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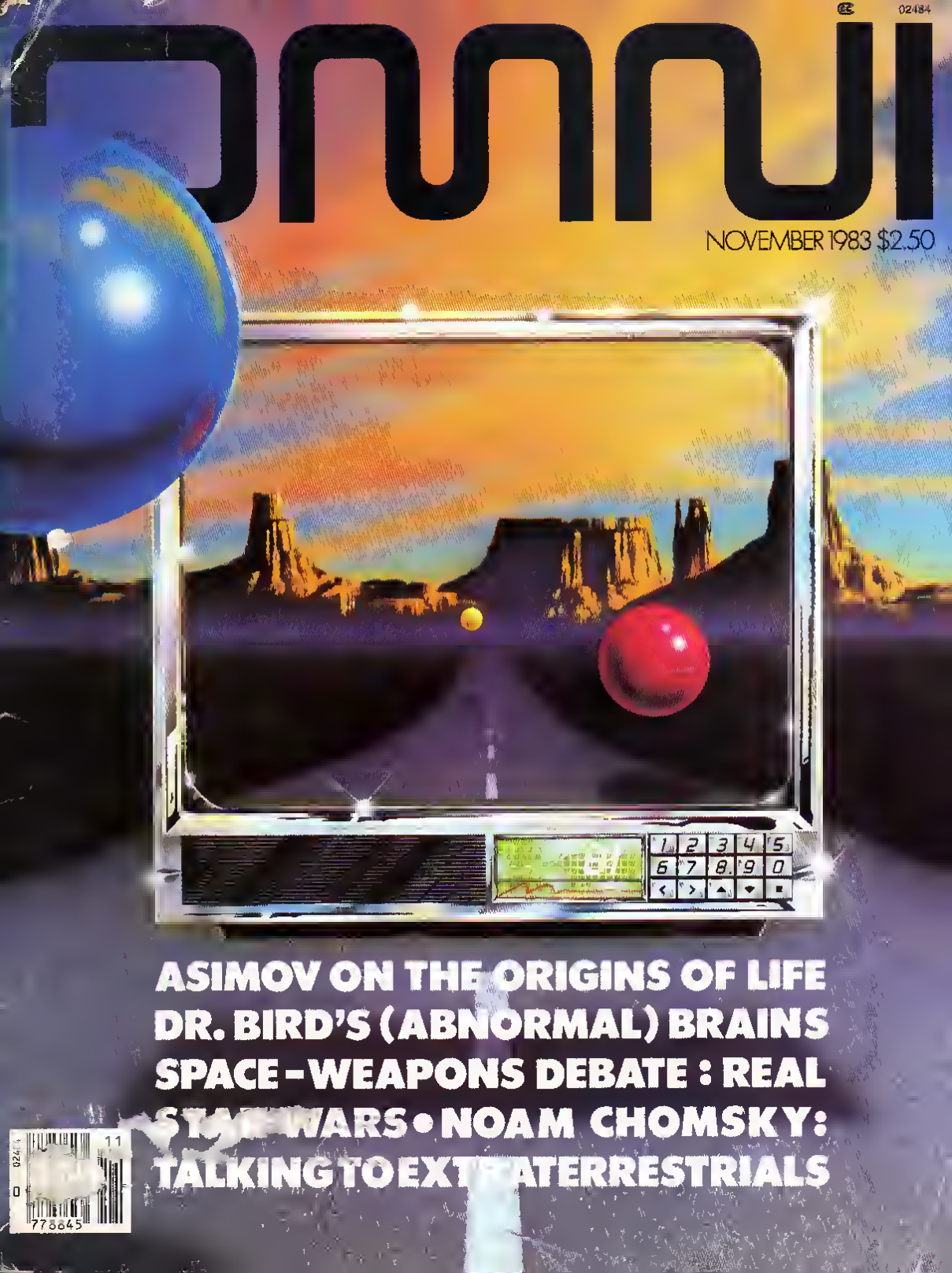

ASIMOV ON THE ORIGINS OF LIFE
DR. BIRD'S (ABNORMAL) BRAINS
SPACE-WEAPONS DEBATE: REAL STAR WARS • NOAM CHOMSKY: TALKING TO EXTRATERRESTRIALS

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VOL 6 NO 2 NOVEMBER 1983

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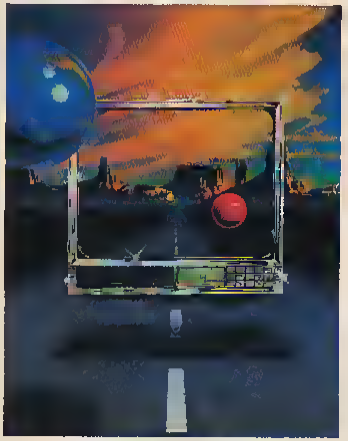

Primary Illusions is artist Jeff Wack's conception of a thoroughly modern Alice who, when the 'glass got all soft like gauze," felt the desert behind and stepped through the video screen (Designer Henry Vizcarra/90' Los Angeles for Warner Home Video)

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FIRST WORD

By Senator Larry Pressler

"America's interests are best served if the skies are clear of deadly weapons. Let's abandon these fortresses in the sky"

In the absence of meaningful negotiations between the United States and the Soviet Union, the first phase of "star wars" could develop at any time. The deployment of antisatellite (ASAT) weapons in space makes this new and dreaded form of warfare a distinct possibility. The Soviets already have a proven killer satellite and have been working on ASAT technology since the late Sixties. The American counterpart, an F-15-launched ASAT, will become operational in the near future, perhaps before the end of this decade. Both superpowers are also experimenting with so-called fortresses in the sky—ballistic-missile defense systems capable of attacking many missiles from a single space platform.

By moving the arms race into space, the danger of nuclear war on earth will not decrease. On the contrary, a space arms race would not only upset the delicate global balance that prevents such terror from occurring but would also increase the risk of a total cosmic conflict. The cost to develop such space armaments is astronomical. Estimates for some complex U.S. space-weapons systems run up to $500 billion, which is double the entire U.S. defense budget for any year during the mid-Eighties.

In the short run, the enormous financial cost of space weaponry would impose a staggering tax burden on the average American and would also reduce the amount that our government would be able to spend on conventional military programs. In the long run, a space arms race would drain the world of resources needed for countless other purposes.

The best, and probably the only, way to halt a deadly space arms race before it actually occurs is through a ban on space weaponry. For two years I have been calling for a resumption of negotiations between the United States and the Soviet Union to achieve such a treaty. In 1981 I introduced a resolution calling on the President to invite the Soviet Union to join in a verifiable ban on antisatellite weapons as a first step toward prohibiting all space-based and space-directed weaponry. Until recently the Soviets did not even concede possession of a killer satellite, much less a willingness to dismantle it. In August Soviet Party Chairman Yuri Andropov, with his call for a ban on antisatellite weapons, acknowledged that the Russians have an ASAT that poses a serious security threat to the West. Although problems remain, I feel the Soviet offer should be pursued, for it may imply a major shift in direction by the Soviet Union. Unfortunately, there has been little movement toward the negotiating table, and a cataclysmic contest for the high ground is closer than ever.

Even if we avoid open warfare, merely arming for it will be a crushing burden. Estimates for the antisatellite weapons range from as low as $3.6 billion to as high as $50 billion. For the ballistic-missile defenses, costs vary from $50 billion for an extremely limited system to $500 billion for the fortress-in-the-sky laser system. This is 20 times greater than the entire cost of the MX missile program and yet these projects have not been subjected to the same kind of intense scrutiny given to the MX.

In addition to the ASATs, the Soviets are also developing sophisticated space weaponry like laser and particle-beam death rays, which can be deployed in or directed at space.

Since space technology apparently knows few bounds, the continued development of ASATs could set off an irreversible chain reaction. The Soviets might try to outpace the United States. We would respond with countermeasures. This kind of arms escalation suggests the dilemma of a compulsive gambler who must continually double his bet—with disastrous results in the end.

Our European allies have strongly urged a resumption of U.S.-Soviet ASAT talks. They are concerned about the lack of progress shown so far. Three rounds of negotiations were held between 1978 and 1979, but a fourth was scuttled after the Soviet invasion of Afghanistan. There is no indication from testimony before the Senate Arms Control Subcommittee that a resumption of these talks is on the U.S. arms-control agenda.

Commercially, the United States and other nations rely heavily on space satellites for communications, weather forecasting, and the exploration of natural resources. Only in a sky free of weapons can we hope to realize the full potential of a revolutionary space technology.

The Pentagon recognizes the commercial consequences of the space threat. It suggests that commercial satellites should be hardened against possible attack or attempted interference. Such defense can be accomplished by the use of shielding or the deployment of rockets that could maneuver away from attackers. But hardening is expensive and adds significantly to the cost of launching a satellite. This kind of fortification also reduces the size of the payload. Given these disincentives, business interest in space might diminish greatly and America's technological edge will be surrendered to foreign nations.

The problem is all too critical to become a political football, both on domestic and international levels. The present pace of space-weapons development makes it imperative that we act quickly to find some acceptable ground for negotiations between the United States and the Soviet Union. America's interests are best served if the skies are clear of deadly weapons. Let's abandon these fortresses in the sky. ○○

Larry Pressler is a Republican senator from South Dakota and chairman of the Senate Arms Control Subcommittee.

CONTRIBUTORS

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DISCH


ELLISON


CADIGAN


POHL

The world of *Star Wars* is only as far away as the Naval Weapons Center in California where the Air Force has been shooting down its own Sidewinder missiles with laser beams. The testing's success—five hits, no failures—lends credibility to President Reagan's March 1983 "star wars" speech in which he proposed to put weapons in space. It's obviously a controversial plan, so we sent journalist *Tim Onosko* to interview every major figure involved in the space-weaponry debate. The resulting article, "Showdown on the High Frontier," ponders the life-and-death scenarios of space war, which is closer to reality than most Americans think. Onosko says, "This issue is here to stay. The people on both sides of this debate are extremely passionate about what they believe." Turn to page 72 for coverage of the latest killer-laser plans and meet the diverse political groups and people, including anti-ERA spokeswoman Phyllis Schlafly and Republican Senator Malcolm Wallop of Wyoming, who back this new technology.

MIT's Noam Chomsky, the subject of this month's Interview, is the most influential linguist alive today. His revolutionary hypothesis—that an inherited neurological structure governs a child's capacity to learn a language—has transformed the way scientists view the origins of speech. "Just as genetics endows each infant with a heart and lungs," says Chomsky, "it provides each newborn with a highly complex language organ." Science journalist *John Gliedman* interviewed the controversial linguist (page 112) and asked him to defend his views on heredity and environment and their role in the acquisition and development of language. Gliedman, who teaches both psychology and philosophy of science at Empire State College (State University of New York), remarks: "Chomsky has a reputation for eating his opponents alive for breakfast. But his personal manner is just the opposite. He's modest, playful, even gentle. He has an encyclopedic mind, and his speech is like written prose."

Dr. Edward Bird is a pioneer in the field of neurochemistry and has spent most of his medical career hunched over a microscope—dissecting and analyzing the brain, in order to understand how chemical interactions between neurons affect physical and mental health. "The human brain is the last frontier of medical research," says Bird, who, as director of the Brain Tissue Resource Center at McLean Hospital, outside Boston, is the proud possessor of one of the best collections of human brains in the world. Neurologists studying brain chemistry request tissue samples from the center because most of the brains are from victims of neurological ailments—Huntington's chorea and Alzheimer's or Parkinson's disease. In "Dr. Bird's Brains" (page 136), freelance writer *Joseph Finder* tours the cold vault where some 250 brains are preserved, and he reports on research that may someday lead to the effective treatment of mental disorders. Finder is the author of *Red Carpet* (Holt, Rinehart & Winston).

Several months ago fiction editor Ellen Datlow decided to try an experiment involving six *Omni* authors. "I commissioned six short, short stories, each could be no longer than five hundred words," she says. "The only other criterion was that the tale be funny. *Harlan [Ellison]* wrote his story the very next day and read it to me over the telephone. The other five writers soon followed. I think the experiment was a success. Each author has produced a gem of a short story, and all six are extraordinarily varied in texture, tone, and theme." "Double Treble," which begins on page 144, features *Frederik Pohl*, *Pat Cadigan*, *Thomas Disch*, *Edward Bryant*, *Gene Wolfe*, and Ellison.

We also offer three full-length short stories this month. *Kate Wilhelm*'s "Sister Angel" is about a strange girl and her evangelist guardian who are implicated in a murder. "400 Boys" (page 82) by *Marc Laidlaw* is a colorful story about punks who roam the streets of a large city after a nuclear holocaust. And in "Amor y Pesetas," which begins on page 128, a young holovision cameraman travels to Spain and is forced to confront a side of himself he never knew existed. *Stephen Robinett* has just finished writing *Crowe*, the first of a series of novels. ∞

LETTERS

COMMUNICATIONS

Let There Be Night

Christian Marchal's idea of nighttime illumination of the earth ["Moonday Antimatter," June 1983] is possibly the worst example of technological tunnel vision yet seen. Most organisms respond to some extent to photoperiodicity. But for the moment, let's just consider plants. When all the earth's plants have their reproductive functions destroyed because there is no more photoperiodicity (just light and less light), what then? No more absorption of carbon dioxide produced by our industries and cars. No more production of oxygen for us to breathe. No more fruit, grain, seeds, and nuts for us to eat. Marchal's idea is nutty as well as dangerous.

Linda Handley
Miami

Mystery Solved

In your May 1983 issue you printed an article by Peter Rondinone entitled "EEEEEs Dropping" [Antimatter]. This might have been a bit of tongue-in-cheek humor, but it also might have been a piece of fiction designed to explore the ability of your readers to put aside logical disbelief.

Surely thousands of your readers recognized those *E*s at first glance. They are laminations from an electrical transformer—probably from the power supply of a pre-Seventies piece of electronic equipment. As far back as 1940 I and other preteeners used them much as the youths of today use Frisbees.

Vern Mercer
Redwood City, CA

Loyal Hacker

The article by Owen Davies touting Adam Osborne's most recent brainchild [Artificial Intelligence, May 1983] is one of the first I have seen regarding the new portables. Congratulations on *almost* scooping the *Portable Companion*, a magazine dedicated to Osborne 1 (OS-1) owners.

I must take exception to the opening concepts, however. The lighthearted reference to owners of the OS-1 "kicking themselves" is a serious disservice to many of your readers. It implies that the unit is in danger of becoming one of many "orphan" computers, obsolete and abandoned by the manufacturer.

The price of the OS-1 is the main feature that attracted me almost a year ago. I was a senior at California State University and was able to use a student loan and $200 or $300 to put together a full system, including a letter-quality printer and some software.

Now, in just five months, I have built my own real-estate-appraisal practice. My initial investment in "Ozzy" as a student allowed me to break out on my own with confidence and an edge on the competitive world.

Michael Jacobs
Long Beach, CA

Go Fly a Kite!

"Kites for Adults," by Scot Morris [Games, June 1983], was a top-notch article. I seldom can say that about kite articles in most publications, but yours has the kind of fresh, well-researched and well-written material that calls for an exceptional response. Congratulations and thanks in abundance.

Valerie Govig
Editor
Kite Lines
Baltimore

Casting the First Stone

I protest the base political rhetoric expressed in the June 1983 First Word. It may be chic to blame all the world's ills on Reaganomics, but that does not solve the problems. Congressman Gore has found a scapegoat, but our problems did not start at the beginning of Reagan's first fiscal year. The government has a finite amount of tax dollars to spend. The question is: How can this money be spent wisely and efficiently? If *Omni* wishes to enter the political arena, let's see some more mature articles rather than ones that just blame the opposition for our problems.

Norman Paskey
Marshall, WI

CONTINUED ON PAGE 180

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.*

Environmental Potboilers

The hysteria over the possible dangers of herbicides has been fueled by Carol Van Strum's book *A Bitter Fog* [excerpted in Earth, June 1983].

Van Strum's work is cunningly written. It reads well, cites a litany of undocumented personal problems supposedly arising from herbicide exposure, and emotionally compels the reader to conclude that herbicides, as poisons, are the devil's own earthly concoction.

But if one emerges from the darkness of allegation and emotion and reviews Van Strum's work rationally, her efforts to inflame are soon discredited.

Van Strum has been on the antiherbicide warpath for some time. She and her husband have tried to act as catalysts for the antichemical crowd. The brew they are making reeks with the odor of an uninformed, special-interest crusade.

The best example of Van Strum's attempt to add a pinch of newt and a dab of bat to enhance her book and her cause is found in the chapter describing a 1981 helicopter torching near Toledo on the central Oregon coast. The torching of the spray chopper took place on Publisher Paper property and destroyed a copter owned by Western Helicopter. Van Strum writes of this criminal act in mesmerizing terms. To hear her spin her yarn, a nearly spontaneous uprising of beer-drinking local folks congregated at the chopper landing site.

Almost on cue, people equipped with gasoline and flares emerged from the shadows. A witchlike old woman stepped forward and did the honors.

Chants resulted and communal justice was affirmed, according to Van Strum. This satisfying, revolutionary-sounding depiction is a hoax. No spontaneous gathering occurred. No old woman was involved. Two women did subsequently claim credit for the torching on behalf of The People's Brigade for a Healthy Genetic Future. Whether their involvement signals a conspiracy or an attempt to grab media attention is unknown.

Nowhere in the book does Van Strum present the kind of objective, verifiable evidence needed to support her claims. Such evidence and documentation is lacking for good reason—it probably doesn't exist.

Dave Dietz
Director
Oregonians for Food and Shelter
Salem, OR

Like the book, the article 'A Bitter Fog' lacks scientific integrity and contains many allegations, fortuitous allusions, and half-truths that are "sexy" but destructive to production.

I, too, live in Oregon's Coast Range. Like millions of Americans, I use herbicides frequently. Extensive lab and human-use documentation have shown these herbicides to be among the safest of all chemicals. If 'small is beautiful,' forest herbicides are extremely beautiful. Only 0.5 pound to 4 pounds per acre per century allows forest reclamation and protection from very unnatural brush conditions. Alternative methods involve far greater chemical hazards that result from excess fuels and machine emissions.

During our own use of forest herbicides, our wildlife populations have soared. We have also controlled many species of toxic plants that are endemic in such unsprayed areas as the Van Strum farm. These plants are known to cause birth defects, illness, and even death at low exposure. Their toxins are absent from most American milk and other foods thanks in large part to the use of herbicides.

Jane Newton
Philomath, OR

It's apparent to me that writers who label all pesticides a danger to the planet are naive and a threat to the society. Any tool known to man can be destructive if improperly used. (In my opinion, Carol Van Strum's pen is a good example of this general rule.)

Such well-meaning antipesticide groups as the Sierra Club and even, of late, the Audubon Society have been trumpeting their negativist points of view so persistently that I fear we are on the road to a kind of agricultural Dark Ages. Quite frankly, an outright ban on pesticides would cripple the entire population.

John Weeks
Salem, OR

Carol Van Strum replies: *In his only specific criticism of my book, Dave Dietz claims to have found a factual error in four pages of chapter 14, wherein a spray helicopter is burned.*

Dietz's opinion notwithstanding, the district attorney in charge of unsolved crimes described my book as "the biggest break in the investigation."

Against Dietz's and Jane Newton's other generalizations, the book and its 23 pages of references document a long history of fraud and secrecy in the testing of pesticides, of routine Environmental Protection Agency (EPA) licensing of pesticides before safety tests were completed, and of the federal government's use of Oregon residents as human guinea pigs to determine pesticide effects. The same evidence that supports my book also supports a recent federal district court decision won—without attorneys—by my husband, a Vietnam veteran who was disabled by agent orange. After reviewing this evidence, Judge Robert C. Belloni decided that federal agencies cannot rely on EPA pesticide-registration research but must conduct their own laboratory tests and complete the human study begun by federal officials in 1979.

'If research shows that these things were causing cancer, were causing birth defects, were causing miscarriages,' Judge Belloni said, 'it's hard for me to believe that the government agencies, after knowing that, would go ahead at all. The fact is that they don't know, and

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QUEST FOR TOTALITY

EARTH

By James Ehmann

The malicious, fanged giant named Bathara Kala cannot be destroyed, but he can be defeated. Since ancient times he has roamed the heavens of Indonesia on a single mission: to plunge the world into darkness by eating the sun. Legend holds that mortals can fend off the demon with noise—by screaming, blowing horns, and beating on *kentongan* drums—and history has shown that this defense of the sun works every time.

Nonetheless, Bathara Kala usually succeeds in turning daytime to night at least for a while, and that is why we were there. No fewer than 26 of the 27 people in our group had journeyed halfway around the world to the city of Surabaja, on the tropical isle of Java, solely to watch this sun-hungry monster create a spectacle known to the Javanese as *gerhana matahari*. We called it a total eclipse of the sun.

The only member of our group to whom the eclipse wasn't foremost in mind was Linda Holloway, twenty-nine, of Glenwood Springs, Colorado, the tour-company escort assigned to shepherd the group. In the week we spent shuttling from Tokyo to Hong Kong to Singapore to Bangkok and Djakarta to reach Surabaja, we spoke of almost nothing but the pending eclipse, and Holloway, who had never tasted totality, confessed something less than a pure appreciation of our quest. "You remind me of a bunch of drug addicts," was the way that she put it. "I think you're all nuts."

All but five of us had been in the path of a total eclipse at least once before, so we tried to explain. On June 11 in Surabaja, beginning at about 10 A.M., the moon would move slowly across the face of the sun, taking a steadily larger bite from the solar disc. At about 11:35 A.M., the sun would be completely obscured, and its hydrogen atmosphere, usually overpowered by the brilliance of sunlight, would explode into view.

Opportunities to witness the event, we told Holloway, are rare. Total eclipses occur only when the new moon passes directly between the earth and the sun, blocking all light coming from the solar disc and casting a shadow on the earth. This perfect alignment of planet, satellite, and star happens only some 70 times per century—about once every 18 months. The route of the lunar shadow, known as the path of totality, is usually several thousand miles long, reaching such lengths because of the earth's rotation during the minutes of eclipse. The shadow is seldom more than 200 miles wide, however, and on the average it will cover any given point on the planet's surface only once every 400 years.

Holloway listened patiently, though she still thought we were crazy. We had, after all, spent a great deal of time and money traveling more than 10,000 miles on the chance—an iffy chance at best—that Surabajan skies would be clear on the morning of June 11.

Millions of Javanese living in the path of totality shared Holloway's opinion, albeit for different reasons. The few rural people who still believed in Bathara Kala were not particularly worried about *gerhana matahari*, because they knew their rituals would ultimately drive the giant away. But their countrymen in cities and villages were at once too modern to accept the myth and too poorly educated to understand the truth. Many were terrified of going blind.

Eclipse over the Javanese city of Surabaja

The concern was not wholly unfounded. During the 90 minutes it would take for the moon to cover the sun—and during the 90 minutes of uncovering after totality—eclipse observers without filters to protect their eyes would risk massive retinal damage as they would any day if they looked straight at the sun. Only the fleeting moments of totality, for which we had journeyed so far, could be safely viewed with the naked eye.

Early on, Indonesian officials decided that the distinction between the phases of partial and total eclipse was too complicated to be grasped by the population at large; so they chose doomsaying over education. Moslem leaders advised the faithful to spend the morning of June 11 in mosques, praising Allah, and the government told everyone else to stay home and watch *gerhana matahari* on TV. Police were prepared to enforce an eclipse curfew if need be, though most Javanese planned compliance. As we shopped on the muggy and dreadfully hot streets of Surabaja on the days before the eclipse, many Surabajans—knowing why we had come to their land—watched us as though we were insane. The rest of the locals assumed that we were hotshot scientists equipped with fantastic gadgetry to protect our vision.

The latter was the better assumption. While most of the visitors to Java were laymen in tour groups like ours, several hundred scientists from a dozen countries were also on hand for this, the longest total eclipse of the decade.

Astronomers have been studying eclipses for at least 4,000 years. During most of that time, the goal was prediction. By monitoring the movements of sun and moon, researchers tried to surmise when the heavenly bodies would align. In more recent years scientists studying eclipses have had another important aim

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MUSICIAN DOCTORS

LIFE

By Douglas Stein

Almost four years ago Dr Robert Hochberg a neurologist at Boston's Massachusetts General Hospital, received a call from Rosalie Leventritt, patron and guiding spirit of the prestigious New York Leventritt Competition for classical instrumentalists and singers She was trying to find a 'careful and patient' physician to treat renowned pianist Gary Graffman who was suffering from a mysterious cramping and curling of the fourth and fifth fingers on his right hand For two years Graffman had been making fruitless pilgrimages to specialists—logging almost as many miles as he had during his busy concertizing schedule Although deeply engrossed in his work on cancers of the nervous system the music-loving Dr Hochberg was intrigued by the baffling problem that had forced the star pianist's premature retirement

Since Graffman's first visit in 1980 Hochberg and his colleague Dr Robert Leffert chief of rehabilitation at Massachusetts General, have treated nearly 250 professional musicians creating, in the process an entirely new specialty for medical research and treatment Like the physicians who first treated professional athletes, they have formed a bridge between passion for an art or sport and medicine No easy task especially when you're dealing with musicians who rarely speak anatomy and who present their disabilities in a language of their own It's not unusual for a musician to tell Hochberg and Leffert, "I can't get out the arpeggios in the Brahms Bb ' or, "My octaves in the Tchaikovsky concerto are sloppy,' or, "My trills in Beefhoven's Opus 109 wobble "

Hochberg and Leffert who come from different disciplines—Hochberg is a neurologist Leffert an orthopedic surgeon who specializes in reconstructing hands—both admit to being "musically naive ' To compensate, they brought on Fred Wenger, a concert pianist and teacher to prescreen all prospective patients If an examination by the specialists is indicated, the musician receives a complete musculoskeletal-system evaluation that focuses on joint function, strength and mobility Blood tests are taken to rule out immune-system dysfunctions or circulatory problems Conduction studies may be done to measure the quality and speed of nerve impulses down the arm Doctors place needles directly into a muscle to make it contract and then they analyze the muscle's response with an oscilloscope and sound transducer 'We do other sophisticated tests to determine whether linkages between the sensation of the periphery the sensing nerve, the spinal chord, and the muscle are intact,' explains Hochberg "These tests are helpful because they get at the basic electromechanical relationships that underlie musical performance "

Videotapes and snapshots made of miniperformances enable the doctors to review with the musicians specific postures or movements that appear needlessly contorted or inefficient Technique the essence of the musician's art comes under medical scrutiny

The doctors have discovered that the complaints-to-instrument ratio is strikingly consistent A whopping 75 percent of their patients are pianists 15 percent are string players (half of those are violinists), and the remaining 10 percent comprise guitarists (steel and classical), woodwind and tuba players, and drummers

The perilous consequences of playing piano probably stem from an uncompromising problem The hand isn't suited to the instrument The piano is fearsomely symmetrical whereas the hand is irregular each finger possessing different strengths and ways of moving The ring finger is most vulnerable to injury since its extensor tendon is attached to those of the third and fifth fingers making it weaker and less independent than its neighbors

In the nineteenth century, pianists went to painful extremes to equalize finger strength Such devices as the "hand guide," the "dactylion," and most gruesome of all the 'royal chiroplast' were popular All utilized a combination of rails, movable brass plates adjustable screws, pulleys and straps that are strikingly reminiscent of stocks and racks

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ORBITAL BARNSTORMING

SPACE

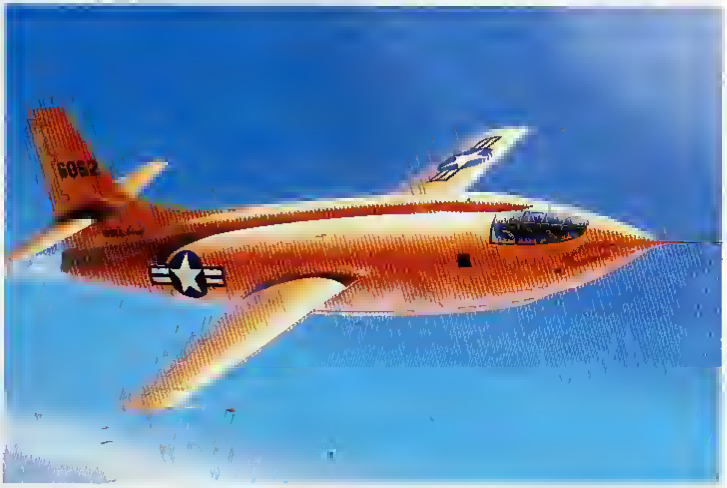
By G Harry Stine

A new manned spaceship under study by the Air Force would bring back the days of goggles, silk scarves, and open cockpits.

The Space Cruiser is the brainchild of Fred W. "Bud" Redding, an engineer who's been building hot flying machines and spacecraft for 30 years. He's probably one of the few people today who knows everything that's needed to design an air or space machine.

The Space Cruiser grew out of his dissatisfaction with what has been called "baroque technology," the fractional improvement of performance that comes from the increasing complexity of overdeveloped gadgetry produced at increasing cost. "I do not see a touch of brilliance in space-vehicle design concepts around the country. Brilliance is simplicity and usefulness." So he set about designing a simple spaceship that could be built with today's technology. The Defense Advanced Research Projects Agency (DARPA) liked Redding's ideas well enough to provide some study funds.

Redding designed a small airplane shaped like a slender cone 26 feet long with a base diameter of 5 feet. It's about the same size as the Bell X-1, the rocket-powered craft in which Chuck Yeager broke the sound barrier in 1947. The X-1 was shaped like a bullet; however, while the Space Cruiser is a scaled-up version of the conical Minuteman ICBM Mark 12 reentry vehicle. It offers ample volume for a pilot in the rear, along with propellant tanks and even a small payload bay. The surface is covered with thermal protective tile like the space shuttle. Since the Mark 12 reentry vehicle has all the aerodynamic characteristics of a streamlined anvil, the Space Cruiser has stubby delta wings to gain supersonic and hypersonic maneuverability in the upper atmosphere. Around the base of the cone is a ring of small rocket nozzles fed from internal propellant tanks. Though small, the rockets can provide a change in the Space Cruiser's velocity totaling more than 2,500 feet per second—about 1,700 miles per hour. That's more than enough for any kind of orbital maneuvers that are likely to be needed.



A spaceship no larger than the Bell X-1 may bring open-cockpit barnstorming to Earth orbit

A human pilot rides just forward of the rocket motors, in a cockpit providing about the same space as a fighter plane's. There's no pressure cabin, the pilot wears a space suit, and the ship holds enough supplies to support him for 24 hours. The Space Cruiser isn't a sealed gumdrop like the Mercury capsule. Since the cockpit isn't pressurized, the hatch must be closed only when the Space Cruiser is in the atmosphere. Bud Redding explains, "In space the Space Cruiser can be operated as an open-seater similar to a World War I Sopwith Camel. With the pilot's helmet protruding above the airframe, visibility is excellent. No claustrophobia or hallucinations here. The pilot owns space."

Although the Space Cruiser has an autopilot, a human really "flies" the ship, much like the pilot of today's F-16 Fighting Falcon does. He's aided by both an inertial-guidance system and stellar-navigation equipment. Up front in the Cruiser is a video camera, a rendezvous radar antenna, and a laser illumination and ranging system. All these devices are mounted on a single gimbal unit at the base of the nose.

These relatively simple astrogation and piloting aids are fed into a single "glass cockpit"—a TV-screen display like those in the space shuttle and the new Boeing airbuses. With them, the pilot can fly his Space Cruiser anywhere in the Earth-moon system, just as he could fly an airplane here on Earth.

Getting the Space Cruiser up there isn't difficult. Eight could be carried into orbit at once in the space shuttle's payload bay. Or a single Space Cruiser could be launched from a silo atop an MX ICBM booster. It could also be put into orbit with a booster from the top of a 747.

Launched from the shuttle, the Space Cruiser could be attached to the front of the wide-bodied Centaur upper stage now being developed as a shuttle upper stage (to carry heavier payloads into orbit) by the Air Force and NASA. This would provide enough power to put the cruiser into geosynchronous orbit 22,300 miles up; there it could rendezvous

CONTINUED ON PAGE 178

ARTIFICIAL INTELLIGENCE

By Owen Davies

For this I spent almost two thousand dollars? To kill imaginary Martians?" Most home computer users can ray-blast only so many alien invaders before wondering how much good all those expensive electronics can really do them. Fortunately, more and more people are discovering an entire world of answers only a phone call away—the world of on-line (dial-up) databases.

On-line databases are computerized reference books, files of information that can be summoned up at will on a computer screen. Many are adapted from traditional printed reference books, but others offer information not available except by computer.

All it takes to get on-line is a modem (an accessory that lets your computer "talk" over the telephone lines to other systems) and a communications program to operate the modem. For an investment that can be as small as $100, it's like having all the libraries in the world as near as your computer—and more.

The variety of on-line databases is astonishing. Several dozen can be used to check stock- and commodities-market prices; some even supply software that can be used to tally profits and losses and forecast price movements. Many bases offer medical information. More than 100 cover the sciences, from astronomy to zoology. Others hold help-wanted advertising, movie reviews, and diet hints.

There is a host of general-interest databases—files like the National Newspaper Index, an electronic version of *Books in Print*, and even the *Encyclopaedia Britannica*. Special-interest databases abound. COFFEELINE will tell you more than you need to know about the world's most popular addiction. Through a database called HORSE, you can check the pedigree of a promising filly coming up for auction; it holds records of more than 1 million racehorses born since 1925. Soon you should be able to tie in to the Kinsey Institute's ACROBAT database and call up a bibliography of Victorian pornographic humor.

And if professionally operated data services prove too limited, there are several hundred amateur-run bulletin-board systems. In their files, you will find everything from public domain computer programs to the names and interests of would-be sexual partners.

"On-line searching will be an indispensable tool in the future," proclaims Jeffrey K. Pemberton, editor of *Online* magazine, a monthly devoted to databases. "Printed indexes and other traditional information sources just can't match the speed and convenience of computerized data systems."

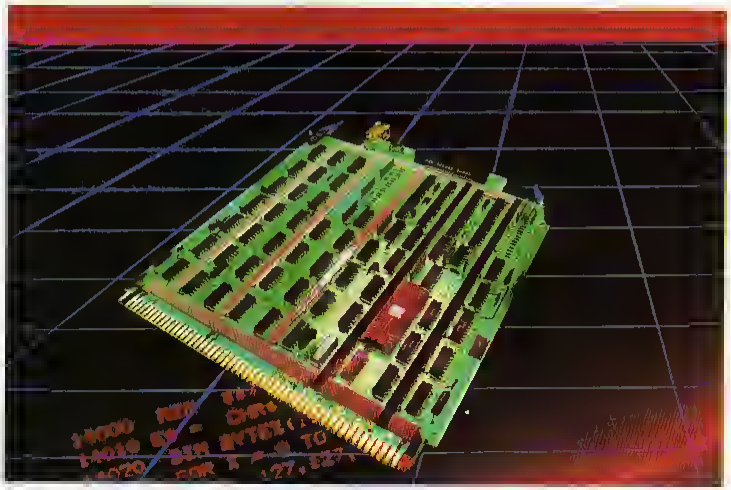
It seems that many people agree with him. About 1,500 databases populate the on-line world—up from barely 1,100 last year and perhaps 900 the year before. The database industry did some $870 million worth of business last year. This year receipts will top $1 billion, according to Jeff Silverstein, an analyst with Knowledge Industry Publications, a White Plains, New York, market-research firm.

In dollar volume, the largest and fastest growing market is for financial data. "Everybody's trying to figure out how to make a buck out of business information," *Online*'s Pemberton comments.

But thanks to the spread of home computers, personal-interest databases more than doubled their market in 1982 and are expected to do so again in 1983. The two largest suppliers of consumer-oriented databases, The Source and CompuServe, report that they expect to double their list of subscribers this year. Oracle, a competitor born only last autumn, reports even quicker growth.

Owing to mounting demand, the line between professional and consumer databases is starting to blur. As Pemberton observes, "Two of the largest database vendors, DIALOG and BRS, were originally geared toward professionals and businesses. But now they've both started after-hours services aimed at consumers. That's clearly the result of the growing home-computer market."

"BRS After Hours" offers 25 of the firm's most popular databases to private subscribers for use during the late-



Silicon chips open a new world of information to anyone with a computer and a few accessories

night hours, when business is at a low ebb. DIALOG's "Knowledge Index" offers similar price reductions for 15 bases.

Among the files available are some with clear personal appeal. AGRICOLA, offering information about food and nutrition as well as general agricultural material. ERIC, specializing in educational resources, and the Magazine Index and the National Newspaper Index, perfect places to locate the article you noticed and then lost last week. Others are clearly professional. INSPEC is one of the largest, most comprehensive engineering databases in the world, MEDLINE holds a similar position in medicine. All of them are available nights and weekends at lower cost.

And the bases themselves are changing to meet the new market among home-computer users. "It's becoming practical for almost anyone to create his own database," Pemberton observes. "Smaller and more specialized databases are appearing. Soon databases will be produced in almost every field."

One good example is Photo-1, a combined information file and communications net for photographers. More than 30 photographers working abroad have filed their résumés and lists of published credits with the service. They periodically report their current location to the New York-based computer system. Photo agencies, newspapers, and magazines with a story to illustrate consult the computer when they need a photographer in a far-off place. If a good one is on location, the photo buyer can save the cost of sending someone overseas.

Publications using the year-old service already include the *Washington Post*, which helped set up Photo-1, *Newsweek*, *Forbes*, and *Geo*. For photographers using the system, it has meant a whole new opportunity to make a living.

In the next two or three years, Pemberton predicts, specialized databases aimed at individual needs will become far more common. He foresees a huge demand for on-line product evaluations of myriad consumer goods, from sports equipment to cameras and household appliances. "Suppose," he suggests, "that the manager of the ski shop at Killington or Vail had set up a database of *Consumer Reports*-style reviews of equipment. It might appear on one of the data services for home subscribers. It would be the first place anyone would check when he wanted to buy a new pair of skis."

Faced with such rapid growth, no one can keep track of all the databases now available or coming on-line. But more than 1,000 of the most interesting are cataloged in the forthcoming *Omni On-line Database Directory*, to be released by *Omni* and Macmillan Publishing Company this month. The work supplies user evaluations of each database, and it describes the base's contents and tells where to obtain the service. The authors, former *Omni* staffers Mike Edelhart and Owen Davies, offer several hints for would-be database users:

- Don't settle for the first database system that comes to mind; search carefully for a vendor whose bases really fit your needs. "In most fields," Edelhart advises, "there are several dozen databases that might interest you. One vendor's search procedure, for instance, may be easier to use than another's. Or vendors may offer the same primary database but a different selection of other bases that may or may not appeal to you. And don't make the mistake of thinking a greater variety of databases is necessarily better. Sometimes one database in your specialty can be more valuable than half a dozen that are not as well tailored to your interests."
- Try to find some partners to share your account with the database vendor, each using a different password to make it easier to figure out how to divide the bill.

> *"Suppose the manager of the shop at Vail set up a base of ski-equipment reviews. It would be the first place anyone would check when he wanted new skis or boots."*

And pay in advance, if at all possible. On-line databases are one of the best values in the computer world, but they are far from cheap. An inexpensive database will cost $15 an hour to use; some top $200 per hour. Agreeing to use a fixed minimum of on-line time each month may bring you a valuable discount.

- Plan your searches carefully before you go to the terminal. What words and concepts provide the most complete and specific picture of the information you need? Many database systems allow you to narrow your search with amazing precision—to look for, say, articles only by a given author that dealt with safety features of foreign cars and appeared in a specific magazine between May and September of 1982. If you don't take advantage of those search facilities, your information hunt will take longer and cost more than it should.

"The most important thing," Edelhart concludes, "is simply to go on-line—to get a modem and find out for yourself how much information is available to you. On-line databases can make the same kind of difference in your life that your first calculator did. It's the difference between struggling to get information and having it, between guessing and knowing. For many of us, access to databases may be the best thing that our computers can give us."

NEW WARES, HARD AND SOFT

Sharp Corporation has come out with a hand-held English/Japanese translator that speaks for itself. The IQ-600 Voice Synthesized Dictionary incorporates advanced voice-recognition and speech-synthesis technology that enables it to listen and vocally respond to user requests. A word can be either typed into the unit's keyboard or spoken into its built-in microphone. The machine will enunciate a spoken translation while a written version simultaneously appears on its liquid-crystal display ($290, from Sharp Corporation, 22-22 Nagaike-cho, Abeno-Ku, Osaka 545, Japan.)

The number-one hits on pop music charts may soon be computer programs. EMI has come out with a 45-rpm record called *Camouflage*. One side is designed for conventional stereos and plays the title song by Chris Sievey. The flip side is a computer program that offers two versions of the video game *Flying Train* and a graphic presentation of the lyrics to Sievey's song. Designed for the low-cost Sinclair ZX81 home computer, the information encoded on the 45 can be played directly into the computer through the headphone jack of a stereo or recorded on tape so that Sinclair owners can enjoy both music and video at the same time. Island Records is following suit by releasing a Pete Shelley/computer-graphics LP compatible with the Spectrum home computer, and Virgin Records is reportedly coming out with its own pop-music software. (About $2, from EMI, 20 Manchester Square, London W1 1ES, England.)

Software pirates make out like bandits, illegally copying more than twice the number of programs that are sold each year. Now new technology may provide some protection. To protect a computer program, the LazerLok system loads a security signal into the computer from a special floppy disk—or a software manufacturer may code it directly onto the commercial program. When the user calls up the protected program, a security check is activated. First, a target, which generates the security signal, appears in the middle of the computer screen. The user touches the decoder to the target to convert the signal into numbers that appear on the decoder's built-in LED display. The user types the code into the keyboard to unlock the program. The system can be used on any micro- or mainframe computer. (About $195, from AMS/RealStar, Suite 100, 6867 Elm Street, McLean, VA 22101.)

COMPUTHERAPY

MIND

By Neil Frude

Once I had a brain and a heart also, having tried them both, I should much rather have a heart." So spoke the Tin Man in L. Frank Baum's *The Wizard of Oz*. In the end this proto-robot did not have to choose. He kept his brains and the silk-and-sawdust heart the Wizard gave him.

Currently there are researchers who are facing something like the Tin Man's dilemma. They are attempting to devise computer programs that will practice the delicate art of dealing with human emotional problems, a computerized version of psychotherapy. There is an obvious problem here. In their dealings with patients, human psychotherapists use both intelligence and empathy. There is no question computers have a formidable intelligence. But would it be possible for them to simulate human concern and empathy convincingly enough to become useful therapists? Some scientists believe so, and they feel that beneath the impersonal exterior of a metal-skinned micro there may someday lurk a sensitive, caring, programmed heart.

Psychologists have come to recognize that the therapeutic benefits of intimacy need not involve a fellow human. Telling even your pet dog about a problem can help. A trouble shared may be a trouble halved, even if it involves only a machine. In a procedure pioneered by two brothers, Harvard psychotherapists Charles and Warner Slack, a person tape-records his unstructured self-talk for an hour or two, plays it back once, and then types significant parts of the "conversation" into a computer terminal. The computer program, modeled closely on the Slacks' own interview style as therapists, is designed to recognize emotionally charged words or phrases and responds by interrupting the self-analysis at appropriate points to ask, "Would you like to talk more about this?" If the reply is "Yes," the client is instructed to continue talking into the tape recorder, which is automatically switched on. The program was written to be especially warm and lifelike. When the person speaks of a sadness, for example, the video monitor displays the message: GOOD. WE ARE LISTENING TO YOU. TALK ABOUT YOUR SADNESS.

In one of the Slacks' studies, patients received half of their therapy from one of the brothers and half from the computer. In comparing the two experiences, several people actually preferred the computer to a human therapist, and most reacted quite favorably to the machine. They spoke to it about their problems with frankness and emotion, and many felt that it had helped them. Two patients who had recently lost someone close to them even confided this fact to the computer — but not to its human counterpart.

Not all computer-based psychotherapy depends solely on the healing power of listening. Just as some human therapists provide direction and suggest realistic solutions to problems, some computer systems are designed to tackle psychotherapy as a problem-solving exercise. They bring their brainpower to bear on human emotional problems, and they present rational solutions. Morton Wagman, a University of Illinois psychologist, has developed a program for dilemma counseling. It is based on the idea that most of the problems people face can be stated in the form of a conflict among two or more different courses of action. The computer elicits such alternatives and then computes several ways in which the problem might be resolved.

Nine out of ten of the students who used this system reported that it helped them, and half said they were more at ease with the computer than they would have been with a person. There was also evidence from a follow-up study that the machine helped reduce the number and severity of the students' problems.

The various programs tend to represent therapists in different ways. In some, they will have active and challenging personas; in others, pensive and quietly sympathetic ones. As well as reflecting different methods and schools of psychotherapy, the computer therapists may be said to imply different philosophies of life. Psychologist Russell Cassel has designed the Computerized Pastoral Counseling System, which has a theoretical basis in the Christian tradition. Patients may eventually be able to choose from a variety of therapeutic approaches, an option that few clinics can provide.

Uses of the computer in psychological therapy are not limited to counseling. Computers are also helping people with such health-related behavior problems as smoking and poor diet habits. A program developed by Dr. Sid J. Schneider, of the Montrose Veterans Administration Hospital in New York, enables a computer to maintain a dialogue through the mail with would-be tobacco quitters. Clients send in a detailed log of the circumstances surrounding each cigarette smoked, and a computer identifies each individual's occasions of special temptation. It then suggests individually tailored help strategies to overcome temptation. Preliminary results suggest that over one third of the participants are helped significantly. The method offers cheap personalized antismoking guidance and holds forth the promise of help for millions of tobacco addicts. A similar

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HEAVY LIGHT

BREAKTHROUGHS

By Jeff Hecht

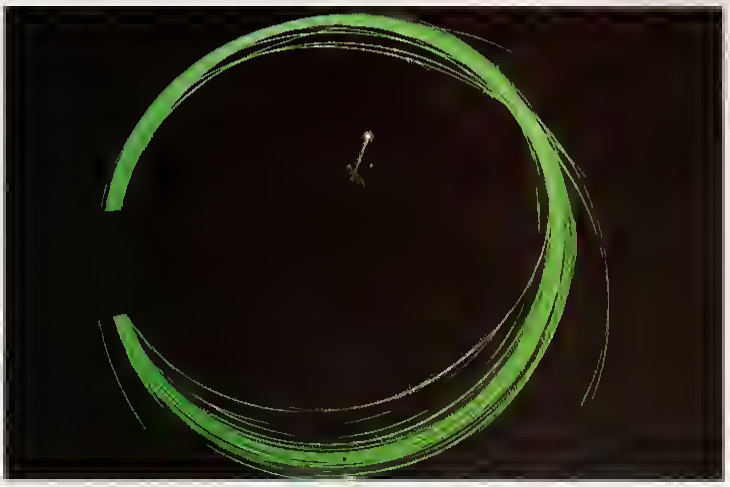
Common sense tells us that a communications cable's capacity should shrink with its diameter In the case of fiberoptics common sense is wrong Today's hair-thin glass fibers can carry more information farther than metal cables thicker fhan a man s arm

A new generation of fiberoptics can do even better The new fibers have already set a record in a Bell Labs experiment, transmitting the equivalent of 6 000 felephone signals for 74 miles through a lighf-carrying core only 0 01 millimeter across withouf signal regenerafors—a capacity far beyond that of any other type of data-bearing cable

It is the tiny core diameter that makes fhe high capacity possible Light can take many different paths along an ordinary fiber as it hits the boundary between the core and the cladding (the surrounding glass) at a glancing angle and bounces back into the core Slight differences in the lengths of these paths cause light pulses to overlap, creating interference thaf limits fhe flow of information In fhe new generation of fibers the core diameter is so small that light can travel in only a single 'mode through the fiber This comparatively straight path eliminates most interference, so single-mode fibers can carry signals farther and faster than others

Optical fibers may soon be adopted for undersea transmission lines Resting under a few miles of ocean water they must be ultrareliable And they re expensive to install so fhey must have high capacity Single-mode fiberoptics win on both counts The component most likely to fail is the signal regenerator One is needed every six miles on a metal-wire cable carrying electronic signals but single-mode optical fibers can go 24 miles between regenerators and the spacing could reach 42 miles says Jack Sipress, director of the Undersea Systems Laboratory at Bell Labs The fiberoptic cable also can carry more calls fhan a metal cable

The new generation of fiberoptics will debut on land because of the long time needed to insfall a submarine cable AT&T s Long Lines division is installing single-mode fiber systems totaling hundreds of miles in length between major cifies MCI Communications plans to run single-mode fibers along more than 4 000 miles of railroad rights-of-way in the eastern United States And Mercury Communications will run single-mode fiber systems alongside British Rail tracks Some observers have begun to wonder whether new-generation fiber systems might do some of the work of communications safellites Single-mode fiber systems could prove less expensive for busy routes shorter than 1 000 miles or so They also offer greater security, because spy satellites can eavesdrop on signals transmitted fo and from orbit Nobody is saying that single-mode fibers will make communications satellites obsolete but they may be able to do some of the same jobs—an important capability as the demand for slots in the geosynchronous orbit shows signs of exceeding the supply



Hair-thin fiberoptics transmit more calls over longer distances than their bulkier predecessors

NEW PRODUCTS

Locating adventurers lost in the wild can be an impossible mission Forfunately electronics has come to the rescue of stranded mountaineers backpackers and other intrepid outdoorsmen The Recco Tracking System includes a short, flat strip fitted with an electronic diode that emits a microwave beam This strip is simply slipped or sewn into clothing or footwear Its signal can be picked up by standard microwave-beam detectors used by search parties The reusable strips are about $7 from Recco AB Box 27122, 102 52, Stockholm, Sweden

Ray Maki was frying fo jump-start his wife s car last fall when the battery blew up in his face Maki did not sustain any serious injury buf he did come up with a new idea—an invention fhat shields automobile batteries The shatterproof Lexan shield is bracketed over the battery to absorb the impact of an explosion should it occur The battery shield currenfly has a patent pending For further information on the shield write PO Box 3111, Tustin, CA 92680

THE ARTS

By Mitch Tuchman

The first three—or was it four?—attempts to coax screenplays out of Stephen King's *The Dead Zone* failed. No author, including Jeffrey Boam, who wrote the first version, and King himself, who wrote the fourth, was able to overcome a central difficulty. Nobody could divine just what the novel was about. It was called *The Dead Zone*, yes, but what was that?

"We did the best we could with the concept given that in the novel the dead zone is not clearly defined," says Boam, after writing the fifth and final draft with director David Cronenberg and producer Debra Hill. "We decided that the dead zone might be that part of the future that Johnny Smith cannot foresee. What he cannot foresee, perhaps he can alter. The dead zone became the arena for free will in a world of predestination."

If not knowing *what* the novel was about was a problem, not knowing *whom* it was about was worse. Johnny Smith, the Norman Rockwell cutout who awakens from a coma with terrifying precognitive visions, was the hero. That much was evident. Frank Dodd, the psychopath, and George Stillson, the demagogue, were the villains. But the novel moves along three parallel tracks, something like *The Bridge at San Luis Rey*. Dodd and Stillson are developed in copious (and irrelevant) detail without crossing Johnny's or each other's path. While it is obvious that they are between the same covers, it is not clear why they are in the same book.

Scenarists, including Boam, had tried to make sense of King's muddled structure. Eventually Boam tossed it aside. He dispensed with a raft of characters—a Vietnamese gardener, a roadhouse operator, one sympathetic and one dubious reporter, a highway crew in Arizona, and an assortment of rape and murder victims—and made more effective use of the ones remaining. The entire structure of the screenplay leads Johnny toward acceptance of his precognitive powers. "I thought these powers were a curse," he muses in the script, "but now I realize they're a gift."

"We are faithful to the tone of the book," Cronenberg states, "more faithful, in fact, than Stephen King's screenplay was. If you had made a movie of Stephen's screenplay [which retained the triple-track structure but added several characters], you probably would have had his fans hollering that we weren't faithful to the book."

Being faithful does not mean that Cronenberg is simply making the movie King might have made had he been a film director, though Cronenberg admits there are ways in which his previous works—he wrote and directed *They Came from Within*, *Rabid*, *The Brood*, *Scanners*, and *Videodrome*—resemble King's. Foremost among the similarities is a fascination with the dark side of the human psyche. "Stephen has a very firm grasp on human darkness and physical death, things dear to my heart. It is looking into the abyss that makes people crazy, and a huge part of the abyss is the anticipation of physical death."

"Both of us use characters who are embedded in a familiar social setting—characters who initially feel secure in their settings. Then some quirk of fate, usually a physical one—in *The Dead Zone* it's a car crash, in *Scanners* it was drugs, in *Videodrome* it was the videodrome experience—leaves the protagonist, by virtue of heightened sensitivity, an outsider. For me this is the situation of the artist: being both inside and outside society at the same time. For King this leads to a choice between a short, spectacular life or a long, dull one."

It is this heightened sensitivity that brings both King's and Cronenberg's characters to their awareness of death, looking down to the edge of the abyss. "In *The Dead Zone*," Cronenberg notes, "this gift that Johnny wakes up with brings him closer to death through his perceptive powers and through enervation."

Thematic similarities notwithstanding, Cronenberg is quick to tote up an equal number of dissimilarities between his predilections and King's. Cronenberg's characters, for instance, are stranger right off the top. King's characters tend to be very, very normal. Even in his short stories, his characters start off normal. As

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Cronenberg, director of The Dead Zone. *"I'd never name my lead character Johnny Smith."*

THE ARTS

By Dava Sobel

The idea seemed so simple and so essential that when Omni Press began preparing a catalog of databases for computer users the editors could hardly believe such a book didn't already exist. But the fact is that millions of home-computer owners ignorant of the reference resources available, were floundering about like a city full of people with telephones and no telephone directories.

That situation is happily remedied now thanks to the *Omni On-line Database Directory*, edited by Mike Edelhart and Owen Davies. It is a popularly written guide to the nearly 1,200 currently accessible resources for every conceivable reference need, from expert advice on wine selection and thoroughbred racing to statistical profiles of economic conditions anywhere in the world. As the first listing of its kind aimed at the growing number of personal-computer users, the text provides evaluations of competing resources and helpful comments from database customers as well as shopping lists of equipment needed to use the services—even telephone numbers to call.

Published in November by Macmillan, the directory sells for $10.95 in paperback and $19.95 in hard cover.

The database guide is just one in a series of new Omni books—a publishing venture that began last year with the book-length publication of *Omni's Continuum*. Here is a preview of Omni Press's major offerings scheduled for release over the coming months.

The Omni Future Almanac, which first appeared in hard cover, has just been released in paperback by The World Almanac Company. Unlike other compendiums of useful and interesting facts, the *Future Almanac* hardly needs annual updating. Indeed, its entries, covering everything from predicted medical triumphs to coming technological flops, promise to remain timely through most of the next two decades. *Library Journal* recently cited the *Future Almanac* as one of the distinguished science and technology books of 1982. The new paperback edition sells for $8.95.

Omni Press presents speculation and information on the future of technology and humanity

Famed novelists Arthur C. Clarke, Ray Bradbury, and James Michener as well as future-oriented scientists like Gerard K. O'Neill and Marvin Minsky all express their views in two *nonfiction* anthologies appearing this fall. *The Omni Book of Space* and *The Omni Book of Computers and Robots*. Each volume pulls together the best analyses, projections, profiles and clear explanations of these subjects from the pages of *Omni* magazine. Both are published by Zebra Books and sell for $3.95 each.

