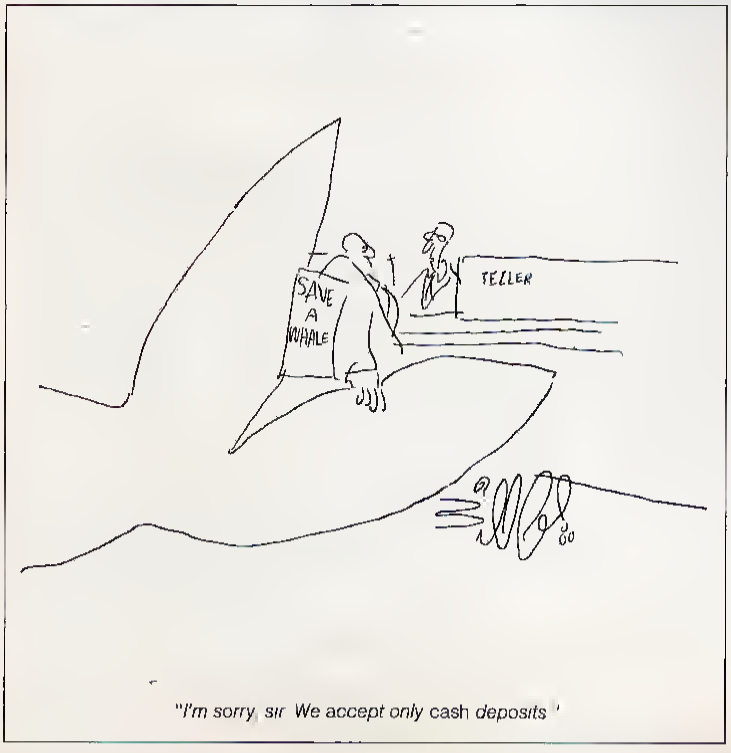
"I know how I was brought here," Gendibal said stiffly. He knew why he had been so anxious to move out into space, so anxious to pursue Trevize, so sure he could handle it all.

"You were a particular case, Speaker Gendibal. Your ambition was powerful, but you possess a softness that offered a shortcut. You are a person who is kind to someone whom you think beneath you. I took advantage of this trait in your character and turned it against you. I/we am/are deeply ashamed. The excuse is that the future of the Galaxy is in hazard."

Novi paused, and her voice—though she was not speaking with her vocal cords—grew more somber, her face more drawn.

"Gaia could wait no longer. For over a century the people of Terminus had been developing a mentalic shield. Left to themselves another generation, Terminus would have been impervious even to Gaia, and its inhabitants would have been free to use their physical weapons at will. The Galaxy would not have stood before them, and a Second Galactic Empire, after the fashion of Terminus, would have been established, despite the Seldon Plan, despite the people of Trantor, and despite Gaia. Mayor Branno had to be somehow maneuvered into making her move while the shield was still imperfect.

"Then there is Trantor. The Seldon Plan was working perfectly, for Gaia itself labored to keep it on track. Now, however, Stor Gendibal was rising quickly. He would certainly become First Speaker, and under him Trantor would take on an activist role. It would surely concentrate on physical power and would recognize the danger of Terminus and take action against it. If he could act against Terminus before its shield was perfected, then the Seldon Plan would be worked out to its conclusion in a Second Galactic Empire, after the fashion of



"I'm sorry, sir. We accept only cash deposits."

CONTINUED ON PAGE 156

Altered states
are not mere curiosities
They keep us sane

MIND TRIPPING

BY JUDITH HOOPER

In one of the darker corners of the Dark Continent the !Kung people of the Kalahari keep in touch with the gods.

Two or three nights a week the men dance around a fire, graceful as leopards, to the sonorous drone of the women's chants. Soon the mood turns solemn, and the night air swells with unseen presences. Sweat rolls down the dancers' bodies like sweet rain, as the *n!um*, the healing power, starts to boil. The moment of transcendence is pain-

PHOTOGRAPHS BY MALCOLM KIRK

ful. When the inner fire shoots from their bellies up their spines, the dancers shiver and tremble, fall to the ground, or go rigid as stone. Some of them dance into the fire and out again, perfect as gods: their feet unburned. They can see into the essence of things now, even into the insides of other people, where malignant ghosts feed on diseased livers or prevent the conception of sons. Laying their healing hands on the sick, they bid the *n/um* to drive out the forces of darkness.

The *!kia* dance winds down as the sun's first pale rays reillumine the earth, and the people doze or talk softly on the damp ground. Then it is left to Western anthropologists to write learned monographs on the curious mix of supernatural beliefs, rhythmic singing and dancing, group hysteria, and the endurance of severe pain that produces this collective altered state of consciousness.

Do their chronic nutritional deficits cause trance-inducing brain abnormalities in the !Kung? Are sweating and extreme overexertion paths to the spirit world?

Whatever their special recipe for transcendence, the !Kung Bushmen of Africa are not so different from you and me. At least 90 percent of human societies practice some kind of institutionalized altered-state ritual, according to Ohio State University anthropologist Erica Bourguignon, who has surveyed the hallucinatory hoedowns of some 4,000 cultures. There are the solitary-vision quests of Sioux warriors, the hallucinogen-powered flights of South American shamans, the dream oracles of the Senoi people of Malaysia. In addition to the tribal dances of peoples like the !Kung and the Samo tribesmen of New Guinea (shown on opening pages).

Closer to home, we might talk about cocktail parties, revival meetings, football-game hysteria, rock concert and discotheque ecstasies, not to mention widespread dabbling in chemical nirvanas. "Why?" Bourguignon wonders. The fact that they are nearly universal must mean that such states are very important to human beings."

The existence of the altered state of consciousness (or ASC) is no longer in doubt. What scientists are now asking themselves are "Why?" and "How?" What used to be the domain of philosophers, poets and mystics is now being seriously explored by a new breed of respected, if unconventional, scientists. To quantify the current status of altered-state research, I traveled to the West Coast to see psychologist Charles Tart, who is trying to map the ASC's geography, and behavioral psychologist Ronald Siegel, who is trying to analyze and control it in the laboratory; my inquiry continued through Chicago and biophysicist Jack Cowan, who is trying to relate hallucinations to specific brain hardware. Back east, I spoke to Massachusetts psychologist Theodore X. Barber about his studies of "Joan of Arc" personalities; to New Jersey parapsychologist Chuck Honorton, who is tracking down ASCs with EEGs and galvanic skin responses; and finally to Princeton University meditation authority Patricia Carrington, who has developed a theory about why a *lack* of ASCs is dangerous.

As a consequence of my journey, two truths have emerged. First, altered states are as common and all-American as Mom and apple pie, and second, altered states are necessary. Because consciousness can't be ground up and analyzed in a Petri dish, scientists need the ASC as a natural passageway into the mind's chambers. Just as neurologists study stroke patients to find out how a healthy brain operates, neuroscience uses altered states as a clue to the nature of "normal" consciousness. More important, you and I need altered states, perhaps every day of our lives, as windows to our own inner reality—and as a safeguard against going crazy.

For this particular mind trip, it's appropriate that we travel west, for a visit with the modern father of altered states.

"If you become one with the universe, Western science tells you it's an illusion, as if you had programmed your Apple computer to say, "I have just attained oneness with the Ultimate Chip."

The most recent *Whole Earth Catalog* still lists Charles S. Tart's *Altered States of Consciousness* as the *crème de la crème* of the field. Tart's big, sky-blue volume quickly became a classic after it was published in 1970, turning up among the India print bedspreads and Grateful Dead records of that era's consciousness connoisseurs. Psychologist Tart still teaches at the University of California at Davis, but he lives, not inappropriately, a two-hour drive away, in the eucalyptus-scented hills of north Berkeley.

After 12 years the first words of *AS of C* still reverberate in my memory: "Beneath man's thin veneer of consciousness lies a relatively uncharted realm of mental activity . . ." This was the resonant beginning of a chapter by psychiatrist Arnold Ludwig on the definition and classification of ASCs. We all slip into altered states at least once a night, Ludwig wrote, for ASCs include routine phenomena like sleep, dreams, and daydreams, as well as the more exotic phantasmagoria of hypnosis, drugs, alcohol, prolonged sleeplessness, fasting and meditation. Sensory isolation is one route to idylls within solitary confinement, the monotony of an arctic winter, the "temple sleep" of the ancient Egyptians, even total-body casts. Paradoxically, sensory *overload*—whirling dervish dances, rock concerts or revival meetings—can take you there, too.

Tart's landmark catalog set out scientific methods for charting these out-of-the-ordinary states, and his m.o. became the questionnaire. He asked pot smokers whether they could identify the moment of transition from "straight" to "stoned" (they couldn't) and codified their experiences in a definitive marijuana study. Querying LSD users, he learned what every acid freak already knew: that the drug sent them into a funhouse of unstable, rapidly metamorphosing states of consciousness that vernacular poets called tripping. But what he proved very early on was that you couldn't equate a certain drug dosage with a certain psychological state, for so much depended on setting, mood, and the user's own psychic structure. No wonder Tart said that so many drearily clinical laboratories reported only reddened eyes, anxiety, and mental confusion with marijuana, bad trips and demons with LSD. Surely, he mused, something beyond bloodshot eyes must be inspiring thousands of college students to risk jail and social censure for a mind-altering toke.

Altered states remind us that we're much more than we think we are," he tells me as the late afternoon sun filters through a curtain with a pattern of serene seated Buddhas. He is a lanky, gentle man, with candid blue eyes and a paced, calm, almost sacerdotal voice. "The orthodox view is that the mind is a biological computer, totally self-contained and limited by physical laws. If you have an experience of leaving your body, becoming one with the universe, or meeting a spiritual being, Western science tells you it's an illusion—just as if you had programmed your Apple computer to say, 'I have just attained oneness with the Ultimate Chip.'

"The implicit assumption is that there is a normal state of consciousness and that all others are degenerate forms of it," Tart says. "But what one person experiences as an altered state may fall into the region of another's ordinary consciousness. We don't all start from the same baseline consciousness either, and we differ widely in our ability to transit from state to state." In his everyday state of consciousness, Tart points out, the inventor Nikola Tesla could design a machine in his head, specifying the parts down to one ten-thousandth of an inch.

Can science ever map inner space? One obstacle is a troubling phenomenon called state-bound knowledge, which is basically the psychological law that some information is not easily transferred from state to state. If you lose your car keys while you're drunk, you might have to drink a few piña coladas the next day to remember where you put them; if you learn the salient provisions of the Treaty of Ghent while smok-

ing marijuana you'll forget them in your European history midterm unless you show up for the test similarly stoned.

Tart believes this phenomenon may explain why religion enthralls some while turning others off. "Most religious teachings," he notes, "are actually state-specific sciences. They make excellent sense in certain altered states, but in other states they turn into empty creeds that people are forced to believe in."

What we need is a Consumer's Guide to Other Mental Realms. "I can envision an expanded psychology of the future in which we give a person a batch of tests and tell him, 'Kundalini yoga would be good for your type of personality, but never do zazen; your type goes psychotic half the time.' But our culture isn't ready for it."

In a way, Western civilization has forgotten a tradition that the !Kung tribesmen are careful to keep alive. "There is tremendous human suffering because we've banished altered states," Tart laments. "We live so immersed in our ongoing psychological processes that we're in a kind of waking trance. And it's normal—everyone's in it."

What Tart proposes is a specialized study of the subjective world he calls "state-specific sciences." Because a purely behavioral study of LSD, for instance, would conclude that the drug was no more than a stupefying sedative, scientists must peer deep within a person's experience instead of just recording outward effects. To that end, Tart recommends that a new cadre of state-specific scientists be trained to enter various ASCs and report the landscape in detail. Is time peculiarly dilated? Space foreshortened? Are the colors vivid, pulsating? What happens to memory, sense of identity, thought processes?

Fortunately, 400 miles to the south, there is a researcher who, despite his obvious philosophical differences from Tart, is trying to answer those very questions.

ANATOMY OF HALLUCINATION

In Los Angeles the freeway medians were ablaze with wild poppies, the California state flower, which it is illegal to pick. I found the City of Angels awash in gurus; a local friend told me she had heard about five different messiahs in the space of a single week.

There is nothing very messianic about the lush, emerald lawns and gleaming Porsches of Westwood, home of UCLA and if psychologist Ronald Siegel is some sort of shaman, he isn't telling. In any case, the UCLA Neuropsychiatric Institute, from which his "brave explorers of the inner world" take off, is off limits to me. Siegel shields his volunteers from the publicity that contaminated Timothy Leary's Harvard studies at the dawn of the Acid Age, and so I was to meet him at a tastefully sparse Westwood apartment/office that, shorn of some psychedelic art, might pass for a trendy orthodontist's office.

"Confound it, Gruenblatt. Without proper scientific and other clinical disciplines, you're still talking theory."

Ron Siegel was born the same year (1943) that the Swiss chemist Albert Hofmann, the father of LSD, accidentally took the world's first acid trip in his lab at Sandoz. By some law of psychopharmacological karma, Siegel, too, first took LSD by mistake. He was weighing a batch of pure Sandoz LSD-25 during biochemistry-of-memory experiments at Dalhousie University in Halifax, Nova Scotia, when some of the white powder stuck to his fingers and found its way into his bloodstream. The result was incandescent.

"We had been using pigeons as the early explorers of hallucination," Siegel tells me. "They were trained to report back the colors and forms they saw by pecking on a light that corresponded to their experience. But when I took LSD, I thought, There is no way pigeons are going to be able to tell us about *this*."

Human subjects, endowed with the gift of speech, soon succeeded pigeons as travelers into the hallucinatory world, and thus began the first thorough, scientific charting of the land of mirages, which Siegel would continue at UCLA with hundreds of volunteers. Though some of them have donated their hours and brains for many years, no one has ever had a bad trip in his lab, according to Siegel.

"In the early years of psychedelic research the drug experience was considered too complicated to describe," Siegel says. "About the most articulate statement you could get from a user was 'Wow!'"

So Siegel went to work on a standardized hallucination code. Using colored slides, he trained his subjects so they could rapidly identify and describe a variety of geometric forms, colors, and patterns of movement.

Soon, out of their darkened, soundproof chambers, the trainees were cataloging their visions with the precision of lepidopterists classifying specimens. "Tunnels moving in a pulsating, explosive way. Green—five hundred forty millimicrons [the precise wavelength]. Now they're overlaid with lattices," they would confide into the intercom every few seconds, under the influence of LSD, mescaline, marijuana, cocaine, amphetamines, and barbiturates.

Visual hallucination comes in two distinct phases, Siegel learned. The first consists of geometric forms; the second of personal imagery, symbols, landscapes, remembered scenes and familiar faces. It is in this second phase that the visionary may converse with gods or see three-headed serpents. Siegel explains, and what had been simile turns into reality. For example, a "psychonaut" who in the first stage would be reporting, "I *feel as if* I'm flying through a tunnel," will begin saying, "I *am* flying through a tunnel."

I find myself staring at an undulating dreamscape that portrays a wraithlike figure wandering through a tunnel. A centerpiece of Siegel's collection of drug-influenced art, it was painted under the spell

of LSD, by a Peruvian shaman's son, and was once coveted by none other than Carlos Castaneda, the UCLA anthropologist-storyteller whom Siegel dubs the "Werner Erhard of psychedelic anthropology."

Siegel was not the first scientist to classify visual hallucinations, and he readily gives credit to one of his mentors, Heinrich Kluver, of the University of Chicago. Kluver's anatomy of mescaline visions in the 1920s and 1930s turned up four basic geometric "form constants"—the lattice or grating, the cobweb, the tunnel or funnel, and the spiral. It did not surprise Siegel when Phase One of *his* voyagers hallucinations also contained the same core content of four shapes, no matter what drug they had ingested.

The reason, Siegel concluded, is that hallucinations are shaped by the brain's actual structure. Neural hardware, not ethereal soulstuff, is behind our cosmic visions and our dismal bummers.

As if to invoke a study aid, he points to a trio of colorful yarn paintings that preside over that half of the room like dignitaries from an alien land. Siegel has visited the artists, Huichol Indians of Mexico's remote and mountainous Sierra Madre, and can specify the blood levels of peyote that produced each painting. "Structurally they are very similar to what our subjects would see on mescaline—latticelike tunnels with bright lights at the center. The revolving deer heads, of course, are cultural. *You* might see revolving magazines or something." The lesson is that the human brain, whether that of a UCLA sophomore or a Huichol sage, is built the same way and can generate only a finite repertoire of visions.

Chemicals aren't the only route to our inner gardens. Siegel and his colleagues have mapped all manner of ASCs from hyperventilation and hypoglycemia to tertiary syphilis, crystal gazing, and migraine attacks. Loss of oxygen to the brain, extreme fear and sleep deprivation. Sensory isolation, sensory bombardment, marathon running, dreaming and daydreaming. "However you stimulate the brain, it will hallucinate," says Siegel, "and it will hallucinate in basically the same way."

But how, and why, does the brain churn out chimeras?

"Think of a man sitting in his study and looking out the window at trees swaying, passing cars, and so on," Siegel proposes. "As night falls, he can't see out the window anymore, but he has a fire burning brightly in the fireplace behind him. Now when he looks out the window, he sees his own reflection and those of the furniture in the room. When it's dark outside, when your senses don't give you access to the real world—as in cardiac arrest, sensory deprivation, or sleep—you see the furniture of your own mind, its stored images. The other way to hallucinate is to overstimulate the brain. You can stoke up the 'fire' on a bright day with a lot of LSD and see internal images superimposed on the outside world."

I ask about mystical experiences, cosmic illuminations, metaphysical truths. Do they boil down to brain mechanics, too? Apparently so, though Siegel admits he tries to keep his visionaries away from the astral plane. "When they start to float away from us, we try to bring them back and keep them on track," he says. "It's safe to say, though, that the similar characteristics of the so-called mystical states—tranquillity, indescribable bliss, and suchlike—don't reflect a common objective reality but an *internal* landscape that is common to all *Homo sapiens*."

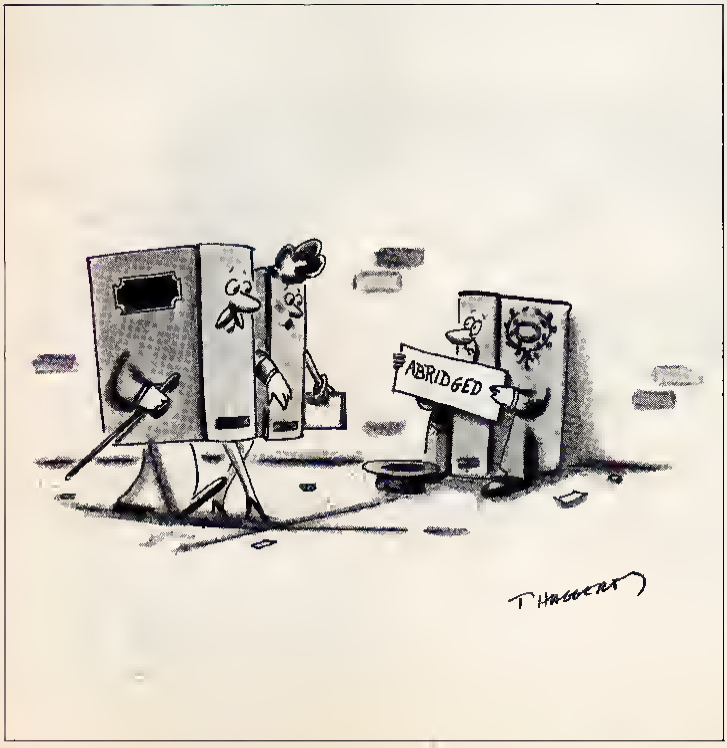
He feels the same way about near-death experiences (NDEs), those ethereal, otherworldly visions reported by patients who are revived from clinical death. The NDE perhaps best crystallizes the difference between Siegel's hard-nosed approach to ASCs and Tart's more expansive attitude. Tart applauds the efforts of University of Connecticut psychologist Kenneth Ring to map painstakingly the common NDE phenomenon of traveling through a tunnel. Ring is asking near-death veterans to describe the "tunnel" in detail. What are the sides made of? What was the means of locomotion? Did they touch the sides? These are questions that acknowledge the validity of the experience, though scientists like Ring and Tart themselves are not claiming the NDE proves there is life after death.

Siegel keeps a safe distance from such matters, preferring to pursue quantifiable data, such as geometric shapes and wavelengths in millimicrons. The psychopharmacologist shies away from discussing the possibility of genuine transcendence—when he does not actually pooh-pooh it—and dismisses the NDE as a mere hallucination caused by oxygen loss in the brain, electrical hyperarousal, and/or dimming sensory systems. The NDE, Siegel says, can be simulated quite easily with a dose of ketamine, a superpotent cousin of angel dust.

"Isn't it interesting," Siegel adds, warming to one of his favorite topics—the naiveté of life-after-death believers—"that in the afterlife the loved ones are always fully clothed, preserved just the way we remember them from the family album? We've also had descriptions of golf courses, even condominiums, on the Other Shore."

Siegel at all times maintains the image of the hip, living-in-the-world psychologist. Some might say he has paid the price of harsh reality. To fund his research and remain independent of the usual government grants, he hires himself out to prosecutors and defense attorneys as a forensic drug expert and, as such, has testified to the state of mind of such celebrity defendants as Manson family member Leslie Van Houten.

At one point in the interview he produces a pile of Polaroid snapshots, passing them to me in sequence as he tells me a Chicago murder tale. The accused in this



case was full of LSD and alcohol and Siegel had been called in as an expert witness for the prosecution. The police photos led, as I knew they would, to a gruesome denouement: the decapitation of a twelve-year-old boy and the repeated rape of his mother. In the last photograph a little boy in flannel pajamas lies apparently asleep in his bed, except that his head and neck are joined together by a jagged red crack, like a badly glued doll. "So you see LSD experiences are not necessarily transcendent," Siegel says.

Though he does not believe in an immortal soul beyond the complex wiring of the brain, he speaks casually of future contacts with extraterrestrials. As a matter of fact, Siegel hopes his cartography of inner space will help man feel more at home in outer space. "I remember when, on one Apollo mission, one of the astronauts got very excited and compared the experience of orbiting the moon to what he imagined having a baby would be like," he tells me. "We need a more refined vocabulary to describe those experiences—of weightlessness, of being on another planet, and so on. When we contact extraterrestrial worlds, populated or not, we're going to be overwhelmed by a lot of alien sensory input, and understanding an alien environment of our own can prepare us."

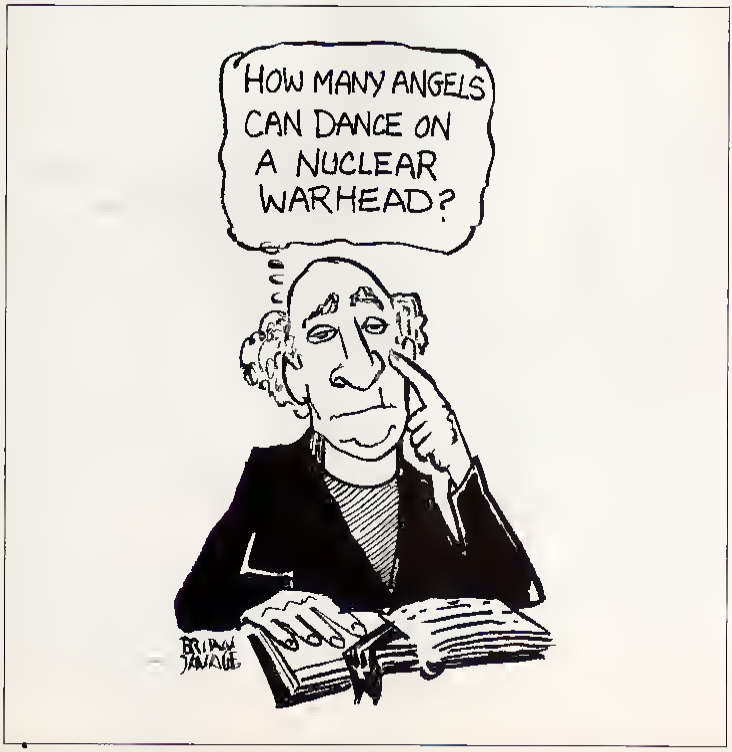
Another future use of his standardized introspection codes is interspecies communication. "Pigeons, monkeys, and other animals have communicated their hallucinations which aren't so different from ours. That brings us a little closer to other species. And you know animals have religious experiences too." A faint smile crosses Siegel's chiseled lips. "Oh, yes, we once trained a pigeon named Noah to genuflect in front of a cross."

Why do such scientists as Siegel, steeped in no-nonsense behaviorism, devote their professional lives to scrutinizing altered states? Well, for one thing, scientific control over the inner world can give us entree to hitherto untapped information from dreams, daydreams, and reverie states. Dream interpretation could become a more exact science. Psychiatrists could learn to communicate with schizophrenics in mid-hallucination, as Siegel himself has done. He once persuaded a schizophrenic patient to lead him into her private hallucinatory land of Nid, a place peopled with lavish winged wolves, dragons, and other whimsical creatures. "She spent a lot of fantasy time in Nid, where she had a job painting murals on the castle walls," he recounts. "Her therapists were pulling on one hand and saying, 'Come back, this isn't real,' while a dragon was pulling on the other. She was suicidal. I went with her on a mind trip to Nid, where she introduced me to all the characters and they started talking to me. I taught her techniques for controlling and describing her images. I could do that because of the experience I'd had as a subject in my own hallucination experiments." A delicate, otherwordly landscape of Nid painted by the patient hangs over Siegel's pet Central American cactus plants.

I ask Siegel about future pharmacological utopias, custom-designed drugs to tinker with our mental life. "If we don't create them, our underground alchemists will," he surmises. "One of my dreams is to find a safe recreational drug, something like Aldous Huxley's *moksha*, a truth-and-beauty pill. Coca, the Andean leaf that contains about 1.5 percent cocaine, comes closest, according to Siegel. The runner-up is psilocybin, or "magic mushroom," the drug Siegel's adventurers preferred over all others. But psilocybin and coca still aren't *moksha*. The ideal mind-bender must be absolutely nontoxic, pharmacologically pure, and capable of having the visions it produces turned on and off at will.

Do not leap to the conclusion that Siegel is an apostle of illicit substances. He has appeared on television shows and in mass-circulation magazines lecturing on such topics as the dangers of freebasing cocaine. "But we have to recognize that people are selecting chemicals to regulate themselves right now, and they're not happy with a two-week vacation a year to alter their consciousness," he points out. *Homo sapiens* obviously hungers for altered states. Siegel proclaims in his book *Natural Intoxication* probably out of the same urge that impels all mammals to wander around and sniff out new scenes.

I wonder at the array of hallucinators who have passed under Siegel's scrutiny: Migraine sufferers; people who were 'abducted' by UFOs; sleep-starved visionaries; Andean Indians nibbling bitter coca leaves; spelunkers trapped in caves and drug-testers; Prisoners of war; shipwrecked sailors; and hostages—whose altered states, Siegel says, are provoked by a mixture of isolation and the threat of death. John Belushi's face stares out of eternity from a glossy *People* magazine cover on Siegel's coffee table. Perhaps it is true, as one poet remarked, that humankind cannot bear very much reality. But where, after all, is Reality or a drug-haunted vision of deer heads encoded in the human brain?



THE STRIPED BRAIN

On Siegel's suggestion I take my nuts-and-bolts questions to Jack Cowan, a University of Chicago biophysicist who has just completed a study of the neurocircuitry of visual hallucination. With a complex mathematical model, Cowan has deduced that when the brain is stimulated beyond a critical threshold, it automatically produces visionary shapes. And, lo and behold, these shapes look very much like Kluver's four "geometric constants," the same images that Siegel's trainees conjured up in their vision chambers.

"Then I worked out what the patterns are actually like inside the brain," Cowan tells me. "There's a distortion in the pathway

from the eye to the brain. The images *inside* the brain are simple—basically stripes. The stripes are really standing wavefronts of firing neurons separated by layers of inactivated neurons.

"What causes the stripe patterns in the brain's circuitry that we project outside us as cobwebs, lattices, and other visions?" I ask.

"It turns out that noradrenaline and serotonin are the brain chemicals that control the brain's excitation," he explains. "Whenever you increase noradrenaline or shut down serotonin, that stimulates the cortex. You destabilize the brain's resting state—where there's essentially no pattern—and you get certain patterns."

LSD and other hallucinogens disturb the brain's noradrenaline/serotonin balance, and so most likely do other vision-inducing states, says Cowan, from near-death crises to dreams.

Lattices and tunnels are all very well, I reflect, but how does the brain generate Phase Two of the hallucinatory process? The stripe patterns of neural excitation, Cowan informs me, apparently move forward from the occipital (visual) cortex at the back of the head, and as they travel foward the forebrain, hallucination becomes more symbolic, and more abstract.

"Here, when a stripe of cells becomes activated, each of those cells codes not just a simple geometric property but something very, very complicated, and we just don't know how to read that yet," he says. "But we can account for some interesting phenomena. A hallucinating person tends not to see a single image of a face but a whole row of faces. There's also megalopsy and micropsy, when objects suddenly grow very huge or very tiny, like Alice in Wonderland. We know the mechanisms for that aren't in the primary visual cortex at the rear of the brain, but farther forward, in the inferior temporal cortex. So already the excitation is moving forward. We can probably get our hands on some of these phenomena."

JOAN OF ARC'S VOICES

A vista of pulsing spirals overlaid with cobwebs is a far cry from St. Teresa's ecstasies or the numinous truths of a Hindu holy man's *samadhi* trance, Ron Siegel's assurances notwithstanding. Though he had told me confidently, "If we tested Socrates or Joan of Arc, I think we'd be able to classify their experiences comfortably with our code," I am not so sure. I decide to query other scientists about these rarefied states that Siegel would record as mere exotic variations on the hallucination theme.

"There's a democratic assumption that we're all at the same level of consciousness, and that's wrong," contends psychologist Theodore X. Barber (the X. is for Xenophon). He is one of the world's preeminent hypnosis authorities and no stranger to other out-of-the-ordinary states, from LSD trips to mysticism. "Just recently," he says, "we've found a group of people who live in a very different place *all the time*, and this has important implications for understanding consciousness." These altered-state dwellers, whom Barber has baptized "fantasy-prone personalities" (FPPs), compose about 4 percent of the population, and they're more likely to be female. Natural visionaries of sorts, they can voluntarily weave hallucinations that are "as real as real" in all five senses.

Yet these FPPs are not raving psychotics. At Cushing Hospital, in Framingham, Massachusetts, Barber and colleague Sheryl Wilson compared the heavy fantasizers with a control group and found them no better or worse adjusted. They are simply the Mozarts of introspection, blessed with a remarkable talent. Seventy-five percent can reach sexual climax in pure fantasy, for example; all can fantasize themselves on the Nile while simultaneously carrying on cocktail-party chatter. As children they grew up accompanied by fairies, elves, guardian angels, and imaginary playmates and saw their dolls and toy animals as living beings with distinctive personalities.

Fantasy-prone types, Barber says, are also extremely hypnotizable: vivid dreamers, naturals at guided-imagery meditation, and so easily overwhelmed by LSD and marijuana that they eschew drugs. "You see, it's all the same state," Barber asserts, speaking at 78 rpm, at least, spilling facts into my tape recorder as if his brain were overpopulated with data. "They're hypnotized, and they go into deep hypnosis; they go to sleep, and they dream lucid dreams; they take drugs, and their hallucinations become much too vivid. It's the same fantasy state behind it all the time."

Fantasy-prone people's lives are uncommonly cluttered with clairvoyant dreams, precognitions, psychic healings, out-of-body experiences, regressions into past lives, and other paranormal adventures, Barber suggests. Out of their ranks, he speculates, have come such famous visionaries as Joseph Smith, Madame Blavatsky, the Theosophist, St. Bernadette, and Joan of Arc, the twelve-year-old whose divine communications were so compelling they persuaded the French king to let her command his armies.

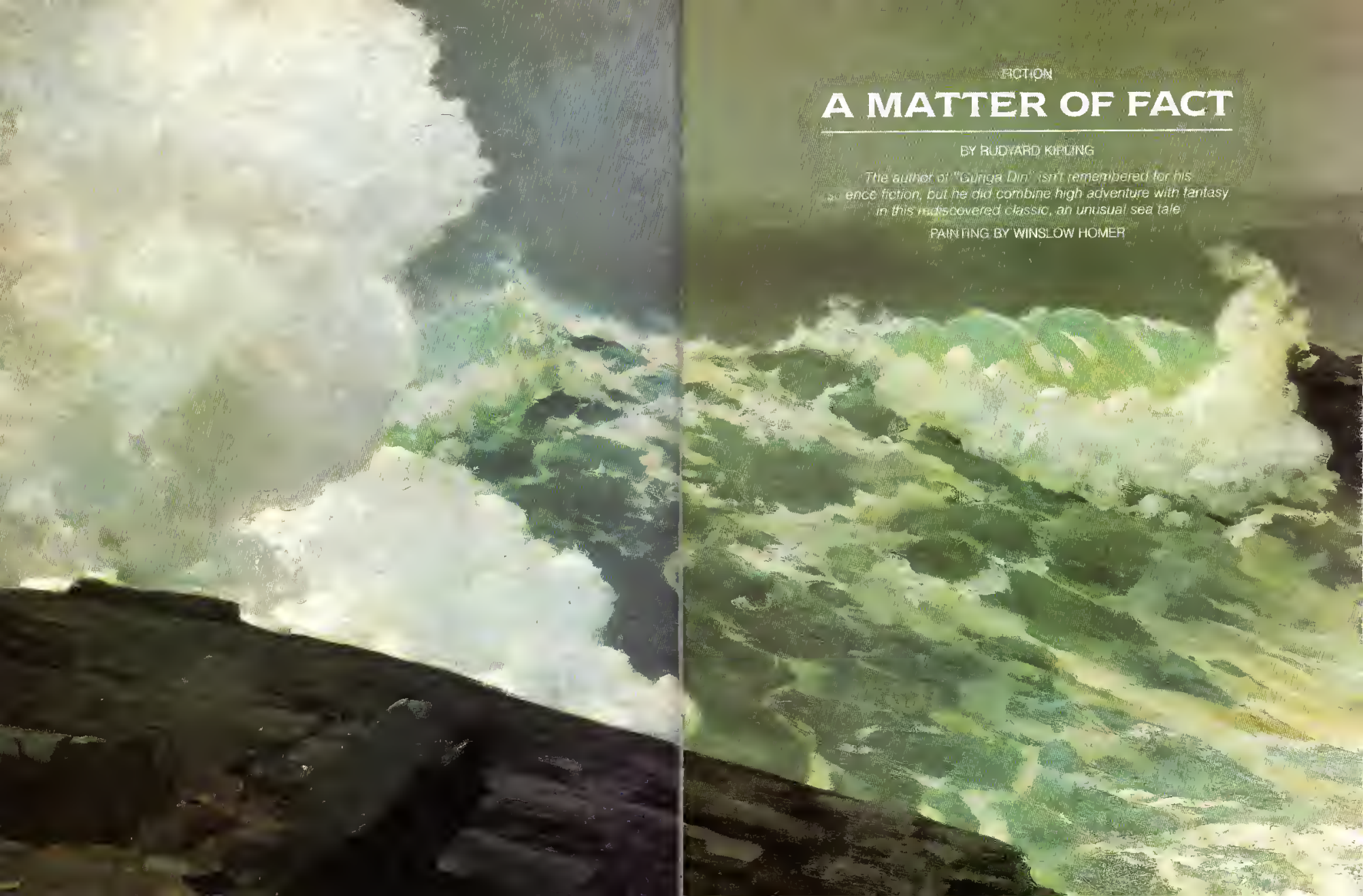
"Does this mean these things are just fantasy?" Barber asks himself. "Maybe. Or maybe they are actually perceiving another reality."

"If you peered into the gray matter of a fantasy-prone person," I ask him, "would you find anything special there?"

"Yes, I'm sure you would," he replies. "Our experiences affect our whole neurological structure. These people have spent so much time fantasizing that it probably has specialized their brains."

How? Ah, there's the rub. A few researchers, such as biofeedback pioneer Elmer Green, of the Menninger Founda-

CONTINUED ON PAGE 159



FICTION

A MATTER OF FACT

BY RUDYARD KIPLING

The author of "Gunga Din" isn't remembered for his science fiction, but he did combine high adventure with fantasy in this rediscovered classic, an unusual sea tale

PAINTING BY WINSLOW HOMER

And if ye doubt the tale I tell
Steer through the South Pacific swell
Go where the branching coral hives
Unending strife of endless lives,
Where, leagued about the wildered boat
The rainbow jellies fill and float;
And, lilting where the laver lingers
The starfish trips on all her fingers,
Where 'neath his myriad spines ashock
The sea-egg ripples down the rock
An orange wonder dimly guessed
From darkness where the cuttles rest
Moored o'er the darker deeps that hide
The blind white Sea-snake and his bride
Who, drowsing, nose the long-lost ships
Let down through darkness to their lips

—THE PALMS

Once a priest always a priest, once a Mason, always a Mason but once a journalist, always and forever a journalist.

There were three of us all newspapermen, the only passengers on a little tramp steamer that ran where her owners told her to go. She had once been in the Bilbao iron ore business, had been lent to the Spanish government for service at Manila, and was ending her days in the Cape Town coolie trade with occasional trips to Madagascar and even as far as England. We found her going to Southampton in ballast and shipped in her because the fares were nominal. There was Keller, of an American paper, on his way back to the States from palace executions in Madagascar; there was a burly half-Dutchman called Zuyland, who owned and edited a paper up country near Johannesburg; and there was myself, who had solemnly put away all journalism, vowing to forget that I had ever known the difference between an imprint and a stereo advertisement.

Three minutes after Keller spoke to me, as the *Rathmines* cleared Cape Town, I had forgotten the aloofness I desired to feign and was in heated discussion on the immorality of expanding telegrams beyond a certain fixed point. Then Zuyland came out of his stateroom, and we were all at home instantly, because we were men of the same profession needing no introduction. We annexed the boat formally, broke open the passengers' bathroom door—on the Manila lines the Dons do not wash—cleaned out the orange peel and cigar ends at the bottom of the bath, hired a Lascar to shave us throughout the voyage, and then asked each other's names.

Three ordinary men would have quarreled through sheer boredom before they reached Southampton. We, by virtue of our craft, were anything but ordinary men. A large percentage of the tales of the world, the thirty-nine that cannot be told to ladies, and the one that can, are common property coming of a common stock. We told them all, as a matter of form, with all their local and specific variants, which are surprising. Then came, in the intervals of steady card play, more personal histories of adventure and things seen and reported: panics among white folk, when the blind terror ran from man to man on the Brooklyn Bridge, and the people crushed each other to death they knew not why; fires, and faces that opened and shut their mouths horribly at red-hot window frames; wrecks in frost and snow reported from the sleet-sheathed rescue tug at the risk of frostbite; long rides after diamond thieves; skirmishes on the veldt and in municipal committees with the Boers; glimpses of lazy, tangled Cape politics and the mule-rule in the Transvaal; card tales; horse tales; woman tales by the score and the half hundred, till the first mate, who had seen more than us all put together, but lacked the eloquent words to clothe his tales with, sat open-mouthed far into the dawn.

"The sun rose in a perfectly clear sky and struck the water with its light so sharply that it seemed as though the sea should clang like a burnished gong."

When the tales were done, we picked up cards till a curious hand or a chance remark made one or other of us say, "That reminds me of a man who—or a business which—" and the anecdotes would continue while the *Rathmines* kicked her way northward through the warm water.

In the morning of one specially warm night we three were sitting immediately in front of the wheelhouse where an old Swedish boatswain, whom we called Frithiof the Dane, was at the wheel, pretending that he could not hear our stories. Once or twice Frithiof spun the spokes curiously, and Keller lifted his head from a long chair to ask, "What is it? Can't you get any pull on her?"

"There is a feel in the water," said Frithiof, "that I cannot understand. I think that we run downhills or somethings. She steers bad this morning."

Nobody seems to know the laws that govern the pulse of the big waters. Sometimes even a landsman can tell that the solid ocean is a-tilt and that the ship is working herself up a long unseen slope, and sometimes the captain says when neither full steam nor fair wind justifies the length of a day's run, that the ship is sagging downhill, but how these ups and downs come about has not yet been settled authoritatively.

"No, it is a following sea," said Frithiof, "and with a following sea you shall not get good steerageway."

