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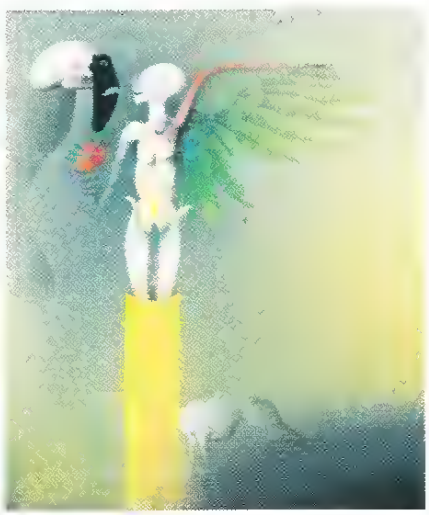

*The art of Paul Wunderlich immediately engages our attention, for it represents a dynamic synthesis between intellectualism and spontaneous expression. His highly stylized compositions function as a utopian ideal, the ecstatic merging of mind and body*

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# FIRST WORD

By Albert Rosenfeld

*"We can no longer afford the iron-lung approach to aging. Money put into research is money put into our national savings."*

Extravagance means big, wasteful spending. But it can also mean misguided thrift. For instance, one of the more extravagant things we do as a nation is spend too little on aging research. By laying out extra millions now, we could save ourselves untold billions not too far down the road.

Today 11 percent of our population is over sixty-five. The annual "health care" expenditures of these people run into the hundreds of billions of dollars. Though only about 5 percent of the over-sixty-five population live in nursing homes, their overall cost to us is well in excess of $20 billion, the single most inflationary segment of America's staggering national medical bill.

By 1990 this figure could jump to an incredible $81.9 billion, according to a recent survey forecast. Yet the entire 1982 budget for the National Institute on Aging, that part of the National Institutes of Health devoted to research in the biology and sociology of aging, is a mere $81.9 *million*—or one one-thousandth of the estimated cost, eight years from now, of taking care (such care as it is) of people in nursing and convalescent homes alone! This doesn't take into account any of the other mounting expenditures involved in trying to repair the deteriorative damage that aging inflicts, and this money usually is spent without even the hope of helping the patient very much.

What if the March of Dimes had elected during the decades of the 1940s and 1950s to devote most of its resources to putting polio victims into iron lungs instead of concentrating on basic viral research and vaccine development? We now know that to have spent *less* money on infantile paralysis research would have been a massive extravagance. Think what we would have been spending all these years on polio care versus the negligible costs of vaccination and prevention, let alone the untold amount of human anguish that has been prevented.

But aging, you'll tell me, is different. Aging means senility and decrepitude, right? Always has, always will. How can one prevent the inevitable?

The good news is that aging, as we have always known it, may no longer be inevitable or irrevocable. Breakthroughs all across the frontier of biomedical science make it increasingly feasible to hope that we may hold back the ravages of senescence—even to abolish many of the degenerative symptoms of the hitherto-universal disease called old age.

For nearly every symptom of aging wear-and-tear, there are remedies and preventive measures being actively investigated: immune boosters, free-radical scavengers, cross-link inhibitors, membrane stabilizers, DNA-repair enhancers, to name a few; and some are even already available in the form of dietary manipulations and life-style revisions. Moreover, scientists are pursuing evidence that senescence is caused by genetic and hormonal "aging clocks," which interfere with our normal metabolic processes. When they are finally understood, they may turn out to be the keys to the aging process itself. Either way, the promise is added years—not years of senility but extra years of vigor and productivity, with the old-but-not-elderly beneficiaries able to enjoy life and to take care of themselves and others, too. The nursing home could follow the tuberculosis sanatorium into virtual obsolescence.

We have traditionally attacked the aging process by going after one disease at a time. But the vast majority of crippling and killing diseases—such as cancer, arthritis, diabetes, atherosclerosis, heart attack, stroke, and the mental disorders (including what we used to call senile dementia)—occur late in life, seemingly an integral accompaniment of the aging process itself. The quest by scientists for the mechanisms of that process may well turn out to be the shortest, most economical route to solving many of the aches and ills that so often render us helpless in the period of decline that precedes death.

These heady new possibilities are being pursued most actively by a number of small, but determined, organizations in the private sector. The oldest of these is the American Aging Association, in Omaha, Nebraska. The newest is the American Longevity Association, in Los Angeles. The most impatiently aggressive and, despite its minuscule budget, perhaps the most productive in both facilitating research and in raising consciousness has been the Washington-based Fund for Integrative Biomedical Research. And now a fledgling organization called the American Federation of Aging Research hopes to become an umbrella organization for many of these aging groups, doing for aging research what the American Cancer Society does for cancer.

The message should soon get through to the politicians in our federal government that we can no longer afford the iron-lung approach to aging. Money put into aging research is money put into our national savings—at high rates of interest in the form of health and vigor, dignity and self-respect, and, of course, dollars and cents. ∞

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*Albert Rosenfeld's book* Prolongevity, *published by Alfred A. Knopf, foreshadowed the current interest in antiaging experiments and is considered a seminal work in the field.*

# JACK WHEATON STUDENT BY DAY SPIDER-MAN BY NIGHT

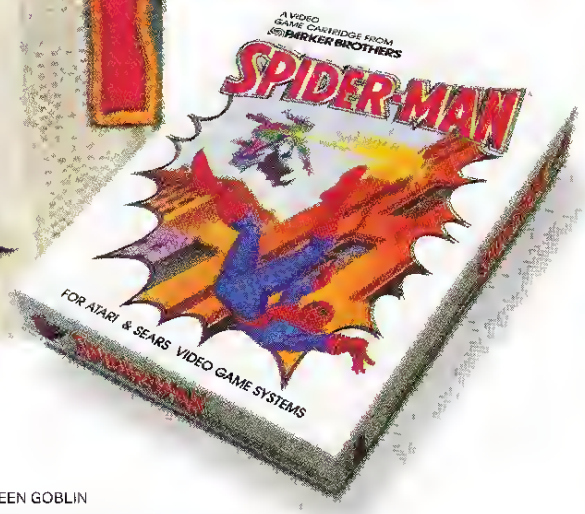
Chasing coeds all day is child's play compared to what Jack Wheaton does when school's out. That's when he dons his crime-fighting garb and starts pursuing ruthless villains. With the SPIDER-MAN™ home video game from Parker Brothers.