And since science fiction has always been half of *Omni*'s glory, Zebra Books will also publish the first two paperback volumes in a set of four short-story anthologies. Isaac Asimov, Harlan Ellison, Damon Knight, and Spider Robinson will all be there, of course, and each book will also contain one original story never printed before. The two books, edited by *Omni* fiction editor Ellen Datlow, will appear in January and cost $3.95 each.

Omni readers addicted to the puzzles, quizzes, and conundrums Scot Morris concocts each month in the magazine can look forward to a whole bookful of them next February. Many new items have been added to each section of *Omni Games*, and answers have been explained in greater depth than was possible in the magazine. Holt, Rinehart and Winston will publish *Omni Games* in a large-format, heavily illustrated paperback that will sell for $11.95.

When it appears next spring, *Trailblazers: The Omni Interviews* (Ticknor & Fields) will constitute the first oral history of twentieth-century science. It is a compilation of the 25 most interesting interviews *Omni* has conducted with internationally famed scientists over the past five years, and is edited and updated by *Omni* associate editor Pamela Weintraub. The scientists speak, often heatedly, on the issues that consume them—the origins of life on earth, the course of evolution, the roots of consciousness, the rationale of human behavior, the fate of earth's resources, the promise of technology, and the endpoints of space and time.

THE ARTS

By John White

What is reality? One eye reveals a two-dimensional world of length and breadth. A second eye is necessary for binocular perception of depth, the third dimension. Another eye—the mind's conceptual power—reveals even more dimensions, as in non-Euclidean geometry and Einsteinian space-time. Is it possible for those higher dimensions to be modeled or displayed in ways that allow them to be visually, tangibly perceived?

That was the concern of artist-mathematician David Brisson, who was associate professor of design at Rhode Island School of Design, in Providence, until his untimely death in 1982, at fifty-one. "I am trying," he told me shortly before suffering the heart attack that ended his life, "to extend the perceptual mechanisms people have and use in understanding reality. My models involve an interaction of the viewer or the thinker with the models themselves."

Brisson's special area of interest was perceptual/mathematical models. These models ranged from large public sculptures and stereo slide projections to a radical new mathematical treatment of real and imaginary numbers that, as he put it, "redefines the nature of relativistic physics, eliminating most of the very strange properties that the special theory of relativity and the general theory of relativity imply. It makes these things much more commonsensical. But most of the constants that exist in relativistic and quantum mechanics, such as the speed of light and Planck's constant," he said, "seem to be questionable on the basis of this modulus."

Brisson exhibited his work internationally and lectured on it in many universities throughout the United States, Canada, and Great Britain. He edited a book called *Hypergraphics: Visualizing Complex Relationships in Art, Science and Technology* for the American Association for the Advancement of Science (AAAS). And throughout his life he published privately several original works, including *Curved 4-Space: A New Reality, A Theory of Dimensionality*, and *Hyper-Horoptoral Space: An Introduction to the Perception of Four Dimensions*.

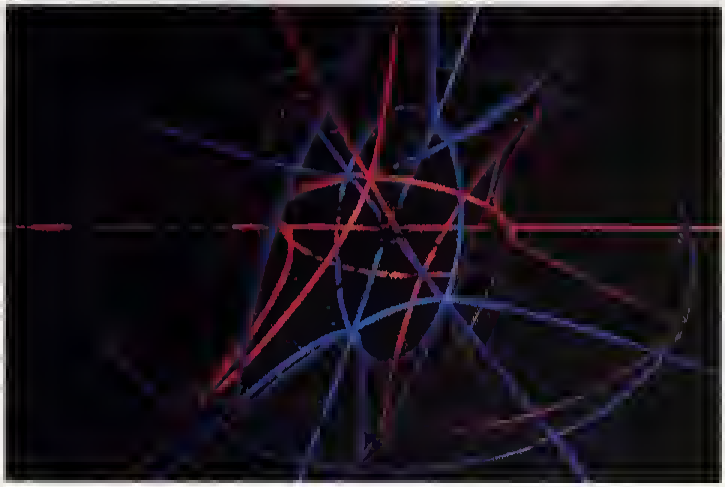
The term *hypergraphics* was coined by Brisson. He defined it in his AAAS book as "a new field comprising computer graphics, perceptual psychology, and modern geometry [that] endeavors to develop new aids to understanding and communicating complex, multidimensional relationships."

Both Aristotle and Ptolemy had argued that space could have only three dimensions, and this became "truth" until the nineteenth-century mathematical revolution led by Georg Riemann, Nikolay Lobachevsky, and Carl Friedrich Gauss refuted Euclid by producing non-Euclidean and higher-dimensional geometries. The fourth dimension of space became legitimate. Theoretically speaking, it is perpendicular to the other three. That, however, is a difficult situation even to *conceive*, let alone *perceive*. The fourth dimension might be real, but it is "hidden" from the others. Could it be seen like the other three?

In his classic essay "On the Origin and Significance of Geometrical Axioms," Hermann von Helmholtz declared, "We find ourselves by reason of our bodily organization quite unable to represent a fourth dimension."

Early this century C. Howard Hinton commented in *The Fourth Dimension*, "All attempts to visualize a fourth dimension are futile. It must be connected with a time experience in three-dimensional space." Likewise, P. D. Ouspensky stated in *A New Model of the Universe*, "The fourth dimension is unknowable."

Brisson obviously did not accept such dicta. He followed the work of Hinton, Ouspensky, Edwin A. Abbott, and especially Henry Manning Parker, whose *Geometry of Four Dimensions* influenced him greatly—followed them and went beyond. In the introduction to his short *Curved 4-Space*, he tacitly replied to Helmholtz, Hinton, and Ouspensky: "The principal difficulty in visualizing the general theory of relativity," he wrote as a kind of philosophical polemic, "concerns the visualization of 'curved' four-dimensional space. This booklet demonstrates



Curved 4-Space *demonstrates a method for visualizing "curved" non-Euclidean hyperspace.*

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THE HIBERNATION BLUES

THE BODY

By Judith Hooper

I should have been a bear,' Patient X told her doctors. "Bears are allowed to hibernate, but humans aren't.' Every October she recounted, there were presentiments of doom; by January her inner life was a vast, frozen tundra. Nothing gave her pleasure; she gorged without satisfaction on sweets and starches and, though sleeping overtime, awoke exhausted. Unable to concentrate on the simplest task, she often took sick leave from work and withdrew further into a private Siberia. She usually lost her current boyfriend, too, around this time of year. Then, when the days lengthened in early spring, her mood soared, and winter seemed a dim, bad dream.

For ten years, with clockwork regularity she had fluctuated between midwinter despair and near-manic summer euphoria. And there wasn't even a name for her problem. Then Thomas Wehr and Norman Rosenthal, of the National Institute of Mental Health (NIMH), in Bethesda, Maryland, got on the case. Noticing a puzzling group of "atypical depressives," whose moods oscillated annually, they gave the syndrome a name and an apt acronym: Seasonal Affective Disorder, or SAD. Winter depressives, they soon determined, are a breed apart—distinct both from unafflicted individuals (whose occasional January doldrums aren't incapacitating) and from "ordinary" depressives and manic-depressives (who don't have annual summer remissions). And the researchers proceeded to find a cure—in the form of a box of light.

In the winter of 1981–82, Wehr and Rosenthal recruited a group of hard-core SAD victims, mostly women in their early to mid-thirties who had suffered through nine or ten winters of discontent, and tried prolonging their daytime artificially. Just before dawn and after dusk every day, the subjects sat in front of a screen that mimicked sunlight with bright, full-spectrum fluorescent lamps. After two or three days their midwinter funks evaporated like magic, only to return as soon as they went off the light therapy. Some continued the regimen all winter long and kept depression at bay. How could such a simple fairy-tale antidote work?

For seasonal depressives, the short days of winter can result in a dark night of the soul

For a clue, consult the animals. "In most species," explains Rosenthal, "the seasonal rhythms governing such things as mating, food intake, hibernation, and migration are cued mainly by the light/dark cycle, which is relatively invariant from year to year."

Animals' biological cycles are orchestrated to produce young in the spring or early summer, when the weather is mild and food plentiful. Likewise, SAD people are twice as likely to have babies in May or June as in August or September; the NIMH team's survey of 219 SAD offspring showed. A little simple counting on fingers places peak *conception* time in August or September, when their libidos, like everything else, are in high gear.

The key appears to be an obscure hormone called melatonin. Secreted by the pineal gland in the brain, it has no known function in man but helps regulate seasonal behavior in animals. Light prompts the pineal gland to suppress melatonin; conversely, the chemical's secretion peaks during the long nights of winter. Injections of melatonin can bring on winter behavior in animals, overriding the effects of light.

Daylight and superbright artificial light inhibit melatonin secretion. Wehr and Rosenthal found ordinary room light does not. It came as no surprise, then, that the controls in the NIMH light experiment, whose placebo was a dimmish yellow light, didn't surface from their depressions.

"Obviously, SAD patients don't actually hibernate, migrate, or go through the extreme temperature changes that many animals do," says Rosenthal. "But certain similarities are striking. They overeat, oversleep, change their food preferences, and gain weight."

Nobody knows how common SAD is. "We have received thousands of letters," notes Rosenthal, "so it isn't a rarity." If you think you have a case, you could imitate the birds and fly south, since the NIMH patients found relief in January trips to the Caribbean and suffered briefer depressions in North Africa. But don't go too far south. In Chile one SAD victim fell into June-to-November funks. ◻◻

RAPTOROUS WATCH

EXPLORATIONS

By Odean Cusack

On a cold November morning, I huddled with a handful of other spectators atop North Lookout, a 1,510-foot-high sandstone promontory that juts like a granite jaw from the face of Hawk Mountain, in Pennsylvania. We were the end-of-the-season diehards, and sightings that day were few: only some chunky rad-tailed hawks, a relatively common species that frequents the mountain en massa during October. "An eagle at five o'clock!" shouted an astute, red-capped observer, and in the far distance I glimpsed the immense, flat wings and steady flight that are the hallmarks of this soaring predator. As the silhouette neared we saw the rich-brown plumage of the golden eagle, the bird that had once been the consort of kings. Exhilarated, we watched till the form became a brief line in the southern sky. The northwest winds, chilling as they were, had again delivered the long-awaited eagle. "Any day that you see an eagle," confirmed a veteran hawk watcher, "is a good day."

Prior to the establishment of Hawk Mountain Sanctuary in 1934, ornithologists believed that the golden eagle had vanished from the East Coast. But each year since, 30 to 40 of these rare and regal raptors have appeared in the skies overlooking the 2,000-acre refuge, the oldest such haven in the world for migrating birds of prey. A part of the Kittatinny or Blue Mountains of the Appalachian mountain system, the sanctuary is a natural boundary between the mountainous country to the north and the Great Valley to the south. As such, its peak, North Lookout, has become the premier vantage point for hawk watching in North America. It is open to visitors year-round, but the prime months are late August through early December. Then some 40,000 seasonal visitors flock to the crowded mountaintop to observe the autumnal pilgrimage of 14 different species of hawks, falcons, and eagles. The trek to the top is invigorating but not too arduous. The adventurous with a zest for mountain climbing may choose an alternate path, but most novice hawk watchers, particularly those laden with photographic equipment, will find the scenic trail challenge enough.

Bird migration is a widely studied but as yet not fully understood phenomenon. An internal biological clock triggered by the decrease in natural sunlight signals the birds to abandon their ancestral nesting and hunting grounds in the north and begin their migration south. Raptors ride the winds much as gliders do, utilizing the air currents to conserve their muscle and energy reserves for the lengthy journey. They are guided by the topography of the terrain and use the Atlantic Coast, the major eastern river systems, and the Appalachian Mountains as navigational aids. As forecasters, the avians put the most astute meteorologist to shame. Through natural selection they have evolved a sensitivity to various weather-indicator variables and can detect climatic changes as far as 200 miles away and up to 12 hours in advance.

Of course, their navigational prowess accounts for only part of their evolutionary success. Like their terrestrial counterpart, the wolf, raptors are the supreme hunters of their domain. Vision eight times keener than our own enables the predator to spot its prey up to two miles away. Formidable, clawed talons, powerful enough in some species to lift the bird's weight, snatch the unwary quarry from its ground or watery habitat to a swift, airy death, and a razor-sharp, hooked beak rends the flesh of the victim.

Diet varies widely among the individual birds. The turkey vultura, an oddity whose minuscule head and tipsy flight distinguish it at a distance from the similarly sized eagle, eats only carrion. The ruby-eyed osprey is a seafarer who may submerge its entire body under water to catch a favorite fish. Our hoary-headed national symbol, the bald eagle, also takes its meals from the sea, rapidly skimming along the surface like a speedboat and plucking hapless creatures from the waves. Its slightly larger relative, the golden eagle, with a wingspan of almost eight feet, has less selective tastes and will eat whatever food is available: rodents, hare, snakes, even a sheep.

Protected by federal law, the golden eagle can still be seen migrating through parts of Appalachia

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FUTURESCOPE

Its listening devices pick up whispered conversations through the walls of a building while its electronic periscope peers down manholes 1 000 feet below An onboard computer is linked with intelligence banks thousands of miles away And the craft s pilots control cannons just by *looking* through their helmets at the quadrants of a fiberoptic grid This powerful helicopter, featured in the film *Blue Thunder* is mere fiction But Hollywood's high-tech vision of the future reflects the general direction law-enforcement technology is taking today

Though new police technology may never include the gun-toting copter designed for the movie set the Los Angeles Police Department (LAPD) recently sponsored a network of futurists city planners, police officials and citizens to consider the social and technological forces that will shape crime fighting in the years to come Known as Forum 2000 the group of 25 was founded in early 1983, by futurist Clyde Cronkhite a deputy chief in charge of research and long-range planning for the department One of the group's most pressing goals studying new technology to aid officials in the prevention of crime

Much of that technology, according to Cronkhite, is already here For example, the LAPD's new bomb robot, originally purchased for the 1984 Olympics can smash through locked doors shoot a gun, and detonate bombs while human controllers watch from a distance To catch criminals without really wounding them, officers have been using the taser, a nonlethal gun that fires two darts, each attached to wires extending from the weapon's nozzle When implanted in a suspect s skin, the dart emits a low-amp high-voltage charge that produces temporary paralysis

Such impressive new technology is only the beginning Almost ready for deployment, says Cronkhite, is the LAPD's $40 million communications system—referred to simply as the X system Located four floors below a downtown office building, behind five-foot thick, bombproof walls X should be fully operational by early 1984 It will give officers instant access to six databases, allowing them to check out-of-state license plates identify stolen trucks cars and boats and recognize suspects at large Because the computer will know where patrol cars are at all times, it will tell dispatchers which cars to send on emergency calls The X system also includes a 911 emergency number that flashes the caller s phone number and address on the dispatcher s screen, discouraging prank calls and false alarms And the system, designed by System Development Corporation, a subsidiary of the Burroughs Corporation also allows officers to communicate with the command post by means of hand-held radios, users can maintain contact with headquarters even if they re trapped in a basement far below ground

For agencies with big bucks, more sophisticated systems have arrived The Federal Bureau of Investigation, the Royal Canadian Mounted Police and the Brazilian national police have begun using automated fingerprint-identification systems In the past clerks had a chance of identifying suspects from fingerprints only if they pored over thousands of files by hand Now high-speed computers can accurately sort through nearly 1 million files in less than an hour Most local police departments will convert to such systems by 1990 And the DeLarue Printrak Corporation a British-based company, is developing a system that will transmit fingerprints electronically from patrol cars

As for the future Forum 2000 foresees all sorts of new hardware Among them portable, pocket-size digital terminals that will give cops access to remote databases, specially designed cars that will allow officers in high-speed pursuit to electronically "kill ' the engine of the suspect s car, ultralight aircraft, improved lie detectors, and electronic implants to monitor parolees Other groups envision guns that film a shooting as it's taking place (see Smile for the Gun ' next page)

Even with massive infusions of new technology, though many Forum 2000 participants doubt that the crime rate will drop unless people begin to trust and cooperate with the police Forum member Selwyn Enzer believes that much of the public's current alienation has been caused by the police themselves He claims they have refused to reexamine their "macho, militaristic. Wyatt Earp" image the stuff of thousands of Hollywood cop shows and movies But Clyde Cronkhite says that with the help of technology the old persona is already changing He espouses his own version of the high-tech/humanistic ethic "I think technology will rid the future officer of much routine paperwork and many time-consuming manual duties it will give him more opportunities to be a human being,' he says "Officers will become more involved in decision making and in creating a safe community "—*ROBERT B TUCKER*

CONTINUUM

SOCIAL DINOSAURS

The dinosaurs most scientists say, were primitive reptilian loners shambling from food site to food site—dim-witted giants with only a vague awareness of their surroundings Now, however, evidence indicates that some dinosaurs may have been social warm-blooded animals traveling together in family groups

The new theory comes from geologist Martin Lockley of the University of Colorado at Denver who recently mapped 900 dinosaur footprints in his state's remote southeastern region The prints run parallel to one another says Lockley suggesting that they were made by a community of dinosaurs moving together in the same general direction

The site studied he adds was near a lake that disappeared millions of years ago and the prints were preserved in the mud near the banks It is a rich area for skeletal remains and the footprint patterns are an excellent indicator of dinosaur habits

According to Lockley other evidence also indicates that dinosaurs had a social existence Recently found dinosaur fossils look more mammalian than reptilian he says 'And some of the bipedal dinosaurs even appear to have been designed for speed with the ability to run perhaps thirty to forty miles per hour this is not the way currently known reptiles are designed Further evidence of social behavior comes from the discovery of dinosaur nest sites that appear to have served 'families year after year

Until recently footprint studies have not been considered very good evidence of dinosaur behavior But the latest investigations have been given more credence, helping to shake up traditional theories of dinosaur life —Rick Boling

Instead of cold blooded loners dinosaurs may have been party animals that traveled in groups and dwelled in familial nests

Until the day of his death no man can be sure of his courage

—Jean Anouilh

SMILE FOR THE GUN

A gun that takes a picture every time it fires a bullet could end the controversy that results whenever someone is shot by a policeman

The inventors Rudy Ortega and Mike Askew of Jacksonville Florida say their gun will document the exact moment a police officer shoots 'If the man who was shot was armed the picture will show that Ortega says And if the man was unarmed it will show that too

The new system consists of a camera mounted inside the butt of the gun a fiber optic lens extending from the camera to the top of the barrel, and a computerized switch A pull on the trigger activates the switch and the camera takes a picture 0 25 second before the gun actually fires Since the camera shoots before the gun says Ortega there is no danger that the picture will be spoiled by smoke vibration or kickback The camera is locked inside the butt by a key kept at police headquarters he adds preventing tampering

Ortega, whose son is a cop in Texas got the idea for the gun following Miami riots touched off by a police shooting An insurance man, he worried about his son being involved in a similar incident and figured there had to be a way to determine exactly what happened in such situations He took his idea up with Askew a private investigator and former Scotland Yard detective and the camera gun was the result

Ortega hopes his invention will be adopted by all police departments and even envisions the day when it is required for all handguns He and Askew hope to market the gun themselves

—Robert Deckert

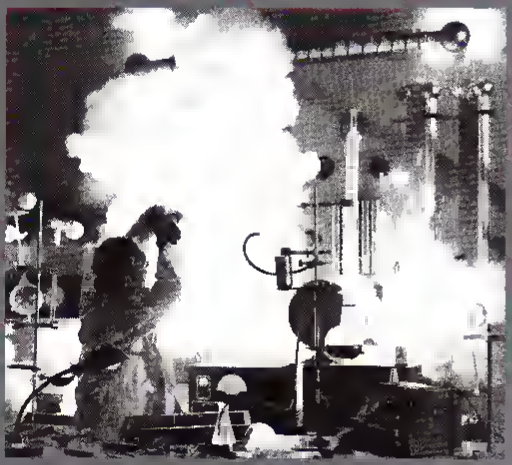
What you see but can't see over is as good as infinite '

—Thomas Carlyle

Man cannot discover new oceans unless he has courage to lose sight of the shore

—Andre Gide

Terminal snapshot At last, a gun to dispel any doubts.



It will be harder to blow up the lab in a chemistry lab with microcomputers doing all the pouring, measuring and heating

COMPUTER CHEMISTRY

No more exploding test tubes, broken beakers or bunsen-burner infernos. In the future all the dirty work in Chem 101 will be done by computers.

If Joe Oravec has his way that is. Oravec, a laboratory supervisor at Wayne State University in Michigan figures no one has ever burned or cut himself on software. So he's introduced microcomputer programs that allow his college freshmen to mix computer-simulated acids and alkali in video display glassware. The software can even make corrosive chemicals drip into computer graphic beakers, altering conditions with a few handy keyboard commands.

Besides eliminating messy and chemical waste, Oravec points out, the new age chemistry class teaches computer literacy. That's a must now that computers do everything from predicting electron clouds around molecules to scanning scientific journals.

"In our research labs we have many sophisticated analytical machines connected to microcomputers," he notes. "And these small computers communicate with a large central computer. We have, in essence, a laboratory computer network." —Gerard Joswiak

I have a spiritual suitcase and I know where I'm going.

—Ethel Waters

He that's born to be hanged needn't fear water.

—Irish proverb

STARFISH JAWS

If a Canadian biologist's brainstorm pans out, starfish skeletons will soon be found in human jawbones.

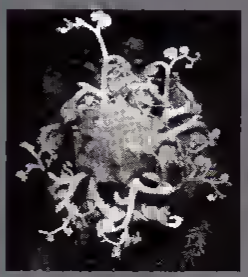
Rebuilding the jaws of accident victims or cancer patients is a difficult process that requires either a bone graft from the patient's own body or from a donor. The trouble with bone grafts is that a severely ill patient needs his bones right where they are. Bone transplants from donors, on the other hand, are often rejected by the recipient's immune system.

But the tiny, inorganic particles (called ossicles) that compose the skeletons of starfish, sea urchins and other echinoderms are biologically inert, so they don't trigger immunological rejection. That's one reason biologist Arthur Fontaine of the University of Victoria thought of using them as a temporary scaffold for jawbone regeneration.

Another good reason is that the pure calcium carbonate or limestone material is full of minute holes that form a continuous network of channels. It looks very solid, notes Fontaine, but put it under an electron microscope and you've got Swiss cheese. Thus, a starfish-skeleton jaw would have the mechanical strength of solid limestone but half its weight. And the 20-micrometer pores are just the right size for fibroblasts, the cells that start the bone repair process. Once new bone grows in its place, the limestone scaffolding automatically dissolves.

Before long, Fontaine hopes, starfish skeletons will be used to repair tooth sockets damaged by disease or injury. Eventually it could give new, lifelike jaws to cancer patients who need massive reconstruction after surgery.

—Timothy Perrin



Starfish: A new reason for head-to-head combat

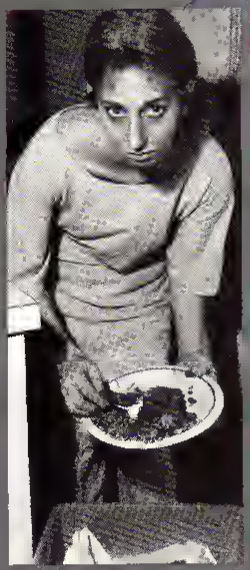
Up to the twentieth century, reality was everything humans could touch, smell, see and hear. Since the initial publication of the chart of the electromagnetic spectrum, humans have learned that what they can touch, smell, see and hear is less than one millionth of reality. Ninety-nine percent of all that is going to affect our tomorrows is being developed by humans using instruments and working in ranges of reality that are nonhumanly sensible.

—R. Buckminster Fuller

I willed my body to science and now science is contesting the will.

—Rodney Dangerfield

CONTINUUM



The "wasting disease" may not be purely psychological

ANOREXIA HORMONE

It starts as a desire for slimness, and ends, all too often, in willed starvation The tenacity of anorexia nervosa continues to baffle psychiatrists but now one scientist has turned up an intriguing biological marker of the illness

Philip Gold and his co workers at the National Institute of Mental Health found that anorexics produce abnormal randomly oscillating levels of the antidiuretic hormone vasopressin This could explain why anorexics urinate too much and why they re unable to hold fluids in their kidneys even when dehydrated It may account for some of their psychological peculiarities too

Gold s study persuades him that anorexics suffer from a defect in the brain's hypothalamus an organ that regulates eating and drinking behavior and that signals the pituitary to secrete vasopressin Interestingly the hypothalamus is known to get chemical messages from the limbic system the brains emotional control center So anorexics mental and biochemical symptoms are probably intertwined

As for vasopressin, it influences more than urination The neurohormone has documented memory-enhancing effects in animals and man Could excessive levels of vasopressin which Gold s patients had in their spinal fluid have something to do with anorexics indelibly coded obsessions with weight?

That's only speculation now, says Gold "But as a clinician I've been struck by the anorexic s fanatical conviction that she is fat It makes one wonder about the contributions of biology "—Judith Hooper

'A believer, a mind whose faith is consciousness, is never disturbed because other persons do not yet see the fact which he sees'
—Ralph Waldo Emerson

What will be will be well for what is is well
—Walt Whitman

"My patience is exhausted
—Adolf Hitler

NUCLEAR-REACTOR SABOTAGE

At a nuclear power plant a crucial emergency cooling system is surreptitiously switched off by a disgruntled employee At another nuclear plant a worker disables a generator intended to provide vital electrical power in emergency situations

These are 2 of 13 such acts—all perpetrated by nuclear workers—reported by America's nuclear-power plants since 1980 Concludes an internal memorandum of the Nuclear Regulatory Commission (NRC) The major threat of sabotage to a nuclear plant is associated with the insider But nuclear reactors which are protected by armed guards, electronic intruder-detection systems, and computerized door locks are all designed to repel terrorist attacks from outside the plant

"Ironically, ever since security systems were developed to thwart attacks from outsiders instead of insiders overall nuclear-plant safety has been hurt says U S Representative Edward J Markey chairman of a congressional subcommittee currently investigating the insider threat to nuclear reactors

To step up internal security at reactors the NRC recently proposed tougher employee screening and a revamping of security procedures But even with these new measures NRC security chief Robert Burnett admits, 'Nobody is going to tell you the risk is zero'
—Eric Mishara

'Destiny is simply the relentless logic of each day we live'
—Jean Giraudoux

Nucle... outside terrorists, but the ... th employee badges

DEMISE OF THE RICKSHAW

Invented 100 years ago by Western missionaries in Japan, it came to symbolize Oriental mystery as well as man's inhumanity to man Now, it appears the human-pulled rickshaw is slated for extinction

Hundreds of thousands of times a day someone hails one of Calcutta's 36,000 rickshaws, which still serve as taxis in that city years after their elimination from the rest of the earth But now the state of West Bengal is reportedly planning to replace all of the city's rickshaws with three-wheeled motorized scootars

Last year officials started enforcing a Colonial Era law limiting rickshaw licenses They seized and burned 18 000 of the handmade wooden vehicles. Then, too, faster, energy-efficient bicycle rickshaws have spread throughout Asia and they may be the real reason for the human-pulled cart's imminent demise

No doubt the Indian government is shamed by the image of thin, ragged men pulling as much as 500 pounds of goods and passengers through monsoon floods and other climatic extremes Yet, according to such experts as Joy Sen, of UNNAYAN, an activist association of Calcutta architects and urban planners, rickshaw abolition will only put the city's 100 000 pullers out of work and onto the streets —Ban Barber

The human-drawn rickshaw It pricks the Asian conscience

"If nobody said anything unless he knew what he was talking about, a ghastly hush would descend upon the earth"

—Sir Alan Herbert

ACCIDENTAL RAINMAKERS

Arthur Ragno and Peter Hobbs were flying through clouds near Seattle-Tacoma International Airport one day when they noticed patches of uniformly sized ice crystals 'It was a uniformity we usually see only with dry-ice seeding ' recalls Ragno a University of Washington meteorologist 'But those clouds hadn't been seeded '

Checking their records the scientists found the crystal concentrations occurred only where their plane had recrossed its own path So they deliberately looped back on their course 20 times and each time—presto—there were ice particles Their conclusion To make rain you may simply need to fly an airplane through clouds

Nobody knows why the mere presence of an airplane creates crystals but Hobbs who directs the University of Washington's cloud- and aerosol-research group has an educated hunch When a plane passes through clouds containing supercooled water droplets, the droplets probably hit the craft and freeze onto it Then they splinter off in a trail behind the plane to become catalysts for the rainmaking process

Rainmaking requires neither occult powers nor dr[illegible] For instant showers, simply fly a plane through some clouds

And this bit of meteorologic serendipity could have a military payoff Monitoring airborne planes for evidence of inadvertent crystal formation the scientists spotted visible lines and holes through clouds Hobbs believes this sort of ice trail could be detected on radar If so, enemy stealth aircraft, with no metallic parts to alert a radar beam would nonetheless leave a telltale signature through certain types of clouds —Joel Schwarz

"The trouble with today's individuals is that they're getting hardar and harder to tell apart"

—Carl Antczak

CONTINUUM

VD, YOU SAY?

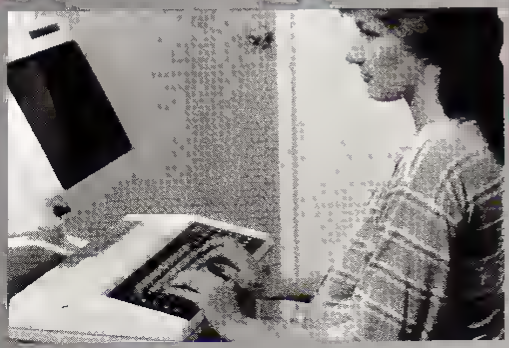
Her name is MAVIS and she gets you to discuss the details of ticklish medical subjects you'd rather not mention at all. Pleasant and efficient though fully automated, MAVIS (for Midland Automated Video Interviewing System) promises to be a big help to doctors and modest patients alike.

MAVIS consists of a videotape recorder, an ordinary television screen, and a small panel of buttons with which the interviewees answer questions. Researchers at England's Midland Center for Neurosurgery and Neurology, where the multilingual MAVIS prototype is being developed, hope to have the first working model installed within the next six months and to make the system generally available in about a year's time.

One use, says bioengineer Clive Thursfield, who is head of the project, will be to conduct pre- and postnatal interviews with women from some of our Asian communities, whose culture and religion make it impossible to discuss aspects of childbearing with a white doctor.'

The actress who poses the on-screen questions in the prototype model Thursfield adds just happens to be named Mavis. But there will be a different interviewer for each specific patient population.

It's versatile and it saves embarrassment,' Thursfield concludes. 'And it's personal in a sort of impersonal way. —Dava Sobel



Many women would rather confide intimate gynecological matters to a friendly, inquisitive machine than to a white coated human

THE ADVANTAGE OF BEING EATEN

Waste no more sympathy on the male praying mantis. It's sometimes an advantage to be devoured by one's sexual partner—or at least that's the theory of three researchers who have recently studied the thirty-odd species that practice sexual cannibalism.

Praying mantis. Being eaten makes evolutionary sense for some male insects, but the vast majority benefit from staying alive

For nonhuman animals there's a sole criterion of genetic success: healthy offspring to perpetuate one's genes. And by being eaten, say the researchers, the male gives up his life so his body can fortify his mate and the gestating progeny to come. Furthermore, if the male of the species seldom mates, it may behoove him to make this ultimate genetic investment in his partner.

The scientists—Ruth E. Buskirk and Cliff Frohlich, of the University of Texas at Austin Institute for Geophysics, and Cornell University entomologist Kenneth G. Ross—have turned up three species in which being eaten presumably works to the male's advantage: the black widow spider, the praying mantis, and the desert scorpion.

Male mantises and desert scorpions mate only a few times in life and fit the Buskirk-Frohlich-Ross model precisely. And while the male black widow, 50 times smaller than the female, doesn't make much of a meal, part of his copulatory organ breaks off during intercourse, so he might as well sacrifice himself.

But these insects are the exceptions. "In most species," notes Buskirk, a behavioral ecologist, "it's an advantage to avoid being eaten. —Barbara Ford

PITUITARY LOVE

Everybody has the ability to fall in love, right?

Not exactly. According to psychologist John Money of Johns Hopkins University School of Medicine, people who have had surgery for a pituitary tumor during childhood or their early teens may never be smitten. "These people can show affection," Money says, "but most of them will never experience pair bonding, the phenomenon most of us call falling in love."

Contrary to the belief of poets, says Money, that mad, romantic, euphoric feeling of love is not a phenomenon of the heart. Instead, it is rooted in neural pathways and hormones emanating from the pituitary gland. "The pituitary regulates an incredible number of different hormones," Money explains, "and when the organ is damaged, hormones and nerve pathways controlling pair-bonding are cut off."

According to estimates, about 5,500 people have ever had pituitary-tumor surgery as children. And Money notes that most of these individuals also have trouble attaining a normal sex drive. "Though they date and even marry," Money says, "these people are usually viewed as thoroughly Christian type characters by their spouses. Their marriages are typically based on companionship, not sex or love."

The neural pathways that regulate pair-bonding have not yet been identified, nor have the hormones and neurotransmitter substances that activate them. "Falling in love and pair bonding are still not serious topics of scientific investigation," Money says. "The present findings suggest that they should be."

—Marc McCutcheon

Be still, my pituitary. Without the proper brain circuitry and hormones, Romeo and Juliet would be incapable of pair bonding.

FIRE SNORKEL

Fires in high-rise buildings are usually confined to a single floor, but smoke and toxic fumes can trap victims throughout the structure. In fact, 80 percent of the fatalities in such fires usually result from asphyxiation.

Now San Francisco inventor William Holmes, who develops rescue devices for a California based company, has a solution: a patented device dubbed the High Rise Fire Snorkel. The snorkel, explains Holmes, is a five-foot-long plastic tube with a mouthpiece. The user simply inserts the tube through the water in a bathroom toilet bowl to an air vent found behind it. The air vent will almost always lead to the roof, Holmes says. So just blow any water out of the tube after you push through, and you can breathe for hours—or until firemen come to the rescue."

The snorkel, Holmes adds, comes with a plastic bag that goes over your head, keeping smoke out of your eyes and nose. "You can buy a model for $7 from Rescue Technology and Equipment Company, 2242 Lombard Street, No. 121, San Francisco, CA 94123. —Eric Mishara

PREVENTING HEART DISEASE

Heart disease typically strikes people in their forties or fifties. But evidence now indicates that the malady can sometimes be traced to the habits of early childhood.

"The arteries of American infants and children can accumulate fatty plaque, the principal promoter of heart disease," says W. Virgil Brown, chairman of the nutrition committee of the American Heart Association (AHA). For that reason, he adds, the AHA has recently recommended dietary restrictions for children two years and older. Restrictions include limiting the intake of fat, sodium, and most important, cholesterol. "Cholesterol is like a pool of foam in the blood," explains Brown. "Its residue may actually penetrate and lodge in artery walls."

The new focus on children's diets, according to Brown, is based in part on autopsies of young soldiers killed in Vietnam. The autopsies revealed severe coronary-artery disease, such as fibrous plaques. "The AHA also considered statistical studies showing that 'U.S. children have higher blood cholesterol concentrations than do children of other populations.' A prudent diet during childhood, it concludes, will reduce the risk of heart attack throughout life. —Richard Levine

Fast-food kids won't relish recent heart disease news.

"As gaslight is found to be the best nocturnal police, so the universe protects itself by pitiless publicity."
—Ralph Waldo Emerson

CONTINUUM

Lecithin: The food additive has been found to spell relief for manic depressive mood swings as well as for senile dementia.

SWEET RELIEF

Manic-depressive psychosis sends victims on an emotional roller coaster that reaches euphoric highs and hellish lows. The element lithium stabilizes behavior in 80 percent of these patients but causes serious side effects that include hand tremors and excessive urination.

Now a food additive called lecithin (commonly an ingredient in cake mixes) holds promise as an effective, virtually side-effect-free alternative to lithium. Lecithin, which is under study at McLean Hospital in Belmont, Massachusetts, has a waxlike consistency. Since it tastes like 'cardboard' and must be eaten in bulk (30 grams daily), it is first blended into ice-cream shakes and sundaes and baked in cinnamon-granola cookies.

According to psychiatrist Bruce Cohen, who is conducting the study, 25 patients were served tasty lecithin treats every day for periods lasting up to three weeks. All the subjects experienced significant reduction of manic-depressive symptoms, and one became "asymptomatic." No one knows how lecithin works, but Cohen theorizes that it stimulates production of acetylcholine, a neurotransmitter (or brain chemical) that manic-depressive patients are reported to have in short supply.

Lecithin is also used to treat Alzheimer's disease, a form of senility that causes memory loss. For this reason, lecithin capsules are a popular health-food store item among the absentminded. And there are concentrations of lecithin in such fat-rich foods as beef, dairy products and peanuts. But to achieve a dosage equivalent to that received by McLean patients with ninety-five-percent-pure lecithin, Cohen says, would mean gorging oneself on these items to the point of discomfort. —Eric Mishara

HAIRY POTATO

For years the green peach aphid was the potato's deadliest foe. But now potatoes won't just lie there in the ground and be eaten. Like the mutant creatures of low-budget horror fare, future spuds will *fight back*.

Cornell University entomologists have endowed the once-supine potato with the ability to turn into lethal flypaper as far as insect pests are concerned. They simply crossbred the familiar cultivated potato with its wild cousin, the hairy potato, to create a hybrid covered with sticky hairs from ground level up. Any aphid, spider mite, flea or beetle that touches the hairs ruptures the glue sacs at the tips—and dies trapped in natural stickum.

The new, improved potato foiled 40 to 60 percent of marauding aphids in field tests, according to Ward M. Tingey, and in the greenhouse its kill rate was 90 percent. Unfortunately, the hirsute hybrid kills beneficial insects as well—a trait the scientists hope to eradicate by fine-tuning the size and distribution of the hairs. And confides Tingey, there's still some gene juggling to be done before the new strain becomes commercial.

'Our goal now,' he says, 'is to eliminate the undesirable characteristics and incorporate such things as high yield, early maturity, good shape, color, size—and, of course, taste.'

The overriding advantage of hairiness, though, is that insects don't readily become immune to it. "The insect would have to genetically change its behavior, some of its development, probably even its morphology to resist potato hair," Tingey explains. —Rick Boling

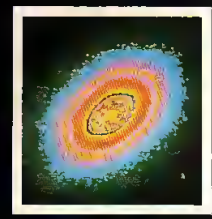
Through a video camera hooked to a microscope, Ward M. Tingey watches the drama of a hairy Bolivian potato ensnaring an aphid.

Electronic eyes search the cosmos for

ATOMS OF LIFE

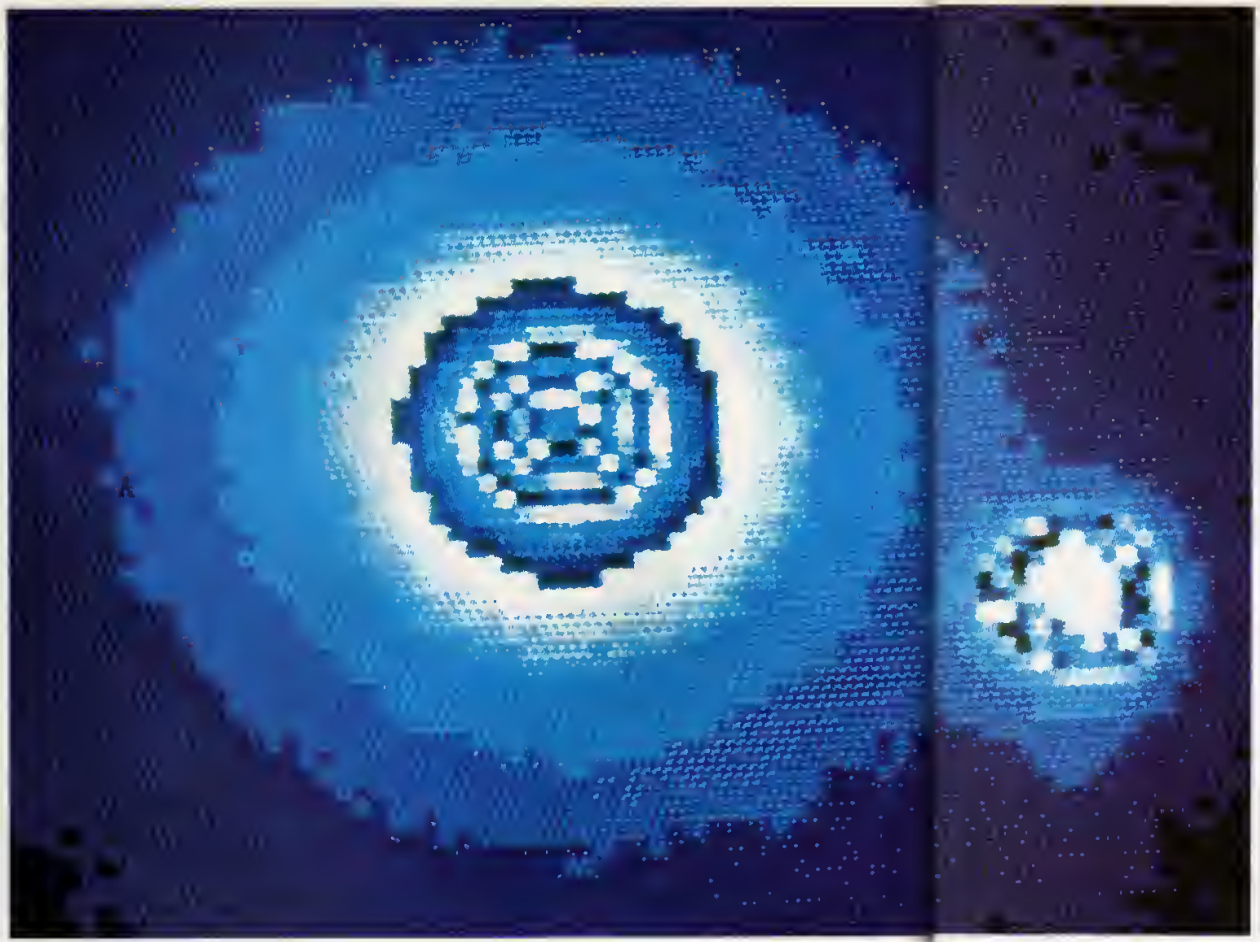
BY ISAAC ASIMOV

The mystery started about 4 6 billion years ago, when the planet, its sun, and the other members of its solar system were formed out of a vast primordial cloud of gas and dust. During



its first half-billion years of existence the planet underwent the final steps of its formation, gathering up the fragments of matter—some as small as pebbles, others as large as mountains—that still cluttered its orbit. Then about 4 billion years ago its molten crust began to cool and solidify. A liquid ocean formed on its surface. Finally, after millions of years, there was life.

Radio images of the Virgo cluster (above) and colliding galaxies (left) can reveal basic chemicals of life. All photos by the Smithsonian Astrophysical Observatory.



"Even though the worlds of our solar system may have failed us, we know chemical evolution has taken place."

As far as scientists can tell, these first traces of life appeared 3.5 billion years ago. In the summer of 1982 a team of scientists from Australian National University discovered algae microfossils at least that age sealed in rock from the planet's surface. It appears that primitive life forms had begun to exist in its seas within 500 million years after the planet achieved its final form—a short time by cosmic standards.

We can make inspired guesses, but we don't know for certain what physical and chemical properties of the planet's crust, its ocean, and its atmosphere made it so conducive to such a sudden appearance of life. We are also not certain about the amount and the forms of energy that permeated the environment in the planet's early days. Thus, the problem scientists face is how to explain the suddenness with which life appeared on this young (4.6-billion-year-old) planet—Earth.

It is a question that has plagued us ever since the nineteenth century, when scientists first began to accept the concept of biological evolution and to dismiss the possibility that life had been created in its present complexity by some supernatural agency. That raised the question of how this extraordinary phenomenon called life could possibly have come to be "by accident." Because Earth's chemistry is not what it was when life originated here, we have to look beyond, to space, to determine what conditions must have been like on our planet before life formed.

It would help if we could find some nearby world that we could study in detail, a world on which life did not exist but where the chemical evolution toward life was already under way. Even if conditions there were so unfavorable that any chemical evolution would surely be aborted and life would never develop, whatever we learned would extend our knowledge far beyond its present state—which is near zero.

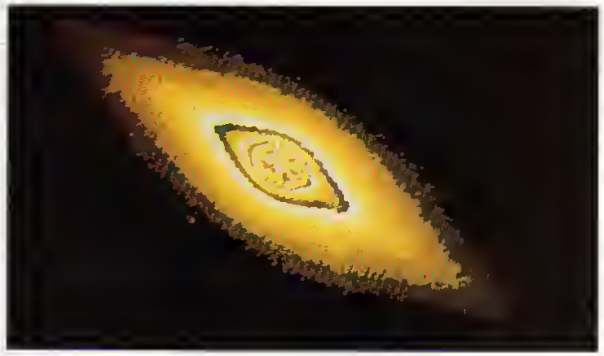
American chemist Harold C. Urey turned to the consideration of this problem after World War II. He suggested that the origins of life could have occurred in a primitive atmosphere like that of Jupiter.

In 1952 one of his graduate students, Stanley L. Miller, tried to duplicate what were thought to be the primordial conditions on Earth. He began with a closed atmosphere and a sterile mixture of water, ammonia, methane, and hydrogen to represent the Earth's early atmosphere and ocean. To represent the catalyzing energy of the sun, he jolted the mixture with electricity.

For a week he circulated the mixture past the electrical discharge, and then he studied it. The colorless mix turned pink. One sixth of the methane had gone into abiotic formation—formation without the intervention of living organisms—of more complex molecules. Among them were glycine and alanine, the two simplest amino acids that can form proteins, compounds characteristic of living tissue.

Over the next 30 years variations on this experiment were conducted, producing more and more complicated molecules, sometimes related to those found in living tissue, sometimes identical to them. All this was done using small volumes of material in a short span of time. What then could be done with an entire planet's atmosphere and ocean over millions of years?

Scientists had hoped to gain some insights into this chemical evolution once we began our space explorations. There were hopes for the moon, but they faded. There were hopes for Mars, but they faded, too. On neither world was there any sign of organic material in the soil. There are now some glimmerings of hope about worlds on the edge of the solar system. For example, Saturn's largest moon, Titan, has a smoggy, methane-rich atmosphere, which may resemble that of primordial Earth. And Europa, Jupiter's smallest moon, is suspected of having an ocean submerged



The chemistry of other galaxies—NGC 3348 (above left) and spindle galaxy NGC 3115 (above)—explode with computer-added color in the microwave imagery of the radio telescope.

beneath its icy crust. But information about both worlds is sketchy, and the evidence for life-giving conditions is not strong.

Even though the major worlds of our solar system may have failed us, even though we can examine no other planetary systems, all is not lost. We now know that chemical evolution has taken place elsewhere in the universe. The place to look is among those evolutionary sites in interstellar clouds drifting through our galaxy, among the stony debris of the asteroid belt, and in the cloud of comets on the edge of our solar system.

The universe as we know it came into existence perhaps 15 billion years ago. About 5 billion years later our sun and its planets began to coalesce from a cloud of gas and dust that had existed for billions of years. Something—perhaps a supernova—occurred, triggering the cloud's condensation. Such interstellar clouds still exist in our galaxy and in others as well. For example, astronomers have located a number of these clouds around the center of the Milky Way. We have discovered that there are thousands of such clouds in the universe, each several light-years in diameter, with masses many times as great as our sun's. The largest known of these is called the Sagittarius B2 radio source. Its mass is estimated to be the equivalent of 3 million suns.

What do these clouds consist of? Radio-telescope surveys indicate they are made of simple atoms with particularly stable nuclei—hydrogen, helium, carbon, nitrogen, oxygen, and neon. Of these six, four—hydrogen, carbon, oxygen, and nitrogen—are of particular interest because the bulk of living tissue is formed from them.

It should be pointed out that these interstellar clouds are "clouds" only in that they are slightly denser than the empty space surrounding them. Matter in them is so rarefied that collisions among the atoms they contain happen infrequently. Since atoms first have to collide before they can combine with one another, astronomers had long assumed that most of these mammoth clouds were made of atoms existing by themselves in a single state. And for a while they were not disappointed.

But that changed. The first time interstellar molecules were found to exist was in 1937 when astronomers from Mount Wilson Observatory, in California, used optical techniques to detect carbon-hydrogen (CH) and carbon-nitrogen (CN) combinations of atoms in an interstellar cloud.

It was thought that much more was not likely to be found, but after World War II a new discipline, radio astronomy, came into being. It was an outgrowth of work done by scientist Karl Jansky, of the Bell Telephone Laboratories, in New Jersey. Jansky had been experimenting with a radio antenna, trying to locate the source of interference in long-distance telephone calls, when he noticed how he would pick up a distinct kind of static with his equipment. Its appearance coincided with nightfall. He eventually realized that the static was actually radiation coming from the center of our galaxy.

Radio astronomy with microwaves became increasingly important the more it was used. Astronomers discovered that each molecule produces a distinct radio-wave signature, the result of shifts in their spin and oscillation. Gradually researchers found that molecules do exist in many clouds in space. So many discoveries have now been made that astronomers believe some molecules are hovering just beyond the resolving power of their equipment, even where none have been found.

It may be just a matter of time before we find more. Since it takes far less energy to emit microwaves than light waves, it is possible to detect, with increasing precision, microwave emissions of even small concentrations of atom combinations.

This was demonstrated in 1968 when a team of physicists and astronomers from the University of California at Berkeley detected the first combinations of more than two atoms near the center of our galaxy. They found water—molecules of two hydrogen atoms and one oxygen atom (H_2O)—and ammonia—three hydrogen atoms and one nitrogen (H_3N). With this discovery, astrochemistry was born.

During the first 15 years of this young discipline, astronomers continued to find an astonishing variety of atom combinations in interstellar clouds. The number grows by the year. (The current official total is well over 60.) And as their techniques improved, astronomers began to find more and more complex combinations, almost all of them involving the carbon atom. In 1971 radioastronomers Lew Snyder, then with the University of Virginia astronomy department, and David Buhl, of the National Radio Astronomy Observatory in Green Bank, West Virginia, detected a molecule of methylacetylene, a seven-atom combination of four hydrogen atoms and three carbon atoms (CH_3CCH). In 1982 astronomers at the Herzberg Institute for Astrophysics, in Ottawa, surpassed that by finding a 13-atom combination—cyano-deca-penta-yne ($HC_{11}N$)—in the atmosphere of a star.

We know as little about the chemical processes that give rise to such multiatom combinations as we know about the chemical processes that gave rise to the complex chemicals in the earth's crust before life appeared. But in the interstellar clouds we at least know what combinations already exist. We may not be certain how combinations like CH_3CCH and $HC_{11}N$ were formed, but they help us guess what sorts of chemicals could have existed on Earth. This discovery also means that there is at least one place outside Earth where we know chemical evolution is going on—in the interstellar clouds.

What we see happening there can't simply be transferred to our speculation about

'Snake bites queen! Details at eleven'

life on Earth. But there is one important similarity. Over the course of billions of years chemical evolution in interstellar clouds has been producing atom combinations built around a carbon skeleton that is exactly what is found in living tissue.

Although the carbon combinations in interstellar clouds are far less complicated than those in living tissue, it is reasonable to suspect that the clouds may also contain a small concentration of more complicated atom combinations. Because their number is relatively small, these combinations give off a feeble emission of microwaves, making them difficult to detect.

It is also conceivable that these molecules have begun to come together to form amino acids in interstellar clouds. (Amino acids are building blocks of protein molecules that are present in all forms of life.) Even though the total mass of amino acids contained in an interstellar cloud could number in the millions of tons, the amino acids could be so diffuse that they would not be detected.

Do we have any way of knowing whether the same thing went on in our solar system? At first glance it seems not. The cloud that became our sun and planets had no doubt been undergoing a chemical evolution during its 10 billion years of existence. It contained a great many atom combinations, perhaps amino acids and even more complex substances. As the clouds condensed to form the solar system, there was tremendous heat—from the sun's nuclear fusion and the planets, which were molten as a result of endless collisions with matter in space. This, many have reasoned, surely would have destroyed all trace of atomic combinations.

But there is more to the solar system than the sun and its planets. It also includes myriad small, even tiny, bodies such as the asteroids, many of which survived nearly unchanged since the solar system's birth. Like other bodies, asteroids are heated by the decay of radioactive elements within them. The smaller an object, the less it is warmed, and the more likely it is to contain matter that has remained unchanged since the solar system was formed. Thus we may find in the smallest asteroids compounds dating back to when the chemical evolution of our solar system was taking place in that primordial cloud.

Since small asteroids are continually colliding with Earth, we can check on this. Although the very smallest dissolve into vapor under the heat of entering Earth's atmosphere, the larger ones survive and are labeled as meteorites. Most are stonelike in nature. A few are metallic. But neither of these two kinds contains a perceptible amount of carbon. There is, however, a third, very rare type of meteorite. Black and easily crumbled, these contain small, stony fragments, called chondrules, from a Greek word for *grains*, that give the object a grainy appearance. The meteorites in which they're found are called carbonaceous chondrites, and they contain car-

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FICTION

SISTER ANGEL

When a charismatic evangelist and his strange daughter invade a bereaved widow's home, mysterious things happen

BY KATE WILHELM PAINTING BY EVELYN TAYLOR

Dinner had been extraordinarily good. Charlie thought with contentment. From the kitchen there now came the soft chugging of the dishwasher, closer the clink of cup on saucer, a pop from the fireplace or a hiss, even closer the nearly inaudible purr of Ashcan on his lap.

The orange cat Candy was stalking the cream on the coffee table. Her forequarters were low, her rear up high, and the white tip of her tail twitched.

"Candy!" Constance said, not raising her voice. The cat discovered that her right hind leg was filthy and started to wash it.

Gretchen laughed. "Heavens, country life could be addictive."

"We're only two hours away from New York," Constance pointed out. "Now we've wined you and dined you, and it's your turn. You said there was an urgent problem you had to discuss. Give."

"Do you believe in ghosts?" Dutch asked suddenly. He was a tall, heavy man with little patience and no evident sense of humor. An engineering consultant, he was leaving for Europe the following day and had asked for, demanded, this visit tonight. "It started last summer," he said. "At her cousin Wanda's house in Connecticut. Vernon and Wanda Garrity. But Vernon's dead now, and Wanda insists that he's haunting her."

"Wasn't he the inventor?" Charlie asked.

"That's the one. He showed us some cats he was working on last summer." He shook his head. "Here's a guy who invents million-dollar gadgets, and in his spare time he plays with toy cats."

"What happened last summer?"

"That night at dinner he says, 'Do you believe in ghosts,' and I said something that squelched the topic. The next day Wanda went home with us, and that evening he was killed. Now, six months later, she says she's getting messages from him."

"How was he killed?" Charlie asked.

"Hit on the head on the beach at their place, robbed. No one was arrested."

"Didn't I meet Wanda years ago?" Constance asked.

Gretchen nodded. "Probably at a slumber party at my house when we were in school. She was there a lot."

Gretchen and Constance had been in college together, had been friends, had parted and lost track of each other until Gretchen's call that morning.

"Don't forget Brother Amos," Gretchen said, "and Sister Angel."

"Fat chance. Brother Amos calls himself an evangelist. He claims that Vernon is in touch with him, and he tells Wanda what Vernon says. Angel is his daughter. He calls her Sister Angel."

"Nasty can of worms," Charlie said, shaking his head.

"I say she should see a shrink."

"Well, she won't," Gretchen snapped.

"So you want Constance to go talk to her?" Charlie glanced at Constance with what was almost an evil grin. She understood the message. It was her turn to explain that she was retired, not taking private cases, busy writing a book and being a country housewife.