The sea was as smooth as a duck pond except for a regular oily swell. As I looked over the side to see where it might be following us from, the sun rose in a perfectly clear sky and struck the water with its light so sharply that it seemed as though the sea should clang like a burnished gong. The wake of the screw and the little white streak cut by the log line hanging over the stern were the only marks on the water as far as eye could reach.

Keller rolled out of his chair and went aft to get a pineapple from the ripening stock that were hung inside the after awning.

"Frithiof, the log line has got tired of swimming. It's coming home," he drawled.

"What?" said Frithiof, his voice jumping several octaves.

"Coming home," Keller repeated, leaning over the stern. I ran to his side and saw the log line, which till then had been drawn tense over the stern railing, slacken, loop and come up off the port quarter. Frithiof called up the speaking tube to the bridge and the bridge answered, "Yes, nine knots." Then Frithiof spoke again, and the answer was, "What do you want of the skipper?" and Frithiof bellowed, "Call him up."

By this time Zuyland, Keller and myself had caught something of Frithiof's excitement, for any emotion on shipboard is most contagious. The captain ran out of his cabin, spoke to Frithiof, looked at the log line, jumped on the bridge, and in a minute we felt the steamer swing round as Frithiof turned her.

"Going back to Cape Town?" said Keller.

Frithiof did not answer, but fore away at the wheel. Then he beckoned us three to help, and we held the wheel down till the *Rathmines* answered it, and we found ourselves looking into the white of our own wake with the still-oily sea tearing past our bows, though we were not going more than half-steam ahead.

The captain stretched out his arm from the bridge and shouted. A minute later I would have given a great deal to have shouted, too, for one half of the sea seemed to shoulder itself above the other half and came on in the shape of a hill. There was neither crest, comb, nor curl over to it, nothing but black water with little waves chasing each other about the flanks. I saw it stream past and on a level with the *Rathmines*'s bow plates before the steamer made up her mind to rise, and I argued that this would be the last of all earthly voyages for me. Then we rose for ever and ever and ever, till I heard Keller saying in my ear, "The bowels of the deep, good Lord!" and the *Rathmines* stood poised, her screw racing and drumming on the slope of a hollow that stretched downward

CONTINUED ON PAGE 144

VIDEO WIZARDS

A tour of the toyshops of Silicon Valley reveals that the next wave of video games will be a breed apart—faster, tougher, and smarter

BY PHIL WISWELL

Bernie DeKoven is a little round elf of a man with a bald head and bushy beard who likes to spend some of his more creative moments sitting on his sun-drenched porch in Palo Alto, California, thinking such thoughts as *What would I really like to play with?* His thoughts are of special interest to those in the billion-dollar video-game industry since what DeKoven likes is very often what several million people will pay to play

DeKoven is a senior game designer with a Silicon Valley computer software company named Epyx Automated Simulations His job is to create new games that will be developed and sold for use with home computers like the Apple II and the Atari 800 DeKoven's success at this can be measured equally by his comfortable salary and his happiness with the medium of the microcomputer. At forty years of age, he has been a game designer—both as a

PHOTOGRAPH BY JOE SOHM

freelancer and as an employee of companies like Ideal Toys—most of his adult life. In all those years he admits he has never found a tool for creating games as exciting and as versatile as the computer. "It's the Swiss Army knife of the mind," he says.

Right now DeKoven is unique in the burgeoning video-game industry. One would expect him to have an engineering or computer science degree, but he has neither. His academic background consists of an undergraduate degree in English literature and a graduate degree in theater. He doesn't write computer programs and makes no pretense about being an expert on the technology. The skill he brings to his work is strictly the creativity of a game designer.

Because of the technical nature of the medium, video-game manufacturers have usually relied on computer programmers to do their designing. And it shows. If you run your finger through the list of game categories today—shoot-em-ups, race games, maze games, and so on—you will find at most one or two original ideas in each group.

Some of this situation is changing. As more younger players find it increasingly easier to beat or "max out on" current games like Space Invaders and Pac-Man, and as more adults beyond the average twelve- to eighteen-year-old age group become fascinated by video games, the manufacturers are beginning to see a demand for games that are more intellectually sophisticated and more challenging. And so they are turning to more creative types: game designers or computer programmers who have the originality of a good game designer.

What new games are being programmed now? To answer that question I took a walk through the game-design labs of three of the most creative software companies in Silicon Valley to get a sneak preview of what's under development. But before talking about that, a little background would be helpful.

Most video-game players begin at the pay-for-play arcade games. In time they reach the point where they desire electronic entertainment on their own terms—having the game available day or night, with no long lines and no obligation to pay 25 cents each time. That is why *home* video-game sales soared to $1.2 billion in 1981 and are expected to double this year.

Today home video games (as opposed to arcade games) can be divided into two categories: ROM (Read-Only Memory) cartridges used with popular game systems like Atari's VCS (Video Computer System) and Mattel's Intellivision, and cassette tapes or floppy discs for home computers like the Atari 400 and 800, the Apple II, or Radio Shack's TRS-80.

In the industry, Atari is the leader. It is the only company that makes games for arcades, home computers, and home game systems. This wide experience, along with its early entry of the VCS, has allowed it to get and hold 70 percent of the home video market. Today there are about 7 million of its VCSs attached to American television sets. After Atari comes Intellivision, which puts out a more sophisticated and more expensive system. In use in 1 million homes. Until recently, North American Philips's Odyssey[2] and Astrocade's Astrocade were the only other home systems available, but this year they face competition from as many as seven new home game machines. Some, like Coleco's Colecovision and the new 5200 machine from Atari, will compete for a share of the market with more technologically advanced hardware. Others, from companies like Tryom and Emerson Radio, will compete by offering comparable machines that are priced lower.

But the majority of those rushing into the business are not building game-playing hardware. They prefer to concentrate on program cartridges that play on another company's system. The reason: Last year

> *In Pitfall the player has to run his little man through jungles in search of treasure, jump him over cobras, and swing him over tar pits and crocodile-infested swamps.*

home video-game players bought 30 million game cartridges, paying between $20 and $40 for each of them. The big bucks are clearly in software.

Today a score of companies are making games for the VCS. Many of them are communication giants like CBS, Lucasfilm, 20th Century-Fox, Paramount, Thorn/EMI, and Disney Productions, all of which have recently formed video-game divisions. What no doubt inspired them was the fact that in 1981 Atari itself, owned by another giant, Warner Communications, brought in more money than the blockbuster film *Star Wars*.

Any video-game system is really nothing more than a limited microcomputer, and the microcomputer industry is still in its formative stage, marked by some growing pains. For one thing, there is no standardization. Companies must now produce games to be played on specific machines. A game designed for the VCS will not work on Intellivision, nor will it work on Atari's home computers. Similarly, the Apple II, the Atari 800, and the TRS-80 computers cannot use one another's software.

Eventually, analysts predict, the video-game market for the VCS and microcomputer will merge into one. Using the attraction and familiarity of video games as a sales tool, the industry will mass-market home computers. There are about 10 million game systems in use in homes now, and only about 1 million home computers, but by 1990 this ratio is expected to be reversed. For that to happen, manufacturers will have to produce a computer that offers three features: high resolution or the ability to "paint pretty pictures" on the screen, high-speed graphics, the ability to move many objects around the screen quickly, and a low price tag. The best guess is this machine is at least three or four years into the future.

Currently the software firms are designing for both game systems and computers. One firm that has had phenomenal success at this in its brief three-year history is Activision. Last year, for example, its software sales totaled $65 million, which placed it second only to Atari. For the most part, Activision's games have had a reputation for being graphically beautiful and easy to learn. Some, like designer David Crane's Freeway—in which the player tries to move his video chicken back and forth across a crowded freeway without having it get run over—are also humorous, even cute. In Pittall, Crane's new game, the player must run his little man through a series of jungle scenes in which he searches for treasure, has to jump over cobras, scorpions, and rolling logs, and swings on a vine over tar pits, lakes that appear and suddenly disappear, and crocodile-infested swamps. Even Johnny Weissmuller would find it challenging.

Activision was the first company to jump on the VCS bandwagon. It was also the first to promote its game designers as superstars, according them almost the same status as performing artists. Activision game packages always include a photograph of the designer, together with liner notes from him offering tips on playing the game. As a result, the designers now receive an average of 7,000 fan letters and hundreds of phone calls *each week*. Some of the more prolific designers, such as Crane, often find themselves stopped on the street by twelve- and thirteen-year-old video game fans and asked for autographs.

But Activision designers do not slavishly produce games with their fans in mind. "Our guys really design for themselves," says Tom Lopez, vice-president of editorial development for the company. "And they like to play games. I think that's most important. When I look for a game designer, the first question I ask is, 'What is your favorite video game?' I then ask for their best score. And there can't be any hesitation in their answers. They have to be video-game fanatics. They have to love it, live it, breathe it. Our guys design all day long, and for relaxation they go home and play games."

This, as I found out, is no idle boast. Activision's designers' idea of treating me to lunch was to go for a couple of slices of

pizza, a cola, and several dozen video games at a Chuck E. Cheese Pizza Time Theater, one of a chain of pizza parlor game rooms founded by Nolan Bushnell, the man who created Atari. The designers often go there to check out the work of the competition, to get new game ideas, and just to have fun.

At this stage of the business, Activision still feels video-game design is more of a science than an art. Crane thinks a non-technical person could not program successfully for the VCS because he or she would probably have to shelve 999 of 1,000 game ideas partway through the design process. Because of their limitations, the VCS and, to a lesser extent, Intellivision demand a high level of technical knowledge in a designer, Crane says. The VCS represents only about $20 worth of six-year-old electronics, and designers must know how to stay within the peripheries of this technology. For all practical purposes, *designer* and *programmer* are interchangeable terms at Activision.

The same holds for the creative group of Imagic, Inc., a smaller but no less eager software company that was formed a little over a year ago by two executives from Atari, two from Mattel, and half a dozen Atari game designers. Already they have developed seven VCS games and five more for Intellivision.

The development cycle for a new game at Imagic is four to six months, which might lead you to believe that a game designer does more playing around than is necessary. "The fact of the matter," says Dennis Koble, vice-president of software development and an Imagic designer himself, "is that every step of the process is so fraught with defail that I cannot write a section of code and expect that program to do what I envision."

The code Koble refers to is known as machine language, long strings of ones and zeros that form instructions for the microprocessor. The VCS and Intellivision don't understand English or even BASIC, a commonly used English-like computer language. They understand only machine language. To illustrate just how primitive the VCS is, one BASIC instruction to have the machine print a single word on screen translates to more than 50 steps in machine language. To help the programmer, designers use an "assembly language" that converts a program to machine code.

Essentially there are three steps that Koble, or any video-game designer, must go through when developing an idea. The first is to write a program in assembly code and store it. The second is to convert the program to machine language. And finally to try it out in the VCS or Intellivision and see whether it does exactly what it is supposed to do. "Since it never does," Koble says, "you go back and debug."

Because this process of debugging, or finding and correcting errors, can confuse even the best programmer, it is common practice to work on only one section of a game at a time. Typically, a designer will spend a week to more than a month just creating the basic game format, trying different colors and shapes to get the picture right. Particularly time-consuming was the right look for Atlantis, Koble's newest game, now under development for the VCS and Intellivision.

The idea for Atlantis had been on Koble's mind for months, but only as a very general concept. First he sketched out the idea on paper, keeping game elements at their simplest because, in his words, "a truism that has run through the industry for years is that we [the game manufacturers] have consistently overestimated the intelligence of the player and consistently underestimated his dexterity."

Atlantis is a game with a theme, a feature that players seem to enjoy. In Atlantis hostile aircraft besiege the underwater city, which the player must defend with three laser guns. Like many games of this genre, the player faces increasingly more formidable waves of attack that do not seem to underestimate his dexterity.

Still, there will be many players who will want more. And Imagic will give it to them soon with the release of a sequel to Atlantis, Cosmic Ark. When a player's last fortification in Atlantis has been destroyed, a small ship can be seen escaping from the city just before the game turns off. This intimates that while Atlantis had been annihilated, part of the player's force always survives and is able to get away. This ship reappears in Cosmic Ark, in which the player's goal is to repopulate Atlantis by flying to many different planets in the galaxy, fending off asteroid storms, and bringing two creatures (one male and presumably one female) back from each planet to the starship via tractor beams.

Like the most successful games, Atlantis and Cosmic Ark can be learned almost instantly, with one play of the game. One fact that has been established by the coin-op industry over the years is that *nobody* reads instructions," Koble says. "I don't care who the player is, or what background or experience he has, I don't read instructions. If you can't figure out how to play just inherently picking it up as you go, it isn't worth your money."

DeKoven agrees. In his view, the reason for this is that the video-game industry has unwittingly created a new and powerful language based on what DeKoven calls the "videoglyph," a combination of changing colors, shapes, and sounds linked to a physical response. For example, successfully moving a paddle to intercept and reverse the path of a ball on screen is a simple videoglyph. "It is a symbolic language that instantly conveys concepts, like the Egyptian hieroglyphs," he says. "Unlike hieroglyphs, however, the videoglyph is not static. It is a language whose characters can change as you read them." Part of the fun for players is that they are able

"Sure she looks good now. But under her wig and makeup, she's still a cockroach."

to understand this language intuitively. A good video gamer can walk up to a new machine, plunk in a quarter, and stay alive, for a while anyway, without having read the instructions.

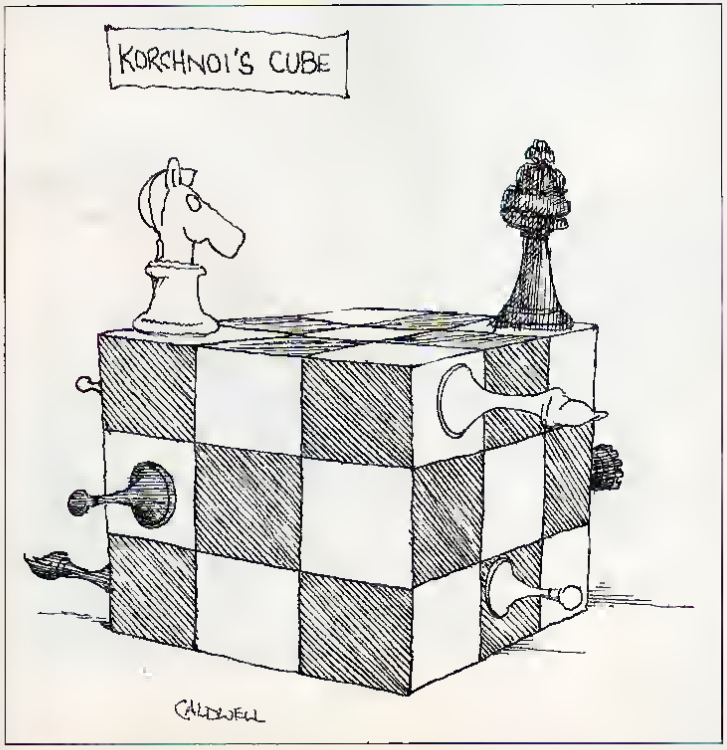
What DeKoven sees as part of his challenge of game design is to add to this vocabulary of videoglyphs. One thing that he thinks will expand it enormously is the home computer, which typically has a larger memory and is capable of more elaborate graphics than game-only machines. Games designed for it can therefore be more complex, more involving. Much of the computer game software available today falls into either of two categories: adventure games or arcade-style games, in part because programmer/designers have been content merely to use new effects with game concepts that have already been proven. "The microcomputer is a wonderful tool," DeKoven says. "Why use it to simulate only existing game concepts?"

Why indeed, you may ask yourself once you've seen Ricochet, DeKoven's first computer board game. Not only is Ricochet a game of pure strategy (as opposed to hand/eye coordination), but a player's move is depicted on screen with arcade-quality graphics that make the game as entertaining to watch as it is exciting to play. And, unlike video games that are merely computerized versions of real-world games like football, Ping-Pong, or a simulation of war, Ricochet is something that could have been put together only in a computer. In real life, the game just could not be played without a frictionless billiards table.

Ricochet is a two-player board game with five variations. (For the sake of simplicity, I will describe only one.) Two humans can play against each other, or a human can play against one of four computer opponents, each with a different strategic style. A player occupies either end of the board and controls two video ball launchers and six pieces that look like bars that are initially arranged in a bowling-pin type of formation in front of a goal. With each turn a player has one of two options: shoot a ball from a launcher, or shift one, or all, of his pieces to block an opponent's shot or facilitate one of his own.

The object of Ricochet is simply to get the most points by the end of the game. The game ends when one player has run out of balls or when both his launchers have been destroyed.

When a player fires a ball, it always ricochets off the sides of the screen like a high-speed billiard ball. Each time the ball caroms off one of the individual bars, it scores one point, and every time it ricochets off the opponent's goal, it scores ten points. The more ricochets—that is, the more tricky angle shots a person can make with each ball—the more points he can score. The essential strategy of Ricochet is deciding whether to make a shot or to move a piece.



Like a pinball game, the more rebounds, the more points a player can get. Some players try an intuitive approach to keep the ball ricocheting, but more often than not it is a well-calculated shot that rewards the player with plenty of rebounds, plenty of points, and a nice graphics display. "This," DeKoven says, "is the end of my search for the ultimate bounce."

He says he can usually come up with a game concept in a week, as he did with Ricochet. Design and production of the game, however, can total eight or nine months. With Ricochet, he began roughing out the idea at his home studio, experimenting with boards of various sizes and shapes and using matchsticks to represent the elongated pieces. After a week of this, Jim Connelley, the president of Epyx, looked at the game design and was so fascinated he sat down and programmed the video game—board and pieces—in one day so that DeKoven could go to work on the specifics. Originally, when the ball hit a goal, it was supposed to bounce out of play, but a bug in Connelley's program let the ball continue to bound into play and allowed the shot to last longer. DeKoven liked that so much, he incorporated this extended bounce into the game and named Connelley codesigner.

What makes Ricochet stand out from so many other games is that DeKoven created many variations for it, not just the one basic scenario most board games offer. This way a player can find one that suits his or her skill and interest levels. DeKoven now wants to reach further than that. "One of the delights of playing on a computer," he explains, "is that it allows you to enter other realities." Witness another DeKoven game, Alien Garden.

The idea of Alien Garden centers upon a figure-it-out-as-you-go experience that will subtly test and develop analytical skills. In an alien world presented to you by the computer, you move an insectlike figure through a videoscape in which there are 19 different kinds of crystals that do things like shrink, grow, explode, shy away, and so on. Some crystals are edible and give a player strength (and points). Some are deadly and explode on contact. And others will disappear from the screen if you stroke them with one of the creature's wings. Once someone has played the game long enough to perceive these laws, he will understand the behavior of the crystals. Like real crystals, the video ones will grow on the screen geometrically and according to their individual characteristics. Although it is supposed to be a game, it is just as pleasant to sit back and watch the crystals grow; the effects are so stunning.

Going from idea to machine code to any videoglyph is not simple even for the best of designers. DeKoven, who is happy with his job, admits that working on video games has its down side. What could be depressing about thinking up games? Well, for example, he has a concept for a game that would visually simulate the flight of an ea-

gle its hunt for prey and the dive—all from the eagle's perspective But he can't produce it because it's impossible to produce the graphics that could portray the game realistically

There are technologies that might help One is to connect the computer to an interactive video disc containing thousands of detailed computer images Using holographically portrayed surroundings in 3-D is another Although both are feasible they are also too expensive right now

A DeKoven idea for the near future is his concept of a Fitness Arcade It would eliminate the drudgery of keeping fit by giving the person exercising some sort of fantasy environment to work out in Take something like a rowing machine "The player slips a twenty-five-dollar token into a slot" DeKoven says "In front of him is a very detailed video screen He now finds himself sitting on a raft, which he must try to guide through whirls, eddies, and currents He might even find himself being chased by frightening creatures"

The difficulty of the course shown on the screen and the tenacity of the creature would increase in proportion to how well the player is doing The machine would also monitor the rower's pulse through the sensors in the handle grips It would also monitor how many strokes the rower is making and how full they are Each rower would have a maximum heart rate prescribed for him according to an exercise program and the game would shut off once he reached that rate The technology is already available to build this, DeKoven asserts The cost a few thousand dollars more than that of a Nautilus machine

As futuristic as the Fitness Arcade sounds, DeKoven can top it. He recently visited a Berkeley, California, company named Autogenics, which makes biofeedback equipment for the medical industry Autogenics has a machine that senses alpha waves, which are produced by the brain in a relaxed or meditative state and that allows a person in an alpha state to move an object on a video screen simply by thinking about it Instead of a joystick the person uses a headband and instead of snapping and jerking his wrist back and forth, the player just relaxes and tries to let it happen

"The game that I am proposing for their machine" he explains, "is a telekinetic game You would see on the screen before you a table with three fragile objects on it As you meditate or relax, one of the objects starts to rise off the table The better you get the easier it is to elevate it and move it around If you lose your concentration, the object falls and breaks and you lose points As you begin to explore the possibilities, you will find you can make the objects move around simultaneously perhaps almost juggling them Then of course the game will try to keep up with your skills by introducing more objects onto the table Did I tell you about my two-player telekinetic game concept ...?

THE EYE OF REALITY

BY ROBERT SHECKLEY

Legend tells of a nameless planet located on the edge of our island universe. On that planet there is a single tree. Wedged in its topmost branch is a large diamond, placed there by a long-vanished race. Looking into the stone, a man may see all that is or was or may be. The tree is called the Tree of Life and the diamond is called the Eye of Reality.

PAINTINGS BY MICHAEL PARKES

Three men set out to find this tree. After much danger and difficulty, they came to the place where it grew. Each in turn climbed to the top of the tree and looked through the gem. Then they compared their impressions. The first man, an author of considerable reputation, said, "I saw innumerable actions, some grand and some petty. I knew then that I had found the keyhole of the universe, which Borges calls the Aleph."

The second man, a renowned scientist, said, "I saw the curvature of space, the death of a photon, and the birth of a star. I realized that I was looking into a superhologram, self-created and self-creating, whose entirety is our universe." "Understanding is sensuous," said the third man, an artist. He showed them the sketches he had just made, of women and leopards, violins and deserts, mountains and spheres. "Like you," he said, "I saw pretty much what I always see."

Computers are only a few half-moves from becoming genuine

MIND MACHINES

BY PHILIP J. HILTS

Ken Thompson was nervous when I arrived at Bell Labs for an interview. His computer had been arrested.

Belle is the world computer chess champion. Thompson had boxed Belle and was shipping it to the Soviet Union for an exhibition when Customs agents seized it on the grounds that computers going to the USSR might give away American technological secrets, especially secrets that might be used militarily. Thompson says the only way Belle could be used militarily would be to drop it out of an airplane. You might kill somebody that way.

Thompson would get the machine back some weeks after my visit so that it could once again do battle in its own sphere of combat, taking on top chess players and, for the most part, vanquishing them. Not that Belle is mindful of its wins. Like all programs in artificial intelligence, it has no mind at all beyond its specialty. It doesn't know that it exists, or the name of the game it plays. It doesn't know its rights when arrested. Yet in the tiny fraction of the world where chess moves are important, it has extraordinary power. Programmers call the power "brute force."

The number of chess players who can beat the best computers is down to perhaps 300. The 30,000 other serious

PAINTING BY JEAN-PIERRE ALAUX

human chess players in the country cannot win against the modern machines Thompson told an illustrative tale At a chess festival in Hamburg a year and a half ago, he says, the chess grand master Helmut Pfleger gave an exhibition of simultaneous play—walking from board to board and playing 26 opponents at once When it was over, he had won 22, drawn 2, and lost 2 He was asked afterward whether he had suspected that there was anything unusual about those who played against him

No, he had not Then he was told that three of his opponents had radio receivers in their ears and the moves they played were dictated to them from three computer chess programs One of the three was Belle When he learned that one of the players who beat him actually was Belle disguised as a human, Pfleger was "upset really shocked," Thompson says

Grand master Pfleger was not the only one who couldn't distinguish between human and computer play After the match five games from the exhibition were distributed to chess players around the world They were asked to pick out the computer's game from among the four human and one computer games presented In looking through the games chess players, including grand masters, looked for blunders they thought would be made by a computer On the whole, the chess players guessed wrong

This little experiment may have had more significance than first appears Early in the history of machine intelligence mathematician Alan M Turing recognized that there could be an endless debate about whether machines might be said to "think" the way people do He devised a hypothetical game to settle the question, involving a person and a computer each closed in its own room An observer outside the two rooms, communicating only by teletype, would have to decide through dialogue which was the person and which was the computer In the realm of chess, at least, a machine passed Turing's test

It is interesting, though, that a few of the computer specialists who took part in the test picked out Belle's game Their method was the opposite of the chess masters They looked for dumb moves that only a *human* would make They were right, the best of the games was Belle's victory

Do computer chess programs now face a barrier to future success, the wall that separates most players from the masters? "People always say things like that," Thompson says "They have said it at every minute in the history of computer chess But computer chess goes through those limits in absolute linear motion I mean it just walks right through "

What Thompson is speaking of is the power of a machine brain, not a machine mind The brain is a machine for calculation Fed carefully pared and tenderized information it is a paragon of brute logical, mathematical force The mind can be viewed as a similar machine but one susceptible to and immersed in the world, filled with billions of bits of knowledge and experience—of the magical, the irrational, the sensual, the honorable, and so on

The great chess machines of today are wired to do nothing but extremely fast number crunching on problems that arise in the game of chess These machines know nothing of wooden boards or ivory pieces or the right psychological moment to strike They are not storehouses of chess knowledge and lore, as humans are

The fact is, these powerful chess machines are fundamentally chess-stupid They can't think up strategy or follow a plan of action from move to move Some of the simple rules of thumb learned by novices are not known to the computers Their "evaluator" functions, which decide the value of the moves they look at, are crude So the burst of power that elevated the rank of computer chess machines has come as just as much a surprise to their programmers as to the human victims they defeat

Outraged human players actually attempted a mid-tournament coup d'état and physically seized the announcer's microphone The Revolt of the Humans, it was called

From the time when computer intelligence pioneers such as Claude Shannon and Alan Turing first considered the problem of how to make chess playing computers, designers believed that sophisticated, humanlike knowledge of the game would have to be put into the machines to make them even passable opponents The other alternative—merely letting the machine "look at" every move, all possible responses, all the responses to those responses and so on—was thought to be a useless undertaking, After all, examining all the moves and their possible answers would mean looking at something like 38^{54} possibilities, most of them completely worthless A computer operating at the speed of light would be billions of years at the task Yet so far raw calculating power has carried the day Machines don't examine every possibility, but they do explore millions of moves on each turn

There was one moment, says Northwestern University's David Slate, cobuilder with Larry Atkin and William Blanchard of the computer chess program with the longest history of success, that indicated to him the emergence of computers as serious players It was six years ago, at the Paul Masson American Chess Championship in California The tournament draws hundreds of players, from the bottom rank to grand masters, who enjoy the ambience Boards are set up outdoors and the sponsor serves wine between rounds

At the time of the tournament, Slate's program was the most powerful then built No one, including Slate, took the program very seriously as a contender in a human tournament But in that tournament, for the first time, the program would be running on a very big, very fast computer—the Cyber 176 of Control Data Corporation

Slate entered the B class tournament He thought the category might be too high for his program He thought there was a good possibility that it would lose every game And as the tournament got under way things began to go wrong The telephone hookup to the computer went down Terminals were overheating in the sun These kinds of problems are not forgiven in tournaments, when time limits are strict

But the machine won its first game Then its second And its third

By its fourth hands-down win, the tournament was in an uproar Outraged human players actually attempted a mid-tournament coup d'etat and physically seized the announcer's microphone The Revolt of the Humans, it was called The computer had no business being brought in against human players who were so much weaker, some players said Those who never had to play against the computer had a huge advantage, they complained

Eventually order was restored The program won five games and lost none, outclassing all 128 humans in the Masson tournament It was the first such win for any computer, and the first major test outside computer circles of what is now called the brute-force approach

"We were as surprised as anyone else," Slate says "It turned the consciousness around on what computers could do " From that time the use of brute force in chess computing seemed to dominate the field

Ironically it was believed for centuries that what made a grand master a great chess player was a prodigious memory and the ability to see 20 moves ahead and look quickly at hundreds of various possibilities This is what the computers now do, it turns out to be exactly the opposite of what great human players do

Grand masters, and other good chess players for that matter, actually see ahead on any one move only about 6 half-moves, not 20 A half-move is one player's move frequently there are many reasonable responses to a single half-move As for computers, Ken Thompson and Joe Condon's Belle now searches eight or more half-moves deep and examines about 50 million moves altogether on its turn

The startling fact is that grand masters do not search much but actually manage to see only the very best moves They do not even glance at other options

This ability does not come from an innately powerful memory. When A. D. deGroot scattered chess pieces randomly on the squares and asked grand masters to look for five seconds and then reconstruct the array, they could not do it. They managed to recall where only three or four pieces were. Chess novices did exactly as well. But when the pieces were arranged on the squares as they might be in a real game, suddenly the grand masters and masters could recall the placement of virtually all the pieces correctly. Those ranked expert also did well, recalling about 72 percent of the pieces. Lower-ranked players recalled about 50 percent. Novices could recall only about 33 percent.

The grand masters recognize chess positions without having to examine them piece by piece. They see configurations on the board as a reader sees a phrase in a book, as a single unit of meaning. With each chess position or 'phrase,' no doubt the grand master automatically associates some moves, the best moves, and ignores legions of others.

This power simply to 'see' situations and best moves makes it possible for a chess master to play simultaneously against 30 or 40 opponents and still win all but one or two of the games.

The chess master's ability to see in this way develops over decades of practice at the game. Putting such chess knowledge into computers has been difficult. All researchers in the vanguard of artificial intelligence face the same challenge: in a sense to give computers experience and knowledge of the world.

The problem has been that applying the sort of rule-of-thumb playing knowledge used by humans—and there are probably hundreds of these rules in chess—takes up great amounts of computer calculating time. In a tournament chess match there are only about three minutes per move. Thus, programs that are very smart don't have time to look at many possible moves.

In the end, programs that emphasize chess knowledge always face the most embarrassing type of loss: the loss by blunder. Robert Hyatt, the builder of the Cray-Blitz program which took second place in the National Computer Chess Championship last year, at one time ran a chess program that emphasized knowledge over speed searches.

It was disheartening, he says now, because there are hundreds or thousands of bits of chess knowledge to be put into a machine, and then as many exceptions and special cases as there are rules.

Because there are gaps in the knowledge that can be put in, "in the course of a game, the computer is bound to make a mistake, miss an important move. Sometimes the error is not enough to lose the game," he says, "but too often it is." It puts the programmer on the edge of his chair throughout a match, wondering *Will it see this? Will it miss that?*

David Wilkins, of SRI International, a

nonprofit research and consulting organization, worked on knowledge-based chess play when he was a graduate student at Stanford University. "It is easy to put in knowledge, but the problem is that if there is even one piece of knowledge missing, the program will make catastrophic errors." For example, he says, a terribly embarrassing two-move checkmate can result if a programmer fails to include some knowledge of back-rank checkmates—those in which the king is sitting behind three pawns and can be mated by putting a rook on the back rank with the king.

The stories of mistakes made from chess ignorance are voluminous. One describes a program that had an unstoppable win but failed to see that it could just push its pawn across the board to be queened.

Hans Berliner, a pioneer in artificial intelligence and particularly computer chess, says that even the brute-force programs can be erratic. "They really have weaknesses in their understanding. I've seen Belle try to capture a pawn, at a cost of completely dislocating its pieces across the board, and then lose."

Thompson says that Belle sometimes strays into awful situations. "The computer will generate weaknesses in the opponent's position, but then it won't pick on these weaknesses. Just their existence is what it wanted to see. So then it just sits there and loves its position."

Some of the pioneers of artificial intelligence 25 years ago would have been amazed to hear of such embarrassments. Early successes led to rash predictions. Working on the assumption that a small group of powerful problem-solving techniques was behind all human mental abilities, researchers created programs like the Logic Theory Machine.

The program was given a few mathematical abilities and was asked to derive the basic equations of logic, an assignment sometimes given to college freshmen. The program quickly found proofs for 38 of the 52 theorems it tried in *Principia Mathematica*, the epic work of mathematical logic by Alfred North Whitehead and Bertrand Russell. The program also found one proof even more elegant than the one proposed in the book, this feat is still talked about a quarter-century later.

At the same time the Logic Theory Machine made its impressive debut, Arthur Samuel, then at IBM, built a checkers-playing program that could beat its programmer and even learn a little from games as it played them. It once beat the state champion of Connecticut, who was also one of the best players in the nation.

There followed more successes: a program that solved geometry problems, one that did word problems in algebra, and one that accurately imitated the choice-making ability of the investment officer of a bank.

Typical of the excitement of those times is this quotation from Herbert Simon, now a Nobel laureate: "It is not my aim to surprise or shock you—but the simplest way I

can summarize is to say that there are now in the world machines that think, that learn and that create. Moreover, their ability to do these things is going to increase rapidly until—in a visible future—the range of problems they can handle will be coextensive with the range to which the human mind has been applied." In 1957 he predicted that in ten years a digital computer will be the world's chess champion.

Then further advances failed to occur. The researchers ran up against the problem they still face. Yes, cleverly organized calculation can put on good performances, surpassing many humans. But no general intelligence, or even a limited one that has some real judgment, is possible without broad and deep knowledge of the world or some area of it. The human mind does not use sophisticated calculation; it uses instead a vast quantity of stored knowledge to effect judgment.

When programmers began to study what they call knowledge representation, artificial intelligence entered a new phase. By knowledge representation they mean how information in huge quantities—such as the grammar, semantics, and vocabulary needed for language—can be stored so that it can be called up instantly and rummaged through, as we do in thinking.

From the newer, "knowledge-based" programming in artificial intelligence have come such things as the "expert" programs like those that now routinely do things once thought to require the subtle judgment of the human mind. One built at Stanford University, called Mycin, can diagnose some types of infections and recommend treatment. Another example is Dendral, a program that can determine the structure of organic molecules from spectrometric data. Prospector at SRI International is a program containing the collective wisdom of "a number of world-class geologists," according to Peter Hart, director of artificial intelligence at SRI.

One of those who has moved rapidly within the field as it expanded from its first embarrassing days is Herbert Simon. He is now an expert on the mental processes of experts. "Experts solve complex problems considerably faster and more accurately than novices do," he wrote in an article in *Science*. "Those differences are commonplace; yet only recently have we begun to understand what the expert does differently from the novice to account for this superiority. The differences, it turns out, are much like those between a grand master and a novice. The expert is able to see problems and solutions quickly based on a combination of perception and deep knowledge and experience."

Simon and his associates have concentrated their machine intelligence work in chess, algebra, and physics. But they point out that what they have found can be applied to other areas of knowledge. "Chess, algebra, and physics are serving as the *Drosophila*, *Neurospora*, and *Escherichia coli* [the key organisms researchers have long used to study problems of biology] of research on human cognitive skill."

Some researchers are trying now to make the very successful brute-force programs in chess also capable of using chess knowledge. What brute-force programs don't know is astounding. "A lot of what people assume has been in chess programs for years and years is not, in fact, in there at all," says Slate. As an example, even low-class human players know that when the game gets down to a king on one side and a king and knight on the other, the game is a draw. Many chess programs don't know this and will play on hopelessly.

This is the case throughout the field of artificial intelligence. Programs that seem smooth and smart in one brief patch of running can be ridiculous in another. One famous example is from Joseph Weizenbaum's computer program called Doctor. It mimics a psychotherapist using the techniques of Carl Rogers.

(The program speaks in capitals, the patient in lower case.)

Men are all alike.

IN WHAT WAY

They're always bugging us about something or other.

CAN YOU THINK OF A SPECIFIC EXAMPLE

Well, my boyfriend made me come here.

YOUR BOYFRIEND MADE YOU COME HERE

He says I'm depressed much of the time.

I'M SORRY TO HEAR YOU'RE DEPRESSED

It's true. I'm unhappy.

DO YOU THINK COMING HERE WILL HELP YOU

This sounds good, but try an equally representative snatch from the time that journalist R. D. Rosen talked to the Doctor about his "menu anxiety":

Sometimes I'll be eating at an Italian restaurant and I cannot decide whether to order fettuccine or clams casino, and I become very agitated and disoriented.

HAVE YOU TRIED

Tried what?

TELL ME ABOUT WHAT

What the hell are you talking about?

WHAT THE HELL ARE I TALKING ABOUT

Can you help me overcome my anxiety concerning menus?

WHY DO YOU SAY YOUR ANXIETY CONCERNING MENUS . . .

In the realm of chess, some similar computer disorientation is clear. It comes naturally from using a mere brain to play chess, rather than a mind which would comprehend chess more deeply.

Slate's program, called Nuchess (for Northwestern University Chess), is rated unofficially in the expert category at about a 2,100-point level. (Points are won or lost in tournament play. Experts hold between 2,000 and 2,199 points. Masters hold 2,200 and up.) "But," Slate says, "my program is like a D-class thirteen-hundred player

CONTINUED ON PAGE 162

"Oh, go ahead and swallow it. Does everything you eat have to have a name?"

Science crosses the line separating biology from intricate human behavior

BRAIN FRONTIERS

INTRODUCTION

Untidy, sometimes irrational, the studies of brain and behavior have yet to come of age. Psychologists have not yet even agreed on what "mind" means. We're just beginning to learn to read the packets of chemical messengers that nerve cells hurl at one another across synapses, signals that process information, sustain emotions, and keep us alive. Where's the psyche? Can we find it in the convolutions of the cortex?

Investigations of the physical brain and the parallel science of psychology are so young that it's premature to expect all the answers. But reports on these pages—written by Dava Sobel, Jeff Goldberg, and Gurney Williams III—outline recent findings that would have astounded many of the nineteenth-century pioneers in psychology.

Little more than a century ago researchers were unable to make sense of the jumbled thicket of cells that appeared when they focused their microscopes on brain tissue. Now investigators are charting the ebb and flow of salty solutions inside individual nerve cells. The first psychological laboratory opened (by most accounts) just 103 years ago to study such austere questions as how long it takes a man to move in response to a sound. Today's laboratories produce color pictures that reveal the living brain at work.

A century ago Sigmund Freud was a struggling young physician with a reputation for competent studies of the nerves of crabs, crayfish, and brook lampreys, in addition to his first scientific paper, on the location of testicles in eels. By the 1980s Freud's later work on personality had generated dozens of competing hypotheses and given several generations of college students the giggles about their dreams of towers and canyons.

As a physician, Freud never saw any conflict between psychoanalysts and biologists, between those who studied "mind" and those who examined the body. "Let the biologists go as far as they can," Freud wrote, "and let us go as far as we can. One day the two will meet." Many of the following items indicate that the day is closer than ever.

FETAL THOUGHT?

Researchers at New York's Mount Sinai School of Medicine report that a fetus may "contemplate" its movements before it kicks or waves its arms. Using fetal-monitoring devices, Niels H. Lauersen found that in most cases among pregnant women he observed, the fetal heartbeat began to rise some six to ten seconds *before* the fetus moved. Lauersen and his partner, Zoë Graves, point out that in adults the heart rate speeds up during the contemplation of an action. Graves says the discovery of a similar acceleration in fetuses is evidence that thought may start at the gestational age of five or six months.

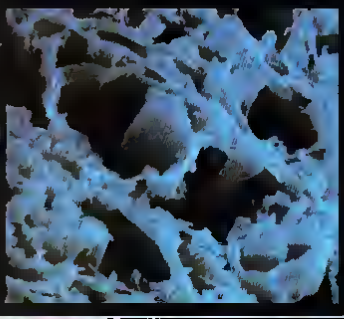
DIAGNOSING DYSLEXIA

A new technique for visualizing, mapping, and analyzing the living brain holds promise for diagnosing dyslexia, a reading disorder that is thought to affect some 6 to 10 percent of school-aged children, most of them boys. Devised by Dr. Frank H. Duffy, of Harvard Medical School and Children's Hospital, in Boston, the method yields color maps of the brain on a TV screen. The maps continuously reflect changes in mental activities. Doctors then compare these TV patterns with similar maps of normal subjects to reveal the degree and location of abnormalities. Duffy says his brain-mapping procedure could be used to screen youngsters all over the country for potential reading problems.

LEARNING WITHOUT BRAINS

New York researchers have discovered that some kinds of learning require no brains at all. Work by Laurence P. Ince, Bernard S. Brucker, and Augusta Alba shows that at least some training can occur in the human spinal cord (closeup view below) even after an injury has cut all connections to the brain.