Jack's not the only one who can save the city from the villainous GREEN GOBLIN™ and his gang of nasties. You can swing across giant skyscrapers on your web trying to defuse deadly time bombs before they wreak havoc and destruction.

Every Parker Brothers home video game offers a unique challenge. Like AMIDAR,™* where you guide gorillas and paint rollers through a maze of squares with warriors and pigs in hot pursuit. Then there's TUTANKHAM,™** where it's up to you to search King Tut's Tomb for hidden treasures being guarded by evil spirits.

These, and other Parker Brothers home video games, are based on popular arcade games, exciting movie themes and comic book adventures. Every game combines brilliant graphics and stirring sound effects that'll get you so involved you'll feel like a part of the action. Just take it from Jack.



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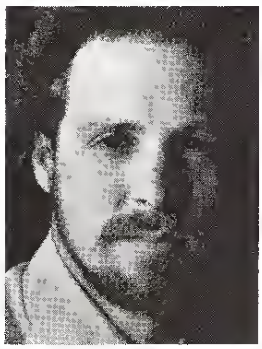
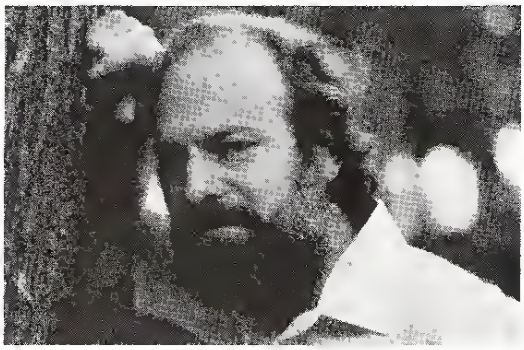


STARR

METZGER



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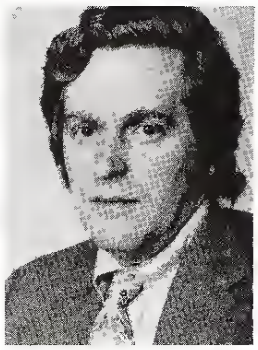

VOLKMAN

Behold Euclid. This ancient Greek handed us a clean and elegant geometry. Beautiful circles, straight lines, classic triangles, nice, neat dimensions—one, two, or three, with nothing in between.

Behold Benoit Mandelbrot. Staff writer *Kathleen Stein* did [illegible] at lunch in the gigantic cafeteria in IBM's Thomas J. Watson Research Center, in Yorktown Heights, New York. Mandelbrot sat down with his standard lunch: a bowl of bright purple sherbet, a separate ice-cream cone stuck open-side-down into the sherbet, and a cup of tea. As Stein interviewed him, Mandelbrot, an IBM Fellow for the past 12 years, proceeded to mash the very Euclidean cone into the sherbet. "At times," Stein explained, "he poured a little tea on the concoction as a means of lubricating the whole process." Eventually Mandelbrot had a mixture that Stein describes as being "somewhere between lumpy and flaky."

The sherbet serves as a metaphor for Mandelbrot's contribution to science. For the French mathematician is the father of fractal geometry—from the Latin adjective meaning 'broken, fragmented.' Mandelbrot and his ilk reject the neat Euclidean universe for one that is lumpy, flaky, and wiggly. It is the geometry of coastlines and clouds rather than of pyramids and statues, of nature rather than artifice. Fractal geometers like Mandelbrot reject even normal dimensions, claiming there is the 1.25 dimension, the 2.6 dimension, and infinite others in between the normal, boring 1, 2, and 3. This is all very abstract stuff, and fortunately there are pictures. "Computer-generated three-dimensional fractals are the most wonderful forms I've seen in a long time," says Stein. "But these weird phenomena will stretch the mind to its limits." Fractal "dragons" and other monsters are on display, beginning on page 62.

Advances in the field of drug-receptor research have opened a new world of knowledge about the mind and the drugs that affect it. Neuroscientists now say our most elemental emotions and drives—love, anger, sex—may be biochemically rather than psychologically controlled. Rarely has a scientific advance carried such enormous implications. Already, pharmaceutical companies are producing new, 'cleaner' antidepressants, antianxiety pills, and painkillers that lack the deadening side effects of conventional drugs. We may someday even see the advent of "meditation pills." In "Brain Drugs" (page 26), Boston-based freelance writer *Douglas Starr* unravels the mystery behind the mind's most basic biochemistry and explains the impact of this breakthrough on psychopharmacology and mental health.

Tucked away in a little-known Montana research facility, engineers have put together a melange of technologies to create a new way of generating electrical power: magnetohydrodynamics. The heart of the device is a huge rocketlike chamber in which hot gases from a coal furnace rush between the poles of high-powered magnets. An array of small plates then tap electrical power from the gases. *Ernest Volkman* explores this nascent technology and the natural phenomena it simulates, in "Firepower Plant," on page 44. Volkman's latest book, *The Devil's Sabbath*, to be published by Morrow, highlights U.S. intelligence operations against the Soviet Union.

No one can speak with greater authority on the progress of ideas in biology than Harvard evolutionist Ernst Mayr, the subject of this month's Interview. On page 72 Mayr discusses the modern synthesis of evolution, clarifies popular misconceptions about chance and natural selection, and blasts his opponents, the creationists. "The odd thing about Ernst Mayr," says science writer *Carol Johmann*, who interviewed him at his Harvard office, "is that philosophically he is optimistic, but he is so pessimistic about the cultural evolution of mankind."

*Lois Metzger*'s tale "The Best of Both Worlds" (page 56) involves an indecisive woman who confronts a life decision and chooses an ideal answer. Metzger has published in the *New Yorker*, the *North American Review*, and *Clarion SF*. Told in antiquated verse form by *Joe Haldeman*, "Saul's Death" (page 104) is a strong apologia for mercenary life. Haldeman is working on *Worlds Apart*, the second volume of a trilogy.