"Aunt Louise," Gretchen said, "asked me to get in touch with you both. She wants someone—a detective—to investigate Amos. And she wants a psychologist—Constance—to talk sense into Wanda."

"Aunt Louise," Dutch added dryly, "is Wanda's mother. She lives in Bridgeport. For the first time in her life, there's money in the family, and she wants to keep it there."

The Garrity house was immense. There was a wide, covered portico outside a spacious foyer two stories high. A balcony bathed in light from windows on the north and south, overlooked the foyer. The living room was down several steps; its southern exposure was glass, opening to a red-tiled terrace, lawn, and beyond it all, a lake. The rooms were large, brightly lighted with wide, tall windows, furnished in warm colors, and accented with American Indian artwork, wall hangings, rugs.

Wanda was an interior decorator; her own house was proof that she was a very good one.

Slender, dark haired, she looked as if she had been ill. She was chain-smoking.

"Please call me Wanda," she had said almost instantly. "I'm sorry Gretchen is out. She's told me so much about you and Charlie. I feel as if I almost remember you. And it will make it that much easier to explain to Brother Amos."

"You have to explain us to him?"

"Not really, but one does, you know." A flush colored her cheeks and left again. With a swift motion she stubbed out the cigarette and took a deep breath.

At first glance it appeared to be a live cat, its tail full and limp; its forepaws dangling. Wanda put it down in the center of the room. They formed a circle around it.

"I don't know what to say. Do you want to ask questions?"

"Not yet," Constance said. "Let's get acquainted. How does anyone manage to gather all these artifacts?"

Wanda stood up. "It took me nearly a year to gather the stuff. Come. I'll show you the rest of the house." She looked inquiringly at Charlie, he shook his head.

When they were out of sight, he opened the sliding glass door and walked outside, down to the narrow strip of beach. The lake was about three miles long and two miles wide. Straight across it there was a bluff, and on that a trailer court where Brother Amos and his daughter lived. He turned to look back at the house, even more imposing here than from the front, because from here he could see the mammoth living room, the terrace, and sun glinting off the upper-floor windows, turning them all gold. From across the lake it must look like a gold mine, he thought.

Inside the house Wanda pointed to him on the beach. She and Constance were on the upper balcony.

"You're day and night," Wanda said. "He's so dark and mysterious, and you're like a Nordic queen—tall, fair, splendid."

Constance smiled. Day and night was how she had always thought of herself and Charlie. "Tell me a little something about Vernon."

"Charlie reminds me of him," Wanda said slowly. "Not the way he looks, but the way he listens, the way he accepts what he hears, maybe. Vernon was like that. Quiet, steady, so loyal that when his first wife left him, he waited for more than a year, really believing she'd come back. We were married five years. We were happy together."

They started down the wide stairs that led to the foyer. Indian masks lined the wall here. "This is for the peyote ceremony," she said, pointing to a grotesquely contorted, brilliantly painted ceramic mask. "And that one was used for the buffalo hunt. He was going to leave me. He had fallen in love with someone else. I just had to get away by myself to think for a while. That's why I left with Gretchen."

Constance could feel the presence of staring eyes from the empty holes of the masks, could feel the presence of the ancient shamans. "Did he tell you that?"

"He said he was haunted by her, obsessed by her; he couldn't stop thinking of her. Wanda's face was so white that it could have been one of the masks.

"You hadn't suspected?"

She shook her head. "I knew there was something preying on him, but not that. I don't know when it could have happened. We were never apart. I don't even know who she is." Her voice was faint, unbelieving. "I never told anyone, not Gretchen, not my mother, no one! And that's one of the things Brother Amos told me. There's no way he could have found out, no way. No one suspected." She started to walk again, this time holding the balustrade tightly.

"Wanda, why did you agree to have Charlie and me come? What do you want?"

"I read your book. You have an open mind; don't automatically reject things. I agreed more than a week ago. Since then, every day there's been something new, something that only Vernon could be saying to me. I just don't know what to think any longer; what to do. Every time I see him I find out more."

"You mean from Amos?"

She shook her head. "From Vernon. Through Brother Amos."

Brother Amos was tall and blond, broad shouldered, trim. He could have been a car salesman, an insurance agent, a government undersecretary. He shook hands heartily. When he took Wanda's hand, he used both of his and pressed hers between them as he gazed into her eyes and murmured something inaudible.

His daughter, Angel, was very thin, still gangly, with long pale hair that was babyfine, and beautiful eyes a deep-violet color.

"It was good of you, Gretchen, to bring company to help enliven the atmosphere in this house. Wanda needs companions

conversation. Too much grieving is bad for anyone. Life is to be lived fully if we are to rob death of its fears."

"I'm acting bartender," Charlie said rather briskly. "Martini mixings, scotch, let's see—" He found the shaker and started to mix martinis. "And for the young lady, we have Coke, Pepsi, juice—"

He glanced at her as he continued to shake the gin and ice, and he was struck by the loveliness of her eyes.

"Coke," she said in a low voice.

"And juice for me," Amos said. "I don't condemn moderate alcohol, you understand, but I prefer to be abstemious. The training of a lifetime is hard to put aside."

"Where do you preach?" Constance asked.

"Nowhere at the moment. My calling came late, too late for divinity school. My church is the world, wherever there are human souls yearning for the Word, the Truth, for Guidance."

Constance knew he capitalized the words in his head. Mildly she said, "A tent revivalist? Really?"

"My dear lady, the Word of God is valid wherever it is uttered, be it in an alleyway, or a tent, or the finest cathedral."

"Here you go," Charlie said cheerfully as he handed out the drinks. "Do you heal at your meetings, Brother Amos? The laying on of hands, all that?"

"Enough about me," Amos protested. "What is your trade, Mr. Meiklejohn?"

"Retired. Out to pasture. Used to be a building inspector of sorts."

Constance looked at him admiringly, wondering if he had rehearsed that answer. In the arson squad for years, he had indeed inspected many buildings for the New York City police department. Amos turned to her.

"And Mrs. Meiklejohn? Do you have a profession?"

"I'm thinking of writing a book as soon as I have enough time."

"A writer! How exciting." He dismissed them both and turned his attention to Wanda. "And you, my dear, are you feeling better today?"

"I'm fine," she said quickly. She looked at her martini, tasted it, put it down, and picked up her cigarette instead.

Charlie poured more martinis, refilled Angel's glass with Coke, and then knocked Amos's glass off the table when he started to refill it. He put it aside, brought out a fresh glass, and filled that one. When he looked up, he found Angel's gaze fixed on him, her violet eyes unblinking, an unfathomable expression on her face. The kind of look children sometimes assume. "Do you go to school here?"

She shook her head.

"I tutor her at home," Amos said. "I don't approve of the moral values the school systems teach."

Dinner was interminable. Everyone waited for Brother Amos to lead the conversation, and this he did willingly, at first, then with more and more reluctance. His store of small talk was poverty-stricken.

When he began to discuss the weather, even Wanda looked desperate. He tried baseball. With dessert he moved on to television, and he was still carrying it alone.

Charlie could see a glaze forming over Constance's eyes, and he suppressed a grin. As soon as there was a pause in the monologue he asked, "Wanda, any chance of seeing those mechanical cats Gretchen told us about?"

She nearly jumped up in relief. Without even making certain all of them were through with the mousse, she went to the door. "Why don't you go into the living room for coffee. I'll bring one of them in."

The others left at a more leisurely pace and had not yet seated themselves when she reappeared, holding a furry white cat.

At first glance it appeared to be a live cat: its tail full and limp, swinging; its forepaws dangling. Wanda put it down in the center of the room, and they formed a circle around it.

"This one's set to respond to my voice. They're all voice activated. They're covered with mink or vicuña, or even silk. They're heat-seeking, but they're so dumb that they can't distinguish one heat source from another. They'll approach the fireplace, stop at a certain temperature, and curl up and purr. Or maybe go over to a light bulb or a toaster, anything that's the right temperature."

Angel moved in front of the toy, bending slightly to peer at its face.

"Kitty, kitty," Wanda said.

The cat moved, slowly rose from the sleeping position to stand on four feet. Its tail went straight up in a realistic way, and it turned its head from side to side and started to walk, a bit stiffly but catlike.

Constance was watching the cat with amusement when she felt a wave of revulsion and fear, then another even stronger, and then something else. Angel screamed.

The next several seconds were confused. Angel was screaming, backing away from the cat. Wanda had thrown her hands over her face and was swaying, moaning. Charlie caught Angel and half carried her out of the path of the advancing cat. He held her against his chest as she screamed again and again and finally started to sob. Amos grabbed the cat and held it at arm's length. Constance backed Wanda into a chair and forced her down. The revulsion, the horror, the terror had faded, leaving her spent and weak.

She saw that Gretchen had gone white also, and she left Wanda, took Gretchen by the arm, and sat her down, too.

"For heaven's sake!" she exclaimed, and took the cat from Amos, who was staring at it as if entranced. She started toward the workroom with it.

The spell was broken. Amos shook himself and ran over to Angel. "Baby, baby, it's just a toy! It's all right, sweetheart."

Angel clung to Charlie, burying her face

"It's obvious that your hysteria is brought about by a deep-rooted oedipal conflict associated with your earliest childhood memories of the primal scene, and therefore—"

CONTINUED ON PAGE 156

SHOWDOWN ON THE HIGH FRONTIER

BY TIM ONOSKO

Down-to-earth infighting will determine whether we can launch "star wars" weaponry

High over the Naval Weapons Center at China Lake, California, a heat-seeking Sidewinder missile sizzled across the sky toward an Air Force Boeing 707. Suddenly the plane shot an intense ray touching the Sidewinder's hull with a long, skinny finger of light. The missile's instruments were scrambled. Seconds later the Sidewinder veered off course, missing its target.

Lasers 1, Missiles 0.

On July 25, 1983, the Air Force announced the final score for this series of tests of its Airborne Laser Laboratory—Lasers 5, Missiles 0. It was a resounding success for the "star wars" theory of defense, a multibillion-dollar program that the Reagan Administration seeks to make national policy. And by revealing how advanced such directed-energy weapons already are, the laser tests raised a question that legislators and the voting public must answer: Who are the Darth Vaders? Is the dark side of the Force with those who seek to block this potentially powerful defense against nuclear attack? Or is it with those who

PAINTING BY JOHN HARRIS

would turn outer space into a high-tech battlefield, adding dangerous complexities to the already precarious balance of terror on earth?

Unfortunately, Han Solo, Luke Skywalker, and the dauntless Princess Leia are not here to simplify the problem into black and white. We're on our own, stuck with ambiguous gray. Meanwhile, ever since March 23, 1983, when President Reagan made his "star wars" speech calling for orbiting hardware to zap any Soviet missiles launched toward North America, the Force has been crackling through Washington. Pro- and anti-space-weapons partisans are doing battle in the Pentagon, and arguments will flash in Congress like light swords. Driving the debate is a sense of urgency because the first batch of new space weapons might be ready for launch during this decade.

Some Pentagon systems are straightforward. The space mine, for instance, is a maneuverable satellite that parks next to an enemy satellite and blows up, destroying them both. Others use far-out techniques for knocking out enemy intercontinental ballistic missiles (ICBMs) with what amount to death rays.

In another area of technology, government researchers are testing the MAL (Miniature Air-Launched weapon), a small, heat-seeking rocket that's launched at high altitude from an F-15 fighter. It would ascend to an orbiting satellite and destroy it on impact. Testing for this antisatellite weapon has already begun.

More sophisticated space weaponry from the Pentagon harnesses the power of light to wipe out incoming ICBMs. Most advanced of the devices today are chemical lasers, which produce light by burning hydrogen and fluorine compounds, and amplify and focus the resulting deadly ray with mirrors. The infrared light such lasers produce, however, could be their weakness. The Soviets might simply make their ICBM hulls so shiny that they would reflect the rays like a mirror. Thus researchers are now looking beyond chemical lasers to beams with shorter wavelengths, like highly energetic ultraviolet rays. These would be substantially harder to reflect.

Another idea calls for a powerful laser generator based on Earth but using orbiting mirrors to reflect its beam at incoming ICBMs. The laser generator might be a linear particle accelerator. Still another design, the excimer laser, generates the ray by passing an electric current through a mixture of a noble gas (like xenon or argon) and a halogen gas (like chlorine or fluorine) to produce a chemical reaction that in turn produces ultraviolet light.

Even further in the future are particle-beam weapons. These devices shoot a stream of particles that penetrate an ICBM and destroy its instruments. Particle beams, however, are apparently still far from being operational. As with other antimissile systems, the beam must be designed to withstand such potential countermeasures as using decoys and "spoofing" (electronically misdirecting) the weapons' intricate command and communications systems.

Now some researchers are looking into yet another far-out idea, which they call a flechette. It would be a giant arrow, huge and full of mass, that would plummet from orbit and smash into a target on the ground with so much speed and kinetic energy that it would instantly hammer the sturdiest fortress into rubble.

While the Pentagon pushes ahead on star-wars projects, another influential group is touting the value of technologies from roughly the same era as the Fifties TV show *Tom Corbett, Space Cadet*. High Frontier, Inc., a Washington, DC, nonprofit group, advocates orbiting 17,000 to 20,000 conventional (nonnuclear) heat-seeking rockets. These would sweep down on incoming Soviet ICBMs. "It's more of an engineering problem than a science problem," says retired Army General Daniel Graham, who founded the organization in 1981. High Frontier's membership comprises conservatives who believe mounting an orbital antimissile system requires little more than money.

> *"The first nation to deploy two dozen of these first-generation laser stations would command the portals of outer space against any other nation."*

Graham, an affable warrior known in the defense establishment as Danny, says the rockets—attached to 432 launchers lifted into orbit by the space shuttle—would be one of three defense layers. Earth-launched antimissile missiles would blast any ICBMs that survived the first attack. And General Electric's new GAU-8 rapid-fire guns would defend U.S. missile silos with a cloud of 30mm shells against anything that squeaked through the first two layers. Also in the plan are a space station and a space transport tug with limited fighter capability.

Before he established High Frontier, Graham was candidate Ronald Reagan's military adviser in the 1976 and 1980 campaigns. Others on the organization's advisory board range from Air Force General Robert Richardson, Admiral Mark Hill, physicist Arnold Kramish, and satellite expert Peter Glaser to science-fiction author Robert Heinlein and conservative activist Phyllis Schlafly. Also active in the organization are Republican congressmen Gordon Humphrey, of New Hampshire, and Kenneth Kramer, of Colorado, and Senator William Armstrong (Republican, Colorado). Thus, High Frontier has influence in the White House.

And the plan has another selling point. Since it includes the use of off-the-shelf technology, we can begin installing the system virtually anytime. As Graham puts it, High Frontier has a "kind of dumb, brute-force approach to things."

Arguably, it is a Fifties approach to things, a set of ideas pioneered in the age of tail fins and basketball-size satellites. John Bosma, an arms researcher working for Graham, takes pride in having unearthed details of Project Defender, a space-based defense study undertaken by the Eisenhower Administration in 1958. Parts of Defender bear remarkable similarity to High Frontier's plan. According to Bosma, it included a subproject that investigated laser weapons, particle beams, directed-nuclear plasmas, and other speculative technology. Another subproject, BAMBI (Ballistic Missile Boost Intercept), was part of the larger concept called SPAD—Space Patrol Active Defense. BAMBI presaged the orbiting missiles of High Frontier's proposal, and SPAD included plans for a "winged, recoverable, vertical-takeoff, horizontal-landing payload booster"—in other words, the space shuttle—to deliver BAMBI to outer space.

Some weapons researchers ridicule the High Frontier rocket system as too simplistic. "It won't drop a lot of money in Livermore's lap," responds Graham with aplomb, referring to the Lawrence Livermore National Laboratory in California, where much of the country's weapons research is done.

The wide variety of exotic plans for new space war technology contributes to the likelihood that at least some of the plans will be developed and deployed. Some observers suggest that means potential enemies will probably launch their own space-weapons systems.

"When they issued the six-shooters to the U.S. marshals, that was going to end it on the western frontier, but the crooks soon got them, too," says Senator Larry Pressler (Republican, South Dakota).

Pressler believes that if one side arms itself with orbiting six-shooters, the other side will soon match them. "Unless something is done, or some agreements are reached, or mankind somehow decides against it, I suppose space weapons *are* inevitable," he says in a sinking tone. "On the other hand, if the Russians are doing it, I suppose we have to. It's the old arms race extended to outer space. And that's a very painful direction if you look at the costs and the potential for destruction that could result."

Costs? Consider the plan that Republican Senator Malcolm Wallop, of Wyoming, is pushing. 24 laser stations orbiting the

earth 800 miles up. According to one Wallop aide, each laser-tracking system would be so fine-tuned that it could be mounted on top of a New York City truck and keep perfect aim on a tennis ball bouncing on a London court. Each station overseeing 10 percent of the earth's surface would have enough fuel (hydrogen and fluorine) for about 1,000 shots. That capability would be enough to contend with "the theoretical contingency of one thousand missiles launched beneath it in almost simultaneous barrage."

The first laser battle station, by Wallop's estimates, would cost $3 billion to $5 billion, with each station thereafter costing $1 billion, for a total of $28 billion plus shuttle-shipping costs. Some critics say the cost could be twice that figure or more.

Is it worth the price? "Oh, hell, yes!" says Wallop. "The dimension of the threat changes enormously if it can shoot down five thousand reentry vehicles [ICBMs] in five minutes." Wallop goes further. For the United States *not* to build an orbiting weapons system might be national suicide, he says. "Any nation that deployed two dozen of these first-generation chemical-laser stations would command the portals of space against any other nation," Wallop maintains, asserting that the Soviets might own the void if they were able to build such a system first.

"It depends on the capability of the weapons they launch and what they wish to do with that newfound capability," he says. "It's conceivable that they would *deny* us access to space."

The day after President Reagan's star-wars speech, Wallop and Senator Paul Laxalt (Republican, Nevada) introduced a joint resolution calling for a space-sited antiballistic-missile system "at the earliest possible date." Specifically, Wallop and his supporters want to speed up work on three Defense Advanced Research Projects Agency (DARPA) programs.

- Project Alpha, demonstration of a five-megawatt chemical laser by 1987, with TRW the prime contractor. Wallop says that a ten-megawatt laser would be possible with more money.
- LODE (Large Optical Demonstration Experiment). Lockheed is the prime contractor for this effort to produce mirrors large enough (13.1 feet in diameter) to direct antimissile laser beams and yet sturdy enough to survive the shuttle trip to orbit. Wallop says that, with more money, we could have 33-foot-diameter mirrors.
- Talon Gold, a superaccurate pointing and tracking system for laser weapons that would enable an orbiting laser to aim at a flying ICBM and lock on long enough to burn out its instruments. Again, Lockheed is the contractor. Wallop is upset because funding reductions deleted a Talon Gold test with the shuttle.

Wallop feels that the greatest injustices being done to space-weapons programs are budget cuts and needless delays. "There's a bizarre level of conversation that comes out of the Department of Defense that says they're not ready to go ahead with development," Wallop complains. "But their specific testimony is that they are."

As military strategy goes, it all sounds like Mom's apple pie. After all, if superweapons in space mean we can neutralize a nuclear attack directed against us without having to destroy a large swath of the earth with a counterstroke, who would oppose them?

Certainly when President Reagan issued his call for space weaponry, a strategy military experts have discussed at least since the Project Defender study, the idea seemed alluring. Not for nothing is the strategy for the present balance of nuclear terror called MAD, the apt acronym for mutual assured destruction. MAD's premise is that no nation would take the risk of starting a nuclear war if its own annihilation were probably assured by its enemy's nuclear counterstroke.

MAD is virtually a legal entity in today's world, resting upon the Anti-Ballistic Missile (ABM) treaty. It bans defensive antimissile missiles because they would upset the evenly matched standoff that so far has saved all our skins. The treaty however, was written before notions like orbiting laser weapons became serious, and does not mention space war. Thus, with the ABM treaty effectively finessed, the major powers are now poised for an out-of-this-world antimissile arms competition.

"Should space be a peaceful sanctuary? Or should we really ascend into what our forefathers innocently called the heavens and build killer satellites?"

Weapons for attacking and defending satellites are part of the issue because in today's warfare, satellites are vital for command, control, communications, and intelligence, known in military circles as C cubed *I*. Supposedly, the United Nations Outer Space Treaty of 1967, which defines astronauts as humanity's international envoys in outer space, precludes space weapons. The treaty, however, specifically mentions only nuclear weapons and weapons that would destroy human life on a massive scale. Its writers did not foresee lasers, particle beams, space mines, and other star-wars concepts now on the military drawing boards. Wallop, for one, argues that existing treaties are no obstacle. And Leonid Brezhnev himself told the United Nations that the ABM treaty did not apply to space weapons; a stand that Brezhnev's successor, Yuri Andropov, reaffirmed in May 1983, Wallop claims.

In fact, reality already is sounding much like the science fiction of a few decades ago. For instance, on September 1, 1982, the U.S. Air Force quietly activated its new space command, headquartered in Colorado Springs. The command was established to "push for understanding and awareness of the Soviet space threat," according to its charter, and to "develop space-defense doctrine and strategy." The Navy followed with its own space command in 1983.

But all of this activity has stimulated a backlash of protest. The opposition takes several forms. Senator Pressler, for one, has introduced a Senate resolution calling for a ban on the development of antisatellite weapons; this would be a first step toward prohibiting *all* space-based weaponry. Pressler is concerned that the focus on space war will slow the nonmilitary development of space. (See First Word, page 6.) He points out that the Defense Department is already urging civilian space users to harden their satellites against attack. "This technology is being held up and could be destroyed by all of this," he says.

A pessimist, Pressler says that arms-control talk "really doesn't amount to much." He notes that the Soviets already have launched an antisatellite weapon. But he adds, "I'm a critic both of the Russians and of our own operations." Pressler also is troubled by the cost of space weaponry; he cites estimates that range from $50 billion to $500 billion. "You're going to impoverish Earth by supporting these sophisticated systems," he says.

"I know that some people say, 'If we just get one step ahead and we build lasers and they're effective, it will give us superiority, and there will be peace,'" Pressler says. "That's also what they said about MIRVs [today's state-of-the-art multiple-warhead ICBMs, which both the Soviet Union and the United States are now pointing at each other]."

Representative Joe Moakely (Democrat, Massachusetts) is even more opposed to space weapons. Moakely emphasizes, however, that he is no pacifist. In fact, during World War II he quit high school at fifteen to join the Navy. Cases like his underscore the fact that the arguments for and against the space-war strategy do not fit into neat ideological pigeonholes.

"I still get a thrill when the American flag goes by. I'm not a peacenik," Moakely says gruffly. "I'm fifty-six years old. I've been through a lot, and I figured, geez, somebody's got to do it, and somebody's got to have people taking a look at this." Scientists like Carl Sagan have joined Moakely in his space-war opposition, which was expressed in a House resolution calling for a sweeping ban on all weapons in space.

More than anything, Moakely is upset by

the speed with which decisions are being made on these complex systems. The House Armed Services Committee, for instance, debated an antisatellite-weapons bill for what seemed to Moakley to be an unconscionably short time.

"Five minutes of hearings on the thing, and now they want us to embark on a brand-new kind of space war!" he fumes.

Moakley, along with many others in Congress and the science community, questions the new weapons' effectiveness and reliability. "I'm afraid of putting *anything* up there that's going to disturb any of those satellites doing the reconnaissance work, because if they start sending some funny signals back — you know — it could be *sayonara*." He also fears that as defense systems become even more complex, with far-out systems orbiting overhead, the chances for mistakes grow.

"As long as we've got humans living on this planet, we're going to have a lot of human error," he says. "So let's give them fewer things to have human error over."

Because Soviet ICBM's are in their boost phase for only a few minutes, decision-making time is limited and systems are highly automated. In military jargon, they take the human out of the loop. Moakley's reaction: "I fear this may take the human out of the planet."

So complicated is the issue of space weaponry that the arguments cross over the old hawk and dove lines. Among the space war lobbying groups, for instance, conservative High Frontier's natural enemy would seem to be the L-5 Society, a group that formed to support space-colony ideas such as those outlined by Princeton physicist Gerard O'Neill. O'Neill envisions giant artificial satellites parked at the L-5 point, where gravitational forces of the moon and Earth are equal. Critics have called L-5 members "space hippies" preoccupied as they have been with such notions as beekeeping in orbit.

But since High Frontier's Graham addressed the L-5 Society's national meetings in 1982 and 1983, the group has split, and some members now embrace High Frontier's arms-in-orbit theory for ensuring peace. Others want to maintain the original L-5 idealism. An article in a recent issue of L-5's magazine tried to heal the rift. Its author, Eric Drexler of the Massachusetts Institute of Technology, proposed that the United States and the Soviet Union jointly establish an antimissile system that would be unable to differentiate between one country's ICBMs and the other's. Graham terms that idea "just plain silly," but it shows how difficult it is to maintain polarity in the wonderland of MAD.

Graham, meanwhile, has little trouble keeping his own perspective on the L-5 ideology of space as a workshop for the human-potential movement.

"That's what gets me about some of the people on the sweetness-and-light side," Graham huffs. "They want the poor old slob—Joe Sixpack, Joe Lunchpail—to pour his tax money in so that one day they could have this marvelous colony of *their* kind of people."

Some members of the opposition have impeccable scientific credentials. One is physicist Richard Garwin, who has worked on a variety of federal weapons-research projects, including satellites and nuclear warfare, and is currently an IBM fellow at the Thomas J. Watson Research Center, in Yorktown Heights, New York, an adjunct research fellow at Harvard, and a professor at Columbia. In February 1983 he led a blue-ribbon bloc of scientists, including Sagan, physicist Hans Bethe, former Johnson Space Center director Christopher Kraft, and former Advanced Research Project Agency director George Rathgens, in petitioning world leaders for a ban on space weaponry.

"He is talking about rendering all nuclear weapons impotent and obsolete," says Garwin about President Reagan's star-wars plans. "That's nonsense; nobody in the community who is working on such things believes that is possible."

> *"The issue of weapons in space brings mankind to a threshold no less significant than the one we faced in the Forties, when the atom bomb was invented."*

We need a strong defense, but the real purpose of space-defense systems is to preserve the U.S. nuclear deterrent—its ICBMs, Garwin argues. And for that purpose, he suggests a simple point defense of our missile silos: SWARMJET, a launcher that can shoot hundreds of miniature projectiles at incoming ICBMs. Ironically, that is the same weapon Graham at one point advocated as High Frontier's third defensive layer.

How complicated can the issue get? Very. Some six months after Reagan's speech there were rumors among informed scientists that the U.S. Arms Control and Disarmament Agency had drawn up an offer to the Russians to limit antisatellite weaponry. The rumors, which surfaced at about the same time the United States was about to test its fighter-launched antisatellite system, raised a few questions. If the offer were serious, wouldn't it have been better to delay tests and put a hold on development costs until after negotiations with the Russians? And what's the national policy on the need for such weapons? *New York Times* columnist Flora Lewis quotes one scientist on the prevailing confusion in Washington:

"Negotiations with the Soviets? Who worries about that? It's negotiations with the White House and the Pentagon that are the first concern."

Whether they are proponents or opponents of space-war preparation, plans, national leaders today are contending with another set of difficult questions. These are among the thorniest:

If the United States decides to commit itself to a major space-war effort, could the government round up enough brainpower to design the systems? George Keyworth, the President's science adviser, believes the answer is yes.

He says that after World War II, scientists appalled by the nuclear weapons they had produced believed in unilateral disarmament. But the Soviets were arming on a massive scale. "And here we sit in 1983, with the Soviets possessing an overwhelming land-based ballistic-missile capability." Keyworth says that many other scientists, still plagued by guilt, remain adamantly opposed to the arms race. But that attitude is "not so prevalent among the younger generation of scientists," he says.

Garwin agrees that the administration can find many willing hands among younger scientists to work on the new weapons. "I think there are lots of scientists who will work on anything that's not criminal," he says. He believes the effort could backfire, however, because the scientists working on the new weapons systems, eager for promotions, would be unwilling to tell their superiors when the designs do not work.

"There's really very little capability in the government," Garwin asserts. "Very few experienced, technically sound people of any independence at all. This government is worse in that regard than any other I can remember."

Even if the people could be found to build such systems, how vulnerable would the hardware be to countermeasures? Colin Gray, an arms strategist who is friendly to the idea of space missile defense, worries that there hasn't yet been enough thought or planning about how to defend the systems themselves.

"I have the impression that the weapons advocates have scarcely begun to think through the whole range of electronic, physical, and tactical countermeasures that could be taken to negate such systems," says Gray, a member of the White House Arms Control Advisory Committee and president of a Virginia think tank called the National Institute for Public Policy. Countermeasures range from throwing debris into the orbital path of a laser system to misdirecting control of a weapon's command systems. Garwin says that even the most sophisticated detection devices can be fooled with such simple decoys as balloons. "If you use plastic or aluminum foil multilayer balloons," he says, "there is

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FICTION

400 BOYS

Life can be a gas after a nuclear war—if you live in Fun City and believe in team spirit

BY MARC LAIDLAW

We sit and feel Fun City die. Two stories above our basement, at street level, something big is stomping apartment pyramids flat. We can feel the lives blinking out like smashed bulbs; you don't need second sight to see through other eyes at a time like this. I get flashes of fear and sudden pain, but none last long. The paperback drops from my hands, and I blow my candle out.

We are the Brothers, a team of twelve. There were twenty-two yesterday, but not everyone made it to the basement in time. Our slicker, Slash, is on a crate loading and reloading his gun with its one and only silver bullet. Crybaby Jaguar is kneeling in the corner on his old blanket, sobbing like a maniac, for once he has a good reason. My best Brother, Jade, keeps spinning the cylinders of the holotube in search of stations, but all he gets is static that sounds like screaming

PAINTING BY STEPHEN BECK

turned inside out. It's a lot like the screaming in our minds, which won't fade except as it gets squelched voice by voice.

Slash goes: 'Jade, turn that thing off or I'll short-cirk it.'

He is our leader, our slicker. His lips are gray, his mouth twice too wide where a Soooooot scalpel opened his cheeks. He has a lisp.

Jade shrugs and shuts down the tube, but the sounds we hear instead are no better. Faraway pounding footsteps, shouts from the sky, even monster laughter. It seems to be passing away from us, deeper into Fun City.

'They'll be gone in no time,' Jade goes.

'You think you know everything,' goes Vave O'Claw, dissecting an alarm clock with one chrome finger the way some kids pick their noses. 'You don't even know what they are—'

'I saw 'em,' goes Jade. 'Croak and I. Right, Croak?'

I nod without a sound. There's no tongue in my mouth. I only croaked after my free fix-up, which I got for mouthing badsense to a Controller cognibot when I was twelve.

Jade and I went out last night and climbed an empty pyramid to see what we could see. Past Riverrun Boulevard, the world was burning bright, and I had to look away. Jade kept staring and said he saw wild giants running with the glow. Then I heard a thousand guitar strings snapping, and Jade said the giants had ripped up Big Bridge by the roots and thrown it at the moon. I looked up and saw a black arch spinning end over end, cables twanging as it flipped up and up through shredded smoke and never fell back—or not while we waited, which was not long.

Whatever it is could be here for good," goes Slash, twisting his mouth in the middle as he grins. 'Might never leave.'

Crybaby stops snorting long enough to say, 'Nuh-never?'

'Why should they? Looks like they came a long way to get to Fun City, doesn't it? Maybe we have a whole new team on our hands. Brothers.'

'Just what we need,' goes Jade. 'Don't ask me to smash with 'em, though. My blade's not big enough. If the Controllers couldn't keep 'em from crashing through, what could we do?'

Slash cocks his head. 'Jade, dear Brother, listen close. If I ask you to smash, you smash. If I ask you to jump from a hive, you jump. Or find another team. You know I only ask these things to keep your life interesting.'

Interesting enough, my best Brother grumbles.

'Hey!' goes Crybaby. 'He's bigger and older than any of us but doesn't have the brains of a ten-year-old. 'Listen!'

We listen.

'Don't hear nothin'," goes Skag.

'Yeah! Nuh-nuthin'. They made away.'

He spoke too soon. Next thing we know, there is thunder in the wall, the concrete crawls underfoot, and the ceiling rains. I dive under a table with Jade.

The thunder fades to a whisper. Afterward there is real silence.

"You okay, Croak?" Jade goes. I nod and look into the basement for the other Brothers. I can tell by the team spirit in the room that no one is hurt.

In the next instant we let out a twelve-part gasp.

There's natural light in the basement. Where from?

Looking out from under the table, I catch a parting shot of the moon two stories and more above us. The last shock had split the old tenement hive open to the sky. Floors and ceilings layer the sides of a fissure, water pipes cross in the air like metal webs, the floppy head of a mattress spills foam on us.

The moon vanishes into boiling black smoke. It is the same smoke we saw washing over the city yesterday, when the stars were sputtering like flares around a traffic wreck. Lady Death's perfume comes creeping down with it.

Slash straddles the crack that runs through the center of the room.

He tucks his gun into his pocket. The silver of its only bullet was mixed with some of Stash's blood. He saves it for the Soooooot who gave him his grin, a certain slicker named HiLo.

'Okay, team,' he goes. 'Let's get out of here pronto.'

Vave and Jade rip away the boards from the door. The basement was rigged for security, to keep us safe when things got bad in Fun City. Vave shielded the walls with baffles so when Controller cognibots came scanning for hideaways, they picked up plumbing and an empty room. Never a scoop of us.

Beyond the door the stairs tilt up at a crazy slant. It's nothing we cannot manage. I look back at the basement as we head up, because I had been getting to think of it as home.

We were there when the Controllers came looking for war recruits. They thought we were just the right age.

'Come out, come out, wherever in free!' they yelled. When they came hunting, we did our trick and disappeared.

That was in the last of the calendar days when everyone was yelling:

'Hey! This is it! World War Last!'

What they told us about the war could be squeezed into Vave's pinky tip, which he had hollowed out for explosive darts. They still wanted us to fight in it. The deal was: we would get a free trip to the moon for training at Base English, then we would zip back to Earth charged up and ready to go-go-go. The SinoSovs were hatching wars like eggs, one after another, down south. The place got so hot that we could see the skies that way glowing white some nights, then yellow in the day.

Federal Control had sealed our continental city tight in a see-through blister

"Actually, it expresses my rage at not having gone into some other line of work."

Nothing but air and light got in or out without a password. Vave was sure when he saw the yellow glow that the SinoSovs had launched something fierce against the invisible curtain, something that was strong enough to get through.

Quiet as queegs we creep to the Strip. Our bloc covers Fifty-sixth to Eighty-eighth between Westland and Chico. The streetlights are busted like every window in all the buildings and the crashed cars. Garbage and bodies are spilled all over.

"Aw, skud," goes Vave.

Crybaby starts bawling.

"Keep looking, Croak," goes Slash to me. "Get it all."

I want to look away, but I have to store this for later. I almost cry because my ma and my real brother are dead. I put *that* away and get it all down. Slash lets me keep track of the Brothers.

At the Federal Pylon, where they control the programmable parts and people of Fun City, Mister Fixer snipped my tongue and started on the other end.

He did not live to finish the job. A team brigade of Quazis and Moofs, led by my Brothers, sprang me free.

That takes teamwork. I know the Controllers said otherwise, said that we were smash-crazy subverts like the Anarcanes, with no pledge to Fun City. But if you ever listened to them, salt your ears. Teams never smashed unless they had to. When life pinched in Fun City, there was nowhere to jump but sideways into the next bloc. Enter with no invitation and... things worked out.

I catch a shine of silver down the Strip. A cognibot is stalled with scanners down, no use to the shaveheads who sit in the Pylon and watch the streets.

I point it out, thinking there can't be many shaveheads left.

"No more law," goes Jade.

"Nothing in our way," goes Slash.

We start down the Strip. On our way past the cog, Vave stops to unbolt the laser nipples on its turret. Hooked to battery packs, they will make slick snappers.

We grab flashlights from busted monster marts. For a while we look into the ruins, but that gets nasty fast. We stick to finding our way through the fallen mountains that used to be pyramids and block-long hives. It takes a long time.

There is fresh paint on the walls that still stand, dripping red black like it might never dry. The stench of fresh death blows at us from center city.

Another alley cat pissed our bloc.

I wonder about survivors. When we send our minds out into the ruins, we don't feel a thing. There were never many people here when times were good. Most of the hives emptied out in the fever years, when the oldies died and the kiddykids, untouched by disease, got closer together and learned to share their power.

It keeps getting darker, hotter, the smell gets worse. Bodies staring from windows make me glad I never looked for Ma or my brother. We gather canned food, keeping unfraquiet. The Strip has never seen such a dead night. Teams were always roving, smashing, throwing clean-fun free-for-alls. Now there's only us.

We cross through bloc after bloc. Bennies, Silks, Quazis, Mannies, and Angels. No one. If any teams are alive they are in hideaways unknown, if they hid out overground they are as dead as the rest.

We wait for the telltale psychic fug—like a whisper in the pit of your belly—that another team gives. There is nothing but death in the night.

"Rest tight, teams," Jade goes.

"Wait," goes Slash.

We stop at two hundred sixty-fifth in the Snubnose bloc. Looking down the Strip, I see someone sitting high on a heap of ruined cement. He shakes his head and puts up his hands.

"Well, well," goes Slash.

The doob starts down the heap. He is so weak he tumbles and avalanches the rest of the way to the street. We surround him, and he looks up into the black zero of Slash's gun.

"Hiya, HiLo," Slash goes. He has on a grin he must have saved with the silver bullet. It runs all the way back to his ears. "How's Soooooots?"

HiLo doesn't look so slick. His red-and-black lightning-bolt suit is shredded and stained, the collar torn off for a bandage around one wrist. The left lens of his dark owlrims is shattered, and his buzzcut is scraped to nothing.

HiLo doesn't say a word. He stares up into the gun and waits for the trigger to snap, the last little sound he will ever hear. We are waiting, too.

There's one big tear dripping from the shattered lens, washing HiLo's grimy cheek. Slash laughs. Then he lowers the gun and says, "Not tonight."

HiLo does not even twitch.

Down the Strip, a gas main blows up and paints us all in orange light.

We all start laughing. It's funny, I guess. HiLo's smile is silent.

Slash jerks HiLo to his feet. "I got other stuff under my skin, slicker. You look like runover skud. Where's your team?"

HiLo looks at the ground and shakes his head slowly.

"Slicker," he goes, "we got flaftened. No other way to put it." A stream of tears follows the first; he clears them away. "There's no Soooooots left."

"There's you," goes Slash, putting a hand on HiLo's shoulder.

"Can't be a slicker without a team."

"Sure you can. What happened?"

HiLo looks down the street. "New team took our bloc," he goes. "They're giants, Slash—I know it sounds crazy."

"No," goes Jade, "I seen 'em."

HiLo goes, "We heard them coming, but if we had seen them I would never have told the Soooooots to stand tight. Thought

"Just one day in kindergarten, and he claims burnout."

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Can genes be altered to change human behavior? In a word, yes

SOUL GENETICS

BY YVONNE BASKIN

In 1965 Nobel Prize-winning chemist Max Perutz fantasized about a molecular-biology examination that students of some future century would take Some sample questions

'1. In the murder trial of *Rex* v *Jones*, counsel for the defense pleads an Oedipus complex acquired by the defendant in infancy as an extenuating factor State how you would isolate and identify the complex in molecular form

'2 Prescribe a therapy at the molecular level for (a) Hamlet (b) Dmitri Karamazov and (c) Hedda Gabler.'

Fifteen years later, in 1980 Perutz said he found the questions only "a few micrometers nearer" to being answered Today, three years later, we have come a few more micrometers Although we know almost nothing about the role of genes in normal human behavior, we have no doubt that alterations in a single gene or in whole chromosomes can cause abnormalities in our intelligence and our behavior

For example, in the genetic disease known as the Lesch-Nyhan syndrome, one missing enzyme throws its victims into a nightmarish world of self-destruction, somehow compelling them to bite and pinch anyone who comes near and even to bite off their own

PAINTING BY WILSON McLEAN

lips and fingers. Children afflicted with Preder-Willi syndrome are mildly retarded, obese, and eat voraciously and pathologically. They've been known to devour almost anything—sticks of butter, pet food, and edible garbage. Men born with XYY chromosomes instead of the normal XY have been found to have a greater-than-average risk of low intelligence and antisocial, although not necessarily aggressive, behavior. We know there are genes strongly involved in schizophrenia, depression, and even the reading disability dyslexia. And such genetic diseases as Fragile X (so called because a male victim's X chromosome is broken), Down's syndrome, and hundreds of other inherited defects cripple the brain to varying degrees.

It's clear from what we've seen of such extremes that genes and individual biochemistry do affect the way a person thinks, feels, and perceives the world and consequently the way he behaves in it. Now neuroscientists are coming closer to the day when they can delineate those genes underlying memory, learning, intelligence, and behavior patterns in higher animals, including humans.

That, in turn, suggests the possibility of moving on to the next step: using this knowledge to change behavior genetically. Science visionaries like the British scientist/writer J. B. S. Haldane and Joshua Lederberg, Nobel laureate in medicine, have imagined future worlds where human selection and enhancement would produce populations of long-lived, clever, sensitive, and peace-loving descendants. They have also envisioned subhuman types to do our bidding and superhuman species designed to perform all our specialized intellectual tasks. As we edge closer to the realization of fantasies like these, experts are already starting to address such questions as: Should we make genetic "improvements"? What should they be? Who will get them, and who won't?

What has convinced many researchers that such feats are possible is the discovery that many higher learning processes once thought to be limited only to mammalian intelligence can be identified and explored in such lowly invertebrates as the fruit fly, the crayfish, and Aplysia.

Aplysia is a splotchy brown sea slug that grows to the size of a human brain. It spends its life grazing on the sea lettuce that grows in the mud flats and tide pools off the Southern California coast. It is safe to say that Aplysia is one of the earth's least charismatic creatures.

But when scooped up and shipped to New York City to Columbia University's Center for Neurobiology and Behavior, Aplysia becomes one of the stars in the search for the molecular foundations of learning, memory, and behavior.

Basically a snail without a shell, Aplysia carries its gills on its back. Inside a respiratory cavity that is protected by a structure called the mantle, which consists of a pair of flaps. The edge of this cavity, the mantle shelf, contains a siphon that draws in water. Ordinarily the creature carries its gills protruding from its back, but at a light touch to either the mantle shelf or siphon, Aplysia will instantly jerk its gills back inside the protective mantle cavity.

This is the slug's modest version of the defensive escape-and-withdrawal responses common to vertebrates. And as with higher-order animals, the simple Aplysia can learn to alter these responses. At Columbia University neurobiology researchers Eric R. Kandel, James B. Schwartz, and colleagues have identified most of the nerve cells involved in gill withdrawal by studying how Aplysia learns and reacts. Now they are dissecting Aplysia's various learning processes, tracking its biochemical and genetic mechanisms. Columbia molecular biologist Richard Axel,

> *"There's no question that alterations in single genes or whole chromosomes can have profound impacts on intelligence—learning, memory, reasoning—and behavior."*

working with Kandel and Schwartz, has already traced bits of the slug's modest behavioral repertoire to specific genes.

Aplysia can be trained by using several learning processes that work with more advanced animals. These techniques include habituation, in which an animal, after being subjected repeatedly to a weak stimulus, learns to respond to it minimally or ignore it altogether; sensitization, in which an animal responds more violently to a harmless stimulus, like a touch, after having been exposed to a painful one, like an electric shock; and classical conditioning, in which an animal learns to respond to a stimulus by associating it with a specific event, as when Pavlov's dogs learned to salivate at the sound of a bell.

So when Aplysia is squirted in the same spot 10 to 15 times with a jet of water, it will eventually respond only weakly to repeated squirts. If, however, the same creature is then jolted with an electric shock, its response to even a light touch will be more violent. And by repeating the shock or increasing its strength, an experimenter can embed the reaction in the slug's memory for minutes, hours, even weeks.

Thus, scientists can classically condition Aplysia's gill-withdrawal response by touching its siphon and, moments later, delivering a strong electric shock to the creature's tail. After 15 repetitions this trained slug will react more violently to a gentle prod than those not taught to associate the touch with a shock of electricity.

Studies by Kandel and Schwartz now indicate that these simple forms of learning in Aplysia occur at the junctions, or synapses, between the nerves where nerve cells communicate by using neurotransmitters, the chemical messengers that carry nerve impulses from one cell to the next. The memory of what has been learned is retained in the form of changes in the amount of neurotransmitter released at specific synapses. These changes alter the connections between nerve cells. Habituation, for example, reduces the amount of neurotransmitter released and consequently the strength of the nerve signal given off. Sensitization increases both.

The researchers hope to discover what precise biochemical mechanisms underlie this change in transmitter release. Learning, Kandel and Schwartz have suggested, is likely to be a "repertoire of mechanisms" instead of a single process.

Evidence so far suggests that biochemistry of simple learning processes may be the same throughout the animal kingdom and may also play a building-block role in more complex forms of learning. Fruit-fly researchers, for instance, have bred a mutant strain called dunce. It has a mutation in a single gene that leaves the creature unable to learn sensitization and conditioned-learning responses. Unlike normal flies, dunces can't learn to avoid odors associated with electric shocks. Dunces also lack one of the biochemicals Aplysia uses in sensitization and conditioned-learning processes. The biochemical is cyclic AMP phosphodiesterase, an enzyme that controls the breakdown of cyclic AMP which is needed for the retention of memories.

Behavior has a strong biochemical ingredient, too. For example, Aplysia's simple life is consumed with eating and copulation. When the animal pauses to lay eggs, it goes through a ritual that fascinates behavior geneticists. The creature, which possesses both male and female sex organs, extrudes from its hermaphroditic egg duct a yard-long string of 10 million eggs. As the string emerges, the slug catches it in its mouth. At this point its heart rate and respiratory rate accelerate. Waving its head back and forth, Aplysia continues pulling the egg string out of its duct and winds it into a tight mass. It then sticks the mass to a solid surface, such as a rock.

The ritual appears to be made up of seven precisely coordinated, independent forms of behavior. Axel notes, and the sequence cannot be modified by experience. "This is what's known as a classical fixed-action pattern," he says. "We want to know what controls it."

Scientists know that this ritual is orches-

Adapted from The Gene Doctors: Medical Genetics at the Frontier, *by Yvonne Baskin. Copyright © 1983, by Yvonne Baskin. Published by William Morrow & Company, Inc.*

trated by substances released from a small group of nerve cells. Axel's team has now isolated, cloned, and determined the molecular code of the gene for one of these substances, the egg-laying hormone. That substance sets in motion the extrusion of the egg string. This gene turned out to carry the blueprint for making not only this hormone but as many as 11 other small proteins, or peptides.

Axel theorizes that most or all of the behaviors involved in egg laying may be accounted for by this constellation of peptides. By deploying various combinations of peptides, each of which carries messages that stimulate or inhibit various nerve cells or other tissues, 'you can really build up complicated behavioral repertoires," he says. One peptide may affect several different responses, Axel notes. And that biochemical versatility is not limited to slugs. "If you think about behavior in man, you see that we also combine very similar pieces of our behavior to make up very different behavioral arrays."

Other groups are pursuing the genetics of behavior by studying mutant fruit flies, mapping chromosomal locations of mutant genes responsible for aberrant behaviors, learning when these genes get switched on, what effect each gene product has, and how it causes abnormal behavior.

There's no lack of abnormalities to study. Some 1,500 strains of mutants are shipped out to geneticists around the world from the 50-year-old mutant-fruit-fly repository at California Institute of Technology (Caltech). Many of these strains exhibit bizarre behaviors. "Drop dead" does just that at the clap of a hand, 'shaker" sufters uncontrollable trembles, "stuck" can't separate after mating, and dumb-but-persistent "buzz off" can't learn to give up courtship after it has been rejected.

Genes also play a crucial role in the behavior and learning processes of higher animals, as any breeder of dogs or fighting bulls well knows. Much of that learning is stereotyped learning, which is to say animals are genetically programmed to learn certain vital things at specific times. They are programmed to learn how to recognize the sight or sound of their parents, their young, predators, and food sources.

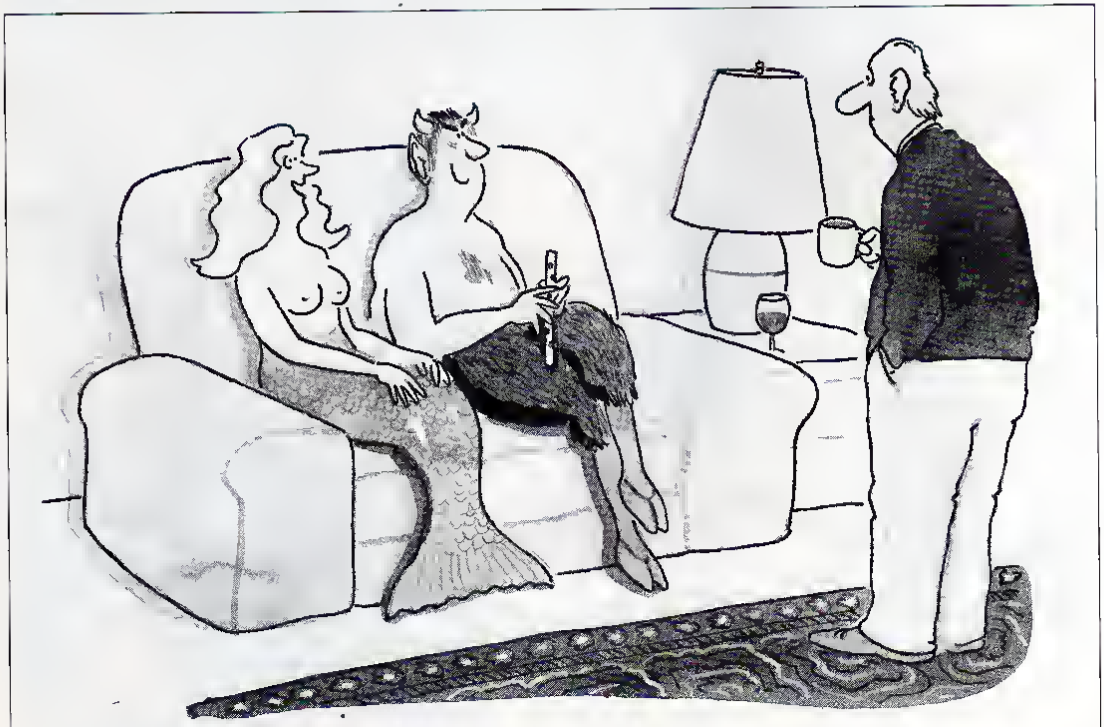
In the Sixties zoologist Peter Marler, of Rockefeller University, found that male white-crowned sparrows could learn to sing in local sparrow dialects but are genetically programmed to learn only the song of their own species. They must also hear the song at a critical, genetically determined period, while they're still chicks and are mentally prepared to "tape" it. Otherwise they will never learn to sing the song. Dozens of other species of birds have been found to sing in local dialects, but for them too the cues and optimal learning periods are genetically programmed.

Scientists are also probing not just what each creature is born to learn but the environmental cues, neural circuits, and biochemical reactions involved in these processes. Eventually the behavior regulating genes themselves will be identified and their functions explained.

We already know that genes direct in considerable detail the wiring of the 10 billion nerve cells in the human brain. We no doubt have a few genes that ensure we will retain certain behaviors and experiences. We also have genes that filter and organize our sense perception of the world.

Our brain, for example, is wired at birth to recognize about 40 distinct sounds from the continuum of noise we hear the moment we're born. All human languages are made up of these sounds. Specific regions of our brains are wired to process written and spoken language, to decode the significance of everything we read and hear, and to use grammar and syntax to impart meaning to what we say. (See this month's Interview with linguist Noam Chomsky, page 112.) Unlike chimps and other primates, human infants are genetically programmed to learn language without any extra encouragement.

There's no question neuroscientists will look for such genes—not to tamper with them, but to understand what they do. Eventually some future generation will have a catalog of the gene sets and biochemi-



'For a long time we thought we were putting each other on."

cal reactions that underlie each possible behavior When that day comes changing behavior by genetic intervention will be feasible Carrying it out and having it work as expected will be another matter.

Nature is frugal, frequently putting one thing to many uses For that reason a single gene or set of genes we might choose to implant in a healthy person's cells is likely to have many more functions than the one we've identified The effect is likely to be far less predictable than that of supplying a normal gene to a patient who has an inherited disease because he lacks it.

Behavioral and intellectual traits may also be hard to tamper with because the wiring pattern of the brain is largely set at birth. Changing this wiring will have to wait until we've learned how to transplant or modify multiple genes in human embryos. And altering the brain's wiring later in development will prove still more difficult.

"The most important limitation here," says Bernard Davis, of Harvard's bacterial physiology department, "is another one, which has not been prominent in discussions of various scary scenarios: motivation. Every embryo or fertilized egg contains a novel, unknown set of genes, and I find it hard to see why anyone would wish to go to great trouble to insert known behavioral genes into such an unknown background." If a couple wished to have a smarter or stronger child than their own genes seemed likely to provide, it would be simpler to start with someone else's egg or sperm, Davis suggests. "This kind of manipulation of embryos seems to be extremely unlikely for the foreseeable future."

Even if science acquires this ability and society somehow has a compelling reason to alter human intelligence, character, behavior, talents, or temperaments, it may still be easier to intervene externally rather than genetically. By the time we've learned that much about the molecular foundations of mood and behavior, we'll also undoubtedly know how to design drugs to make us more sensitive, sociable, clever, kind, or whatever we choose. Mood- and behavior-altering drugs already exist and they will continue to be available to us. In new, improved forms Education behavior modification, indoctrination and psychosurgery have also proved to be powerful tools for modifying human behavior.

"If you think about the brain, culture has a far more profound effect on future generations than does genetic constitution," Axel says. "Cultural transmission of information is profound. If we want to change people, we ought to be dealing at the level of culture and not at the level of the genes. And that is possible right now. You'd have to modify a lot of embryos to match the impact that some religious cults have had."

A few scientists do think that changing our programmed behavior is important to our survival. They feel we should use drastic means to accomplish this if not genetic engineering, then some sort of cultural engineering. Harvard sociobiologist Edward

CONTINUED ON PAGE 160

There are more than 1 million insect species, and for every one, idiosyncrasy means survival

UBIQUITOUS BUGS

BY KATHRINE JASON

Magnificent and menacing, winged and earthbound, brilliant as war paint or dreb as dirt: Insects fill every earthly habitat, from the frigid Himalayan snowfields to the turbulent surface of the sea. Some are pests that suck our blood, destroy our food (ambush bug, page 101, bottom), and poke holes in our plants (the ravenous plant hopper, page 98, bottom, and the whitefly nymph, page 101, top). Others pollinate flowers or spin slender strands of silk. But no matter what the species, each breed of insect has honed its traits for the serious business of survival

The many musicians of the insect world, for instance, do their singing in search of a mate. With just a few months of allotted life, they have no time for learning, but croon instinctively, scraping their wings in ametory chirps and trills. Sounding their songs, summer balladeers, like the katydid (pictured directly below) and the short-horned grasshopper (page 96), quickly attract partners, depositing hundreds of eggs before death quickly descends in the fall.

While crickets click and rattle for love, butterflies and moths have their own esoteric style. Weaving from blossom to blossom like windblown kites, they may seem aimless in their aerial antics, but their behavior is impeccably logical, genetically programmed to find them food and water. Traveling the continents

In preordained paths, butterflies like the painted lady flutter their iridescent wings seductively, en route they mate and lay their eggs, which hatch into caterpillars, then metamorphose into winged fliers. Still awaiting adulthood and flight the commander butterfly, tiger swallowtail, and death's-head sphinx caterpillars are shown on pages 97, 99, and 100, respectively.