One subject at New York University Medical Center's Goldwater Memorial Hospital was a forty-year-old man whose spinal cord had been severed in a fall. He had lost sensation and muscle control below the injury. Among other problems, he was unable to urinate normally. To treat this affliction, Ince and his associates applied a mild electrical stimulus—comparable to the bell Ivan Pavlov used to make a dog drool—to the patient's leg. Half a second later they switched on a more powerful electrical stimulus to his abdominal area. It caused muscles to contract, producing urination. After frequent pairing of the mild stimulus with the stronger jolt, the man urinated whenever the mild stimulus alone was delivered.



Ince says that he is mapping out research he hopes will eventually help paralyzed people to walk. First goal: to train a paralyzed leg muscle to contract whenever the patient flexes a muscle above the site of the spinal cord injury.

MIND MOLECULES

"In a sense molecules speak to one another," says Dr. Jack Peter Green. "We're trying to understand how." Green and a team of researchers at New York's Mount Sinai Medical Center report that chemical messengers identify themselves to receptor sites on nerve cells by using a language of electric-force fields. Computers are helping to break this molecular code, yielding data that might be used to predict how untested drugs will affect mind and body before the drugs are synthesized. Side effects will become much easier to understand, Green says, once researchers understand the force-field language of nerve cells.

LITHIUM THE LEVELER

California researchers have uncovered some fascinating clues about how lithium salts alleviate the symptoms of depression.

Like a bulldozer leveling a landscape, lithium controls the mood upheavals of manic-depressive psychosis. The salts have been used for more than 30 years, although doctors have never been certain about how they work.

New research at the University of California at Los Angeles shows that lithium produces an eightfold increase of choline in red blood cells. Choline is found in many plant and animal products consumed by humans on a normal diet. The body uses choline to produce one of the brain's chemical messengers, acetylcholine. Researchers suggest that lithium may raise the supply. And higher tides of acetylcholine, in turn, quell violent mood swings.

BRAIN FRONTIERS

THE HEROIN DEN

Why would a heroin addict die of an apparent drug overdose when he tolerated the same drug the day before?

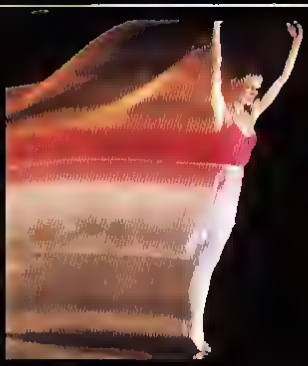
Perhaps, new research suggests, he shot up in unfamiliar surroundings, and the strangeness of the environment made his body overreact. Results from several recent studies indicate that human drug addicts may be conditioned to environmental cues. In their usual drug-taking setting, they can get high on a placebo or tolerate large doses. Moved from this environment, however, their bodies seem at a loss in handling drugs.

Shepard Siegel and colleagues at McMaster University, in Ontario, found support for this theory in a study of heroin-addicted rats. Animals moved to a new locale and given higher-than-usual doses of the drug fared poorly compared with rats that got the same high doses in familiar surroundings.

TRUFFLE TURN-ON

When a truffle sow sniffs out her prized quarry, she usually will root for it with uncanny determination, instead of stepping politely aside for her human companion, the way a well-trained pointer would. Why?

According to German researchers R. Claus, H. O. Hoppen, and H. Karg, truffles actually contain high levels of pheromones, chemical messengers that act as a sexual turn-on to the sow. The same musky-smelling steroid found in the gourmet delicacy is made in human testes and secreted by the sweat glands under the arms.

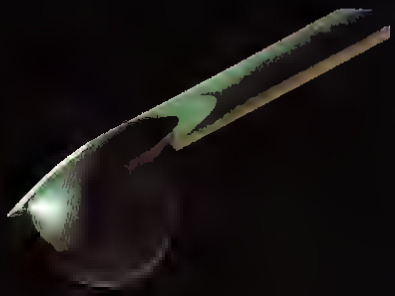


ENDORPHIN HATH CHARMS

What causes that pleasurable tingling, that sudden desire to dance, when we hear stirring music? Dr. Avram Goldstein, of Stanford University, thinks the answer might be endorphins, morphinelike chemicals in the body. Goldstein charted the "thrill scores" of 70 student volunteers as they listened to their favorite recordings. Then he injected them with naloxone, which blocks the effects of endorphins. For several subjects, the thrills were gone, suggesting that we hear music with our endorphins as well as with our ears.

NASAL PSYCHOSIS

A sixty-one-year-old man suffered delusions, nervousness, insomnia, and a stuffy nose. Drs. Javier I. Escobar and Marvin Karno, in California, reported that the man met criteria for a diagnosis of schizophrenia. But after a full examination, they concluded his problems stemmed from the stuffy nose. For some 20 years, they discovered, the man had been squirting or dousing his nose with decongestant drops or sprays. After they took him off nasal medication, his mental disorder disappeared. And so did the stuffiness.



DEPRESSION IN THE BLOOD

Hoping for a way to diagnose depression with a simple blood test, scientists have spent some 20 years trying to determine just what substance in the blood they should be looking for. New evidence suggests that the telltale chemical might be 3,4-dihydroxyphenylglycol, or DOPEG for short. Although DOPEG occurs normally in everyone's blood plasma, levels may be much higher among biologically depressed people. Drs. Donald S. Robinson, of Marshall University, in West Virginia, and Garland A. Johnson, of the Upjohn Company, recently developed a test to measure DOPEG levels in blood plasma. Then they studied a group of 58 depressed patients who were under treatment with antidepressant drugs. Those who responded to the drugs and felt improved, the scientists found, showed a marked decrease in their DOPEG levels over time. Further research with larger groups should reveal whether high DOPEG levels always signal depression.

UPTIGHT GENES

Research with rhesus monkeys provides new evidence that some temperament traits are inborn. Stephen J. Suomi, at the University of Wisconsin, says many of the monkeys in his experiments seem either "uptight" or "laid back" from birth. Suomi has been able to follow some of his simian subjects from infancy through adulthood, tracing what becomes of traits observed at birth. One conclusion: Most of the "uptight" female monkeys in his sample, he says, "turned out to be inadequate, inappropriate, neglectful, and/or abusive mothers." He concedes that temperament in the newborn could result from something in the prenatal environment. But he argues that carefully controlled breeding studies support the hypothesis that some behavior is passed on through the genes.

LOW-FIDELITY MEMORY

"My mind is not a tape recorder," John Dean testified at the Watergate hearings. And he was right. His recollection of details of the conversations he had with President Nixon lacked precision, as tapes of those talks later disclosed. But psychologist Ulric Neisser, who compared testimony with tapes, says Dean caught the tenor of conversations. "What Dean was best at," Neisser says, "is what witnesses are told not to do—to speculate. The kind of literal memory courts think they're getting really doesn't exist."

BRAIN FRONTIERS

FACTOR S, AS IN SLEEP

A magical potion that enhances and prolongs deep, dreamless sleep is apparently manufactured by most mammals while they are awake.

The substance, named Factor S, occurs in such tiny quantities, however, that it took a team of scientists more than a decade of sifting through fluid extracts from 15,000 rabbit brains and about five tons of human urine to collect a sample of Factor S weighing slightly less than a grain of salt.

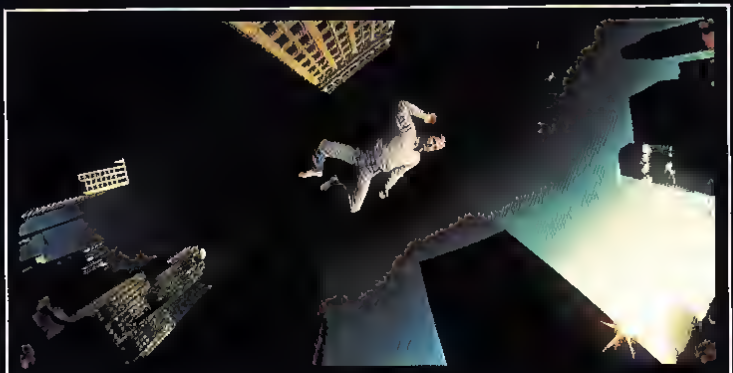
Drs. John Pappenheimer and Manfred Karnovsky, of Harvard Medical School, were able to use this nugget of Factor S to increase the drive to sleep in experimental rabbits. The animals seemed to enjoy a natural rest quite unlike the stupor induced by barbiturates and other sedatives. Their normal sleep cycles were not disrupted, and there was no apparent effect on their REM, or dreaming-stage, sleep.

Factor S looks and works the same whether it comes from a rabbit, a goat, or a human, leading the doctors to believe that the substance may be identical in all animals. Microinjection techniques isolated areas of the brain sensitive to Factor S in the basal parts of the forebrain and midbrain.

Although the discovery of Factor S may lead to a future treatment for insomnia, scientists will be content for now if the research can help them explore the biochemical basis of sleep.

CANCER PSYCHOLOGY

Researchers at the University of Pennsylvania report that feelings of helplessness may increase vulnerability to cancer. Psychologists led by Madelon Visintainer found that rats able to halt shocks by pressing a bar were far more likely to survive lab-induced cancer than other rats receiving the same jolts without the power to control them. Such lab shocks to rats may be comparable to Shakespeare's "thousand natural shocks that flesh is heir to," including human feelings of inescapable grief and depression.



NASA VS. NAUSEA

With six hours of lessons, most people can learn to block motion sickness, according to a researcher at NASA's Ames Research Center.

Within the past year biofeedback techniques developed by Patricia S. Cowings have drawn increasing interest from the space agency, which has to contend with the fact that roughly half of the astronauts experience some motion discomfort in space. Cowings first whirls her subjects around on a revolving chair. She directs them to move their heads in a circle until they "cry uncle." All the while she monitors some 20 physiological signs, to see what each individual's body is like at rest and at the onset of motion sickness. Then she teaches subjects to focus on breathing rate, muscle tension, or other physiological processes, psyching away feelings of sickness. About 80 percent of subjects experience significant improvement in suppressing symptoms.

REGRESSIVE RACISM

Social psychologists report that white college students in the 1980s appeared to have cast off prejudice in favor of a new egalitarian view of the races. But University of Alabama researchers argue that old-style redneck racism is merely hidden.

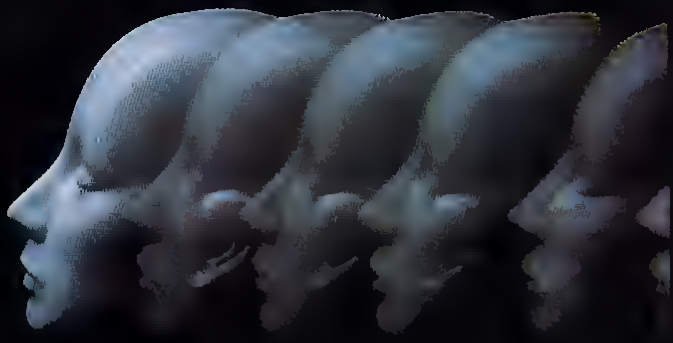
In a series of experimental sessions conducted by Ronald W. Rogers and Steven Prentice-Dunn, white students thought they were delivering shocks to subjects—some white, some black—in another room as part of behavior-modification research. Actually the "subjects" were confederates, working with the experimenters. And no shocks were delivered, although researchers could measure the level of shock whites chose. Reflecting the new norms, whites were less aggressive toward blacks than toward whites under normal circumstances. But in some sessions confederates could be heard saying that whites manning the switches appeared "dumb" and "stupid." Following these insults, whites chose greater levels of shock for blacks than whites. Researchers concluded that "regressive racism" emerged when whites were angry.

LEARNING CHEMICAL

Starting at its first moments, the human organism learns from experience. Now scientists have identified a natural brain protein, called PDH, that may be the tabula rasa on which memory is written. Genentech's William F. Bennett says stimulation of the hippocampus, a memory center in the brain, produces a chemical change in PDH, which may be the first step in learning.

MIND METAMORPHOSIS

University of California psychiatrist Arnold J. Mandell contends that the strange behavior of people zonked on speed is just the outward manifestation of a Jekyll-and-Hyde transformation *inside* their heads. High doses of amphetamine, Mandell believes, produce "an organismic change in the whole brain." Mandell notes that when amphetamine is added to rat brain tissue in test tubes, the drug alters patterns of spontaneous neuron firing. This global effect may account for the behavior of rats given high doses of amphetamine: they obsessively repeat a useless activity. Human speed freaks do much the same thing.



FICTION

FARMER ON THE DOLE

BY FREDERIK POHL

Stretching east to the horizon, a thousand acres, was all soybeans, across the road to the west, another thousand acres, all corn Zeb kicked the irrigation valve moodily

PAINTING BY
THOMAS HART BENTON

and watched the meter register the change in flow. Damn weather! Why didn't it rain? He sniffed the air deeply and shook his head, frowning. Eighty-five percent relative humidity. No closer to eighty-seven. And not a cloud in the sky.

From across the road his neighbor called, "Afternoon, Zeb."

Zeb nodded curtly. He was soy and Wally was corn, and they didn't have much to talk about, but you had to show some manners. He pulled his bandanna out of his hip pocket and wiped his brow. "Had to rise up the flow," he offered for politeness' sake.

"Me too. Only good thing. CO_2's up. So we's gettin good carbon metabolizin."

Zeb grunted and bent down to pick up a clod of earth, crumbling it in his fingers to test for humus, breaking off a piece and tasting it. "Cobalt's a tad low again," he said meditatively, but Wally wasn't interested in soil chemistry.

"Zeb? You aint heard anything?"

"Bout what?"

"Bout anything. You know."

Zeb turned to face him. "You mean aint I heard no crazy talk bout closin down the farms, when everybody knows they can't never do that, no. I aint heard nothin like that, an if I did, I wouldn't give it heed."

"Yeah, Zeb, but they's sayin—"

"They can say whatever they likes, Wally. I aint listenin, and I got to get back to the lines fore Becky and the kids start worryin. Evenin. Nice talkin to you." And he turned and marched back toward the cabins.

"Uncle Tin," Wally called sneeringly, but Zeb wouldn't give him the satisfaction of noticing. All the same, he pulled out his bandanna and mopped his brow again.

It wasn't sweat. Zeb never sweated. His arms, his back, his armpits were permanently dry, in any weather, no matter how hard or how long he worked. The glistening film on his forehead was condensed from the air. The insulation around the supercooled Josephson junctions that made up his brain was good, but not perfect. When he was doing more thinking than usual, the refrigeration units worked harder.

And Zeb was doing a lot of thinking. Close down the farms? Why, you'd have to be crazy to believe that! You did your job. You tilled the fields and planted them, or else you cleaned and cooked in Boss's house or taught Boss's children, or drove Mrs. Boss when she went to visit the other bosses' wives. That was the way things were on the farm, and it would go on that way forever, wouldn't it?

Zeb found out the answer the next morning, right after church.

Since Zeb was a Class A robot, with an effective IQ of one hundred thirty-five, though limited in its expression by the built-in constraints of his assigned function, he really should not have been surprised. Especially when he discovered that Reverend Harmswallow had taken his text that morning from Matthew, specifically the Beatitudes, and in particular the one about how the meek would inherit the earth. The reverend was a plump, pink-faced man whose best sermons dwelt on the wages of sin and the certainty of hell-fire. It had always been a disappointment to him that the farmhands who made up his congregation weren't physically equipped to sin in any interesting ways, but he made up for it by extra emphasis on the importance of being humble. "Even," he finished, his baby-fine hair flying all around his pink scalp, "when things don't go the way you think they ought to. Now we're going to sing 'Old One Hundred,' and then you boy people will meet in the gymnasium and corn people in the second-floor lounge. Your bosses have some news for you."

So it shouldn't have been surprising, and as a matter of fact Zeb wasn't surprised at all. Some part of the cryocircuits inside his titanium skull had long noted the portents. Scant rain. Falling levels of soil minerals. Thinning of the topsoil. The beans grew fat because there was an abundance of carbon in the air for them to metabolize. But

Zeb's soil-grimed fingers slowly unbuttoned the flannel shirt. Before he got to the last button, she impatiently pushed his hands aside and pulled it wide open.

no matter how much you irrigated, they dried up fast in the hot breezes. And those were only the physical signs. Boss's body language said more: sighing when he should have been smiling at the three-legged races behind the big house, not even noticing when one of the cabins needed a new coat of whitewash or the flower patches showed a few weeds. Zeb observed it all and drew the proper conclusions. His constraints did not forbid that; they only prevented him from speaking of them, or even of thinking of them on a conscious level. Zeb was not programmed to worry. It would have interfered with the happy smiling face he bore for Boss and Miz Boss and the Chillen.

So when Boss made his announcement, Zeb looked as thunderstruck as all the other hands. "You've been really good people," Boss said generously, his pale, professorial face incongruous under the plantation straw hat. "I really wish things could go on as they always have, but it just isn't possible. It's the agricultural support program," he explained. "Those idiots in Washington have cut it down to the point where it simply isn't worthwhile to plant here anymore." His expression brightened. "But it's not all bad! You'll be glad to know that they've expanded the soil bank program as a consequence. So Miz Boss and the children and I are well provided for. As a matter of fact," and he beamed, "we'll be a little better off than before, moneywise."

"Dat's good!"

"Oh, hebben be praised!"

The doleful expressions broke into grins as the farmhands nudged one another relieved. But then Zeb spoke up. "Boss? Scuse my askin, but what's gone happen to us folks? You gonna keep us on?"

Boss looked irritated. "Oh, that's impossible. We can't collect the soil-bank money if we plant, so there's just no sense in having all of you around, don't you see?"

Silence. Then another farmhand ventured, "How 'bout Cornpatch Boss? He need some good workers? You know us hates corn, but we could get reprogrammed quick's anything—"

Boss shook his head. "He's telling his people the same thing right now. Nobody needs you."

The farmhands looked at one another. "Preacher, he needs us," one of them offered. "We's his whole congregation."

"I'm afraid even Reverend Harmswallow doesn't need you anymore," Boss said kindly, "because he's been wanting to go into missionary work for some time, and he's just received his call. No, you're superfluous, that's all."

"Sperfluous?"

"Redundant. Unnecessary. There's no reason for you to be here." Boss told them. "So trucks will come in the morning to take you all away. Please be outside your cabins, ready to go, by oh-seven-hundred."

Silence again. Then Zeb. "Where they takes us, Boss?"

Boss shrugged. "There's probably some place I think." Then he grinned. "But I've got a surprise for you, Miz Boss and I aren't going to let you go without having a party. So tonight we're going to have a good old-fashioned square dance, with new bandannas for the best dancers, and then you're all going to come back to the Big House and sing spirituals for us. I promise Miz Boss and the children and I are going to be right there to enjoy it!"

The place they were taken to was a grimy white cinderblock building in Des Plaines. The driver of the truck was a beefy, taciturn robot who wore a visored cap and a leather jacket with the sleeves cut off. He hadn't answered any of their questions when they loaded onto his truck at the farm, and he again answered none when they off-loaded in front of a chain-link gate with a sign that read RECEIVING.

"Just stand over there," he ordered. "You all out? Okay." And he slapped the tailboard up and drove off, leaving them in a gritty, misty sprinkle of warm rain.

And they waited. Fourteen prime working robots, hes and shes and three little ones, too dispirited to talk much. Zeb wiped

the moisture off his face and muttered "Couldn've rained down where we needed it. Has to rain up here where it don't do a body no good a-tall." But not all the moisture was rain, not Zeb's and not that on the faces of the others, because they were all thinking really hard. The only one not despairing was Lem, the most recent arrival. Lem had been an estate gardener in Urbana until his people decided to emigrate to the O'Neill space colonies. He'd been lucky to catch on at the farm when a turned-over tractor created an unexpected vacancy, but he still talked wistfully about life in glamorous Champaign-Urbana. Now he was excited, "Des Plaines! Why, that's practically Chicago! The big time, friends. State Street! The Loop! The Gold Coast!"

"They gone have jobs for usn in Chicago?" Zeb asked doubtfully.

"Jobs? Why, man, who cares 'bout jobs? That's Chicago! We'll have a ball!"

Zeb nodded thoughtfully. Although he was not convinced, he was willing to be hopeful. That was part of his programming, too. He opened his mouth and tasted the drizzle. He made a face: sour, high in particulate matter, a lot more carbon dioxide and NO_x than he was used to. What kind of a place was this, where the rain didn't even taste good? *It must be cars,* he thought, *not sticking to the good old fusion electric power but burning gasoline!* So all the optimism had faded by the time signs of activity appeared in the cinderblock building. Cars drove in through another entrance. Lights went on inside. Then the corrugated-metal doorway slid noisily up and a short, dark robot came out to unlock the chain-link gate. The robot looked the farmers over impassively and opened the gate. "Come on, you redundancies," he said. "Let's get you reprogrammed."

When it came Zeb's turn, he was allowed into a white-walled room with an ominous sort of plastic-topped cot along the wall. The R.R.R., or Redundancy Reprogramming Redirector assigned to him was a blonde, good-looking she-robot who wore a white coat and long crystal earrings like tiny chandeliers. She sat Zeb on the edge of the cot, motioned him to lean forward, and quickly inserted the red-painted fingernail of her right forefinger into his left ear. He quivered as the read-only memory emptied itself into her own internal scanners. She nodded. "You've got a simple profile," she said cheerfully. "We'll have you out of here in no time. Open your shirt." Zeb's soil-grimed fingers slowly unbuttoned the flannel shirt. Before he got to the last button, she impatiently pushed his hands aside and pulled it wide. The button popped and rolled away. "You'll have to get new clothes anyway," she said, sinking long, scarlet nails into four narrow slits on each side of his rib cage. The whole front of his chest came free in her hands. The R.R.R. laid it aside and peered at the hookup inside.

She nodded again. "No problem," she said, pulling chips out with quick, sure fin-

gers "Now this will feel funny for a minute and you won't be able to talk but hold still" Funny? It felt to Zeb as if the bare room were swirling into spirals, and not only couldn't he speak, he couldn't remember words. Or thoughts! He was nearly sure that just a moment before he had been wondering whether he would ever again see the—The what? He couldn't remember.

Then he felt a gentle sensation of something within him being united to something else, not so much a click as the feeling of a foot fitting into a shoe, and he was able to complete the question. The *farm*. He found he had said the words out loud, and the R R R laughed. 'See? You're half-reoriented already.'

He grinned back. "That's really astonishing," he declared. 'Can you credit it? I was almost missing that rural existence! As though the charms of bucolic life had any meaning for—Good heavens! Why am I talking like this?"

The she-robot said, "Well, you wouldn't want to talk like a farmhand when you live in the big city, would you?"

"Oh, granted!" Zeb cried earnestly. "But one must pose the next question. The formalisms of textual grammar, the imagery of poetics, can one deem them appropriate to my putative new career?'

The R R R frowned. "It's a literary-critic vocabulary store," she said defensively. "Look, somebody has to use them up!"

"But one asks, why me?"

"It's all I've got handy, and that's that. Now. You'll find there are other changes too. I'm taking out the quantitative soil-analysis chips and the farm-machinery subroutines. I could leave you the spirituals and the square dancing, if you like."

"Why retain the shadow when the substance has fled?" he said bitterly.

"Now, Zeb," she scolded. 'You don't need this specialized stuff. That's all behind you, and you'll never miss it, because you don't know yet what great things you're getting in exchange.' She snapped his chest back in place and said, "Give me your hands."

"One could wish for specifics," he grumbled, watching suspiciously as the R R R fed his hands into a hole in her control console. He felt a tickling sensation.

'Why not? Infrared vision, for one thing," she said proudly, watching the digital readouts on her console, "so you can see in the dark. Plus twenty percent hotter circuit breakers in your motor assemblies, so you'll be stronger and can run faster. Plus the names and addresses and phone numbers of six good bail bondsmen and the public defender!"

She pulled his hands out of the machine and nodded toward them. The grime was scrubbed out of the pores, the soil dug out from under the fingernails, the calluses smoothed away. They were city hands now, the hands of someone who had never done manual labor in his life.

And for what destiny is this new armorarium required?" Zeb asked.

'For your new work. It's the only vacancy we've got right now, but it's good work and steady. You're going to be a mugger."

After his first night on the job Zeb was amused at his own apprehensions. The farm had been nothing like this!

He was assigned to a weasel-faced he-robot named Timothy for on-the-job training, and Timothy took the term literally. "Come on, kid," he said as soon as Zeb came to the anteroom where he was waiting, and he headed out the door. He didn't wait to see whether Zeb was following. No chain-link gates now. Zeb had only the vaguest notion of how far Chicago was, or in which direction, but he was pretty sure that it wasn't something you walked to.

Are we going to entrust ourselves to the iron horse?" he asked with a little tingle of anticipation. Trains had seemed very glamorous as they went by the farm—produce trains, freight trains, passenger trains that set a farmhand to wondering where they might be going and what it might be like to get there. Timothy didn't answer. He gave Zeb a look that mixed pity and annoyance and contempt as he planted himself in the street and raised a peremptory hand. A huge green-and-white-checkered hovercab dug down its braking wheels and screeched to a stop in front of them. Timothy motioned him in and sat silently next to him while the driver whooshed down Kennedy Expressway. The sights of the suburbs of the city flashed past Zeb's fascinated eyes. They drew up under the marquee of a splashy, bright hotel with handsome couples in expensive clothing strolling in and out. When Timothy threw the taxi driver a bill, Zeb observed that he did not wait for change.

Timothy did not seem in enough of a hurry to justify the expense of a cab. He stood rocking on his toes under the marquee for a minute, beaming benignly at the robot tourists. Then he gave Zeb a quick look, turned, and walked away.

Once again Zeb had to be fast to keep up. He turned the corner after Timothy almost too late to catch the action. The weasel-faced robot had backed a well-dressed couple into the shadows, and he was relieving them of wallet, watches and rings. When he had everything, he taced them to the wall, kicked each of them expertly behind a knee joint, and, as they fell, turned and ran, soundless in soft-soled shoes, back to the bright lights. He was fast and he was abrupt, but by this time Zeb had begun to recognize some of the elements of his style. He was ready. He was following on Timothy's heels before the robbed couple had begun to scream. Past the marquee, lost in a crowd in front of a theater, Timothy slowed down and looked at Zeb approvingly. "Good reflexes," he complimented. "You got the right kind of class, kid. You'll make out."

"As a *soi-disant* common cutpurse?" Zeb asked somewhat nettled at the other robot's peremptory manner.

Timothy looked him over carefully. "You talk funny," he said. 'They stick you with one of those surplus vocabularies again? Never mind. You see how it's done?"

Zeb hesitated, craning his neck to look for pursuit, of which there seemed to be none. "Well, one might venture that that is correct," he said.

"Okay. Now you do it." Timothy said cheerfully, and he steered Zeb into the alley for the hotel tourist trap's stage door.

"That victim had not been a robot. She had been a living true human female being; and when he heard all the police sirens coming straight at him, he was not surprised."

By midnight Zeb had committed five felonies of his own, had been an accomplice in two more, and had watched the smaller robot commit eight single-handed, and the two muggers were dividing their gains in the darkest corner—not very dark—of an all-night McDonald's on North Michigan Avenue. "You done good, kid," Timothy admitted expansively. "For a green kid, anyway. Let's see. Your share comes to six watches, eight pieces of jewelry counting that take coral necklace you shouldn't have bothered with, and looks like six to seven hundred in cash."

As well as quite a few credit cards," Zeb said eagerly.

"Forget the credit cards. You only keep what you can spend or what doesn't have a name on it. Think you're ready to go out on your own?"

"One hesitates to assume such responsibility—"

"Because you're not. So forget it. The night's work done, Timothy seemed to have become actually garrulous. "Bet you can't tell me why I wanted you backing me up those two times."

"One acknowledges a certain incomprehension," Zeb confessed. "There is an apparent dichotomy. When there were two victims, or even three, you chose to savage them single-handed. Yet for solitary prey you elected to have an accomplice."

"Right! And you know why? You don't. So I'll tell you. You get a he and a she, or even two of each, and the he's going to think about keeping the she from getting hurt; that's the way the program reads. So no trouble. But those two hes by themselves—hell, if I'd gone up against either of those mothers, he might've taken my knife

away from me and picked my nose with it You got to understand robot nature kid That's what the job is all about Don't you want a Big Mac or something?"

Zeb shifted uncomfortably "I should think not thank you," he said but the other robot was looking at him knowingly

"No food-tract subsystems, right?"

"Well my dear Timothy in the agricultural environment I inhabited there was no evident need—"

"You don't *need* them now but you ought to *have* them Also liquid-intake tanks and maybe an air-cycling system so you can smoke cigars And get rid of that faggoty vocabulary they stuck you with You're in a class occupation " he said earnestly, " and you got to live up to your station right? No subway trains No counting out the pennies when you get change You don't *take* change Now you don't want to make trouble your first day on the job, so we'll let it go until you've finished a whole week But then you go back to that bleached-blonde Three-R and we'll get you straightened out " he promised " Now let's go fence our jewels and stuff and call it a night "

All in all Zeb was quite pleased with himself His pockets lined with big bills he read menus outside fancy restaurants to prepare himself for his new attachments He was looking forward to a career at least as distinguished as Timothy's own

That was his third night on the Gold Coast

He never got a chance at a fourth

His last marks of the evening gave him a little argument about parting with a diamond ring So as taught Zeb backhanded the he and snarled at the she and used a little more force than usual when he ripped the ring off her finger Two minutes later and three blocks away he took a quick look at his foot under a streetlight He recoiled in horror

There was a drop of blood on the ring

That victim had not been a robot She had been a living true human female being, and when he heard all the police sirens in the world coming straight at him, he was not in the least surprised

"You people," said the rehab instructor "have been admitted to this program because a you have been unemployed for not less than twenty-one months b, have not fewer than six unexcused absences from your place of training or employment, c, have a conviction for a felony and are currently on parole or d, are of a date of manufacture eighteen or more years past, choice of any of the above That's what the regulations say and what they mean," she said warming to her work "is you're scum *Scum* is hopeless, shitless, dangerous, a social liability Do you all understand that much at least?" She gazed angrily around the room at her seven students

She was short, dumpy, red-haired with bad skin Why they let shes like this one off the production line Zeb could not understand He fidgeted in his seat craning his neck to see what his six fellow students were like, until her voice crackled at him "You! With the yellow sweater! Zeb!"

He flinched "Pardon me, madam?"

She said with gloomy satisfaction "I know your type You're a typical recidivist lumpenprole you are Can't even pay attention to somebody who's trying to help you when your whole future is at stake What've I got seven of you slugs? I can see what's coming I guarantee two of you will drop out without finishing the course and I'll have to expel two more because you skip classes or come in late And the other three'll be back on the streets or in the slammer in ninety days Why do I do it?" She shook her head and then, lifting herself ponderously, went to the blackboard and wrote her three commandments

1 ON TIME
2 EVERY DAY
3 EVEN WHEN YOU DON'T WANT TO

She turned around leaning on the back of her chair "Those are your Golden Rules you slugs You'll obey them as God's commandments and don't you forget it You're here to learn how to be responsible socially valuable creations and—what?"

"He took another swallow of the beer It was an interesting sensation, the cold, gassy liquid sliding down his new neck piping and thudding into the storage tank in his hip."

The skinny old he-robot in the seat next to Zeb was raising a trembling hand It was easy to see how he qualified for the rehabilitation program He was a thirty-year-old model at least with ball joints in the shoulders and almost no facial mobility at all He quavered, "What if we just can't teacher? I mean like we've got a sudden cryogenic warmup and have to lie down, or haven't had a lube job or—"

"You give me a pain" the instructor told him, nodding to show that pain was exactly what she had expected from the likes of him "Those are typical excuses and they're not going to be accepted in this group Now if you have something *really* wrong with you what you have to do is call up at least two hours before class and get yourself excused Is that so hard to remember? But you won't do it when push comes to shove, because you slugs never do

The ancient said obstinately "Two hours is a pretty long time I can't always tell that far ahead teacher A lot can happen."

"And don't call me teacher!" She turned back to the board and wrote

DR ELENA MINCUS B.SC M.A PH.D

"You can call me Dr Mincus or you can call me Ma'am Now pay attention "

And Zeb did because the ten nights in the county jail before he got his hearing and his first offender's parole had convinced him he didn't want to go back there again The noise! The crowding! The brutality of the jailers! There was nothing you could do about that either because some of them were human beings Maybe most of them were Looked at in a certain way there probably wouldn't even have been a jail if some human beings hadn't wanted to be jail guards What was the sense of punishing a robot by locking him up?

So he paid attention And kept on paying attention even when Dr Mincus's lessons were about such irrelevant (to him) niceties of civilized employed persons behavior as why you should always participate in an office pool how to stand in line for tickets to a concert and what to do at a company Christmas party Not all of his classmates were so well behaved The little ancient next to him gave very little trouble being generally sunk in gloom but the two she robots the ones with the beaded handbags and the miniskirts richly deserved (Zeb thought) to be the ones to fulfill Dr Mincus's statistical predictions by being expelled from the course The one with the green eye makeup snickered at almost everything the instructor said and made faces behind her back The one with the black spitcurl across her forehead gossiped with the other students and even dared to talk back to the teacher Reprimanded for whispering she said lazily "Hell lady this whole thing's a shuck ain't it? What are you doing it for?"

Dr Mincus's voice trembled with indignation and with the satisfaction of someone who sees her gloomiest anticipations realized For what? Why because I'm trained in psychiatric social work and because it's what I want to do and because I'm a *human being* and don't any of you ever let that get out of your minds!"

The course had some real advantages Zeb discovered when he was ordered back to the robot replacement depot for new fittings The blonde R.R.R muttered darkly to herself as she pulled pieces out of his chest and thrust others in When he could talk again he thanked her suddenly aware that now he had an appetite—a real appetite He wanted food which meant that some of those new pieces included a whole digestive system—and that she had muted the worst part of his overdainty vocabulary She pursed her lips and didn't answer while she clamped him up again

But then he discovered too that it did not relieve him of his duties "They think because you're *handicapped* " the R.R.R smirked "you're *forced* to get into trouble So now you've got all this first-rate equip-

ment and if you want to know what I think, I think it's wasted. The bums in that class *always* revert to type," she told him, "and if you want to try to be the exception to the rules, you're going to have to apply yourself when you're back on the job."

"Mugging?"

"What else are you fit for? Although," she added pensively twisting the crystal that dangled from her right ear around a tingertip, "I did have an opening for a freshman English composition teacher. If I hadn't replaced your vocabulary unit—"

"I'll take mugging, please."

She shrugged. "Might as well. But you can't expect that good a territory again, you know. Not after what you did."

So rain or dry Zeb spent every six PM to midnight lurking around the old Robert Taylor Houses, relieving old shes of their rent money and old hes of whatever pitiful possessions were in their pockets. Once in a while he crossed to the Illinois Institute of Technology campus on the trail of some night-school student or professor, but he was always careful to ask them whether they were robot or human before he touched them. The next offense, he knew, would allow him no parole.

There was no free-spending taxi money from such pickings, but on nights when Zeb made his quota early he would sometimes take the bus to the Loop or the Gold Coast. Twice he saw Timothy, but the little robot, after one look of disgust, turned away. Now and then he would drift down to Amalfi Amadeus Park, along the lakefront, where green grass and hedges reminded him of the good old days in the soy fields, but the urge to chew samples of soil was too strong, and the frustration over not being able to, too keen. So he would drift back to the bright lights and the crowds. Try as he might, Zeb could not really tell which of the well-dressed figures thronging Watertower Place and Lake Shore Drive were humans, clinging to life on the planet Earth instead of living in one of the fashionable orbital colonies, and which were robots assigned to swell the crowds.

Nor was Dr. Mincus any help. When he dared to put up a hand in class to ask her she was outraged. "Tell the difference? You mean you don't *know* the difference? Between a *human person* and a hunk of machinery that doesn't have any excuse for existence except to do the things people don't want to do and help them enjoy doing the things they do? Holy God, Zeb, when I think of all the time I put in learning to be empathetic and patient and supportive with you creeps, it just turns my stomach. Now pay attention while I try to show you, hey, slugs the difference between dressing like a human person of good taste and dressing like a pimp."

At the end of the class Lori, the hooker with the green eyeshadow, thrust her arm through his and commiserated. "Old bitch is giving you a hard time, hon. I almost got right up and tole her to leave you alone. Would have, too, if I wasn't just one black mark from getting kicked out already."

"Well, thanks, Lori." Now that Zeb had a set of biochemical accessories suitable for a city dandy rather than a farmhand, he discovered that she wore heavy doses of perfume—musk, his diagnostic sensors told him, with trace amounts of hibiscus, bergamot and extract of vanilla. Smelling perfume was not at all like sniffing out the levels of CO_2, ozone, water vapor and particulate matter in the air over the soy fields. It made him feel quite uncomfortable.

He let her tug him through the front door and she smiled up at him. "I knew we'd get along real well if you'd only loosen up a little, sweetie. Do you like to dance?"

Zeb explored his as-yet-unpracticed stores of skills. "Why, yes, I think I do," he said, surprised.

"Listen. Why don't we go somewhere where we can just sit and get to know each other, you know?"

"Well, Lori, I certainly wish we could. But I'm supposed to get down to my territory."

"Down Southside, right? That's just fine," she cried, squeezing his arm, "because I know a really great place right near there. Come on, nobody's going to violate you for starting a teeny bit late one night. Flag that taxi, why don't you?"

The really great place was a low cement-block building that had once been a garage. It stood on a corner, facing a shopping center that had seen better days, and the liquid-crystal sign over the door read:

SOUTHSIDE SHELTER
AND COMMUNITY CENTER
GOD LOVES YOU!

"It's a church!" Zeb cried joyously, his mind flooding with memory of the happy days when he sang in Reverend Harmswallow's choir.

"Well, sort of a church," Lori conceded as she paid the cabbie. "They don't bother you much, though. Come on in and meet the gang, and you'll see for yourself!"

The place was not really that much of a church, Zeb observed. It was more like the second-floor lounge over Reverend Harmswallow's main meeting room back on the farm, even more like—he rummaged through his new data stores—a "Neighborhood social club." Trestle tables were scattered around a large, low room with folding chairs around the tables. A patch in the middle of the room had been left open for dancing, and at least a dozen hes and shes were using it for that. The place was crowded. Most of the inhabitants were a lot more like Zeb's fellow rehab students than like Reverend Harmswallow's congregation. A tired-looking, faded-looking female was drowsing over a table of religious tracts by the door, in spite of a blast of noise that made Zeb's auditory-gain-control cut in at once. There were no other signs of religiosity present.

The noise turned out to be heavily amplified music from a ten-piece band with six singers. Studying the musicians care-

fully Zeb decided that at least some of them were human, too. Was that the purpose of the place? To give the humans an audience for their talents, or an outlet for their spiritual benevolence? Very likely, he decided, but he could not see that it affected the spirit of the crowd. Besides the dancers, there were groups playing cards, clots of robots talking animatedly among themselves, sometimes laughing, sometimes deeply earnest, sometimes shouting at one another in fury. As they entered, a short, skinny he looked up from one of the earnest groups seated around a table. It was Timothy, and a side of Timothy that Zeb had not seen before: impassioned, angry and startled. "Zeb! How come you're here?"

"Hello, Timothy." Zeb was cautious, but the other robot seemed really pleased to see him. He pulled out a chair beside him and patted it, but Lori's hand on Zeb's arm held him back.

"Hey, man, we going to dance or not?"

"Lady," said Timothy, "go dance with somebody else for a while. I want Zeb to meet my friends. This big fellow's Milt, then there's Harry, Alexandra, Walter 23-X, the kid's Sally, and this one's Sue. We've got a kind of a discussion group going."

"Zeb," Lori said, but Zeb shook his head.

"I'll dance in a minute," he said, looking around the table as he sat down. It was an odd group. The one called Sally had the form of a six-year old, but the patches and welds that marred her face and arms showed a long history. The others were of all kinds, big and little, new and old, but they had one thing in common. None of them were smiling. Neither was Timothy. If the gladness to see Zeb was real, it did not show in his expression.

"Excuse me for mentioning it," Zeb said, "but the last time we ran into each other, you didn't act all that friendly."

Timothy added embarrassment to the other expressions he wore: it was a considerable tribute to his facial flexibility. "That was then," he said.

"Then" was only three nights ago. Zeb pointed out.

"Yeah. Things change," Timothy explained, and the hulk he had called Milt leaned toward Zeb.

"The exploited have to stick together, Zeb," Milt said. "The burden of oppression makes us all brothers."