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FEBRUARY

# LETTERS

# COMMUNICATIONS

### The Eye of the Beholder

The October 1982 pictorial "The Eye of Reality," the text of which was written by Robert Sheckley and which was beautifully illustrated by Michael Parkes, had a great punch line. "Like you, I saw pretty much what I always see."

This line reminded me of a similar story. Some years ago a builder, an architect, and a banker were watching an impressive new building being erected.

The builder said, "I think of the incredible coordination of mind and matter that it takes to bring this into being."

The architect said, "I think of the contribution to aesthetics and culture that this structure will bring about."

The banker said nothing, but when asked to reveal his thoughts, he replied, "I think of women."

The architect and builder were surprised at this answer and asked why.

The banker said, "Because I always think of women."

Ted Slack
Miami, Fla.

### Project Bigfoot

Kudos to *Omni* for the items about Bigfoot in the October 1982 issue [Antimatter], but if you will, I have a few small corrections that I would like to add to an already confused situation.

Not only did the Walla Walla Bigfoot tracks have ridges on the toes, but they had actual "toe prints" just like fingerprints, making them expensive ($5,000 and up) to fake. Paul Freeman was broke and, in my opinion, honest.

The U.S. Border Patrol "tracker" whom the U.S. Forest Service sent to Walla Walla was experienced in tracking humans and bears. He had never seen a Bigfoot-type track before. He failed to find any human tracks near the Bigfoot tracks. He also failed to take into account that while one watershed rider, Bill Epoch, was waiting for Freeman to return to the site of the second set of tracks, the tracker must have been under surveillance by Bigfoot because Freeman and Epoch found *fresh* Bigfoot tracks laid down right over their own incoming tracks. Both men got goose pimples.

Richard Greenwell, cofounder of the International Society of Cryptozoology, a rival organization of our own National Cryptozoological Society, states that I have threatened to sue over the fact that the International Society of Cryptozoology and Greenwell reject applicants who question strict biological-origin theories for strange new animals. I have never wanted to sue or threatened to do so. There is plenty of room for theorists of all types in the monster-hunting fraternity.

John Beckjord
Seattle

### Another Wizard

Phil Wiswell's article "Video Wizards" [October 1982] presents an exciting overview of the new breed of video games. But the article should have mentioned both members of the team—Jaron Lanier and Bernie DeKoven—who designed and produced the game Alien Garden.

Chet Frankenfield
Development manager
Epyx Automated Simulations
Sunnyvale, Calif.

### Disney Dreams

Let me tell you an interesting story pertaining to your September 1982 article "Tomorrow Lands," by Tim Onosko. When I found out that EPCOT [Experimental Prototype Community of Tomorrow] would not have residents, I was furious at WED [Walter Elias Disney] Enterprises for not honoring Walt's wish, and I said so to one of its managers while I was consulting on the EPCOT space movie. The manager told me that they were "afraid of the sociology," which was quite ironic.

It seems that Walt Disney set up WED because the board of his film company thought the idea of a theme park was too far out. It would never work. Now WED thinks having people live at EPCOT is too far out. If Walt were alive today, would he have created still another company to make his dream come true?

Jerome Glenn
Washington, D.C.

# 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.*

### Defensive Space Stations

I would like to congratulate *Omni* for presenting Gregory Benford's brilliant idea for a defensive nuclear strategy [First Word, September 1982].

The Reagan Administration seems to be committed to some vague plan that will persuade the USSR to produce fewer weapons at the same time that we produce more. The administration thinks its weapons escalation is going to scare the USSR.

The nuclear freeze idea is appealing, but without reliable verification it is potentially very dangerous. We are faced with a no-win situation: either a massive weapons buildup or a nuclear freeze.

A defensive strategy offers a third option that could ultimately satisfy both the people who seek security through nuclear weapons and the people who seek security from them. A system of defensive space stations would augment our national security and reduce the risk of nuclear holocaust.

Mr. Benford's idea deserves wide attention. I hope that it wins acceptance in the Senate.

John Jernigan
White Meadow Lake, N.J.

I would like to take exception to some of the misleading observations about the dangers of nuclear power made by Gregory Benford, in First Word.

The demonstrations against munitions makers that Mr. Benford obliquely referred to served mainly to focus national attention on the grisly, ever-present nightmare that our politicians continue to treat in the most cavalier manner. All U.S. nuclear weapons are built under government contract. The blame for "the nuclear Armageddon problem" rests squarely on our government's unbridled defense policies and our lack of responsibility for our own national direction.

The only comment I wish to make about the assertion that the use of chemicals in warfare is a red herring is that napalm is a chemical weapon.

When Mr. Benford claims that we are too quick to subscribe to a plan of de-escalation, I would tend to believe that it is because *we started* the "offensive weapons race," in 1945, not because "the West has always been more flexible."

We have not stood off the USSR with nuclear superiority. The strategic peace has been kept for the past 37 years through the policy of MAD (Mutually Assured Destruction).

"A defensive arms race" is definitely not "a third escape hatch." The only "escape hatch" is a complete and total weapons freeze.

Daniel Burr
Houston

Gregory Benford's suggested projectile battle stations would be as *effective* as the Maginot Line.

Benford has humane goals, but his thinking is simplistic. Nuclear weapons are not the ultimate threat. An orbital fusion-powered, wide-angle particle beam, creating a lethal flux of radiation at ground level, may be more devastating. You could also consider mini–black holes being formed at relativistic velocities so that time dilation would allow them to reach their target, or....

*Omni* should look to a better future, not plan for the next—and last—war.

Dutch Guckenberger
Sanford, Fla.

### Altered States

Judith Hooper's article "Mind Tripping" [October 1982] left me angry and disappointed. Isn't society sufficiently drug related? I agree that there are altered states of consciousness, but please don't mention them in the same breath with drugs! That is just sensationalism.

The only way one can gain real understanding is by confronting reality, not through some drug-induced fantasy.

After the "trip" comes the crash. Any experienced person will tell you that it is not very pleasant (in fact, it's terrible), and it certainly does not leave you in any condition to face reality.

I can't believe that a learned scientist would use LSD to meddle with brain chemistry.

Donald Clay
Galveston, Tex.