From the brilliant butterfly to the tentacled roach, there are more than 1 million insect species, and each has its own particular means of survival. These tiny invertebrates defy us in their perseverance, their diversity, their sheer numbers. But alien as they seem, they are creatures of the earth, descendants of the same evolutionary forces that molded man.

THE ARMIES OF 1990

Generals can fine-tune all the instruments of future war except one: the man on the front line

BY PETER McCORMICK

In the shadow of the mushroom cloud and the particle beam, after years of steadily escalating nuclear stockpiles that assure the world's destruction many times over, it is sobering to learn that the Army still sees a future for the foot soldier. And that tomorrow's command post could well be a muddy thicket littered with camouflage nets, wires, dirt holes, and four-wheel-drive vehicles that have run out of gas.

"Technology hasn't done much for the poor old soldier," concedes General Donn A. Starry, the former head of Readiness Command at MacDill Air Force Base, in Florida. Indeed, it appears that the pace of future war will only exacerbate the confusion, fear, pain, and exhaustion that have ever been the soldier's lot. New generations of weapons offer the capacity to fight without letup, but generals don't yet know how to make their soldiers fight without sleep.

At the outset, future warriors will go into battle in much greater comfort than ever before. The bulky fiberglass protective vests worn in Vietnam will be replaced by waistcoats of Kevlar, a light, woven fiber. Instead of tinned rations, the troops will carry freeze-dried or dehydrated foods that take up far less space and taste better, too. The new M-1 tank, as well as the M-2 and M-3 armored vehicles that will carry soldiers into battle, travels fast and even has air-conditioning.

So much for the good news. Because small arms have become increasingly automated, each soldier has to carry greater loads of ammunition. He also has to drag along infrared night sights for his weapons and cumbersome goggles for his eyes. During nuclear-, biological-, or chemical-warfare alerts, he will sweat in specially treated rubber gloves, boots, and mask that have a combined weight of more than eight pounds.

Decontamination procedures are impractical, to say the least, according to an officer who recently reviewed them. Says Major Kenneth Miller, at Fort Benjamin Harrison, in Indiana: "Taking into account the time needed to change gear, the number of people, and the amount of available equipment, decontamination becomes an impossible task. You wouldn't have time to fight a war. You'd be spending your whole time at the front changing your clothes and washing yourself."

Noise on the future battlefield will be a painful assault in itself, guaranteed to damage the soldiers' hearing. George

PAINTING BY ERNST FUCHS

Garinther, chief of acoustics at Aberdeen Proving Grounds, in Maryland, notes that a 155mm howitzer creates a 181 decibel explosion. A single round from an M-16 rifle hits 159 decibels. Remember, for comparison, that a rock band in concert rarely exceeds 115 decibels.

Existing ear-protection devices would only handicap the soldier by making him deaf to the warning noises of incoming shells. It might be possible to develop an infantry helmet that screened ambient noises, although no such protective gear is in the offing right now.

But in future wars, noise and the burden of gear and weapons would be tiny problems when compared with risks to life. Sometimes modern technology actually adds to the danger.

Since the early Seventies, when precision-guided weapons first came into wide use on the battlefield, microprocessors and laser and infrared technology have raised rocket-propelled missiles to new heights of accuracy. The most common antitank weapon in the U.S. Army is the TOW, for tube-launched, optically tracked, wire-guided missile. After launching the missile, however, the operator must keep the target lined up in the cross hairs of his sight. As he does so, he risks discovery by his attackers, for he must stay very still and frighteningly exposed.

The Army calls the necessary fortitude required here the "pucker factor." And although weapons currently under development reduce the pucker factor, it has not been altogether eliminated.

Missiles with infrared sensors that home in on the heat of the target's engine, for example, still have to be launched by someone. And that someone has to step into the enemy's line of fire at each launch. Missiles with electro-optic systems that steer them toward a spot of laser light on the target depend ultimately on a soldier who is standing, unprotected, playing the laser beam on the target.

The newest Army field manual, called *FM 100-5, Operations*, reiterates the obvious when it says, "The confusion, extreme stress, and lethality of the battlefield place a heavy burden on courage and human endurance.

"Commanders," it continues, "must assess human abilities and limitations as they plan and fight their battles." Unfortunately, the manual offers no specific directions for doing so. When it comes to helping the enlisted man cope with stress, there is "considerable disagreement within the Army," according to Colonel C. F. Tyner, director of neuropsychiatry at the Walter Reed Institute of Research, in Washington, D.C. "It is clear," Tyner says, "that we don't have a knowledge of the important controlling variables—about which elements will promote performance and which elements will detract from it."

Nevertheless, the Army is investigating several strategies, paying particular attention to the problem of fatigue. A 1981 study, "Management of Stress in Army Operations," reveals that continuous combat in World War II and the Korean War amounted to two or three engagements a day. In future fast-paced conflicts, the report predicts, 10 to 12 engagements a day will be the norm. A soldier might enter a battle knowing that he will get no rest for the next 100 hours. And the Army expects that for every three men who fall victim to enemy fire, at least one soldier will become a "stress casualty."

"We believe sleeping should be incorporated into field doctrine so that it becomes the same thing as rifle cleaning," says Tyner.

One study conducted by the British Army in 1979 reveals some of the limitations of sleepless troops. During a nine-day field exercise, one group of men was permitted three hours of sleep every 24 hours. Some 90 percent of the subjects completed the full nine days. The second group slept an hour and a half every day. After two days, the group fell apart, then rallied after being ordered to attack an "enemy" unit. But the following day, half of these men dropped out of the exercise.

"Decontamination is an impossible task, considering the number of people. You wouldn't have time to fight a war. You'd spend all your time changing clothes."

The third group got no sleep at all. After 72 hours the men ceased to be effective. And 24 hours later the entire platoon withdrew from the exercise because the soldiers were unable to stay awake.

Armed with such data, military leaders still face a problem that may be as difficult as designing a laser gun. How can men in the din of battle be disciplined to take a nap when they are told to?

One possible way to get troops to sleep on command is a technique developed seven years ago by Robert Monroe, of the Monroe Institute in Faber, Virginia. Monroe's system capitalizes on the knowledge that electrical impulses traveling through the brain change frequencies according to the body's state of wakefulness. Beta frequencies, above 16 hertz (cycles per second), occur when an individual is wide awake; the alpha range, encompassing relaxed awareness, runs from 16 down to 7 hertz; below that level are the theta and delta frequencies of deep sleep. (A combination of alpha and theta frequencies marks REM, or rapid-eye-movement or dream-stage sleep.)

Although these frequencies are all beyond the range of human hearing, the brain is capable of detecting their distinct characteristics. Monroe trained his research subjects to become responsive to frequencies of 10 hertz and below by putting earphones on them, then playing a recording of a 300-hertz signal in one ear and 310 hertz in the other.

Subjects listening to the two tones actually perceive a 10-hertz tone, the frequency difference between the signals. It registers in the brain as a low, undulating wave. Monroe reports that during this perception, subjects find it easy to drop off into a catnap.

Sleep training follows the lines of Ivan Pavlov's classical conditioning. Subjects are told to say to themselves, "Go to sleep" at the same time they relax under the effect of the earphone tones. Eventually—after some five to ten half-hour sessions—trainees no longer need the earphones. They find they can put themselves to sleep simply by repeating the phrase "Go to sleep." The self-command is comparable to the sound of the tuning fork Pavlov used to train dogs to salivate.

Monroe's system recently underwent a trial at Fort Benjamin Harrison, where Army officials say all the results aren't in. "We're going slow with it," says psychologist James Caviness, chief of the soldier-performance division. "Our job is not to laugh at the possibilities but to try them."

Caviness says the technique appeared successful when tested with a comparatively small group of 20 subjects, and more trials are under way. All who wanted to were able to go to sleep, he says, and none found the sleep-inducing tones unpleasant. "None of our students ever thought, 'Oh my God, I'm going to sleep,' and fell into a zonked-out state," he says.

On future battlefields, Caviness suggests, officers might hand out portable stereo headphones producing different combinations of tones to foster different levels of sleep. Tone patterns could be programmed into the earphones' circuitry to help subjects travel from light sleep to deeper stages and then into a dreaming state. But these stages of a normal sleep cycle—which can take several hours to pass through—could be compressed into minutes at the battlefield.

Caviness says other combinations of tones from Monroe's tapes appear to *increase* alertness. Continued success in research might someday lead the Army to issue psychological-support gear as well as guns to men headed for the front.

Caviness also alluded to "sponsored research to develop performance-enhancing drugs without harmful side effects," but he had little information about it. And given the outcry of a few years ago, when the public learned that unwitting soldiers had received experimental doses of LSD, the

Army is understandably wary of discussing drug approaches to combating stress and improving efficiency.

In place of the amphetamines that were issued to the Army's elite Long Range Reconnaissance Patrols in Vietnam, the 1981 stress-management study offers yogalike exercises for the soldier to try. On the surface, these suggestions seem appropriate for the physical symptoms of stress most of us know too well—forgetfulness, inability to concentrate, persistent weariness, involuntary twitching, numbness, dry mouth, upset stomach and bowels, excessive sweating. But for the wet, weary soldier who is isolated under fire and engulfed in his own helplessness, they seem pathetically inadequate.

- He should breathe deeply and tell himself that he is relaxing.
- After stretching and thinking of his "favorite, most quiet place," he should "feel the peace" around him and "notice how calm and relaxed" he is.
- It is also suggested that in the midst of war he "find a quiet place where he will not be disturbed," then repeat such phrases as "Warmth is flowing into my hands, they are warm, warm, warm."

More promising as a hedge against stress, perhaps, is the Army's hope of fostering stronger ties among fighting men through its recent focus on "unit cohesion." The idea is to reinstate the regimental system that the Army abandoned after World War II, thus creating an organization of men whose main loyalty is to a relatively small, homogeneous group, rather than training each individual to behave efficiently among strangers.

"Units that stay together always do better," says General Starry, former head of the Readiness Command at MacDill.

A former Department of Defense official who is now a private consultant for military matters holds that the Army is overlooking the most obvious way to prepare troops for stressful conditions.

"It's the easiest problem in the world," says the consultant, who asked not to be named, "and I know of no army in the world that has done it, except for the Special Forces. You *can* train people for stress. We just don't do it. If you train three quarters of the time at night, you'll do more than anything else to train for stress. The stress level in night training is exceptionally high, providing highly efficient practice for conditions encountered after training."

"It's totally impossible for the peacetime Army to do this," he adds, "because it's not convenient for headquarters staff."

Starry concedes the need for "a better balance between day and night training." He also points out that although machines have now been developed to operate around the clock, the difficulties of repairing them have not been solved. "There are no night-sighting devices on wrenches," he says. "People are going to have to learn that there are things they can't do that they're accustomed to doing in daytime."

The one arena where technology seems to have met and perhaps even surpassed the soldiers' needs is communications. The Army and the Marine Corps have devised a Position Location Reporting System, or PLRS, that is being developed by the ground-systems group of Hughes Aircraft. It is an ultrahigh-frequency radio network that links 370 small user units to transportable command stations. The user units can be carried on a soldier's back or mounted in a plane, jeep or helicopter. Turning on the unit makes it transmit digital data, which central computers use to determine the relative positions of all troops. If the radio frequency is jammed by the enemy, PLRS automatically jumps to another frequency. Each receiver is also a miniature relay station, capable of transmitting data to other stations.

Out in the field, soldiers rely on handheld readout devices attached to the user units to obtain many kinds of information, from their own range and bearing to the location of other units, targets, or landmarks. Ground units are accurate to within 15 meters; airborne equipment, within 25 meters. Troops can also receive medical-evacuation reports simply by pressing one of several secret-code combinations of keys. If a unit is captured in battle, the enemy would not be able to get much out of it. Working under a $260 million contract, Hughes expects to begin delivering the first operational units in 1986.

Critics charge that PLRS *will* wind up giving vital data to enemy forces, and furthermore that reliance on the technology will destroy soldiers' navigational and map-reading skills.

"We've let the technocrats persuade us that because they've had these wonderful technical opportunities come along, we should avail ourselves of them," Starry says. "But soldiers don't *need* to know all that information. And if they did know it all, they couldn't cope with it or act on the data intelligently."

Starry is one who sees highly complex technology as a deadly damper on the efficient conduct of battle. And he is not alone. The Army's Training and Doctrine Command issued a paper last fall called "AirLand Battle 2000." It notes that forces of the future will have to be "light, self-sustaining and capable of rapid movement." It also advocates "a considerable degree of independent decisions and decentralized execution."

In the theology of wartare, new doctrines define the formula that binds the way soldiers will fight with the new tools they will use. As the U.S. Army takes a hard look at the remaining years of the twentieth century and makes plans for the next, it joins new technology with greater willpower. Fighting, until it is extinguished by nuclear explosions, will remain a continuing refinement of the will to dominate coupled with the cunning to survive. ∞

"Harry, could you come here for a moment."

CONTINUED FROM PAGE 16

examination of the sun's atmosphere—the corona—which is visible only during the precious minutes of total eclipse.

Totality thus offers a unique laboratory for learning about the sun. The corona's pearly-white spikes are shaped in part by the sun's magnetic field; the magnetic field, in turn, is affected by solar storms and by the sunspots that appear on the solar surface. So the changing shape and composition of the corona give scientists crucial information about the volatile interior of the sun, and these data may also help physicists and engineers harness nuclear fusion. The reason: If they can learn how the electrically charged gas of the corona is contained by the sun's magnetic field, they will be better equipped to control the plasma, or gas, circulating in man-made fusion reactors.

On Java, understanding such solar dynamics was the special hope of Jay Pasachoff, of Williams College, and Ray Smartt of Sacramento Peak Observatory. In separate experiments they planned to observe the magnetic loops somehow formed within the corona. William Livingston, of Kitt Peak National Observatory, meanwhile sought to measure the motion and velocity of coronal gases. And Donald Landman of the University of Hawaii planned to examine the composition of solar prominences—spots at the edge of the solar disc, created when superheated hydrogen condenses into tongues of flame.

Other researchers hoped to use the eclipse to study the size of the sun. Alan Fiala, of the U.S. Naval Observatory, for example, wanted to find out whether the sun is shrinking, thereby giving out less energy from one decade to the next. To test that possibility, he and his associates, stationed at the edges of the shadow's path, planned to time the moon's traverse of the sun. This information, combined with the known size and speed of the moon and the known distances between Earth, moon, and sun, promised to yield an extremely accurate measurement of the star's diameter and, by extrapolation, its total energy output. All Fiala's observers had to do was decide precisely when the eclipse was total and when the light from the sun came back into view.

Only clouds, diffusers of both light and shadow, could interfere with the scientists' plans, and with ours. But through most of our journey, the weather inspired only high hopes. Tokyo was sunny. Hong Kong was sunny. The day we spent rattling around on a bus tour of southern China was sunny. Singapore, Bangkok, and Djakarta were sunny. Our stomachs knotted, however, on the last leg of the trip. The flight into Surabaja on June 9 descended through 30,000 vertical feet of cirrostratus, cirrocumulus, altostratus, altocumulus, and stratocumulus clouds—threatening news in all shapes and shades of gray.

The weather on June 10 was no better, so contingency plans were made. A few people hired cars and drivers to speed for holes in the overcast, if need be. Several groups chartered buses. A pair of rock climbers considered scaling the volcano northeast of Surabaja in the hope that its cone would reach above the cloud deck. And a group of New Englanders reserved seats on a domestic flight scheduled to take off 20 minutes before totality; once airborne and above the clouds, they planned to bribe the pilot with 500 greenback dollars to alter course and fly them directly into the path of the eclipse.

On the night before, Bathara Kala was due. a lot of us sat in hotel bars—keeping the faith, dulling our fears, telling of eclipse sprints in the past. Few spoke of failure.

Jim McKay, a meteorologist with the U.S. weather service in Philadelphia, saw that his chosen site would be clouded out during the 1972 eclipse over Quebec. "so we raced toward the northeast. It was a road rally, maybe forty cars. We were going eighty-five miles per hour and we had cars passing us; we had both lanes going in the same direction. The cops just backed off. And we got clear; we saw it."

Ernie Asten, who owns a hardware store in San Francisco, believed that his chosen site in Montana would probably be clouded out during the crucial part of the 1979 eclipse, so he and his friends piled into a small plane and went looking for a hole in the clouds. "We were at three thousand feet when totality began," he said. "Everyone leaned toward the window. It was all elbows in there; the circumstance for viewing wasn't the best. But the compensation, the thing the people on the ground couldn't see, was this inky carpet of lunar shadow rolling over the snow-covered landscape at the speed of sound, enveloping it."

In Kenya for the 1980 eclipse, Fred Espenak, of the NASA/Goddard Space Flight Center, realized at the last minute that his position would be clouded out. He leaped into his van, ripped over dirt roads until he found a break in the clouds, jumped out, saw totality begin, then watched the rest of the eclipse as he ran, keeping himself under the hole as the clouds blew along.

On June 11, scientists wished for such mobility but had none. Saddled with unwieldy equipment, from telescopes to digital computers, most American researchers had come to Tanjung Kodok, an ocean promontory on Java's north coast. Secured by the National Science Foundation (NSF), the site lay on the centerline of the path of totality so, in theory, researchers there could take advantage of the eclipse at its longest duration—five minutes and seven seconds. But at that locale on June 11, a thin layer of high stratus clouds hung between observers and eclipse, providing enough pollution to damage experiments dependent on the detection of electro-

magnetic radiation. For months after the eclipse, researchers would have to work on the data, trying to separate the faint coronal spectra from the far more intense spectra of clouds. Only astronomers who depended on direct observation or simple instruments enjoyed complete success.

Our own group was stationed 25 miles south of Tanjung Kodok, in downtown Surabaja, and for us, conditions were perfect. No sprint schemes were needed. Only a few puffy cumulus clouds wandered the sky, and though a few of them crossed the sun during the partial phases, they were nowhere even close at totality.

Our chosen site that day was the parking lot of the Bumi Hyatt Hotel, and there we found that the Indonesian government had sadly underestimated its people. Using sign language alone, we convinced hotel staffers that when totality arrived, they could watch with the naked eye. We also showed them how to look at the partial phases using our solar filters, made from two thicknesses of black-and-white film, completely exposed and developed. As they looked, they spoke the universal language of eclipse chasers: "Ooohh" and 'Aaahh,' they said.

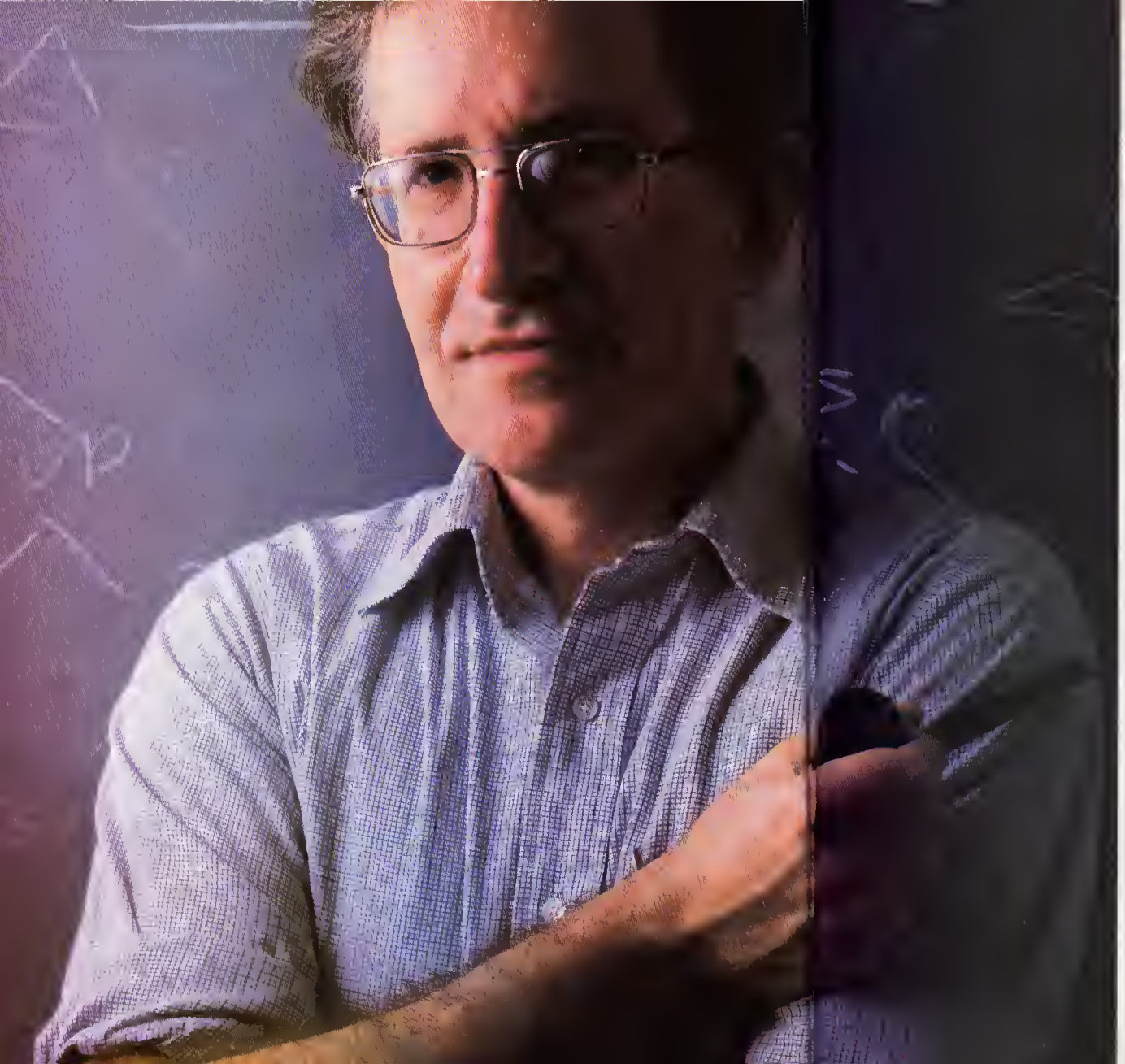
Few Javanese witnessed the event, however. The streets of the city were empty. Men taped newspapers over their windows and tethered their children to furniture. Pregnant women hid under beds and rubbed their bellies, believing this would save the babies from being born with skin speckled by tiny images of the sun. Thousands of Moslems jammed mosques throughout the city, and their frenzied prayer chants were broadcast outside by loudspeakers. Through that noise, we heard only one Surabajan doing battle with Bathara Kala, quite close to our viewing site, someone had set off a medium-bore cannon to scare him away.

In the moments before *gerhana matahari*, roosters crowed, the air took on an eerie lemony hue, and Venus appeared in the sky. Then the tiny remaining horns of the crescent sun slid suddenly together and coalesced into a single magnificent shaft of light—the sun's final ray, penetrating a valley on the mountainous edge of the moon. The black lunar disc then appeared as if by magic, the sky went nearly dark, the soft tones of sunset poured to horizons all around us from the limits of the shadow of the moon, and the sun's corona burst bright, reaching 1 million, 2 million, 3 million miles into space.

The collective hysteria of eclipses claimed most of us. Demon or no demon, we stood screaming.

When the first slice of light reappeared, I spotted Holloway. She was awestruck, quivering, red in the face, and breathless. Some hours later we spoke.

"I have to admit that I decided today to marry for money and not love so I can afford to do this again," she said. I cast her a curious glance. She shrugged. "The monkey's on my back." ☒



The revolutionary linguist who believes we have a "language organ" in our brain also thinks there are some things no amount of learning can teach

INTERVIEW

NOAM CHOMSKY

In 1953 a rickety old tub that had been sunk by the Germans and later salvaged was plodding its way across the Atlantic on the first voyage of its new life. Aboard that listing ship, a seasick young Philadelphian hit on an idea that would make him an internationally known scholar and would radically alter the way linguists view language.

"I remember exactly the moment when I finally felt convinced," Noam Chomsky recalls of the crossing. Sure of himself, he set about emphasizing the role of the mind, outlining the unconscious mechanisms that make human speech possible and insisting that a genetically programmed 'language organ' in the brain primed the human infant to master the intricacies of his mother tongue. This language organ allows for the gift of speech that sets humans apart from the other animals. But it also defines and delimits the characteristics of all human languages, from Urdu to Navajo.

Before Chomsky's breakthrough in the mid-Fifties, American linguists did not believe that brain structure played any significant role in shaping language. They viewed the young child's mind as a blank slate, capable of learning virtually *any* conceivable kind of language. They had no concept

PHOTOGRAPH BY LESLIE HARRIS

then that certain languages might exist almost beyond human comprehension, just as X rays and ultraviolet radiation are invisible to the naked human eye.

Many of these linguists were searching for purely mechanical procedures—"discovery procedures"—that would objectively describe the structure of any human language. Chomsky himself started out as a structural linguist and published a technical paper on discovery procedures while he was a junior fellow at Harvard, in the early Fifties. He considered this work to be real linguistics, although he was exploring alternative ideas.

But by the time he set out on that fateful ocean voyage, he was ready to concede that "several years of intense effort devoted to improving discovery procedures had come to naught." His other efforts, carried out in almost complete isolation, were yielding consistently interesting results. This was Chomsky's pioneering research in generative grammars and explanatory theory. Chomsky expanded the definition of *grammar* to include all the elements and rules of each language that the child assimilates as he learns to speak and understand what is said to him, as well as the linguist's theory of what goes on in the speaker's/hearer's brain.

Chomsky believes that language, along with most other human abilities, depends upon genetically programmed mental structures. In other words, language learning during childhood is part of the body's preprogrammed pattern of growth. Just as heredity endows each infant with a heart and lungs that continue to develop after birth, it provides each newborn with a highly complex language organ. The accidents of evolution have shaped this language organ so that it is capable of learning only those languages within a relatively narrow range of logical structures. Other languages, no less suitable for intelligent communication but lacking these human hallmarks, would be virtually unlearnable, even for the most gifted linguist. Chomsky foresees the day when scientists will have constructed a kind of linguistic analogue to Mendeleyev's periodic table—a list of the linguistic "atoms" and their permissible combinations that defines *every possible* human language.

Chomsky's rise to scientific prominence was meteoric. After completing his undergraduate studies at the University of Pennsylvania, he went on to earn a doctorate there in 1955. That was the year he failed to find a publisher for his book *The Logical Structure of Linguistic Form* and the prestigious journal *Word* rejected a paper summarizing his new ideas—practically by return mail. Yet, two years later his short monograph *Syntactic Structures* took the linguistic community by storm. Scarcely a decade passed before Chomsky was the world-renowned leader of an intellectual revolution in the field of linguistics.

Aside from the originality of his ideas, Chomsky owes his success to his awesome ability as a debater: he's famous for surgically dissecting the logical flaws in rival views. Then, too, he happened upon the linguistics scene during a period of growing dissatisfaction with traditional theories. His widely recognized gifts as a teacher also helped him. As University of California at Berkeley philosopher John Searle observed, Chomsky did *not* win over the established linguists in the Sixties. "He did something more important: he convinced their graduate students."

During the Sixties Chomsky achieved national recognition as a critic of the Vietnam War. He recalls that he sometimes made eight speeches a day while producing a torrent of documented critiques of American policy as well as numerous technical books and papers in linguistics and philosophy. He was also a tax resister and withheld half of his federal income taxes as a protest against the war.

With changing political fashions, Chomsky has found it increasingly difficult to

> *"Language depends on a set of genes that is on a par with the ones that specify the structure of our eyes or circulatory system, or determine that we have arms instead of wings."*

place his political essays in mainstream magazines, but he continues to be widely read and respected as a political commentator in Western Europe and Latin America. Since 1958 he has written 21 books and about 100 articles on linguistics, philosophy and psychology. He has also found time to author or coauthor an additional 11 books and perhaps 1,000 articles on political and social themes.

Chomsky once said that "anybody who teaches at age fifty what he was teaching at age twenty-five had better find another profession." Over the last 25 years his own linguistic theory has passed through four main stages, each differing in major ways from its predecessor. Chomsky is unique among contemporary scientists in that most of his opponents defend theories he either originated or profoundly influenced. Today he is a professor in the department of linguistics and philosophy at the Massachusetts Institute of Technology.

Psychologist and science journalist John Gliedman, who studied Chomsky's theories in the late Sixties at MIT, discussed ideas about language and mind in the linguist's austere campus office.

Omni: Why do you believe that language behavior critically depends on the existence of a genetically preprogrammed language organ in the brain?

Chomsky: There's a lot of linguistic evidence to support this contention. But even in advance of detailed linguistic research, we should expect heredity to play a major role in language because there is really no other way to account for the fact that children learn to speak in the first place.

Omni: What do you mean?

Chomsky: Consider something that everyone agrees is due to heredity—the fact that humans develop arms rather than wings. Why do we believe this? Well, since nothing in the fetal environments of the human or bird embryo can account for the differences between birds and men, we assume that heredity must be responsible. In fact, if someone came along and said that a bird embryo is somehow "trained" to grow wings, people would just laugh, even though embryologists lack anything like detailed understanding of how genes regulate embryological development.

Omni: Is the role of heredity as important for language as it is for embryology?

Chomsky: I think so. You have to laugh at claims that heredity plays no significant role in language learning, because exactly the same kinds of genetic arguments hold for language learning as hold for embryological development.

I'm very much interested in embryology, but I've got just a layman's knowledge of it. I think that recent work, primarily in molecular biology, however, is seeking to discover the ways that genes regulate embryological development. The gene-control problem is conceptually similar to the problem of accounting for language growth. In fact, language development really ought to be called language *growth*, because the language organ grows like any other body organ.

Omni: Is there a special place in the brain and a particular kind of neurological structure that comprises the language organ?

Chomsky: Little enough is known about cognitive systems and their neurological basis, so caution is necessary in making any direct claims. But it does seem that the representation and use of language involve specific neural structures, though their nature is not well understood.

Omni: But clearly environment plays *some* role in language development. What's the relationship between heredity and environment for human language?

Chomsky: The language organ interacts with early experience and matures into the grammar of the language that the child speaks. If a human being with this fixed endowment grows up in Philadelphia, as I did, his brain will encode knowledge of the Philadelphia dialect of English. If that brain had grown up in Tokyo, it would have encoded the Tokyo dialect of Japanese. The brain's different linguistic experience—English versus Japanese—would modify the language organ's structure.

Roughly the same thing goes on in animal experiments, showing that different kinds of early visual experience can modify the part of the brain that processes visual information. As you may know, cats, monkeys, and humans have hierarchically organized brain-cell networks connected to the retina in such a way that certain cells fire only when there is a horizontal line in the visual field; other hierarchies respond only to vertical lines. But early experience can apparently change the relative numbers of horizontal- and vertical-line detectors. MIT psychologists Richard Held and Alan Hein showed some time ago, for example, that a kitten raised in a cage with walls covered by bold, black vertical lines will display good sensitivity to vertical lines as an adult but poor horizontal-line sensitivity. Lack of stimulation apparently causes the horizontal-line detectors to atrophy.

An even closer analogy exists between language growth and the growth that occurs in human beings *after* birth—for example, the onset of puberty. If someone came along and said, "Kids are trained to undergo puberty because they see other people," once again everybody would laugh. Would we laugh because we know in great detail the gene mechanisms that determine puberty? As far as I can tell, no one knows much of anything about that. Yet we all assume that puberty is genetically determined.

Omni. Still, as your own example shows, environmental factors do play a major role in physiological growth.

Chomsky. And it goes without saying that the onset of puberty may well vary over quite a range depending on childhood diet and all kinds of other environmental influences. Nonetheless, everyone takes for granted that the fundamental processes controlling puberty are genetically programmed. This is probably true of death as well. You may be genetically programmed to die at roughly a certain point; it's a reasonable theory.

Look, all through an organism's existence from birth to death, it passes through a series of genetically programmed changes. Plainly language growth is simply one of these predetermined changes. Language depends upon a genetic endowment that's on a par with the ones that specify the structure of our visual or circulatory systems, or determine that we have arms instead of wings.

Omni. What about the linguistic evidence? What have you learned from studying human languages to corroborate your biological viewpoint?

Chomsky. The best evidence involves those aspects of a language's grammar that are so obvious, so intuitively self-evident to everyone, that they are quite rightly never mentioned in traditional grammars.

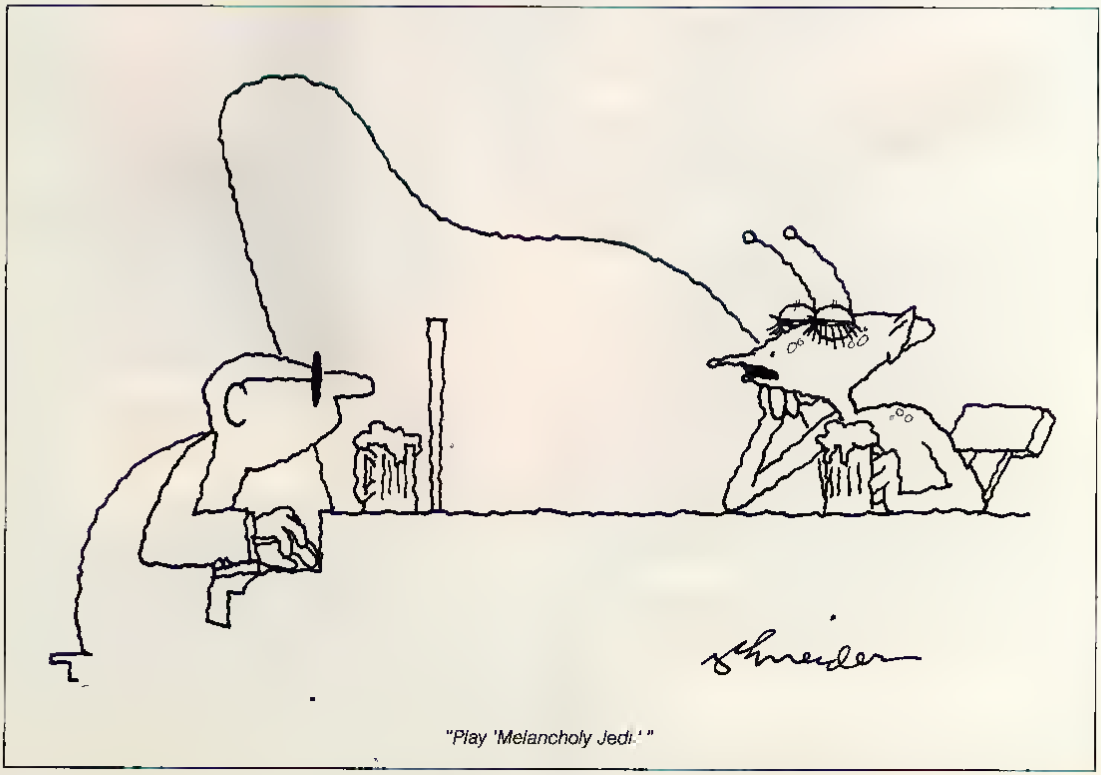
Omni. You mean that school grammars fill in the gaps left by heredity? They teach everything about French or Russian, for example, that can't be taken for granted by virtue of the fact that you're a human?

Chomsky. That's right. It is precisely what seems self-evident that is most likely to be part of our hereditary baggage. Some of the oddities of English pronoun behavior illustrate what I mean. Take the sentence "John believes he is intelligent." Okay, we all know that *he* can refer either to John or to someone else, so the sentence is ambiguous. It can mean either that John thinks he John, is intelligent, or that someone else is intelligent. In contrast, consider the sentence "John believes him to be intelligent." Here the pronoun *him* can't refer to John; it can refer only to someone else.

Now, did anyone teach us this peculiarity about English pronouns when we were children? It would be hard to even imagine a training procedure that would convey such information to a person. Nevertheless, everybody knows it—knows it without experience, without training, and at quite an early age. There are any number of other examples that show that we humans have explicit and highly articulate linguistic knowledge that simply has no basis in linguistic experience.

Omni. There's just no way that children can pick up this kind of information by listening to the grown-ups around them?

Chomsky. Precisely. But let me give you



"Play 'Melancholy Jedi.'"

another example. English contains grammatical constructions that are called parasitic gaps. In these constructions, you can drop a pronoun and still understand the sentence in the same way as when the sentence contains a pronoun. Consider the sentence, 'Which article did you file without reading it?' Notice that you can drop the pronoun *it* without changing meaning or grammaticality. You can say, "Which article did you file without reading?' But you can't say, "John was killed by a rock falling on," when you mean, "John was killed by a rock falling on him." This time omitting the pronoun destroys both meaning and grammaticality.

Constructions of this type—where you can or cannot drop the pronoun—are very rare. In fact, they are so rare that it is quite likely that during the period a child masters his native language (the first five or six years of life), he never hears any of these constructions, or he hears them very sporadically. Nonetheless, every native speaker of English knows flawlessly when you can and can't drop pronouns in these kinds of sentences.

Omni: So we're faced with a mystery. How could anyone possibly learn enough about the English language to possess the rich and exotic grammatical knowledge that we all seem to possess by the time we are five or six years old?

Chomsky: There's an obvious answer to that. The knowledge is built in. You and I can learn English, as well as any other language, with all its richness because we are designed to learn languages based upon a common set of principles, which we may call universal grammar.

Omni: What is universal grammar?

Chomsky: It is the sum total of all the immutable principles that heredity builds into the language organ. These principles cover grammar, speech sounds and meaning. Put differently, universal grammar is the inherited genetic endowment that makes it possible for us to speak and learn human languages.

Omni: Suppose that somewhere else in the universe intelligent life has evolved. Could we, with our specialized language organ, learn the aliens' language if we made contact with them?

Chomsky: Not if their language violated the principles of our universal grammar, which, given the myriad ways that languages can be organized, strikes me as highly likely.

Omni: Maybe we shouldn't call it *universal*, then. But please explain what you mean.

Chomsky: The same structures that make it possible to learn a human language make it impossible for us to learn a language that violates the principles of universal grammar. If a Martian landed from outer space and spoke a language that violated universal grammar, we simply would not be able to learn that language the way that we learn a human language like English or Swahili. We would have to approach the alien's language slowly and laboriously—the way that scientists study physics, where it takes generation after generation of labor to gain new understanding and to make significant progress. We're designed by nature for English, Chinese, and every other possible human language, but we're not designed to learn perfectly usable languages that violate universal grammar. These languages would simply not be within our range of abilities.

Omni: How would you assess current research about universal grammar?

Chomsky. In the last three or four years there's been a major conceptual change in the underlying theory. We now assume that universal grammar consists of a collection of preprogrammed subsystems that include, for example, one responsible for meaning, another responsible for stringing together phrases in a sentence, a third one that deals, among other things, with the kinds of relationships between nouns and pronouns that I discussed earlier. And there are a number of others.

These subsystems are not genetically preprogrammed down to the last detail. If they were, there would be only one human language. But heredity does set rather narrow limits on the possible ways that the rules governing each subsystem's function can vary. Languages like English and Italian, for example, differ in their choice of genetically permitted variations that exist as options in the universal grammar. You can think of these options as a kind of linguistic menu containing mutually exclusive grammatical possibilities.

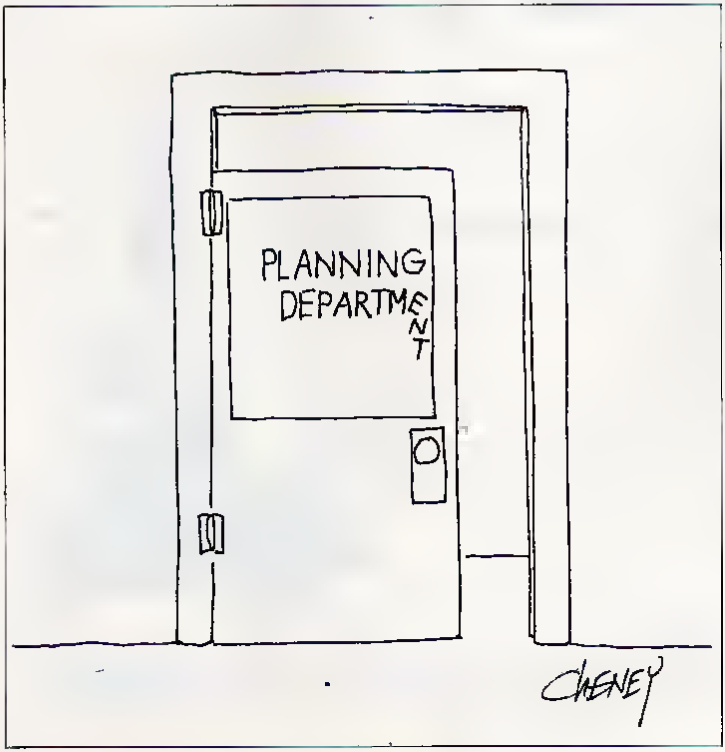
For example, languages like Italian have chosen the "null subject" option from the universal-grammar menu. In Italian you can say *left* when you mean 'He left' or 'She left.' English and French have passed up this option and chosen instead a rule that requires explicit mention of the subject.

Omni: What are some other grammatical options on the universal-grammar menu?

Chomsky. In English the most important element in every major grammatical category comes first in its phrase. In simple sentences, for example, we say *John hit Bill*, not *John Bill hit*. With adjectives we say *proud of John*, not *John of proud*; with nouns we say *habit of drinking wine*, not *drinking wine of habit*; and with prepositions we say *to John*, not *John to*. Because heads of grammatical categories always come first, English is what is called a head-initial language.

Japanese is a head-final language. In Japanese you say *John Bill hit*. And instead of prepositions, there are postpositions that follow nouns: *John to*, rather than *to John*. So here's another parameter the child's got to learn from experience: Is the language head-initial or head-final?

These grammatical parameters are interconnected. You can't pick them any more freely than, say, a wine fanatic who insists on white wine with fish and red wine with meat is free to choose any main dish once he's decided on his wine. But grammars



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RINGWORLD

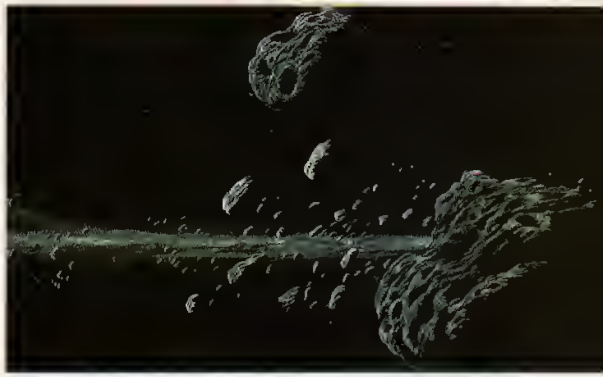
TEXT BY OWEN DAVIES

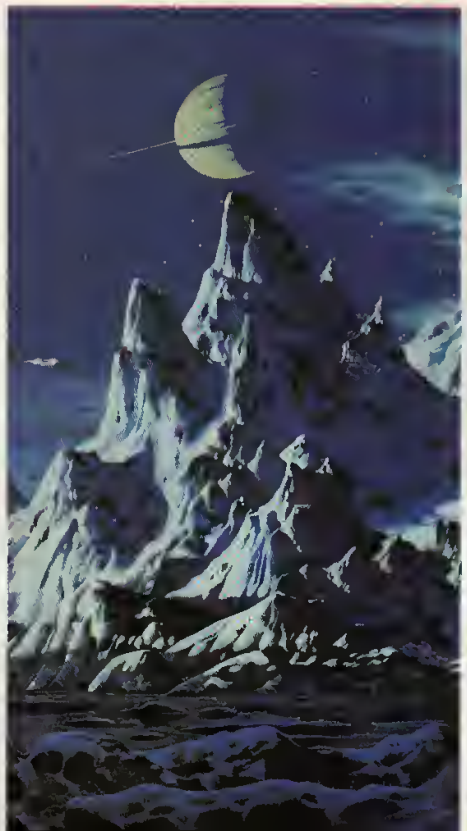
"The most beautiful thing we can experience is the mysterious," wrote Albert Einstein. "It is the source of all true art and science."

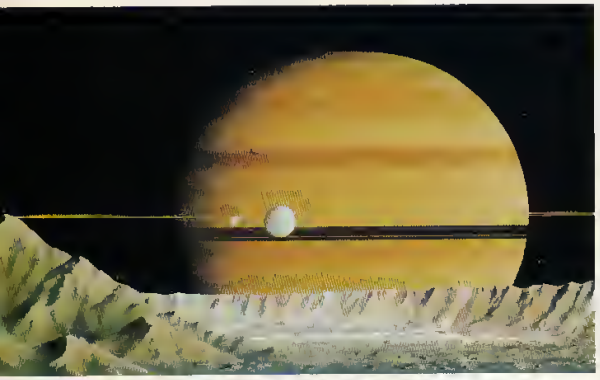
For scientists and artists alike, Saturn is the ultimate beauty—and mystery. Ringed, maddeningly blurred through even the most powerful telescopes, the yellow giant hangs 800 million miles away, its distant gravity tugging at the imagination of all who view it.

Science always struggles to explain mystery. Art already understands; it seeks not to banish mystery but to celebrate it. Thus, the line is drawn: science pressing at the frontiers, art rejoicing in the new

Views of Saturn by Hitoshi Ikematsu (below left), Steve Dodd (below right), and Hans Marten (from the planet, looking out at the rings). All show the planetary system as artists viewed it before Voyager arrived







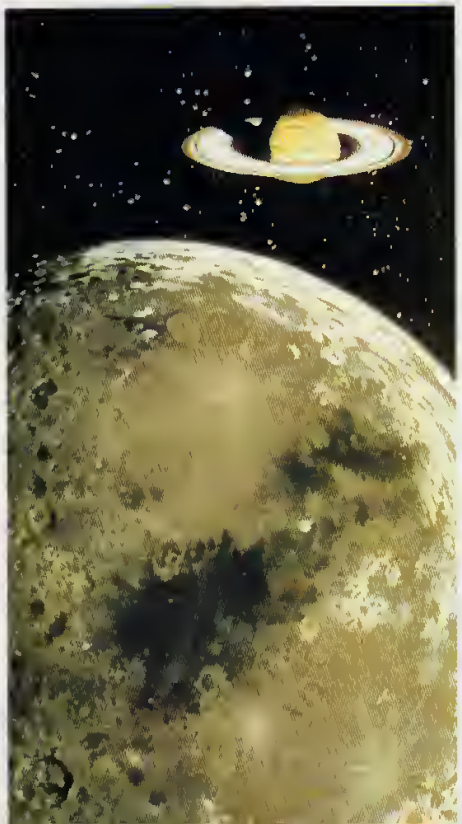
Kim Poor's view of Saturn from Dione (left) shows Tethys and Enceladus as well. David Egge's portrait of Iapetus (below left) accurately foretold its appearance in Voyager pictures. In Hans Marten's view of Saturn from the rings (below right) the planet is broodingly near

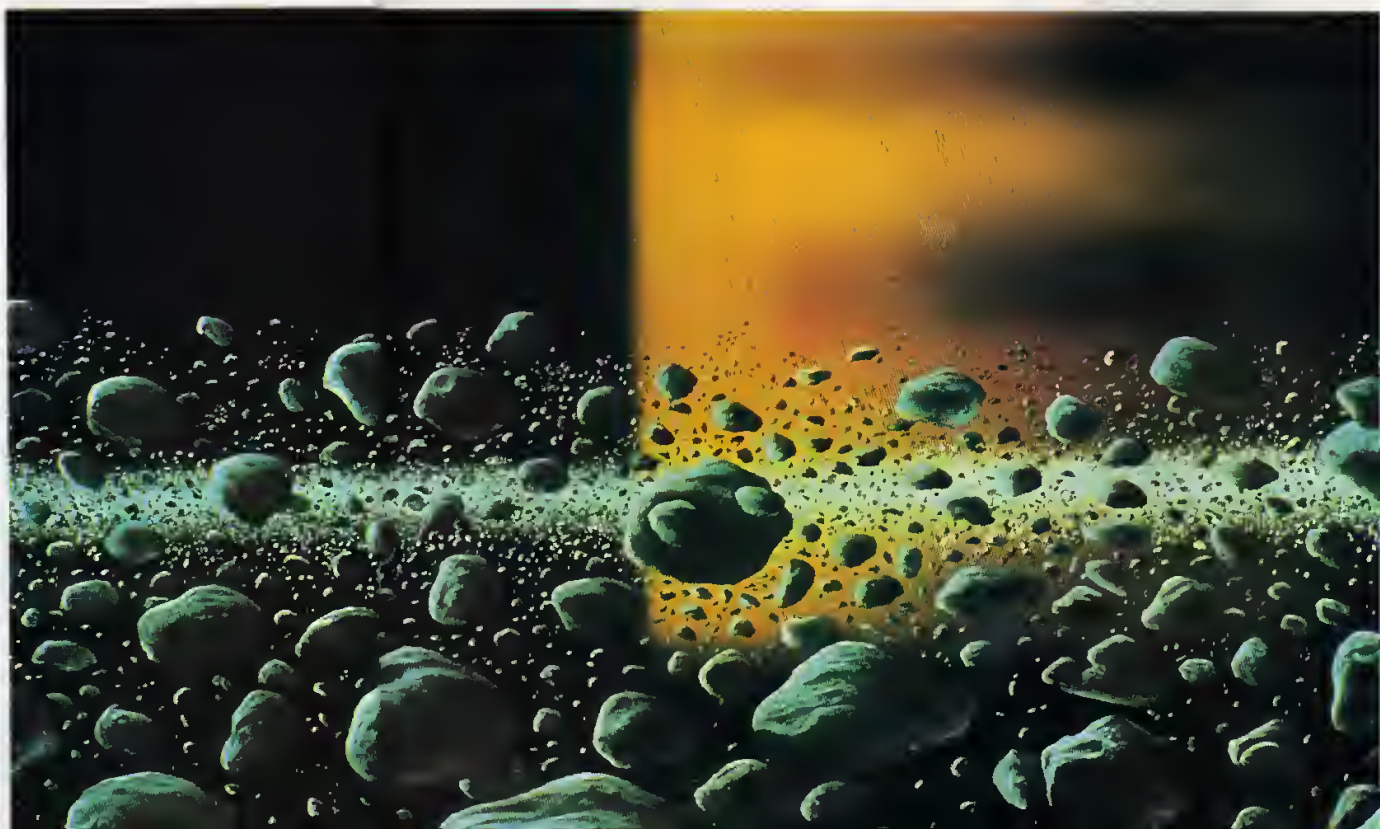
"The most beautiful thing that we can experience is the mysterious"

enigmas that appear whenever science examines the old. But the conflict is false. The victories of science become triumphs of art as well, the intricate understanding of science offers beauty of its own.

In August 1981 NASA found both knowledge and mystery. *Voyager 2* flew past Saturn, probing the puzzles uncovered by *Voyager 1* ten months earlier. Between them, the two probes transformed scientists' ideas of Saturn. There were not three or four rings but half a dozen. They were not smooth bands but strange spirals and braids. Cassini's division, the gap between the major rings, was filled by ringlets.

And there were moons. Not just Dione. Tethys, Enceladus, Iapetus, and the other five or six that telescopes could spy but twice that many





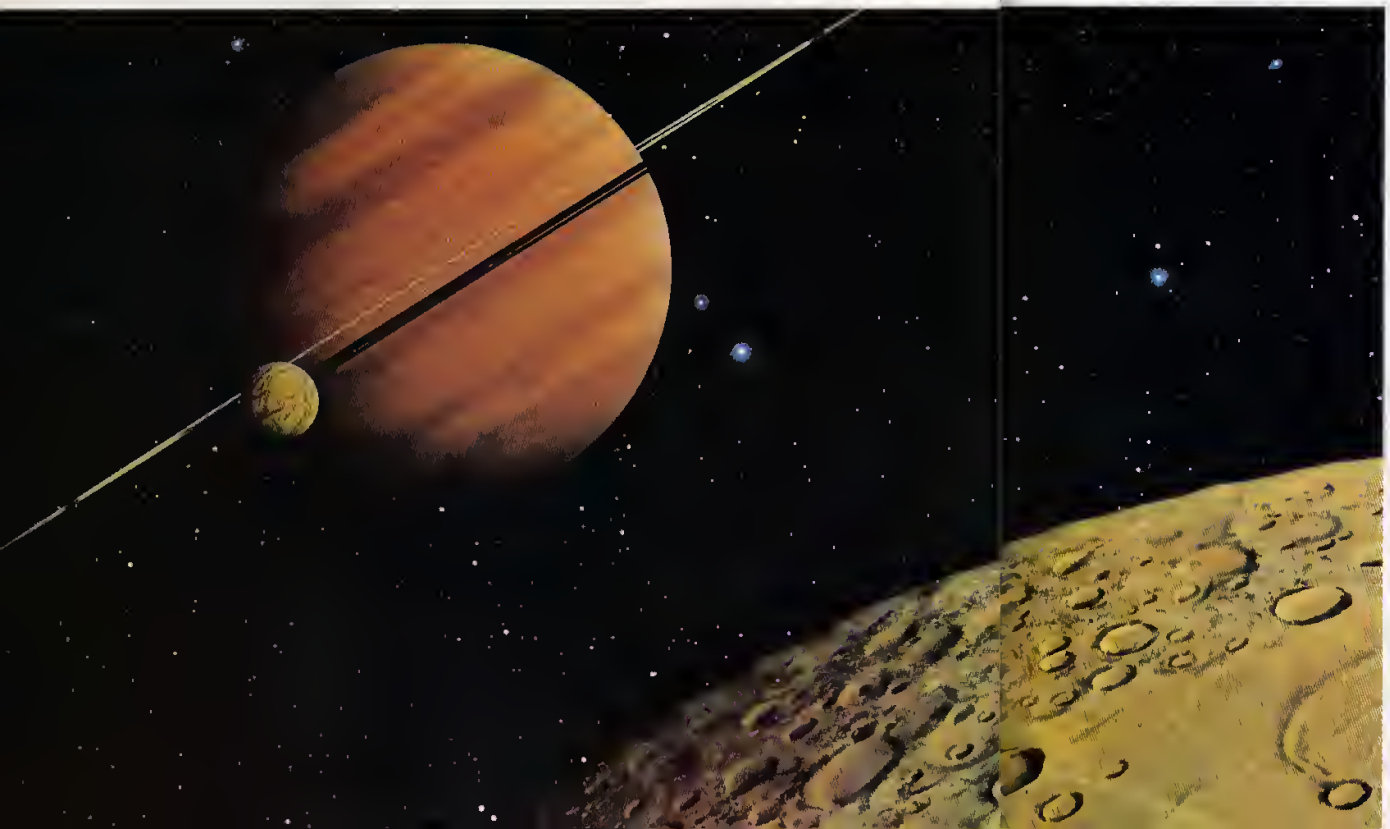
"There will be no more Voyagers, but for science a slim hope remains."

As scientists pondered their data, other satellites appeared—at least 22 in all—and it seems more could yet be found.

Today the remaining mysteries of Saturn are for artists alone. There will be no more *Voyagers*. But for science one slim hope remains. The Galileo mission to Jupiter, to be launched in 1986, will produce enough spare parts and test equipment to build a Saturn orbiter. NASA, unable to fund the mission alone, has asked the European Space Agency (ESA) to join in the effort. Unless ESA agrees very soon, however, NASA will be forced to abandon the project.

Whatever happens, there will be no end to the mystery of Saturn. The ringed planet will inspire artists for many decades to come.