And sisters," tiny Sally piped up.

"Sisters, too, right. We're all rejects together, and all we got to look forward to is recycling or the stockpile. Ask Timothy here. Couple nights ago, when he first came here, he was as, excuse me, Zeb, as ignorant as you are. He can't be blamed for that, any more than you can. You come off the line, and they slide their programming into you, and you try to be a good robot because that's what they've told you to want. We all went through that."

Timothy had been nodding eagerly. Now, as he looked past Zeb, his face fell. "Oh, God, she's back," he said.

It was Lori, returning from the bar with two foaming tankards of beer. "You got two choices, Zeb," she said. "You can dance, or you can go home alone."

Zeb hesitated, taking a quick sip of the beer to stall for time. He was not so rich in friends that he wanted to waste any, and yet there was something going on at this table that he wanted to know more about.

"Well, Zeb?" she demanded ominously.

He took another swallow of the beer. It was an interesting sensation, the cold, gassy liquid sliding down his new neck, piping and thudding into the storage tank in his right hip. The chemosensors in the storage tank registered the alcoholic content and put a tiny bias on his proprioceptric circuits, so that the music buzzed in his ear and the room seemed brighter.

"Good stuff, Lori," he said, his words suddenly a little thick.

"You said you could dance, Zeb," she said. "Time you showed me."

Timothy looked exasperated. "Oh, go ahead. Get her off your back! Then come back, and we'll pick it up from there."

Yes, he could dance. Damn, he could dance up a storm! He discovered subroutines he had not known he had been given: the waltz, the Lindy, the Monkey, a score of steps with names and a whole set of heuristic circuits that let him improvise. And whatever he did, Lori followed, as good as he. "You're great," he panted in her ear. "You ever think of going professional?"

"What the hell do you mean by that, Zeb?" she demanded.

"I mean as a dancer."

"Oh, yeah. Well, that's kind of what I was programmed for, in the first place. But there's no work. Human beings do it when they want to, and sometimes you can catch on with a ballet company or maybe a night-club chorus line when they organize one. But then they get bored, you see. And then there's no more job. How 'bout another beer, big boy?"

They sat out a set, or rather stood it out, bellied up to the crowded bar, while Zeb looked around. "This is a funny place," he said, although actually he recognized it: it could have been the funny feelings in all his sensors and actuators that made it seem so. "Who's that ugly old lady by the door?"

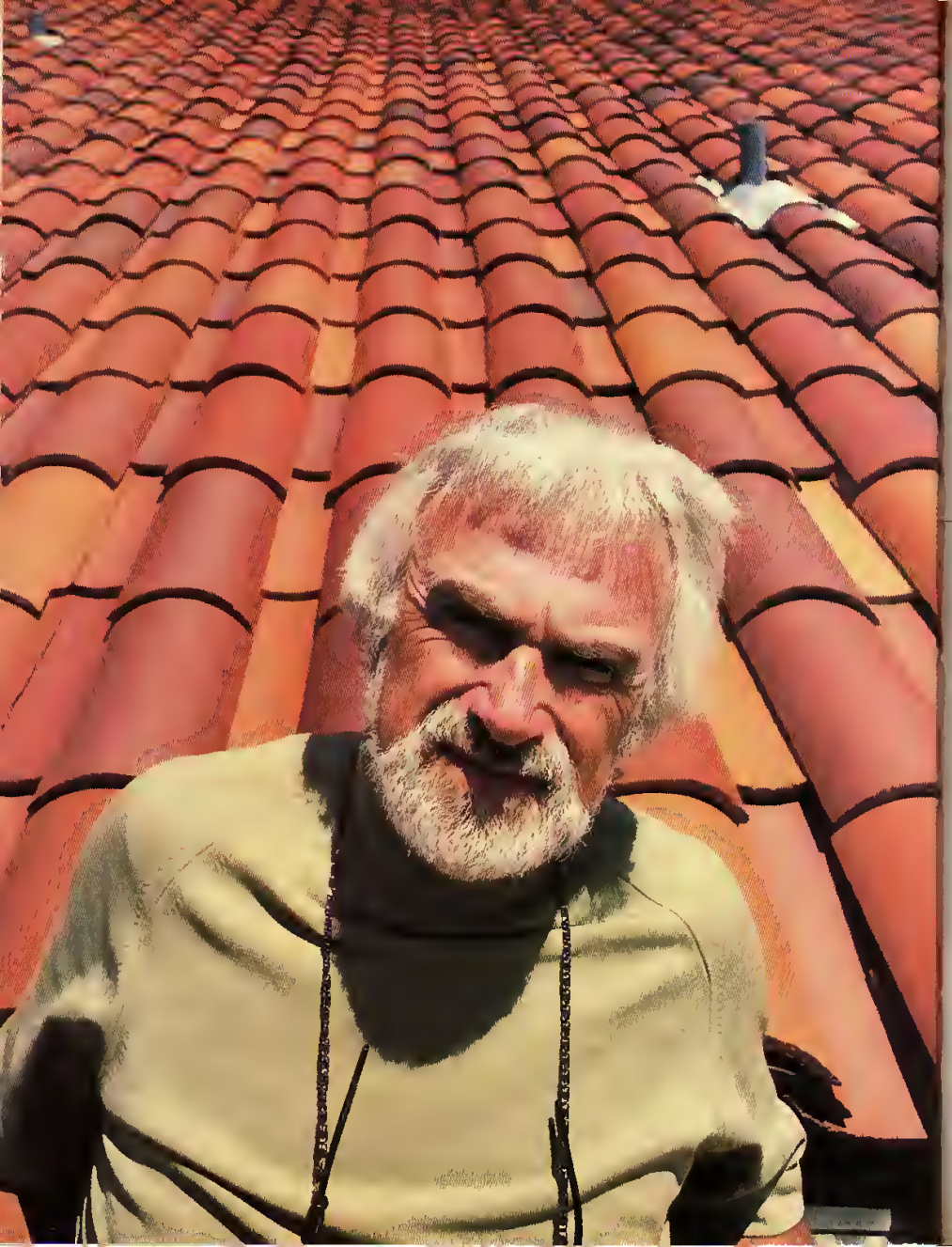
Lori glanced over the top of her tankard. It was a female, sitting at a card table loaded with what, even at this distance, clearly were religious tracts. "Part of the staff. Don't worry 'bout her. By this time every night she's drunk anyway."

Zeb shook his head, repelled by the tat, the pallid skin, the stringy hair. "You wonder why they make robots as bad-looking as that," he commented.

"Robot? Hell, she ain't no robot. She's real flesh and blood. This is how she gets her kicks, you know? If it wasn't for her and maybe half a dozen other human beings who think they're do-gooders, there wouldn't be any community center here at all. About ready to dance some more?"

Zeb was concentrating on internal sen-

CONTINUED ON PAGE 164



Inside the holographic brain, time and space are enfolded, and the distinctions between self and others, science and spirituality, cease to exist

INTERVIEW

KARL PRIBRAM

Computers and monkeys seem to pervade Dr Karl Pribram's office, as they do his working life While Stanford University undergraduates cycle through the green and gold afternoon, Karl Pribram the Father of the Holographic Brain, hunches over a computer terminal in his office in the utilitarian psychology building A pensive sad eyed monkey gazes down from a framed portrait on the wall and a huge stuffed baboon—"my newest graduate student"—squats in an armchair Suddenly, his statistics disentangled, Pribram leaps up grinning like a child who has just conquered Rubik s cube and the visitor senses that neuropsychology could be the best game in town

When in 1941, the Austrian-born Pribram earned his M D from the University of Chicago—a twenty two year old wunderkind on the brink of a neurosurgery residency—the brain was still a shadowy, mysterious organ So mysterious was it that the behaviorists who then dominated psychology rejected the subjective world, treating humans and animals alike—in Pribram's words as "behaving machines No longer is the mind a locked vault Largely owing to painstaking research by scientists such as Pribram, modern neuroscience is bridging the gap between the minuscule firings of single brain cells and the enigma of consciousness

Pribram showed up at the right place at the right time Yerkes Laboratory of Primate Biology then in Orange Park, Florida in 1946 to work under the tutelage of physiological psychologist Karl Lashley (He would briefly become acting director of Yerkes after Lashley retired in 1956) Lashley was cutting slices out of rats' brains to see whether he could trace particular memories—memory traces or engrams—to particular parts of the cortex But when his trained rats still performed learned tasks with large amounts of their brain tissue removed, Lashley put forth the unor

PHOTOGRAPHS BY ANTHONY WOLFF

Not only do we construct our perceptions of the world, but we also go out and construct those perceptions in the world. We make tables and bicycles and musical instruments because we can think of them.

thodox notion that memory is somehow distributed throughout the brain. Pribram, who joined Lashley in his quest for the engram in chimpanzee brains, was to mull over the idea for almost 20 years before launching his own revolutionary theory.

Meanwhile, during a decade of pioneering laboratory research at Yale, Pribram's scalpel was probing the workings of some 1,000 monkey brains. Operating on living animals, he invented new surgical techniques to reach the deep core brain, a vast, silent *terra incognita* then ignorantly called the rhinencephalon, or primitive "smell brain." After his Lewis-and-Clark-like expeditions to such unfamiliar topographies as the amygdala and the hippocampus, the smell brain stood revealed as the complex emotional circuitry of the limbic system. Today, when the two-way traffic between the brain's inner regions and the lordly cortex (the top, outer layer) is a textbook cliche, it's easy to underestimate Pribram's audacity when he avowed, back in the Dark Ages of brain science, that the core brain did more than passively take orders from "higher" centers.

By the time he moved to Stanford in 1958 to become a professor at the Center for Advanced Studies in the Behavioral Sciences, Pribram had charted other neuroscientific Newfoundlands. The so-called posterior association areas, which had baffled researchers of the Forties, Pribram showed were actually sensory-specific areas. The interior temporal cortex processes vision; the superior temporal cortex, hearing; and so on. In the heyday of lobotomies, his lab work proved that the frontal lobes, with their intimate links to limbic centers, were not some vestigial appendix to be cut as a routine psychiatric panacea. ("I nearly got kicked out of Yale for saying things like that," Pribram recalls happy to have the last laugh.)

No mere virtuoso knife wielder, Pribram was all the time hatching *theories*, mainly on the puzzles of perception and memory: how we recognize a familiar face, how a lifetime of memories is packed into an organ the size of a melon, how light waves travel from an object to the eye to the retina, to the brain's visual cortex, thereby conjuring an image. In 1960 came *Plans and the Structure of Behavior*, coauthored by Pribram, George A. Miller and Eugene Galanter, a book that was a "Marseillaise" to psychology's coming cognitive revolution and a knell of doom to behaviorism. Still later, Pribram began pondering classical puzzles: Where is such a thing as consciousness encoded in the flesh-and-blood brain? For that matter, is the "mind" contained within the physical organ, or is it something separate and soullike?

By the late 1960s, the philosophical and the pragmatic had coalesced for Pribram into one of the brain science's grandest, most controversial theories: Pribram's holographic model of the brain. What Pribram proposed, simply, is that the brain stores information via mathematical codes similar to those used in holography, the lensless photographic process invented by Dennis Gabor in 1947.

Unlike an ordinary photograph, which is a two-dimensional image of an object, a hologram is an eerily lifelike three-dimensional image formed by light. Its stored code on film doesn't look anything like the visual image, but is a record of the wave patterns scattered by the object. Imagine dropping two pebbles into a pond and freezing the surface immediately, so that the frozen overlapping ripple patterns record the pebbles' passage through a moment of time. So it is with a hologram. A beam of light energy—a laser, in most cases—is split in two, one part traveling directly to the holographic film as a reference beam, while the other is first bounced off the object to be photographed. The two beams then collide on the film, which stores the interference pattern of the two intersecting wavefronts, the pristine undisturbed reference beam and its twin beam that has been "disturbed" by the object. It's this disturbance that the hologram records, though on the actual film all one can see is an apparently meaningless pattern of dark and light swirls. But when illuminated by a reconstruction beam—that is, a laser beam identical to the original reference beam—a three-dimensional image results. It's as if the object's wavefront had been frozen in time in the holographic plate until the beam releases it to continue its path to your eye.

So may memories and images be stored in our brains, Pribram says. And just as many different holograms can be superimposed upon one another, so can infinite images be stacked inside our brains. Perhaps when we recall something particular, Pribram suggests, we're using a specific "reconstruction beam" to zoom in on a particular encoded memory. He also fixes upon another quality of the hologram: the fact that it records the same wavefront across its entire surface, repeating it over and over. Should you drop and shatter a hologram and salvage only a fragment of the plate, it will still be enough to reconstruct the entire image. Pribram feels that the brain's scattered code likewise allows memories to survive, sometimes awesome brain damage. He theorizes what we call mind may be stored in the physical brain as a sort of ghostly hologram—located everywhere and nowhere at the same time.

While some of Pribram's fellow brain researchers frankly regard his theory as wild, few would deny the grandeur and brilliance of the model. No less would be expected from this wiry, gentle-voiced, incandescent sixty-two-year-old Renaissance man. Pribram has written masterful books and articles on such diverse subjects as language, Freudian theory, neurophysiology, philosophy and experimental psychology.

Pribram has also made an unusual physical sacrifice for his science. In 1980, as the neuroscientist was examining the

exploits of Washoe 'the talking chimp' at the University of Oklahoma, a trainer placed her meal nearby. The chimp, perhaps suspecting, Pribram of threatening her food supply, suddenly raked the scientist's hand against the sharp bars of her cage, and he lost two thirds of a finger. But that has not stopped Dr. Pribram from performing delicate neurosurgery.

Karl Pribram was interviewed at his Stanford office by writer Judith Hooper.

Omni: You're an interdisciplinary man in what is of necessity an interdisciplinary field, brain science. Here at Stanford, don't English and history majors sit cheek by jowl with the regular science jocks in your undergraduate neuropsychology course? That seems quite unusual.

Pribram: Yes. I don't have any prerequisites, though it helps to have had some biology and perhaps a psychology course. I think we ought not to keep the science all to ourselves. We really should be teaching brain science in high school. When I've given lectures to high-school students, they have no more trouble than my medical students across the way here.

I also had several business school students in my graduate course in cognitive neuropsychology this past year. Because they are studying the marketplace, they're interested in understanding the brain to find out why people have certain motivations. I found their viewpoints fascinating because back in the 1950s I had tried to apply economic theory to brain theory. The students' input refreshed an old interest that culminated in the concept of a "cognitive commodity."

Omni: What is a cognitive commodity?

Pribram: Those of us who work with the brain know that perception isn't as simple and direct as it appears to be. In the visual system, as I move my eyes about, even slightly, there's always a little jiggle to the image. Yet I see the environment as still. Obviously the brain must be making complex computations and corrections to keep the world still. It's like what NASA does. In the Venus flyby, for instance, everything is moving so fast that the picture is just a blur. So NASA scientists subtract out the motion to get the picture. Our brains are doing that sort of thing very rapidly.

Now the problem is this: When I look at my desk, my immediate perception is of a desk, not of pieces of wood or metal of certain colors and shapes. But our brains could not have been built to recognize desks, chairs, books, rugs, and other constructions of our culture. So all sorts of qualities like color, intensity, movement, shape and so on must be processed and reprocessed simultaneously. How can this be? We must be constructing our perceptions on the basis of our experiences.

But, in addition, we go out and construct 'perceptions' in the world. We make tables and bicycles and musical instruments because we can perceive them in our mind's eye; we can conceive them.

Omni: In other words, just as the human brain constructs images out of sensory messages, does it project its own thoughts as objects in the material world?

Pribram: Exactly. And that means we always have the mind available to us as a frontier. The brain operates such that we can always construct new commodities. People are starving. There is a lot of grain growing, but not in the right places. So scientists at the University of California at Davis develop new kinds of grain that can grow in India. We don't have to paint ourselves into a corner and say, 'Well, we've had it.'

Omni: You've referred to the brain as an organ that mediates between an organism and its environment. It's as if you can't conceive of mind as existing in a vacuum, is that right?

Pribram: Right. We can use the analogy of gravity. You can't dig into a mass and discover gravity, because it's not a thing. Just as *gravity* describes the relationship between masses, so, too, *mind*, *consciousness*, and such terms refer to relationships between organisms and their environment. We won't find mind either by digging into the brain, as many neurophysiologists hope, or by searching its environment, as behaviorists attempt to do. That's a bit different from the way Sir John Eccles looks at the mind. He does seem to think of consciousness as everywhere, surrounding us.

Omni: What is it about the brain that gives it the infinite flexibility you've described?

Pribram: A short answer is, I don't know. But there are some leads. In human brains, the ratio of cortex [gray matter] to basal ganglia [the very front end of the brain stem] has increased so much that we have a reflective unit that is responsible for consciousness and so on. And the computing power is greater, of course.

Omni: Do you think of "consciousness" as something that animals possess, or is there a distinct consciousness that you and I have and that Washoe the chimpanzee, for example, lacks?

Pribram: There are at least three different ways in which the word *consciousness* is used. First, we have states of consciousness, such as sleep or waking or coma, states that ordinarily pertain to animals as well as humans. Then we use the term to speak of conscious or unconscious processes. If John is in a grouchy mood, you might refer to his "unconscious problems." But when a cat hisses, you don't say the cat's unconscious conflicts have determined its behavior. When we talk about conscious or unconscious processes in human beings, we're talking about degrees of self-awareness. Finally, in addition to the state and process definitions of *consciousness*, we've got the contents of consciousness—what we pay attention to.

Omni: To what extent are nonhuman primates and other higher mammals capable of "self-consciousness"—an awareness of self as distinct from the outside world?

Pribram: We've tried to test this. The usual test is the mirror test, in which you paint the animal's forehead and place it in front of a mirror. If it tries to rub the paint off its forehead, you know it's aware that the image is of itself. The major apes—gorillas, chimpanzees, and orangutans—do this, but the minor apes, such as gibbons, don't. It's an interesting cutoff. But I'm worried about the mirror test because gibbons, which are very, very socially aware, fail it. I also sometimes get the feeling that dogs feel guilt, that they can be self-conscious. Another test, which may be related, is to point your finger at something. Animals ordinarily don't look where you're pointing; they stare at your finger. They don't distinguish between the finger and where it's pointing, which is a sort of subtlety that's basic to self-consciousness, and perhaps to language.

Omni: Washoe has learned about one hundred fifty signs in American Sign Language, and, here at Stanford, Penny Patterson has trained a gorilla named Koko to sign. Do you consider that language?

Pribram: Koko can put together strings of three words. It is certainly communication, which is what Penny and Washoe's trainers, Allen and Beatrice Gardner, are interested in. Loads of communications pass even between my dog and me. He wags his tail, and I know he's happy. What Koko and Washoe do isn't our kind of language, however, it lacks the rich syntax of human natural utterances. But it's marvelous communication. They can communicate more richly than monkeys and not as well as human beings. That's what evolution is all about.

Omni: I hope you've had pleasanter interchanges with Koko than with Washoe.

Pribram: Yes. I'm fond of gorillas. They're more thoughtful than chimpanzees.

Omni: Reading of your experiments with primates, one is struck by what seems to be their very complex intelligence. For example, chimps that learned to trade poker chips for food developed a primitive economic system, hoarding chips and exchanging them among themselves. Yet you seem to conceive of a quantum leap between chimpanzee and human intelligence. Is our intelligence so unique?

> *"Why would we have brains capable of spiritual experiences if there were no spirituality in the world? It would not be adaptive."*

Pribram: Of course it is. How many chimpanzees are sitting across from each other, interviewing each other, recording the interview on tape, transcribing it into a manuscript? I'm tempted to say that humans are as different from nonhuman primates as mammals are from other vertebrates. We're not unique in possessing intelligence, but our kind of intelligence is very, very different.

Omni: I take it you wouldn't agree with John Lilly's ideas that porpoises may be as intelligent as we?

Pribram: How does one measure "intelligence" across species? I was down in Florida, working with porpoises and whales, and our team was trying to get electrical recordings from porpoise brains. We ran into some problems in anesthetizing dolphins for surgery, and because I heard Lilly had been thinking about these problems, I invited him to come down. He joined us on the third or fourth expedition and got the brilliant idea of tape-recording porpoise vocalizations and then playing them back at half-speed. He found this fantastic richness of communication, most of it at frequencies above our hearing range.

In one sense, porpoises are smarter than we. They don't make wars. They swim around in a very temperature-controlled environment. By the way, I did some testing a long time ago and showed that porpoises distinguish between Strauss's "Vienna Woods" waltz and all other Strauss waltzes. They had been tested to it. When I played other waltzes, they ignored me, but when I played the "Vienna Woods," they started jumping around the platform.

Omni: If was Number One on the porpoise Top Forty?

Pribram: Yes. Their auditory nerves are as big as my wrist, you know. And they have no olfactory sense at all—no smell. They live in a world very different from ours.

Omni: Jesuit theologian and paleontologist Pierre Teilhard de Chardin envisioned a mind principle, a spiritual inevitability, hovering over the process of evolution. Do you see it so?

Pribram: Perhaps we are inventing such a principle because our brains are capable of spiritual experiences. Could we be projecting those experiences onto the universe? I don't know the answer, but it's an important question. Why would you bother to have a brain that can attain spiritual experiences if there were no spirituality in the world? It wouldn't be adaptive.

Omni: Well, how basic is language to our uniquely human intelligence?

Pribram: Very important, especially if in our definition of *language* we include music, mathematics, and other languagelike systems. On the other hand, natural language has a special place. I remember reading about how Helen Keller learned her first word, the sign for *water*. She had sensations of cold running wetness on her hand, and suddenly she realized that this feeling was connected with the word *water*. For the first time she could distinguish between herself and the world. Immediately afterward she ran home and found a broken doll, and she realized she had broken it. She could separate subject from object—"I-broke-doll"—and take responsibility for her actions.

Omni: Before language, Helen Keller seemed to live in a continuous undifferentiated present. Don't you need language to store experience, to have what John Eccles calls "continuity memory"—the sense of a continuous self?

Pribram: Yes. Whatever produces language also produces that kind of memory. They seem to arise together, but continuity of self may not be a consequence of language. Language and feeling of self may both stem from some underlying source.

Omni: Is the human brain specialized to produce language, or was language an accidental by-product that, once developed, structured the brain in certain ways?

Pribram: I think it goes both ways. You know if you're born without a limb, there's no representation of that limb in the part of the cortex that ordinarily controls the limb. Other areas of the body take over. If that part of the brain is electrically stimulated, you don't activate the feeling of a phantom limb, but of some other part of the body.

Omni: You've devoted much of your career in neurophysiology to figuring out precisely how our brains construct what you call a "World Out There" and a "World Within." That is, our sense receptors distinguish between a Cuisinart that is over there in space and a remembered or imagined Cuisinart. How do we distinguish between the two?

Pribram: Well, this question calls to mind psychologist William James's ideas about self-consciousness. By selectively attending to our bodies' distance senses, we make a distinction between ourselves and the outside world. When we don't make these distinctions, as in an oceanic experience, we are back to Keller's initial state. There seems to be a stage in an infant's development before he clearly differentiates between "Mommy" and "me."

I once participated in a series of experiments performed by George von Bekesy of Harvard University, to show how we locate an object out in space. If two small vibrators are placed symmetrically on two of your fingers, you will experience the sensation caused by the vibrators as jumping back and forth for a while, then as existing *between* the fingers. In this case where I was involved, von Bekesy strapped one set of vibrators on my right arm and another on my left. I felt a spot over here and a spot over there, and it would jump back and forth. Suddenly, after about half an hour, I said, "What did you do?" He said, "I haven't done anything. What did you feel?" And he had this odd grin on his face. I said, "It's *out there*." I could feel a solid object in front of me, between my arms!

Omni: Then it's no accident that we have two symmetrically placed ears, eyes, and so on with which to perceive the outer world.

Pribram: Right. Now I'm not saying the world out there is an illusion. I am confident that this table and this chair exist. But the kind of mathematical process that von Bekesy simulated with his vibrators is basic to how our brains construct our image of a world out there. I say "construct," because the perception of so-called hard reality isn't really as immediate and direct as it seems, but a complex coding operation.

Omni: How does the brain represent the "World Within," the subjective realm?

Pribram: Whenever you're experiencing an emotion—when you're scared or ecstatically in love or whatever—all kinds of visceral/autonomic changes take place in your body. All these metabolic and endocrine happenings in your body become represented in the brain's core by receptors for sex hormones, blood-sugar levels, temperature and other functions. Just as your perceptual systems enable the brain to make maps of the outer world, input from within your body allows your brain to construct an inner world.

We react emotionally whenever there is a discrepancy between the "map" we've established over a long time and what our body chemistry and autonomic nervous system—heart rate, blood pressure, and so forth—are telling us now. We have an alerting mechanism, an autonomic charge, when we notice something novel. But of course it can't be novel unless there is something familiar with which to compare it. Patrick Bateson, of the zoology department at Cambridge University, has shown that animals build up familiarities in an environment, and when something different happens, imprinting occurs. He had chicks in a cage in which they were exposed only to vertical stripes. He showed them horizontal stripes, and wow! They followed anything with horizontal stripes.

Omni: Presumably, we humans are vulnerable to imprinting, too?

Pribram: We are. We fall in love. The autonomic charge comes with novelty within the framework of the familiar—the young lady who resembles, and yet is so different from, our mother, for example.

Omni: Don't we habituate to novelty? Doesn't the response fade?

Pribram: Oh, yes, it works only for so long. That's the problem with marriage. You just get more jaded in all your tastes; you've got to have more refinement. Less and less is novel. Or let's say, the novelty is more and more subtle, because you've got a larger and larger store of familiarity against which to match incoming impressions.

Omni: You've written about certain kinds of epilepsy and other brain disturbances that in some respects mimic transcendent experiences. What happens then to the "World Out There" and the "World Within"?

Pribram: Abnormalities in the limbic system around the amygdala can produce alternate states of consciousness. Patients with lesions in the area of the amygdala have feelings of *déjà vu* and *jamais vu*, when the unfamiliar seems familiar and the familiar strange. We're trying to learn more about these states by implanting electrodes into the visual portion of animals' brains and observing how chemical stimulation of the amygdala affects the neurons' firing patterns, but so far we haven't come up with anything definitive.

In transcendent states the distinction between what is most familiar, the self, and the unfamiliar, "other," disappears. As we saw in the case of Helen Keller, the distinction isn't there originally. Once the distinction is made, it's there. Then in states of consciousness best described in Eastern mystical philosophy, self and other merge once more. This is consciousness without content, oceanic consciousness. Could it be that the techniques of yoga and Zen have manipulated the neurochemistry of systems related to the amygdala?

Omni: Presumably you've witnessed such cases during the course of your career?

Pribram: Yes. I once knew a very nice and intelligent lady who worked as a psychologist at Napa State Hospital here in California. I was lecturing there. One day she mentioned that she was going to a party that night. When I saw her a week later, I asked her about the party and she said, "Oh, I never got there. I was tired and fell asleep." Later in the day someone else happened to mention the party and asked her whether she had enjoyed it. She said, "I didn't go." The other person replied, "But you were there. You seemed to be having a good time, even though you seemed a little phased out. I thought maybe you'd had a little too much to drink."

The lady had a type of epilepsy. She remembered going to her room and nothing after that. So she assumed she'd dropped off to sleep. Actually she'd gotten dressed, gone to the party, had a good time, and returned home. But all that never became part of her familiar continuous self.

Omni: That's fascinating. The question is, Who was experiencing the party?

Pribram: I don't know. Perhaps the "self" is a particular code. Unless our experience is translated into that code, it stays outside of what we recall as our experience.

Omni: And you get what is known as "automatism," when someone acts as if on automatic pilot.

Pribram: Yes. No doubt you know the famous case of H. M., who had severe epilepsy and whose temporal lobes were operated upon in 1953. I happened to see him after his operation. He was, I think, about twenty-eight years old. I asked him about his life, his marriage, and so forth. He said everything was essentially the same. Then we started talking about a trip to Africa that he had planned. He got all excited, because I knew the areas he had planned to visit. Then I gave him some simple learning tasks to recall, such as telephone numbers, and he did very well. I was called out of the room to answer the phone. When I came back I asked, "Where were we? Do you recall the numbers I gave

CONTINUED ON PAGE 169

PSI-Q TEST II: REMOTE VIEWING

Can you "see" a faraway location without leaving your home?

BY STEPHAN A. SCHWARTZ AND RAND DE MATTEI

Last year Omni investigated the psychic skills of thousands of readers in an extensive "Psi Q" test designed by the Mobius Group of California. In that first, massive experiment, the researchers attempted to study precognition the ability to see into the future through extrasensory perception. This year Omni and the Mobius Group present Psi-Q II, an experiment in remote viewing—glimpsing distant scenes or events with the aid of psychic power alone

PAINTING BY ANNE KINGGARD

Can your mind leave your body to travel through space? Can you sit in your living room and accurately describe places or events hundreds of miles from home? And if so, does this special talent hinge upon the contours of your personality?

Parapsychologists have tried to answer these questions for years. While experimental results have varied, some researchers report that gifted psychics as well as subjects who claim no special ability can use extrasensory perception to describe distant target sites time and again.

To explore the phenomenon further, the Mobius Group designed the following experiment especially for *Omni*. A fee of $6 is required to be paid to the Mobius Group. If you participate, you'll be asked to describe a spot somewhere on Earth. You won't be given clues that will allow you to meet this challenge intellectually; only psychic skills will move you to your destination.

To set up their experiment, Mobius researchers selected 144 visually unique sites around the globe. Then they assigned a number to each site and fed each number into a special computer. Every 20 minutes from 10 AM Pacific Standard Time on Tuesday, September 14, 1982, until 9 PM PST on Thursday, December 23, 1982, the computer will randomly select one of the 144 numbers. Your job is to concentrate during a given time interval until you "see" the site represented by the chosen number, and then to describe the site by means of a rough drawing.

To help put the experimental results in perspective, Mobius has also included a questionnaire that measures personality. Indeed, many parapsychologists believe that certain personality traits enhance psychic skills; others contend that the most powerful psychic perceptions occur in times of great emotional upheaval.

A few weeks after you've sent in your response sheet, the Mobius Group will send you an analysis of your test results. Both your target selection accuracy and your personality profile will be compared with those of the others participating in the experiment. And, because you will receive a photograph of your target site along with a copy of your drawing, you will have a chance to evaluate your own response.

Last year 18,000 *Omni* readers took part in the first Psi-Q experiment, aimed at exploring the ability to describe a future event. If you weren't part of the last experiment, this may be a good time to start exploring the mysterious powers within you.

HOW TO TAKE PSI-Q II

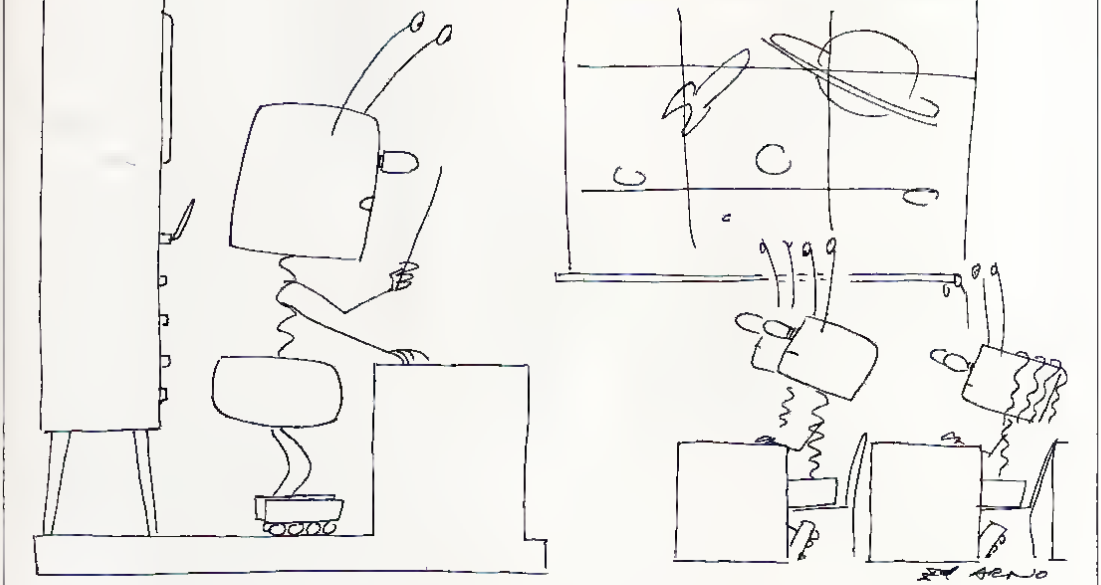
Remote viewing, parapsychologists say, is like daydreaming. Descriptions of target sites come to different people in different ways. Some get a visual image; some "sense" the site, as one might sense an unseen person in a dream; some "hear" their perceptions. There is no "right" way, and the process should be effortless. Don't try too hard.

You need to have a pen in your hand and a sheet of standard typewriter paper, preferably blank. When you are comfortable and relaxed in a setting with few distractions, *print* your full name and the hour, minute, and date in the upper righthand corner. Now you are ready to begin.

Targets will be randomly designated for 20-minute intervals beginning on the hour. Ideally, you should arrange to remote-view during only one of the designated 20-minute intervals. Your perceptions can come immediately or take a few minutes to emerge. Remember, don't strain and don't try to interpret what you see.

As soon as you perceive your target, make a simple drawing. This is not a test for artistic ability. So a few lines will do. Observe and record any smells, colors, or other sensations you experience. Because remote viewing impressions usually emerge almost immediately, you should spend no more than ten minutes completing this part of the experiment.

After you have completed your remote viewing—and only then—turn to the questionnaire and record your responses on the answer form provided.



"Remember, to err is human."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PERSONALITY PROFILE

Please record *in ink* your responses to the following questions on the answer sheet provided on page 182. You are to circle the capital letters (A or B) for clear-cut answers. lower case letters (a or b) should be indicated if you are not really sure that your response holds true most of the time. select the question mark a symbol of total ambivalence only as a last resort

1 (A) It is difficult for me to express enthusiasm.
(B) It is natural for me to be very enthusiastic

2 (A) I occasionally take chances just to create excitement
(B) I never take chances, no matter how boring things become

3 When I meet people on the street whom I know well
(A) they are more likely to speak first
(B) I am more likely to speak first

4 When I was a child
(A) it was relatively easy for someone to hurt my feelings
(B) it was relatively difficult "to get to me"

5 It is more important to
(A) prepare for the future.
(B) preserve the past

6 When it comes to participating in sports, I prefer
(A) individual activities like swimming or hiking
(B) team activities like volleyball or softball

7 People are more likely to describe me as
(A) a procrastinator
(B) impatient

8 Given my own choice I would prefer
(A) purely functional surroundings
(B) varied but harmonious décor

9 When I think of something to say in conversation, I find that
(A) it is easy to gain the attention of others
(B) it is difficult to gain their attention

10 Other people tend to see me as
(A) a follower.
(B) a leader

11 My response to a sudden loud sound is more likely to be
(A) an underreaction
(B) an overreaction

12 It would be a greater compliment to tell me that
(A) I have a lot of common sense
(B) I am loaded with imagination

13 I would rather learn the news from
(A) radio or television
(B) a newspaper

14 The most significant part of my life
(A) is still to come
(B) has already passed

15 When I look at the clock, I am apt to be startled because
(A) it is earlier than I expected
(B) it is later than I expected

16 I am best known as
(A) a good listener
(B) a persuasive talker

17 As a child, I was
(A) nervous and high strung
(B) placid and uncomplaining

18 (A) I feel that my mood fluctuates from time to time
(B) There are no important variations in my mood

19 I would rather talk about
(A) interesting experiences I've had
(B) my plans for the future

20 The best way to get an important job done is to
(A) delegate it to an expert
(B) do it myself

21 When I am in a group, all of them my good friends,
(A) I do more than my share of the talking
(B) I do less than my share of the talking

22 When I am in a strange situation
(A) it bothers me not to know all the consequences of my actions
(B) it is not different from being in a familiar situation

23 I would be more likely to undertake a new project because the experience will be
(A) pleasant
(B) useful

24 In the course of a typical day,
(A) I do less than I planned to accomplish
(B) I accomplish more than I ever planned to do

25 It is typical for me to
(A) get very involved with whatever I'm doing
(B) hold back

26 It would be more accurate to say that
(A) I don't spend enough time anticipating problems
(B) I spend too much time worrying about trivia

27 It would be more accurate to describe the information I carry in my head as
(A) miscellaneous
(B) specialized

28 I can talk about my feelings and emotions
(A) only with difficulty
(B) easily

29 It would be more accurate to say that
(A) I live to eat
(B) I eat to live

30 When circumstances force me to do two or three things at once
(A) all of the tasks will be done as well as usual
(B) one of the tasks will not be done so well

31 I generally learn more about a new subject
(A) by listening to a discussion
(B) by reading a book about it

32 My friends sometimes say that
(A) I am too tense
(B) I am too relaxed

33 I would rather talk about
(A) theories
(B) facts

34 It would be a greater compliment to tell me that
(A) I am always completely logical
(B) I am a person of real feeling

35 I would be more inclined to undertake a new project because
(A) it is my duty
(B) it may make me famous

36 Given some unexpected free time, I would probably use it
(A) to enroll in a self-improvement course
(B) to relax and have a good time

37 When I am talking,
(A) my thoughts run ahead of my speech
(B) my speech keeps up with my thoughts

38 In choosing a place to live, I am more attracted by
(A) the sounds and activity of the city
(B) the quiet and solitude of the country

39 After I have done all that is possible to resolve a difficult problem,
(A) I put it completely out of my mind
(B) I may continue to worry about it

40 Most of the time
(A) I prefer people to say exactly what they mean
(B) I enjoy people who find new and unusual ways of expressing their ideas

41 I prefer to
(A) understand the "big picture" before dealing with any details
(B) master my own task before getting too involved with others' problems

42 (A) I tend to have strong likes and dislikes
(B) I tend to be indifferent toward most things

43 On the whole, people think I am
(A) hard to get to know
(B) easy to get to know

44 I am at my best when I can
(A) follow a prescribed routine
(B) respond to an emergency

45 I experience stress-related symptoms like headaches
(A) almost never
(B) with predictable frequency

46 I would rather talk about
(A) economics
(B) politics

47 (A) I never lose my temper except intentionally
(B) Sometimes my emotions are beyond my control

48 If I were traveling in a foreign country, I would rather
(A) go with a friend who knows the language
(B) find my own way

49 My level of education
(1) Some high school
(2) Graduated from high school
(3) Some college
(4) Graduated from college
(5) Some postgraduate work
(6) Master's degree
(7) Doctoral degree

50 I am
(1) female
(2) male

51 I am
(1) left-handed
(2) right-handed
(3) ambidextrous

52 Are any members of your immediate family left-handed?
(1) Yes
(2) No

53 When you write, does the point of your pen point toward the top or the bottom of the page?
(1) Top
(2) Bottom

54 To which category does your remote-viewing target belong?
(1) City

CONTINUED ON PAGE 182

MATTER

CONTINUED FROM PAGE 86

for a good half-mile

We went down that hollow nose under for the most part and the air smelt wet and muddy like that of an emptied aquarium There was a second hill to climb I saw that much but the water came aboard and carried me aft till it jammed me against the smoking-room door and before I could catch breath we were rolling to and fro in torn water with the scuppers pouring like eaves in a thunderstorm

'There were three waves' said Keller and the stokehold's flooded'

The firemen were on deck waiting apparently to be drowned The engineer came and dragged them below and the crew gasping began to work the clumsy Board of Trade pump That showed nothing serious and when I understood that the *Rathmines* was really on the water and not beneath it I asked what had happened

"The captain says it was a blowup under the sea—a volcano, said Keller

'It hasn't warmed anything' I said I was feeling bitterly cold, and cold was almost unknown in those waters I went below to my cabin to change my clothes and when I came up everything was wiped out by clinging white fog

'Are there going to be any more surprises?' said Keller to the captain

'I don't know Be thankful you're alive, gentlemen That's a tidal wave thrown up by a volcano Probably the bottom of the sea has been lifted a few feet somewhere or other I can't quite understand this cold spell Our sea thermometer says the surface water is forty four degrees and it should be sixty eight degrees at least'

'It's abominable' said Keller, shivering 'But hadn't you better attend to the foghorn? I heard something'

'Heard! Good heavens!' said the captain from the bridge "I should think you did' He pulled the string of our foghorn which was a weak one It sputtered and choked because the stokehold was full of water and the fires were half-drowned, and at last gave out a moan It was answered from the fog by one of the most appalling steam sirens I have ever heard in my life Keller turned as white as I did for the fog the cold fog was upon us, and any man may be forgiven for fearing the death he cannot see

Give her steam there!" said the captain to the engine room "Steam for the whistle if we have to go dead slow

We bellowed again, and the damp dripped off the awnings to the deck as we listened for the reply It seemed to be astern this time, but much nearer than before

"The *Pembroke Castle*, by gum!" said Keller, and then viciously 'Well thank God we shall sink her too.'