### Ecological Illness

Thank you for printing the article regarding my trials and tribulations in trying to live with twentieth-century technology. However, I would like to correct one error in the item "Allergic to Life," by Yvonne Baskin [Continuum, October 1982].

The "red dye" referred to, used for X-ray studies, should have been rad dye, or radiographic dye.

By the way, I felt specific reactions from this test for six years and on occasion still feel the needles in my instep.

This test was given to me under some hazy circumstances. The morning I was to be discharged from the hospital an aide rolled in a gurney for me to hop onto. He said there was one more test scheduled for me. What occurred after that was a real nightmare. After the testing, the pain was so bad that I was given codeine. When I asked what they had put into me, I was told "an R.A. dye," which in my codeine-induced stupor got translated into "a rad dye." What the aide actually meant was a radioactive dye.

I think that the medical profession is remiss when it does not confer with patients and inform them what tests were administered. More to the point, why do doctors persist in putting things into our bodies without pretesting to see what that pill or chemical will do to us?

The American Medical Association is very skeptical about the field of ecological illnesses; yet an ecological illness is caused by the body's inability to cope with specific chemicals in the air, in food, and in water, medicines included.

Harriett Molloy
Potrero, Calif.

# CHATTEY'S ISLAND

# EARTH

Nigel Chattey was nineteen when he lost his ship to a storm in the English Channel and nearly drowned. At twenty-one he slept with camels in the deserts of India and chased gold smugglers through Afghanistan. By the age of twenty-two he'd been driven from China with a platoon of Communist cavalry at his heels.

He was living in Westchester County, New York, near the calming waters of the Hudson, when, at forty-eight, his lust for adventure struck again. This time Chattey gave up his successful engineering consultation firm to promote a construction project as huge in scope as the Great Wall of China.

The plan—to modernize the Erie Canal and build a Manhattan-sized island off the coast of New York—would revive industry throughout much of the nation, Chattey proclaimed. It would reduce American reliance on foreign oil, drastically reduce unemployment, create a favorable balance of trade, and actually *improve* the environment. And to soothe those who worried about the expense, he promised that the complex would pay for itself in less than a decade.

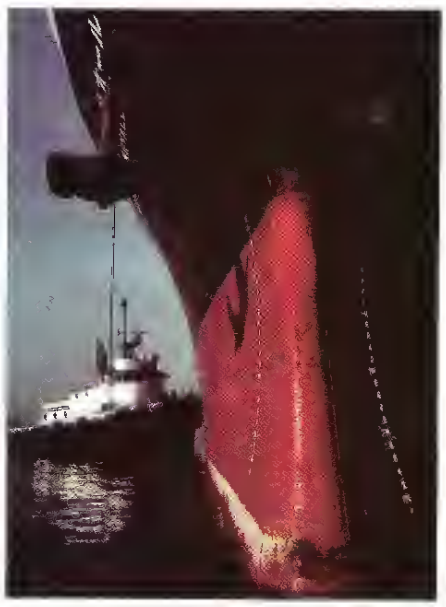
Chattey stumbled across this remarkable scheme back in 1971, when Mobil Oil Corporation hired him to find an East Coast locale for its new generation of oil refineries and petrochemical centers. He searched for six months and finally found the ideal spot—the Cholera Bank, a 100,000-acre plateau as flat as a billiards table and sitting some 70 feet below the surface of the sea.

If Mobil could only build an island atop this plateau, Chattey reasoned, it would create the deepest port in all of North America. With access to tankers four times too large to enter other ports, the company could then buy oil in bulk, saving $1.20 per barrel, or millions of dollars a day. Moreover, since winds blowing past the Cholera Bank usually whisked out to sea, industrial emissions from energy facilities built on the island wouldn't pollute residential communities located on the mainland.

Chattey pointed out that an artificial island had *already* been built in the Netherlands. The technology, he explained, was simple. Sand and gravel could be used to build powerful walls on the ocean floor. When four such walls formed a box that rose above sea level, water could be pumped out and landfill dumped in. The island could then be expanded by building a series of these regions, one adjacent to the other.

The idea proved a bit too grand for Mobil executives, but in the subsequent months Chattey weighed the advantages of pulling off the scheme for society at large. The island, he reasoned, would be home to dozens of polluting industries—from oil refineries and coal-fired power plants to chemical factories and steel mills. Industrial and human wastes now dumped into the ocean could be treated on the island or disposed of in basins beneath the landfill surface. Perhaps most important of all, the artificial island would serve as a superport for much of the continental United States.

Indeed, the proposed island would lie at the mouth of the Hudson River. The Hudson, stretching 160 miles inland, is already connected to the Erie Canal. The canal, in turn, reaches across New York State to the Great Lakes. The canal had been little used for decades, Chattey knew, but if it could be modernized, it would connect the huge deepwater port with industrial centers, farmlands, and mines in the heartland.



*Supertankers would visit Chattey's island.*

Westbound barges traveling a widened canal, Chattey figured, would then bring midwestern states fertilizers and industrial raw materials produced cheaply at the island. Eastbound barges would generate a huge profit by hauling grain and low-sulfur coal to the island for shipment around the world to parts of the United States, Europe, and Asia.

Chattey estimated that the project would create 20,000 jobs during construction and more than 100,000 jobs afterward. Industries based on the island itself, he claimed, might stimulate a second industrial revolution.

Chattey spent the next five years figuring out his plan of attack. Then in 1976 he met attorney and fellow engineer Constantine Sidamon-Eristoff. After hearing Chattey's ideas over lunch, Eristoff could barely contain his excitement. His advice: "You'd better write it down."

So Chattey gave up his Fifth Avenue office and went to work in a 10′ × 10′ room in the basement of his Irvington, New York, home. When he emerged four months later, he'd written a report covering everything from how much the island would cost to the taxes the government could expect to collect. He dubbed this extensive plan ICONN-Erie (with ICONN standing for Island Complex Offshore New York and New Jersey).

Then Chattey called his old friend John Petty, president of Marine Midland Bank. Petty read Chattey's prospectus carefully and came away believing that ICONN-Erie could mean renewed economic prosperity. So he got the bank to award Chattey a stipend of $10,000 a month for promoting the idea.