Saturn is seen from Iapetus in Don Dixon's painting (right) and from Tethys in Kim Poor's striking image (below right). The ringed planet and its moons (below left) sprang from Poor's imagination shortly after the first Voyager flyby of Saturn in November 1980.



ATOMS OF LIFE

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bon. Much of what we know about them comes from studies of two meteorite specimens: the Murray meteorite, which exploded into several fragments in the sky over Murray, Kentucky, in 1950; and the Murchison meteorite, which showered fragments—some weighing more than 14 pounds—on Murchison, Australia, in 1969. Both meteorites yielded similar results: a discovery made all the more impressive by the fact that they fell on opposite sides of the world 19 years apart.

The carbon content of each has been extracted and analyzed by scientists at NASA's Ames Research Center. Analyses showed that among the molecules present were several types of amino acids. Six of them—valine, alanine, glycine, proline, aspartic acid, and glutamic acid—were varieties that often occur in earthly proteins.

There are two types of amino acids: L and D. When either type links up to form proteins, it forms chains that are all L or all D. A chain made of both varieties doesn't fit together well, and even if one managed to form, it would break apart easily. Here on Earth, protein chains are all L. Why that is, isn't clear. The all-L chain may just have happened to be the first to get complex enough to display the properties of life and reproduce itself. It may have taken over the Earth before an all-D molecule managed to reach the requisite complexity. In any event, all earthly organisms, from viruses to whales, contain the L-type amino acids.

Although only one kind of amino acid will be formed in living tissue, both kinds do appear when chemists form amino acids in the laboratory using chemicals that are not from living tissue. If the amino acids from the meteorites were not mixed but were all L or all D, we could strongly suspect that life processes similar to our own were involved in their production. In fact, researchers found L and D amino acids in equal amounts, indicating they were formed by ordinary chemical processes.

But in 1982 geoscientists Michael Engel, of the University of Oklahoma, and Bartholomew Nagy, of the University of Arizona, examined a piece of the Murchison meteorite and discovered that it contained amino acids that were predominantly L. This meant either the fragment had been contaminated by some sort of earthly material or there was something wrong with the experimental procedure, or there had been something more complicated than amino acids present at one time in the meteorite's past. If is possible that this was what remained of a bit of an all-L protein that broke down in L amino acids.

Recently it has turned out that the Murchison meteorite contains still other chemicals essential to life—the nucleic acid bases of DNA and RNA. According to Dr. Cyril Ponnamperuma, director of the Laboratory of Chemical Evolution at the University of Maryland, all five essential bases—adenine, cytosine, guanine, thymine, and uracil—are found in the meteorite.

In an experiment similar to Miller's, Ponnamperuma adds, he and his colleagues have managed to produce all five bases from a mixture of methane, nitrogen, and water that is similar to Earth's primordial atmosphere. Such findings make it seem more likely that life could arise anywhere that suitable conditions occur.

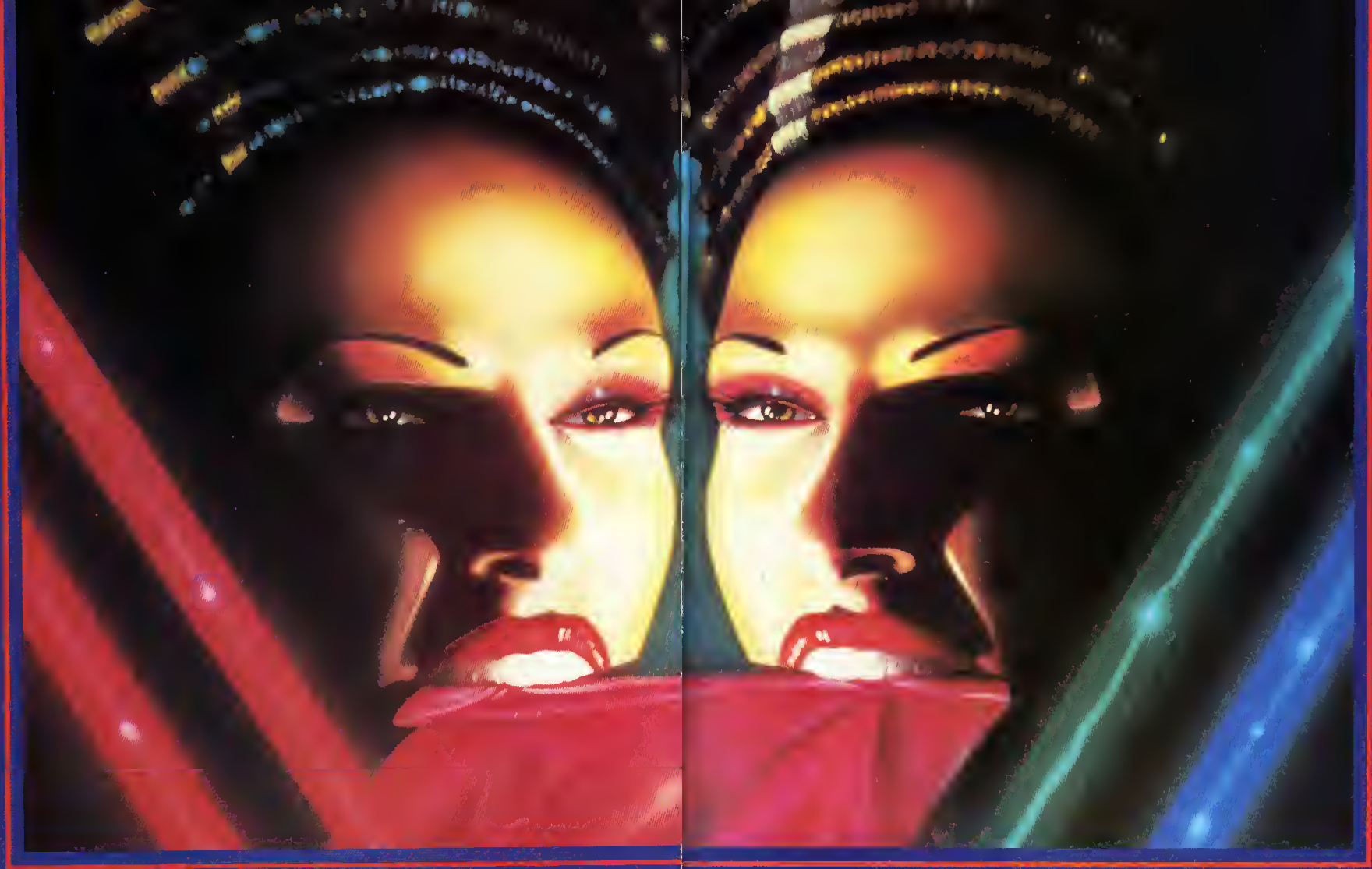
Will we ever be able to find out for certain how life evolved in space? Perhaps. Out on the very edge of the solar system, beyond the orbit of Pluto, are billions of tiny bodies that may hold the answers to our questions about the chemical evolution of life. A little over 30 years ago Dutch astronomer Jan Oort suggested that there is a vast cloud of comets, one to two light-years from the sun, that surrounds our solar system. The comets are thought to be the remnants of the outermost region of the cloud from which the solar system was formed. They are thought to consist of icy chunks largely made of hydrogen, carbon, nitrogen, and oxygen atoms. Because they are far from the sun, they have remained undisturbed by its radiation for millions of years, so they may still contain the unchanged products of chemical evolution—the key to the formation of life.

It is also possible that chemical evolution on Earth did not originate from scratch. It may be that every once in a while a comet collides with a planet and some of its molecules survive the impact. If that planet were potentially hospitable to life, as Earth was, the molecules could accumulate and continue their chemical evolution.

British astronomer Fred Hoyle and his colleague Chandra Wickramasinghe, an expert on interstellar dust, speculate that chemical evolution in interstellar clouds, and therefore in comets, actually reached the stage of living viruses. (See "Seeds of Life," May 1983.) They further suggest that approaching comets may still sometimes infect planets like Earth with new strains of pathogenic viruses, an event that would explain our periodic plagues. (Few astronomers agree, however.)

The cloud of comets is too distant for us to send an astronaut or probe for a closer look, but we can examine the occasional comet that slips away from the cloud and makes periodic passes by the inner solar system. With each pass a comet is exposed to the sun's heat and radiation, which disturb and eventually destroy it. Still, if a comet approaching Earth for the *first* time (as Comet Kohoutek was thought to have done in 1973) could be studied at close range, it might be able to tell us something about how far chemical evolution had proceeded in the cloud where life evolved. It might also tell us why such a complicated process as the evolution of life from inert chemicals could occur in as short a time as half a billion years.

"Okay, one last question. The bigger they are, the harder they fall. Never, sometimes, or always?"



FICTION

AMOR Y PESETAS

BY STEPHEN ROBINETT

Even the most unromantic man can be seduced by the beauty of great art, especially when it's performed by an exotic and elusive dancer

PAINTING BY JEFF WACK

"*Amor y pesetas*," my father used to say, quoting the traditional Spanish toast. "Love and money. It's what we all want, isn't it, Ted? But love—love's the one that causes all the trouble."

My father, as anyone who overheard one of these wistful bits of sentimental philosophy could tell, was a romantic. To some extent I take after him. Some people say my style with a holovision camera even resembles his. But my trouble has always been with the other half of the toast—*pesetas*, money.

I was having that trouble in Madrid when I recalled one of my father's rambling discussions of life and holography, this one from his own wandering youth in the late Eighties, before my mother, before me.

"There's a place in Seville, Ted, where all the flamenco dancers start out. After that, if they're any good they work their way toward Madrid. But Seville's the place to see them, especially the women." Here he always paused and remembered—probably some particular woman—then shook his head to clear it and smiled self-consciously. "Especially the women. Seville gets them first. If gets those few precious years in their lives when they're perfect, before fame, money, and time corrupt them. In Seville they're the best they'll ever be, and that's the best there is, Ted. It's worth seeing, worth taping."

Worth seeing, worth taping—the comment stuck in my mind. In Madrid, scraping the bottom of my expense money from Selman Enterprises, I needed something worth seeing, worth taping, worth adding to Selman's line of *Great Performances* holotapes—and most of all, something worth justifying more expense money. Selman pays field men like me by advancing expense money and deducting the advance later from a flat fee for any usable tapes we send back to him in Los Angeles. He thinks of it as an incentive system. Field men either come up with another Great Performance or run out of money in the middle of nowhere and starve to death.

I invested close to my last dime in train fare from Madrid, hotel in Seville, food, and a ticket to see María Tereza Vasquez, the best flamenco dancer in Seville according to the hotel clerk.

She was. From the moment the lights dimmed in the cafe and the first chord sounded on the guitar—more important, from the first step María Tereza Vasquéz took onto the small stage that jutted into the audience—I was transfixed. The slow initial chords of the guitar, played off against the sound of her heels on the stage or the sharp clack of her castanets in the air, drew me in. The increasing tempo, volume, and complexity, the intricate flourishes of dance and music, the white petticoats and complicated *rasqueados* of the guitar revealed in flashes held me fast, captivated me. But more arresting than any technical execution of the dance was María Tereza Vasquez herself, a true Spanish beauty, jet-black hair, fair skin the color of fine paper, and an air of haughty arrogance that went well beyond the demands of the dance. She filled the café with her self-confidence, her certain knowledge of her own beauty and accomplishment. The attitude showed in her every gesture, her every movement. Whatever problems she had in life, whatever ambitions and setbacks, she knew beyond any doubt—and I knew it watching her—that in this one thing, flamenco, she was perfect.

I called Selman that night, collect, catching him before eight Los Angeles time. He came on the phone frowning, his habitual armor against field men and their demands for more money. I told him about María Tereza Vasquéz.

"A flamenco dancer?" His frown deepened. "I don't know, Ted. Dance tapes don't sell. And that folk crap is at the dead bottom of the list."

"This one will sell."

He hesitated, catching the tone of certainty in my voice. "You sound sure."

"I am sure. It's not just the dance, Sid. It's the dancer. She'll sell. When she was done, that place just about came apart at the seams with all the yelling and clapping and foot stomping. I've never seen anything like it. She walked around up there onstage with her hands on her hips and a look on her face that—I can't describe it."

"Triumph?"

"Contempt. It was as if she thought the audience was incapable of expressing appreciation of her in any way equal to her due. She had performed for us poor wretches, and now it was our turn to perform for her. The look on her face said she knew we weren't up to it, and she was going to stand there and rub our noses in our own inadequacies. Does that make any kind of sense?"

"Not much."

"It did at the time. And I'll tell you something else. They loved it. Every man in that place wanted her. Every man in that place was in love with her."

"Including you."

"Sid, it'll sell."

"I doubt it. Look, if you want to do it on spec, maybe."

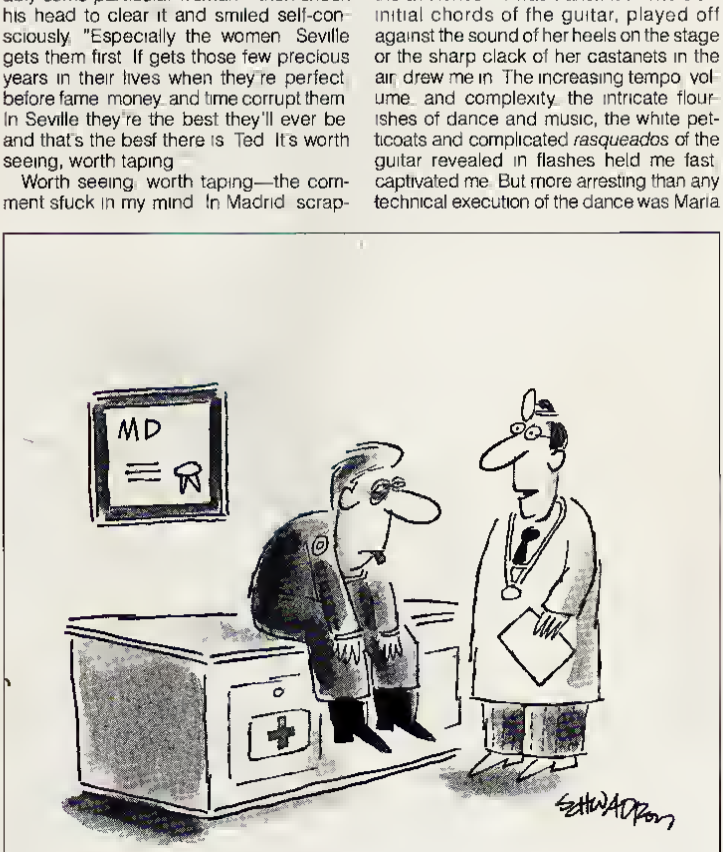
"*Spec!*" This was another of Selman's ploys to keep down expenses. If he felt dubious about a project, he refused to back it, allowing a field man to work it up on his own if he chose, then accepting or rejecting the completed project. "How the hell am I supposed to do that? I'm at the bottom of the cookie jar, Sid. Without a couple of extra bucks—"

Selman solemnly shook his head. "I can't do it, Ted."

I felt myself getting angry. I was out on a limb, and Selman was working away with his little saw. "You *can!* You just *won't!*"

"Same thing. If you believe in this project so much, work it up. Then we'll talk."

My anger hardened into determination. I spoke slowly and distinctly. "Okay, Sid. I'll



"I'm afraid, Captain Kirk, that after countless space missions on starship Enterprise *you're suffering from terminal jet lag."*

do just that. And I guarantee that you'll want it so bad your teeth will hurt."

"Maybe."

"And it'll cost you."

"But first, Teddy, my boy, you've got to get the tape, don't you?"

I tried. Over the next few days I contacted everyone I thought could put me in touch with Maria Tereza Vasquéz—the manager of the cafe, the bartender, the busboy. All of them agreed on one thing. Maria Tereza Vasquez saw no one. Though she owned the cafe, she never mingled with patrons. When I explained that I had no intention of mingling—though mingle I would have done at the drop of a mantilla—that I had business with her, they all shrugged and smiled, as though my problem were interesting but manifestly unsusceptible to solution. I gave each of them my card with a note on the back saying I wanted to talk about making a holotape of her performance, and I asked them to pass it along to Maria Tereza.

Sid was right about one thing. Like everyone else who saw Maria Tereza, I was in love. Every night I sat at her feet in the café, front row center. I tried to get her attention onstage. She scorned me. She scorned everyone.

She strutted above us all and let everyone want her but no one have her.

I expected my reaction to fade with familiarity. If anything, it got worse. Every night I wanted the café empty. I wanted her there alone, dancing for me and no one else. I felt jealous and possessive and in competition with every other male in the place—just the way she wanted me to feel, just the way she wanted everyone to feel. I thought about her all day and dreamed about her all night. Sometimes, waiting in the alley behind the café to catch her on the way out or staking out the front entrance in the late afternoon to meet her going in—never successfully—I held her image so vividly in my mind's eye that I whimpered. It was a pitiful and forlorn noise that explained to me my father's hesitation forty years later, when he remembered Seville—especially the women.

Once, in desperation, I stopped the old woman who shuffled out of the cafe every night after the place was cleaned up and gave her one of my cards, hoping she would get it to Maria Tereza. She looked at the card, studying it and blinking, looked at me, studying me and blinking, then reread the card and tucked it under her shawl. Like the others, she shrugged and smiled, then started off down the alley, a stooped and swaying figure in a black peasant dress, a shuffling symbol of the futility that I felt.

Why did I—why did any man—react that way to Maria Tereza Vasquéz? A need to prostrate ourselves before an image of perfection like native worshipers before a tribal god? Though equally primitive, our response had nothing in it so idealistic. True, in the pool of light onstage, at that moment in her life, Maria Tereza Vasquéz was perfect: the best she could be, the best there was—and also something more. It doesn't make much sense when I say it now, though I felt it with absolute certainty at the time, but she was uncompromisingly female. She embodied the best of everything a woman could be. What did make sense was the effect she had on men. Somehow, probably just by being the way she was, she brought out every response a man can have to a woman—above all else, desire, forever unfulfilled.

After a week of unrequited everything—love, lust, and longing—I found a note in broken English waiting for me at the hotel desk. If I would go to the Calle Socorro near the Plaza San Marcos the next morning, "you perhaps find what you search for." When the next morning? The note didn't say. I arrived at dawn after a sleepless night and waited.

By eleven, the elation that had kept me awake all night rapidly turning to disappointed depression, I was beginning to think no one would show. I had scrutinized every even arguably preffy face I saw in the street. None was the right face. By twelve I was sure no one was coming. I gave it another half-hour. At last, upset and dejected, I started out of the street.

"Miss Lockley, has my head come back from vacation yet?"

As I neared the end of Calle Socorro an old woman approached me. 'Señor.'

"Sí.'

"You search for Maria Tereza Vasquéz?"

I finally recognized her, the old woman from the alley behind the cafe. My excitement returned. "Yes, yes. I'm the one.'

'Come with me."

I followed her through the narrow and winding streets of the quarter, past stucco facades and occasional glimpses through ornate wrought-iron gates of immaculately tended courtyards. The quarter, in the fifteenth century a Jewish ghetto, was now one of the most exclusive and expensive in Seville. She talked to me in rusty but adequate English about Seville, flamenco, and Maria Tereza Vasquez as an artist—no, as an objet d'art, an artifact, a national treasure comparable to whatever part of Christopher Columbus was actually buried in the Seville cathedral.

As we walked, the shuffling scrape of her footsteps echoing in the narrow streets, the conversation gradually shifted from Maria Tereza Vasquez, the national monument, to me—my occupation and background, what I wanted from Maria Tereza, my family—in particular, my father. She wanted to know what he did (like me, holographer), where he was from (Toledo—Ohio, not Spain), what he looked like (me, more or less). I had the distinct impression the conversation had gone from idle chit-chat to interview, possibly interrogation.

Finally we arrived at the entrance to a courtyard, closed off from the street like the others by a wrought-iron gate. Inside I could see a two-tiered fountain spilling water. Low hedges marked off colorful flower beds. Masses of bougainvillea cascaded down the inside walls from the roof.

"Please wait here, *señor*."

Again, I waited. The old woman opened the gate with a big iron key, closed the gate with a clang, relocked it, and shuffled across the courtyard, disappearing through an archway and into the house. Five minutes later, she reappeared, circling the fountain and approaching the gate, her shawl pulled close.

She arrived at the gate and stood a moment, gazing at me through the wrought-iron bars. "Now I must tell you something."

"Maria Tereza—'

"She will not see you."

'But—"

"Please listen to me, *señor*. It is important. To you. To me. To your father."

"My father? What's he—'

'Many years ago, when I also look like the Maria Tereza Vasquéz you see each night, I know your father.'

I remembered her questions about my background and nodded. "Go on."

'He come here just like you to make holograph."

I had seen most of my father's tapes. None were flamenco dancers. 'Did he succeed?'

"He was a beautiful man, your father, *muy mimoso*." Here she paused, her eyes tak-

ing on a far-off cast that echoed the look on my father's face when he talked of Seville. Reluctantly she pulled herself from her memories and looked at me, smiling. In her smile I saw traces of the beauty my father had seen. She opened her shawl and withdrew a holotape canister, handing it to me through the bars of the gate. "This he made and the others you saw."

"Others?"

"Tell him I give thanks for these children of my old age who have provided for me so well. Tell him ..." her voice broke slightly, "... tell him *amor y pesetas*. He will know what it means."

Before I could say anything more, she turned and shuffled across the courtyard toward the archway. I called to her. She either ignored me or failed to hear.

I waited a few moments longer, looking at the empty courtyard, then turned away and started back toward my hotel, the tape canister in my hand, the fresh image of the old woman at the gate blending in my mind with the still-vivid image of María Tereza Vasquéz onstage.

In my hotel room, I cleared a space at the foot of the bed and set up my playback projector, preparing for the call to Selman. Even in two dimensions, even shrunken to the size of a phone screen, enough of the power of María Tereza Vasquez would come through to show him what I had. My father had seen to that. He put everything he knew into the tapes so they would bring out everything he felt. Then he gave them to her, children of her old age.

I ordered a sangria from the hotel bar and put it on the nightstand next to the bed. I would have preferred scotch, but I passed on it. I wanted a clear head to talk large figures with Selman.

Or did I? I sat on the edge of the bed, the phone at my elbow on the nightstand, looking at the space where the projection would appear. Money—once Selman saw what I had, he would load me down with bushel baskets of it. Was that what I wanted? Was that what kept me front row center night after night?

I positioned the phone in front of me and punched out Selman's number. Wherever the call caught up with him—he was next to a pool with tennis courts visible in the background, probably his club—it looked expensive. After preliminary pleasantries, we got down to business.

"Ted, my boy, you've got something for me. That much I can see on your face."

I hesitated, looking from Selman to the foot of the bed.

"Ted? Is someone there?"

I returned my attention to Selman, my mind made up. "Nope. Not a soul here but me. I just wanted to let you know you were right about that flamenco dancer. It would bomb in Toledo—Ohio, that is."

He laughed too much at my little joke. "Okay, so what now? How about Italy? La Scala. The opera season's coming up. Maybe there's something interesting this year. On that one I'd cover expenses."

The thought of more grubbing for Selman depressed me. Still, the alternative depressed me more. I didn't have much choice. "Okay."

"Good. I told you so, Teddy my boy. I told you so."

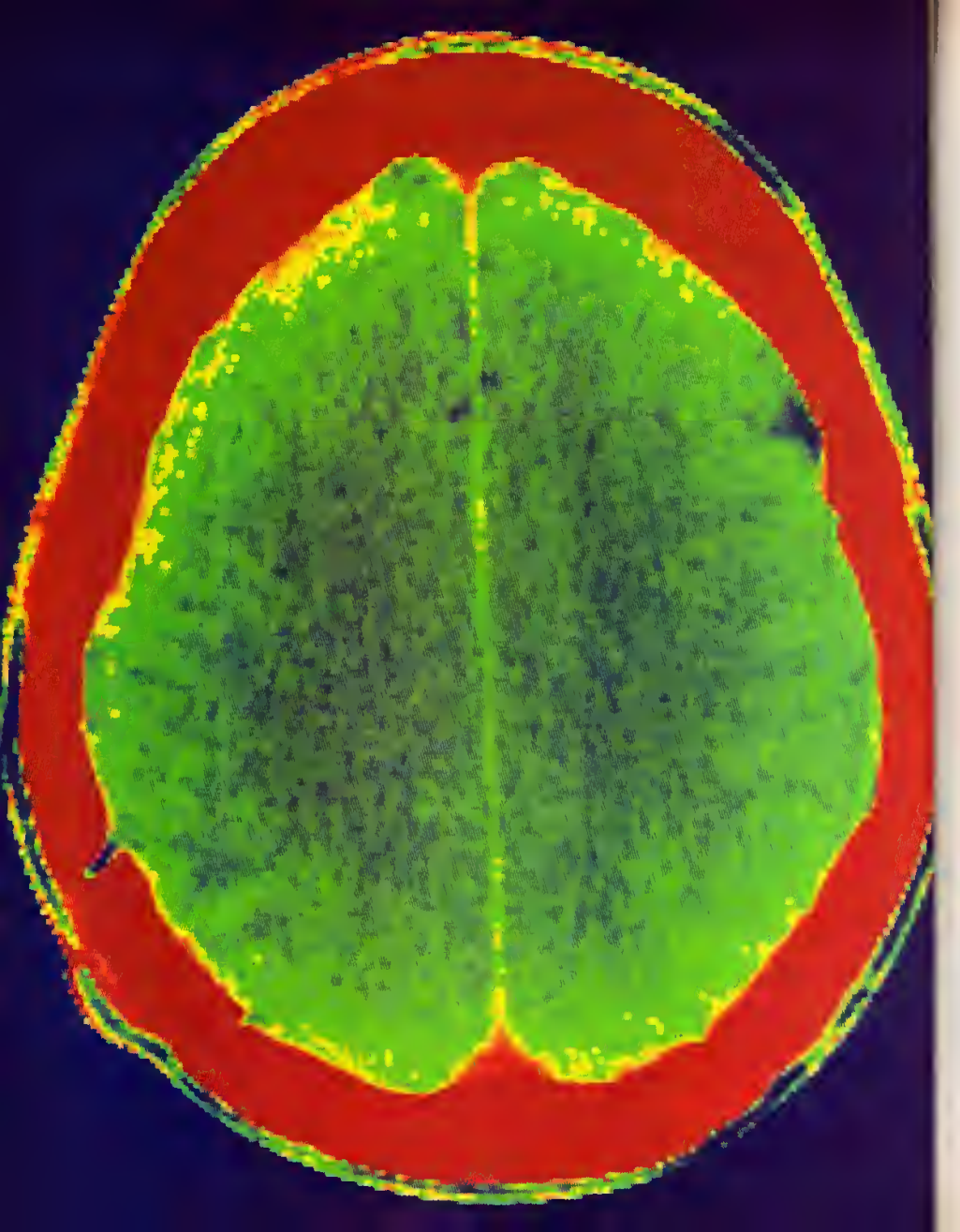
"Yep. You told me so."

When I got off the phone, I sat back against the headboard, one leg dangling over the edge of the bed. I picked up the sangria and sipped it, feeling tranquil for the first time in days, thinking about what I had just done and why. Some of my decision had to do with my father. I had evidently inherited more of his romantic nature than I cared to admit. But most of it had to do with my own feelings, what I wanted night after night when I sat at her feet in the cafe—jealous, possessive, competitive for her attention.

I reached over and hit the playback key on the tape deck. The projector light winked on. When the first chord sounded on the guitar, I forgot about my father. I forgot about the shuffling old woman who led me through the streets. When the image materialized, I saw only her, haughty and proud, arrogant, perfect, oblivious of me.

I raised the glass of sangria in a toast, love and money, *amor y pesetas*. ∞

"The antiaggression drug looks promising, but we'll need more research money. Steinmetz just freed the rats."



Clues to genetic madness lurk in the folds and creases of

DR. BIRD'S BRAINS

BY JOSEPH FINDER

The human brain weighs about three pounds and feels, in the palm of your hand, like a quivering gelatinous mass of soft cheese. Freshly removed from the skull, it is a glistening, pearly pink, and in a solution of formalin, it resembles a huge pickled walnut. A few months ago in New Hampshire the brain was removed from the body of a seventy-two-year-old woman thought to have died from Huntington's chorea, a tragic inherited disorder characterized by mental deterioration and involuntary movements. At the request of her daughter, who wanted to determine whether her mother had indeed been a Huntington's victim, the brain was wrapped in a plastic bag, packed with dry ice in a styrofoam container, and sent to McLean Hospital, a few miles outside Boston.

There, in a specially regulated cold room in the hospital's Mailman Research Center, it was unpacked by a neuropathologist named Edward Bird (above), who sliced the brain in two, placing one half in formalin and the other half in a deep freeze. This was the latest addition to Dr. Bird's Brain Tissue Resource Center at the hospital, a collection of more than 250 human brains, most of them from people who had been victims of Huntington's, Alzheimer's disease, Parkinson's disease, or schizophrenia—all mental disorders that researchers suspect have a neurological basis. It is one of the world's largest collections of human brains (and certainly of "abnormal" brains), and one of only three collections in the world that dissect the brain and supply tissue samples to scientists who study the brain chemistry of mental disorders. Bird founded this "brain bank," as well as one in Cambridge, England.

"Many leading scientists are used to working only with rats' brains, which you can look at right at the instant of death," Bird says. "The thing is, animals don't get Parkinson's, Huntington's, or any of these diseases, so the only way to understand these conditions is to examine the human brain. A lot of scientists, however, don't think a human brain removed from the body even just a few hours after death is any good chemically. A friend of mine at Tufts University, for instance, was skeptical about the value of analyzing postmortem human brains, so I asked him to do an experiment. Put a dead rat in the freezer and compare its brain tissue chemically to that of a freshly killed one. He did, found no differences, and now he's convinced. It's a battle we have to fight all the time, but I think we're gradually persuading people."

Bird has been trying to unlock the secrets of the human brain for most of his medical career. A fifty-seven-year-old, Canadian-born physician, endocrinologist, and associate professor of neuropathology at Harvard Medical School, he became interested in the presence of metals in the brain while teaching in Winston-Salem, North Carolina. He suspected there might be a correlation between Huntington's and manganese in the brain's basal ganglia, the four nerve-cell clusters at the center of the brain comprising the substantia nigra, caudate nucleus, globus pallidus, and putamen. In order to devote serious study to the matter, Bird took a year's sabbatical at Addenbrooke Hospital, Cambridge University. His theory turned out to be wrong, but he became so fascinated with the chemistry of the brain that he stayed at Cambridge seven years.

"My feeling was that unless we got brain tissue to look at, we were just dabbling," Bird recalls. The brains were not easy to come by. He spoke to the various lay societies for mental illness and managed to persuade doctors at local psychiatric hospitals around Cambridge to urge the families to consent to autopsies of Huntington's victims. Slowly, at first, calls came in from hospitals. "In those days I used to get in the car, toot over, and pick the brain up," he remembers, "because it seemed like a rare thing to get a brain. Then we

started getting them so fast that I set up a system for collecting brains from hospitals some as far as four hundred miles away, using railway express We'd send out a carton of dry ice they'd put it in the box and we'd have it the next day" Within six years he had more than 300 brains

Bird joined forces with Leslie Iversen, a noted Cambridge neurochemist, to study Huntington's-associated chemical changes in the brain Since the two researchers lacked the expertise to analyze neuron receptors they began sending vials of tissue to Johns Hopkins Hospital, in Baltimore, for assays Johns Hopkins became interested in receiving more samples from the brain bank as did other hospitals and universities in the United States 'The thing began to grow like wildfire,' Bird says "It ended up that we were sending more tissue to the United States than to anywhere else

One hospital that heard about the brain bank McLean Hospital the renowned private psychiatric hospital in Belmont Massachusetts recruited Bird to set up a similar bank Bird returned to the United States in 1978, traveled around the country speaking to mental-health groups and visiting hospitals and once again the brains rolled in

When we meet at McLean Hospital, Bird a slender, bespectacled man whose soft speech is a mix of Canadian pronunciation and Southern drawl, is wearing an ill-fitting and somewhat blood-spattered white lab coat We walk down the hall from his office, through two sealed wooden doors, and enter a room that's colder than a meat locker (the temperature is kept at a constant −20°C) Bird unwraps an aluminum foil-covered globular object, a frozen half of a human brain belonging to the seventy-two-year-old woman from New Hampshire who died a few days before

"This woman is thought to have had Huntington's chorea," Bird says, holding the half-brain gingerly "The whole brain was pretty light in weight, about one thousand grams Normally a brain weighs around fourteen hundred grams, but one thousand grams doesn't seem too abnormal for an older woman"

The other half of the brain, soaking in a container full of neutral formalin solution in another part of the lab, will sit for a few weeks so that its cellular structure will be fixed "Then it will be sliced, stained, and analyzed under a microscope to determine whether it exhibits the changes of a Huntington's brain, which should have cells missing in the caudate region The frozen half Bird is handling will be used to study chemical alterations in the levels of neurotransmitters, the chemicals sent between neurons that either pass on or block the message-carrying electrical impulses This work may someday lead to the development of psychochemical agents to treat Huntington's and other now incurable mental diseases

"I've managed to get some information about the newest religious cult on Earth It seems to be called condo conversion

With a large knife he begins slicing the brain, starting at the front and proceeding with each slice toward the back, making heart-shaped pieces a few millimeters thick "We used to slice the brain with an electric cutter" he says, "but we found it produced too much heat on the surface of the slices and that alters the brain chemistry So now we keep it at just the right temperature by cutting it by hand in this room" As he slices farther along, the sections become larger He has reached the midbrain and the basal ganglia "If this were Huntington's, the caudate would be shriveled It's good caudate But we really can't tell if it's Huntington's disease until we do a careful microscopic examination"

Continuing to slice, he falls silent After a time he says, "The daughter of this patient is very anxious because she's married and has children If her mother had it there's a fifty percent chance the daughter does, too, and then there's a good chance she's passed it on to her children But, boy, it sure doesn't look like Huntington's to me"

It is no mere academic question to him The daughter has been calling him every day to ask about the histopathology—the changes in the tissue caused by disease He gives her his standard reply: that it takes six weeks for the analysis to be done Since Bird is also a physician who spends several days a week working with patients that suffer from these devastating illnesses, he knows how important his conclusions will be to the family

Bird has cut most of the way through the brain and comes upon the pineal gland, a tiny cone-shaped structure connected by neural pathways to the eyes "That's one of the few glands that work at night and go to sleep during the daytime," he says "It has a periodic rhythm The fascinating thing about the pineal gland is that if we were to measure the substances in it now and find that it was working optimally—producing melatonin, which is what it does—then we'd say that this person died in the middle of the night And if it's working at the lowest levels, we would say that the person died around two in the afternoon or thereabouts We did a paper on that It was quite a surprise, we never thought we'd find that Oddly, it makes no difference that the patient may have died at two in the morning but not had the autopsy until two in the afternoon The gland just stops working at the moment of death, and the enzymes stay at that level" He is done cutting the slices, wraps each in heavy-duty aluminum foil, and puts them into a plastic bag We descend to the basement, to the dissecting lab

The counters of the lab are stacked with oblong, white plastic containers, each holding half of a human brain bathed in formalin At the far end of the lab is a flat metal table under a hood The table, specially designed for brain dissection by Bird, keeps the brain sections spread out on its surface at a constant −10°C The inspiration for the table came, he says, from a

similar device used in England to cool beer.

In the next few hours Bird and his assistants will cut out tissue from each of the regions in the brain, using various maps, including one charted in 1909 by German neurologist Korbinian Brodmann. Using a scalpel, Bird removes small chunks from each "Brodmann area," and his assistant chops up the pieces finely and places the tissue in labeled vials. Later the vials will be placed in a freezer at −70°C. these will be sent to scientists requesting tissue samples or will be analyzed in Bird's lab.

The assay process designed by one of Bird's fellow neurochemists, Philip Langlais, is the latest in high-tech sophistication—and a major advance in neuroscience. Scientists have long been able to measure the presence of neurotransmitters in the human brain but not how rapidly these passed between neurons. Simply measuring the presence of a neurotransmitter does not reveal whether the transmitter is active or just being held in the neuron's storage sites, a common malfunction in certain types of diseased brains. When a transmitter is released from the end of a neuron, certain chemical enzymes outside the neuron often break down the transmitter into other substances, called metabolites, which decrease the amount of the transmitter absorbed by the next neuron.

It's easy to measure the metabolites in rats. You just inject a live rat with a radioactive amino acid, which is converted into a neurotransmitter and eventually metabolites. Then kill the rat and perform a radioactivity analysis of its brain, which will show where the neurotransmitter went.

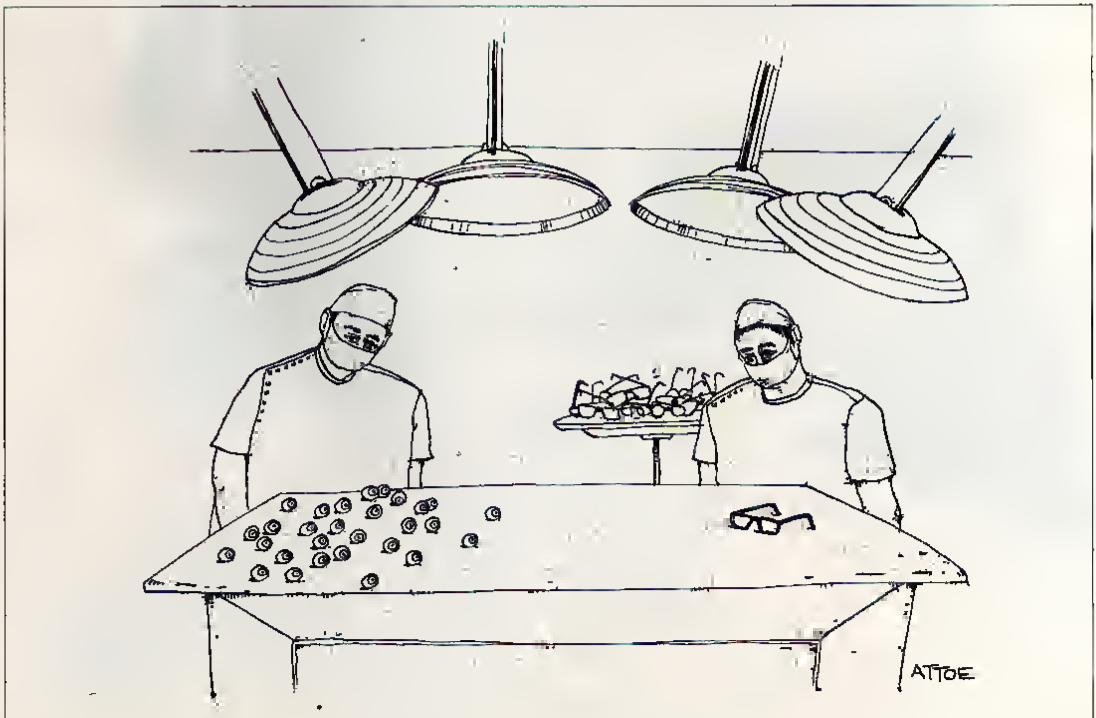
In human beings, of course, that can't be done, which is why Langlais's method is so valuable. The tissue sample is homogenized in an acid to remove the neurotransmitters and then placed in a centrifuge, which separates the cell membranes from the extracted neurotransmitters and their metabolites. Then a chemical analysis is done to determine how efficiently the neurotransmitters were being used.

While this technique is groundbreaking, it is also quite controversial since it is based on analysis of tissue taken from postmortem brains. Langlais recently submitted a paper, drawing upon his new assay method, to a leading scientific journal. It was rejected because postmortem-brain material wasn't considered "reliable." "I guess they think the only reliable tissue to study would be stuff obtained from someone who passed away in a vat of liquid nitrogen," Langlais says.

Nevertheless, Bird and his brain banks are accorded great respect at the National Institutes of Health (NIH) and the National Institute of Mental Health. "Scientists often have great trouble getting reliable material, and the results of their work often differ, but Ted [Bird] bridges the gap between the material and the user," says Dr. Thomas Chase, a renowned neurologist and the director of experimental therapeutics at NIH's National Institute of Neurological and Communicative Disorders and Stroke. "Ted has really pioneered in this area, and the scientific value of his work is enormous," says Dr. Chase.

Important breakthroughs in neurochemistry have frequently come from data supplied by brain banks. Bird and Iversen's work with brains of schizophrenics, for instance, helped substantiate what neurochemists had long theorized: that schizophrenia was accompanied by an increase in the neurotransmitter dopamine. Similarly, Bird and Iversen found that brains from individuals with Huntington's chorea showed a decrease in the amount of brain chemicals that inhibit voluntary movements. Such data are essential before effective treatment can be developed.

In addition, scientists in England, using tissue provided by Bird's brain bank, began to make great advances in the study of Alzheimer brains. In 1976 Bird and others in England first charted the noticeable decrease in the enzyme choline acetyltransferase found in Alzheimer cortexes, a finding that a group at Johns Hopkins was recently able to utilize to uncover other abnormalities in the cortex of Alzheimer brains. They noticed that many of the neu-



"It's no use, they keep rejecting them."

rons that produce the neurotransmitter acetylcholine in the basal nucleus—a tiny area in the forebrain where the optic nerves cross—were missing.

One of the neuropathologists in Bird's lab, Jean-Paul Vonsattel, works not on brain chemistry but on its histopathology. "Not since Alzheimer began looking at brains seventy-five years ago has anyone learned as much by examining the brain as Jean-Paul," Bird says. "He looked at one hundred Huntington's brains under the microscope and found an intriguing pattern. We knew that the caudate in Huntington's is atrophied, and we used to just cut out the caudate, homogenize it, and analyze it. But Jean-Paul has found that the atrophy actually starts in one *part* of the caudate—the upper medial segment. This is going to change entirely the way we look at the brain. Now we'll be gridding the caudate, dividing it into specific areas, and analyzing tiny sections of each of those areas."

And perhaps most promising, Bird and other neuroscientists are beginning to detect chemical differences between the right and left halves of the human brain. Studies performed on the living brain with such modern, noninvasive techniques as PET (positron emission tomography) scans, using radioactive-labeled glucose, have shown that right-handed people with depression show a markedly lower level of glucose uptake in the left side of their brains. When the depression is treated, the glucose uptake evens out. "Not too many people have done brain chemistry on this," Bird says. "This is the next major area to which we're turning our attention. It may be that differences between the two sides of the brain are involved in a number of mental disorders. Maybe in some areas it's normal to have a balance on both sides—maybe that's what makes us balanced human beings."

Despite Bird's efforts, the greatest obstacle to brain research is still a shortage of human brains to study. Fewer and fewer autopsies are being done, an ironic result of the enormous progress medicine has made in the last several years. The development of such techniques as CAT (computerized axial tomography) scans, PET scans, and echograms has convinced many physicians that clinical diagnoses are so accurate that autopsies can't tell them anything they don't already know. As Bird's research shows, this belief is wrong. There are all sorts of abnormalities that only a close chemical and histopathological examination of the brain can reveal.

Still, the practical applications of much of this work are far off. Although neuroleptic drugs have proved somewhat effective in treating schizophrenia, and L-dopa, a dopamine substitute, appears to help people suffering from Parkinson's disease, most mental disorders remain untreatable. A great deal of study of the brain must still be done to solve its conundrums. As Bird put it, "The human brain is the last frontier of medical research." DC

SHOWDOWN

CONTINUED FROM PAGE 80

absolutely no sensitivity to whether there is a reentry vehicle inside or if they are empty. They look the same to radar."

Keyworth agrees it's a complicated problem. But he says there's a solution. "The thing to focus on is data processing. If you can handle enough data fast enough, you can do a pretty darn good job of discrimination," Garwin counters. "No kind of processing is going to help."

Even if a system survived countermeasures and worked well, would it make war more or less likely? Would it save lives? There are contrasting scenarios to answer these life-or-death questions. One somewhat hopeful picture comes from Gray.

"If a Soviet planner knows that he must duel for the first time with an American active defense that he has never faced before, that has got to increase the uncertainties of his offense to an unimaginable degree," he says. "It vastly reduces the calculability of an attack, so it's got to increase uncertainty, which has to be good for deterrence. Also, of course, at some unimaginable point deterrence may fail, and active defenses could make a life-and-death difference in the damage that North America might suffer. You're talking about saving tens of millions of lives."

By contrast, Garwin's scenario is terrifying. It opens with a kind of two-step dance. First we orbit an anti-ICBM system, and then the Russians put up space mines to neutralize it. Then the space-weapons proponents cry "Foul!" They will find it intolerable for us to allow the Soviets to put up space mines, Garwin predicts. "But," he says, "it would be intolerable to the Soviets to allow us to disarm them [neutralize their ICBM threat] by deploying something that is pictured as being one hundred percent effective."

"So they *will* put up those space mines," says Garwin. "We *will* shoot them in peacetime. They will shoot down our satellites in peacetime, and that's not going to do us any good. We will have *no* satellite-based defense system. We will just have a war that is totally unnecessary and will do no good because it will end up with us not being able to defend against nuclear weapons."

Not a pretty prospect. Even some proponents of space weapons agree that their plans open up new possibilities for conflagration. With automated systems in place on both sides, superpowers will be tempted to test the sophistication of their weaponry. After the first button is pushed, for several minutes the confrontation will be a kind of chess match between systems and countersystems and counter-countersystems. "As a prelude to a large nuclear campaign, it is very credible indeed," Gray acknowledges. "You're talking about very complicated military systems that have never been tested under operational conditions. You're talking in the context of the enemy having the maximum incentive to degrade, neutralize, or blow you out of the sky. And there are many, many vulnerabilities to [the proposed] space-based systems."

And there is the moral issue. Should we really ascend into what our forefathers innocently called the heavens and build killer satellites? Or should space be a peaceful sanctuary for all humankind?

Gray has a simple answer to the question of whether we can avoid sending military hardware into orbit. "The one-liner is 'No,'" he says. A virgin outer space, free of weapons, he terms "romantic nonsense." The notion of putting weapons in space to defend urban areas is morally salutary and not the contrary," he says.

Keyworth argues that MAD, the current chicken game whereby we and the Soviets try to scare each other out of making the first move in a nuclear war, is inherently unstable. "I think, looking back on history, the likelihood of mutual assured destruction's maintaining peace and stability for hundreds of years is not high," he says. "What the President did was to look at the roots, the very foundations of this reasoning, and ask 'Aren't we capable of a more stable and more moral basis for defense?'"

Garwin says that though such arguments have a certain ring, they lack substance. They are, in fact, simpleminded since space-based antimissile weapons, rather than precluding the need for a nuclear defense based on counterstroke, simply add a new level of complexity to the mind-numbing game we're playing.

"The fact that there *must* be another way, as the President says there is, does not guarantee there *is* another way," says Garwin. "There is no other way in a world that has vast numbers of nuclear weapons."

Daniel Deudney, a senior researcher at the Worldwatch Institute in Washington, D.C., believes we have arrived at one of history's turning points. He hopes that we turn away from space weapons. "I think that weapons in space bring us to a threshold as significant as the one we faced in the late Forties, when the atom bomb was invented," he says. "If we head off this military race in space, we will have closed off a major avenue of confrontation that's arguably as great as the problem we have had with the atom bomb and the subsequent diminishment of our security."

The arguments, pro and con, over the technical, strategic, and moral questions of space war are heating up. But Deudney has stripped the issue down to a single question. Should we have these weapons simply because we are able to build them?

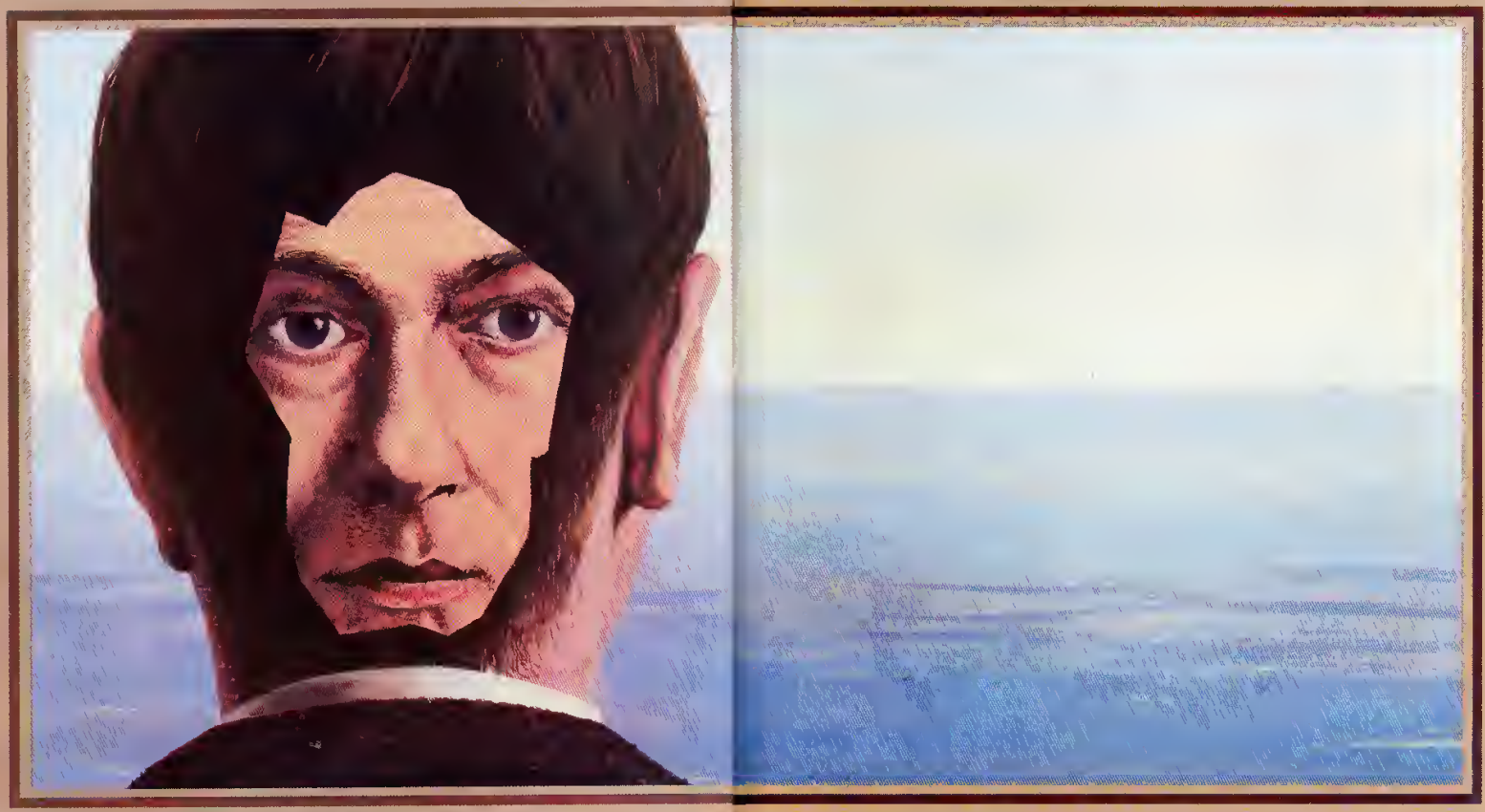
"We have got to mature enough as a species so that every scientific principle we discover is not automatically fashioned into a weapon," he says.

Can we?

"*That* is the big question that hangs over the human species," he says. "I think that space will be the decisive arena for answering the question." ∞

Fiction

DOUBLE TREBLE



Six fantasies linked by
Harlan Ellison, Poul Anderson,
Thomas M. Disch,
Edward Bryant, Gahan Wilson,
Fritz Leiber
PAINTINGS BY RENE MAGRITTE

ESCAPEGOAT

by Harlan Ellison

Sixty feet above the smooth surface of the North Atlantic, next to the forward rail of the *Titanic*'s main deck, a rippling slit opened in the darkness of the night. A scintillant orange mist swirled through the slit, and the three Time Commandos stepped through onto the deck of the luxury liner.

Even before he had emerged completely from riptime Sgt. Ratliff was complaining. "Why me? Why is it always me? Why the hell don't one of *you* smartapples ever volunteer? Just once! Why's it always me has to do the dangerous stuff?"

It was 11:27 PM. on April 14, 1912. The orange mist sucked itself back into the slit, the egress into riptime vanished, and the raiding patrol from the far future stood in the darkness.

The *Titanic* rode a surface of saintly calm. That millennium's *Oberstgruppenführer* of Time Commandos, 'Blackjack' Alec de la Ree fished among the shaped charges in a bandolier pocket, came up with a nasty stub of cigar, wetted it, and wedged it in the left corner of his mouth. "Because Ratlips," he said, grinding Ratliff's gears with the hated nickname, "you know damned well you've got the highest probability distribution quotient of anybody on the team." The words *probability*, *distribution*, and *quotient* were almost unintelligible around the cigar butt. He lit up with a wooden kitchen match endemic to the phenomenological year in which this raid was being staged. "Just once is there a chance we can pull off a patrol without you piss and moan? Try to fix your pea-brain on the idea, Sergeant. We're here in service of humanity! Bernoulli equations picked *you*, chum, not us. You're the one stays behind so the rest of us get back through riptime. That's what you draw your pay for."

The third Time Commando, Corporal Cicero, chimed in with agreement and annoyance that Ratliff was sturmdranging again. "You're a fast pain in the fundament, y'know that?"

"Okay, okay," Ratliff said. "But I'm gonna register a beef when we get back to Chronobase."

"Let's just correct this node in the Phenom Flow, save the future again, and go home," de la Ree said. "Then you can squeal all you want."

He glanced down at the fingernail of his left thumb, where the subjective hour of this year in the Phenom Flow strobed crimson in digital readout. They were crossing the Grand Banks. "It's eleven-forty their time." He stared off the starboard bow. "There it is!"

A gigantic, menacing hulk of ice loomed up fifty feet from the flat surface of the sea.

"Move fast!" de la Ree hissed. The trio of Time Commandos rushed to complete their assigned tasks. Within two minutes they were back at the bow rail.

"Everything set?" de la Ree asked. The cigar was out; he was winded from his activities. Ratliff and Cicero nodded: it was all set. De la Ree smiled. "In thirty seconds the future'll be set right; humanity'll be okay for another thousand years, and we get some relief time."

He opened the slit into riptime, shooed Cicero into the pulsing orange mist, and took a step toward the egress. "I still think it's chicken-doo," Ratliff said. "What if I get caught in the Flow?"

De la Ree gave him one last look of disgust as he relit the cigar stub, blew a cloud of noxious smoke at the noncom, and said, "Up yours, Ratlips. Just save humanity and we'll see ya at Chronobase." As he placed one foot into the mist, he looked back and added, "An' try not to drag a decade along with ya, y'wanna listen to me?" Then he was gone.

At that moment, still doing twenty-two knots, the great liner began slipping to port as the First Officer yelled to the Wheelman that a berg was drifting in on their starboard side. The Wheelman reacted instantly. The ship slid slowly toward safety.

"He opened the slit into riptime, shooed Cicero into the pulsing mist, and took a step toward the egress. "I still think it's chicken-doo," Ratliff said. "What if I get caught in the Flow?"

So Ratlips ensured the future of humanity by triggering the charges as he leaped into the orange mist of the riptime, and sank the *Titanic*.

Thinking crankily, *There's gotta be an easier way to make a living. A guy could get hurt like this!*

IN THE SHOP

by Pat Cadigan

Mrs. Tedescho thought that hell must look exactly like the waiting room for Motorama Auto Service—same drab concrete walls, uncomfortable plastic chairs, and old magazines. There was no piped-in music; it would have been inaudible over the grinding yammer of drills and other tools. She sighed grumpily and looked at her watch. Over an hour now.