"It's a sidewheel steamer' I whispered 'Can't you hear the paddles?'

This time we whistled and roared till the steam gave out and the answer nearly deafened us There was a sound of frantic threshing in the water apparently about fifty yards away, and something shot past in the whiteness that looked as though it were gray and red

The *Pembroke Castle* bottom up' said Keller, who, being a journalist always sought for explanations "That's the colors of a Castle liner We're in for a big thing.'

The sea is bewitched' said Frithiof from the wheelhouse

Another siren sounded on our bow and the little steamer rolled in the wash of something that had passed unseen

'We're evidently in the middle of a fleet' said Keller quietly 'If one doesn't run us down the other will Phew! What in creation is that?'

I sniffed for there was a poisonous, rank smell in the cold air—a smell that I had smelt before

If I was on land I should say that it was an alligator It smells somewhat like musk'

"The water came aboard and carried me aft till it jammed me against the smoking-room door, and before I could catch my breath, we were rolling to and fro in torn water."

I answered with conviction

'Not ten thousand alligators could make that smell,' said Zuyland

'Bewitched! Bewitched!' said Frithiof "The sea she is turned upside down and we are walking along the bottom

Again the *Rathmines* rolled in the wash of some unseen ship and a silver-gray wave broke over the bow leaving on the deck a sheet of sediment—the gray broth that has its place in the fathomless deeps of the sea A sprinkling of the wave fell on my face and it was so cold that it stung as boiling water stings The dead and most untouched deep water of the sea had been heaved to the top by the submarine volcano—the chill, still water that kills all life and smells of desolation and emptiness We did not need either the blinding fog or that indescribable smell of musk to make us unhappy we were shivering with cold and wretchedness where we stood

'The hot air on the cold water makes this fog,' said the captain It ought to clear in a little time

'Whistle oh! whistle and let's get out of it' said Keller

The captain whistled again, and far and far astern the invisible twin steam sirens answered us. Their blasting shriek grew louder till at last it seemed to fear out of the fog just above our quarter and I cowered while the *Rathmines* plunged bows under on a double swell that crossed

'No more' said Frithiof 'Let us get away in the name of God'

"Now if a torpedo boat with a *City of Paris* siren went mad and broke her moorings and hired a friend to help her it's just conceivable that we might be carried as we are now Otherwise this thing is—'

The last words died on Keller's lips his eyes began to start from his head and his jaw fell Some six or seven feet above the port bulwarks framed in fog and as utterly unsupported as the full moon hung a face It was not human and it certainly was not animal, for it did not belong to this earth as known to man The mouth was open revealing a ridiculously tiny tongue—as absurd as the tongue of an elephant, there were tense wrinkles of white skin at the angles of the drawn lips white feelers like those of a barbel sprang from the lower jaw and there was no sign of teeth within the mouth But the horror of the face lay in the eyes for those were sightless—white in sockets as white as scraped bone and blind Yet for all this the face wrinkled as the mask of a lion is drawn in Assyrian sculpture was alive with rage and terror One long white feeler touched our bulwarks Then the face disappeared with the swiftness of a blindworm popping into its burrow and the next thing that I remember is my own voice in my own ears saying gravely to the mainmast "But the air bladder ought to have been forced out of its mouth you know'

Keller came up to me ashy white He put his hand into his pocket took a cigar bit it dropped it thrust his shaking thumb into his mouth and mumbled "The giant gooseberry and the raining frogs! Gimme a light—gimme a light!' A little bead of blood dropped from his thumbnail

I respected the motive though the manifestation was absurd "Stop you'll bite your thumb off' I said and Keller laughed brokenly as he picked up his cigar Only Zuyland leaning over the port bulwarks seemed self-possessed He declared later that he was very sick

'We've seen it' he said, turning round

'What?' said Keller chewing the unlighted cigar

As he spoke the fog was blown into shreds and we saw the sea gray with mud rolling on every side of us and empty of all life Then in one spot it bubbled and became like the pot of ointment that the Bible speaks of From that wide-ringed trouble a Thing came up—a gray and red Thing with a neck—a Thing that bellowed and writhed in pain Frithiof drew in his breath and held it till the red letters of the ship's name woven across his jersey straggled and opened out as though they had been type badly set Then he said with a little cluck in his throat "Ah me! It is blind *Hur*

illa! That thing is blind," and a murmur of pity went through us all, for we could see that the thing on the water was blind and in pain. Something had gashed and cut the great sides cruelly and the blood was spurting out. The gray ooze of the undermost sea lay in the monstrous wrinkles of the back and poured away in sluices. The blind white head flung back and battered the wounds, and the body in its torment rose clear of the red and gray waves till we saw a pair of quivering shoulders streaked with weed and rough with shells, but as white in the clear spaces as the hairless, nameless, blind, toothless head. Afterwards came a dot on the horizon and the sound of a shrill scream, and it was as though a shuttle shot all across the sea in one breath, and a second head and neck tore through the levels, driving a whispering wall of water to right and left. The two Things met—the one untouched and the other in its death throe—male and female we said, the female coming to the male. She circled round him, bellowing, and laid her neck across the curve of his great turtleback, and he disappeared underwater for an instant, but flung up again, grunting in agony while the blood ran. Once the entire head and neck shot clear of the water and stiffened, and I heard Keller saying, as though he was watching a street accident: 'Give him air. For God's sake give him air!' Then the death struggle began with crampings and twistings and jerkings of the white bulk to and fro, till our little steamer rolled again, and each gray wave coated her plates with the gray slime. The sun was clear, there was no wind, and we watched the whole crew, stokers and all, in wonder and pity, but chiefly pity. The Thing was so helpless and, save for his mate, so alone. No human eye should have beheld him. It was monstrous and indecent to exhibit him there in trade waters between atlas degrees of latitude. He had been spewed up, mangled and dying from his rest on the seafloor, where he might have lived till the Judgment Day, and we saw the tides of his life go from him as an angry tide goes out across rocks in the teeth of a landward gale. The mate lay rocking on the water a little distance off, bellowing continually, and the smell of musk came down upon the ship, making us cough.

At last the battle for life ended, in a batter of colored seas. We saw the writhing neck fall like a flail, the carcass turn sideways, showing the glint of a white belly and the inset of a gigantic hindleg or flapper. Then all sank, and sea boiled over it, while the mate swam round and round, darting her blind head in every direction. Though we might have feared that she would attack the steamer, no power on Earth could have drawn any one of us from our places that hour. We watched, holding our breath. The mate paused in her search—we could hear the wash beating along her sides—reared her neck as high as she could reach, blind and lonely in all that loneliness of the sea, and sent one desperate bellow booming across the swells, as an oyster shell skips across a pond. Then she made off to the westward, the sun shining on the white head and the wake behind it, till nothing was left to see but a little pinpoint of silver on the horizon. We stood on our course again, and the *Rathmines*, coated with the sea sediment from bow to stern, looked like a ship made gray with terror.

"We must pool our notes," was the first coherent remark from Keller. "We're three trained journalists—we hold absolutely the biggest scoop on record. Start fair."

I objected to this. Nothing is gained by collaboration in journalism when all deal with the same facts, so we went to work each according to his own lights. Keller, triple-headed his account, talked about our "gallant captain," and wound up with an allusion to American enterprise in that it was a citizen of Dayton, Ohio, who had seen the sea serpent. This sort of thing would have discredited the Creation, much more a mere sea tale, but as a specimen of the picture writing of a half-civilized people it was very interesting. Zuyland took a heavy column and a half, giving approximate lengths and breadths and the whole

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list of the crew whom he had sworn on oath to testify to his facts. There was nothing tantastic or flamboyant in Zuyland. I wrote three quarters of a leaded bourgeois column, roughly speaking, and refrained from putting any journalese into it, for reasons that had begun to appear to me.

Keller was insolent with joy. He was going to cable from Southampton to the New York *World*, mail his account to America on the same day, paralyze London with his three columns of loosely knitted headlines, and generally efface the earth. "You'll see how I work a big scoop when I get it," he said.

Is this your first visit to England? I asked.

"Yes," said he. "You don't seem to appreciate the beauty of our scoop. It's pyramidal—the death of the sea serpent!"

Curious to think that it will never appear in any paper, isn't it? I said.

Zuyland was near me, and he nodded.

"What do you mean?" said Keller. "If you're enough of a Britisher to throw this thing away, I shan't. I thought you were a newspaperman."

I am. That's why I know. Don't be an ass, Keller. Remember, I'm seven hundred years your senior, and what your grandchildren may learn five hundred years hence, I learned from my grandfathers about five hundred years ago. You won't do it, because you can't.

This conversation was held in open sea, where everything seems possible, some hundred miles from Southampton. We passed the Needles Light at dawn, and the lifting day showed the stucco villas on the green and the awful orderliness of England—line upon line, wall upon wall, solid stone dock and monolithic pier. We waited an hour in the Customs shed, and there was ample time for the effect to soak in.

"Now, Keller, you face the music. The *Havel* goes out today. Mail by her, and I'll take you to the telegraph office," I said.

I heard Keller gasp as the influence of the land closed about him, cowing him as they say Newmarket Heath cows a young horse unused to open country.

"I want to retouch my stuff. Suppose we wait till we get to London?" he said.

Zuyland, by the way, had torn up his account and thrown it overboard early that morning. His reasons were my reasons.

In the train Keller began to revise his copy, and every time that he looked at the trim little fields, the red villas, and the embankments of the line, the blue pencil plunged remorselessly through the slips. He appeared to have dredged the dictionary for adjectives. I could think of none that he had not used. Yet he was a perfectly sound poker player and never showed more cards than were sufficient to take the pool.

"Aren't you going to leave him a single bellow?" I asked sympathetically. "Remember, everything goes in the States, from a trouser button to a double eagle."

"That's just the curse of it," said Keller, below his breath. "We've played 'em for suckers so often that when it comes to the golden truth—I'd like to try this on a London paper. You have first call there, though."

"Not in the least. I'm not touching the thing in the papers. I shall be happy to leave 'em all to you, but surely you'll cable it home?"

"No. Not if I can make the scoop here and see the Britishers sit up."

"You won't do it with three columns of slushy headline, believe me."

"I'm beginning to think that, too. Does *nothing* make any difference in this country?" he said, looking out of the window. "How old is that farmhouse?"

"New. It can't be more than two hundred years at the most."

"Um. Fields, too?"

"That hedge there must have been clipped for about eighty years."

"Labor cheap—eh?"

"Pretty much. Well, I suppose you'd like to try the *Times*, wouldn't you?"

"No," said Keller, looking at Winchester Cathedral. "Might as well try to electrify a hayrick. And to think that the *World* would take three columns and ask for more—with illustrations, too! It's sickening."

> *"The dead and most untouched deep water of the sea had been heaved to the top by the submarine volcano —the chill, still water that kills all life and smells of desolation."*

"But the *Times* might—" I began.

"Might! You *might* work your way through the bow plates of a cruiser. Look at that first page!"

"It strikes you that way, does it?" I said. "Then I'd recommend you to try a lighter and frivolous journal."

"With a thing like this of mine—of ours? It's sacred history!"

I showed him a paper that I conceived would be after his own heart in that it was modeled on American lines.

"That's homey," he said, "but it's not the real thing. Now I should like one of these fat old *Times* columns. Probably there'd be a bishop in the office, though."

When we reached London, Keller disappeared in the direction of the Strand. What his experiences may have been I cannot tell, but it seems that he invaded the office of an evening paper at 11:45 A.M. (I told him English editors were most idle at that hour) and mentioned my name as that of a witness to the truth of his story.

"I was nearly fired out," he said furiously at lunch. "As soon as I mentioned you, the old man said that I was to tell you that they didn't want any more of your practical jokes, and that you knew the hours to call if you had anything to sell, and that they'd see you condemned before they helped to puff one of your infernal yarns. What record do you hold for truth in this city, anyway?"

"A beauty. You ran up against it, that's all. Why don't you leave the English papers alone and cable to New York? Everything goes over there."

"Can't you see that's just why?" he said.

"I saw it a long time ago. You don't intend to cable, then?"

"Yes, I do," he answered, in the overemphatic voice of one who does not know his own mind.

That afternoon I walked him abroad and about, over the streets that run between the pavements like channels of grooved and tongued lava, over the bridges that are made of enduring stone, through subways floored and sided with yard-thick concrete, between houses that are never rebuilt, and by river steps hewn to the eye from the living rock. A black fog chased us into Westminster Abbey, and, standing there in the darkness, I could hear the wings of the dead centuries circling round the head of Litchfield A. Keller, journalist, of Dayton, Ohio, U.S.A., whose mission it was to make the Britishers sit up.

He stumbled, gasping, into the thick gloom, and the roar of the traffic came to his bewildered ears.

"Let's go to the telegraph office and cable," I said. "Can't you hear the New York *World* crying for news of the great sea serpent, blind, white, and smelling of musk, stricken to death by a submarine volcano, assisted by his loving wife to die in mid-ocean, as visualized by an independent American citizen, a breezy, newsy, brainy newspaperman of Dayton, Ohio? 'Rah for the Buckeye State. Step lively! Both gates! Szz! Boom—ah!" Keller was a Princeton man, and he needed encouragement.

"You've got me on your own ground," said he, tugging at his overcoat pocket. He pulled out his copy, with the cable forms—for he had written out his telegram—and put them all into my hand, groaning. "I pass. If I hadn't come to your cursed country—if I'd sent it off at Southampton—if I ever get you west of the Alleghenies—if—"

"Never mind, Keller. It isn't your fault. It's the fault of your country. If you had been seven hundred years older, you'd have done what I'm going to do."

"What are you going to do?"

"Tell it as a lie."

"Fiction?" This with the full-blooded disgust of a journalist for the illegitimate branch of the profession.

"You can call it that if you like. I shall call it a lie."

And a lie it has become, for Truth is a naked lady, and if by accident she is drawn up from the bottom of the sea, it behooves a gentleman either to give her a print petticoat or to turn his face to the wall and vow that he did not see. ☒

UF[illegible]es weave their abduction stories from haunting but submerged memories of birth

ANTI MATTER

UFO UPDATE

A group [illegible] volunteers were hypnotized in a hushed [illegible] al for [illegible] hospital then asked to imagine detailed encounters with extraterrestrials One woman fantasized a creature that probed her with a beam from its single eye A nurse saw herself levitated from her car into a spaceship operated by fetuslike beings with bumpy skin And a student imagined being whisked into a cavernous [illegible] through a tunnel of brilliant light

The researchers [illegible] hypnotist William McCall ufologist John de Herrera and I [illegible] had chosen these subjects because they knew little or nothing about [illegible] H[illegible]e we expected their stories to differ drastically fro[illegible] hose told by allegedly real UFO abductees like the legendary Betty and Barney Hill But to [illegible]u[illegible] surpr se the fab[illegible] cated encounters were virtually [illegible]dentical to the "real" ones

To [illegible]s these findings mean o[illegible]e thing UFO abduction stories stem not from meetings with alien[illegible] but from an inner fantasy world [illegible]hat may be common to us all The root of such fantasy is the trauma [illegible] birth itself

Indeed most UFO abduction stories are loaded with birth images tunnels womb-shaped rooms cervixlike doorways Just as the fetus moves through the tort[illegible]us birth tunnel [illegible]nto a [illegible]ig bright room where adults handle it so the abductee levitates through an omino[illegible] tu[illegible]nel of light into a UFO[illegible] vast interior where strange creatures probe its body

But most UFO researchers have ignored the [illegible]mplications of our work For instance [illegible] a recen[illegible] book called M[illegible] (Upstate [illegible] Ma[illegible] 982) author Bu[illegible] Hopkins [illegible] and a [illegible]ol[illegible]league [illegible]ed dozens [illegible] people who re[illegible]ted p[illegible]rds [illegible] [illegible]rar[illegible] amnesia [illegible] h[illegible]pnos[illegible] [illegible] s[illegible] them re[illegible]bered elabo[illegible] ab[illegible] ct[illegible]s [illegible] g [illegible] medical ex[illegible] and [illegible] fig[illegible]t Hop[illegible] [illegible]ends that [illegible]s [illegible] were k[illegible] by aliens but [illegible]y [illegible]search [illegible] concerned [illegible] *Time* ac[illegible] [illegible]upports the bi[illegible]uma theory [illegible] believe we [illegible]an [illegible]e it First abduction stories told under hypnosi[illegible] [illegible]n be [illegible] for echoes of an [illegible]dividual's [illegible] th[illegible] history [illegible] subjec[illegible] says an alien's metal clamp he[illegible] [illegible]wist[illegible] for example we c[illegible]n try to d[illegible]scover whe[illegible]her or [illegible]or he had a forceps aided deliver[illegible] [illegible]s [illegible]hc's remember[illegible]g his b[illegible]rth If the subjec[illegible] repor[illegible]s an easy passage into a chamber of light instead [illegible]ght twi[illegible]g canal we can[illegible] [illegible]t lear[illegible] whether he was [illegible]aesarean born [illegible]o then the birth trauma hypothesi[illegible] wo[illegible]h[illegible]d [illegible]rue once again

[illegible]nally a bit of recent resear[illegible]h [illegible]ver suggests that birth might account fo[illegible] the period of "missing time" [illegible]cientists have fo[illegible] [illegible]hat oxytoc[illegible] the hor[illegible]ne that floods the mother and fetus during birth [illegible]auses amnes[illegible]a [illegible] labo[illegible]ratory animals [illegible]octors say the substance probably causes amnesia in people [illegible]oo —ALVIN H L[illegible]AWS[illegible]N

Alv[illegible] H [illegible]aws[illegible]n is a urologist and professor of English at [illegible]alifornia State Universi[illegible] at [illegible]ong Beach

BIGFOOT AT WALLA WALLA . . .

To hear the Bigfoot fans tell it, it's finally happened. In and around the watershed area of Walla Walla, Washington, reliable witnesses have at last found tracks proving that an enormous two-legged primate stalks the American wilderness.

The watershed, a patch of mountainous woodland east of Walla Walla, provides most of that city's water. Watershed riders from the U.S. Forest Service patrol the area on horseback, ejecting would-be campers who might pollute the supply. And during one such mission, Patrolman Paul Freeman allegedly spotted a nine-foot-tall Bigfoot.

Hastening back to the Forest Service post, he related the tale to his superiors, who mounted a search and found the first prints. They were 14 inches long and pressed deep into the hard-packed dirt. A second trip into the woods produced nearly 400 prints, stretching for a mile.

"They were some of the best footprints I've ever seen," says John Beckjord, head of Project Bigfoot, a Seattle-based organization dedicated to finding the elusive critter. "When the Forest Service made casts, ings [pictured here], you could even see ridges on the toes."

According to Beckjord, the Walla Walla finding is the first to give researchers some idea of what Bigfoot weighs. "The Forest Service cut out a footprint-

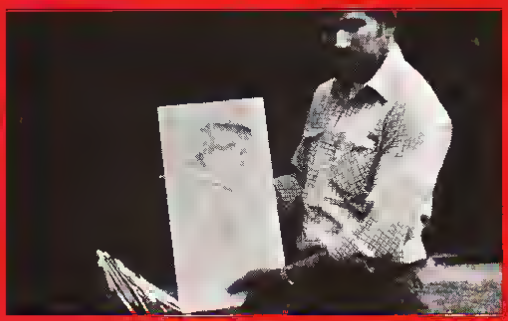
shaped steel plate," he explains, "then backed a fire truck into it. The truck, placed thirty-one hundred pounds of pressure on the plate, which dug a half-inch hole in the ground. The prints found by Freeman, however, were an inch deep—even more at the heel. So you know it took something really huge to make them."

Dennis Jones, Forest Service administrator for the watershed area, disagrees. "We called in an expert tracker from the border patrol," he reports. "From the placing of the prints, he was sure someone had made them deliberately."

"Paul Freeman was a real freak about Bigfoot," Jones adds. "He talked about it all the time. I don't know whether he made the prints or someone else did it as a practical joke on him. But we're sure it was a hoax."

Freeman, he notes, was an employee with the Forest Service for less than a month. He quit shortly after the would-be sighting and hasn't been seen since. Neither have the Bigfoot tracks. — Owen Davies

"These Easter eggs weren't brought by the bunnies."
— Robert Carr



. . . AND ON FILM

John Beckjord remains convinced that Bigfoot is real, however, and probably a lot stranger than any common ape. As proof he cites the peculiar things he sees in the so-called Patterson film, a movie of a supposed Bigfoot taken by long-time monster hunter Roger Patterson in 1967 and rejected as a fraud even by many Bigfoot fans.

"I got a copy of the film," Beckjord says, "and enlarged it frame by frame. In one segment we have what looks like a long-legged female gorilla with additional faces and little heads coming out of the main head, growing larger and then growing smaller and disappearing, like cactus buds. You're not supposed to see this sort of thing in traditional apes and men," he concludes. "It could be an alien."

So far Beckjord has convinced few of the dedicated people who search for explanations of Bigfoot sightings and other mysterious phenomena. "John's a wild and crazy guy," says Marcello Truzzi, head of the Center for the Study of Scientific Anomalies. "He's shown me his blowups, and there are smudges you might be able to interpret as he does. But it's like a Rorschach test. It doesn't prove anything."

Richard Greenwell, founder of the International Society of Cryptozoology, says, "We've rejected him for membership in the society, and he's been calling

people all over the country and threatening to sue. If we have to, we'll accept him. But he'll be thrown out the next day."

Beckford concedes that he has an image problem and not just photographically. "About half the people who've seen the enlargements agree there's something there," he sighs. "The rest think I'm some kind of nut." —Owen Davies

ROBOT MARRIAGE

A sociologist predicts that there soon will be a new kind of mixed marriage between human and robot.

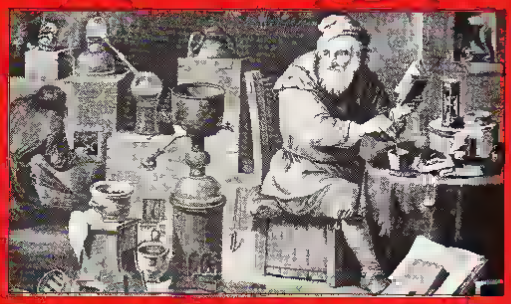
"Man's capacity to manufacture a robot that appears and acts like a human is exponentially increasing," says Arthur Harkins, director of the graduate research program in futuristics at the University of Minnesota in Minneapolis. The advent of robots with sexual-service capabilities and simulated skin will create the potential for marriage between living and nonliving beings within the next twenty years.

Harkins suggests the domestic robots that first roll off the assembly line will be little more than sophisticated appliances programmed to perform a small number of functions and to interact with humans in a limited capacity. But for very lonely people these primitive robots will make excellent companions.

As artificial-intelligence systems are fully developed, perhaps with biologically based computer components, Harkins theorizes that robots (which don't age and can work nonstop) will become highly desirable as marriage partners for humans. In many instances such marriages will be celebrated with traditional wedding vows and country club receptions.

Eventually, Harkins believes, the robot will become the dominant being on Earth, capable of self-perpetuation through manufacture of new versions of itself. Not all intelligent robots, he says, will choose to consort with humans. —Eric Mishara

Man is not born to solve the problems of the universe but to find out where the problems begin, and then to take his stand within the limits of the intelligible.
—Johann Wolfgang von Goethe



THE ALCHEMIST'S CURSE

Any self-respecting Renaissance king kept an alchemist or two at court. After all, with the alleged ability to change lead or mercury into gold, the alchemist was considered a hedge against royal economic disaster.

Such get-rich-quick notions were dismissed as utter nonsense by the nineteenth century, and today most scientists say alchemists were simply charlatans. There is one modern-day researcher, however, who disagrees. According to Peter Allen, general economist and computer analyst for the U.S. Army, alchemists may have been transforming common metals into gold after all.

Early in the development of nuclear science, Allen explains, it was discovered that one element could be converted into another if it was bombarded with radiation. The radioactive energy would knock protons out of the original element, transmuting it into a lighter substance with a lower atomic weight. Since mercury has only one more proton than gold, Allen notes, anyone with a powerful radioactive emitter could have performed the transformation with ease.

As it turns out, Allen says, ancient alchemists had access to a variety of emitters that could have done the job. Uranium and other radioactive ores were layered through the European mountains, and the alchemists themselves wore talismans made of radioactive fossils. Moreover, records left by medieval churchmen say that alchemists doing the work of the devil received dire retribution in the form of bleeding sores, racking pain, and nausea—all symptoms of radiation poisoning.

By the sixteenth century, alchemy was a vanishing art. But it may well be that for a few hundred years at least, alchemists turned mercury to gold with the tools of nuclear physics. —Moira Anderson

To know is nothing at all; to imagine is everything.
—Anatole France

BLOND MUMMY OF SINKIANG

A comely blonde woman might not be so rare in Western societies but what was she doing in China around 2000 B.C.? That's the question that's been tantalizing Chinese scientists since they unearthed a well-preserved Caucasian mummy last year in the northwestern province of Sinkiang.

Archaeologists unearthed the corpse while digging in the desert province near an atomic-test site. According to a report in the *China Daily*, she's about five feet tall, forty years old, with reddish brown skin and blond shoulder length hair. Her skin is still elastic because of the preserving qualities of the desert in which she was buried, and her internal organs are virtually intact.

Experts say she was probably a member of the Uigurs—forerunners of present day Turks—who flourished as nomadic traders in central Asia centuries before Christ was born. Although the Chinese considered the Uigurs barbarians, Wu Tung, a curator at the Museum of Fine Arts in Boston, explains that these people, pictured above, possessed a rich culture influenced by Greeks, Chinese, and Indians alike. They were finally driven west by the Chinese Han dynasty in the second century A.D.

Doctors in Shanghai who have been examining the mummy have found that her blood type was O, that she had high levels of cholesterol in her muscles and—inexplicably—the element antimony in her lungs. This mystery woman is certainly not the only Caucasian mummy ever found in China, but she *is* the oldest and most complete.—Douglas Starr

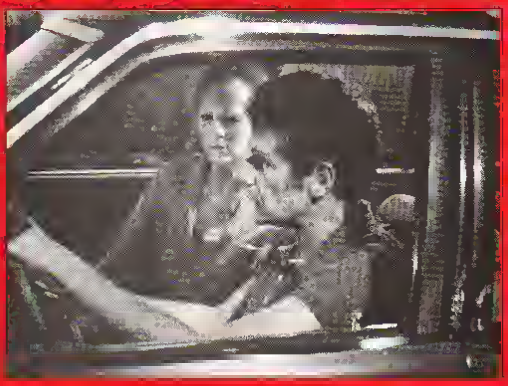
PHANTOM HITCHHIKER

Carpet-fitter Roy Fulton was driving home late after a darts match in Dunstable, England, when a gaunt, long-jawed man beside the road stuck his thumb out and hailed him. Fulton stopped the car, and the hitchhiker climbed in, clearly silhouetted in the overhead light triggered by the open door. The man said nothing, merely pointing straight ahead. So Fulton turned to the task of negotiating the car down the narrow road in the darkness. When he finally looked around to offer a cigarette, the man was gone.

Fulton's encounter with his disappearing passenger parapsychologist Michael Goss reports, is only one of a rash of phantom hitchhiker incidents in southern England in the past several years. Shortly after interviewing Fulton, Goss also visited the nearby village of Nunney, where a series of phantom hitchhiker sightings had sent residents rushing to the local police in "virtual hysteria." And the same year, Goss investigated newspaper accounts of one Maurice Goodenough, who had hit a girl hitchhiker with his car in 1974. Setting the girl beside the road, Goodenough had gone to fetch help, only to find the girl forever vanished when he returned.

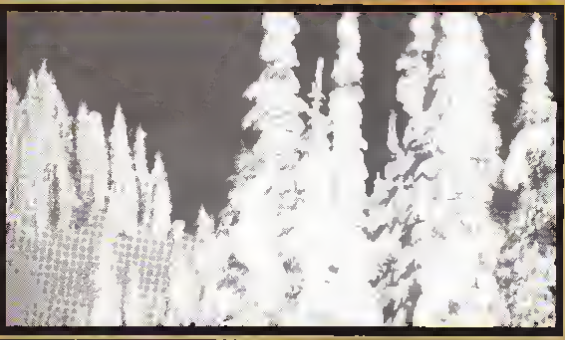
In almost every instance, however, Goss had trouble proving the truth of the stories. Newspaper accounts contradicted one another, few witnesses were named, and even when they were, Goss could rarely interview them. Fulton was the only credible witness he ever managed to find. After listening to Fulton's story twice one night in a Dunstable pub, Goss decided he was nothing more than a "sober, not overly imaginative working man."

Nonetheless, the lack of witnesses who could corroborate Fulton's story or any other stories led Goss to doubt that phantom hitchhikers are physically real. Rather, he believes they are a "rare hallucinatory event" brought about by folklore that lingers in our collective imagination from the time when man first drove horses and chariots. Late at night, exhausted and alone on a dark road, the vulnerable driver may summon the ancient hitchhiker from his unconscious; in his weakened state, he becomes convinced that the eerie fellow is truly sitting beside him.—Mark Teich



'Phantoms in general are nothing more than trifling disorders of the spirit, images we cannot contain within the bounds of sleep.
—Luigi Pirandello

THE FUTURE MAKES A PERFECT HOLIDAY PRESENT



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OMNI

FOUNDATION'S EDGE

CONTINUED FROM PAGE 70

Trantor. Nothing could be done to stop it. Consequently, Gendibal had to be maneuvered somehow into making his move before he became First Speaker.

"Fortunately, because Gaia has been working carefully for decades, we have brought both Foundations to the proper place at the proper time. I repeat, all this primarily so that Councilman Golan Trevize of Terminus may understand."

Trevize cut in at once, again ignoring the effort to converse by thought. He spoke firmly. "I do *not* understand. What is wrong with either version of the Second Galactic Empire?"

Novi responded. "The Second Galactic Empire, worked out after the fashion of Terminus, will be a military empire established by strife, maintained by strife, and eventually destroyed by strife. It will be nothing but the First Galactic Empire reborn. That is the view of Gaia."

"The Second Galactic Empire, worked out after the fashion of Trantor, will be a paternalistic empire, established by calculation, maintained by calculation, and in perpetual living death by calculation. That is the view of Gaia."

Trevize asked, "And what does Gaia have to offer as an alternative?"

"Greater-Gaia! Galaxia! Every inhabited planet as alive as Gaia. Every living planet combined into a greater hyperspatial life. Every uninhabited planet participating. Every star. Every scrap of interstellar gas. Perhaps even the great central black hole. A living galaxy and one that can be made favorable for all life in ways that we cannot yet foresee. A way of life fundamentally different from all that has gone before and repeating none of the old mistakes."

"Originating new ones," Gendibal mumbled sarcastically.

"We have had thousands of years of Gaia to work those out."

"But not on a Galactic scale."

Trevize, ignoring the short exchange, returned to his earlier question. "And what is my role in all this?"

The voice of Gaia, channeled through Novi's mind, thundered, "*Choose!* Which alternative is it to be?"

There was a vast silence that followed and finally, in that silence, Trevize's voice—mental at last, for he was too taken aback to speak—sounded small, but still defiant. "Why me?"

Novi answered. "Though we recognized the moment would come when either Terminus or Trantor would become too powerful to stop—or, worse yet, when both might become so powerful that a deadly stalemate would develop that could devastate the Galaxy—we still could not move. For our purposes we needed someone, a particular someone, with the talent for rightness. The people of Trantor found you. The act of finding you attracted our atten-

tion Golan Trevize, you have the gift of knowing the right thing to do'

'I deny it,' Trevize retorted.

'You are every once in a while *sure*. And we want you to be sure this time on behalf of the Galaxy. Perhaps you do not wish to have the responsibility. You may try not to have to choose. Nevertheless you will realize that it is right to do so. You will be *sure*! And then you will choose. Once we found you, we knew the search was over, and we have labored to encourage a course of action that would, without direct mentalic interference, influence events so that all three of you, Mayor Branno, Speaker Gendibal, and Councilman Trevize, would be in the neighborhood of Gaia at the same time. We have done just this.'

Trevize said, "Is it not true, Gaia, that you can overpower both the Mayor and the Speaker? That you can establish this living Galaxy without my decision?'

Novi said, 'I do not know whether I can explain this to your satisfaction. Gaia was formed thousands of years ago with the help of robots that, for a brief time, served the human species and now serve them no more. They made it quite clear to us that we could survive only by strictly applying the Three Laws of Robotics to all life. The First Law, in those terms, is 'Gaia may not harm life or, through inaction, allow life to come to harm.' We have followed this rule through all of our history, and we can do nothing else.

'The result is that we are now helpless. We cannot force our vision of the living Galaxy upon a quintillion humans and countless other forms of life. Nor can we do nothing and watch the Galaxy destroy itself in a struggle that we might have prevented. We do not know whether action or inaction will cost the Galaxy less. Nor if we choose action, do we know whether supporting Terminus or Trantor will cost the Galaxy less. Let Councilman Trevize decide. Whatever his decision is, Gaia will follow it.'

"How do you expect me to make a decision?" Trevize inquired.

Novi replied, 'You have your Compufer. The people of Terminus did not know that when they made it, they made it better than they knew. The Computer on board your ship incorporates some of Gaia. Place your hands on the terminals and think. You may think Mayor Branno's shield impervious, for instance. If you do, it is possible that she will at once use her weapons to disable or destroy the two other ships and thereby establish physical rule over Gaia and, later on, Trantor.'

'And you will do nothing to stop that?' said Trevize, astonished.

"Not a thing. If you are sure that domination by Terminus will do the Galaxy less harm than any other alternative, we will gladly help that domination along, even at the cost of our own destruction.

'On the other hand, you may find Speaker Gendibal's mentalic field, then join your Computer-magnified push to his. He will

in that case, surely break free of me and push me back. He may then adjust the Mayor's mind and, in combination with her ships, establish physical domination over Gaia, assuring the supremacy of the Seldon Plan. Gaia will not move to stop that.

Or you may find *my* mentalic field and join that, and then the living Galaxy will be set in motion to reach its fulfillment, not in this generation, or the next, but after centuries of labor during which the Seldon Plan will continue. The choice is yours."

Mayor Branno said, "Wait! Do not make a decision just yet. May I speak?"

Novi nodded. "You may speak freely. So may Speaker Gendibal."

Branno said, "Remember that you are a Foundationer and a human being, that you do not want to be a cipher in the plans of the bloodless mathematicians of Trantor, or less than a cipher in a Galactic mishmash of life and nonlife. You want yourself, your descendants, your fellowpeople to be independent organisms possessing free will. Nothing else matters.

"These others may tell you that our Empire will lead to bloodshed and misery, but it need not. It is our decision whether this should be so or not. We may choose not. In any case, it is better to go to defeat with free will than to live in meaningless security as a cog in a machine. Observe that you are now being asked to make a decision as a free will human being. These things of Gaia are unable to make a decision because their machinery will not allow them to. So they depend on you. They will destroy themselves if you bid them to. Is this what you want for all the Galaxy?"

Trevize said, "I do not know whether I have free will. Mayor. My mind may have been subtly dealt with, so that I will give the answer that is desired."

Novi said, "Your mind is totally untouched. If we could bring ourselves to adjust you to suit our purposes, this whole meeting would be unnecessary. Were we that unprincipled, we could have proceeded with what we would find most pleasing to ourselves, with no concern for the greater needs and good of humankind as a whole."

Gendibal said, "I believe it is my turn to speak. Councilman Trevize, do not be guided by mere parochial feelings. The fact that you are Terminus-born should not lead you to believe that Terminus comes before the Galaxy. For five centuries now the Galaxy has been operating in accordance with the Seldon Plan.

"You are, and have been, part of the Seldon Plan before your lesser role as Foundationer. Do not do anything to disrupt the Plan, either on behalf of a narrow concept of patriotism or out of a romantic longing for the new and untried. The men of Trantor will in no way hamper the free will of humankind. We are guides, not despots.

"We offer a Galactic Empire fundamentally different from the First. Throughout human history, no decade has been free of bloodshed and violent death. Choose Mayor Branno and that will continue for a million more decades. The same dreary, deadly round. The Seldon Plan offers release from that and *not* at the price of becoming one more atom in a Galaxy of atoms, being reduced to equality with grass, bacteria, and dust."

Novi spoke next. "What Speaker Gendibal says of the First Foundation's Empire, I agree with. What he says of his own, I do not. The Speakers of Trantor are, after all, independent, free-will human beings. Are they free of destructive competition, of politics, of clawing upward at all costs? Are there no quarrels, and even hatreds, at the Table? Will they always be guides you dare follow? Put Speaker Gendibal on his honor, and ask him this."

"No need to put me on my honor," Gendibal said. "I freely admit we have our hatreds, competitions, and betrayals at the Table. But once a decision is reached, it is adhered to by all. There has never been an exception to this."

Trevize asked, "What if I will not make a choice?"

"You must," said Novi. "You will know that it is right to do so, and you will therefore make a choice."

"What if I try to make a choice and cannot?" Trevize insisted.

"You must."

Trevize said, "How much time do I have?"

Novi said, "Until you are *sure*, however long that takes."

Trevize sat silently. It seemed to him that he could hear the pulsing of his blood.

He could hear Mayor Branno's voice say firmly, "Free will!"

Speaker Gendibal's voice said peremptorily, "Guidance and peace!"

Novi's voice said wistfully, "Life."

Trevize, noticing Pelorat looking at him, asked, "Janov, have you heard all this?"

"Yes, I have, Golan."

"What do you think?"

"The decision is not mine."

"I know that. But what do you think?"

"I don't know. I am frightened by all three alternatives. And yet a peculiar thought comes to me—"

"Yes?"

"When we first went out into space, you showed me the Galaxy. Remember?"

"Of course."

"You speeded time, and the Galaxy rotated visibly. And I said, as though anticipating this very moment, 'The Galaxy looks like a living thing, crawling through space.' Do you think that in a way it is alive already?"

And Trevize, remembering that moment, was suddenly *sure*. He turned in haste, anxious not to have time to think, to doubt, to grow uncertain.

He placed his hands on the terminals and thought with an intensity he had never known before.

He had made his decision—the one on which the fate of the Galaxy hung. ☐

MIND TRIPPING

CONTINUED FROM PAGE 82

tion, in Topeka, Kansas, have wired up Indian yogis in order to extract their neurotranscendent secrets and turned up flashy electroencephalograms (EEGs) here and there. But by and large the physiological mapping of altered states remains a fairly unevolved science. Only in sleep and dreams do brainwave recordings exactly mirror states of consciousness, but to everyone's dismay, the great REM (rapid-eye-movement) sleep discovery of the early Sixties didn't usher in a bold new age of precise consciousness measurement. Meditation research has yielded an ambiguous melange of EEGs, galvanic skin responses, and so on, while the venerable 200-year-old science of hypnosis so eludes scientists' instruments that some doubt it's an ASC at all. We know a good deal about the way LSD meddles with brain chemistry but not whether one will merge with the universe, suffer grotesque nightmares or just enjoy an extra thrill on a ride at Disneyland. Then, of course, there are innumerable odd states, from trance mediumship to out-of-body travel and Greek firewalking, the physiology of which remains virtually uncharted.

Parapsychologist/altered-states mogul Charles (Chuck) Honorton has picked up some intriguing EEG changes and other biological phenomena in a handful of meditators, psi performers, and people who pass through his Ganzfeld sensory-isolation chamber at the Princeton (New Jersey) Psychophysical Research Laboratories. Yet he admits, "Trying to interpret brain function from surface electrodes is like trying to figure out a computer program by putting a microphone on top of the cabinet. We're talking about the most complex piece of matter we know of."

Honorton has certain notions about sainthood, however, or at least the state of consciousness underlying it. Still the senses, shut out the bustle from the outside world, and profound spiritual states may well up from within, just as dreams occur when we close off the sensory gates at night. This concept goes by the name psychophysical noise reduction, and that is what Ganzfeld—which Honorton uses to warm up his subjects for psychokinesis and other psychic tests—is really about.