Chattey and Eristoff used the grant to travel the country with a "dog-and-pony show," an hour-long sales pitch including



CONTINUED ON PAGE 103

# GRAMMATICAL GENES

# LIFE

By Anthony Liversidge

William R. Bennett, Jr., a Yale professor, once used a computer to show that a trillion imaginary monkeys, all typing rapidly, would take more than a trillion times the age of the universe to come up with Hamlet's line "To be or not to be, that is the question."

He then, however, instructed the computer to include some constraints on its otherwise random selection of characters. A typical rule was that the frequency with which each letter occurred was to be the same as in Act III of Shakespeare's play.

The electronic simians suddenly began to show signs of literary ability, though some effort was apparently involved, since a large proportion of strong expletives kept showing up. One memorable morning after an all-night computer run, Bennett found this on the printout:

TO DEA NOW NAT TO BE WILL AND THEM BE DOES DOESORNS CALAWROUTOULD!

If this momentous result suggests that in some way the forms of language, of thought, even of life itself, may have more to do with mathematics and probability than one might expect, perhaps so. The anecdote is from a remarkable new book, *Grammatical Man*, by Jeremy Campbell (Simon and Schuster), which effectively advances a provocatively original thesis along these lines.

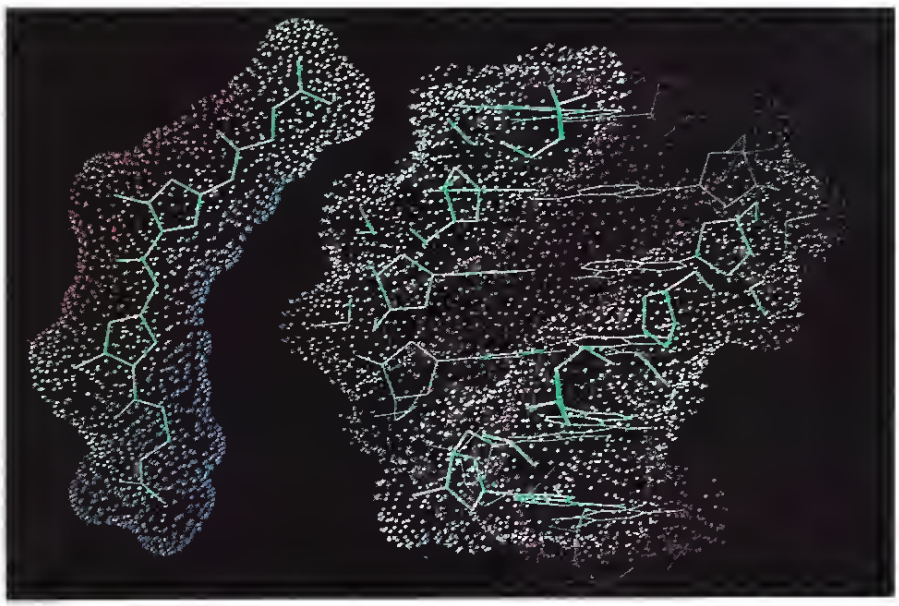
Campbell's book is the most convincing attempt yet to suggest that many important questions about human existence may eventually yield to an analysis based on so-called information theory, a group of mathematical and statistical constructs until recently used only by communications engineers. Biologists, in particular, have been drawn to information theory, for it just may hold the answer to two of the greatest questions of all: how complex life forms were initiated, and how the great leaps in evolutionary development were made.

The hub of the vast intellectual wheel that Campbell sets spinning in his book is the work of Claude Shannon, a Bell Labs scientist who first worked out his mathematical theorems in designing telecommunication equipment in World War II. An uncompromising intellectual perfectionist, Shannon, later a professor at MIT, won scientific fame and a bagful of honorary degrees after he published the ideas in a classic paper in the *Bell System Technical Journal* in 1948.

On the operational level, Shannon's information theory amounts to a technical approach in electrical engineering, by which an electrical message to be sent along a wire is encoded with extra, redundant "bits" of information. The additions ensure that, in decoding, any interfering noise that might mar the communication is removed. The ideas were originally intended merely to help improve the efficiency of sending messages over long distances, and indeed in this narrow application they have proved startlingly powerful, paving the way for radar and color television and enabling spacecraft to transmit high-quality images over millions of miles.

On the philosophical level, however, the formulations, which enable scientists to understand any communication process better, may prove to have very much wider application. As Campbell shows, they seem unexpectedly relevant to a host of subjects far from their field of origin: molecular biology, language, the brain, psychology, art, music, computers, and sociology, to name a few. So much of what happens in the realm of life can be viewed as a process of transferring information that perhaps, as Shannon asserts, "to the powerful theories of chemistry and physics must be added a late arrival, a theory of information. Nature must be interpreted as matter, energy, and information."

Not surprisingly, one field where this framework seems most illuminating is genetics. Deoxyribonucleic acid (DNA) itself operates, after all, as an information process, embodying instructions that are followed in creating proteins. Consider, for example, such an elementary organism as a virus, which simply consists of genetic material wrapped up in a protein capsule. Viewed in terms of Shannon's analysis, the genetic code of a virus should carry many redundant instructions



*An analysis of DNA's structure may reveal the special grammar that underlies the language of life*

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# RETURN TO THE MOON

## SPACE

By James E. Oberg

Ten years ago the last man on the moon promised to return. "I take man's last steps from the surface for some time to come, but we believe not too long into the future," astronaut Gene Cernan mused out loud as he paused before climbing his spacecraft's ladder. "We leave the moon as we came, and, God willing, as we shall return, with peace and hope for all mankind. Godspeed from the crew of *Apollo Seventeen*!"

Because of continuing shortages of funds, imagination, and boldness, the thought of sending human beings back to the moon has receded further and further since that moment. Ironically earthmen are probably further from landing on the moon now than they were when the first *Sputnik* was launched more than a quarter-century ago. Then it took less than 12 years to accomplish the first landing mission. Now the idea that astronauts might return to the moon within 12 years, by 1995, is generally considered absurd and unrealistic.