From the garage came the sound of an engine gunning ferociously.

She looked down at the article she'd been trying to get interested in. "Rebore: Yes or No? The Answer Will Surprise You!" Mrs. Tedescho doubted it. She flipped the pages of the magazine dispiritedly, tossed it on the battered coffee table in front of her, and picked up another. Something that sounded like a power saw arguing with a steel beam squawked and then cut off, leaving her nerves jangling.

"How Dependable Is *Your* Car?" asked serious black type on the page she'd absently opened to in the magazine. She made a face. That was like a bad comedy routine. *My car is so dependable. How dependable is it? It's so dependable that the moment I think I'm going to be able to spend a weekend accomplishing all the things I've been putting off for a month or more, it comes down with automobile flu.*

The edges of the magazine crumpled in her hands. She'd been driving home from work making a mental list of things to do when the damned thing had suddenly started running rough, chugging on hills, stalling on lights, and worst of all, dieseling abominably after she'd coaxed it into her driveway. To Mrs. Tedescho, dieseling was the height of automotive insolence.

Well, it had just better run after this, she thought grimly, or she'd take a tire iron to it. She wasn't prone to violence, but a car that ate fan belts the way this one did and developed mysterious leaks that cleared up as soon as a mechanic even glanced at it could bring out the beast in her.

She became aware of the thin, tinny sound of a radio playing rock music. *Wonderful*, she thought. *first metal tools, now metal music.* But no yammering drills rose to drown it out, and gradually she realized she hadn't heard anything but the radio for the last minute or so. *Now* what was going on in there?

A sign on the grease-stained door to the garage warned that only employees were allowed past that point. Mrs. Tedescho ignored it and pushed through. The huge garage was completely still. Cars sat in repair bays with their hoods yawning open like forsaken dental patients.

"Hello?" she called, her voice echoing. "What is this, Miller time already?" No one answered. In the middle of the garage, a man's cap lay on the floor. She picked it up between two fingers. Mixed in with the old and new grease stains were spatters of dark red. There was some on the floor, too. Near a gaping Toyota, a tall chest of tools had tipped over, scattering sockets all over the place. Whatever had happened had been covered by the sound of drills and other things.

A sudden sharp banging sound from the last repair bay made her jump.

She hurried to it, stepping over rags and tools and other caps strewn around the floor. Now she could hear the mutter of an engine, perfectly tuned, the idle set low and throaty.

"Hello?" she called again as she reached the bay. The car idling there revved, rolled forward a few inches, and stopped short.

"*There* you are, you bastard!" she shouted. "What the *hell* are you doing? Do you *know* how long I've been waiting

reading goddamn *Motoring Monthly*? Thanks to you, the whole day is shot!' She slammed her purse down on the hood; the car backed up until its rear bumper thumped the wall.

'*Stop* that, you son of a bitch, and get this hood open!"

The hood popped up. Mrs. Tedescho took one look and slammed it shut again.

'I *thought* so! You greedy, stinking piece of junk, you had to have all of them, didn't you. One wasn't enough, was it? Do you know what it's like trying to find a place that will take a foreign car? *You* ought to have to do it—then you wouldn't go around gobbling mechanics like fan belts!'

The hood popped open again, and a black cable came snaking out. Mrs. Tedescho swatted it with her purse. "Spoiled little shit today, aren't you?' She grabbed a nearby crowbar. "Try that stuff with me and I'll turn your crankcase into a colander." A tremor ran through the car from bumper to bumper as it squeaked mournfully. Mrs. Tedescho dropped the crowbar, stood to one side, and crooked her finger. The car rolled forward, and the driver's side door swung open. "Let's go,' she said, getting in. "I'd like to get the grocery shopping done at least.'

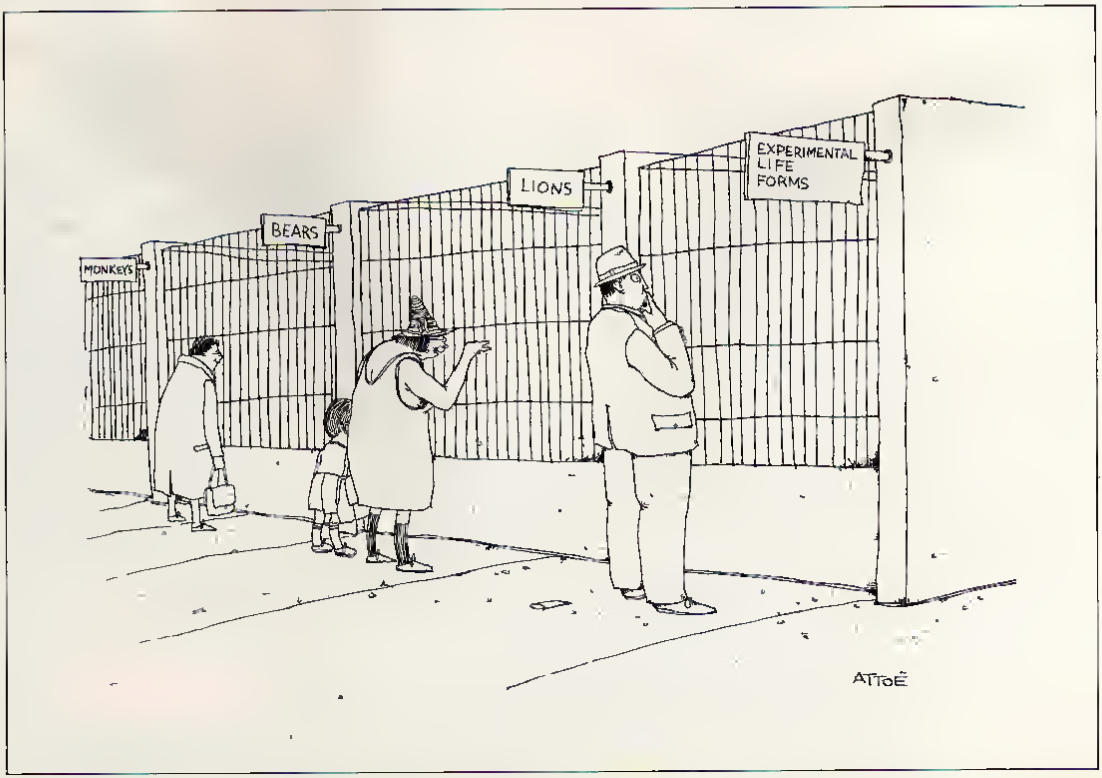
She pounded the horn with her fist. "I mean now, dammit!'

Whimpering, the car rolled through the empty garage.

THE WANDERING JEW

by Thomas M. Disch

And then there was the time—it was right around the summer solstice—that She fell in love and lighted off with the object of Her love to the Poconos because in Her words the city had become too much for Her. So there we all were, the eight of us, crammed together into the bathtub and gradually dying of thirst once we'd recovered from being half-drowned. We got two hours of sunlight every morning—in *June*, just imagine!—and most of that couldn't get through the shower curtain, which was all right for me, I'm a succulent creeper and *thrive* in shady places, but pity the poor asparagus fern. It never did recover. Its stalks went from green to yellow to brittle-brown. While the coleus got limp as death, though it did revive quickly enough once She returned and cut it back, which it had been needing anyhow as it was getting very leggy. She would never tall in love again, She told us, as Her scissors snipped and pruned. Men were beasts. Well, we could have told Her that. The end of the problem, you're thinking? Oh no, there was worse to come. For somehow She'd got it into Her head to grow a pot of basil in this landfill. She'd brought back from the Poconos. So the entire windowsill was entirely given over to this tacky plastic planter filled to the brim with ground shale, pine-needle dust, and mealybug eggs. I mean, all we were missing was acid rain! If that makes me sound like a pot-bound, totally urban houseplant, so be it. Nature's all very well in its place, but *its* place is the country and *my* place is a pot, and never the twain shall meet if *I* can help it. Well, there we were, back at our duty stations—except for the poor asparagus fern, of course—which meant that I was hanging right over that imported plague spot with my leaves practically scooping up the mealybugs from the planter. I'll tell you, I almost died. If She hadn't swabbed my every axil and crotch with Q-Tips dipped in malathion, I wouldn't even be alive today to tell the tale. I realize there are those, like my old friend here *Dizygotheca elegantissima*, who feel it's bad form to so much as mention sucking insects, but being just a common creeper myself, grown from a cutting in a jelly glass and lacking any experience of nurseries, I believe in calling a spade a spade. I was infested; no two ways about it. It's an ill wind that blows no good, however, which is to say that if it hadn't been for the mealybugs and the malathion I might never have been able to communicate my philosophy of life to Her, since She wasn't the sort of person who relates to plants easily. Now there are some plants, mostly out there in nature who will tell you that blood and chlorophyll never mix, but down deep I know that people and plants need each other. It's only that



people usually live at such a dreadful *speed*, as though they ran on electricity like those nasty appliances of theirs. But give people half a chance to adjust their biorhythms to ours, and soon enough there's not a person alive who can't be as calm as a cactus. 'Never mind that silly hunk of beefcake off there in the Poconos,' my leaves whispered as She dabbed on the malathion. 'He never really loved you the way we do. He doesn't need you the way we do. How could you possibly go back to someone who sends you home with a planter full of mealybugs? Forget him already. Put down some roots. Grow.' For that's what She'd been threatening to do—go back to him and leave us to spend all the rest of the summer in the bathtub. Well, that's not what happened. She didn't go back to him. *He* came to live with *Her*—with two cats and a schnauzer! Once the cats had demolished the coleus, that was it for us. We released Her from our enchantment and had ourselves adopted by Her cousin Flora. And bless Her, here our Flora comes with the mister. My, is it that time already? How the time does go by when you're chatting with friends.

BEAN BAG CATS®
by Edward Bryant

FROM: John J. Finnegan, President
Wake & Finnegan
Marketing Division

TO: David Brooks, Head Copywriter
Creative Projects Department

Okay, son. Where is it? Life Pro Labs is getting a little antsy. They're laying out more cash for this campaign than you know. Show me something rough.

FROM: Brooks
TO: Finnegan

You want it, Boss. It's yours. It ain't been easy trying to figure how to sell a pussy that looks like a strudel. Notes follow.

A significant portion of the Bean Bag Cat campaign will obviously be oriented toward urban consumers. A genetically modified, nonambulatory pet will be very attractive to apartment, co-op, and condominium dwellers.

Imagine the numerous possibilities for utilizing what is essentially a live cat without paws or legs. Standard accessory packs should include Velcro grip strips so that the Bean Bag Cat can be placed securely on a sofa arm, chair seat, or any other surface in a limited living space.

Models will initially include the ten most popular feline breeds. BBCs will be available either in kitten or adult format, although the kittens will be hormonally arrested so that they will stay cute for an indefinite product span.

Item: Life Pro Labs says they'll have the growth-curve problem licked in a year or so, and then we'll be able to offer a BBC that the consumer can obtain as a kitten and then be able to watch grow into adulthood in a matter of weeks.

They'll simply have to change the SaniKit attachments. These can be marketed separately as an educational experience for children, emphasizing the lesson of pet-care responsibility.

About the SaniKits. Since prospective consumers will obviously realize that the BBC won't be able to get to a sandbox on its own—or at least not at any practicable speed—the campaign will have to mention the SaniKit bags that the pet owner will be obliged to change at a maximum of three-day intervals.

There must be a marketable way to warn owners that failure to observe the maintenance schedule in the Bean Bag Cat will result minimally in feline renal dysfunction, maximally in cat all over the living room. Perhaps research and development can come up with an audible warning such as the low-battery indicator in home smoke alarms. Call them SaniKat Kits, and Life Pro Labs can look forward to a lucrative accessory trade.

Emphasize in the campaign that Bean Bag Cats will purr, lick, nibble, and squirm just like the original model. But they will not scratch furniture, chase birds, or wander around the neighborhood at night.

FROM: Finnegan
TO: Brooks

Looks terrific so far. LPL should love it. One problem. Late word from the lab says there's a hitch in the DNA splicing for the kitties. First year's model run will have to be surgically modified from existing stock so as to stay competitive in the market place. Will need some glossing. Can do?

CONTINUED ON PAGE 176

Since his discovery, McGuire has hoisted an Israeli flag over his ranch and hitched a silver Star of David to his belt

ANTI-MATTER

UFO UPDATE

Last fall rancher Pat McGuire (at right) from Laramie Wyoming, was defeated by Governor Ed Herschler in one of the most bizarre gubernatorial primaries in American history At his first political rally McGuire climbed to a podium in a local shopping mall and screamed "A vote for McGuire s a vote for the extra *terrentiais*!"

McGuire s campaign trail really began in 1976 on the couch of psychologist Leo Sprinkle Staring at the ceiling McGuire nervously recalled getting lost in a snowstorm while hunting elk in the Tetons Though he was found alert and walking six hours later, he couldn t remember where he d been

Sprinkle, a University of Wyoming professor and president of a group called PRO UFO then hypnotized McGuire After 24 sessions the cattle rancher recalled his abduction by aliens who flew him to Israel during the Yom Kippur War That says McGuire when he learned that aliens had given the Jewish people "protective powers' to keep the Arabs in check So you see McGuire explains "If a Syrian pushes a button to fire a missile at an Israeli jet, there s always an invisible alien perched on his shoulder ready to send the missile off target "

Since this discovery, McGuire has hoisted an Israeli flag over his ranch and hitched a silver Star of David to his belt buckle But he points out the UFO contact that inspired his political career didn't occur until a month after he left Sprinkle s care Someone had mutilated one of his cows, and the sheriff it seems chalked it up to vandals

McGuire however claims the cow had been shredded with cookie-cutter precision as if it had been run through a machine "As I stared at it ' he adds I could feel this *wonderful* energy In fact McGuire says this 'energy' turned out to be Michael the alien who insisted McGuire run for governor because he "like the Jewish people had been given special powers that would benefit the human race

How did Wyoming Governor Herschler feel about campaigning against an opponent with political strategies amazing from aliens? I felt unfortunate says Herschler ' McGuire got eight thousand votes which proves a lot of people in this state have seen UFOs I guess I'd like to see one too The governor adds however that McGuire s role in the Israeli army didn t help his campaign

McGuire agrees 'Let s face it ' he says 'this is redneck country And I ain't got any Jew blood in me I m all Irish So I guess some people think I m nuts

Even McGuire s ex-wife Wenda admits "This Israeli thing went too far Though she too got messages from aliens she says she never heard anything about the Mideast But her seven-year-old daughter, Julie says I speak to the aliens when I m brushing my teeth And last time they told me about my dog Mack He ran away But they said they re taking care of him on the *planet Israel* '

Like her father Julie has also gone into politics She ran for president of her third-grade class and she says with the help of the aliens I won *PETER RONDINONE*

ROBOTS FOR THE DEAD

A family attends the funeral of a dearly loved relative, then returns home to find him sitting in his favorite chair, chatting just as he used to.

This scenario was conceived by psychologist Neil Frude, of University College in Cardiff, Wales. The bereaved, says Frude, will one day reap sustenance from life-size robots that are moving and talking replicas of their dead relatives; the robots will be programmed to talk the same way, make the same gestures, and physically interact with their owners.

In recent years, Frude observes, the dying have made videotaped messages for their loved ones, who screen the tapes time and again in a desperate attempt to maintain the fiction that their nearest and dearest are still alive. The sort of person who leaves video testaments, Frude adds, would probably welcome the chance of bequeathing an electronic double encased in a look-alike vinyl shell. He could make a bid for something akin to immortality by ordering a computerized automaton in his own image, matching its values, opinions, and preferences to his own.

Frude admits that the idea of a bereaved person conversing with a plastic model of a dead relative is "profoundly disturbing." But such weird relationships, he says in his new book, *The Intimate Machine*, might well arise to satisfy human needs.—Ivor Smullen

The worst of a modern stylish mansion is that it has no place for ghosts."
Oliver Wendell Holmes

GREEN BLOB

For Harry and Tilly Deeder, of Toronto, New Year's Eve 1982 went off with a bang. They were washing party dishes when a huge green blob crashed through their roof and splattered across the rug. "It smelled like a toilet," says Tilly. When the police arrived, the Deeders learned the blob was in fact a hunk of human waste released from a passing plane.

Apparently, the police explained, valves on the waste outlets of airplanes are sometimes ill-fitted or partially open. As a result, the waste seeps out onto the fuselage, where it freezes and falls off. A chunk can often weigh more than 30 pounds; its green color comes from the disinfectant used in the airplane's washrooms.

Hoping to sue the airline responsible for the $9,000 in roof damages, the Deeders scooped up a sample of the waste, refrigerating it overnight and bringing it to Canadian Transport safety inspector Reginald Phillips in the morning. The overnight delay, however, destroyed the Deeders' chance of winning a case. When planes land, Phillips explains, their waste tanks are emptied within hours. "Ideally," he says, "a sample should be rushed to the nearest airport immediately."

According to Phillips, there are more than ten such incidents a year in the United States and Canada, and the dangers are immense. Frozen waste once caused the engine of a Boeing 747 to fall off and smash someone's Cadillac in Texas. And waste infected with malaria once plunged into a reservoir in southern France.

Meanwhile, Tilly Deeder can't believe she didn't get anything out of this. "No money," she says, "nothing but a big mess." Nonetheless, she's keeping a sample of the waste frozen in her icebox as evidence, just in case the blob strikes again.—Peter Rondinone

If flying saucers are not a physical fact, they are a psychical one, and that in itself is a fact.
—Carl Gustav Jung

WEEPING MADONNA

For the past two years folks Thornton California have been mystified by a sculpture in the Mater Ecclesiae Mission Church

Some people claimed the 60 pound statue of the Virgin Mary could move 30 feet on its niche Others reported that the statue cried real tears Carlota Cuellar of Modesto insisted that she was cured of asthma after praying to the weeping Madonna And church volunteer Manuel Pittaluga produced color photos that apparently showed the face of Christ floating above the statue in midair

As tales of these miracles circulated church attendance tripled and the local diocese named a panel of priests to study the mystery The verdict? "A deception was perpetrated Bishop Roger Mahony says "But we don't know why someone would want to do this sort of thing

Mahony explains that the Roman Catholic Church validates miracles that are accompanied by clear important messages But the weeping Madonna failed to give any such pronouncements Moreover the oily liquid found on the statue's face didn't resemble human tears and the statue's shifting could be explained by someone secretly moving it

What about the photographs with Christ's head? Charles V Morton director of the Institute of Forensic Science Criminalistics Laboratory in Oakland California studied the photos and concluded The pictures of Jesus were from commercially available religious magazines In fact the edges were clearly cut and in one case there's a crease across the face of Jesus showing where the paper had been folded

Although the weeping Virgin of Thornton has proved to be a hoax investigators say there's yet another crying Madonna this one allegedly oozes fragrant, oily tears in Russian Orthodox churches along the East Coast Sherry Baker

We need utopias Without utopias the world would not change

Thornton Wilder

MILLENNIUM BALL

The *Queen Elizabeth II* steams across the dark Atlantic on board the world's most gifted minds discuss human survival through the year 3000 It's New Year's Eve 1999 and the ship is en route to the Great Pyramid of Cheops where the guests will attend a world ball to celebrate the new millennium

This is the vision of Ed McNally a twenty-four-year old Justice Department lawyer and president of the Millennium Society, who conceived of the big bash one night in 1979 at Mory's the official Yale drinking club Someone he explains had read an O Henry short story After Twenty Years about friends who have a reunion, and we thought we should do the same But then someone pointed out that in twenty years it would be 1999 and we all agreed something bigger was called for"

Living in the shadow of the bomb McNally says "we decided that organizing a world celebration twenty years away would be an expression of confidence in mankind It was clear that we had to choose a site that would reflect man's timelessness And standing in the desert at the cross roads of the Old World the Great Pyramid is undoubtedly the most timeless place on earth

Since 1979 the prestigious Thomas Cook travel group has been sending out its gold engraved French-folded invitations to the *QE II*'s exclusive guest list Each ticket according to Cook's public relations manager Carol Walsh, costs over $6 000 in 1983 dollars

Given the cost McNally's buddies from Yale fear they might be excluded from what was originally supposed to be a class reunion Being Ivy League however McNally is confident everyone will earn enough money to buy a ticket "If a guy can't afford the trip " he says we wouldn't want to know him anymore anyway —Peter Rondinone

"Everything clever has *already been thought we must try to think it again*

—Johann Wolfgang von Goethe

[illegible] BURIAL

This past winter in the Bevarian town of Pferrkirchen a heart patient at the district hospital was declared dead by the night nurse who then had him wheeled into the morgue But the patient identified only as Joseph M (to protect him from further publicity), proved to be very much alive

'I though I was going mad when I woke up Joseph recalls 'Everything in the room was white was stricken with fear After spending five hours screaming in the locked ice cold room he adds he was heard by hospital personnel and released

The hospital has refused comment on how a live man could have been mistaken for a corpse The night nurse however has been fired And Joseph's family might take legal action against the hospital pending the outcome of a police investigation

Three days after waking up in the morgue the eighty-three-year-old man left the hospital 'He spends his evenings merrily drinking beer in the local pub his son reports 'But there's no way he'll step foot near that hospital again

Sherry Baker

In the morning when we rise from bed although surprised to find ourselves still alive, we are even more amazed to find everything just as we left it the night before '

—Tommaso Landolfi

FRANKENSTEIN IN L.A.

Los Angeles cabinetmaker Edward Stewart may be a modern day Dr Frankenstein In 1959 he claims he restored a dead friend to life with a simple technique He opened the man's chest rubbed his heart with a secret life-giving plant juice then stimulated the heartbeat with 110 volts of electricity The friend says Stewart has been sipping piña coladas Hawaii ever since

Stewart also claims his revivification technique works on the small animals he suffocates in jars in his garage It takes three hours to revive a dead mouse he reports and four hours for a small dog

Sometimes he adds but those little chicken giblets in the A&P you know chicken hearts—and I make them beat again using my plant juice before I cook them for dinner

According to Stewart he discovered the plant juice one day while trimming hedges around his former home Hawaii Sap from one of the tender limbs splattered onto his wrist he says and he suddenly noticed the skin begin to twitch Nonetheless he adds he can reveal the name of the plant When the juice is zapped with electricity he says it gives off a deadly gas I'm afraid the Russians will get it and take over the world '

To promote his idea Stewart has spent the past decade sending his papers

[illegible] space defense agencies One scientist who evaluated the concept was Lynn Eldridge of the Jerry Lewis Neuromuscular Research Center in Los Angeles She says Stewart may not be perpetrating a joke The extracts from plants like belladonna are used to supply nutrients to human organs which must be kept alive while en route to a transplant So Stewart might cut the heart out of a mouse and keep it alive with plant juice But this effect is short lived and the organ must be placed into a healthy body or it dies It's impossible to place a live organ in a dead body and expect it to revive every other organ in that body I think Stewart has observed a basic scientific phenomenon but his interpretation is out there

Stewart recently discovered he had a cancerous tumor Though he admits he could leave instructions for someone to revive him should he die he still goes for radiation treatments "If something went wrong with the plant juice he says I wouldn't be around to perfect it and give it to mankind " Besides he claims "government investigators are watching my garage They've told me not to experiment on humans which is a damn shame

—Peter Rondinone

"Don't let your mind be cluttered up with prevailing doctrine

Alexander Fleming

SISTER ANGEL

CONTINUED FROM PAGE 70

against him, no longer crying. Amos tried to loosen her grasp, but she shook her head and held on.

"Come on, honey. I'll take you home. It's all right now." Amos pried her loose and held her, stroked her fine hair, all the while making soothing noises.

"I need a drink," Constance said, rejoining them.

"Amen," Charlie said, already at the long table where the bottles were lined up. He filled a glass with brandy and downed it.

Wanda stared fixedly at Brother Amos. "He was here, wasn't he? What did he want?"

He nodded. "Yes. Tomorrow we'll talk. I have to take my girl home now. She's had a shock. She's very sensitive to this kind of thing, very sensitive."

"In the morning? At ten?"

"After lunch. I'll come at two."

Charlie handed Angel a glass of water. Her face was swollen, flushed. He patted her lightly on the shoulder, then took brandy to Wanda.

Amos took the glass from his daughter, put it down, and left with her, his arm around her shoulders.

Wanda stood up shakily. "If you'll excuse me," she said in a low voice.

Gretchen went with her.

Constance drank her brandy almost as fast as Charlie had done earlier. "Another."

They both had another. They sat in facing chairs, not talking yet. Finally he said, "You were swell."

"And you had your hands full. What happened, Charlie?"

"Damned if I know. Did you feel—?"

She nodded. "Like I was at one of those awful horror movies, and I was the victim."

"Yeah. Maybe another brandy. And I've got to retrieve that glass." He went behind the table, then cursed briefly. It was gone.

Constance pointed to the water glass. "He handled that."

He picked up the glass carefully, holding it at the bottom, and dumped the remaining water back into the pitcher. He started to leave with the glass, then hesitated, a curious look on his face.

"Will you be all right alone for a couple of minutes?"

"Fine," she said, glad that he had asked, startled that he had asked.

Gretchen joined them while they were having coffee. Wanda had taken a sleeping pill and was sleeping already, lucky Wanda.

"I don't dare close my eyes," Gretchen said. Then darkly she added, "I sure wish Dutch had been here, the ape, laughing at ghosts."

"That's the last kind of thing you should say now." Constance said severely. "All Wanda needs is any sort of confirmation and she'll be over the edge so deep we may not be able to pull her out again."

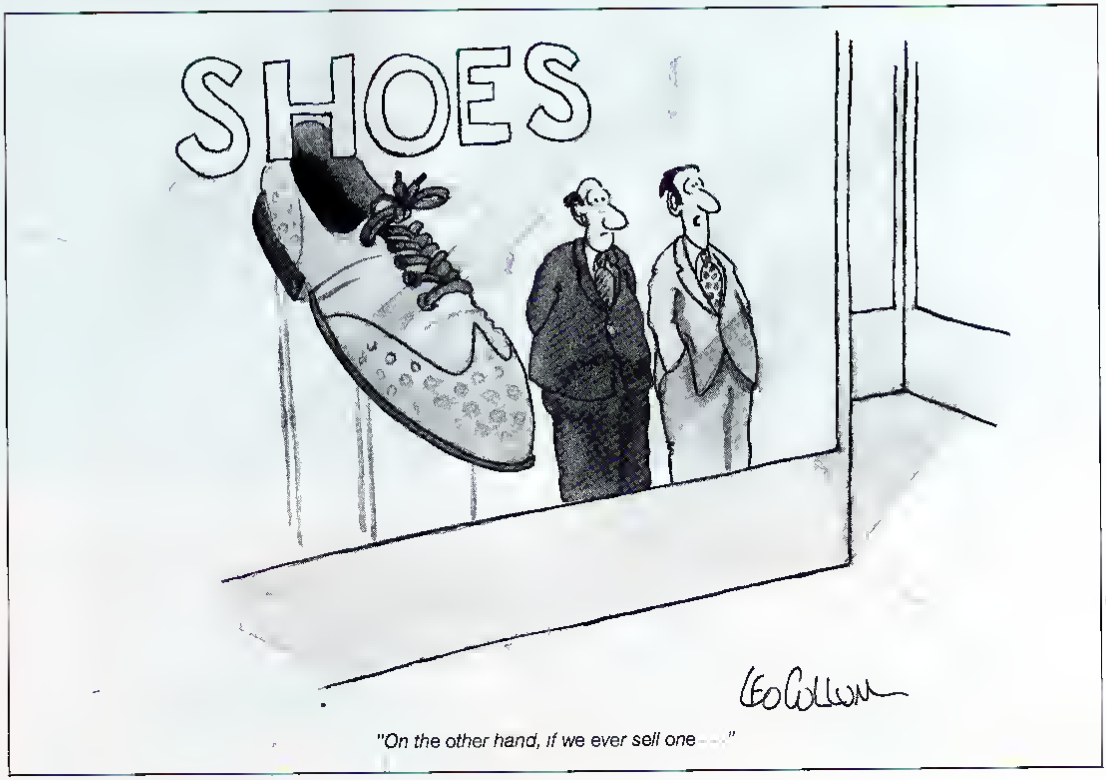
"What else do you think it could have been? It was Vernon, mad as hell at us for playing with his toys! She knows that!"

That night Charlie dreamed. He was dancing with a woman. His eyes were closed, his cheek against her hair, his hands moving down her soft, silky body, warm and yielding to his touch, so responsive that her body and his were not really separate but moved together as if joined at a common nerve center. Her hands were like warm kisses on his skin, where they touched he came alive. *Now*, he whispered into her hair. *Now!* They sank into cloudlike softness.

He came wide awake and sat upright, wet with sweat, shivering. He got out of bed, pulled on his robe, and stumbled from the bedroom. Behind him Constance made a slight noise, and he turned and saw her, an old woman with graying hair, lines at her eyes, old, old.

Moments later she sat up, certain he had said something. She reached out to touch him and found his bed empty.

Slowly she got up and put on her robe and slippers, troubled, wanting to find him. Going down the stairs she felt again the presence of the masks, the staring eye



"On the other hand, if we ever sell one . . ."

holes, and she drew her robe tighter about her. He was standing at the broad expanse of glass in the living room, outlined against the pale dawn light.

"Charlie! What's wrong?"

He stiffened. When he turned to her, he again saw an aging woman with tousled hair, sleep-heavy features. The image faded, and he saw Constance.

"I thought I heard something." Deliberately he faced the lake that was like a silver skin over an abyss.

She went to stand at his side but did not touch him. He seemed hard, unknowable. "Char—"

"Go back to bed. I have to think, and I have to be alone for a while." His eyes were like obsidian discs.

Why didn't it fade? he thought almost savagely after she left. Dreams always fade on awakening, the most frightening dream loses its power after you're fully awake. The edges begin to crumble, and details sink back to the pit. He was still waiting for the dream reality to fade an hour later, when rain fractured the surface of the lake.

Gretchen and Constance had breakfast in a pleasant room off the kitchen. Charlie had gone into town, and Wanda was not feeling well. As soon as they were through eating, Gretchen left to do some errands.

Outside the rain was splashing on the red tiles, and the lake was churned by a brisk wind. And Charlie did not have a raincoat with him.

Constance knew exactly where it was, in their hall closet at home. Charlie would be soaked. She had not even seen him that morning. She had been in the shower and when she got out he was gone. The rain began slanting in against the glass.

She prowled the silent house restlessly, finally settling down to look through some scrapbooks. Many of the pictures were of Vernon, a gray-haired, slender man with a straight carriage and squared shoulders. There were also many pictures of children, most of them in braces or in wheelchairs. There were several of Vernon holding one child or another up at a game of chance, a ball toss, or dart board; one of Wanda at a fund-raising booth with a child eating cotton candy at a counter. There were no more pictures after that series.

Charlie called shortly before noon. "I won't be back for a couple more hours. Everything quiet?"

"You wouldn't believe how quiet. What are you doing?"

"Can't talk now. Okay? Guess who's chief of police in Bridgeport these days. Tony Francello! We're having lunch."

Constance stared at the phone for a long time after replacing it. She shivered with a sudden chill. What in God's name was wrong with Charlie? He had talked like a stranger. She rubbed her arms briskly, but the chill was deep within her.

Amos and Angel arrived shortly before two. "Hello," Constance said cheerfully, admitting them.

Amos nodded at her. "I told Sister Angel that she could watch television while I talk to Mrs. Garrity. I'll hang up your coat, honey." He hung both coats in the closet, and Angel went down the hallway toward the television room. Constance started to follow her.

"Mrs. Meiklejohn," Amos said urgently, "your husband is in danger. I see him surrounded by flames, and he is desperately afraid. Take him away from here!"

"What are you talking about? What do you mean?"

"He is in mortal danger! He fears the flames as he fears hellfire! If you want to save his sanity and his life, take him away from here!" Without waiting for a response, he turned and ran lightly up the stairs.

With great effort Constance released the railing she had grasped. Flames! She had known when Charlie began having nightmares about arson. She remembered too vividly the way he had muttered, thrashing about in his sleep. They had talked about it then but not since, never since. He had asked for a transfer, had changed his job, and gradually the nightmares had stopped. Her palms were wet.

The masks stared down at her. They saw everything with those empty eyes, heard

Seems the Japanese have made another breakthrough.

everything knew everything And Amos? How had he found that out?

Half an hour later she joined Angel in the television room "Mind if I watch with you?" she asked 'It sure is quiet in this house today."

Angel shrugged She was watching a game show

"Our daughter is in college," Constance said "She wants to be a biologist What will you major in?"

Angel continued to watch the show "I don't know '

"That s the best way to enter I think. Leave it open until you've tried out various fields. Where will you go?

"I don't know '

"Well I don't think it hurts to wait until you're older to decide Have you always been afraid of cats?"

"I'm not afraid of cats '

"Mechanical ones, I meant '

Angel pushed a button on the remote control

"It really isn't very different from the windup toys that kids play with when they re young you know '

Angel pushed the button again, then again

"Actually, what you're doing now with that control is pretty much how the cat works I think You give a signal, and it does something that it's been programmed to do "

The television stations were flicking by faster and faster

"It wasn t aiming at you, you know You just happened to be closest to it '

Flick flick They were back to the original game show She turned up the volume

"Angel, there are people who can help you These things don t get better by themselves You don t have to be so afraid

Suddenly Angel jumped up and glared at Constance. "Leave me alone! I'm not afraid of a stupid cat!'

She ran from the room

Gloomily Constance turned off the television set and followed the girl She reached the foyer just in time to see Charlie leading Angel back into the house, his arm about her protectively

"Take it easy,' he was saying "No one's going to hurt you Who was chasing you, anyway?"

"She wants to hurt me ' Angel said breathlessly her face pressed against his side 'She won't leave me alone '

' Who, honey? Just tell me who '

Angel pointed at Constance standing in the hallway entrance

When Charlie looked at Constance, his face was set in hard lines This is how *they* must have felt she thought distantly She meant the ones he interrogated, the ones he suspected, the ones he intended to stop one way or another the ones he hated

Before either could say anything, Amos came running down the stairs

' Time to go home, Sister Angel Lessons to do Sister Wanda is resting now We'll come back later "

There was a glint in his eyes that suggested satisfaction or possibly contempt

In their room a few minutes later, Charlie outlined what he had found out "His name is Andrew Donovan, half a dozen pinches but never a conviction Petty stuff Con games, most of them The chicken-drop switch, stuff like that And for the last few years he s been with a carnival, a magic act Long black hair full black beard Played in Bridgeport last summer, but no one would recognize him now

She shook her head What was happening here went beyond a con game

"It all fits," Charlie said brusquely "He killed Vernon split and came back when things quieted down Now he's working his way into the house What more could you ask for?"

She told him about the picture album Vernon could have met him at the carnival 'But why did he kill Vernon? Petty con men don t murder as a rule "

'So Vernon found out something about him What difference does it make? Even if he didn't do it, he's a con artist And with the background of a magic show mind reading and all, the rest of it's easy This is exactly what Wanda needs to know

'She won't be convinced '

'I've got what they wanted We're finished here You take the car back home this afternoon I'll be along in a few days

He was at the window The rain had stopped and a feeble sun was lighting the clouds that lingered

"Charlie, what s wrong with you? What s happened to you?"

His expression was so miserable that she wanted to go to him hold him hard "I don't know I have to be alone for a while I have to think something through "

"Vernon became obsessed with someone else all at once," she said slowly "I think that was the ghost he wanted to talk about that night Who is it, Charlie?

He had averted his face, did not answer

Like Vernon she thought Just like Vernon 'You didn t get any sleep last night ' she said "Why don't you take a short nap now before dinner?"

Outside their room she looked up and down the hallway and said under her breath, 'You can't have him! Ghost ghoul, whatever you are you can't have him!'

Gretchen met her in the foyer "Telephone for Charlie Is he in your room?"

"He s sleeping I'll take it ' She took it in the living room

' Constance? Hey, how're you? It's Tony '

"Fine, Tony What a nice surprise to have you here " Tony chatted a moment or two before he came to the point

' It s about that other set of prints on the glass She's Angela Schnabel, a runaway from Philadelphia juvenile court But hell, she's going to be eighteen in a few months, and she s clean No one's going to haul her back now '

'Juvenile court? For what?" *Eighteen? It seemed impossible*

Nothing. Abandoned by her mother. She was a ward of the court in a disturbed children's home and split.'

She paced the living room for several minutes, then sat down and called Philadelphia information and got two numbers, one of a colleague she had worked with and another of a child psychologist she knew by repufation.

Her friend protested that the information she wanted was not available. Constance hung up, called the child psychologist and talked to her for a long time. Then she called back her friend.

'Dr. Walker will intercede for you,' she said forcefully. 'She has influence at the detention center. Just get over there, Vanessa, will you, for crying out loud?'

Vanessa grumbled, but said she would do it and call back as soon as she had anything to tell.

Constance was still waiting when Gretchen and Charlie joined her. Charlie looked as if he had not slept.

Gretchen sprawled on the couch. 'She's giving us all the old heave-ho, I'm afraid. She'll be down to tell us officially that we're invited to leave. I guess last night was the last straw.'

'Amos called her Sister Wanda today. I was afraid he had won.' Constance remembered the glint in his eyes.

'Maybe what I have to tell her will change her mind,' Charlie said.

'I doubt it.' Wanda entered the room. 'Brother Amos already told me about his past. He went through a conversion last fall as real as the one that changed the life of Saul of Tarsus.'

'You know about his little mind-reading act with the carnival?'

She nodded. 'Everything. And he really does communicate in ways not available to the rest of us. He said Constance knows that now.' She looked inquiringly at Constance who nodded.

'He knows things he shouldn't.'

'See? I've invited him and Sister Angel to stay here but not until my other guests have departed,' she said without a trace of embarrassment. 'They will join us tonight for a short while and move in to keep me company tomorrow. Will that be convenient?'

She sank into one of the overstuffed chairs, picked up her cigarettes, and lit one. 'He also said that you, Charlie, should leave here tonight. Whatever it was that haunted Vernon has now transferred its attention to you. You're in danger.'

'Vernon hasn't told you anything about that ghost yet?' Charlie's voice held a trace of mockery.

'Not yet.' Wanda admitted. 'But he will eventually. Last night was the first time he has shown displeasure. That was because you're here under false pretenses. You're the one who wanted to play with the cat and you're very threatening to Amos.'

Charlie laughed. 'You told him about us?'

'No. I've told him nothing.' She stubbed out the cigarette and lit another. 'There's no need to tell him anything. He knows.'

Why didn't Vanessa call back? Constance looked again at her watch. 'When do you expect Amos and Angel tonight?'

'Around nine-thirty.'

At dinner they all poked at their food without interest. The call for Constance came midway through the meal.

When she returned to the dining room Wanda was regarding Charlie. 'That's exactly how Vernon acted,' she said. 'That same kind of absent look, pale, tauf—'

Charlie stood up, stalked from the room, with Constance right behind him.

She nearly pushed him into the television room and closed the door. It was almost nine-thirty.

'I can't leave.' Charlie said grimly. 'Angel's scared to death. She needs help.'

'I know she does. Charlie, go along with me for the next hour. Whatever you start to think, please trust me!'

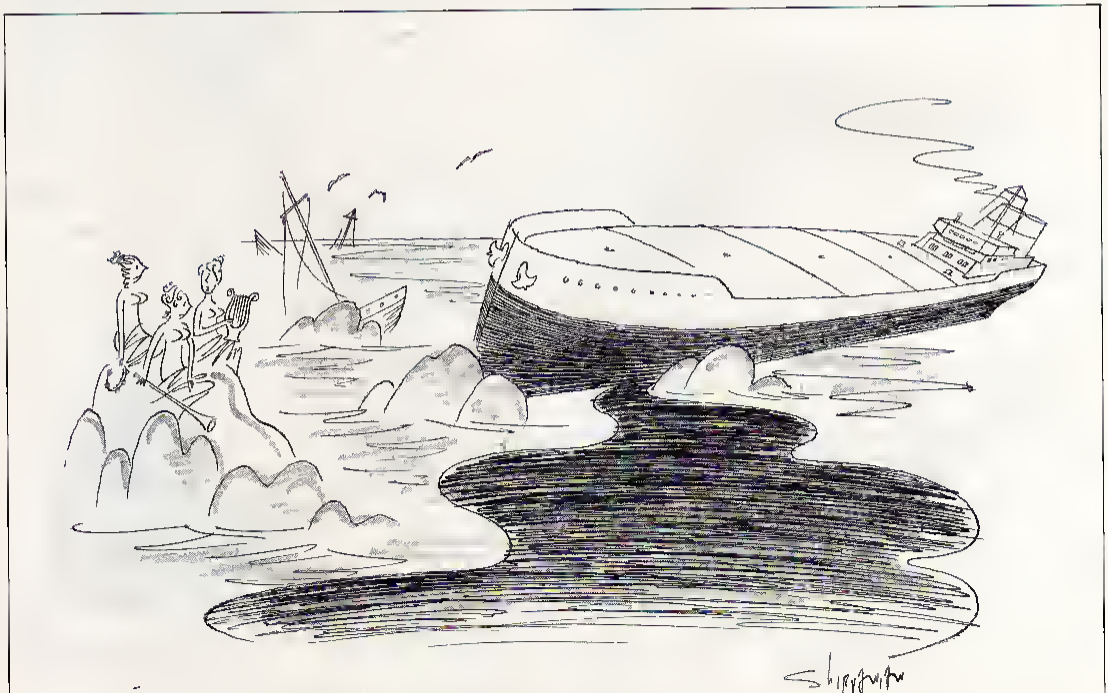
'If you do anything to hurt her—'

'You know I won't hurt her.'

He rubbed his eyes and took a deep breath. 'What are you up to? Who called?'

'I can't tell you. You're too open to her.'

'We shouldn't have come. We can leave now, forget all this. Maybe that's what we should do—just get the hell out of here.'



'We should have let this one pass.'

'We can't. You can't. It's too late for that.' She looked at her watch. 'It's time. He'll be upstairs with Wanda. Angel is going to have dessert with us. Let's go back now. And Charlie, don't interfere. Promise!'

He shook his head. 'I can't promise that.'

'All right. But you do trust me, you know. You can't stop trusting me now.'

Almost all day she had been with him, gone briefly now and again, but then back, even stronger. Whispering in his ear, sitting on his lap, lying with him, moving with him, caressing him with her warm hands that were touches of electricity. When he paused at the dining-room door, she was seated at the table with cake before her. Her fork halted in midair. She looked directly at him. He saw her across the room and he felt her in his arms, her warm breath on his neck, her laughter in his ear. Her incredible violet eyes, he thought, unable to look away until she lowered her gaze. Then he moved, resumed his seat.

'Good evening, Angel.' Constance said briskly. 'It's time that we all began telling the truth around here, don't you think? First of all, Charlie is a detective. He used to work for the police in New York, now he's freelance.'

He started to rise, relaxed again. She didn't care. In his mind he was holding her—the way he had held her when the cat moved—hard, tight, with her face pressed against him.

'We were hired,' Constance went on, very businesslike, almost brusque in her speech, 'to investigate Amos.'

Charlie closed his eyes, moving in a slow waltz with her. If he looked at Constance, he would see an old, rather ugly woman. He kept his eyes closed and felt the lithe body against him.

'You know what I'm telling you is true,' Constance said. 'And this is true also. I'm a doctor, a psychologist—'

There was a wave of hatred, loathing, terror. Charlie snapped his eyes open. The emotional wave was gathering momentum, hitting him like surges of power. Gretchen screamed. Charlie tried to yell, tried to call out Constance's name, but could make no sound. *Stop it*, he tried to whisper. *Stop it!*

Constance had been prepared for something, but not this. She was the target, she knew that as she felt nausea and vertigo. She felt as if she were falling from a terrible height, falling faster and faster, and knew that when she hit she would die. She wanted to fling out her hands to catch herself, to stop the fall. If she did that she would be lost. There were words in her head, words she had to say now.

She tried to speak, her throat was paralyzed, her tongue paralyzed. Angel leaned forward, her eyes wide and staring, her face as pale as death. And in her mind Constance cried, *No!*

'Angela,' she said in a hoarse whisper, 'close your eyes. Go to sleep.'

Angel blinked. For a moment Constance

was afraid it was not going to work, but the childish face relaxed. Her eyes closed. She took a deep breath and let it out slowly.

It was over. Charlie's hand shook when he reached for his water and took a drink. It was all over, he thought. He looked at Constance, who was very pale.

"You were swell," he said huskily.

She nodded, grateful, but kept her attention on the girl across the table from her. Slowly, softly she said, "Angela, go into your deepest trance. Very relaxed, comfortable, down, down."

In a few minutes Constance asked, "Angela, does Amos hypnotize you?"

"Yes."

"You won't allow him to ever again. Angela. Do you understand?"

"Yes."

"When he tries to hypnotize you again, you will remember what I'm telling you now and he won't be able to control you ever again." Constance repeated this several times before she was satisfied and then said, "I am not your enemy, Angela. I won't send you back to the home. You don't have to hate me. You don't have to be afraid of me. Do you understand?"

Charlie watched in fascination, but time was running out. He caught Constance's eye and tapped his watch. She nodded.

"When you wake up, Angela, you will remember what we've talked about, all of it. You won't be afraid or nervous, but very relaxed and peaceful. You'll know that Charlie is not your father, Angela. You'll want to stay here with us tonight so we can take care of you. You don't have to go with Amos." As before, she repeated each part of her message several times.

At Constance's command Angel opened her eyes. She blinked rapidly a few times and started to eat her cake.

"Do you remember what happened?" Constance asked.

"Nothing happened."

Gretchen had not said a word throughout. Now she got up and started for the door. "I want coffee. Maybe I want a drink, too. Charlie? Constance?"

They both nodded and she left.

Charlie looked helplessly from Constance to Angel and back. Had it taken? He couldn't tell. Constance raised her eyebrow in a let's-wait-and-see manner, and he dug his fork into his cake.

Angel looked at him and said scornfully, "I knew you were a cop from the beginning. You look like a cop, walk like a cop, smell like a cop."

Charlie grinned at his cake and started to eat it. "That's more like it, kid," he said under his breath. Aloud he asked, "You had that much experience with cops?"

"Yeah." She looked past him. He turned to see Amos in the doorway.

"Come along, Sister Angel. Time to go study."

She started to rise from her seat and then sat down again. A puzzled look flickered across her face. She shook her head.

Sister Angel, it's late. Time to go home."

Again she shook her head. "They said I can stay here."

"We'll come back tomorrow. You can wait one more day."

She was pushing crumbs around her plate with her fork, not looking at him. She shook her head.

Now Amos walked around the table and put his hand on her shoulder lightly. "Be a good girl, Sister Angel. You hear me? Get up and come along home."

Gretchen entered carrying the coffee tray, to which she had added brandy and glasses.

"Hi, Amos. Just in time. Join us?"

He was watching Angel closely, his hand tight on her shoulder now. "Be a good girl, Sister Angel," he repeated clearly.

She stood up. "Is it okay if I go watch TV awhile?"

"Run along," Constance said. "We'll be in here if you want anything."

Angel nearly ran from the room.

"You can't keep her," Amos said harshly.

Charlie shrugged. "She wants to stay."

Amos looked at him, his eyes narrowed. His face was mean and rigid. "You'll regret this," he said. "You don't know what you're doing." He marched out, and Charlie followed him through the hallway, watching until he left the house.

He returned to the dining room, where Gretchen was drinking brandy as if it were going out of style. "What was that all about?" she demanded of Constance.

"I don't want her to overhear," Constance said, and Charlie took his glass and stood by the open door to keep watch.

"She's a runaway," Constance said then. "She was in a home for disturbed youngsters in Philadelphia up until two and a half years ago. There was a scandal, the director apparently helped her gave her money, then she vanished, and he resigned. She was classified schizophrenic. Her father abandoned her and her mother when she was three. When she was six, she landed in a hospital with multiple bruises, abrasions, a concussion, and she had been sexually molested. She had no memory of the incident. Mother said it was an attack by an unknown. Case closed. Two years later it was repeated, but this time Mother was implicated by a neighbor in the beating. Mother came under investigation. A series of live-in boyfriends, child abuse. Mother was ordered into therapy. When Angel was twelve her mother had her committed, called her sexually promiscuous and incorrigible. She authorized a series of shock treatments."

Gretchen looked pale and sick. Charlie's face was a mask.

"They started her on hypnoanalysis. And they got the story about her father, about her mother's boyfriends, who she wished were her father, and about her mother's reaction each time. And they got a dose of what we've had from her, the projections she's capable of. Easier to call her schiz-

"I'm sorry I accused you of pilfering, Ardmore. Your office supplies do walk off by themselves!"

ophrenic than try to deal with that. Delusions of grandeur, retardation, nymphomania, schizo. She's had it all pinned on her. Physically she's like a thirteen-year-old, but God only knows what's in her head."

"They gave you the key words to induce trance?" Charlie asked after the silence had persisted many minutes.

"Yes. First she had to know that I was a doctor. That was the cue they left with her, that she would respond to a doctor using those words." She glanced at Gretchen and added, "It's a posthypnotic suggestion to return to trance instantly on cue. Obviously Amos planted one also, but he's an amateur. He didn't know enough to protect his power over her."

"He isn't even her father," Gretchen said in disbelief.

And they were in the area last summer, Constance thought, when Vernon became obsessed with a mysterious woman and was killed. She looked at Charlie, he shook his head slightly.

"I'm going to keep her company," Gretchen said then. "She may be lonesome tonight, and afraid. Poor little kid."

Charlie nodded. "I want to check the security system."

It wasn't over, he thought. Not with Amos out there in a rage, not with that strange girl in the house. Constance went upstairs to get her notebook. As she passed the masks on the stairway wall she scolded them. "You knew all the time," she muttered severely. "Damn enigmatic Indians."

When she returned to the living room Charlie was closing the drapes.

"You think he'll try to get in tonight?"

"Not if he's got half the brains he should have, but I'm spending the night right here on the couch."

And she would keep him company, she thought, eyeing the chairs, the other couch. The upstairs bedrooms were very far away.

"I saw a chess set earlier," she said. "Want a game?"

After Gretchen and Angel went upstairs, Charlie made another inspection of the house. From the dark television room he looked out at the yard. It was raining, and the wind was blowing fitfully. It would be good to be home, he found himself thinking, and longed to be there in front of the fireplace, the silly cats trying to filch anything edible, Constance in her chair, reading or writing away.

Amos would not be able to give her up, Charlie thought later, studying the game where he was going to be mated in another move or two.

"Vernon must have seemed a real threat," Constance said, finishing his thought as she so often did.

"Yeah. But why does Angel keep on looking if she's found someone?"

"The three-year-old in her is still looking, remember? When the father becomes lover, the three-year-old knows something is wrong, and the search is on."

"And it'll never end for her."

"I don't know. I want her, Charlie. I want

to work with her find out what she's capable of help her learn to control it'

Charlie thought of the images of Constance that Angel had put in his head—old, ugly, fearsome even. He doubted that Angel would let Constance near her. Yet, they couldn't just turn her loose. And they couldn't send her back to the institution. She isn't our problem, he wanted to say, but obviously Constance thought she was.

"I resign," he said then. "Want to break the tie?"

"Sure." She started to set up the pieces again, then stopped when Wanda appeared in the doorway.

"Why are both of you still up?"

"How did you get down here? I didn't hear you," Charlie asked.

"The back stairs. It's after two."

"Is anything wrong?" Constance asked sharply. Wanda had on a long robe that looked warm, but she was shivering and very pale.

"Please, both of you, please go on to bed. This is terrible. I have to be alone sometime! There's always someone—" She fled into the darkened hall.

Constance followed her to the kitchen. "What happened?"

Wanda put a tea kettle on the stove and turned on the burner. "I want a cup of tea."

Constance looked at her helplessly. "Were you dreaming? Is that it?"

"Just leave me alone."

"Listen to me, Wanda. Angel isn't his daughter, and she's the one with telepathic powers. He never knows anything until he gets it out of her. She's given him information, not Vernon. And it's information right out of your head, our heads, not from beyond the grave."

Wearily Wanda said, "I called Amos and turned off the security system so he can get in. There are things moving in the house, unquiet things. I have to see him alone. You and Charlie have to go upstairs. Mind your own business. If Vernon tries to tell me something, Charlie just gets in the way." She moved toward the hall.

In defeat Constance walked with her. They could not order her not to see Amos. They were nearing the end of the hall, the bright living room open before them, when she stopped abruptly. Her fingers dug into Wanda's arm, pulling her back; her other hand covered Wanda's mouth. Amos, standing in the living room, was holding a small gun and looking at Charlie.

"Just don't forget it's here," Amos was saying, putting the gun in his raincoat pocket, keeping his hand on it. "When she comes out with her tea, then we'll talk."

Wanda pulled hard against Constance, and she tightened her grasp, forcing her back farther into the shadows.

"You don't think people might talk if you come in and shoot up the company?" Charlie asked pleasantly. His voice was so mild, so easy, he might have been asking about ball-game scores.

"You're a tire bug. Angel told me. Me and Wanda and Angel are leaving, and we're going to let you play with tire." He turned so that he could see the hallway to the kitchen. "Just sit still until your wife joins us with her tea."

"Were you afraid Vernon was going to take her away from you?"

Amos moved out of range. Constance let go of Wanda and ran to the living room.

He was standing close to Charlie, speaking in a low, intense voice. "... her fault. She can't help it. He was going to investigate, her, take her away."

"And you killed him. He just wanted to do something decent for the kid."

"Decent! You know what she does! She told me about you, how she wanted you. I know what that means."

"What does it mean?" Wanda asked, holding onto the doorframe. "What exactly is it she does?"

For a moment Amos looked too stunned to speak. He recovered quickly. "She's sick. I've known it for a long time, but I thought I could cure her. I thought my love would be enough to make her well. She needs medical treatment, a hospital, help—"

Suddenly Constance felt as if she had been punched in the stomach. She doubled over in pain, unable to breathe, and at the same time a red hatred poured

"I'm sorry, but medical science still has a lot to learn about halitosis."

through her, wrenching her numbing her Things were flying through the air, the masks were flying She tried to dodge, but something caught her on the side of the head and she fell, dazed

Charlie threw his arm up in front of his face to ward off the masks One caught on his elbow, and he felt his entire arm go numb Hatred and fury blinded him He grunted and fell when something smashed into his midsection

The chessboard flew from the table scattering pieces and hit Amos in the back He was yelling hoarsely "Angel! For God's sake, stop it! Sister Angel be a good girl Stop!" He was cut off by a scream Charlie could not tell whose it was Wanda crumpled to the floor

Constance pulled herself to her knees Angel was on the top step, barefooted, dressed in a man's pajama shirt that reached down to her mid-thighs She was crying as a child cries openmouthed her eyes tightly closed screaming

She had to make the child hear her, had to say the right words to make her hear Her words were drowned in screams An end table flew across the room and hit Amos on the leg She said the words again and could not even hear them The entire room was alive, moving, crashing *She'll kill us all* Constance thought distantly

"I'm coming!" Charlie whispered "Hold on, baby I'm coming!" He tried to move but tripped over the chess table He felt it jerk out from under his body, saw it fly across the room and crash into the wall He pulled himself on the carpet, clutching it, trying to drag himself to her *I'm coming* he whispered *Honey, don't scream! Stop screaming! I won't let him send you back Angel! I swear it!*

Amos was dragging one leg holding on to the back of a chair, unable to stand upright, yelling to her, calling her name over and over The chair tilted and he crashed to the floor The gun was shaken from his pocket Angel kept screaming

Amos flung up his hand to ward off something he rolled and doubled up in pain, and his hand closed on the gun He was moaning "Stop it, Angel! My God Angel—" He convulsed with pain again, and then he lifted the gun and fired

"Angel!" he screamed He dragged himself to the steps, and she fell down on top of him Her eyes were opened she stared unblinking at the ceiling, her long white hair swung when he lifted her "Angel!" he cried out again and pressed her body to him, cradled her like an infant rocking back and forth, crying out her name over and over

Constance buried her face in her hands and shook with weeping

She felt Charlie's arms around her and leaned against him blindly

His eyes were closed tight his face pressed against her neck He stirred first, and lifted his head

"I'll be damned! Constance look!"