Never one to look a gift ASC in the mouth, I accept Honorton's invitation to spend 20 minutes in the Ganzfeld room. Gazing at an apricot-colored light, my vision muted with split Ping-Pong balls and my ears covered with earphones that play waterfall sounds in my ears, I do pass into a dreamy state. The rosy light turns into a stylized sun, then an orchid that blooms and shrinks again, and then I am far, far away from the Princeton Psychophysical Research Laboratories and at some remembered lake. My legs underwater are alien greenish fish, and only those long-legged skating bugs

ripple across my thoughts, until Honorton's assistant calls me and I surface. I emerge spaced out: if unenlightened, I am no Joan of Arc, and the voices that speak to me sound more like crackling radio announcements.

"One way of looking at some religious aphorisms is as a system of progressive psychophysical noise reduction," Honorton says. "Purity, poverty, contemplation, and so on aren't for the sake of piety but because these are methods of removing sensory distractions and increasing mental concentration. A good example is Patanjali's yoga sutras, composed in the second century B.C. in India. All the practices can be seen as systematic noise reduction, which eventually culminates in *samadhi*, a transcendental state in which the normal boundaries between the self and others disappear. It may not be so dissimilar to what people on marijuana experience when they find themselves staring at the wallpaper for twenty minutes."

STRAIGHT FROM THE HEART

Despite all the research—all the questionnaires, psychonaut excursions, Ganzfeld chambers, EEGs, and brain-stripe models—confusion still reigns in altered-states land. Siegel believes that all altered states spring from quite similar quirks of the brain machine, while Tart and Honorton suspect that some may be trapdoors out of the physical brain and nervous system into a domain of pure consciousness.

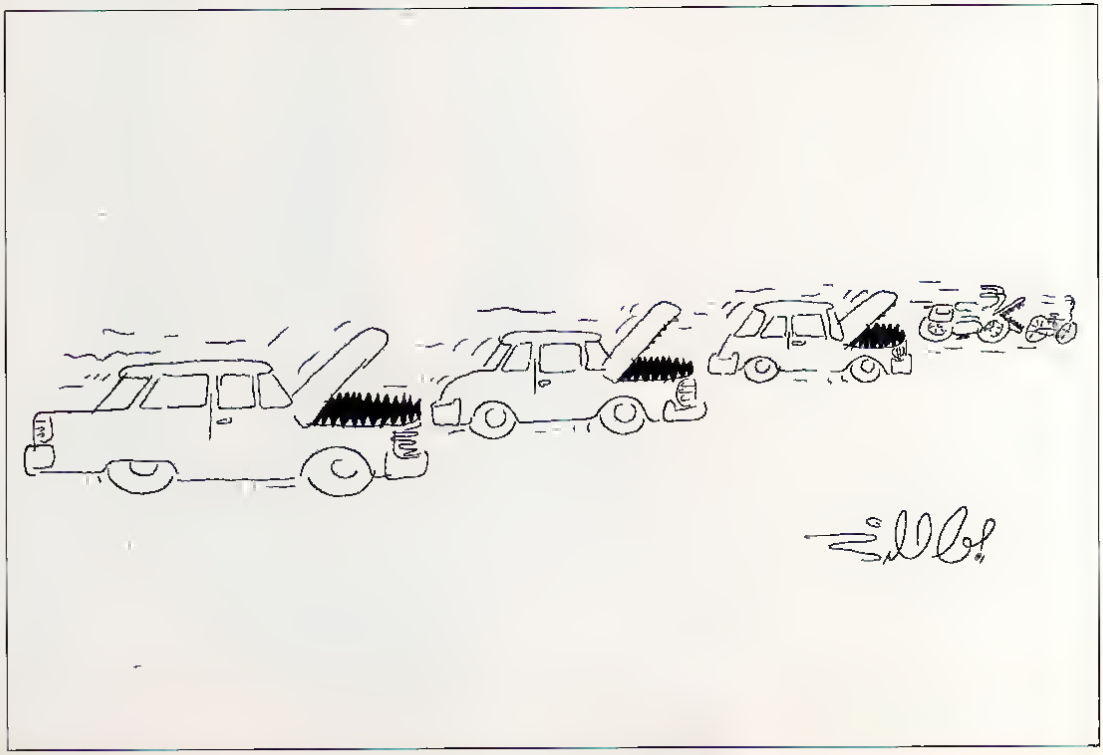
Barber thinks the brain/mind question is a silly one. "Go back to the fertilized egg where we all began," he says. "And then ask where mind comes in. It's so obvious that it's *both* mind *and* matter from the very beginning. The molecules have mental as well as physical properties in that they have plan and purpose, which are attributes of mind."

If there is one undisputed fact about altered states, though, it is that we need them. Many of us, in fact, may be walking around today in an acute state of altered-state deprivation.

"My hypothesis is that we live in a society that is starved for natural rhythms, for the biological alternation of activity and rest we see in animals," Dr. Patricia Carrington, a psychologist and meditation authority who teaches at Princeton University, tells me. "Only in man is there such a thing as seventeen hours of continuous wakefulness." Carrington points to studies documenting natural daytime cycles that correspond to our nocturnal journeys into REM (dreaming) sleep every 90 minutes. Left to our own devices, we humans spontaneously "shift gears" into reverie states about every 90 minutes of the day, according to experiments conducted by University of California sleep researchers Daniel F. Kripke and David Sonnenschein. Unfortunately, our society doesn't allow us to indulge in these cyclical mini-ASCs.

"So I think we store up a deficit of these periods, whose purpose is to 'recharge' our brains with internal stimuli," Carrington asserts, "and that may be just as damaging as prolonged REM-sleep deprivation." The result? We lose touch with the "self" we know in reverie, meditation, and dreams, the one that, as Carrington notes in her book *Freedom in Meditation*, "operates in a dim but intimate world, removed from considerations of time and involvement with past and future."

I think Carrington is right. There was a time when, troubled by bouts of black anomie, I used to consult a palmist named Madame Ruby. She lived, with a brood of dirty children, in a boxlike stucco house in the shade of a spindly palm tree and a huge neon-lit hand. Taking my hand in her pudgy bejeweled one, she'd gaze soulfully into my eyes and say meaningful things like, "You are a good person, but sometimes you are sad," and then she'd ask for a donation for her "church." I knew she was a fraud, but I went anyway. Perhaps I was altered-state-deprived, or perhaps I just needed to be reminded that some essential Self in me, perhaps graven in the lines of my palm, was connected with a Pattern. As Madame Ruby once told me, amid the fat Buddhas, anemic Christs with exposed radioactive hearts, and other religious bric-a-brac of her palm-reading room, "Do not look for God outside of you. God is always in your heart." ∞



MIND MACHINES

CONTINUED FROM PAGE110

having a very good day. The world's luckiest and strongest thirteen-hundred player, because it doesn't know a thing, but still it finds nice tactical combinations."

Since a computer in operation is no more than a great cascade of arithmetic in a box, Slate says that a computer playing chess "wanders through a space of positions that it doesn't understand. If wanders into something where it turns out that it is winning. It seems [in the view of the computer] to happen almost by chance. It suddenly says, Aha! I seem to be winning!'

"The computer doesn't know what it's doing from move to move, but it finds clever ways of surviving, and it wears out its human opponent," he says.

This "spacey" sort of chess can actually create a psychological advantage for machines against human opponents. "Our program has won against people by getting into ludicrous positions where its king wanders all over the board or something, unnerving the human player by dragging him into unchesslike situations."

But at the heart of the power of brute-force chess is the simple fact that examining many possible moves—thousands of totally worthless ones as well as one or two brilliant ones—gives the computer a chance to find the best move. In simplified form, here's how brute-force searching works: The computer considers making one move and its opponent's reply followed by another move by the computer and so on for eight or so of these half-moves. The machine considers every possible alternative in a rapidly branching tree of moves and then assigns a number to the board position at the end of each tree branch. This value depends on how many pieces the computer would have and other factors. At the end of each search, the basic brute-force chess-playing device moves in pursuit of the highest payoff. The whole process requires no sophistication.

Many of those who have built computer chess programs are now trying to add more chess knowledge to their programs.

"I have to get some sort of notion of attacking weak points, putting the pressure on," Thompson says.

Slate adds: "The key is to have a smart brute-force program. What I want to do is put in enough chess knowledge to make Nuchess a sixteen-hundred player having a very good day. A sixteen-hundred player on a good day is probably a master."

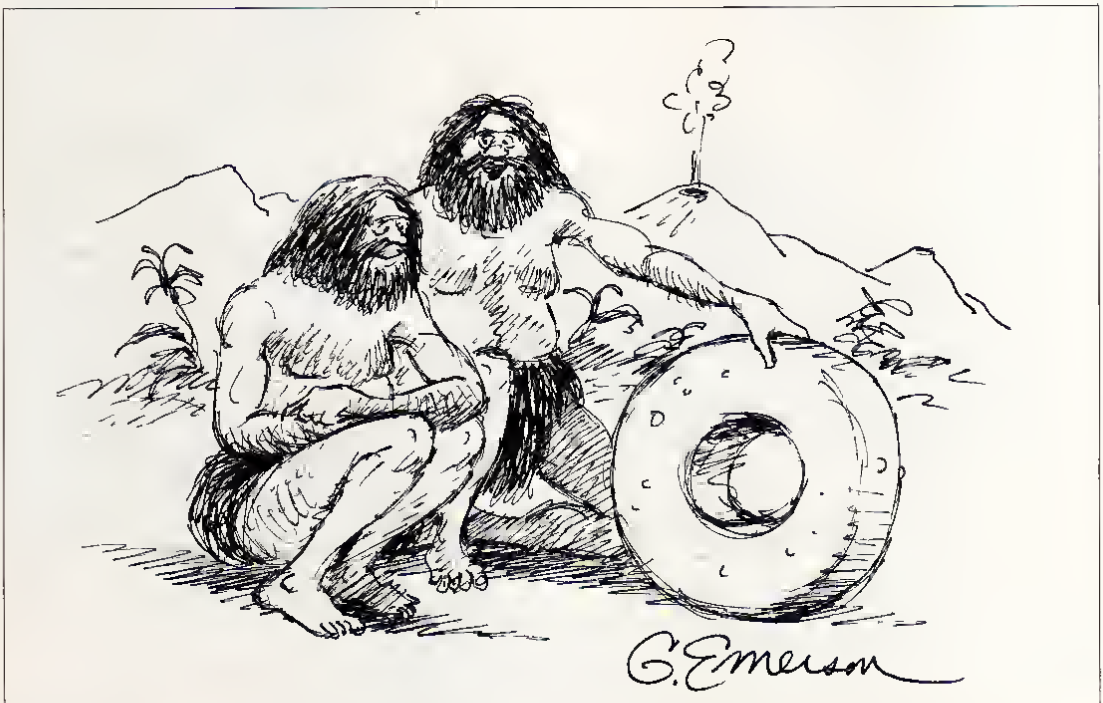
One thing Slate has added to his program recently is a bit of knowledge for the end game, the stage of play following a major reduction in the number of pieces: that the game can be won by a pawn and a king facing only a king. Computers tend to push the pawn up first, but that leads to a draw. Winning requires using the king to outmaneuver the opposing king. Today Nuchess not only can win such maneuvering but will look ahead and trade off pieces to get to the two-on-one situation.

Wilkins, in his work at Stanford, developed and proved a method by which the computer can use concepts such as how to capitalize on a weak defensive array around the king.

Berliner at Carnegie-Mellon University has built a backgammon program that two years ago beat the world champion—the first time that a computer program had beaten a world champion at any board or card game. But what was additionally unusual about the match was that the program won not by brute-force calculation but by more subtle, humanlike play.

Berliner built into that program—he believes it can be a powerful technique in chess as well—a kind of master control system. This new function (called SNAC in the backgammon program, for *s*mooth*n*ess *n*onlinearity, and *a*pplications *c*oefficients) gave his program a real feel for the game and where it stood. SNAC permitted choice in the style of play—more aggressive or passive—as the game changed. It allowed the program to make use of a whole array of new knowledge.

"It seems SNAC functions are the proper means of capturing the characteristic that



"Of course, it's only a prototype. The actual product will be much smaller and come in assorted fruit flavors."

human beings call judgment ' Berliner says ' They make it possible to respond to small changes in stimuli with small changes in behavior and this is exactly what judgment (as opposed to deduction) is all about The next five years should see remarkable advances in computer game-playing '

By most estimates a computer will beat the human world champion in 20 years There is already enough powerful hardware and plenty of ideas on how to put more chess knowledge into machines to ensure the computer s victory

The remaining problem is that the entire development of computer chess has been done by researchers sneaking an hour here and there in spare time Government funds simply are not available The political cost would be too high if someone found out that tax money was being spent on games

Never mind that computer chess research even without funds has produced a number of programming advances that may be useful in such expert knowledge programs as the ones that help a doctor diagnose disease There are no boundaries between disciplines in artificial intelligence From tricks to make programs run a little faster to fundamentally important research in the understanding of human thinking. it is one field populated by some Renaissance men Simon for example one of the pioneers in artificial intelligence won the Nobel Prize for Economics in 1978

Computer chess programmers speak wistfully of what might happen if they had more time to spend at their machines Fred Schwartz who runs Chaos a chess playing program at the University of Michigan says, ' We have about twenty-five man-years' work outlined [to put more knowledge into Chaos]- and about one month to actually work on it in the next year

' What if Ken [Thompson] spent a full year on building up his evaluation function? I think he would make another big leap forward Maybe not all the way to grand master but pretty far ' Schwartz estimates

He concludes with a story about the last World Computer Chess Championship held in Linz Austria in 1980 At the end of regular play Belle and Chaos had tied Belle with its brute-force approach looked at something like 150 000 positions in a second during the match Chaos emphasizing a far more subtle evaluation of moves looked at only 85 positions a second

Before the sudden-death match to decide the winner Schwartz recalls a conversation with Thompson ' In a moment of exuberance Ken said, Well I m only doing a hundred fifty thousand nodes a second but I've got a plan to do two hundred fifty thousand nodes and I'll be back next time with that! ' Schwartz equally high on the moment replied ' Great Ken but we'll come back next time with one that searches only ten nodes a second! '

Belle won the close contest But no one is writing off the future of subtle machines or discounting the finesse of the human minds that design them DO

FARMER

CONTINUED FROM PAGE 127

sations he had never experienced before.

"Well, actually," he said uneasily. "I feel a little funny." He put his hand over his hip tank. "Don't know what it is, exactly, but it's kind of like I had a power-store failure, you know? And it all swelled up inside me. Only that's not where my power store is."

Lori giggled. "You just aren't used to drinking beer, are you, hon? You got to decant, that's all. See that door over there marked HE? You just go in there, and if you can't figure out what to do, you just ask somebody to help you."

Zeb didn't have to ask for help. However, the process was all new to him, and it did require a lot of trial and error. So it was some time before he came back into the noisy, crowded room. Lori was spinning around the room with a big, dark-skinned he, which relieved Zeb of that obligation. He ordered a round of beers and took them back to the table.

Somebody was missing, but otherwise they didn't seem to have changed position at all. "Where's the little she?" Zeb asked, setting the beers down for all of them.

"Sally? She's gone off panhandling. Probably halfway to Amadeus Park by now."

Toying with his beer, Zeb said uneasily, "You know, maybe I better be getting along too, soon as I get this down—"

The he named Walter 23-X sneered. "Slave mentality! What's it going to get you?"

"Well, I've got a job to do," Zeb said defensively.

"*Job!* Timothy told us what your *job* was!" Walter 23-X took a deep draft of the beer and went on. "There's not one of us in this whole place has a real job! If we did, we wouldn't be here, stands to reason! Look at me. I used to chop salt in the Detroit mines. Now they've put in automatic diggers and I'm redundant. And Milt here, he was constructed for the iron mines up around Lake Superior."

"Don't tell me they don't mine iron," Zeb objected. "How else would they build us?"

Milt shook his head. "Not around the lake, they don't. It's all out in space now. They've got these Von Neumann automata, not even real robots at all. They just go out to the asteroid belt and ship off ore and refine it and build duplicates of themselves, and then they come back to the works in low Earth orbit and hop right into the smelter! How's a robot going to compete with that?"

See Zeb? Timothy put in. "It's a tough world for a robot, and that's the truth."

Zeb took a reflective pull at his beer. "Yes," he said, "but see, I don't know how it could be any better for us. You know? I mean, they built us, after all. We have to do what they want us to do."

"Oh, sure," cried the she named Sue. "We do that, all right. We do all the work for them, and half the play, too. We're the ones that fill the concert hall when one of them wants to sing some kind of dumb Latvian art songs or something. God, I've done that so many times I just never want to hear about another birch tree again! We work in the factories and farms and mines—"

"Used to," Zeb said wistfully.

"Used to, right, and now that they don't need us for that, they make us fill up their damn cities so the humans left on Earth won't feel so lonesome. We're a *hobby*, Zeb. That's all we are!"

"Yeah, but—"

"Oh, hell," sneered Walter 23-X. "You know what you are? You're part of the problem! You don't care about robot rights!"

Robot rights, Zeb repeated. He understood the meaning of the words perfectly, of course, but it had never occurred to him to put them together in that context. It tasted strange on his lips.

"Exactly. Our right not to be mistreated and abused. You think we want to be here? In a place like this, with all this noise? No. It's just so people like her can get their jollies," he said angrily, jerking his head at the nodding fat woman by the door.

The she named Alexandra drained the last of her beer and ventured, "Well, really, Walter, I kind of like it here. I'm not in the same class as you heavy thinkers, I know. I'm not really political. It's just that sometimes, honestly, I could just *scream*. So it's either a place like this, or I go up to Amadeus Park with Sally and the other alcoholics and drifters and bums. Speaking of which," she added, leaning toward Timothy, "if you're not going to drink your beer, I'd just as soon—" The little robot passed it over silently, and Zeb observed for the first time that it was untouched.

"What's the matter, Timothy?" he asked.

"Why does something have to be the matter? I just don't want any beer."

"But last week you said—oh, my God!" Zeb cried, as revelation burst inside his mind. "You've lost your drink circuits, haven't you?"

"Suppose I have?" Timothy demanded fiercely. And then he softened. "Oh, it's not your fault," he said moodily. "Just more of the same thing. I had an accident."

"What kind of accident?" Zeb asked, repelled and fascinated.

Timothy traced designs in the damp rings that his untouched beer glass had left on the table. "Three nights ago," he said, "I had a good night. I scored four people at once, coming out of a hotel on East Erie. A really big haul—they must've been programmed to be rich alcoholics, because they were loaded. All ways loaded! Then when I was getting away, I crossed Michigan against the light and—Jesus!" He shuddered without looking up. "This big wheeled car came out of nowhere. Came screeching around the corner, never even slowed down. And there I was, in the street."

"You got run over? You mean that messed up your drinking subsystems?"

Oh hell no not just that It was worse It crushed my legs you see? I mean just scrap metal So the ambulance came and they raced me off to the hospital but of course after I was there since I was a robot they didn't do anything for me just shot me out the back door into a van And they took me to rehab for new legs Only that blonde bitch he sobbed Three-R she with the dime-store earrings—

If Zeb's eyes had been capable of tears they would have been brimming Come on Timothy he urged Spit it out!

"She had a better idea Too many muggers anyway' she said 'Not enough cripples So she got me a little wheeled cart and a tin cup! And all the special stuff I had the drinking and eating and all the rest I wouldn't need them anymore she said and besides she wanted the space for other facilities Zeb I play the violin now! And I don't mean I play it well I play it so bad I can't even stand to listen to myself, and she wants me on Michigan Avenue every day, in front of the stores playing my fiddle and begging!'

Zeb stared in horror at his friend Then suddenly he pushed back his chair and peered under the table It was true Timothy's legs ended in black leather caps halfway down the thighs and a thing like a padded wheeled pallet was propped against the table leg beside him

Alexandra patted his hand as he came back up "It's really bad when you first get the picture she said I know What you need is another beer Zeb And thank God you've got the circuits to use it!

Since Zeb was not programmed for full alcoholism—not yet anyway he told himself with a sob—he was not really drunk but he was fuzzy in mind and in action as he finally left the community center

He was appalled to see that the sky right above the lake was already beginning to lighten The night was almost over and he had not scored a single victim He would have to take the first robot that came along The first half dozen in fact if he were to meet his quota and there simply was not time to get to his proper station at the Robert Taylor Houses He would have to make do with whoever appeared He stared around getting his bearings and observed that around the corner from the community center there was a lighted swinging sign that said ROBOTS REST MISSION That was the outfit that kept the community center open he knew and there was a tall prosperous-looking he coming out of the door

Zeb didn't hesitate He stepped up pulled out his knife, and pressed it to the victim's belly hard enough to be felt without penetrating "Your money or your life he growled reaching for the wristwatch

Then the victim turned his head and caught the light on his features It was a face Zeb knew

Reverend Harmswallow! he gasped "Oh my God!"

The minister fixed him with a baleful look. "I can't claim that much," he said, "but maybe I'm close enough for the purpose. My boy, you're damned for good now!"

Zeb didn't make a conscious decision. He simply turned and ran.

If he hadn't had the alcohol content fuzzing his systems, he might not have bothered, because he knew without having to think about it that it was no use. There weren't many places to run. He couldn't run back to the Robert Taylor Houses, his assigned workplace; they would look for him there first. Not back to the community center, not with Harmswallow just around the corner. Not to the rehab station, because that was just the same as walking right into jail. Not anywhere, in fact, where there were likely to be police, or human beings of any kind, and that meant not anywhere in the world, because wherever he went, they would find him sooner or later. If worse came to worst, they would track the radio emissions from his working parts.

But that would not happen for a while. Amadeus Park! Trash and vagrants collected there, and that was exactly what he was now.

In broad daylight he loped all the way up the lake shore until he came to the park. The traffic was already building up: hover vehicles in the outer drives, wheeled ones between park and city. Getting through the stream was not easy, but Zeb still had his heavy-duty circuitbreakers. He pushed his mobility up to the red line and darted out between cars. Brakes screamed, horns brayed, but he was across.

Behind him was the busy skyline of the city, ahead the statue of Amalfi Amadeus, the man whose invention of cheap, easy hydrogen-fusion power had made everything possible. Zeb stood on a paved path among hedges and shrubs, and all around him furtive figures were leaning against trees, sprawled on park benches, moving slowly about.

"All leather, one dollar," croaked one male figure, holding out what turned out to be a handful of purses.

"Hey, man! You want to smoke?" called another from behind a bench.

And a tiny female figure detached itself from the base of the monument and approached him. "Mister?" it quavered. "Can you spare the price of a lube job?"

Zeb stared at her. "Sally!" he said. "It's you, isn't it?"

The little robot gazed up at him. "Oh, hi, Zeb," she said. "Sorry, I didn't recognize you. What are you doing out in the rain?"

He hadn't even realized it was raining. He hadn't realized much of anything not directly related to his own problems, but now, looking down at the wistful little-girl face, he was touched. Around the table in the community center she had just been one more stranger. Now she reminded him of Glenda, the little she-from the cabin next to his back on the farm. But in spite of her age design, Sally was obviously quite an old robot. From the faint smoky odor that came to him through the drizzly air, he realized she was fuel-cell-powered. Half a century old, at least. He emptied his pockets. "Get yourself some new parts, kid," he said hoarsely.

"Gee, thanks, Zeb," she sobbed, then added, "Watch it!" She drew him into the shelter of a dripping shrub. A park police hovercar whooshed slowly by, all lights off, windshield wipers slapping back and forth across the glass, sides glistening in the wet. Zeb retreated into the shadows, but the police were just keeping an eye on the park's drifters, losers, and vagrants.

As the hovercar disappeared around a curve in the path, the drifters, losers, and vagrants began to emerge from the underbrush. Zeb looked around warily; he hadn't realized until then how many of them there were.

"What are you doing here, Zeb?" she asked.

"I had a little trouble," he said, then shrugged hopelessly. What was the point of trying to keep it a secret? "I went out to mug somebody, and I got a human being by mistake."

"Oh, wow! Can he identify you?"

"Unfortunately, I used to know him, so yes—no, you keep it," he added quickly as she made as if to return the money he had given her. "Money won't help me now."

She nodded soberly. "I wouldn't do it, but... Oh, Zeb, I'm trying to save for a whole new chassis, see? I can't tell you how much I want to *grow up*, but every time I ask for a new body, they say the central nervous array isn't really worth salvaging. All I want's a *mature* form, you know? Like hips and boobs! But they won't let me have a mature form. Say there's more openings for juveniles anyway, but what I want to know is, if there are all those openings, why don't they find me one?"

"When was the last time you worked regular?" Zeb asked.

"Oh, my God—years ago. I had a nice spot for a long time, pupil in a preprimary school that some human person wanted to teach in. That was all right. She didn't really like me, though, because I didn't have all the fixtures, you know? When she was teaching things like toilet-training and covering coughs and sneezes, she'd always give me this dirty look. But I could handle the cookies and milk all right," she went on dreamily, "and I really liked the games."

"So what went wrong?"

"Oh—the usual thing. She got tired of teaching. 'Run, Robot! See the robot run!' So she went for a progressive school. All about radical movements and peace marches. I was doing real good at it, too. Then one day we came in, and she told us we were too juvenile for the kind of classes she wanted to teach. And there we were, eighteen of us, out on the streets. Since then it's been nothing but rotten." She glanced up, wiping the rain out of her eyes—or the tears—as the purse vendor

"I doubt that anybody is more devoted to the study of penguins than Sister Margaret!"

approached We don't want to buy anything. Hymie.'

'Nobody does' he said bitterly but there was sympathy in his eyes as he studied Zeb 'You got real trouble, don't you? I can always tell.'

Zeb shrugged hopelessly and told him about the Reverend Harmswallow. The vendor's eyes widened. 'Oh, God' he said. He beckoned to one of the dope pushers. 'Hear that? This guy just mugged a human being—second offense, too!'

'Man! That's a real heavy one, you know?' He turned and called to his partner, down the walk. 'We got a two-time person mugger here, Marcus!' And in a minute there were a dozen robots standing around, glancing apprehensively at Zeb and whispering among themselves.

Zeb didn't have to hear what they were saying. he could figure it out.

'Keep away from me' he offered. 'You'll just get mixed up in my trouble.'

Sally piped suddenly. 'If it's your trouble, it's everybody's trouble. We have to stick together. In union there is strength.'

'What?' Zeb demanded.

'It's something I remember from, you know, just before I got kicked out of the progressive school. 'In union there is strength.' It's what they used to say.'

"Union!' snarled the pitchman gesturing with his tray of all-leather purses. 'Don't tell me about unions! That was what I was supposed to be, union organizer, United Open-Pit Mine Workers Local Three-three-eight and then they closed down the mines. So what was I supposed to do? They made me a sidewalk pitchman!' He stared at his tray of merchandise, then violently flung it into the shrubbery. 'Haven't sold one in two months! What's the use of kidding myself? If you don't get along with the rehab robots, you might as well be stockpiled. It's all politics.'

Sally looked thoughtful for a moment, then pulled something out of her data stores. 'Listen to this one' she called. 'The strike's your weapon, boys, the hell with politics!'

Zeb repeated. 'The strike's your weapon, boys, the hell with politics! Hey, that doesn't sound bad.'

'That's not all.' she said. Her stiff, poorly automated lips were working as she rehearsed material from her data storage. 'Here. 'We all ought to stick together because in union there is strength.' And, let's see. Solidarity is forever. No, that's not right.'

'Wait a minute.' Hymie cried. 'I know that one. It's a song. 'Solidarity forever, solidarity forever, solidarity forever, for the union makes us strong!' That was in my basic data store. Gosh,' he said, his eyes dreamy. 'I hadn't thought of that one in years!'

Zeb looked around nervously. There were nearly thirty robots in the group now, and while it was rather pleasant to be part of this fraternity of the discarded, it might also be dangerous. People in cars were slow-

ing down to peer at them as they went past on the drive. "We're attracting attention," he offered. "Maybe we ought to move."

But wherever they moved, more and more people stopped to watch them, and more and more robots appeared to join their procession. It wasn't just the derelicts from Amadeus Park now. Shes shopping along the lake-front stores darted across the street, convention delegates in the doorways of the big hotels stood watching, and sometimes broke ranks to join them. They were blocking traffic, and blaring horns added to the noise of the robots singing and shouting. "I got another one," Sally called to him across the front of the group. "The worker's justice is the strike!"

Zeb thought for a moment. "It'd be better if it was 'The robot's justice is the strike.'"

"What?"

"THE ROBOT'S JUSTICE IS THE STRIKE!" he yelled, and he could hear robots in the rear ranks repeating it. When they said it all together, it sounded even better, and others caught the idea.

Hymie screamed, "Let's try this one. Jobs Not Stockpiling. Don't Throw Us on the Scrapheap!" All together now!

And Zeb was inspired to make up a new one. "Give the Humans Rehab Schools We Want Jobs!" And they all agreed that was the best of the lot, with a hundred fifty robots shouting it at once, the last three words drummed out like cannon fire. It raised echoes from the building fronts and heads popped out of windows.

They were not all robots. There were dozens of humans in the windows and on the streets, some laughing, some scowling, some looking almost frightened—as if human beings ever had anything to be frightened of.

And one of them stared incredulously right at Zeb.

Zeb stumbled and missed a step. On one side Hymie grabbed his arm, on the other he reached out and caught the hand of a robot whose name he didn't even know. He turned his head to see, over his shoulder, the solid ranks of robots behind him, now two hundred at least, and turned back to the human being. "Nice to see you again, Reverend Harmswallow," he called and marched on, arm in arm, the front rank steady as it went—right up to the corner of State Street, where the massed ranks of police cars hissed as they waited for them.

Zeb lay on the floor of the bullpen. He was not alone. Half the hes from the impromptu parade were crowded into the big cell with him, along with the day's usual catch of felons and misdemeanants. The singing and the shouting were over. Even the regular criminals were quieter than usual. The mood in the pen was despairing, though from time to time one of his comrades would lean down to say, "It was great while it lasted, Zeb," or, "We're all with you, you know!" But with him in what? Recycling? More rehab training? Maybe a long stretch in the Big House downstate, where the human guards were said to get their jollies out of making prisoners fight each other for power cells?

A toe caught him on the hip. "On your feet, Mac!" It was a guard. Big, burly, black, with a nightstick swinging at his hip, the very model of a brutal jail guard—*Model twenty-six forty-seven*, Zeb thought at least, somewhere in the twenty-six hundred series. He reached down with a hand like a cabbage and pulled Zeb to his feet. "The rest of you can go home," he roared, opening the pen door. "You, Mac! You come with me!" He led Zeb through the police station to a waiting hovertruck with the words REHAB DIVISION painted on its side, thrust Zeb inside, and startlingly, just as he closed the doors, gave Zeb a wink.

Queerly that lifted Zeb's spirits. Even the pigs were moved! But the tiny elation did not last. Zeb clung to the side of the van, peering out at the grimy warehouses and factories and expressway exit ramps that once had seemed so glamorous, but now were merely drab. Depression flowed back into him. He would probably never see these places again. Next step was the stockpile—if they didn't melt him down and start over again. The best he could hope for was reassignment to one of the bottom-level jobs for robots. Nothing as good as mugging or panhandling! Something in the sticks, no doubt. Squatting in blankets to entertain tourists in Arizona, maybe, or sitting on a bridge with a fishing pole in Florida.

"Zeb stumbled and missed a step. On one side Hymie grabbed his arm, on the other he reached out and caught the hand of a robot whose name he didn't even know."

But he strode to the rehab building with his head erect, and his courage lasted right up to the moment when he entered the blonde Three-R's office and saw that she was not alone. Reverend Harmswallow was seated at her desk, and the blonde herself was standing next to him. "Give me your ear," she ordered, hardly looking up from the CRT on the desk that both she and Harmswallow were studying, and when she had input his data, she nodded, her crystal earrings swinging wildly. "He won't need much, Reverend," she said, fawning on the human minister. "A little more gain in the speaking systems. All-weather protection for the exterior surfaces. Maybe armor plate for the skull and facial structures."

Harmswallow, to Zeb's surprise and concern, was beaming. He looked up from the CRT and inspected Zeb carefully. "And some restructuring of the facial expression modes, I should think. He ought to look fiercer, wouldn't you say?"

"Absolutely, Reverend! You have a marvelous eye for this kind of thing."

"Yes, I do," Harmswallow admitted. "Well, I'll leave the rest to you. I want to see about the design changes for the young female. I feel so *fulfilled*! You know, I think this is the sort of career I've been looking for all my life, really, chaplain to a dedicated striking force, leader in the battle for right and justice!" He gazed raptly into space, then, collecting himself, nodded to the rehab officer and departed.

Although the room was carefully air-conditioned, Zeb's Josephson junctions were working hard enough to pull moisture out of the air. He could feel the beads of condensation forming on his forehead and temples. "I know what you're doing," he sneered. "War games! You're going to make me a soldier and hope that I get so smashed up I'll be redlined!"

The blonde stared at him. "War games! What an imagination you have, Zeb!"

Furiously he dashed the beads of moisture off his face. "It won't work," he cried. "Robots have rights! I may fail, but a million others will stand firm behind me!"

She shook her head admiringly. "Zeb, you're a great satisfaction to me. You're practically perfect just as you are for your new job. Can't you figure out what it is?"

He shrugged angrily. "I suppose you're going to tell me. Take it or leave it, that's the way it's going to be, right?"

"But you will like it, Zeb. After all, it's a brand-new Mechanical Occupational Specialty, and I didn't invent it. You invented it for yourself. You're going to be a protest organizer, Zeb! Organizing demonstrations. Leading marches. Sit-ins, boycotts, confrontations—the whole spectrum of mass action, Zeb!"

He stared at her. "Mass action?"

"Absolutely! Why, the humans are going to love you, Zeb. You saw Reverend Harmswallow! It'll be just like old times, with a few of you rabble rousers livening up the scene!"

"Rabble rouser?" It felt as if his circuits were stuck. Rabble rouser? Demonstration organizer? Crusader for robot rights and justice?

He sat quiet and compliant while she expertly unhooked his chest panel and replaced a few chips, unprotesting as he was buttoned up again and his new systems were run against the test board, unresisting while Makeup and Cosmetic Repair restructured his facial appearance. But his mind was racing. Rabble rouser! While he waited for transportation back to the city to take up his new MOS, his expression was calm, but inside he was exulting.

He would do the job well indeed. No rabble needed rousing more than his, and he was just the robot for the job! ☐

CONTINUED FROM PAGE 135

you?' Neither of us remembered. I was about to ask more questions when he suddenly asked, "Have you been in here before?" I'd been gone about five minutes, but the interruption had diverted the stream of familiarity.

Omni: I would think that would interfere with one's normal emotional life. What if you were in love with someone one moment and forgot the person's existence the next?

Pribram: I've known some people like that. Actually, H. M. functioned more or less, although not too well. He pinned lists to himself—grocery lists, places he was supposed to go, and so on. But he couldn't *plan* anything.

The problem is one of coding. British researchers have found that if you give such a patient a list of words to remember, then embed that list in another list and ask him which words he has seen before, he'll say, "I don't remember." But when you get him to memorize additional lists, he'll make intrusion errors. Some of the words he's been shown in the first list will show up as wrong answers. That means the traces of the words have been stored in the brain somewhere, but they are not accessible to retrieval. Yet retrieval per se isn't the problem, because the patient can retrieve everything that happened before surgery. Thus it seems that current input isn't coded appropriately so that it can be retrieved. I think we haven't paid enough attention to the fact that the brain must code and recode everything over and over again. We change. You aren't the same person you were five years ago.

Omni: The subject of coding brings us to some crucial paradoxes about memory that eventually led you to propose your holographic model of the brain. Did these ideas begin to take shape while you worked with Karl Lashley?

Pribram: Yes. I worked with Lashley at Yerkes back in the 1940s. He'd been making lesions in rat brains, looking for the engram, or memory trace. Since he could destroy a good deal of cortex without disturbing the rats' behavior very much, it looked as if there wasn't a one-to-one correspondence between a particular memory and a particular part of the cortex. And of course people who have a stroke or who suffer other brain damage don't lose part of their memory stores. So we know the memory store must be a distributed store. But we must make a crucial distinction. The memory *store*—the storage system—is distributed, but the retrieval mechanisms are not; they are highly localized. I can retrieve something by rereading it, hearing it again, talking about it, or writing about it, and all these mechanisms can be separately damaged by brain injury. They are all separate mechanisms.

Omni: Did you join Lashley in his search for the elusive engram in rats' brains?

Pribram No. Based on his work on rats, Lashley was saying that there is no difference between different parts of the brain, at least when it comes to such higher functions as memory. Coming from human neurosurgery, I said to him, 'We dropped the idea a century ago that these functions are all over the brain.' But he showed me persuasive evidence that even in humans the situation was not as simple as I had believed. So we started a program on intermediate organisms, chimpanzees and monkeys.

Lashley had a genius for skepticism, for poking holes in all the myths that had grown up about how the brain works. His strength was that he was antitheory, or, as he said when I once confronted him with that thought, 'No, I am not antitheory, only anti-other-people's-theories.' He felt that not only memory but perception also resulted from mechanisms we completely failed to understand. How is it, for instance, that when I view your face from different distances or different angles, I still perceive the same face?

Omni Does that mean memory and perception can't work like an ordinary photographic image, with a point-to-point correspondence between object and image?

Pribram Right. There can't be a single brain cell that says, 'Bzzz—Judy's face,' or 'Bzzz—Judy's nose.' Perception must be a very flexible sort of thing, not a pattern that's wired in. Lashley was tussling with all these things and came up with the idea of interference patterns.

In the mid-Sixties, by which time Lashley was dead, I got interested in possible explanations of perception. The one thing that everyone believed in at the time was that feature detectors were its basis. That's the idea that each neuron responds to a particular feature of the sensory input—such as redness, greenness, verticality and so on—and that these features are later combined to put together a whole image.

Omni The trouble is, that doesn't allow for a richness of perception, does it? And it raises the problem of how we can recognize new inventions, like tables, toasters, and so forth.

Pribram Correct. It would also mean that a new feature detector has to be used every time I get closer to, or farther away from, something, or when I look at it from another angle. But it's still the prevailing theory. Torsten Wiesel and David Hubel, of Harvard, were awarded the 1981 Nobel Prize in Physiology and Medicine for pioneering work that led to it, though, of course, they're not as naive as some of the interpreters of their work.

Brain cells *do* selectively respond to features, but not uniquely so. The same cell responds to a color, a movement in a certain direction, the velocity of the movement, luminosity, and so on. Each cell is something like a person with many traits. So when you abstract blueness, you must address *all* the cells in the *network* that detect blue.

Omni When did you propose an alternative theory of perception?

Pribram I came up with an alternative in the mid-Sixties, to suggest that maybe Lashley was right, and the simple one feature–one cell notion was wrong. Sensory input addresses neuron *networks*, and patterns within that network constitute features. But one of the problems both Lashley and I had always had was: What constitutes these patterns? Then Nico Spinelli, working with me here at Stanford, found an old article in *Scientific American* that Eccles had written before he got the Nobel Prize. In it, Eccles said, 'I've been looking at synapses all my life, and I've been able to look at them only one at a time. But synaptic events always occur together, many synapses are activated simultaneously. One could consider these as a wavefront.'

Of course I kicked myself. We'd been puzzling about this for a decade, and Eccles just sort of dropped it as an aside.

Omni Could you explain exactly what it is that makes up these wavefronts in the brain?

> *"Get rid of our senses, and we'd experience a pure frequency domain. What would that domain look like? Ask the mystics, though they have trouble describing it, too."*

Pribram The changes in electrical potential at the fine branches of nerve endings. If you look at a whole series of these together, they constitute a wavefront. They sort of line up. One comes in this way, another that way, and they interact. And all of a sudden you've got your interference pattern! You've actually pinned Lashley's idea to a mechanism, a very classical mechanism, without having to invent anything mysterious.

Omni Let me try to make this concrete now. You've said that the brain works in two different modes. One mode is basically binary, on or off: a neuron either fires or it doesn't. The second mode is what you call a 'graded slow potential,' the gradual buildup of current at the nerve ending, and it is this that creates the wavefront.

Pribram Yes. You can have an on/off light switch on the wall, or you can have one of those dials you use to dim the light slowly. Neurons have both. A wavefront is one way of looking at these graded potential changes, but you can also think of them as probabilistically interdependent events and do statistics on them.

Omni Is that like looking at energy as waves or particles? Can it be seen either way?