Do not despair, however. Many historians of exploration, who tend to take the long view of things, believe that lunar development may follow the Antarctic model. In this view, the Apollo landings were the equivalent of the Roald Amundsen/Robert Scott South Pole races of the early 1900s. They were followed by flights over the pole a few decades later. But it was not until 1947 that Operation Deep Freeze began to set up permanent scientific stations on the coast of Antarctica and, in 1957, at the South Pole itself.

The moon may also be explored in progressive phases spread over three or four decades. New, unmanned orbital missions may complete mapping and geochemical surveys within the next ten years. They could be followed near the turn of the century by one or more permanent scientific stations.

By then the space shuttle and shuttle-derived vehicles, together with upper stages developed for use near Earth (the orbital transfer vehicles), will make the expeditions feasible and cheap, a fraction of the original price of Apollo—which cost about $24 billion—should buy a huge expansion of capability.

The foundations for such a lunar program are now being laid by half a dozen groups of specialists and space enthusiasts. In Houston next month, while the fourteenth Lunar and Planetary Science Conference convenes to analyze recent results from interplanetary studies, the first meetings to organize these efforts are to be held.

In what they called the Lunar Initiative, space scientists at the NASA Johnson Space Center, in Houston, recommended last year that a permanent lunar base be established during the first decade of the next century. To help work out by 1990 where and how such a facility should be built—and what its purpose would be—the scientists further suggested that a series of unmanned lunar missions be prepared. The first step, which should occur as soon as possible, would put a half-ton survey satellite into lunar orbit; it would be followed by remote-controlled rovers on the lunar surface.

Support for a moon base has appeared from a number of unexpected places. Last May two physicists from the Los Alamos National Laboratory issued their own independent plan. According to Drs. Paul Keaton and Eric Gelfand, a 24-person facility could be built by the end of the century for considerably less than was spent on the entire Apollo program in the 1960s. Keaton and Gelfand called for "a national commitment for an International Research Laboratory on the moon," adding that "a vigorous civilian program like that proposed here is our best guarantee that outer space will be used to strengthen our economy and address basic problems on Earth." This advocacy by scientists with no traditional ties to space research seemed to take on additional significance because the White House science adviser is a former Los Alamos official. (He reportedly gave a "positive response" to the proposal—"so long as no money was involved.") Other nuclear scientists throughout the nation, particularly Dr. Edward Teller (who is best known for his work on the hydrogen

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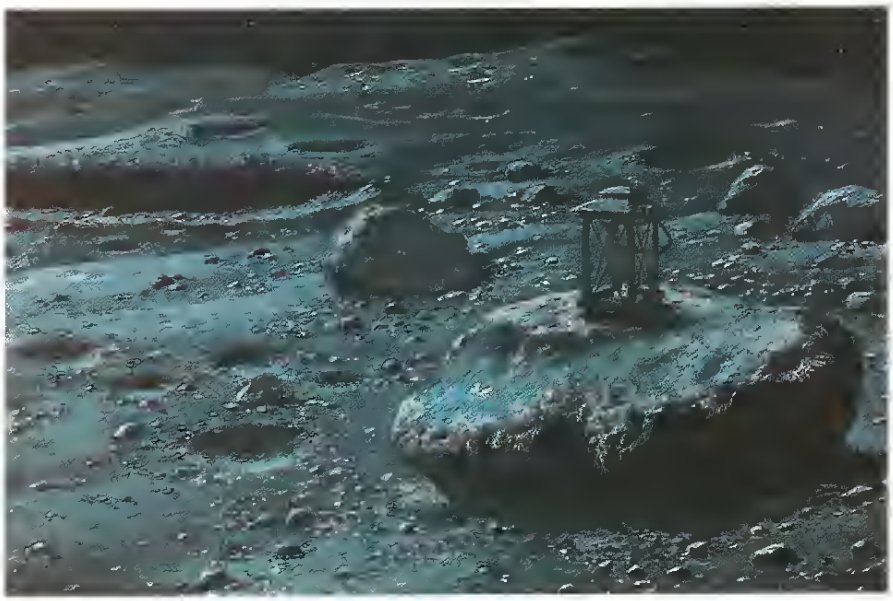

*The lunar surface may be rich in water to support a human colony and provide rocket fuel.*

# ETHNOTHERAPY

## MIND

By Judith Hooper

At an unusual therapy group meeting in Berkeley, California, a young Jewish woman sobs bitterly, reliving the traumatic rite of passage of the nose job. A young man wearing a yarmulke, deep in a role-playing session, lashes out at remembered Jewish princesses who required six-figure incomes of their chosen mates, while other participants work to exorcise from their psyches terrifying concentration-camp nightmares or intrusive Jewish mothers. Is it so difficult to be Jewish?

Yes, according to Berkeley clinical psychologist Judith Weinstein Klein, whose all-Jewish encounter groups are the prototypes of a new phenomenon, ethnotherapy. If you are of Italian descent, an Irish Catholic, or even a garden-variety Anglo-Saxon Protestant, you may also be eligible for this emerging form of psychotherapy.

Like it or not, the ethnotherapists explain, everything from your table manners and child-rearing attitudes to your sexual phobias and fantasy lovers is influenced by your ancestry, and it's time for mental-health workers to face this fact. Should you happen to fall in love with a person from a different ethnic group, the added element of ethnicity may lead to special, usually hidden, troubles. For instance, Klein notes, a gentile father may applaud his son's quiet dinner-table demeanor, while the Jewish mother fears her child is behaving unnaturally and that he may even be getting sick. Or an Italian American wife may believe her marriage is on the skids because her Irish husband never confides his feelings, when in fact he's only being true to his upbringing.

Ethnotherapy brings such oft-tabooed issues out into the open, with special workshops for Italian Americans, Jews, Irish Catholics, blacks, and other groups, coupled with conventional therapy that employs ethnospecific techniques. "Jews in therapy typically overwhelm you with verbiage and self-analysis," says Irving Levine, director of the American Jewish Committee's Institute of Pluralism and Group Identity (IPGI), in New York City. "But an exclusively verbal therapeutic style will probably be less effective with an Asian American patient, for instance."

Yes, of course we're all individuals with our individual traumas, psychic scars, and special hang-ups. However, out of ethnotherapy's early research, there has evolved a collection of certain striking ethnic psychoprofiles.