Nothing in the room was disturbed, nothing broken Constance raised her head reached up to feel her temple expecting a lump a cut blood There was nothing Amos rocked back and forth sobbing holding Angel in his arms

The police had come and gone, and now the sky was lightening

Charlie and Constance stood before the wide expanse of glass and looked at the lake unbroken by a ripple He told the police that Amos had come for his daughter and had shot her when she appeared on the top step Constance and Wanda had repeated the story

"That poor kid," one of the policemen had said over and over *Poor kid*, Constance echoed in her mind *She never had a chance* She remembered the toy cat, how it had thrown Angel into a panic, equating herself with it—soulless, willless, an automaton, taking orders, never free And with powers that never would be studied, never understood, never used for something other than deception and destruction Powers that finally killed her after making her life hellish "She never had a chance," she whispered

Charlie tightened his grip on her hand *And Amos, he never had a chance either* he thought *He would have had to kill father figures for an awfully long time*

"I wish we were home" he murmured, yearning for their comfortable living room, the three raunchy cats, the quiet fire, the silent snow accumulating outside

She leaned against him and sighed

They went upstairs then, and when they got to their room they shared one of the twin beds just to hold each other just to be close ∞

BOYS

CONTINUED FROM PAGE 86

there was a chance we could hold our own but we got smeared.

'They *threw* us. Some of my buds flew higher than the Pylon. These boys... incredible boys. Now Four hundredth is full of them. They glow and shiver like the lights when you get clubbed and fade out.'

Vave goes, 'Sounds like chiller-dillers.'

"If I thoughf they were only boys I wouldn'f be scared. Brother' goes HiLo. "But there's more to them. We tried to psych them out, and it almost worked. They're made out of that kind of stuff. It looks real and it will cut you up, but when you go at it with your mind it buzzes away like bees. There weren't enough of us to do much. And we weren't ready for them. I only got away because NimbleJax knocked me cold and stuffed me under a transport.

'When I got up it was over. I followed the Strip. Thought some teams might be roving, but there's nobody. Could be in hideaways. I was afraid to check. Most teams would squelch me before I said word one.'

'It's hard alone, different with a team behind you,' goes Slash. 'How many hideaways do you know?'

'Maybe six. Had a line on JipJaps, but not for sure. I know where to find Zips, Kingpins, Gerlz, Myrmies, Sledges. We could get to the Galrog bloc fast through the subtunnels.'

Slash turns to me. 'What have we got?'

I pull out the beat-up list and hand it to Jade, who reads it. 'JipJaps, Sledges, Drummers, A-V-Manas, Chix, Chogs, Dannies. If any of them are still alive, they would know others.'

'True,' goes Slash.

Jade nudges me. 'Wonder if this new team has got a name.'

He knows I like spelling things out. I grin and take back the list, pull out a pencil, and put down FOUR HUNDRED BOYS.

'Cause they took Four hundredth, Jade goes. I nod, buf that is not all. Somewhere I think I read about Boys knocking down the world, torturing grannies. It seems like something these Boys would do.

Down the street the moon comes up through smoke, making it the color of rust. Big chunks are missing.

'We'll smash em,' goes Vave.

The sight of the moon makes us sad and scared af the same time. I remember how it had been perfect and round as a pearl on jewelrymart velvet, beautiful and brighter than streetlights even when the worst smogs dyed it brown. Even that brown was better than this chipped-away bloody red. Looks like it was used for target practice. Maybe those Boys tossed the Bridge af Base English.

'Our bloc is gone,' goes HiLo. 'I wanf those Boys. It'll be those doobs or me.'

'We're with you,' goes Slash. "Let's move fast. Cut into pairs, Brothers. We're gonna hit some hideaways. Jade, Croak, you come with me and HiLo. We'll see if those Galrogs will listen to sense.'

Slash tells the other Brothers where to look and where to check back.

We say good-bye. We find the stairs to the nearest subtunnel and go down into lobbies full of shadow, where bodies lie waiting for the last train.

We race rats down the tunnel. They are meaner and fatter than ever, buf our lights hold them back.

'Still got that wicked blade?' goes Slash.

"This baby?' HiLo swings his good arm, and a scalpel blade drops into his hand.

Slash's eyes frost over, and his mouth tightens.

'May need it,' he goes.

"Right, Brother.' HiLo makes the blade disappear.

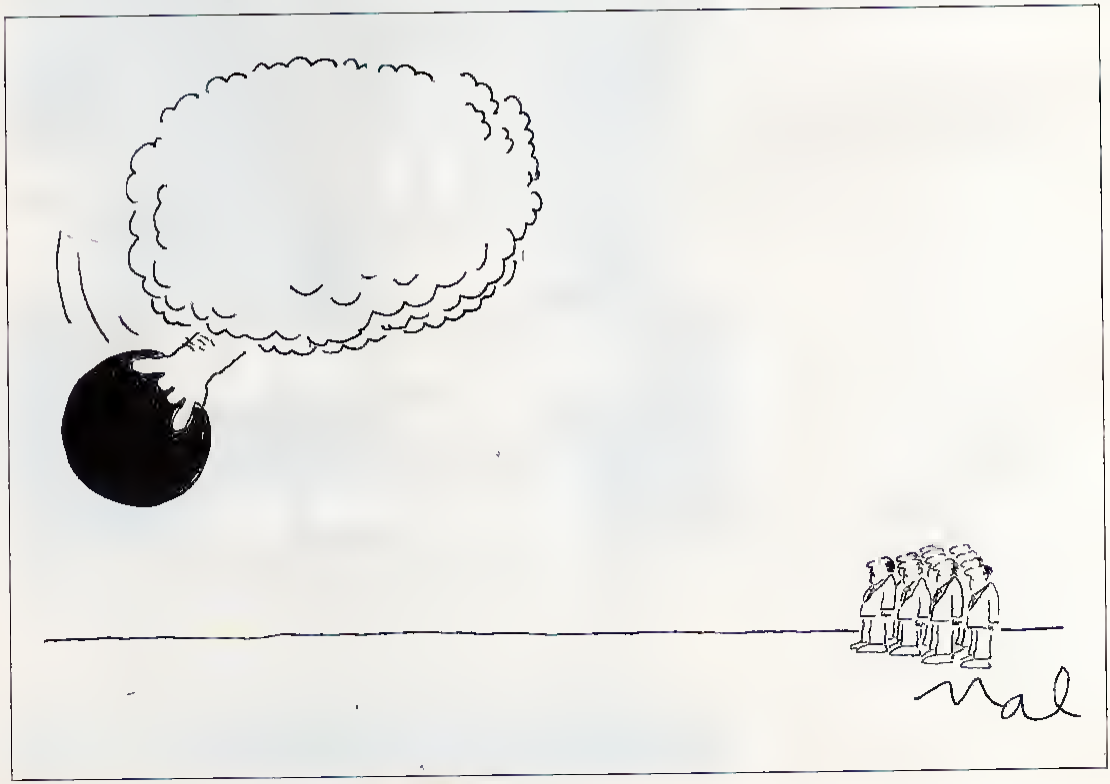
I see that is how it has to be.

We pass a few more lobbies before going up and out. We've moved faster than we could have on ground, now we are close to the low end of Fun City.

'This way,' HiLo points past broken hives. I see codes scripted on the rubbled walls. Galrog signals?

'Wait,' goes Jade. 'I'm starved.'

There is a liquor store a block away. We lift the door and twist it open, easy as



breaking an arm. Nothing moves inside or on the street as our lights glide over rows of bottles. Broken glass snaps under our sneakers. The place smells drunk and I'm getting that way from breathing. We find chips and candy bars that have survived under a counter and we gulp them down in the doorway.

'So where's the Galrog hideaway?' goes Jade, finishing a Fifth Avenue bar.

Just then we feel that little deep tug. This one whispers death. A team is letting us know that it has us surrounded.

HiLo goes, "Duck back."

"No," goes Slash. "No more hiding."

We go slow to the door and look through. Shadows peel from the walls and streak from alley mouths. We're sealed tight.

'Keep your blades back, Brothers.'

I never smashed with Galrogs. I see why Slash kept us away. They are tanked out with daystars, snappers, guns, and glory stix. Even unarmed they would be fierce with their fire-painted eyes, chopped topknots a dozen colors, and rainbow geometrics tattooed across their faces. Most are dressed in black; all are on razor-toed roller skates.

Their feelings are masked from us behind a mesh of silent threats.

A low voice: "Come out if you plan to keep breathing."

We move out, keeping together as the girls close tight. Jade raises his flashlight, but a Galrog with blue triangled cheeks and purple-blond topknot kicks it from his hand. It goes spinning a crazy beam through the dark. There is not a scratch on Jade's fingers. I keep my own light low.

A big Galrog rolls up. She looks like a cognibot slung with battery packs, wires running up and down her arms and through her afro, where she's hung tin bells and shards of glass. She has a laser turret strapped to her head and a snapper in each hand.

She checks me and Jade over and out, then turns toward the slickers.

"Slicker HiLo and Slicker Slash," she goes. "Cute match, but I thought Soooooots were hot for girlies."

"Keep it short, Bala," goes Slash. "The blocs are smashed."

"So I see." She smiles with black acid-etched teeth. "Hevvies got stomped next door, and we got a new playground."

"Have fun playing for a day or two," goes HiLo. "The ones who squelched them are coming back for you."

"Buildings squashed them. The end of the ramming world has been and gone. Where were you?"

"There's a new team playing in Fun City," HiLo goes.

Bala's eyes turn to slits. "Ganging on us now, huh? That's a getoff."

"The Four Hundred Boys," goes Jade.

"Enough to keep you busy!" She laughs and skates a half-circle. "Maybe."

"They're taking Fun City for their bloc—maybe all of it. They don't play fair. Those Boys never heard of clean fun."

"Skud," she goes, and shakes her hair so tin bells shiver. "You blew cirks, kids."

Slash knows that she is listening. "We're calling all teams, Bala. We gotta save our skins now, and that means we need to find more hideaways, let more slickers know what's up. Are you in or out?"

HiLo goes, "They smashed the Soooooots in thirty seconds flat."

A shock wave passes down the street like the tail end of a whiplash from center city. It catches us all by surprise and our guards go down. Galrogs, Brothers. Soooooot—we are all afraid of those wreckers. It unites us just like that.

When the shock passes we look at one another with wide eyes.

All the unspoken Galrog threats are gone. We have to hang together.

"Let's take these kids home," goes Bala.

"Yeah, Mommy!"

With a whisper of skates, the Galrogs take off.

Our well-armed escort leads us through a maze of skate trails cleared in rubble.

"Boys, huh?" I hear Bala say to the other slickers. "We thought different."

"What did you think?"

"Gods," Bala goes.

"Gods!"

"God-things, mind-stuff. Old Mother looked into her mirror and saw a bonfire made out of cities. Remember before the blister tore? There were wars in the south, weirdbombs going off like firecrackers. Who knows what kind of stuff was cooking in all that blaze?

"Old Mother said it was the end of the world, time for the ones outside to come through the cracks. They scooped all that energy and molded it into mass. Then they started scaring up storms, smashing. Where better to smash than Fun City?"

"End of the world?" goes HiLo. "Then why are we still here?"

Bala laughs. "You doob, how did you ever get to be a slicker? Nothing ever ends. Nothing."

In ten minutes we come to a monster-mart pyramid with its lower mirror windows put back together in jigsaw shards.

Bala gives a short whistle, and double doors swing wide.

In we go.

The first thing I see are boxes of supplies heaped in the aisles, cookstoves burning, cots, and piles of blankets. I also spot a few people who can't be Galrogs—like babies and a few grownups.

"We've been taking in survivors," goes Bala. "Old Mother said that we should." She shrugs.

Old Mother is ancient. I have heard. She lived through the plagues and came out on the side of the teams. She must be upstairs, staring in her mirror, mumbling.

Slash and HiLo look at each other. I cannot tell what they are thinking. Slash turns to me and Jade.

"Okay, Brothers, we've got work to do. Stick around."

"Got anywhere to sleep?" Jade goes.

The sight of all those cots and blankets made both of us feel tired

Bala points at a dead escalator "Show them the way Shell."

The Galrog with a blond topknot that's streaked purple speeds down one aisle and leaps the first four steps of the escalator She runs to the top without skipping a stroke and grins down from above.

'She's an angel,' goes Jade

There are more Galrogs at the top Some girls are snoring along the walls.

Shell cocks her hips and laughs. 'Never seen Brothers in a monstermart before

'Aw, my ma used to shop here' goes Jade He checks her up and over

"What'd she buy? Your daddy?'

Jade sticks his thumb through his fist and wiggles it with a big grin The other girls laugh but not Shell Her blue eyes darken and her cheeks redden under the blue triangles I grab Jade's arm

"Don't waste it" goes another Galrog

"I'll take the tip off for you" goes Shell and flashes a blade "Nice and neat."

I tug Jade's arm and he drops it.

'Come on, grab blankets,' goes Shell 'You can bed over there.'

We take our blankets to a corner wrap up and fall asleep close together I dream of smoke

It is still dark when Slash wakes us

"Come on, Brothers lots of work to do"

Things have taken off we see The Galrogs know the hideaways of more teams than we ever heard of some from outside Fun City Runners have been at it all night, and things are busy now

From uptown and downtown in a wide circle around Four hundredth they have called all who can come

The false night of smoke goes on and on, no telling how long It is still dark when Fun City starts moving

Over hive and under street, by sewer, strip and alleyway we close in tourniquet-tight on Four hundredth where Soooooots ran a clean-fun bloc From First to One thousandth, Bayview Street to Riverrun Boulevard, the rubble scatters and the subtunnels swarm as Fun City moves Brothers and Galrogs are joined by Rat beaters Drummers Myrmies and Kingpins from Piltdown Renfrew and the Upperhand Hills The Diablos cruise down with Chogs and Cholos Sledges and Trimtones JipJaps and A-V-Marias Tints Chix, RockoBoys, Gerlz Floods, Zips, and Zaps More than I can remember

It is a single team, the Fun City team and all the names mean the same thing

We Brothers walk shoulder to shoulder with the last Soooooot among us

Up the substairs we march to a blasted black surface It looks like the end of the world but we are still alive I can hardly breathe for a minute, but I keep walking and let my anger boil.

Up ahead of us the Four Hundred Boys quiet down to a furnace roar

"Do you realize that what you just said will go down in history as the first words from Jupiter?"

By Three hundred ninety-fifth we have scattered through cross streets into the Boys' bloc

When we reach Three hundred ninety-eighth fire flares from hives ahead There is a sound like a skyscraper taking its first step A scream echoes high between the towers and falls to the street.

At the next corner I see an arm stretched out under rubble Around the wrist the cuff is jagged black and red

'Go to it,' goes HiLo

We step onto Four hundredth and stare forever I'll never forget.

The streets we knew are gone The concrete has been pulverized to gravel and dust, cracked up from underneath Pyramid hives are baby volcano cones that hack smoke, ooze fire and burn black scars in the broken earth Towers hulk around the spitting volcanoes like buildings warming themselves under the blanked-out sky

Were the Four Hundred Boys building a new city? If so it would be much worse than death.

Past the fires we can see the rest of Fun City We feel the team on all sides a pulse of life connecting us one breath

HiLo has seen some of this before, but not all He sheds no fears tonight.

He walks out ahead of us to stand black against the flames He throws back his head and screams.

"Heeeeeey!"

A cone erupts between the monster buildings It drowns him out so he shouts even louder

'Hey you Four Hundred Boys!"

Shattered streetlights pop half to life Over my head one explodes with a flash

'This is our bloc, Four Hundred Boys!'

Galrogs and Trimtones beat on overturned cars It gets my blood going.

"So you knocked in our hives, you Boys So you raped our city'

Our world I think of the moon, and my eyes sting.

"So what?"

The streetlights black out The earth shudders The cones roar and vomit hot blood all over those buildings I hear it sizzle as it drips

Thunder talks among the towers

"I bet you will never grow UP!"

Here they come

All at once there are more buildings in the street I had thought they were new buildings, but they are *big* Boys Four hundred at least.

"Stay cool,' goes Slash.

The Four Hundred Boys thunder into our streets We move back through shadows into hiding places only we can reach

The first Boys swing chains with links the size of skating rinks Off come the tops of some nearby hives The Boys cannot quite get at us from up there but they can cover us with rubble

They look seven or eight years old for all their size, and there is still baby pudge on their long sweaty faces Their eyes have a vicious shine like boys that age get when

they are pulling the legs off a bug—laughing wild but freaked and frightened by what they see their own hands doing They look double deadly because of that They are on fire under their skin, fever yellow

They look more frightened than us Fear is gone from the one team We reach out at them as they charge sending our power from all sides We chant but I do not know if there are any words it is a cry It might mean, "Take us if you can Boys, take us at our size"

I feel as it I have touched a cold yellow blaze of fever; it sickens me, but the pain lets me know how real it is I find strength in that we all do We hold onto the fire sucking it away sending it down through our feet into the earth

The Boys start grinning and squinting They seem to be squeezing inside out The closest ones start shrinking dropping down to size with every step

We keep on sucking and spitting the fever The fire passes through us Our howling synchronizes

The Boys keep getting smaller all the time smaller and dimmer Little kids never know when to stop Even when they are burned out they keep going

As we fall back the first Boy comes down to size One minute he is taller than the hives; then he hardly fills the street A dozen of his shrinking pals fill in on either side They whip their chains and shriek at the sky like screaming cutouts against the downtown fires

They break past HiLo in the middle of the street and head for us Now they are twice our size now just right

This I can handle

"Smash!" yells Slash

One Boy charges me with a wicked black curve I can't see till it's whispering in my ear I duck fast and come up faster where he doesn't expect me

He goes down soft and heavy dead The sick, yellow light throbs out with his blood fades on the street

I spin to see Jade knocked down by a Boy with an ax There is nothing I can do but stare as the black blade swings high

Shrill whistle Wheels whirring

A body sails into the Boy and flattens him out with a footful of razors and ball-bearings Purple-blond topknot and a big grin The Galrog skips high and stomps his hatchet hand into cement leaving stiff fingers curling around mashed greenish blood and bones

Shell laughs at Jade and takes off

I run over and yank him to his feet Two Boys back away into a dark alley that lights up as they go in We start after but they have already been fixed by Quazis and Drummers lying in wait

Jade and I turn away

HiLo still stares down the street One Boy has stood tall stronger than the rest and more resistant to our power He raps a massive club in his hand

"*Come on, slicker,*" HiLo calls *"You remember me don't you?"*

The biggest of the Boys comes down eating up the streets We concentrate on draining him but he shrinks more slowly than the others

His club slams the ground Boom! Me and some Galrogs land on our asses The club creases a hive and cement sprays over us glass sings through the air

HiLo does not move He waits with red-and-black lightning bolts serene, both hands empty

The big slicker swings again, but now his head only reaches to the fifth floor of an Rx HiLo ducks as the club streaks over and turns a storefront window into dust

The Soooooot's scalpel glints into his hand He throws himself at the Boy's ankle and grabs on tight

He slashes twice The Boy screams like a cat Neatest hamstringing you ever saw

The screaming Boy staggers and kicks out hard enough to flip HiLo across the street into the metal cage of a shop window HiLo lands in a heap of impossible angles and does not move again

Slash cries out His gun shouts louder One blood-silver shot It leaves a shining line in the smoky air

The Boy falls over and scratches the cement till his huge fingertips bleed His mouth gapes wide as a manhole his eyes stare like the broken windows all around His pupils are slit like a poison snake's his face long and dark hook-nosed

Gbd or boy, he is dead Like some of us

Five Drummers climb over the corpse for the next round but with their slickie dead the Boys are not up to it The volcanoes belch as though they too are giving up

The survivors stand glowing in the middle of their bloc A few start crying and that is a sound I cannot spell It makes Crybaby start up He sits down in cement, sobbing through his fingers His tears are the color of an oil rainbow on wet asphalt

We keep on sucking up the fever glow grounding it all in the earth

The Boys cry louder, out of pain They start tearing at each other running in spirals and a few leap into the lava that streams from the pyramids

The glow shrieks out of control out of our hands gathering between the Boys with its last strength—ready to pounce

It leaps upward a hot snake screaming into the clouds

Then the Boys drop dead and never move again

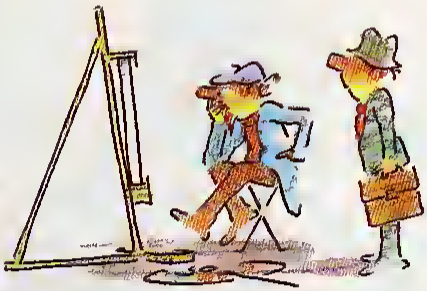
A hole in the ceiling of smoke The dark-blue sky peeks through turning pale as the smoke thins The Boys last scream dies out in the dawn

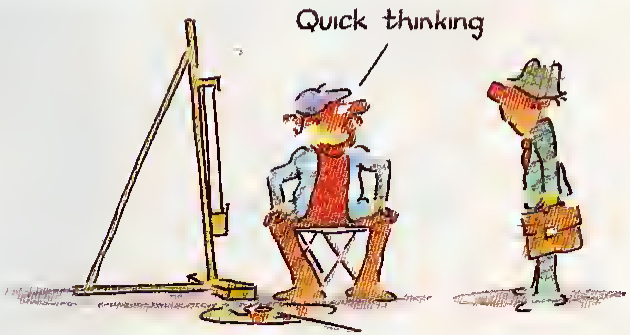
The sun looks bruised, but there it is Hiya up there!

"Let's get to it," goes Slash "Lots of cleanup ahead" He has been crying I guess he loved HiLo like a Brother I wish I could say something

We help one another up Slap shoulders and watch the sun come out gold and orange and blazing white I don't have to tell you it looks good teams DO

The Artist





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are even more sensitive than this culinary example might suggest. A slight change in just one of the universal grammar's parameters can have enormous repercussions throughout the language. It can produce an entirely different language.

Again, there's a close parallel to embryology, where a slight shift in the gene mechanisms regulating growth may be all that separates a fertilized egg from developing into a lion rather than a whale.

Omni: So what exactly would you say *is* the grammar of English?

Chomsky: The grammar of English is the collection of choices—head-initial rather than head-final, and null subject forbidden, for example—that define one of a limited number of genetically permitted selections from the universal-grammar menu of grammatical options. And of course there are all the lexical facts. You just have to learn your language's vocabulary. The universal grammar doesn't tell you that *tree* means "tree" in English.

But once you've learned the vocabulary items and fixed the grammatical parameters for English, the whole system is in place. And the general principles genetically programmed into the language organ just churn away to yield all the particular facts about English grammar.

Omni: It sounds as if your present research goal is to reach the point where you can define every human language's grammar simply by specifying its choices from the universal grammar's menu of options.

Chomsky: That's the kind of work you would hope would soon be done: to take a theory of universal grammar, fix the parameters one way or another, and then deduce from these parameters the grammar of a real human language—Japanese, Swahili, English, or whatnot.

This goal is only on the horizon. But I think that it is within our conceptual grasp. Undoubtedly the principles of universal grammar that we currently theorize are wrong. It would be a miracle if we were right this early along. But the principles *are* of the right type, and we can now begin to test our present system with complex examples to see what is wrong and to make changes that will improve our theory.

Omni: Judging from what you've said about language and heredity, it sounds as if you must be sympathetic to the aims of sociobiology. Is that a fair assumption?

Chomsky: Well, I think that in some respects the sociobiologists are on the right track. I think it's true that a good deal of our personal behavior, social behavior, reactions, and so on are the reflection of genetic programs, and I think that it's a worthwhile enterprise to discover what these programs are. But while I think the general idea behind sociobiology is right, I also think that sociobiologists should be extremely cautious about the specific conclusions they draw from their research. Unfortunately, they often draw conclusions that are remote from evidence or theory.

Omni: Many sociobiologists would dispute your note of caution. They claim that science has already gained enough information about the relationships between genes and behavior to permit some shrewd guesses about some of the ways heredity influences human social behavior. What do you say to these claims?

Chomsky: I'm very skeptical. I haven't really studied the newer research in enough detail to make any informed judgment. But as for the earlier work—for example, E. O. Wilson's *Sociobiology*—well, about ninety percent of the book was on nonprimates, and that looked interesting. There was a little bit on primates, which was more questionable. And there was a final chapter on humans that was completely empty. I don't think Wilson understood what he was talking about in that final chapter. There were real errors in what he did describe in any detail. I don't even understand why the chapter on humans was tacked on to the book. It didn't seem to belong.

Omni: What do you think about the claim made by Wilson and others that there's an innate incest taboo in human beings?

Chomsky: Sorting out what is and what is not genetically preprogrammed in human behavior is a very difficult task. As I said, I agree with the *general* approach of sociobiology. I think it's a reasonable approach. But it's important to be very cautious in making any claims about the role of heredity in human affairs—especially claims that would have social consequences if they were true. Science is held in such awe in our culture that every scientist has a special responsibility to make clear to the lay audience where his expert knowledge actually yields scientifically verifiable results and where he is guessing, indulging in sheer speculation, or expressing his own personal hopes about the success of his research. This is an important task because the lay audience is in no position to make these distinctions.

Omni: Moving on to another controversial area in the behavioral sciences, how do you think your views differ from B. F. Skinner's behaviorist theory of language, learning, and mind?

Chomsky: Skinner used to take a relatively extreme position. At one point he held that, apart from the most rudimentary functions, essentially nothing of importance was genetically programmed in the human brain. Skinner agreed that humans were genetically programmed to see and hear, but that's about all. Accordingly he argued that all human behavior was simply a reflection of training and experience. This view can't possibly be correct. And in fact Skinner's approach has led absolutely nowhere in this area. It has yielded no theoretical knowledge, no nontrivial principles as far as I am aware—thus far, at any rate.

Omni: Why is that?

Chomsky: Because Skinnerian behavior-

ism is off the wall. It's as hopeless a project as trying to explain that the onset of puberty results from social training. But I really don't know whether Skinner still maintains this extreme position. [*He has since modified it.—Ed.*]

Omni. What about the late Jean Piaget? Where do you stand on his theories of the child's mental development?

Chomsky. Piaget's position is different. It's more complex than Skinner's. Piaget held that the child passes through cognitive states. According to my understanding of the Piagetian literature, Piaget and his supporters were never really clear about what produced a new stage of cognitive development. What they could have said—though they seemed to shy away from it—is that cognitive development is a genetically determined maturational process like puberty, for example. That's what the Piagetians *ought* to say. They don't like this formulation, but it seems right to me.

Omni. In other words, Piagetians place much more emphasis on the role of experience in cognitive development than you do. Are there other differences as well?

Chomsky. Yes. Piagetians maintain that the mind develops as a whole rather than as a modular structure with specific capacities developing in their own ways. This is a possible hypothesis, but in fact it seems to be extremely wrong.

Omni. How do you mean?

Chomsky. Well, consider the properties that determine the reference of pronouns that we talked about earlier. Once you ferret out these rules for pronouns, they seem to have nothing in common with the logical operations that Piagetians single out as being typical of the early stages of the child's mental development.

Omni. In other words, a four-year-old who may not realize that the amount of water stays the same when you pour the contents of a low, wide glass into a tall, thin container nevertheless displays sophisticated logical abilities in his grasp of the complex rules of English grammar?

Chomsky. Yes. And these abilities are independent of the logical capacities measured by tests. There's just no resemblance between what a child does with blocks and the kind of knowledge that he displays of English grammar at the same age. In fact, I think it's sort of quixotic to expect tight interconnections between language development and growth in other mental domains. By and large, body systems develop in their own ways at their own rates. They interact, but the circulatory system doesn't wait until the visual system reaches a certain stage of organization before proceeding to imitate the visual system's organizational complexity. Cognitive growth shouldn't be different in this respect either. As far as we know, it isn't.

Omni. What about the problem of free will? If genes play a crucial role in structuring the mind's abilities, is free will an illusion?

Chomsky. Well, that's interesting. Here, I think, I would tend to agree with Descartes. Free will is simply an obvious aspect of human experience. I know—as much as I know that you're in front of me right now—that I can take my watch and throw it out the window if I feel like it. I also know that I'm not going to do that because I want the watch. But I could do it if I felt like it. I just know this.

Now, I don't think that there's any scientific grasp, any hint of an idea, as to how to explain free will. Suppose somebody argues that free will is an illusion. Okay. This could be the case, but I don't believe that it's the case. It *could* be. You have to be open-minded about the possibility. But you're going to need a very powerful argument to convince me that something as evident as free will is an illusion. Nobody's offered such an argument or even pretended to offer such an argument.

So where does that leave us? We're faced with an overwhelmingly self-evident phenomenon that *could* be an illusion even though there's no reason to believe that it is an illusion. And we have a body of scientific knowledge that simply doesn't appear to connect with the problem of free will in any way.

Omni. Do you think that science will ever solve the problem of free will?

"Offhand, Mr. Winslow, I'd say you've been watching too much television."

Chomsky Personally, I don't think so. People have been trying to solve the problem of free will for thousands of years, and they've made zero progress. They don't even have *bad* ideas about how to answer the question. My hunch— and it's no more than a guess—is that the answer to the riddle of free will lies in the domain of potential science that the human mind can never master because of the limitations of its genetic structure.

Omni Can you spell out what you mean?

Chomsky We can laugh at a rat that always fails a complicated maze. We can say, 'The rat is always going to fail because it can't look at the maze in the right way. It's doomed to fail this test forever.'

Similarly, some other intelligence, organized along hereditary lines different from our own, could look at the human race and say, "Those humans are always formulating the problem of free will in the wrong way. And the reason they don't understand the problem has something to do with their biological nature."

It could well turn out that free will is one maze that we humans will never solve. We may be like the rat that simply is not designed to solve a certain type of maze and will never do so even if it works on it for ten million years. Look, in principle, there are almost certainly true scientific theories that our genetically determined brain structures will prevent us from ever understanding. Some of these theories may well be ones that we would like to know about.

Omni That's a discouraging prospect.

Chomsky I don't see it as much of a reason to despair. In fact, I kind of like the conclusion. I'm not sure that I want free will to be understood.

Omni Do you think that any other human abilities fall into the same mysterious category as free will?

Chomsky In my opinion all of them do.

Omni All of them?

Chomsky Take for example the aesthetic sense. We like and understand Beethoven because we are humans, with a particular, genetically determined mental constitution. But that same human nature also means there are other conceivable forms of aesthetic expression that will be totally meaningless to us. The same thing is as true for art as it is for science. The fact that we can understand and appreciate certain kinds of art has a flip side. There must be all kinds of domains of artistic achievement that are beyond our mind's capacities to understand.

Omni Do you think genetic barriers to further progress are becoming obvious in some areas of art and science?

Chomsky You could give an argument that something like this has happened in quite a few fields. It was possible in the late nineteenth century for an intelligent person of much leisure and wealth to be about as much at home as he wanted to be in the arts and sciences. But forty years later that goal had become hopeless. Much of the new work in art and science since then is meaningless to the ordinary person.

Take modern music—post-Schönbergian music. Many artists say that if you don't understand modern music it's because you just haven't listened enough. But modern music wouldn't be accessible to me if I listened to it forever. Modern music is accessible to professionals and maybe to people with a special bent, but it's not accessible to the ordinary person who doesn't have a particular quirk of mind that enables him to grasp modern music, let alone make him want to deal with it.

Omni And you think that something similar has happened in some scientific fields?

Chomsky I think it has happened in physics and mathematics, for example. There's this idea, which goes back to the French mathematicians known collectively as Bourbaki, that the development of mathematics was originally the exploration of everyday intuitions of space and number. That is probably somewhat true through the end of the nineteenth century, but I don't think it's true now. As for physics, in talking to students at MIT, I notice that many of the very brightest ones, who would have gone into physics twenty years ago, are now going into biology. I think part of the reason for this shift is that there are discoveries to be made in biology that are within the range of an intelligent human being. This may not be true in other areas.

Omni You seem to be saying two things. First, that whatever defines our common human nature will turn out to be a shared set of intuitions that owe much of their strength and character to our common genetic heritage—our species genotype. Second, that the exhaustion of these intuitions in many areas is producing a peculiar kind of artistic and scientific specialization. Further progress in music or mathematics, for example, requires a scientist or artist with an unusual heredity.

Chomsky Well, it's a different mental constitution—something like being a chess freak or a runner who can do a three-and-one-half-minute mile. It's almost a matter of logic that this change is going to occur sooner or later. Has it happened already? That's a matter of judgment. It's a matter of looking at, say, the twentieth century and seeing whether there are signs of this change. Is it the case, for example, that contemporary work in the arts and sciences is no longer part of our common aesthetic and intellectual experience? Well, there are signs. But whether the signs are realistic or whether we are just going through a sort of sea change and something will develop, who knows? Maybe a thousand years from now we'll know.

Omni Do these possibilities ever make you feel that you're living in a time of creative stagnation?

Chomsky I don't really feel that. I think that there are too many possibilities. There's too much human potential that hasn't as yet been realized. And don't forget that the vast majority of the human race hasn't even entered into the world that we're claiming may

be finished. Who knows what the Third World will contribute to mankind's store of science and art when it does catch up with the industrialized nations? We are well short of real stagnation or termination, but that doesn't rule out the possibility that one might be able to perceive signs of such a change, or even be able to gain some insight into the ultimate limits to our intelligence by examining these signs.

Omni: How do these ideas fit into your choice of linguistics as a career?

Chomsky: My choice of linguistics was like most people's choice of work. It was an accident that depended on whom I met, where I was, and that sort of thing. Linguistics, however, was a fortunate choice for me because I think that linguistics is an area where it is possible to construct a very rich science.

Omni: How would you assess your own contributions to linguistics?

Chomsky: They seem sort of pre-Galilean.

Omni: Like physics before the scientific revolution in the seventeenth century?

Chomsky: Yes. In the pre-Galilean period people were beginning to formulate problems in physics in the right way. The answers weren't there, but the problems were finally being framed in a way that in retrospect we can see was right.

Omni: How "pre-" do you mean? Are you saying that linguistics is about where physics was in the sixteenth century? Or are we going back still further to Aristotle and to other Greek ideas about physics?

Chomsky: We don't know. It depends, you see, on when the breakthrough comes. But my feeling is that someday someone is going to come along and say, 'Look, you guys, you're on the right track, but you went wrong here. It should have been done this way.' Well, that will be it. Suddenly things will fall into place.

Omni: And then we'll have a scientific revolution in linguistics?

Chomsky: I would think so, although to speak of scientific revolutions occurring outside a small core of the natural sciences is rather misleading. In fact, there was one major scientific revolution in the seventeenth century, and there have been a lot of outgrowths from it since then, including biochemistry and molecular biology. But that's it. Nothing remotely resembling a scientific revolution has ever occurred in the social sciences.

Omni: How should a scientist exercise responsibility for the uses of his research?

Chomsky: The same way that any human does in any area of life.

Omni: Do you think that there are areas in science so potentially vulnerable to social misuse that they should not be pursued?

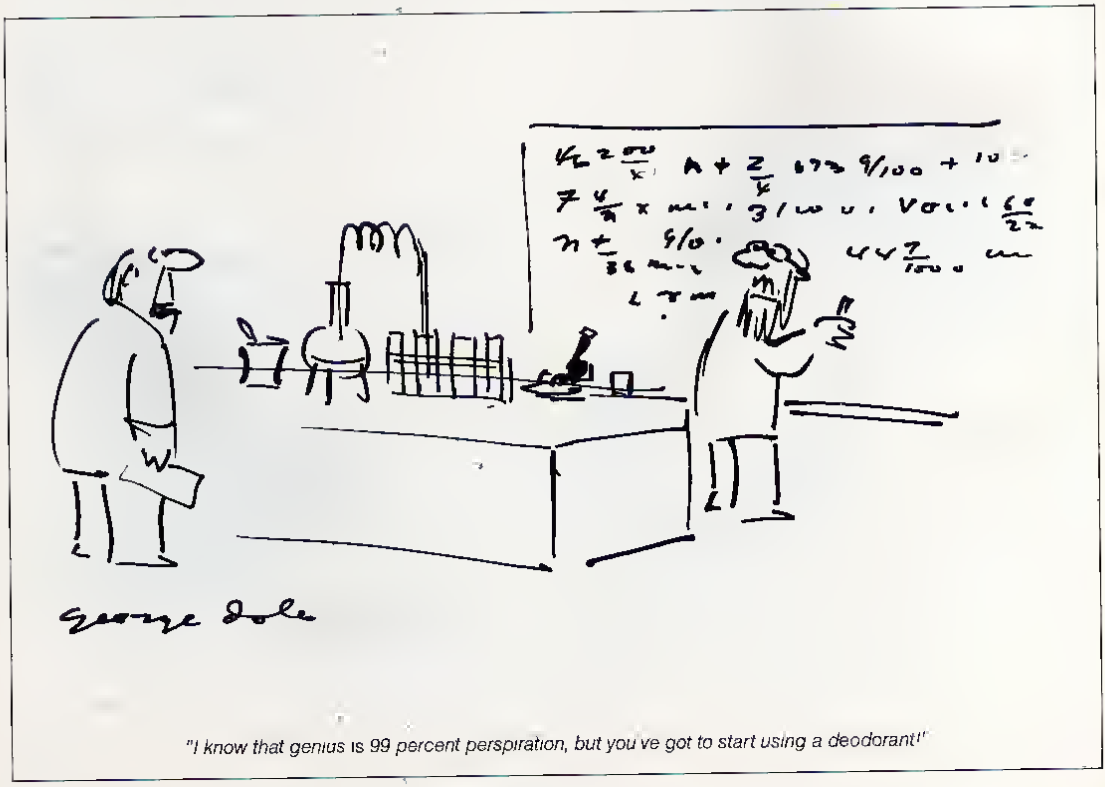
Chomsky: I think there are. For example, research on how to build more effective nuclear weapons. I don't think that should be pursued.

Omni: What about fundamental research—say, basic research in molecular biology that might conceivably give the weapons makers of the next generation a new set of destructive tools?

Chomsky: There's no simple answer to that question. Human beings are responsible for the predictable consequences of their actions. I would stop doing what I was doing if I discovered that I was engaged in an area of scientific research that I thought, under existing social conditions, would lead to, say, oppression, destruction, and pain.

Omni: An anachronistic question then: If you were a physicist in 1929, would you have done basic work in nuclear physics even though there was already speculation about the possibility of someday building an atom bomb?

Chomsky: It's not an easy question. It's tempting to say, 'Yes, because we have to understand the world.' On the other hand, it could be that basic research in nuclear physics will lead to the extinction of the human race or to something close to that. So I don't think a glib answer is possible. Still, if you ask me specifically, I'm sure that my answer would have been yes. I would have done the work just out of interest and curiosity and with the hope that things would somehow work out. But whether that would have been the morally responsible path is not clear. **OO**



"I know that genius is 99 percent perspiration, but you've got to start using a deodorant!"

TREBLE

CONTINUED FROM PAGE 149

FROM Brooks
TO Finnegan
No problem. Just like the suicide from drinking varnish: a horrible death but a beautiful finish.

By the by, what have you got for me after I finish pitching the Bean Bag Cats?

FROM Finnegan
TO Brooks
A treat.
How do you feel about Modular Dogs®?

CREATION

by Gene Wolfe

Monday, August 1. Had a flash of insight today. Had been mulling over Gott's (Harvard) notion that the universe contains just one magnetic monopole—because that's its seed, the same way each raindrop holds just one dust particle. (Means the guys at Berkeley and U. of Houston are wrong about catching them in their balloon over Nebraska, of course.) Why not make one in the accelerator? Because you can't move anything that heavy. Monopoles should be ten billion times (or so) the mass of a hydrogen atom. Flash of insight: To make industrial diamonds, you get the pressure with an explosion. Why not use an electrical discharge? Had some time on the accelerator, tried it. Nothing. Shot electrons at nothing to see if they were attracted or repelled. Got electrons, a few positrons. Probably equipment glitch.

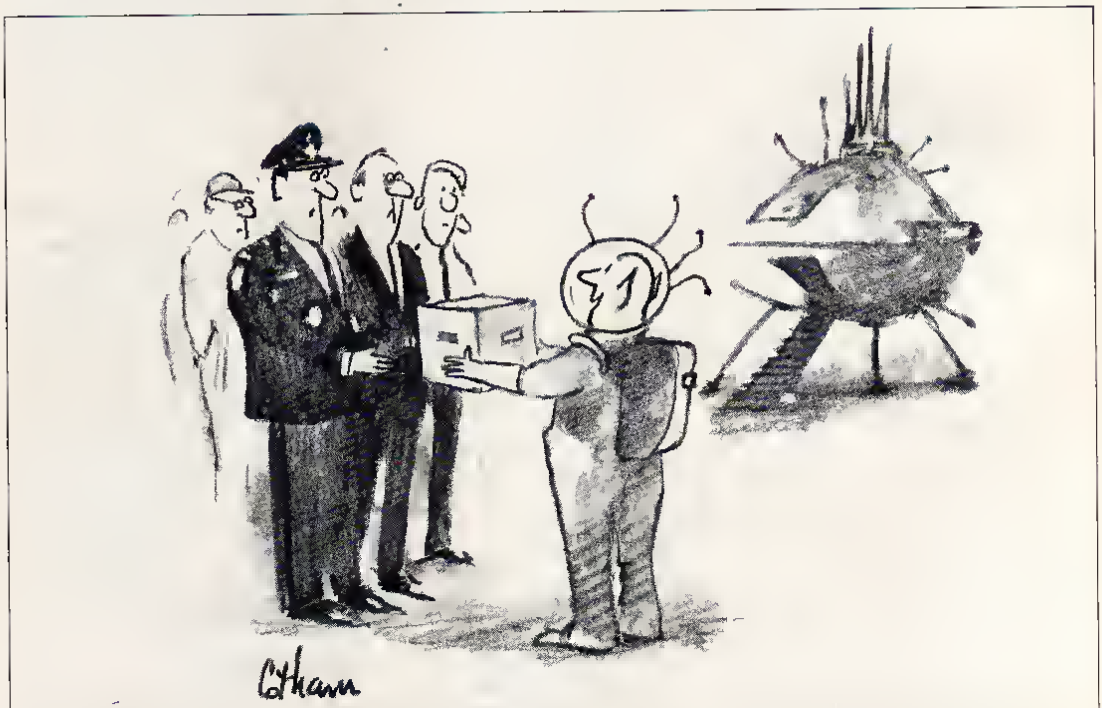
Tuesday, August 2. Anomaly in target. Took it out of accelerator, washed it, scrubbed with pumice, etc.—still no good. Put it under scope. Dark spot of water and cleanser that won't wipe off. Heavy stuff seems to be settling out.

Wednesday, August 3. Told Sis and Martha. How'd you like to say, 'My brother (husband) the Nobel laureate?' Martha: 'Gene, you're crazy, heard you talk before,' etc. Sis interested. (What I expected from both, in other words.) Told her about it—found monopole, made microverse. Gott right. Drove to lab. The microverse seems pyramidal. Strange. Tilted it, water flowed as by gravity, leaving some solids dry. Gravity interuniversal. Wanted to phone John Cramer about it, but he's off Gast-professoring in West Berlin. Had to lecture, didn't get much done.

Thursday, August 4. Rigged up light in lab so I can switch it on to study microverse. It's no longer pyramidal, cubical now and bigger. Which only means it's gone from four angles to eight. No doubt it'll continue until it approximates a sphere, if I let it. Funny to think how I've written about this odd particle or that (like the monopole) existing "in some strange corner of the universe" without guessing it might be true. (Special properties at corners?) Anyway, it seems no matter how big it gets, it takes up no "room," not being in our universe at all. When I measure the target with calipers, it's the right size still. But ruler enters the microverse and loses a little length, making it appear the target has grown. (N.B.: Remember to write on concept of "room" for *Physical Review C*.)

Friday, August 5. Introduced cellular material (scrapings) from the apple Sis put in my lunch. Astounding results. Green matter spread over all inorganic stuff above water. (That's been growing itself. I think it seems to be expanding with the microverse, though not as fast.) Went over to Biology and bummed tissue samples from rabbits, mice, and so forth, and put them in. Nothing—they seem to have died.

Saturday, August 6. It seems I was wrong about the animal tissue. Today I saw a couple of little things darting around and one or two swimming. They seem large for microorganisms, wanted to catch some and bring them back, but they were too fast for me. What's more surprising, the vegetable matter has turned itself into club moss or something of the kind. With my good glass, I can even see spore pods hanging from the branches. Fascinating! Wanted to do the animal tissue thing again, but had tossed out the cultures. Scraped my wrist and put the scrapings in. They grew, too.



"This gift from the people of my planet to yours will enable you to cure disease, prevent famine, unlock the mysteries of the universe, and share the accumulated knowledge of our civilization. Some assembly is required."

Caught the little critter before he got too lively and scraped *him* Put him back Soon running around as good as ever and the tissue I had taken from him became another, much the same

Sunday, August 7 Decided not to go to the campus today though I knew it would mean (as it did) Martha would nag me about church Slept late, watched baseball on TV Got to talking about the microverse with Sis and she wanted to tell the 'people' about us Silly, but she was so fired up I couldn't refuse to help her She made little drawings on a sheet of paper so it could be folded to make a booklet, beginning with the arc discharge and ending with me watching the Yankees drop one to the Angels We went over to the campus and reduced it half a dozen times on the good copier, and she folded it up Maybe I shouldn t say it here but I don t think I've ever felt prouder in my life than when I showed her the microverse—she was that thrilled (She's already talking about putting in a few cells of her own.) But when I used the glass myself, why horrors! The critters were eating the spore pods or whatever they are I want to have a better look at those so I began casting about for a way of scaring them off There was a fruit fly circling the apple core in my wastebasket, and I caught it and put it in It worked like a charm and off they scampered Sis said we ought to title her book, but we couldn t think of anything appropriate After much talk, we just wrote our names GENE and sis on the cover and dropped it in

SECOND COMING

by Frederik Pohl

I guess, just as with the Kennedy assassination, everybody can remember exactly where he was and what he was doing on the day the space people brought Jesus back to Earth

I was aboard Air Force One with the President—I'm Secret Service—and when Major Manley radioed the unbelievable message from the orbiting space shuttle we turned right around and headed straight for California Beat the shuttle down and waited, parked at the end of the landing strip, watching TV.

Of course, business had stopped all over the world Everybody was watching the pictures from the big telescope on Mauna Kea—what a brute that spaceship was, half a mile long!—and listening to replays of Manley's message

Well, the shuttle made its turn and came down and they got the crew out and into Air Force One while the ground people were still purging the fuel vapors "You sure it s Jesus?" the President demanded

"That s what they say Mr President I took a picture of Him—see for yourself." And he passed over a Polaroid

The President winced "I didn't think He'd look like *that* "

"Well He's Jewish you know—' "

'No, I mean He's so *young* It's been nearly two thousand years!'

Major Manley explained 'They were traveling at light speed almost all this time—you know time dilatation? After they rolled away the stone and took Him out of the cave—'

'They *kidnapped* Jesus?'

'They don't look at it that way Mr President He was not in very good shape They figured we were through with Him So they took Him to their planet, where they have a place to keep specimens of life forms from all over the galaxy—'

"They put *Jesus* in a zoo?' Manley shrugged What s He doing now?" the President asked

'They say He's watching TV mostly Doesn't much like what He sees, they say, but I didn't talk to Him myself—I don't speak Aramaic Anyway, I was glad to get out of there, because that ship's pretty scary You just wouldn t *believe* all the nasty kinds of weapons they've got!'

The President's eyes gleamed, and the secretary of defense exulted, 'New weapons! What a bargaining chip!'

The President glanced around the room, and the expressions of delight were unanimous There remained only one thing to do He crooked a finger and his secretary turned on her recorder 'Take a decree, Mabel I, the President, and so on, do hereby proclaim that Jesus Christ is come again, and—uh—'

And He's ours!' the secretary finished. And then, raptly 'Thank God'

It looked pretty good there Of course, the other countries were screeching their heads off *Pravda* raged The Chicoms canceled a trip by their soccer team, and the Israeli ambassador practically had a heart attack trying to argue that He was, after all, one of their nationals by birth That didn t matter, we were first and NASA cleared the Canaveral runways for His landing But He requested all three networks to provide thirty minutes for a prime-time telecast and that was when it all went sour Never mind He didn't look right Never mind He spoke in Aramaic, which practically nobody understood It was what He said that was the bad part—that and the fact that before we got the translation, there was a priority call from the Mauna Kea telescope people to say the ship was breaking out of orbit and heading back out into space "But what did He *say*?" moaned the President, and the translator, sweating, shook his head

'Something about He doesn't like the way we've spoiled His planet ' he croaked. 'Says He told us what to do, and we haven't done it—we've messed everything up—'

"Hell ' shouted the President 'we can fix that up Call Him back We can make a deal We'll give Him His own TV station so He can preach to the multitudes, let pilgrims come visit Him—anything He wants!'

But the translator was shaking his head again "He doesn't want that He says He s going back with the space people They've got a better class zoo "∞

SPACE

CONTINUED FROM PAGE 22

with a satellite before returning to Earth Or, with extra supplies on board, it could go around the moon

The front 12 feet of the cone could be folded back so the cruiser could be used as a pusher vehicle—a 'space tug'—for large payloads like satellites For space operations sidecars and other modules could be mounted to the body to hold payloads and propellant This forward-facing operation would allow the pilot, with his head out of the cockpit, to keep his eye on the payload ahead

But the Space Cruiser is more than a space tug, a pickup truck a jeep an inspection vehicle, a space cutter, and a repair vehicle It s also a better reconnaissance plane than the Lockheed SR-71—a veteran high-altitude Air Force jet—or a reconnaissance satellite A Space Cruiser could be launched at random times into various orbits, travel to space over any part of the world in less than an hour, then come back to its original orbit

A delta-winged cone is extremely maneuverable at supersonic and hypersonic speeds But once it slows below the speed of sound, it's a rock As far as Redding was concerned, the technical compromises needed to produce a plane capable of flying at subsonic, supersonic, and hypersonic speeds—like the space shuttle—would have destroyed the elegant simplicity of the Space Cruiser He decided to do without technological frills

How does this flying brick land when the mission s over? The Space Cruiser pilot pops a drogue parachute at supersonic speed about 100 000 feet up Once the cruiser is slowed to subsonic speed at 15 000 feet the pilot deploys a 3,000-square-foot gliding 'parasail' like those used by sport parachutists Even in a 35-knot wind, the Space Cruiser could land in a 100-foot clearing

The Redding Space Cruiser concept draws the same response from everyone with the slightest infection of the right-stuff syndrome—fighter pilots, race-car drivers, Walter Mittys of all sorts The design spawns dreams of popping out of a silo and boosting straight up Or climbing off the back of a 747 at 40,000 feet or being ejected from the shuttle payload bay and lighting the Centaur booster for a trip to the moon. Then opening the cockpit cover and looking around at the universe Then flying back into the atmosphere at Mach 15 and popping the parasail to land right next to the recovery crew with a bump no greater than that incurred from landing a plane

What s the tab? The Space Cruiser could be developed for less than the cost of a squadron of F-16 fighter planes In fact, because of its simplicity, the cruiser itself would have a unit cost of less than $50 million—cheap for a spaceship even one little bigger than an antique biplane ∞

SOUL GENETICS

CONTINUED FROM PAGE 95

O. Wilson is one who believes this.

"It's extremely likely that within ten years, twenty at the outside, a number of genes will have been identified whose effects can be traced through the actual production of particular chemicals in the brain and thence to measurable properties of temperament, mood, and even cognitive ability," Wilson said in 1982.

"If we could change our basic nature—the strength of the sex bond, the pleasure you get from children—through genetic intervention, then with more knowledge, you could come up with human beings who respond to the world in very different ways—some taking deep pleasure in living in a city, for example, others who are able to live in rural communes. Suppose we really could do it. Should we?" Wilson believes we should. If we don't make changes, he predicts, our outmoded Stone Age behavioral legacy will threaten our future. The possibility of improving our species, however, raises troubling questions.

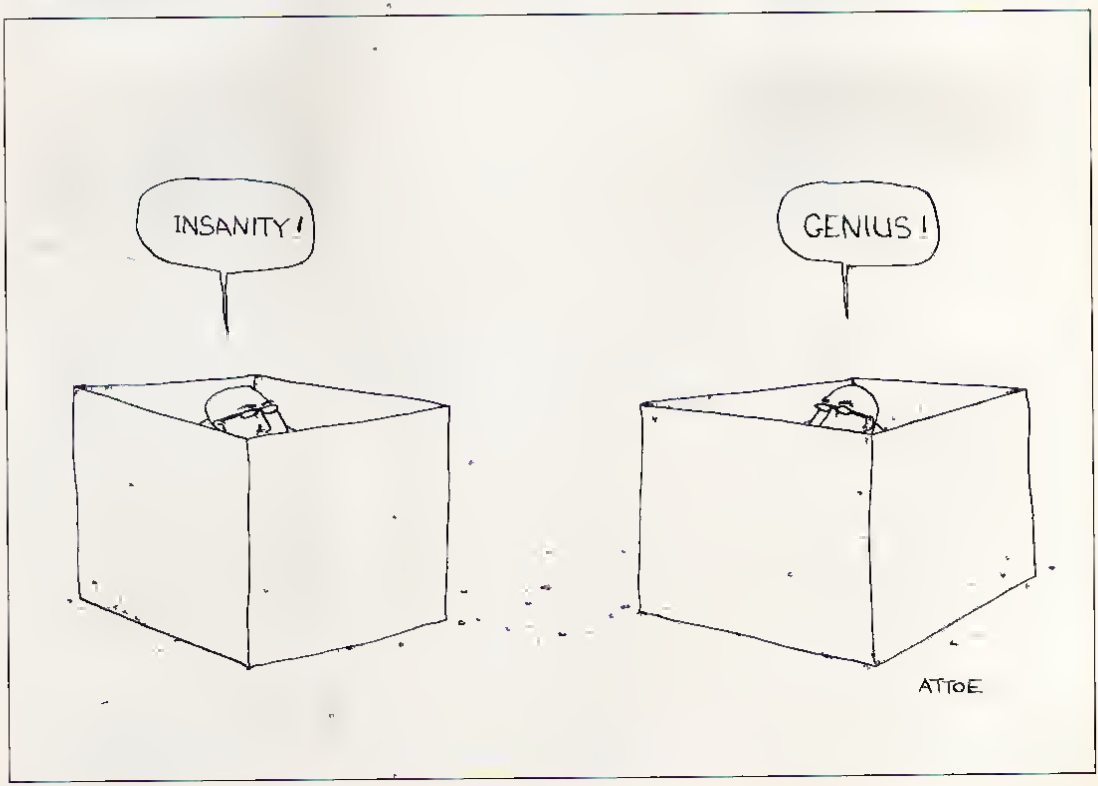
Philosophers, bioethicists, theologians, futurists, and others continue to ponder the ethics of such a prospect. Who will get the "improvements"? Perhaps enhancements should be reserved for those who "deserve" them most by whatever criteria we choose—intelligence, creativity, talent. But genetic manipulation might make the deserving even more deserving, reinforcing the existing economic, social, and cultural inequalities among people. Perhaps we should follow our society's commitment to equality of opportunity for everyone and use our new knowledge to even out the inequities of genetics, too.