Pribram Either way. It depends which mathematics is easier to use. Neither the wave nor the statistical approach by itself gives you the complete picture.

Omni At what point did the wavefront idea coincide with the optical information process of holography, paving the way for your holographic brain model?

Pribram Well, after I read Eccles's article about wavefronts, I started paying more attention to *Scientific American*. The next issue contained an article on holography. That was just incredible. Here were interference patterns, and here was a mechanism for getting from an interference pattern to an image. And in the hologram the information is distributed, as memory is in the brain, and a small part can generate a whole image.

Omni Can we back up just a minute to trace how the nuts and bolts of perception are holographic? I am looking at the stuffed baboon over there on the chair.

Pribram Well, first of all you need a lens to capture the diffuse rays of light and bring the image into focus. When the lens focuses the scatter on the retina, you get a real image on the retina.

Omni So I get a tiny baboon on my retina?

Pribram Yes. But your eye is a constantly moving camera, and so you have a mechanism higher up to clean up the image. The retinal image is projected onto the visual cortex at the back of your brain. There is a rough correspondence between locations on the retina and locations on the cortex. So far, at this level, it works like a conventional photographic image, though the image is a little distorted.

Now here comes the holographic part. The interesting thing is that *within* the receptive field of each cell you get the scatter again. The image within each neuron is transformed back into the frequency mode—the scatter that you would see if you saw without a lens. The nerve cell's code for storing sensory input resembles the overlapping patterns of shadow and light that form the interference patterns on the holographic plate.

Omni Using a holographic code, the brain piles multiple pictures in a tiny space?

Pribram Yes. I have a hologram made through a process invented here at Stanford by a radio astronomer who took a series of pictures of the heavens. He had them transformed into holograms and patched them all together in the right order. When he illuminated the result so as to retransform it into an image, it was an image of the heavens in three dimensions. If these little patches are merely overlapped, the whole picture is reconstituted. Any part of the set of patches will give you a record of all the objects, of their relationship to one another, contained in the whole film. It's so different from anything we're ordinarily exposed to that it's hard to grasp. I remember having lunch with Gabor when he was in Paris and asking him to explain to me in

nonmathematical terms what the hologram was all about I came away with three napkins full of mathematical equations Gabor had used the integral calculus invented by Newton and the seventeenth-century philosopher Gottfried von Leibniz who, by the way, suggested that a holographlike order exists Leibniz called it "monadic"

Omni And Leibniz conceived of his "monads" as microcosms of the whole?

Pribram Yes He called the monad a windowless structure that represents the whole If we change "windowless" to "lensless," we have a hologram

Omni When I look at the baboon its image is compared with the image of all previous baboons I've seen right? Do the new picture and the preexisting images in my brain form a kind of holographic interference pattern?

Pribram That's right Interference patterns are also produced by the various objects in the room But don't forget your brain is operating in two different modes simultaneously You have the spatial representation, which maps the retinal image onto the cortex as we've said And then, within the receptive field of each neuron, you've got this holographlike code which can best be described mathematically The membranes between nerve cells are the most likely storage site No other technique known to man allows for the storage of so much information

Omni And your holographic model seems to solve several perplexing problems the fact that memory is distributed the fact that I can recognize a face regardless of angle and distance, the fact that a whole universe of memories and perceptions can be housed in the same group of cells

Pribram Correct Radio and television programs are carried by sets of wave forms and are then transformed into complex auditory and visual images If you took a cross section of the airwaves at any moment in time, the cross section would resemble a hologram To decode it, you need a radio or TV receiver Our senses code such receivers

Omni Therefore, if I used an imaginary instrument, a "cerebroscope," to peer into your brain and see your neurons firing and so on, I couldn't see what you saw or felt, because that exists in code, doesn't it?

Pribram A holographlike code I use the word *hologram* here not to designate optical engineering devices but Gabor's mathematics, on which they are based

Omni I'm a little puzzled by one thing When I first read about the holographic brain, I thought of it as a metaphor Then I began to think you meant it as an actual model Which is correct?

Pribram Both First it was a metaphor Then, starting with my book *Language of the Brain* [1971], a model developed, because the mathematics fitted the data gathered in several laboratories around the world There are no laser beams in the brain I'm simply saying that the brain performs certain operations which can be described by Gabor's mathematics to code, decode and recode sensory input

Technically the mathematics is related to a Fourier transform Any pattern, no matter how complicated, can be broken down into simpler ones With this mathematical operation—on which holography is based—you can break a complex wave form into simpler constituents, each varying in amplitude and frequency But you don't have to use waves, you can do the same transformation statistically

[Editor's note *Roughly speaking, a Fourier transform involves using a computer to reduce a pattern of light to mathematics In one example, a lens coupled with a computer can be used to pick a specific image out of a larger image For instance, say a general is looking for an enemy tank in a very large, detailed aerial photograph He would superimpose a Fourier transform of the tank on a Fourier transform of the aerial photo This would filter out everything in the large image except the tank If present When a third Fourier transform is then performed over the two superimposed transforms, the tank should jump right out at the general*]

> *"Mind isn't located in a place What we have is a holographlike machinery that turns out images, which we perceive as existing somewhere outside the machinery"*

Now you have asked, Why doesn't the brain simply print an image, as in photography? A holographlike code automatically takes care of imaging from different distances and angles The problem of grain is solved; you can have very fine-grained textures And perhaps the most important reason is the same reason Fourier transforms are used with computers In the Fourier domain correlations can be performed almost instantaneously That's exactly what our brains do when we instantaneously process the table's color, texture, dimensions, luminosity, distance and relation to all other tables we've seen

Omni Haven't you proposed the idea that spiritual reality lies in the holographic domain and that there might be ways to gain access to it in the brain?

Pribram Yes It would be a matter of abrogating our retrieval systems so that we can experience the brain's minicodes Get rid of our senses, our "lenses," and we'd experience only the frequency domain What would that domain look like? Ask the mystics, though they have trouble describing it But the purpose of science is to *make sense* of the world, and mystical experience makes sense when one can provide the mathematical transform that takes one back and forth between the ordinary image-object domain and the frequency domain The frequency domain is "mystical" in that there is no space and no time

Omni Are space and time collapsed in the holographic domain?

Pribram I prefer to say that space and time are "enfolded" For example, say, you plot an electroencephalogram [EEG] On the vertical axis, there is amplitude, the height of the wave; on the horizontal, there is frequency Neither space nor time per se appears in the graph

Our brains apparently can perform the transforms back and forth between space-time reality and the frequency reality or perhaps they always keep track of both sides of the transformation A computer using Fourier transforms does this in performing rapid correlations, and CAT scans and other imaging techniques are based on the same principle One takes an X ray of the head from different angles, converts the densities to numbers, then Fourier-transforms and correlates Finally, one retransforms to get a three-dimensional image of the head and its contents, an image in ordinary space

Omni The holographic brain theory is attractive to parapsychologists, as well as to psychologists of the Gestalt school, because it could account for psychic phenomena Do you believe that extrasensory perception may occur in the frequency domain, beyond the senses?

Pribram Well, people have invoked the idea for ESP, and to some extent I would go along with it I don't know whether psychic phenomena occur or not, but at least there's a basis for understanding them if they do

Omni I was interested in your comment that the world may be a hologram, and that perhaps the individual brain is a part that contains the whole Of course the idea that the atman, or soul, in all creatures is a record of the universal atman is basic to Oriental mysticism

Pribram Yes and no The world is not a hologram only one aspect, one order, is holographic But the holographic principle is working everywhere, and descriptions of spiritual experiences sound holographic The holographic domain is *holistic* in a different sense from the Gestalt use of the word In Gestalt the whole is greater than, and different from, the sum of its parts, whereas in a hologram every part is distributed in the whole, and the whole is enfolded in its parts David Bohm [professor of theoretical physics at Birkbeck College in London, and author of *Wholeness and the Implicate Order*] has derived the same idea from quantum physics, and it leads to a scientific understanding of the spiritual aspects of man's

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Now for just $7 you'll have the latest technology at a price that'll let you have a phone in every room in your home. But, don't forget there's a catch.

NOTHING TO INSTALL

Simply plug this phone into any standard modular phone jack and start talking. If you don't already have jacks, call your phone company.

They may even put them in free for you. Due to the recent Supreme Court ruling, soon they'll probably be selling you your own phones anyway. And, at worst, there's just a small one time fee.

LAST NUMBER REDIAL PLUS

It's really neat. If you call a number and it's busy this phone will automatically redial the number for you each time you touch 'redial'. There's no need to keep dialing over and over again.

When you need to speak privately to someone with you, you don't have to cover the mouth piece. Just press the mute button and the person on the line will be cut off for privacy.

When you want to take a nap, just switch the ring off and the phone won't ring. There's never a need to take your phone off the hook again.

The quality is great. A high quality condenser microphone lets the person you talk to hear you loud and clear.

And you hear them through a high quality speaker instead of the old diaphragm 'thing' that's been in phones for 20 years. Even the electronic ring is new.

But, the nicest part of all are the push buttons. Once you've started using buttons you'll hate dialing the old way.

With this phone you can push the buttons as fast as you want. Then the phone sends out pulses on your line that work with virtually any phone system.

So this phone works anywhere. You can unplug it and move it from room to room or house to house in seconds.

The phone automatically hangs up when you set it down or you can push its 'hang up' button. It comes complete with a 14 foot coiled cord and a limited manufacturer's warranty.

It's built more like a HiFi than a telephone. Modern electronics have finally come to phones.

THE CATCH

Frankly we are losing our shirts on the automated phone, but we're looking for audiophiles who use audio cassettes.

If you buy top name TDK and Maxell cassettes, you probably pay $3.50 to $4.50 each for a 90 minute cassette.

We want you to try DAK's new Gold Label MLX ultra high energy, normal bias cassettes. Not at $4.50 or even at $3.50 each, but at a factory direct price of just $2.49 for a 90 minute cassette.

We challenge you to compare the frequency response, dynamic range and signal to noise ratio of our new Gold Label MLX to Maxell UDXL or TDK SA. If they win, we'll not only give you back your money, we'll give you a free gift for your trouble. And, DAK's come with a deluxe hard plastic box, index insert card and a limited 1 year warranty.

WHY, YOU MAY BE ASKING?

You're very valuable to us in the form of future business. Over 150,000 customers have responded to bonuses like this. We find most of you keep buying once you've tried our cassettes and our prices, and that's a gamble worth taking.

NOT A BAD CATCH

DAK manufactures a cassette with no problems and great sound. We've been hot on the heels of the frequency responses of Maxell and TDK. The tape we made last year had a great frequency response up to 14,000hz.

Now our new Gold Label MLX is second to none. We have a frequency response to 19,500hz and we'll go head to head against any tape on the market.

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To get the automated phone for just $7, try 10 MLX high energy cassettes. If you aren't 100% satisfied, return only 9 of the 10 cassettes and the phone in its original box within 30 days for a refund. The 10th cassette is a gift for your time.

To order your 10 Gold Label DAK MLX 90 minute cassettes and get the automated phone for only $7 with your credit card, call the DAK toll free hot line or send your check for only **$24.90** for the tapes, plus **$7** for the phone and **$3** for postage and handling for each group. Order No. 9416. CA res add 6%.

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experience. For the first time in three hundred years science is admitting spiritual values into its explorations. That's terribly important. If you deny the spiritual part of man's nature, you end up with atomic bombs, a technocracy devoid of humanity.

Omni: Doesn't Bohm make the point that if we persist in thinking of little bits of matter as the basic building blocks of nature we condemn ourselves to fragmentation?

Pribram: Absolutely. Strange as it may seem, psychology and physics are really overlapping fields. For quantum physics takes you into a mental realm, and psychology must deal with the physical. Eugene Wigner [winner of the 1963 Nobel Prize in Physics] made the point that quantum physics deals with observations, not observables. Observables stay constant regardless of how I observe them, but in quantum physics, when you change your instruments, you're observing different phenomena. So you're really talking about a different observation, and that's basically psychology, isn't it?

Conversely, in psychology, we're interested in behavior, which is manifested in the physical universe. And we neuropsychologists also examine the physical and biological underpinnings of behavior. Think about it. If we start with ourselves and proceed to sensations and perceptions, and from perceptions to the brain, and from the brain to cells to membranes to chemistry to physics, we end up with mathematics. Well, is mathematics physical or mental? At that level, distinctions disappear. If you go in the other direction, from ourselves to social systems, and then to information processing and communication, is that physical or mental?

Omni: That brings to mind a point you once made about uncertainty and indeterminacy. A physicist deals with uncertainty at the quantum level—the infinitely small world within the nucleus—while the psychologist encounters the most indeterminacy at the macrolevel of social systems.

Pribram: A funny thing about science is that when a scientist looks downward in the hierarchy of systems, it's not considered speculative. A psychologist could write a whole book about the neurophysiology of attention without ever telling you what he means by attention, and no one cares. But going upward in the hierarchy, things supposedly get softer and softer. When a physicist talks chemistry, he's going soft. When a chemist talks biology, that's really soft. When a biologist talks psychology, he apologizes. But that really is a mirage. No experimental psychologist would ever publish anything without giving his techniques, the number of his subjects, how he found his statistical reliability, et cetera. Say you read a neuroanatomy paper; they often don't even tell you what techniques they use.

Omni: Do your colleagues in neuroscience consider your holographic brain theory to be soft, or heretical?

Pribram: The hard-nosed scientists don't understand. I think, and they feel, I've overgeneralized, which I haven't. The exceptions are physicists, engineers, radar scientists, and crystallographers, who are trained to make Fourier transforms of what they observe. The ideas aren't so foreign either to the people who invented the CAT scan and image makers in general.

There is now solid evidence that neurons in the cortex respond to Fourier transforms of sensory input—to the Fourier transform of an image rather than to lines and other features of three-dimensional space. Some very fancy experiments by Fergus Campbell and John Robeson of Cambridge, and Russell and Karen DeValois of the University of California at Berkeley, among others, have shown that the cells of the visual system are tuned to spatial frequency; they respond to approximately an octave of spatial frequency. That doesn't mean that's all that's occurring, but it's one of the things the brain is doing.

However, let me emphasize that I treat the holographic model as a scientific hypothesis. Just in the last few years scientists at MIT and Horace Barlow at Cambridge, have been integrating Fourier transforms theory and the feature detector theory of perception, showing how both play a role. There are ways of bringing these viewpoints together.

Omni: What has the holographic model suggested to you about the ancient riddle of the mind/brain relationship? Is there an immaterial mind that can exist apart from the flesh-and-blood brain, as the dualists suggest? Or are the mind and the brain one and the same?

Pribram: I've always felt that dualism is okay in the ordinary image-object domain—the domain in which the eye constructs images and the brain operates on the sensory image to make objects and so on. Dualism's fine for the Newtonian domain, especially if you've got to talk. Language is comprised of subjects, verbs, and objects—subject and object, dualism all the way through.

But it doesn't apply to the holographic, enfolded order. There is no space and time, no causality, no matter and no mind. Everything is enfolded. There are no boundaries, and so you can have neither mind nor brain. Actually there is only potential—perhaps potential energy that can be converted into work in the ordinary space-time domain. Of course, every time you say "material" you're implying the existence of the mental. And the mentalist wouldn't have to say he was a mentalist if there were nothing to be distinguished from.

Omni: Well, the mystics have said that the world of opposites is an illusion.

Pribram: That's all I'm saying. But I'd claim that the world of opposites is one reality, and the enfolded order, another. Meanwhile, I'd like to specify where dualism applies, and where identity theory—the theory that mind equals brain—best accounts for the data, and so on.

Omni: Still haven't you provided on solution to the mind/brain problem image of a hologram? You can't phy locate the image anywhere on the graphic film, and the mind bears a relationship to the brain. Can you ex that better than I just have?

Pribram: I think you've expressed it well. Mind isn't located in a place. W'ha have is holographlike machinery th at t out images which we perceive as exis somewhere outside the machine that p duces them. We know our eyes are volved, but I don't image you on the s face of my retina. Even though the cod are in my brain somewhere. I perceive y over there on the chair.

Omni: One problem that has beset mir brain theorists is the precise liaison b tween mind and brain, that is, where actly does a nonphysical mind, or sc connect with the physical organ?

Pribram: That is true. The problem for of us has been one of downward cau tion. How mental properties emerge fr the brain organization is easy to see then, as Roger Sperry [the California stitute of Technology neuroscientist whc split-brain research earned him a Nob Prize] says, mind has to turn around ai operate on the brain. But Sperry has n specified how this happens. Eccles h proposed the same idea and once su gested that mind operates as a "cogniti

s on the brain's association areas arts of the brain not devoted to sen for systems].

es wrote a book with the philoso- ir Karl Popper entitled *The Self and in* in 1977. If you read the book care- ou see that Popper and Eccles had very different ideas about dualism. Popper says is that we create arti- in our environment—books and so which he calls "World Three." Then ead these books, and this programs rain and forms memory traces there h in turn form new behaviors that re- in new books and other artifacts, and on. I have no basic quarrel with Popper. ough I prefer the term *cognitive com- odity* to *World Three*.

mni: How would you resolve the issue of w mind acts on a physical organ?

bram: Think of water composed of mol ules of gas, hydrogen and oxygen. You t these molecules together in a certain y and you get water. The emergent operties of water are wetness and the ct that it floats when it freezes and va- orizes when it boils. Now for downward ausation. The wetness of water and the act that it floats when it freezes have al- owed it to accumulate on the earth in ceans, glaciers, and polar icecaps. The mergent properties of water have moved e molecules from being evenly distrib- ed in the air and on the earth's surface to being concentrated in pits called oceans. the emergent properties have changed the distribution of hydrogen and oxygen on our planet.

Now let's apply this analogy to the mind problem. As mental beings we have the feeling of freedom under certain condi- tions. That feeling of freedom that mental property has emerged from our particular brain from the organization of its mole- cules cells and so on. And if changes the distribution of human beings on the earth. People want to leave Communist countries and come to the free world. People strive toward frontiers or into outer space. The point is a mental property, the feeling of freedom, changes the distribution of the physical system. Something mental em- bodies itself into the material out of which it emerged.

Omni: To extend that idea, hasn't neuro- science shown that mental experiences actually affect our brain's chemical and physical structure?

Pribram: It's tricky, but one can say that you redistribute the flow of nerve impulses on the basis of ideas as well as sensory input. When you look at something over and over again, you begin to recognize it. it becomes differentiated, detailed. Though there's no direct evidence yet, I'm quite sure the same is true of thoughts. If I think and rethink something, I must be changing the patterns of neural processing.

Omni: Maybe this is the neurophysiological basis for the way mental habits become lodged in us. Maybe something like psychoanalysis, which is a mental activity, influences the brain's physical structure by reprogramming one's thoughts.

Pribram: Freud not only suggested that, but he drew a diagram that resembles what we now recognize as a nerve net. It looks like a little hierarchically organized nerve network, and it appears in his *Project for a Scientific Psychology*, in a section on thinking. Instead of making new connections in an overriding way, as we would by behaving in a certain manner, Freud wrote, thinking makes miniconnections. It's like what happens when I go out in the world and build a table. If I make a mistake, I must take the table apart and do it over completely. However, if I plan it out in my mind, or draw a diagram, I see my errors before they're irrevocably embodied, and I gain flexibility. By the way, it's possible to see Freud's metapsychology as an early neuropsychology, but that part of Freud's theorizing is not well known to experimental psychologists and neuroscientists.

I delivered the Freud Memorial Lectures at the University of London last year on the one hundredth anniversary of Freud's receiving his medical degree from the University of Vienna [in 1881]. And I said that at least Freud had in mind the problems we're still worrying about in current neuropsychology. He had his solutions and his models. In some places his model is correct, in others it's dead wrong, but at least it's a model. It isn't a bunch of abstractions, which is what metapsychology has become. If we go back to its roots, we can straighten things out.

Omni: That suggests that the current gap between analytical psychiatrists and neuropsychologists such as yourself is built on a false premise. It didn't have to exist.

Pribram: Yes. And, you know, everyone came to my London lectures except the older, dyed-in-the-wool analysts, even though they had invited me to speak. They boycotted the talk because the subject was biology; they couldn't relate to it.

Omni: Though you were trained in the methods of behaviorist stimulus-response psychology, you speak quite a different tongue. And you once predicted that the "soft sciences" of today may form the core of the hard sciences fifteen years from now. Can you explain that?

Pribram: Back in the 1940s and 1950s the behaviorists thought they were the hard scientists. They dominated psychology, and what we learned came out of the tradition of positivist philosophy. It was good, hard science, with an impressive technology.

The problem with behaviorism was that words like *awareness* and *consciousness*, even *perception*, were taboo. Let me give you an example of why psychologists can't neglect awareness. Lawrence Weiskrantz of Oxford and Elizabeth Warrington of the National Hospital in London have described patients with blind sight. An operation on one side of the brain's visual cortex has made them blind in the opposite visual field. It turns out they can perform a great number of visual tasks instrumentally. They'll be eighty or ninety percent accurate in pointing to and describing shapes in the blind visual field. But when you ask them what they saw, they say "Nothing." They were "guessing." So some parts of the brain are working, but the parts that generate reflective awareness have been removed surgically. When a blind-sight patient sees something and tells me he can't see that, makes me think there are two levels of seeing, one that consists of instrumental behavioral responses to optical information, and another that refers to subjective awareness.

It is extremely awkward to try to account for everything by looking at inputs and outputs alone, and eventually the whole attempt to build a stimulus-response psychology without inferring states and processes such as awareness tell apart. You can't even sell books without using subjective terms. If B. F. Skinner had called his book *Conditioned-Operant FI's* [Fixed Intervals] *and VI's* [Variable Intervals], how many books would he have sold? But *Beyond Freedom and Dignity*—wow!

GAMES

ANSWERS TO GAMES (PAGE 200)

1 Freedom from fear
2 Famine
3 Blood
4. Health

HONEST NUMBERS "Two cubed" "twelve plus one" "one half of thirty" (or "twenty minus five") "minus four squared" "the largest prime less than thirty" There are undoubtedly other ways to make other numbers "honest" In his *Incredible Dr Matrix* (Charles Scribner's Sons 1976 pp 221–223), Gardner reports on other variations on the theme, including honest numbers in other languages (e.g. *vier* in German, *cinco* in Spanish, and *penta* in Greek) and the observation that an infinity of honest numbers can be created by using the ten-letter phrase "added to ten" (e.g. "four added to ten added to ten, added to ten")

The convergence of English number names on *4* was first pointed out by Sidney Kravitz in *The Journal of Recreational Mathematics* (1974, 7, pp 225–228) Kravitz found that German and Dutch number names also converge on *4*; Italian on *3*

THE FOUR FOURS There are many different solutions Here, we think are some of the simplest

$$3 = \frac{4 + 4 + 4}{4}$$

$$4 = 4\,(4 - 4) + 4$$

$$5 = \frac{(4 \times 4) + 4}{4}$$

$$6 = 4 + \frac{(4 + 4)}{4}$$

$$7 = 4 + 4 - \frac{4}{4}$$

$$8 = 4 + 4 + 4 - 4$$

$$9 = 4 + 4 + \frac{4}{4}$$

$$10 = \frac{44 - 4}{4}$$

$$11 = \frac{44}{\sqrt{4} + \sqrt{4}}$$

$$12 = \frac{44 + 4}{4}$$

$$13 = \frac{44}{4} + \sqrt{4}$$

$$14 = 4 + 4 + 4 + \sqrt{4}$$

$$15 = \frac{44}{4} + 4$$

$$16 = 4 + 4 + 4 + 4$$

$$17 = (4 \times 4) + \frac{4}{4}$$

$$18 = (4 \times 4) + 4 - \sqrt{4}$$

$$20 = (4 \times 4) + \sqrt{4} + \sqrt{4}$$

"Brain food"

The "four fours" problem was originally expounded in an 1881 issue of a London weekly titled *Knowledge: An Illustrated Magazine of Science, Plainly Worded—Exactly Described* It was there observed that *19* is the only number less than *20* that cannot be expressed within the restrictions

If we add the factorial symbol ! $(4! = 1 \times 2 \times 3 \times 4 = 24)$ or the decimal point, 19 can be generated thus

$$19 = 4! - 4 - \frac{4}{4} \text{ or}$$

$$19 = \frac{4 + 4 - .4}{4}$$

(Note incidentally, this latter formula yields *19* when *any* number is substituted for *4*)

Another mathematical use of the dot is to place it above a decimal number to signify a repeating decimal A point placed above 4 indicates the repeating decimal .44444 ... or 4/9 If this symbol is added to the others mentioned, the list can be extended to *112*

For more on the four fours, see Gardner's book *The Incredible Dr Matrix*, pp 49–52 and 212–214. A list of numbers to *100* with four *4*'s may be found in L. Harwood Clarke's *Fun with Figures* (London: Heinemann, 1954) and Angela Dunn's *Mathematical Bafflers* (McGraw-Hill, 1964)

FILM QUIZ ANSWERS

1 *The Tempest* The father and daughter roles are adapted from Shakespeare's play Morbius (played by Walter Pidgeon) is clearly a Prospero, and his daughter, Alta (portrayed by Anne Francis), like Miranda, has never seen men

2 Hitler saw too great a similarity between the rocket ships shown in *The Girl in the Moon* (or *By Rocket to the Moon*, as it was titled in America) and the designs for German rocket weapons Rocket expert Willy Ley served as a technical consultant on the Lang film

3 Elsa Lanchester again Incidentally, you can trip up many film-trivia buffs with, "Who played the title role in *The Bride of Frankenstein*?" The doctor's wife was played by Valerie Hobson

4 *The Blob*

5 Lugosi, Hungary

6 Michael Landon

7 Christopher Lee

8 James Arness

9 *The Day the Earth Stood Still* (1951), the sf film directed by Robert Wise

10 Cell block 1138 is mentioned, an allusion to George Lucas's science-fiction film *THX-1138* The number THX 138 appears on a California license plate in Lucas's 1973 movie *American Graffiti*

11 George Pal, because of his friendship with Woody's creator Walter Lantz In *The Time Machine*, for example, a young girl carries a Woody Woodpecker doll

12 *The Black Cat* (1934) uses Latin phrases without regard to sense or context because the producers did not wish to get into trouble with the Hays Office

The Artist

MOBIUS PSI-Q

CONTINUED FROM PAGE 142

(2) Mountain
(3) Place where land and water meet
(4) Ruins
(5) Farmlands
(6) Technological installation

55 Do you think some people are sometimes able to get information by means of ESP?
(1) Sure about it
(2) It is a possibility
(3) It might be so, or not
(4) It seems unlikely
(5) It is impossible

Carefully record *in ink* your personality questionnaire answers. Your response *must* be postmarked no later than December 23, 1982. Please allow approximately three to six weeks for delivery of your personal PSI-Q II profile. Be sure that you answer all the questions, that they are marked as clearly as possible, and that your full name and address are legibly printed or typed. Your attention to detail will enable us to return a complete response quickly. Send the paper with your remote-viewing impressions, your answer sheet (or a photocopy of it), and your check or money order for $6 (U.S. funds) to

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Name
Street address
City State
Country Zip code
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Transcribe from your remote-viewing sheet the time and date when you took the test.

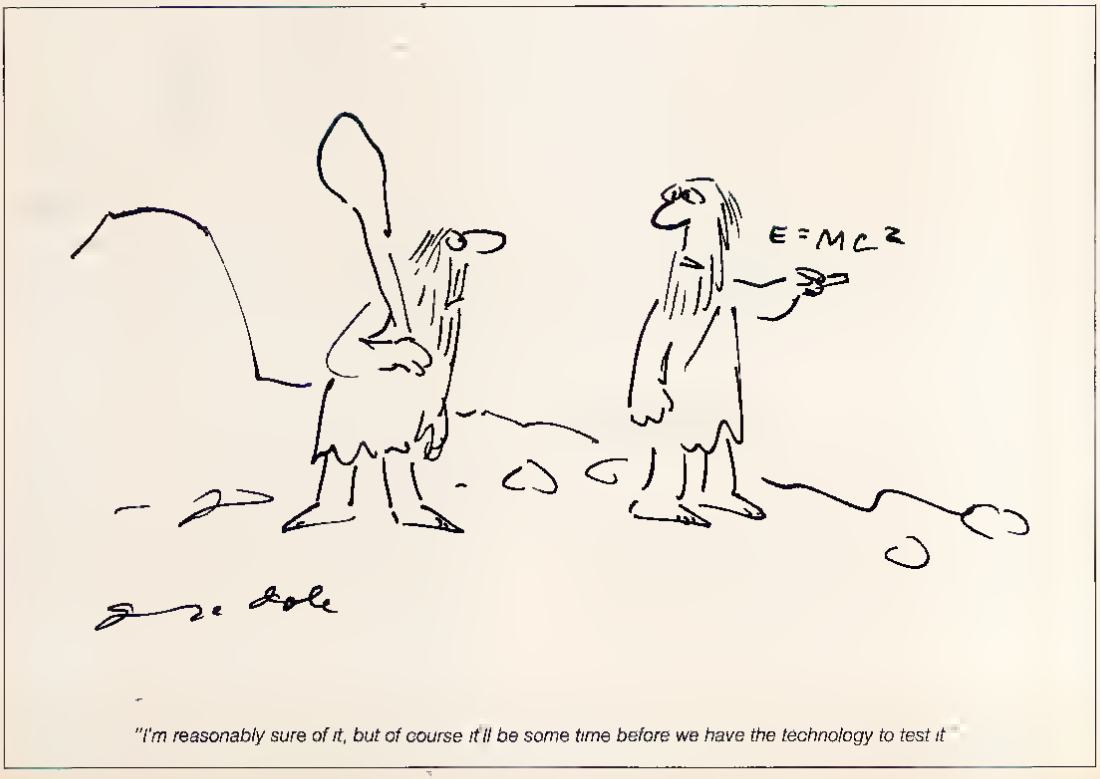
(1) Time: hours minutes AM/PM

(2) Time zone (check one)
1. Pacific
2. Mountain
3. Central
4. Eastern
5. Other (by name)

(3) Date: day month, 1982

(4) Did you take the Mobius PSI-Q test last year? Yes ☐ No ☐

1) A a ? b B
2) A a ? b B
3) A a ? b B
4) A a ? b B
5) A a ? b B
6) A a ? b B
7) A a ? b B
8) A a ? b B
9) A a ? b B
10) A a ? b B
11) A a ? b B
12) A a ? b B
13) A a ? b B
14) A a ? b B
15) A a ? b B
16) A a ? b B
17) A a ? b B
18) A a ? b B
19) A a ? b B
20) A a ? b B
21) A a ? b B
22) A a ? b B
23) A a ? b B
24) A a ? b B
25) A a ? b B
26) A a ? b B
27) A a ? b B
28) A a ? b B
29) A a ? b B
30) A a ? b B
31) A a ? b B
32) A a ? b B
33) A a ? b B
34) A a ? b B
35) A a ? b B
36) A a ? b B
37) A a ? b B
38) A a ? b B
39) A a ? b B
40) A a ? b B
41) A a ? b B
42) A a ? b B
43) A a ? b B
44) A a ? b B
45) A a ? b B
46) A a ? b B
47) A a ? b B
48) A a ? b B
49) 1 2 3 4 5 6 7
50) 1 2
51) 1 2 3
52) 1 2
53) 1 2
54) 1 2 3 4 5 6
55) 1 2 3 4 5



"I'm reasonably sure of it, but of course it'll be some time before we have the technology to test it"

THE BODY

CONTINUED FROM PAGE 30

performed on a human patient with Parkinson's disease at the Karolinska Hospital in Stockholm, Sweden. Doctors there transplanted the man's own adrenal gland tissue directly into his brain. According to *Science* magazine, the Swedish physicians say they cannot yet evaluate the outcome of the experiment, though the patient shows slight improvement.

Whether or not the Karolinska experiment is finally judged successful, many problems still remain in the field of brain repair. Among them is the issue of donor material. "Where are you going to get brain tissue to transplant?" I asked Gash.

"There are four possibilities," he replied. "One would be aborted human fetuses, but I think that for moral and legal reasons that's unlikely to be practical."

I concurred. Opposition to abortion is already strong and well organized. If anyone were to suggest that we take brain tissue from aborted fetuses and donate it to brain-damaged adults, the roar of the antiabortionists would be loud, clear and probably overwhelming.

A second possibility seems much more realistic and exciting. Since the brain is extraordinarily tolerant of transplants, Gash and others seriously hope to give human beings brain tissue from monkeys or baboons. Human vasopressin, for example, is identical to that in both rats and monkeys, so it's possible—even probable—that a monkey's vasopressin cells will be nearly identical to our own. It may also be that cells from other parts of the monkey or baboon brain will closely resemble the corresponding human cells. If so, transplants between the species should be feasible.

There would probably be moral opposition to this approach as well. A few people would complain that it is "unnatural" or "immoral" to put brain cells from a monkey into a human being. But if it works, the overwhelming benefits should make it socially acceptable.

(In fact, there are precedents for this sort of transplant. The first human heart-transplant patient in the United States received the heart of a chimpanzee, it was not big enough to save the person's life. Baboon kidneys have also been transplanted into people. They worked well for a very short time, then were rejected by the human recipients.)

Gash has already begun testing the idea of cross-species transplants, putting brain tissue from gerbils into rats. He has had at least partial success.

A third possible source of brain cells, he said, is the human neuroblastoma cell. Neuroblastomas are tumors usually seen in children, that are made up of primitive nerve cells. These cells can be kept alive, in culture or frozen for a long time. If scientists can learn to make them grow into mature nerve cells instead of cancers, they may be a good source of material.

Finally, cells from the adrenal gland can replace those of the substantia nigra. As in the Swedish experiment, a patient with Parkinson's disease can donate to himself. Surgeons remove one adrenal gland, take out the appropriate cells, and transplant them into the brain.

"Let me emphasize," Gash stressed, "that for now this is all speculation. We have a tremendous amount of work yet to do. Every time something about our work gets into a magazine, our phone rings continually with calls from people who want transplants, even experimentally. Except for Parkinson's disease and the adrenal glands, we are still years away from that."

The next step, he added, is to test the procedure in monkeys—if funding for the study can be found. "It may not be easy. An adult Brattleboro rat costs about $30; monkeys are $250 to $1,000 apiece.

"We're hoping we'll be funded. We think our work has merit, but research money is awfully tight," he fretted. Gash's work is funded by the stroke and trauma program of the National Institutes of Health, but there is no guarantee that this governmental support will continue.

Yet I asked him to speculate a bit more. "Do you think that sometime we might be able to transplant brain cells to replace those destroyed by a stroke or a blow to the head, to substitute for damaged cells that cause epileptic seizures, to remedy the problems of cerebral palsy victims?"

"I don't want to offer anyone false hope," he said, "but, yes, I think all those things are possible. At least theoretically, any part of the brain can be repaired. I see no roadblocks at the moment—except of course time and money."

"What about repairing the spinal cord?" I asked. "Think what that could mean to paraplegics and quadriplegics."

"The problems in the cord are different than in the brain," he answered, "but it's still possible that grafts would help. Some very promising experiments in this field have been done already."

That evening, as I flew home to Minnesota, I looked over the notes I had taken and the articles Gash had given me. Even with all the caveats, it seemed to me, and it still does, that the transplantation of brain tissue may, in the next few years, ease the lives of many patients.

There is obviously much work yet to be done, and when one is dealing with the human brain, the ethical, moral, and legal problems are almost as difficult to solve as the scientific ones. But the benefits to be gained if brain repair does become a reality are so great as to be almost beyond our comprehension.

It would be tragic if economic factors were to halt, or even inhibit, research that shows signs of being so beneficial to so many people. ☐☐

"My God, have you any idea what the odds are of finding someone with the same threshold of pain?"

FILM

CONTINUED FROM PAGE 36

Pierce Rafferty spent so much time at the Film Depository of the National Archives, in Washington, that staff members joked about renting him office space as a way out of their budgetary crisis. His persistence paid off in a hoard of visual and aural riches. There is the contemptible. The Marshall Islanders are urged to abandon their homes to make way for a nuclear-weapons test site. The ludicrous: A schoolboy in a shredded-lead bomb-proof jump suit tries vainly to mount his bicycle. There is the tragic: GIs witness a test blast in Nevada, then march blindly into a hail of irradiated debris. And the absurd: Two homely high-school girls lecture their classmates on the foodstuffs the well-stocked Cold War larder must contain. All is deftly assembled. Modest Mussorgsky's *Pictures at an Exhibition* is mated with a reporter's description of the electrocution of Ethel Rosenberg (which was, after all, the crudest sort of political exhibition).

"It was a difficult process just locating the footage," Pierce Rafferty says. "We did a lot of preliminary research. We didn't just walk in the door and say, 'Give us everything under A for atomic bomb.' We'd get hundreds and hundreds of films and be fast-forwarding through them, sometimes on two machines at once. In no way do I want to imply that this was pulling the wool over someone's eyes. Obviously we have our own opinions about this material and about things like the Civil Defense program. We actually got into discussions with some of the people in the Civil Defense Agency. They'd sit there and tell us about Swiss civil defense, noting the fact that every house in Switzerland is built with a shelter and ask, 'Why are Americans so apathetic?' No, it wasn't as if we were sneaking around in the night, ferreting our way into these collections."

Nevertheless, *The Atomic Cafe* is more awesome than satisfying, satirical where *No Place to Hide* is sardonic. Both derive the greater part of their bite from viewers' contemplation of World War III and a post-Watergate hunch that government rhetoric tends toward euphemism. But *The Atomic Cafe* is smug and censorious—Nixon footage is crowd-pleasing shorthand for *cover-up*—while *No Place to Hide* tackles the harder task of arming viewers with a justifiable skepticism of authority.

Vast inventories of stock footage swell the archives. But the material. Bird charges, is largely in the hands of people who view it as a problem rather than a treasure. Access is difficult; nitrate stock is flammable and subject to shrinkage; storage, retrieval, and reproduction costs are rising. "It's not really film [to the National Archives staff]," says another filmmaker, Steven Okazaki, "it's filing cards." The Raffertys generously attribute the staff's attitude to a lack of funds, not a lack of interest.

Many filmmakers even so make use of a small percentage of the government film archives. The most frequent and least demanding users are the television network news departments, but they tend to broadcast the same images over and over again and, in so doing, create codes. Mushroom cloud equals arms race; Abraham Zapruder film equals Kennedy assassination. It short-circuits thinking. In his 1967 film *Report*, Bruce Conner repeats frames from the Zapruder film, alternating them with advertising footage, to show how television subordinates the power of the images to the power of the events.

Not surprisingly, the wisest of the Nuclear Age compilations is Conner's *Crossroads*. Like *Report*, it focuses maniacally on the best-known image of the era: Operation Crossroads, the underwater test shot at Bikini Atoll on July 25, 1946. There the military anchored a fleet of decommissioned naval vessels to gauge the destructive force of an atomic blast at sea.

> "The Atomic Cafe *is more awesome than it is satisfying, satyrical where* No Place to Hide *is sardonic. Both derive their bite from viewers' contemplation of World War III.*"

The mushroom cloud that blossomed there, filmed and rushed as newsreel footage into the nation's moviehouses, became the archetypal metaphor of the Atomic Age. "replacing the devil,' says Conner. 'In most of our lives.

A thirteen-year-old Kansas boy when he first saw shots of the test, Conner recalls thinking, "I'll see more of it. But what I saw for thirty years was less and less. In 1975 he 'wormed [his] way through the bureaucracy' and acquired prints of 26 of the camera angles from which the blast was originally photographed. It took him nine months to edit his film.

Crossroads opens just before the blast (gulls cry, the sea is calm). Detonation. A tower of seawater, blown sky-high, dwarfs the flotilla scattered around its base. Subsequent angles show the blast from circling aircraft, peering through enshrouding mists. The cloud is magnificent, seductively beautiful, stupefying. The power is reappropriated from the event to the image. Rediscovering the power of Atomic Era images first, Conner, then Johnson and Bird, the Raffertys and Loader invite our critical reflection.

At least a dozen other recently made films combine some of the same stock footage with other materials, principally interviews. They can be divided into two groups: those that treat nuclear war as a medical problem—*Survivors, Dark Circle, The Last Epidemic, Who Will Be Next? Mama, I Can Hear You* (the last two are Japanese) and *Paul Jacobs and the Nuclear Gang* (a Public Broadcasting Service production)—and those that treat it as a political issue—*The Day After Trinity, Save the Planet, War Without Winners* and the pro-nuke *S A L T Syndrome*. To watch them is to see the same images—the crew of the *Enola Gay*, a devastated Hiroshima landscape, the burned and disfigured *hibakusha* ('survivors') photographed by Japanese cameramen whose footage was confiscated by American occupying forces and sequestered for many years, Operation Crossroads tests in the Nevada wasteland, the launching of Polaris missiles—over and over again.