The mother-child relationship is the crux of Jewish family life, according to Klein, and the archetypal Jewish mother is much as Woody Allen and Philip Roth depict her: nurturing, overprotective, worried, intrusive, guilt-instilling, possessive of and ambitious for her children. Partly because of her unique brand of mothering, Jews typically grow up to be ambitious, successful, expressive, and insecure people. They suffer more often from anxiety, dependency, fear of separation, and psychosomatic illnesses than other ethnic groups, but they are less susceptible to schizophrenia and other psychoses. Fortunately, Jewish guilt—which boils down to disappointing others' expectations or demands—is a lighter burden to carry than soul-searing Catholic guilt.

The Jewish family is extremely, often suffocatingly, close, Klein says, yet perfect intimacy may not prevail in the marriage bed. Encumbered as it is with subconscious incest taboos, sex is a psychic minefield for Jewish lovers. Jewish men complain that Jewish women are demanding, pushy, marriage-obsessed, and mercenary—"How do you stop a Jewish woman from making love?' goes one ethnic joke that Klein considers particularly revealing, answer: "Marry her!'—but Jewish women berate Jewish men for their dependency, sexual inhibitions, and neuroticism.

Confronting the dominant American ideal of the female as a willowy, blonde, WASP goddess, the Jewish women Klein surveyed wanted to change at least eight of their physical attributes. Ritual rhinoplasty is still the Jewish girl's passport to womanhood. And women may feel doubly alienated from the mainstream of Judaism because of their traditional exclusion from male-

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*A celebratory folk dance. Part of many people's ethnic heritage is a unique set of hang-ups.*

# PLANET 10

# STARS

By Patrick Moore

One of the most fascinating questions in present-day astronomy is: Could there be a planet beyond Neptune? In other words, is there a tenth member of the solar system awaiting discovery?

I say beyond Neptune and not beyond Pluto, which is often considered the outermost, because Pluto is not a proper planet at all. Its diameter is a mere 1,440 miles, considerably less than that of the moon; even including its satellite Charon, its mass is negligible by planetary standards, and what mass it has is mostly just ice. For these reasons, Neptune could more accurately be described as the outermost planet.

The saga of Planet 10 began around the turn of the century, when the American astronomer Percival Lowell began studying the motion of Uranus to see whether there were any perturbations in its orbit that might be caused by the gravitational influence of some unknown planet. Predicated on his studies of perturbations and his calculations, Lowell decided in 1905 that there was a ninth planet out there, and he went so far as to predict where it was located.

Pluto did show up not far from where Lowell had said it would be found, but in other respects it did not live up to his expectations. His work had suggested that Pluto would have a relatively large mass, similar to the earth's. When measured, however, Pluto was small. Almost entirely composed of ice, Pluto could not conceivably have caused these perturbations. This means that some celestial body other than Pluto was exerting this pull on the orbits of Uranus and Neptune. For these reasons astronomers believe either that Lowell's prediction of Pluto's location was a matter of sheer luck or that another planet, Planet 10, still awaits discovery.

I have never credited the idea that it was luck. It seems to be too much of a coincidence. And so in 1974 I made two suggestions how we should go about searching for the missing body. First, it is very likely that when Pluto was discovered, the unknown planet was right out there behind it. If this were true, we should be able to make a very rough and ready calculation of where it is now. Second, I suggested that man-made probes could provide us additional information for our search.

It was confirmed at a NASA conference in June 1981 that there were slight irregularities in the movements of both Uranus and Neptune that could have been caused by an unknown body. Also we already have two space probes tailor-made for investigating this further. They are *Pioneer 10* and *Pioneer 11*.

After bypassing Jupiter in December 1973, *Pioneer 10* began a never-ending journey away from the center of our solar system. Right now it is somewhere between the orbits of Uranus and Neptune. After its encounter with Saturn in 1979, *Pioneer 11* began its journey out of the solar system on a path diametrically opposite to the route taken by *Pioneer 10*. Its present position is somewhere between the orbits of Saturn and Uranus. With these two probes situated on either side of our solar system, we now have a real chance of locating another object, possibly a planet, beyond the orbit of Neptune.

Should that mysterious object be a planet, it would affect only one of the *Pioneer* craft, the one closer to it. If the perturbing body is something that is more massive—a dead star, for example—it would affect both spacecraft. Stars existing in pairs are common, and so it is entirely possible that the sun has a companion, a dying star of low luminosity, such as a black dwarf.

There is one more possibility: that the perturbing object is a black hole, from which nothing—not light, not matter—can escape. Its distance from Neptune's orbit would be on the order of 100 trillion miles, a distance that, by astronomical standards, is not all that far.

All this is highly speculative, but the evidence so far indicates that there is *something* out there at the edge of the solar system. Unknown planet? Dead star? Black hole? We cannot tell now, but if we can manage to stay in touch with the *Pioneers*, we may find out. ∞

*The planet Neptune. What is lurking out there beyond it—a black hole, a dead star, or Planet 10?*

# BRAIN DRUGS

# THE BODY

By Douglas Starr

Locked in his plastic restraining chair, the brown rhesus monkey sits relaxed, not suspecting what is about to occur. Slowly a scientist injects *something* into a plastic tube leading into the monkey's thigh. Within seconds there is a startling transformation. The animal starts squirming about, desperately craning to find the source of his fear. His eyes bulge. He howls. He wrings his hands and picks at himself neurotically. Finally, with his heart beating at a sprinter's pace and his blood pressure soaring, the monkey becomes rigid, eyes darting, hands gripping, chest pumping, he takes the sharp, shallow breaths of paralyzing fear.

What the monkey is showing is anxiety—the same uneasiness that chronically afflicts tens of millions of Americans. Yet there is no hidden reason for the monkey's discomfort, no traumatic childhood for a psychologist to probe. This complicated and disturbing behavior is caused solely by the actions of a chemical on a single protein group in his brain. The discovery of how to induce it marks a milestone in several fields of medicine.