What enhancements would have priority? Different individuals and cultures would have different suggestions based on their values and what they think the world and human beings should be like in the future. Philosopher Stephen Stich, of the University of Maryland, says that several generations of widely divergent choices could bring on a "genetic fragmentation of the human species." He worries that members of different cultural groups might become so different that they could no longer intermarry and have children.

Stich predicts that, as the technology grows in sophistication, there will be intense social pressures to use our new genetic powers. "During the last year or two we have seen an explosion of interest in home microcomputers, many of the people who buy these wonderful, expensive machines do so in the hope that they will give their children a competitive edge in a technologically competitive world. Closer to the fringes of our society, we have seen that some women are prepared to have themselves impregnated with the sperm of a Nobel Prize winner in the hope of bearing an intellectually gifted child.

Both of these phenomena underscore the fact that the desire to help one's children to excel is a powerful and widespread motivational force. When we learn how to increase intelligence, memory, longevity, or other traits conveying a competitive advantage through genetic engineering, there will be no shortage of customers ready to take their place in line. Moreover, those unwilling or unable to take advantage of the new technology may find that their offspring have been condemned to a sort of second-class citizenship in a world where what had been within the range of the normal gradually slips into the domain of subnormal."

For the foreseeable future any enhancements we might want to perform on ourselves will be limited by the well-orchestrated genetic legacy of evolution we have within us. But if it ever becomes possible to perform genetic manipulations, we will have to answer some big questions. Will we be tempted to use them as the ultimate solution to social problems, to eliminate strife by making people less aggressive and more cooperative? Would we be willing to give up a great deal of our humanity, just as the denizens of *Brave New World* did, for the sake of stability, peace, and freedom from want?



THE EYES OF CERGA

STARS

By Derral Mulholland

Anyone interested in visiting one of the most futuristic observatories in the world should begin by heading for the old Saracen stronghold of Gourdon in southern France and from there start to climb up into the French Alps. As one approaches the 1,200 meter mark he will see looming at the very brink of the cliff above, the tip of a cupola that encloses one of the world's most powerful astronomical instruments a 200-inch Schmidt telescope. Climbing higher the visitor will see a dozen other structures scattered across the Calern plateau. Some are strangely shaped—like two objects that resemble giant inverted mushrooms and one building complex that resembles a large, concrete molehill. This is the Calern Observatory, operated by the French government under the auspices of CERGA (for *Centre d'Etudes et de Recherches Géodynamiques et Astronomiques*). The observatory is an audacious plan to gather on one site a collection of some of the latest high-technology instruments in astronomy. The result is the world's most sophisticated observatory specializing in astrometry, a specialty that most astronomers consider deadly dull.

Astrometry concerns itself with the direct measurement of dimensions in the universe. This includes not only the positions in the sky of stars and planets but also the measurement of their diameters and of astronomical time. Astronomers in this specialty have recently begun to use laser ranging to determine the distances to satellites and to the moon.

Astrometry is the most fundamental part of astronomy. The star catalogs that other astronomers use to find targets and that navigators use to pinpoint their locations on Earth are made possible by astrometry. So are the tables that keep track of the paths of the sun, moon and planets through the star field. Calculations of eclipses, sunrise and sunset, phases of the moon, leap seconds, and the direction of true north are all astrometrically based. CERGA hopes to perfect such products.

The purpose of the CERGA Schmidt for example, is to photograph large areas of the sky. It can do this with high enough quality to determine the position of even faint stars, an ability that will be needed for tracking Halley's Comet. Because these images are so small, the sharpness with which they are photographed is important. Some design elements of the Schmidt, however, are not all that well suited to this use, and here at Calern new technology is being exploited to eliminate these shortcomings.

While most telescopes can be focused by hand and eye, the Schmidt has no eyepiece. Used exclusively to take photographs, it is an enormous camera with no viewfinder. All focusing is done by making external adjustments that, when calibrated to compensate for such variables as the temperature inside the scope and the angle at which it's tilted, *should* yield an accurate focus.

Calern astronomers are now using a computer to eliminate as much of the guesswork as possible. The computer checks the internal temperature of the telescope and its tilt to calculate the exact focus. Even the film holder, mounted to the telescope by three precision-focus screws, is computerized. Each screw is positioned electronically by the computer for the proper focus. After being exposed and developed, a plate is analyzed and data on it are stored in another computer accessible by telephone. An astronomer with a terminal can ask the computer what part of the sky was photographed on a plate, the faintest star visible on it, and the typical size of the images recorded. From this he might be able to determine which photographs would be most useful to him.

Although the building that houses the Schmidt telescope looks like a standard observatory structure, its nearest neighbor does not. Some 200 meters away is what looks like a cluster of concrete igloos or a large molehill. This is the site for CERGA astronomer Antoine Labeyrie's large optical interferometer. (An interferometer is essentially a pair of receiving devices, such as two radio or two optical telescopes, which are combined to equal the resolving power of a much larger

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CERGA's Eskimo-modern design hides one of the world's most productive observatories

FORUM

CONTINUED FROM PAGE 14

this is the point of my ruling, that they are going to have to find out.'

Dietz, Newton, John Weeks, the Forest Service, the Bureau of Land Management and other advocates of polluters' rights may sincerely believe herbicides are safe. But as A Bitter Fog *and Judge Belloni point out, "The fact is that they don't know."*

Under the doctrine of strict liability, the laws of Oregon and most other states define herbicides and other pesticides as "unusually hazardous" substances. Should the user of such a substance have the right to expose others without their knowledge or fully informed consent?

Dietz, Newton, and Weeks mistakenly interpret A Bitter Fog *as championing a total ban on herbicides. Nowhere does the book suggest such action. What it does champion are the basic human rights of those who bear the risks of exposure to hazardous chemicals—the right to know the effects of the chemicals and the right to say no to being exposed.*

Angels

Regarding the article on the Guardian Angels [Mind, July 1983]: The Angels were asked by frustrated citizens to organize a chapter in Portland, Oregon, last year.

The police of Portland have used their badges to confiscate salable street drugs without either making an arrest or leaving a receipt. They have admitted to planting cocaine on bikers when unable to make an arrest for any other reason. When a number of witnesses saw our fine police leaving a dead opossum in front of a local black-owned restaurant (as a racial threat), the city gave the officers a little time off and then moved them to a neighborhood where they were not so well-known.

Portland's police are openly hostile toward the new Guardian Angel chapter. From my perspective, the greatest fear of the police is that their questionable activities might be observed by responsible citizens in our community.

Perhaps in the eyes of Chicago's police superintendent Richard Brzeczek there is no corruption in his city, but in Portland the vigilantes and brownshirts wear blue uniforms, not red berets.

Patrick Landels
Portland, OR

I think that Brzeczek should reexamine his opinion of the Guardian Angels. I'm not sure that his assessment is an objective one. Perhaps he is slightly envious of the respect that the Angels have gained in their relatively short history. The reasons for this well-deserved regard are clear to see. The Angels are efficiently achieving their main goal, which is to protect citizens from crime. And they manage to do this with an air of humility and respect that's unlike the attitude of many (not all) police officers.

If, instead of resenting the Angels, police departments would work more closely with them, citizens might feel that they have the responsibility and the ability to make their neighborhoods safer.

Denise Buzz
Conshohocken, PA

"You won't believe it. This guy really is the guru of high tech."

Before the Fall

I am writing concerning the article "Death Sentences" by Dava Sobel [February 1983]. I am particularly concerned about the author's statement with regard to the TWA aircraft that plunged several thousand feet over Michigan in 1979. Never in the history of aviation has so much rumor, insinuation, and just plain falsehood been connected with an incident. The article states that Captain Gibson "set the hand brake and pushed the bulk erase button on the black box. No one ever did find out what happened before the fall." Whether the captain erased the tape is neither here nor there. As he well knew, the tape is a 30-minute continuous loop that automatically overwrites all but the last 30 minutes of conversation. Since the aircraft landed 45 minutes after the incident ended, the first words on the tape would not have started until 15 minutes *after* the incident was over. The tape had it not been erased, would have been totally useless in determining "what happened before the fall."

The article also states that the Air Line Pilots Association later voted Captain Gibson Pilot of the Year. Pilots do not vote for the Pilot of the Year because there is no such award, nor has there ever been.

The article was right about one thing. No one ever did find out what happened before the fall. The National Transportation Safety Board (NTSB) was too busy blaming the pilot to have time to search for the real cause of the accident.

Captain D. Leppard
Chairman, ALPA National
Accident Investigation Board
Washington, DC

Paul Turner, who analyzes cockpit voice recorder tapes for the NTSB, tells Omni *that a recording of the conversation of the crew members 15 minutes after that incident might well have provided clues about what went wrong in the air.—Ed.*

Innocent Computers

I must take exception to Michael Edelhart's comments on the movie *WarGames* in the August issue [Artificial Intelligence]. By calling the computer WOPR a "villain" and a "rogue," he missed the most important message of the movie. It was mankind that programmed the computer and mankind that must take the responsibility. Blaming computers for man's mistakes is a popular practice but one that a scientific magazine should not engage in.

Jeffrey Blaufarb
Bronx, NY

Bless you!"

CONTINUED FROM PAGE 44

carcass or a stranded whale. The legendary peregrine falcon, a severely endangered species, feasts almost exclusively on other birds. Like a missile homing in on a target, the swift and deadly peregrine, capable of speeds close to 200 miles per hour, hovers above its quarry, then tucks its wings close to its body and dives in for the kill, kamikaze style.

The extraordinary hunting ability of the raptors once made them the prized companions of European nobility. In the Middle Ages, the sport of falconry was a favorite pastime of royalty. A lady or lesser lord might fly a small falcon or sparrow hawk, a more powerful nobleman, the valued peregrine, but only a king could display the powerful golden eagle.

The same rapacious qualities that ennobled the raptors to royalty, however, made them the bane of farmers and ranchers in the United States. Rural superstition erroneously blamed eagles for preying on everything from lambs to human babies; the smaller hawks and falcons were considered at best a nuisance and at worst a scourge to be eliminated whenever possible. At one point, in fact, the accessibility of Hawk Mountain made it a death trap for the birds, since hunters could settle into roosts of their own. Alerted to the slaughter, Rosalie Edge, a militant and visionary conservationist, purchased the land and appointed as its first curator a young naturalist, Maurice Broun. During the 32 years he spent at the mountain, Broun became a legend of sorts—physically ousting the hunters from his hills and working vehemently to inspire protective legislation for his beloved avians. The painstaking records he kept of migrating patterns, meteorological conditions, and species seen are a boon to modern-day ornithologists, whose studies are often hampered by lack of historical data. Broun also had an uncanny sense for the passage of eagles and could often predict the precise time when one would appear.

By paying attention to weather patterns and examining records and past migration flights, the amateur watcher can also predetermine the prime days for hawking. In general a low-pressure system over New England, an advancing cold front from Canada, and several days of northwest winds are the conditions most conducive to raptor gazing. Beyond that, however, recommending the most auspicious time at Hawk Mountain is rather like recommending a fine wine—much depends on the individual taste of the connoisseur.

For sheer grandeur of numbers, September hosts the dramatic migration of the broad-winged hawk, the earliest and most abundant migrant. On a prime day thousands of these soaring birds blot the sky, often spiraling to altitudes so high they look like a swarm of bees. A few dozen bald eagles and the kestrel, the smallest American falcon, also pass through at this time. The kestrel, a playful species, often engages his larger relatives in an audacious game of aerial tag.

The colors of autumn highlight October, the month that sees the greatest variety of species, including the ungainly turkey vulture, the exquisitely streamlined peregrine falcon, and scores of hawks. In November, toward season's end, the rough-legged hawk—the rarest of all the mountain's wayfarers—makes its appearance. An Arctic species, its name comes from the thick feathering on its legs, an adaptation to the frigid temperatures of the north. And, of course, the golden eagle will match its wings against any cold November wind. 'The way of an eagle in the air,' said the ancient sage King Solomon, 'is too wonderful to understand.' Perhaps. But on a clear day at Hawk Mountain, it is well within our vision. ∞

Hawk Mountain, located on Route 2 in Kempton, Pennsylvania, between Allentown and Harrisburg, offers $15 one-year memberships to support its educational and conservation activities. For information on memberships, species sighted, and weather conditions, call (215) 756-6961.

Other locations to spot migrating raptors on the East Coast are (north to south):
Mount Tom, MA
Mount Peter, NY
Raccoon Ridge, NJ
Hook Mountain, NY
Montclair, NJ
Bake Oven Knob, PA
Waggoner's Gap, PA
"Pulpit" Tuscarora Mountain, PA
Cape May, NJ
Assateague Island, MD
Peter's Mountain, VA
Lenoir "Thunder Hill," NC

The only known hawk-lookout post in California is Point Diablo (near San Francisco). In Minnesota, Hawk Ridge Nature Reserve (near Duluth). In Utah, Wellsville Mountain Hawk Lookout (near Logan).

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a result we are lighting the film to look like a Norman Rockwell painting.

"I would never name one of my lead characters Johnny Smith—never," Cronenberg continues, "but I'm not going to change the development and the movement of the characters and the basic machinery of Stephen's novel.

"The tone of Stephen's novel is small town and rural, which my stuff rarely is." Cronenberg's standard settings, by contrast, are massive apartment blocks and immaculate medical institutes, birthplaces of anomie and nightmare. "Architecture," Cronenberg has stated (Film, May 1981) "is an expression of the fact that human beings don't live out in nature."

And there is a moral distinction. Cronenberg interprets King's work as "unabashedly Christian in its conception of evil," citing particularly the punishing evangelical harridans in *Carrie* and *The Dead Zone*. "You're the devil . . . sent from hell" is a King-like line (whispered to eerie effect by Coleen Dewhurst in the latter film), a line that Cronenberg says he would never have written for one of his earlier films.

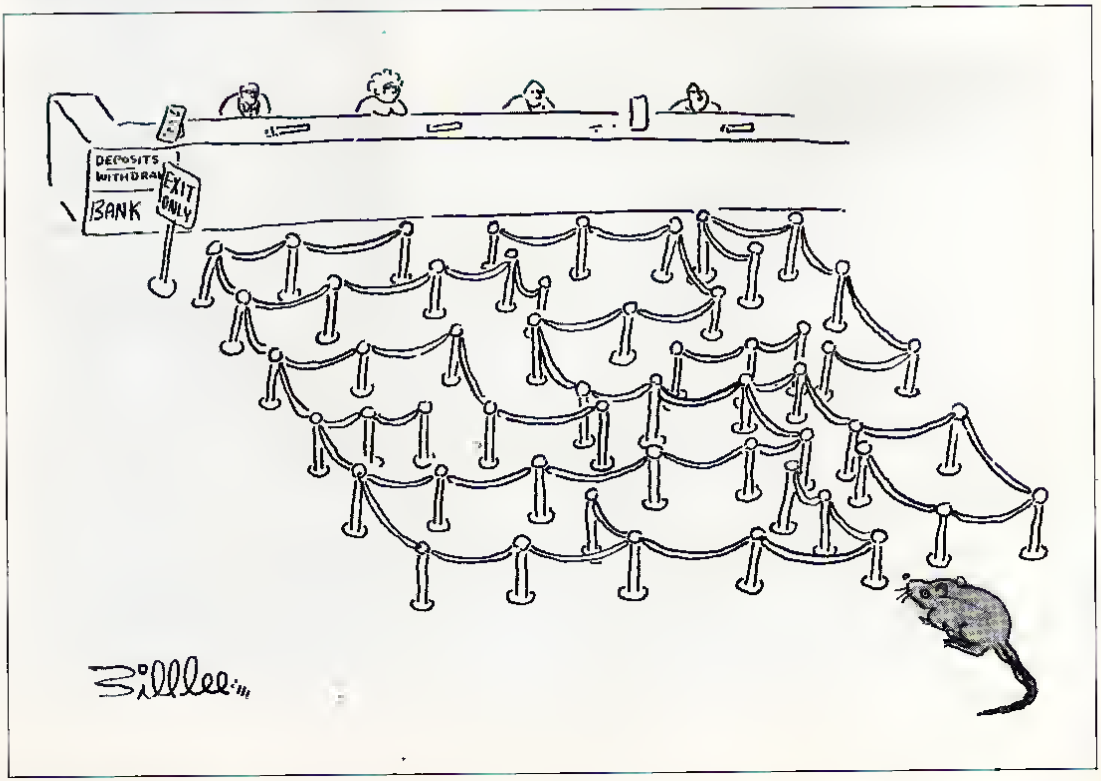
"We run parallel courses," he concludes, "but we use different metaphors. My morality plays are set in the realms of science and psychology." There the battles are not between good and evil but between body and mind. A Cronenberg hero stems the onslaught not of devils but of rampaging pestilences and mutating plasmas. Hence the gouts of steaming gore percolating up through all his films—repulsive but (until the cranial eruption in *Videodrome*) fully justified by plot. In *The Brood* a wife externalizes her conjugal rage as a swarm of elfin demons. In *Scanners* fetuses polluted by sedatives grow up to control the central nervous systems of friends and enemies. In *Videodrome* pornographic TV images induce tumors that in turn induce hallucinations.

"People ask me why my films are so extreme," Cronenberg says, then quotes William Blake: "The road of excess leads to the palace of wisdom." My audience is daring me to be extreme."

The Dead Zone, though punctuated by Johnny Smith's grim visions, forgoes Cronenberg's customary organic excesses. Thus, his assistant on location admonishes: "This is not a Cronenberg flick. You have to keep telling yourself that." And, of course, she is wrong. *The Dead Zone*, in fact, continues a trend—a moral analysis of altruism—that has revealed itself increasingly as a weakness in Cronenberg's films. By submitting altruism to more rigorous tests in each succeeding film, Cronenberg has lost moral clarity. Things now appear muddled. In *Videodrome*, for instance, Max Renn gets ensnared by the chicken-and-egg conundrum of violence on television versus violence in our streets and bedrooms—which came first? Neither he nor Cronenberg is able to wriggle free to any kind of unambiguous resolution. And the film suffers from it.

In adapting *The Dead Zone*, Boam and Cronenberg faced condensing King's interminable development of Stillson's demagoguery and of Johnny's mounting obsession with it. These they replaced with a brief vision of Stillson nuking the planet and of Johnny leaping into the dead zone with an ill-considered but conventionally heroic assassination attempt. By way of justification, they offer Johnny briefly pondering that shallow old canard (quoted with some self-righteousness by producer Hill on location): "Given the opportunity, would you have killed Hitler?" History tells us that Jack Ruby was similarly obsessed years before his fateful Dallas encounter.

Two weeks into a ten-week shoot, Boam privately doubts the propriety of this message. The script he fears condones assassination as long as the assassin considers his action a moral one—and what lunatic does not? Cronenberg, in his haste to reimpose the moral clarity that more and more eludes him, has settled for a moral defense for every trigger-happy fanatic. "Hitler made me . . . ∞



MIND

CONTINUED FROM PAGE 30

approach might help in other health-behavior areas—dieting and fitness training for example—or in dealing with such psychological problems as aggressiveness, underassertiveness and anxiety.

Physicians are often surprised at the readiness with which patients accept interviews by and advice from a computer. The astonishing truth is that people frequently prefer machines to human consultants—especially when asked about highly sensitive areas. Patients will answer a machine's questions about sexual problems, gynecological health, and alcohol intake for example, without embarrassment and with more accuracy than they would in personal interviews. Responding to a program specially written for a hospital in Glasgow, Scotland, for instance, alcoholics admitted to drinking 50 percent more alcohol than they had reported to human therapists.

Another highly sensitive area where computers excel is in forecasting suicide. John Greist, a psychiatrist at the University of Wisconsin, has written an interview program that helps to identify people likely to take their own lives. The computer often provides a more accurate picture than that obtained during a live interview.

Advances in computer technology suggest that therapeutic systems will become increasingly sophisticated. Computers now merely *simulate* understanding, but they may soon be able to really understand the subtleties of human emotions. And whereas patients currently have to type in their messages to get replies printed on a screen, research in voice recognition and voice synthesis will mean that someday there will be real conversations between humans and machines. It could also be possible to provide optional therapeutic voices, allowing the client to choose between a "male" or a "female" therapist, or between an all-American or an Eastern European accent. Such refinements seem sure to make the therapeutic interview even more effective.

Should we welcome such an intrusion of mere mechanical systems into our emotional lives, or is this a domain machines should not enter? There is certainly something a little bizarre about a suffering human being confiding dark secrets to a metal box. But judging from the millions of self-help books sold each year, self-help programs are likely to find a huge market. The evidence so far suggests that people will accept "the intimate machine," and we should be prepared for momentous developments along these lines. The Tin Man eventually gained his heart; hard technology is about to gain a soft core. OMNI

Editors note: Neil Frude is a psychologist at University College, Cardiff, Wales, and the author of The Intimate Machine, *which was published by The New American Library.*

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COMMUNICATIONS

CONTINUED FROM PAGE 12

Computers for Peace

I am in complete agreement with Dr Henry Heimlich [Interview June 1983] and his concept of computers for peace It is the only coherent idea to surface during the Information Age I agree with every one of Heimlich's thoughts including his assertion that now is not the time to solve the peace issue with love—we're not ready for it yet Today's attitude in business and government is What's in it for me? Reagan and company's ideas for peace and national security represent this Neanderthal mentality Fortunately, however, good ideas like Dr Heimlich's won't die or fade away like MacArthur's old soldiers

G Patrick Abbott
Sonora, CA

No Tylenol Threat

I have reviewed the article 'New Tylenol Threat,' which appeared in the Continuum section of the June 1983 issue McNeil Consumer Products Company objects to the strong implication that the use of acetaminophen at recommended doses may cause liver damage The few undocumented "case reports" in the medical literature certainly provide no basis for this implication. I realize that as a popular science journal reporting technical issues to the lay public, you have a responsibility to advise the public of health risks This responsibility, however, carries with it the imperative that you do not inappropriately frighten the public The sensationalized statement 'at very high doses the liver, pancreas, and kidneys, especially, just turn to slush' serves no constructive purpose and is both inaccurate and misleading

The article contains numerous incorrect statements The comment from David W. Martin that 'acetaminophen overdose is much harder to treat than an aspirin overdose' is inaccurate Unlike aspirin, there is an antidote for acetaminophen overdose, and the condition is not difficult to treat Data on acetaminophen overdose show that while deaths were infrequent even before the availability of an antidote, the use of the antidote has virtually eliminated fatalities and greatly reduced morbidity In addition, acetaminophen toxicity occurs only following very large overdose ingestions, whereas aspirin overdose may occur both as a result of massive single ingestions or as a result of chronic dosing.

The statement that 'double the recommended dose is getting up near the toxic range' is false and misleading The recommended single dose is 650mg or 1,000mg for an adult The toxic dose, which must be ingested as a single massive overdose, is 10g to 15g, at least 10 to 15 times the therapeutic dose

The implication that 'taking even the recommended dose daily for an extended period might be risky' is unsubstantiated and partially misleading We carefully monitor all reports of hepatic toxicity with acetaminophen, and there is no support for this statement

The last statement, "if tissue damage occurs with doses less than those generally considered toxic, it is usually reversible' is also false. Tissue damage occurs only with a large overdose Even then, the overwhelming majority of patients recover completely, with no residual liver or other organ damage.

In summary, acetaminophen is an effective and safe analgesic and antipyretic under almost all clinical conditions

Thomas Gates
Medical Director
McNeil Consumer Products Company
Fort Washington, PA

Sounding off on Defense

Richard Levine's article "Weapons Builders Speak Out" [Continuum, March 1983] addresses a critical problem facing the United States today

As a recent engineering graduate, I specifically avoided accepting interviews with any company that was involved in 'bombs and guns' (as one old physics professor put it) The money was very good, but I chose to follow my morals rather than my pocketbook and not take money from a company that advanced the arms race.

I believe that the government's and arms industries' tactic of siphoning off our top engineering minds and putting them to work on bigger and better ways to destroy our fellowman is dangerous and detrimental to our society These people should be working on the extremely serious problems of pollution, energy, and health. Instead these areas are neglected because of a lack of funding and of initiative.

The U.S. government is inflating the defense industry by offering 'exciting" jobs and high pay and by citing the old rationale that defense workers are helping to protect their country. In the long run, however, wasting raw materials to build bombs that can destroy the world is not my idea of a sound defense

Robert Levi
Santa Barbara, CA

I was extremely disappointed by the article "Weapons Builders Speak Out," in which the position of a small group of engineers was used to condemn America's policy of peace through strength There was no mention of the hostile external threats that this nation faces, nor of the thousands of engineers who are deeply committed to defense projects and see them as vital to our nation's survival

Levine's obtuse reference to 'Germany under Hitler" and a 'war-crimes commission' was an insult not only to the men and women of this country who are dedicated to our defense establishment but to any American who believes in the integrity of this great nation

Jeff Rank
Gambrills, MD

CONTINUED FROM PAGE 40

a method of the direct visualization of such 'curved' non-Euclidean hyperspace.'

Actually, Brisson developed not one but three ways of optically seeing beyond three dimensions. The first and easiest uses the standard 3-D glasses with one blue lens and one red lens. The viewer looks through them at an object (Brisson called it a hyperfigure) constructed from wire. Each set of colored segments forms a three-dimensional shape—say, a cube or pyramid. But because both shapes are contained in the complete wire structure, the structure itself is a hypercube or -pyramid since it "nests" both 3-D shapes within itself. Brisson would place the hyperfigure on a slowly rotating base. Then, when seen through 3-D glasses, the viewer would experience seeing one solid shape apparently pass through another. It is a fascinating and exceedingly unusual visual effect.

The second method Brisson developed uses what he called hyperstereograms. A stereogram is a set of two images of something seen from two slightly different positions. If viewed by someone with normal vision, the images allow a perception of three dimensions. Brisson extended this principle by reasoning that if 3-D stereograms result in 3-D perception, then 4-D stereograms would produce 4-D perception. Thus he developed the hyperstereogram, which is a set of two images of a hyperfigure, with each image drawn from a slightly different perspective. When the images are viewed properly, the viewer sees the images fuse and become one image with full four-dimensionality.

There are many visually interesting forms in four dimensions, most of which were discovered by geometers more than a century ago. But they were "seen" conceptually, not perceptually because they exist only in imagination (unless, as some maintain, imagination is grounded in a "higher" reality such as the realm of Platonic forms or Pythagorean numbers). With Brisson's method, it is now possible to see four-dimensional forms directly.

Interestingly this process can be raised to the fifth dimension, the sixth, and higher so that you can see two hyperfigures become a hyperhyperfigure, and so on. Just as the cube can be projected into the hypercube (also called the tesseract, orthotope, or double-square prism—see Games, June 1982), which is a 4-D figure with 16 vertices and eight cubical faces, so can the hypercube be projected another dimension higher to become a 5-cube, or two hypercubes connected by a set of parallel lines.

Brisson's third method of multidimensional perception employs multiple slide projections of hyperstereograms. He used this when lecturing because it is easiest for the audience. The wire sculptures require 3-D glasses, and unless the sculptures are of very large size they cannot be seen well beyond the first few rows in an auditorium. Their advantage is that they add motion to what is perceived as they are rotated. But neither wire sculptures nor slide projections are suited to print.

For his publications, therefore, Brisson used the hyperstereogram method, although it is the most difficult to use because it requires some visual training by the viewer. In *Hypergraphics* Brisson pointed out that artists, for the most part, have ignored the work of nineteenth-century and early twentieth-century geometers who made visual projections of four-dimensional objects. (Cubists and Futurists are notable exceptions to this rule.) He said, however, that contemporary artists should not be intimidated by the complexity of the underlying mathematics.

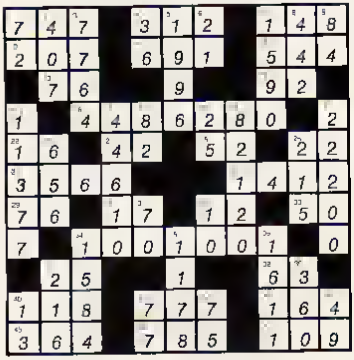
Most people find that they have to look at a number of hyperstereograms before they are able to actually see or scan the hyperobject and truly appreciate the richness of the experience. Brisson noted that viewers' eyes often water after lengthy multi-D sessions. This is most likely due to the "unusual manner of subjective interpretation but not to the particular physical use of the eyes, which isn't unusual."

GAMES

ANSWERS TO GAMES (PAGE 200)

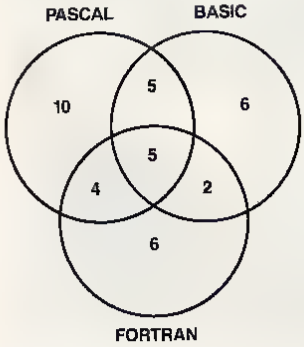
WORDS FOR # (1) Number (2) Pounds (3) Space (4) Sharp, (5) Tic-tac-toe, (6) Octothorp, (7) Non-add (8) Fracture

CAL-Q-MATH PUZZLE



ACROSS

1 9 × 83 = 747
4 0.12 × (26 × 100) = 312
7 72 + 76 = 148
10 1983 − 1776 = 207
11 707 − (4 × 4) = 691
12 (1974 − 666) − (8 × 13) − 660 = 544
14 1959 − 1867 = 92
16 4,486,280
22 (1/2 bh = A), 1/2 (4 × 8) = 16
24 2x = 126 − 42, x = 42
25 (144/2) − 20 = 52
26 60 − 38 = 22



27 (1983 − 200)/½ = 3,566
28 (40 × 50 = 2,000) − (21 × 28 = 588) = 1,412
29 76/1 = 76
30 100 − 50 − 50 + 17 = 17
32 12, 13, 14, 21, 23, 24, 31, 32, 34, 41, 42, 43 = 12 possible numbers
33 F = 9/5 × C + 32, 9/5 × 10 + 32 = 18 × 10 + 32 = 50
34

64	32	16	8	4	2	1 (base 2)
1	0	0	1	0	0	1

64 + 0 + 0 + 8 + 0 + 0 + 1 = 73
37 12 + 13 = 25
38 (√49 × √36) + 21 = (7 × 6) + 21 = 63
40 34 + 78 + 6 = 118
41 √603,729 = 777
43 24 × 15 + 1 = 361 (losses), 15 × 35 = 525 (wins), 525 − 361 = 164 (net)
45 300 + 64 = 364
46 V = π r²h, 3.14 × 5² × 10 = 785
47 Answer 109 (89 + 2, 91 + 3, 94 + 4, 98 + 5, 103 + 6 = 109, 109 + 7)

DOWN

1 (7 × 9) + 9 = 72
2 (40 × 10) + 7 = 407
3 4 × 1941 = 7764
4 21 + 12 + 3 = 36
5 2000 − 4 = 1996 (2000 will be the last year of this century, the twenty-first century starts on January 1, 2001. The four letters in *four* make 4 the only "honest number")
6 Mercury (7) + Venus (5) + Earth (5) + Mars (4) = 21
7 1600 − 10 = 1590
8 544 − 52 − 50 = 442
9 6 × 14 = 84
15 1876 + 1912 + 1821 + 1959 + 1959 + 1850 = 11,377
17 223,050 / 5 = 44,610
18 (4 × 3 × 7) − 2 = 82
19 √625 = 25
20 (550.50 × 12 × 20) − 50,000 = 82,120
21 24 × 925 = 22,200
23 2,000 × 0.328 = 656
26 0.2x = 43, x = 5 × 43 = 215
31 9 + 25 + 36 = 70
32 17 × 6 = 10
34 (3 × 5,280)/10 = 1,584
35 998.31 × 0.18 = 179.69, 179.69 + 998.31 = 1,178
36 $7^3 + 8^3 + 3^3 + 9^3 = 343 + 512 + 27 + 729 = 1{,}611$
37 204 + 12 = 216
39 5,760/16 = 360
40 52/4 = 13
41 (360/5) + 5 = 77
42 60 + (60 × 0.25) = 75
44 18 + 9 + 11 + 5 + 6 = 49

NEBULOSITY. Here is the only solution. Note the orderly lineup of digits in the sum.

741
5672
41982
369952
2587861
18129221
161219890
234558219
+ 817654352
1234567890

If you are mathematically inclined, try to prove that this puzzle cannot be solved in base 12, base 37 or *any* other number system. Send your proof to NEBULOSITY, *Omni* Games, 1965 Broadway, New York, NY 10023-5965. There is no time limit on entering this contest, but in case of ties the earliest postmark wins. ⊠

STARS

CONTINUED FROM PAGE 182

instrument.) At the CERGA site, Labeyrie, an interferometer expert, wanted to see whether it was possible to install an interferometer and get it to work in the cold, windy climate of the Alps. He first set up a pilot project called I2T (for Interferometer—Two Telescopes) that uses two small (25-centimeter) telescopes. When the two telescopes are fixed on an object, the light beams from each are reflected into the building, where they are combined into a single image. To adjust their focus, the tubes are moved on rails that extend north and south from a central building.

This procedure works only if the distances and angles of the telescopes can be controlled to within a micrometer, about one thirtieth the width of a human hair. I2T was built to find out whether such a setup would work. It works.

Since the astronomers were interested in looking at fainter stars than I2T could detect, Labeyrie had to design an interferometer that would use bigger telescopes. The task proved difficult. The trouble with big telescopes is that their long metal tubes droop, or bend, throwing off the precision required for interferometry.

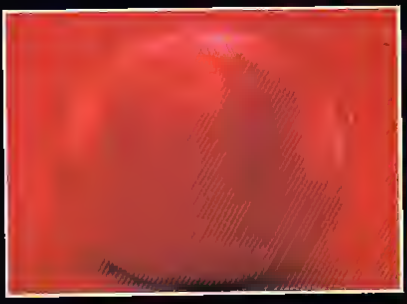
Labeyrie found the solution to this problem a decade ago, when he came across a unique amateur telescope marketed by the Edmund Scientific Company, in New Jersey. Instead of being a straight tube, the telescope is a sphere with a short, squat tube protruding from it. Labeyrie was particularly interested because spheres don't bend. And so the giant inverted mushrooms at Calern are simply large-scale versions of this design. Each is equipped with a 152-centimeter primary mirror, and each rests on a mount lined with rubber feet, actually rollers that rotate the base of the telescope and aim it in the desired direction. Computer controls can make adjustments of as little as 0.01 millimeter.

These are only the first pair of what is envisioned to be a whole complex of telescopes that will surround the igloolike cluster of buildings. The cluster will serve as the control center and optical focus for an array of telescopes. Thus equipped, Labeyrie expects eventually to study not only the sizes of stars but their shapes, pulsations, atmospheres, and other attributes that previously could be studied only on our closest star, the sun.

And why the peculiar mole-burrow design? This was architect Antti Lovag's futuristic response to the unusual requirements for a research building at Calern. At that altitude the fierce winds blowing over and around a building would cause turbulence, which interferes with the way light comes into the telescopes. So he had to design a building with aerodynamic lines that would create as little turbulence as possible. The result now sits on the Calern plateau, a molehill on the mountain. ⊠

NEXT OMNI

MUTANT VEGETABLES

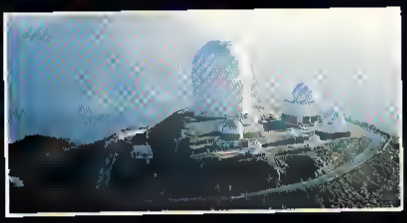


What evil lurks in the heart of a tomato? What heinous secret lies buried beneath the purplish skin of an eggplant? Five years ago we stunned health-food faddists by revealing the *real* ingredients of natural foods. (Oranges have formaldehyde, for example, and cantaloupes contain amyl acetate.) In the December *Omni* we bring you an even greater horror. Most of the "natural" vegetables and fruits we eat aren't natural at all, but recombinant products of man's first forays into agricultural genetic engineering. Don't miss this pictorial expose of onions, apples, and, yes, even persimmons—all results of man's attempt to pervert his environment . . . and his salads.

CYBERFUTURES

Mention automation and robotics to the workers on Detroit's assembly lines and you're likely to raise visions of mass unemployment. Ask John Diebold and Isaac Asimov about those topics, however, and you'll get a thought-provoking look at the next 20 years—and a little nostalgia as well. It was Diebold, a noted business consultant, who coined the term *automation* and Asimov who first used the word *robotics*. Oddly, these giants of the Computer Age had never met until *Omni* united them. What happened when they got together makes fascinating reading in this issue.

ANDES HIGH



They flashed brilliantly across the Andes skyline, strange lights seen by *Gemini* astronauts. Scientists scoffed at the sightings—until NASA revealed that this area of Chile has the greatest magnetic anomaly in all of South America. Now astronomers and spiritual meditators alike trek to the Chilean Andes, where the skies are among the clearest in the world. They come to solve riddles—to seek more-distant stars and to commune with the heavens above from this "new Jordan."

INTERVIEW

Mankind has expelled itself from the Garden of Eden, has become an outsider. "All the animals are afraid of us." So says renowned field zoologist George Schaller. At this moment Schaller is engaged in a race to rescue the planet's wildlife from extinction. In the jungles of China he struggles to save the last 1,000 wild giant pandas from starvation while their only food source, bamboo, goes into a leafless hibernation for up to three years. Schaller is perhaps the world's leading expert on the ecospheres of rare animals—including lions, tigers, gorillas, snow leopards, and other exotic species. His mission is not only to save the dwindling numbers of these animals but also to educate humans about the implications of habitat destruction. In December's *Omni* Schaller spins tales of lions in the Serengeti, gorillas of the Virunga volcanoes, and goat tracking in the Himalayas. And he implores us to stop the destruction of these wild and wondrous creatures.

CONTINUED FROM PAGE 20

from the Middle Ages. In fact, Robert Schumann permanently maimed his ring finger on one of these contraptions, and few fared better than he. At the turn of the century surgery to sever tendon junctures became popular but did little to improve performance.

When pianists are called upon to "sing out" the melody with the weak fingers or to combine rapid, forceful, intricate and repetitive movements, the strain on the muscles can cause damage. Similarly, when a pianist must "thunder" to project a melody over a full orchestra, the strain on the fingers over time can be devastating. Not surprisingly, then, the pianist's most common complaint is tendinitis, predominantly of the back of the hand and the extensors on the top of the forearm. This problem, however, says Leffert, "crosses all instrumental boundaries." Violinists, for instance, seem more prone to tendinitis of the flexors in the neck, hand, wrist, and forearm.

Most of the musicians who go to Hochberg and Leffert suffer from some sort of tendinitis. But what remains most vexing to the doctors are the mystery disorders—motor-control problems that show no nerve damage or musculoskeletal impairments. Unlike tendinitis, which most often hits the younger, less established musicians, the mystery ailments occur in the most successful and accomplished performers. And what's even more mysterious, these musicians don't have very much in common. They share little in background, technique, practice habits, musical outlook, repertoire, or physical characteristics. Graffman and a close friend of his, pianist Leon Fleisher, both suffered from a similar disabling motor-control problem, but Fleisher believes he induced his problem with fanatical overpractice, whereas Graffman traces his difficulties to an in-concert injury of the fourth finger. None of Hochberg and Leffert's other troubled pianists practiced as unremittingly as Fleisher or played right-hand octaves with "one-three," as did Graffman.

The question is, How did pianists like Fleisher manage to bypass tendinitis in the first place? Hochberg and Lefferf suspected that this syndrome might be a late, terminal tendinitis. In order to be sure, they needed to measure the artist making music on an instrument. "We know what muscle does what, what strength and movements may be normal for a hand," says Leffert, "but not for the performer, not for the specific application of that hand to a piano, violin, or harp over that time span. If a sports doctor can use a computer to analyze a tennis serve, evaluating the biomechanics of muscle contraction and relaxation during the serve, we ought to be able to do the same for the pianist."

With a machine called Selspot, they have made some headway. Selspot uses light-emitting diodes (LEDs) placed across selected joints. Two sets of TV cameras, mounted above and on the side of the arm being tested, track each LED. When a musician flexes or extends his wrist, the position of diode A on his finger shifts with respect to diode B on his forearm, and the cameras record this. So as the instrumentalist performs, information is fed into a computer, which draws a computerized stick figure, enabling the doctors to work out the speed and direction of the movement. Hochberg and Leffert hope to use Selspot in tandem with electrophysiological recordings of musicians' responses to measure how various instrumental techniques affect the body.

In addition, the doctors hope to learn what it means, medically, to relax. It was once believed that pianists had to sweat to really play well. To relax was to lose concentration and power. Today pianists no longer believe that, but even though they may feel relaxed at the keyboard, Hochberg and Leffert are finding that their muscles may not be. Needle-electrode studies have shown that both Fleisher and Graffman have hyperactive flexors, that is, an inability to relax the flexor muscles and a corresponding inability to freely employ their extensors. By means of the Selspot and electrophysiological recordings, the doctors are in the process of formulating a working medical definition of relaxation.

As in much research, though, a control group of unaffected or self-recovered musicians is needed to counterpoint the data on disabled players. Toward this end, the doctors have begun to distribute a musicians questionnaire—a detailed inquiry into numerous aspects of the artist's health and playing style—to a number of conservatories, symphony orchestras, and healthy colleagues of their ailing patients. By cross-referencing these data, the physicians are hoping to formulate a set of practice and performance norms.

Ultimately, the quest for the optimally functional pianist might extend to the engineering of a special testing piano. Outfitted with pressure gauges, electrodes, and sophisticated measuring and recording devices, this dream piano would allow Hochberg and Leffert to scrutinize further the physiological limitations of the pianist in the act of performance—a kind of window into the musician's body in the very act of creation.

But Lefferf maintains, "You have to be a little humble in this business. You take someone who was successfully doing something for years, and then it doesn't work. You have to be a bit presumptuous to say 'Change this, this, and this—end of problem!' We are not primarily concerned with what muscle does what, but rather how a performer masters such intricate and moving phrases. The real question is, How do they do that *wonderful* thing?"

PHENOMENA

For centuries the aborigines have revered this great reddish hulk that looms over the flatlands of central Australia. And photographer Pete Turner can understand why. "First you begin to see it from miles away, and as you approach it, it seems to rise from the land. It's probably the closest thing on this planet to the megalith of *2001*." Tinted a rusty rouge because of its high concentration of iron oxide, Ayers Rock, as it's called, almost magically changes hues with atmospheric conditions. Less mystically minded geologists say this 340-meter-high rock is the tip of a buried mountain range and is one of the oldest geological formations of its kind on the planet. To capture its sweep and grandeur, Turner attached a 20mm lens to his Nikon F2 and used Kodachrome 25 film. To heighten the stone's monolithic aura, he made this striking mirror image out of his original photo.

If numbers make you numb
this will make you #

GAMES

By Scot Morris

This month's offerings are for readers who like to play with numbers and who have requested that we print more digital diversions.

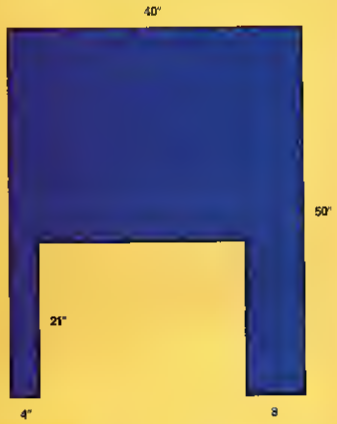
For starters, consider #. There's no single word for it. Sure, it means *number*, but only in certain contexts. Willard R. Espy wrote the poem below about eight kinds of #. It appears in his *Another Almanac of Words at Play*. How many can you identify?

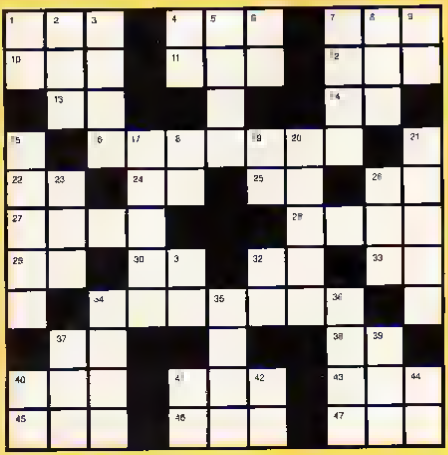
Many offices encumber
My diurnal rounds
1. Before a digit, I'm a #.
2. After digits, #.
3. In a printer's proof, a #.
While, if at the harp
You should pluck me from my place
4. I would be a #.
5. In one game, I'm #;
6. An # on 'phones.
7. In business, I'm #, although
8. A # when in bones.

CAL-Q-MATH. Victor E. Taylor, of Green Mountain Falls, Colorado, has sent us a cross-number puzzle that is guaranteed to keep any numerophile off the streets and out of trouble. Fill in the grid at right according to the clues below. Some numbers may be entered immediately; others may require a little research with an almanac or encyclopedia.

ACROSS

1 Lives of a cat times the last two digits of the year in which *Pioneer 10* left the solar system
4 Twelve percent of (complete miles in a marathon times Celsius temperature of boiling water)
7 1 Down + 13 Across
10 Birthday celebrated by the United States this year
11 Boeing aircraft number minus (Apocalypse horses times leaves on a lucky clover)
12 (Nixon's resignation year minus the Number of the Beast [Rev. 13:18]) minus (corners on a cube times a baker's dozen) minus yards in three furlongs
13 Same as 29 Across
14 Years that elapsed between purchase and statehood of "Seward's Folly"
18 Of these seven digits, the sum of the first and second equals the third, the third digit minus the sixth equals the seventh, the fourth digit is 3/4 of the third, the fifth digit is 1/2 of the first, and the sum of all seven digits equals the number of teeth in the only primate that reads *Omni* (or needs to)
22 This is the area of a triangle that has a four-inch base and is eight inches high, in square inches
24 Value of x when $x + x + 42 = 126$
25 Half a gross minus half of Noah's rainy days
26 Of 60 students registered for computer camp, 18 take BASIC, 24 take PASCAL, 17 take FORTRAN, 7 take BASIC and FORTRAN, 9 take PASCAL and FORTRAN, 10 take PASCAL and BASIC, and 5 take all three subjects. How many students aren't taking any of the three computer languages?
27 (The current year minus dollars for passing go in Monopoly) divided by 1/2
28 Number of square inches in the figure shown at right
29 Trombones in the big parade divided by (half of the number of times the postman always rings)
30 C − L − (X times V) + XVII
32 Using only the digits *1* through *4*, how many two digit numbers, not allowing repetition of digits, can be created?





SUN
LOSE
UNTIE
BOTTLE
ELISION
NINETEEN
NONENTITY
EBULLIENT
+INSOLUBLE
NEBULOSITY

Numbers to numb you. Fit them crossword-style at left, add them the only way possible at right.

33 If the temperature is 10°C, what is it in Fahrenheit?
34 Palindromic number that is the binary (base 2) equivalent of 73 (base 10)
37 32 Across + 40 Down
38 ($\sqrt{44}$ Down times $\sqrt{4}$ Down) + 6 Down
40 Sum of atomic numbers of carbon, platinum, and selenium
41 $\sqrt{603,729}$
43 Alexis bets $15 a shot for 25 consecutive times on one number on a roulette table The first 24 bets lose, the twenty-fifth wins and pays 35 to 1 Alexis quits and tips the croupier a buck What is the net amount of winnings?
45 Perfect game in bowling plus number of 1 × 1 squares on a chessboard
46 Volume of a cylinder ten inches tall, with a five-inch radius, when $\pi = 3.14$
47 Fill in the missing number 89 91 94 98 103 ___ 116

DOWN
1 (Months with 31 days times number of two-eyed face cards in a deck) + number of U S Supreme Court justices
2 (Winks in a nap times legs on a basketball team) + number of continents on earth
3 F D R 's presidential terms times year of Japan's attack on Pearl Harbor
4 Sum of points for blackjack boxcars (craps), and a football field goal
5 Subtract the only number that tells how many letters are in its English name from the last leap year of this century
6 The number of letters in the names of the four planets closest to the sun
7 Street number of the White House minus street number of the British prime minister's residence
8 12 Across minus 25 Across minus 33 Across
9 Feet in a fathom times days in a fortnight
10 Sum of the years in which the following states were admitted to the Union Centennial State, Grand Canyon State Show Me State, Aloha State, Land of the Midnight Sun State and Golden State
17 The average of 62,971, 42,684, 38,461, 26,252, and 52,682
18 (Faces on Mount Rushmore times Stooges times hills of Ancient Rome) minus moonless planets in solar system
19 $\sqrt{625}$
20 Amount of interest paid on a $50,000 loan when the monthly payments are $550 50 for 20 years
21 Pure gold karats times sterling silver number (disregarding decimal points)
23 In a baseball player's four-year career he was at bat 2,000 times (excluding walks) and his batting average was .328 How many hits did he get?
26 The discount on a TV is 20 percent of list cost If the discount is $43, what is the list cost?
31 $3^2 + 5^2 + 6^2$
32 To the nearest mile how many miles in 17 kilometers?
34 (Cans of water added to frozen orange-juice concentrate times feet in a mile) divided by Bo Derek
35 Dollar value of an investment of $998 31 at the end of one year if the interest is 18 percent per annum
36 Sum of the cubes of the digits in the four corners of this puzzle
37 Squares of all dimensions on a chessboard plus VHF television channels
39 Grains in a troy pound divided by drams in an avoirdupois ounce
40 The top card on a deck of well-shuffled cards (no jokers) has a one in ___ chance of being an ace
41 (Degrees in a circle divided by *Omni*'s anniversary last month) + $\sqrt{37}$ Across
42 For a retailer to make a 25 percent gross profit on an item costing her $60, how much should she sell the item for?
44 Holes on a golf course plus total number of players on a team in baseball, football basketball, and ice hockey

NEBULOSITY

An alphametic puzzle substitutes letters for numbers, its a combination of *alphabet* and *arithmetic* A given letter always stands for the same number Most such puzzles not only have solutions in decimal (base 10) arithmetic but in other bases as well Very few have solutions in one base only On the facing page is one of the cleverest, by Steven R Conrad first published in *Recreational Mathematics*

Harry Nelson, former editor of the *Journal of Recreational Mathematics* tells me that he took this problem to Japan recently and proposed a 5,000-yen prize to the Tokyo Recreational Mathematics Club for the first person to both (1) find the decimal solution and (2) show that there is no other solution in any other base Several people solved the first part, but no one was able to crack the second part After a few months the prize was awarded for the closest answer *Omni* bets that our readers will succeed where the Japanese failed We'll double the ante to 10,000 yen and send it to the first *Omni* reader who sends us a proof for part 2 Nelson has agreed to referee If you know enough math to enter, you probably know enough to figure out how much you'll get if you win

At any rate, you can solve the alphametic without knowing any math more complex than addition

Answers on page 192.

COMPETITION #31 OMNI DICTIONARY

In May we printed the results of our first search for entries in *Omni's Fractured Dictionary* We covered letters *A* through *E* Now we invite you to work on the next five chapters, *F* through *J*

Fission Where Huck Finn went when he skipped school

Geometry What the acorn said when it grew up

Hexagon The curse is lifted

Igloo (1) An icicle built for two (2) Stuff for repairing your ig

Iran Between Iraq and a hard place

Send us as many as three original definitions no more, starting with letters *F* through *J* The grand prize-winner will receive $100, runners-up (2–10) $25 each, and all ten will get a copy of our new book *Omni Games* All entries become the property of *Omni*, none will be returned Use a postcard, please (or a card in an envelope), and include your name and address Send entries, by December 15, 1983 to *Omni* Competition #31, 1965 Broadway, New York, NY 10023-5965

LAST WORD

By Jack Handey

"It's fascinating to think that all around us there's an invisible world we can't even see. I'm speaking, of course, of the World of the Invisible Scary Skeletons."

Every once in a while, everybody has one or two deep thoughts. I happen to get a lot of them.

Whether they ever find life there or not, I think Jupiter should be considered an enemy planet.

When the chairman introduced the guest speaker as a former illegal alien, I got up from my chair and yelled "What's the matter, no jobs on Mars?" When no one laughed, I was real embarrassed. I don't think people should make you feel that way.

It's amazing to me that one of the world's most feared diseases would be carried by one of the world's smallest animals: the real tiny dog.

One thing that makes me believe in UFOs is, sometimes I lose stuff.

I guess more bad things have been done in the name of progress than any other. I myself have been guilty of this. When I was a teen-ager, I stole a car and drove it out into the desert and set it on fire. When the police showed up, I just shrugged and said, "Hey, progress."
Boy, did I have a lot to learn.

Sometimes, when I drive across the desert in the middle of the night, with no other cars around, I start imagining: *What if there were no civilization out there? No cities, no factories, no people?* And then I think, *No people or factories? Then who made this car? And this highway?* And I get so confused I have to stick my face out the window into the driving rain—unless there's lightning, because I could get struck on the head by a bolt.

The face of a child can say it all, especially the mouth part of the face.

The difference between a man and a boy is, a boy wants to grow up to be a fireman, but a man wants to grow up to be a giant monster fireman.

I think the monkeys at the zoo should have to wear sunglasses so they can't hypnotize you.

Sometimes life seems like a dream, especially when I look down and see that I forgot to put on my pants.

Love can sweep you off your feet and carry you along in a way you've never known before. But the ride always ends, and you end up feeling lonely and bitter.
Wait. It's not love I'm describing. I'm thinking of a monorail.

To me, clowns aren't funny. In fact, they're kinda scary. I've wondered where this started, and I think it goes back to the time I went to the circus and a clown killed my dad.

I wouldn't be surprised if someday some fisherman caught a big shark and cut it open, and there inside was a whole person. Then they cut the person open, and in him is a little baby shark. And in the baby shark there isn't a person, because it would be too small. But there's a little doll or something, like a Johnny Combat little toy guy—something like that.

I bet it was pretty hard to pick up girls if you had the Black Death.

Sometimes I wish Marta were more loyal to me. Like the other day. The car parked next to ours had a real dirty windshield, so I wrote THIS CAR LOOKS LIKE A FART in the dirt. Later I asked Marta if she thought it was a childish thing to do. She said, "Well, maybe." Man, whose side is she on, anyway?

Sometimes I wonder if I'm sexy enough. When I walk into a singles bar with my "fashionable" shirt, "fashionable" slacks and a big new rubber manta-ray helmet, I can't help wondering: *Do women want to talk to me for myself, or do they just want to get a feel of that nice rubber manta skin?*

It's too bad that whole families have to be torn apart by something as simple as wild dogs.

The land that had nourished him and had borne him fruit now turned against him and called him a fruit.
Man, I hate land like that.

Life, to me, is like a quiet forest pool, one that needs a direct hit from a big rock half-buried in the ground. You pull and you pull, but you can't get the rock out of the ground. So you give it a good kick, but you lose your balance and go skidding down the hill toward the pool. Then out comes a big Hawaiian man who was screwing his wife beside the pool because they thought it was real pretty. He tells you to get out of there, but you start faking it, like you're talking Hawaiian and then he gets mad and chases you.

It's fascinating to think that all around us there's an invisible world we can't even see. I'm speaking, of course, of the World of the Invisible Scary Skeletons.

Whenever I hear the sparrow chirping, watch the woodpecker chirp, catch a chirping trout, or listen to the sad howl of the chirp rat, I think, *Oh boy! I'm going insane again.* ∞

Jack Handey spends his time writing comedy for TV, the movies, and print. He lives, and thinks his deep thoughts, in Los Angeles.