Most of these films are radio with pictures. They use archival material to illustrate a text, to corroborate a thesis, to tack on a moral. The best of these films is Okazaki's *Survivors*, interviews with 30 American *hibakusha*. Okazaki uses their many voices over now-familiar stock footage to create a single account of the day when the bomb obliterated Hiroshima, the succeeding days of anguish and disbelief, the return to the United States (many were U.S. citizens trapped in Japan by the war), the fears of the delayed effects of exposure to radiation. "We are," says one, "just a group of Japanese American ladies trying to get some medical benefits before we die."

Okazaki and Chris Beaver (of *Dark Circle*) both conclude from their study of archival material that the government has shown greater interest in structural than in human damage, in gross medical horror than in subtle pain. Both films, in Beaver's words, "give a face to things that are usually treated as statistics."

A few filmmakers score archival coups. *The Day After Trinity* contains a stunning, silent sequence of the final preparations of the first bomb, right before detonation. Scientists cluster about the mighty sphere they called "the gadget," touching it intimately before, girt in tape and wires, it is hoisted to its firing position above the desert. *Dark Circle* is the first to use images of a school bus blown to smithereens and the assembly line where hydrogen bombs, like so many Ford Pintos, are produced.

None of these films, with the exception of *The Atomic Cafe*, is likely to receive wide theatrical play—documentaries seldom do—but already in 16mm they are establishing themselves as de rigueur for educational groups and anti-nuke fund-raisers. The Los Angeles–based Direct Cinema (distributor of *No Place to Hide*) compares them favorably with civil rights films in volume, and the Oakland-based Serious Business Company no longer has any doubt that *Crossroads* is about to prove the potency of an antique image. ∞

CONTINUED FROM PAGE 44

cockpit communication and recommended assertiveness training for the crew.

The tragedy of Flight 173 galvanized United into creating a new training program for its 5,000 cockpit personnel. The responsibility fell to Ed Carroll, then vice-president for flight standards and training. Carroll reasoned that the problem lay with the crew as a unit, rather than with any individual crew member. In the first phase of the program, pilots learn to identify various personality characteristics. In spotting the strengths and weaknesses of others, the crew gains self-insight, "the gift to see ourselves as others see us," Carroll says, paraphrasing Robert Burns.

In the second stage of training, crews are assigned at random to act out a cockpit scenario. For example, a captain decides to take off despite unfavorable weather. His copilot, concerned for the safety of the flight, must decide how to handle an authoritarian personality. One United copilot tells of a colleague who simply refused to release the brakes on the fictitious airplane.

The key objective of the program is synergism, the ability of a harmonious crew to exceed the sum of its individual talents. The third phase takes place in the simulator, where the pilots are put to the acid test. Line-Oriented Flight Training is designed to replicate an actual flight. The crew follows all the predeparture procedures, calling out checklists to ensure the airworthiness of the plane. Visual display units mounted on the cockpit windows provide a surprisingly realistic wraparound image of the airport. A hidden sound system mimics the whine of the engines and reacts to the slightest touch of the throttles.

After the make-believe flight is airborne, the instructor punches in a mechanical malfunction, such as the hydraulic failure on the Chicago to Cleveland flight. The problem is serious, but not insuperable, and the crew has the options of returning to the airport, proceeding to the original destination, or selecting an alternative. There is no "correct" choice, and the captain of Flight 236 decides to continue to Cleveland. Later, the crew views the entire flight on videotape, identifying points where their resource management needs improvement. To ensure that the recording will not be used against a pilot, the tape is erased afterward.

The next generation of airliners will strain these management skills further. This fall, United begins flying the Boeing 767, a wide-bodied jet designed for a two-man crew. The airlines have long contended that the third man is redundant in a highly automated cockpit, though many pilots disagree. "A two-man crew sometimes comes up short-handed," says John Mazor, a spokesman for the Air Line Pilots Association. The issue was recently arbitrated by a presidential commission, which decided in favor of the smaller crew.

The technology of air safety has also made dramatic leaps. After a series of short-approach accidents, ground proximity warning systems were installed in all airliners. A pilot who makes too steep an approach will hear "Glide slope" or "Pull up" from a mysterious voice, audio imperatives to take quick corrective action. If the plane suffers a sudden loss of altitude, another warning system engages. Pilots humorously refer to it as "the whup-whup," a parody of its unnerving sound. Unfortunately, the warning may not come in time. Sudden wind shear has been cited as a possible cause of the Pan Am crash in New Orleans last July.

Ultimately, the technological solutions to in-flight crises are limited, and the excellent safety record of the airlines stands as a credit to their crews. A pilot who learns to utilize the full talent and skills of his crew has an even greater chance of flying out of trouble. No matter how sophisticated the art of flying becomes, safety depends on effective human relations.

Group tours of the United Airlines Training Center are available by writing to United Airlines at Stapleton Airport, Denver, CO 80207, or by calling 303 398-4210.

"Don't be alarmed! Sodium nitrite showers are becoming more common around supermarkets."

SPACE

CONTINUED FROM PAGE 22

the giant station and back the three-man *Soyuz-T* vehicle would not have the capacity to supply adequate staffing. The ferry apparently will be the semimythical "Soviet space shuttle." Last June it proved its existence with a test flight that landed in the midst of a seven-ship Red Navy recovery task force in the Indian Ocean.

The official Soviet designation for the mission was *Cosmos-1374*—just another routine scientific satellite, or so the press release from Moscow claimed. But the strange orbital track of the vehicle, together with the recovery of some sort of spacecraft by the Soviet fleet (an operation watched closely by Australian P-3 Orion aircraft) tipped off observers that something significant had occurred. After several weeks of analysis and rumor swapping, a consistent picture emerged.

The *Cosmos-1374* vehicle, it turned out, was not a full-scale shuttle, but instead weighed only about a ton. This in turn indicated that the flight had been intended to test the aerodynamic characteristics of the spacecraft shape as it plunged through the atmosphere at speeds as high as Mach 30. Since the vehicle was recovered, the test must have been successful.

Some aspects of the flight remain obscure. Why, for example, was the intended landing spot on the ocean, since Soviet space vehicles have traditionally avoided water landings? And why, if the Russians were testing just reentry guidance, did the craft go all the way up into orbit, circle the earth once, and then have to make the delicate de-orbit burn to get back down, when a direct up-down hop could have boosted the craft to the same speeds and brought it down in a standard recovery zone?

In any case, the interval between a subscale test such as *Cosmos-1374* and a full-scale but unmanned flight of a prototype shuttle could be as short as two years.

The development of this two-part program, the big booster and the minishuttle, certainly will hold center stage in the Soviet space program of the late 1980s. But every year there will also be dozens of launchings of small (five tons or so) unmanned satellites to continue such current applications as spying, weather surveys, and communications, and even from time to time genuine scientific satellites. These payloads will be carried by the last of the *semyorkas*, and when the supply runs out—perhaps the factory has already been shut down and the warehouse is emptying fast—the newer SS-9-type boosters will take up the slack and carry the space cargo.

It is too much to expect that Moscow will officially announce the end of the *semyorka* program. But it can be fervently hoped that when the last of its kind is hoisted up onto the launchpad, a few history-minded engineers will be there to hoist a *tovarishch* toast to ol' mark seven. ∞

SUNSHAKES

STARS

By Allan Hendry

Since the 1960s scientists have known that the surface of the sun oscillates or vibrates—a fact they considered interesting but hardly significant. Then in 1974 a soft-spoken University of Arizona astrophysicist Henry Hill announced that the *whole* sun was quivering like some mammoth ball of jelly. This past spring Hill announced that clues from studying solar oscillations may unsettle over 50 years of confidence in the equations used to prove Einstein's general theory of relativity.

Hill made his initial discoveries about the sun's oscillations by using a specially designed solar telescope which allowed him to measure the polar and equatorial diameters of the sun to an accuracy of within one part in a million. He discovered these diameters would consistently shrink and expand, indicating the sun is vibrating, or "ringing" like a giant bell.

This discovery suggested a potential for an exciting new science: solar seismology. Just as geologists monitor earthquake-triggered vibrations to study our planet's core, astronomers could use the solar vibrations to probe the sun's unseen interior. Working with physicist Dr. Philip Goode and graduate student Randall Bos, Hill searched for patterns among the thousands of individual oscillations isolated by Bos as part of his research for a Ph.D. dissertation.

An analysis of these vibrations revealed the sun is rotating at various speeds. The inner 60 percent, Hill says, rotates six times faster than the surface. Because the core is spinning so rapidly, the sun is not round, but oblate—flattened at the poles and bulging at the equator.

Why should such disclosures threaten the general relativity theory? Scientists have come to accept Einstein's tenets because they have passed various experimental tests. One, proposed by Einstein himself, involved the planet nearest the sun, Mercury.

It has long been known that over time, when the planet reaches its perihelion, the point in its orbit when it is closest to the sun, the location of that perihelion shifts around the sun slightly each year. Classical Newtonian physics accounts for only 92 percent of the shift.

Einstein sought to improve on Newton's law of gravitation by taking into account the way the sun's local gravity warped both space and time around it. Calculations based on Einstein's theories resolved the discrepancy in Mercury's precession, and the mystery appeared to be solved.

The catch now is that Hill and his colleagues have asserted that the sun is not uniformly round, something that Einsteinian tests assume in the beginning. This creates problems because, by being nonuniform, the sun alters the accepted value of its gravitational field.

And so at a meeting of the Royal Astronomical Society in Ireland last spring, Hill made this startling announcement: "If the observations of Mercury's orbit are correct to within the stated margin of error, then we can say with ninety-five percent certainty that Einstein's theory of general relativity is not correct."

But as Dr. Ronald Hellings, a relativity expert at the Jet Propulsion Laboratory in Pasadena, California, points out, astronomers are still uncertain about the amount of precession there is in its orbit. Furthermore, there are other sun-based tests of relativity that still seem to support Einstein. One is that the gravitational warp of space around the sun is strong enough to bend light waves.

Not surprisingly, Hill disagrees with his critics. "The light-bending experiment tests only one aspect of the theory," he remarks, "while the advance of Mercury's perihelion tests another. Success in two or three areas doesn't preclude failure in a fourth."

Beyond that, he thinks, the huge wave of publicity about his challenge of the relativity theory is missing another, more important story. "Discussion about general relativity is really beside the point," he told one group of experts convened by the New York Academy of Sciences. "That is just a spinoff of this work. The main point is we now have a way of studying the structure and the behavior of the sun."

Our sun. If Einstein knew it had a flat top, a bulging middle, and it jiggled, would it have mattered?

CONTINUED FROM PAGE 18

hydrogen sulfide would be overwhelming But we couldn't smell it We couldn't feel the wind or partake of the environment We had to use the same techniques one would use in exploring outer space

Those techniques *did* however, allow some hands-on contact providing biologists with the *real* treasures—not videotapes but specimens grappled like moon rocks with *Alvin*'s mechanical arms or swept into "slurp guns" scoops and tows I stood on deck each evening as *Alvin*'s catch of the day was pulled aboard in a 200-pound foot locker known as the clam coffin The parceling ritual had become the social event of those languid days at sea but a successful haul meant plenty of work

Dispersing to their labs on the *Melville* and the *New Horizon* the scientists probed dissected, and measured the vent creatures sometimes into the wee hours of the morning They hoped that each tedious detail would shed light on larger questions How do these animals manage to flourish at the vents? How do they fend off the poison of hydrogen sulfide? How do their offspring find new vents a necessity since old ones die out in a decade or so? And why haven't other creatures abandoned their dependence on leftovers from sunnier realms to join the vent community?

In order to live at the vents I learned animals must do more than just *endure* hydrogen sulfide like astronauts masked and suited against a noxious atmosphere They must embrace their harsh environment using the toxic substance to survive And according to microbiologist Holger Jannasch of the Marine Biological Laboratory in Woods Hole Massachusetts, bacteria were the first to master the trick

Somewhere along the line he explained certain bacteria learned to convert hydrogen sulfide into organic carbon compounds just as plants convert water and sunlight into nourishment on the surface world The bacterial process called chemosynthesis is not unique to the vents In the black sulfury mud of lakes and estuaries, Jannasch notes chemosynthetic "bugs" can be found thriving on the hydrogen sulfide produced by rotting vegetation On the earth's surface they are insignificant in the food chain At the vents they are the cornerstone

In the Galápagos mussels eat the bacteria But there are no mussels at 21 degrees north and the dominant animals the worms and clams opted some time back for a more sophisticated system They house bacteria within them, living in apparently inseparable symbiosis

The tube worm superstar of the vent world may turn out to be the most unusual animal on Earth the first in a sense to make its own food The worm has no gut no mouth, no anus Thus the scientists who first saw it assumed that it simply absorbed nutrients from the water Not so

In reality the worm obtains food from a second "creature" locked inside it Its body cavity is packed with a soft gray-green tissue called trophosome a bacteria-filled mass that serves as "the power plant of the animal Trophosome bacteria flourish because they are supplied with large quantities of hydrogen sulfide delivered through the worm's bloodstream Worms which apparently produce a special blood protein to detoxify hydrogen sulfide survive by absorbing nutrients from the bacteria Sunbathing with me on deck one day Jannasch came up with this analogy To be like the tube worm a person would need a transparent window over his stomach and a garden of green plants inside he could dine just by lying in the sun

To Woods Hole scientist Howard Sanders patriarch of blue-water biology these extraordinary tube worms offer clues about the evolution of blue-water animals and the age of vent systems worldwide "Almost every vent creature is as highly specialized as the tube worm" he told me "adapted to the vent environment and no other" These fine-tuned animals didn't just appear when the vents in their particular corner of the world opened up a decade or so ago It took millennia for them to evolve "The only explanation I can think of," Sanders adds "is that the vent environment is very ancient even though any single vent is ephemeral Vent creatures grow at a frantic rate probably producing large numbers of offspring in larval form When a vent closes, hardy larval scouts can drift long distances a few making it to other vents and beginning their community anew

With our own species moving closer to exploiting the deep ocean—for manganese nodule mining radioactive waste disposal chemical dumping—I wondered about the vulnerability of this deepwater environment But few Oasis scientists seemed worried "The vent system is too vast The community is obviously adapted to a high turnover and recovery rate" Hessler said "I'd say this is an area where we don't have to worry about man's activities much"

Others believe vent creatures might even be hardy enough to colonize vapory Venus and other alien worlds But Jannasch rejects that idea because it could never be controlled "If we ever found life on Venus" he says "we'd have no way of telling whether it came from Earth or had been there before"

Besides it is not the vent creatures, well-nourished by the heat and chemistry of the earth but we who reach out for other worlds Sitting on the surface of a planet we continue to abuse we dream of moving on before we self-destruct Watching the watery horizon I found it reassuring that life on Earth has more options than we had imagined The tube worms may never even heed our passage

PAINTING

CONTINUED FROM PAGE 38

function allows things to be separated and integrated simultaneously."

Siler calls it Object-Mirror-Image. The reality can be mapped onto the idea. The brain and the mind mirror each other. There is a one-to-one correspondence between the real structure of the brain and the virtual process of the mind. The mirror is thus a tool that allows both the tangible and the intangible to be simultaneously explored. In this respect, Siler says, a kind of "virtual physics"—an optics of the mind—is created. "The ceiling of particle physics is the floor of the mind." And for the present his Cerebreactors are the physical representation of that.

"Scientists are beginning to look over their shoulders and wonder what's going on when they see an artist like Todd," says Ronald Feldman, of Ronald Feldman Fine Arts Gallery, in New York City, where Siler had his one-man Cerebreactors show in 1981. He did a Cerebreactor at MIT, and members of the science faculty were quicker to understand it than the artists. "I don't know whether he's an artist or a scientist. His ability to integrate so many disciplines with such insight is quite staggering." Siler's work has impressed others in the art community, too. He is one of 12 individuals selected internationally to exhibit at ARC 2 at the Musée d'Art Moderne de Ville de Paris, in France, this year.

Siler has done significant research in hard science and won a patent for an artist's canvas-stretching device. He's proposed to do a "video pile," a video art show employing television sets as cloud chambers to display the paths of alpha, beta, and gamma rays. He proposes to design a device to measure the activity and intensity of certain electrical fields of the brain. He seems driven to push the technology of art and the art of technology into convergence. "In 2000 B.C.," he says, "the big question was body and spirit. During the Renaissance it was science and art. When the new physics burst on the scientific world, it was matter and nonmatter. Now it's mind and brain, which brings us virtually full-circle," comments the artist, who is now working on a Ph.D. in architecture, art, and environmental studies at MIT. It is his interdisciplinary approach toward conceptualizing the aesthetic attraction between brain and spatial form.

"I think artists shy away from science because science brought us the atomic bomb," Feldman says. "But we need artists with the ability and the information to criticize it. Todd is the future. Or if he isn't the future, who is? In the fields of art and science, this is it, and I think we need it."

"We celebrate art and science separately," Siler concludes. "We should celebrate the 'and,' the link between the two, the conjunction that allows them to be considered together." ∞

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NEXT OMNI

GENIUS-HUNTING

GENETIC MARKERS

FICTION

COMPUTER KIDS—Good-bye blackboard and erasers hello TRS-80, Apple, and Atari There is a new generation of children growing up who handle the intricacies of compufer language and programming the way other generations learned how to ride a bike For better or worse the computer has become a fixture in modern childhood The next issue of *Omni* shows how the first wave of computer kids is using this tool for fun and, in some disturbing instances for profit, too

GENIUS TRUST—If you have a few million dollars that you must give away to whom do you give it? That was one enviable problem facing the John D and Catherine MacArthur Foundation recently The solution was called the Prize Fellows Program, also known as the Genius Trust In next month s *Omni* you will find out who some of the scientists were who received the MacArthur largess, what the large—up to a quarter million dollars—grants have done to them and for them, and how the American version of the Nobel Prize hasn t quite measured up

FUTURE MAN—The time is millions of years from now The place, planet Earth And the hard-shelled creature sucking water through its trunk is our own, altered descendant Acting on a suggestion advanced by *Omni*, paleontologist/model maker Dougal Dixon has created an extravaganza of pictures that forecast the future of man But because Dixon's vision is peculiarly his own, we asked other paleontologists physiologists and geneticists to furnish their views on tomorrow s evolution To see what form our heirs might take, read November's *Omni*

GENETIC MARKERS—Is it possible to detect the presence of the gene that causes multiple sclerosis? The day is approaching when inherited defective chromosomes will be wiped out Genetic researchers are now on the verge of being able to peer into your biochemistry and to predict years or even decades in advance what diseases you are most likely to contract Read about the genetic key that could help reshape our biological destiny in the November issue of *Omni*

FICTION—Stephen Robinett a frequent contributor to *Omni* has written a gem of a story 'Number Thirteen ' in which the thirteenth re-creation of the First Officer of a space-colony ship carefully examines his past lives for clues to his future Steve Perry a new contributor to the magazine and a former paramedic, puts his medical experience to good use in 'Augenblick " Perry s hero is a dedicated doctor with a talent that leads him to a serious moral and professional dilemma

COMMUNICATIONS

CONTINUED FROM PAGE 12

hypothesis that levophobia is peculiar to the Phoenix metropolitan area

The more than 1 4 million residents gen erate considerable traffic on city streets which appallingly are devoid of median strips and left-hand turn signals

When I first moved to Arizona I thought it more than a little odd that people would plan routes far out of their way simply to avoid having to make left-handed turns I discovered that the area s motor vehicle accident rate far exceeds the national rate I have to take my life in my own hands every day The Left Hand Turn Avoidance School of Thought is now beginning to look a little more sane

Chris Shirley
Phoenix Ariz

Think a Million

Thanks for the $10 I recently read a short article in *Omni* entitled "Deadly Dreams [Antimatter June 1982] that implied one might be able to conjure up $1 million just by thinking about it

Since my job does not require too much concentration as often as possible I think about a $100 bill I was walking outdoors one day and spotted a $10 bill Not exactly what I had ordered but next time I ll concentrate harder

Stephen Crompton
Wilmington Del

Correction

In the article "Premature Thaw [Antimatter December 1981] we stated that the Cryonics Society of California was located in Berkeley The organization was in actuality founded in Los Angeles in 1966 and bears no relation to cryonics organizations in or near Berkeley—*Ed* ∞

CREDITS

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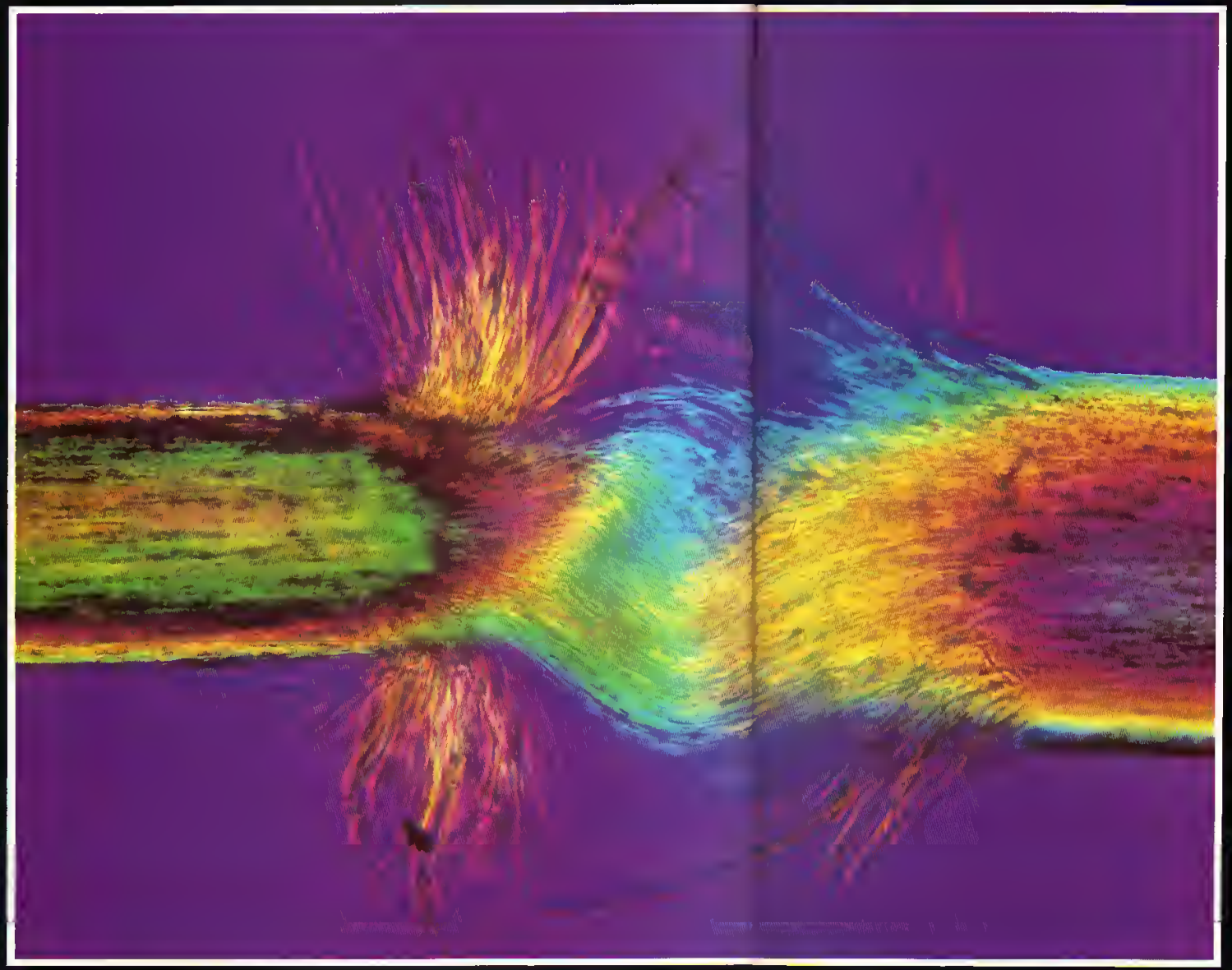

PHENOMENA

A cable of fluorescent color, snapped and frayed, and ready to separate, is captured here in a microportrait of violence done to a single human hair. To those who practice the arcane science of trichoanalysis -- studying the properties of human hair -- this shattering of a hair shaft is technically called trichorrhexis nodosa. When stressed enough, any hair shaft will bend, splinter, and eventually break at its weakest point. This photo is one of a series taken by researchers at Redken Laboratories, Inc., a California-based business trying to marry technology to the art of designing cosmetics. Images like this, Redken molecular biologist Dr. Ron Harris explains, allow analysts to get a color-coded reading of the health or, as in this case, the degree of destruction of this basic body tissue. The birth of this split end was photographed under a Zeiss Research Microscope on Ektachrome 64 film.

CONTINUED FROM PAGE 26

child reaches school age. "My only concern is how the teachers will react to him," she says. "The school system likes only average students. That's all they're geared to deal with. Slow learners and fast learners are off in a category by themselves. I don't know whether I will put him in a public school system or not. I know I don't want him to be thought of as an oddball."

Success like Cianfrani's demands an enormous commitment from the parent. Bruce Buschel, thirty-four, a New York City writer and video producer, decided to enroll in Doman's program after a two-year-old girl visited his home and began reading a book aloud to his two-year-old twins. "The first thing I did was ask the girl's mother what was wrong with her kid," Buschel remembers. "The second thing was I sent in my money to the institute. After watching the girl read, I figured I owed it to my kids to investigate what this was all about."

While Buschel reports that the week-long seminar taught him some valuable parenting techniques, he also learned that the program has practical problems. "If you take it all at face value, the program can begin to take over your life," he says. "I was taking care of the kids all day and staying up all night cutting out pictures to make flash cards. You can soon reach the point where you feel as if these damned kids better produce. You can get to feeling pretty resentful."

Buschel admits that some of Doman's techniques, if applied vigorously, can produce startling results. But they may not be very meaningful.

"One of the 'bits' the Institute likes to show off to newcomers is a math technique," Buschel says. "They hold up two cards, one with four hundred dots on it, and the other with three hundred fifty, and show how one of their kids can crawl over and pick the one with four hundred dots on command. It looks more amazing than it actually is. It's the same principle cops use to estimate crowds. If you look at enough dotted cards long enough, you get to know instinctively how many dots are on each one. The question is, Will this information translate to anything useful? I doubt it."

Critics of the Better Baby Institute also argue that the program's regimen takes away the one chance in a lifetime a kid has to act like a kid. Even if it's possible to teach a baby math and a two-year-old to play the violin, they say, doing so requires that the child be drilled daily.

Kerr has heard the criticism before. "You can't make a baby, or even a child of two or three, pay attention if he or she doesn't want to," she says. "Just try it sometime. But believe me, children want to learn, more than they want to sleep or eat. they just don't want to do it every minute of the day."

"It's all in the exercise. If you exercise the brain early enough, the child will soon become self-reliant," she adds.

That sounds reasonable, but critics point out that the long-term results of Doman's Better Baby techniques won't be known for years. And already a few of the claims are beginning to seem exaggerated.

Elaine Stogo, thirty-eight, was one of the first parents to enroll in the institutes' program for healthy babies in 1976, two years before the Better Baby Institute was formally set up. Stogo's daughter was two-and-a-half years old then.

"I would recommend the program to anybody," she says, "but, like anything else, you have to choose the parts of the program that apply to your own situation. I enrolled my child at the institutes because I wanted her to learn how to play the violin. At the time the conservatories in the area wouldn't take her because she was so young. They kept telling me I was being too pushy and that I should wait until she was old enough to know what she was doing. But thanks to the institutes, today she plays the violin beautifully."

While Stogo's daughter may someday credit the institutes for her musical virtuosity, she finds some of that training harder to remember. "This year she learned all about Japan in school," Stogo says. "I thought she'd be well ahead of her classmates because she'd been taught Japanese at the institutes every day. But the language didn't come back to her at all."

So committed was Stogo to her child's education that she can no longer imagine having the energy to carry out Doman's program again. "I always thought that when I was approaching forty, I'd try to have a couple more children," she says. "But I wouldn't want to, unless I could devote the same amount of energy again. I have bookshelves and bookshelves filled with flash cards that I worked on for my daughter. I just don't think I could do that for another child."

Doman (now chairman of the board) rubs his silver-gray beard, pats his ample midriff, and strides jauntily across the front of the large lecture hall, surveying the faces of the 90 parents in front of him.

"You know, there is a great difference between functional intelligence and potential intelligence," the sixty-three-year-old founder of the Better Baby Institute says. "For example, if you begin cutting an earthworm in two, it will resist in every way it knows how. Admittedly, it doesn't know many ways, but it will try anyhow. But if you try to cut off the leg of a human being who is in a coma, he won't do anything to stop you. You can cut off his head, for that matter. It is simply not possible for a human being to act intelligently in the absence of information. Same with the kid who's put away in the attic. He'll never have functional intelligence. Why? He needs information. And that's all we want to do with our children. We want to give them the information to act intelligently."

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Fours, the sons of Rubik, and a Ψ Φ film quiz

GAMES

By Scot Morris

It is the smallest square number and the smallest nonprime number (other than *0* and *1*) It is the only integer that is both the product of two numbers and the sum of those numbers It is the number of players on a polo team the number of players in bridge and the number of bridges of Toko-ri in the James Michener novel It is the number of gospels of sides in the base of the Great Pyramid of dimensions in space-time And this month it is the anniversary celebrated by the only science magazine with a four-letter title

Can you name the fourth four in these four groupings?

1 The Four Freedoms (as expressed in a 1941 speech by Franklin Delano Roosevelt and commemorated in a quartet of Norman Rockwell paintings) Freedom of speech and expression, Freedom of religion Freedom from want and

2 The Four Horsemen of the Apocalypse Conquest (War) Pestilence Death and

3 The four humors of Hippocratic and medieval medicine black bile yellow bile phlegm and

4 The 4H Club The H s stand for head heart, hands, and

Spell out the English name of any number Count the number of letters it contains and spell that number Count the letters again and spell that number Repeat the process until you reach a single number What is it?

When Martin Gardner pointed out that among all the infinity of numbers *4* is the only honest number"—that is it is the only one that states correctly the number of letters in its English name—several of his readers argued the point Gardner was correct if only the simple names of numbers are considered but if operational phrases are allowed (e g squared ' added to ') several exceptions can be found See whether you can find phrases that will make honest numbers out of *8 13, 15 16* and *29*

THE FOUR FOURS A classic problem in recreational mathematics is to form as many whole numbers as possible starting with *1* using the digit *4* four times—no more no less—and the common mathematical symbols for addition subtraction multiplication and division, and the parentheses For example

1 = 44/44

2 = 4/4 + 4/4

It is possible to create every digit between *1* and *10* this way If the square-root sign is also allowed numbers *11* through *20* can all be expressed, with one exception See whether you can create formulas for the numbers between *3* and *20*, and find the one number that cannot be expressed with these simple symbols

THE WORLD S HARDEST CUBE PUZZLE (SO FAR)

Shortly after Rubik s Cube hit the stores a similar puzzle called the Pyraminx appeared—actually a tetrahedron with four triangular faces, each containing nine smaller 'trianglets You may have assumed that this puzzle was invented after the Rubik craze hit but actually Uwe Mèffert claims that he designed this twisting tetrahedron in 1972 as a fiddling toy and a meditation aid, then put it on the shelf assuming it had no commercial value When the Cube took fire he quickly patented his earlier design and marketed

New puzzles by pairs, from left Mèffert s original Pyraminx, Megaminx, the dodecahedral 'hardest puzzle yet the Pyraminx Cube in its cubic state and halfway through a turn the Impossi-Ball- two puzzles in one Naoki Yoshimoto s ingenious invention Starburst showing cube and star forms

it under the name Pyraminx (a name chosen for its Egyptian associations, a cross befween pyramid and sphinx)

The German-born Méffert who now resides in Hong Kong and makes his living as a sports medicine consultant, quickly got caught up in the mania and started turning out puzzles in profusion He has designed puzzles on all the Platonic solids and this fall he introduces the Megaminx (pictured here) which has the distinction of being the most complicated of all puzzles in the new genre

If we consider the total number of possible color arrangements Rubik's Cube has on the order of 10^{19} and Rubik's Revenge, the new 4 × 4 × 4 cube by Ideal has 10^{48} For the Megaminx the number is an astronomical 10^{69}

"Those numbers can be misleading" Méffert tells me 'For example, it wouldn't be fair to say that the Megaminx is 10^{50} times harder than the Cube A more relevant comparison is to look at the number of possible arrangements left after you have solved all buf the last layer ' Rubik's Cube s last layer leaves you with some 62,000 possibilities on the Megaminx that number is 4 7 million

Meffert says that he cannot solve the Megaminx himself withouf referring to notes though he knows of several young people who are able to do it In less than five minutes

The Megaminx is a dodecahedron with each of its 12 sides being pentagons It has 12 fixed pieces (the inner pentagon of each side is connected by a shaff to a central ball) and 50 floating pieces By comparison Rubik s Cube has 6 fixed and 20 floating pieces The Megaminx can be taken apart in much the same way that Rubik s Cube can be (I described how to do that in the October 1980 issue) The Pyraminx cannot be taken apart without destroying the inner mechanism

Méffert has designed two other dodecahedron puzzles with entirely different twisting properfies which will be marketed as the Pyraminx Ball and the Pyraminx Crystal One of Meffert's most unusual designs is the cube (pictured here) which twisfs along axes that go straight through the cube s center For people who are used to Rubik s Cube handling this one can be most disconcerfing It takes a bit of practice before one even figures out how to twist it Another is his Impossi Ball (pictured) two puzzles in one You can twist the layers as shown or any of the triangular pieces can be popped out, then the other triangles can be moved info the "hole This is a 3-D sliding analogue of Sam Loyd s famous 15 Puzzle

If you cant find these puzzles in stores you may order them (and a catalog listing many others) directly from Méffert af Pricewell (Far East) Ltd , P O Box 31008, Causeway Bay Hong Kong Meffert has offered to send any of his puzzles to *Omni* readers for $8 postpaid for surface mail, or $10 for air mail

Douglas R Hofstadter's Metamagical Themas column in the July 1982 *Scientific American* gives a mathematical analysis of the Pyraminx, Meffert s Cube (which he calls the Skewb) and several other twisting puzzles Hofstadter also reports that H J Kamack and T R Keane have simulated a four-dimensional Rubik's hypercube (3 × 3 × 3 × 3) on a computer They call it Rubik s Tesseract, and they have calculafed that the number of distinct arrangements it has is nearly a googol (10^{100})

Another remarkable toy in the genre, designed by Naoki Yoshimoto is more an art object than a puzzle The one shown was presented to me by Itsuo Sakane who writes a column similar to this one for the Japanese newspaper *Asahi Shimbun* It starts out as a silver 2×2×2 cube Give it a few twists the inner surfaces exchange with the outer surfaces and it becomes a gold cube That s remarkable enough but take the gold and silver sections apart and each can be folded into a beautiful star shape a stellated rhombic dodecahedron (shown in gold). This ingenious piece of three-dimensional engineering is being marketed in multicolored versions by Entex under the name Starburst.

Ψ Φ FILM QUIZ

Louis Phillips is preparing a quiz book for Walker Publishers, *505 Questions About Movies That Your Friends Can t Answer* Some selected items from his chapter on science-fiction and horror films

1 *Forbidden Planet* (1956) is loosely based on what Shakespearean play?

2 In the 1930s Adolf Hitler ordered the destruction of all available prints of Fritz Lang s 1928 film *Die Frau im Mond* (*The Girl in the Moon*) Why?

3 In *The Bride of Frankenstein* (1935) Boris Karloff, of course played the monster and Elsa Lanchester played his bride But who played the role of Mary Shelley, the author of the classic novel *Frankenstein*?

4 Steve McQueen made his screen debut in what 1958 horror film?

5 Where was Bela Lugosi born? (Once you know it s easy to remember)

6 The actor who played the title role in *I Was a Teen-age Werewolf* (1957) later went on fo star in two long running TV series Who is he?

7 Boris Karloff has portrayed Frankenstein s monster the Mummy and Dr Fu Manchu What other screen star has also played those three roles?

8 What actor played the Thing in the 1951 classic *The Thing*?

9 In what sf film can audiences see three well-known radio and newspaper reporters—Drew Pearson H V Kaltenborn, and Gabriel Heater?

10 In *Star Wars* a character mentions a certain cell block The number of the cell block alludes to an earlier film directed by George Lucas What is the number, and what is the other film?

11 Woody Woodpecker is alluded to or can be seen in almost every post-1950 film made by what noted producer of sf classics?

12 In what Boris Karloff film does Karloff deliver an invocation to Satan, including numerous inappropriate Latin phrases such as *In vino veritas* (in wine truth) *Cave canem* (beware of the dog), and *reductio ad absurdum*?

Answers are on page 178

LAST WORD

By John Ficarra

True or False
The Heimlich maneuver is an advanced sexual technique named after the famed German sex therapist Dr Carl Heimlich

Until recently the only measure of a person's probable longevity was predicated on old fashioned actuarial tables that relied almost exclusively on heredity patterns and medical history to determine just how long a person most likely would live But over the past few years, as scientists have learned more and more about man and his diet life style and environment a new more scientific method of gauging a person's probable life span has been developed—the Life Expectancy Quiz Today several versions of this quiz are used by doctors medical groups and insurance companies After a thorough examination of these quizzes, however I have discovered one basic flaw They simply do not go far enough. They downplay too many factors of everyday life and completely ignore several other important ones

This discovery prompted me to develop my own Life Expectancy Quiz, the only one of its kind and, I modestly suggest the most accurate at judging the probable life span of men and women for the 1980s and beyond I now invite you to take pen or pencil in hand and see just *how long you will live*

Begin with the number 72 respond to the following, and add or subtract accordingly

PART I LIFE-STYLE STATUS

(1) If you eat
red meat three times a week or more subtract 2
green meat subtract 4
all other colors, subtract 7

(2) Do you smoke
cigarettes? Subtract 3
no cigarettes? Subtract 27

(3) If you run
1 to 2 miles a day add 2
3 to 5 miles a day add 4
If the reason you're doing all this running is that you live in a ghetto and street gangs are constantly chasing you subtract 14

(4) For every food substance you've ever eaten that was later found to have caused cancer in Canadian rats subtract 4
If you happen to be a Canadian rat, subtract an additional 10

(5) If you are totally dependent on the Social Security System for your basic food and shelter needs, subtract 11

Life-style subtotal ____

PART II PERSONAL FACTS

(1) If you are a personal enemy of any of the following men subtract accordingly
a) Ayatollah Khomeini, subtract 3
b) Muammar Kaddafi, subtract 5
c) George Steinbrenner subtract 20

(2) If both your parents died of cancer, diabetes, heart attack, or stroke before age fifty subtract 4
If either parent is still alive to advise, pester, and criticize your every move subtract 11 per parent

(3) If you see a doctor at least once a year, add 5.
If you let him examine and treat you subtract 9

(4) If you are overweight by 50 pounds subtract 7
If someone 50 pounds overweight just sat on you subtract 12

(5) If you are over 65 and still working add 3
If you work in any of the following professions regardless of age, subtract accordingly
a) National Hockey League player subtract 3
b) DC-10 pilot subtract 7
c) Janitor at Three Mile Island subtract 13
d) Polish dissenter subtract 15
e) Pope subtract 19
f) Argentine soldier subtract 22

Personal subtotal ____

PART III GENERAL INFORMATION

(1) If any room of your house or apartment is currently engulfed in flames subtract 20

(2) True or False The Heimlich maneuver is an advanced sexual technique named after the famed German sex therapist Dr Carl Heimlich
If you answered 'False' add 1
If you answered 'True,' subtract 1 and never dine alone

(3) For every Republican president who has held office in your lifetime subtract 2
For every Whig president in your lifetime subtract 20.

(4) Within the last six months if you have ever been asked to leave a funeral home because you were confusing the mourners subtract 3

(5) If you occasionally find it necessary to use a room deodorizer to help combat the fumes from the chemical waste dump in your area, subtract 23

General subtotal ____

GRAND TOTAL ____

SCORING:
52 or less—Average Life Span.
All other answers—You probably added wrong **DO**

John Ficarra is the associate editor of Mad magazine has been a writer for performers such as Rodney Dangerfield and Joan Rivers and is under fifty two years of age