"For the first time we have a good, reproducible model of human anxiety," says Philip Skolnick, who collaborated with Steven Paul on the project at the National Institute of Mental Health (NIMH). "We can stimulate anxiety for a week or two and see whether the subject develops hypertension. One researcher even thinks anxiety is cancer-related. What enormous power we have now to study psychophysiology!"

This power is not limited to studying anxiety or any other of the myriad human afflictions. It's the power to study the mind's most basic biochemistry, an infant science that's describing the brain as never before. At the center of this knowledge are the receptors—chemical "keyholes" that serve the nerves of the brain as receiving stations for the chemical messengers of the mind. Sex, hunger, pain, sleep, even creativity and imagination, may be caused more by the interaction of chemical and receptor than by anything we experience or learn.

Rarely has a scientific advance carried such enormous implications. In a decade or so, people will be taking an entirely new generation of sleep-aiding or anxiety-easing drugs that produce none of the side effects of today's sleeping pills or sedatives. Psychology will change, placing less of the stigma of mental illness on the patient. And each of us will have to consider a most troubling thought: If feelings and ideas are triggered by chemicals, what is so special, what is unique, about the way I think and feel?

Perhaps less than we would like to believe. "There's a revolution going on," says Candace Pert, a neuroscientist with the NIMH. "We have grossly misunderstood how hard-wired we are."

If the study of drug receptors is indeed a revolution, then Pert's research with Dr. Solomon Snyder, of Johns Hopkins University, in 1973 helped to fire the opening shot. The notion that there must be drug receptors in the brain had been around for years, but it took Snyder and Pert to find them. To do this, they put radioactively labeled morphine in a solution of liquefied rat brain, filtered the mixture, and took a radiation count of the tissue that remained. They found that the morphine had bonded to some very specific portions of the liquefied brain tissue. Because the drug so precisely fitted the receptors, they reasoned, the drug must actually mimic a substance naturally found in the brain.

That startling discovery set loose a torrent of activity in which scientists are avidly using the new technique to plumb the brain's chemistry. Soon British scientists isolated the brain's own morphine. Members of that chemical family—variously called endorphins or enkephalins—include the brain chemicals that relieve pain during acupuncture and cause the euphoria of runner's high. Other researchers discovered the receptors that mediate anxiety and those that keep one awake. There's even a receptor for the street drug PCP, although scientists can't yet figure out just what the receptor normally does. So far, more than two dozen types of brain receptor have been discovered, some say the

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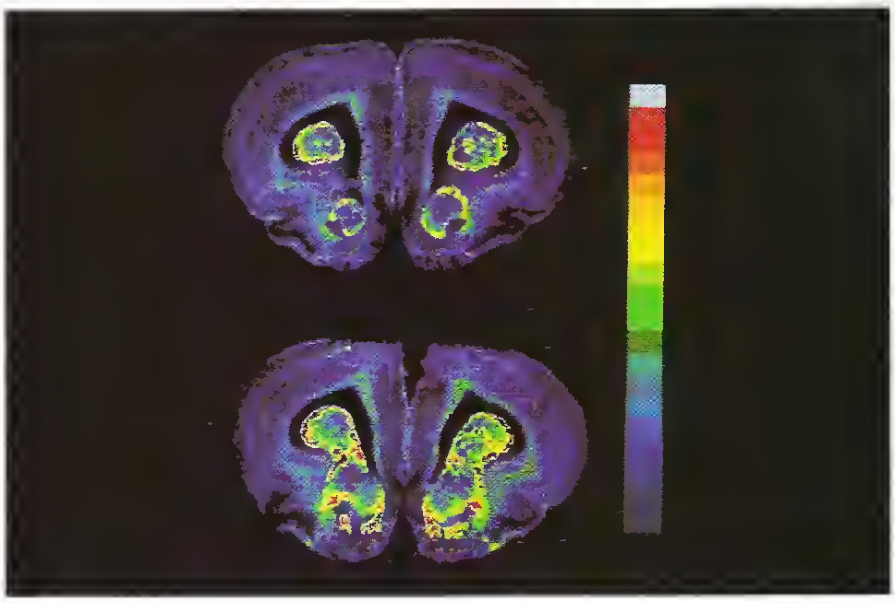


*Candace Pert's rat brains. The red areas reveal those parts richest in opiate receptors*

RADIO

# THE ARTS

By Derek Best

It is a genuine luxury to discuss radio drama. Normally, when attempting criticism, one is haunted by the looming specter of the cliche. But radio is untouched, like a pristine snowfield on which one can walk anywhere and be assured of making fresh tracks. Radio has been so largely ignored as a serious medium that reciting the alphabet would be an original statement. And if the critic is in virgin territory, imagine how the makers of such radio series as *Star Wars*, *The Empire Strikes Back*, and *The Hitchhiker's Guide to the Galaxy* must feel. Probably a little like God on the first day of creation.

Radio of course is not new. Some of us even remember it. Most of us don't. Probably the average *Star Wars* fan knows, say, Bob and Ray only as two strange old men who hosted *Saturday Night Live* one week. Even to those who do hold fond memories of the "wireless" and the golden age of radio drama, these new series must come as something of a shock. Everything is different. The boundaries of perception have been pushed back, the old conventions are gone, the speed and flow of information have been increased, the degree of sophistication expected in the listener is greater. For instance, though old-style radio drama almost mandated a slow fade-out and fade-in between scenes, the "new" style thinks nothing of having an abrupt switch, leaving the listener to orient himself. Actually we orient ourselves quite easily. In this age of the whiz-bang, quick-cut TV commercial, we have learned to perceive things differently. The radio equivalent of a cut does not disorient us in the least.

Production technology is now thoroughly modern. Actors no longer huddle around a single microphone for an unedited performance while a man in the corner slams doors and bangs coconut shells together. Today's radio drama is electronic, layered, edited, synthesized, and twenty-four-tracked. While the performers of pop music complain that radio has become a producer's medium, the new technology has made radio drama rewarding for both performers and listeners.

*Today's radio drama is electronic, layered, edited, synthesized, and twenty-four tracked*

Let's be specific. National Public Radio (NPR), the noncommercial, publicly supported radio network based in Washington, D.C., is running and rerunning three science-fiction serials. Each consists of 12 or 13 half-hour episodes and can be heard in most large American cities. Two of the series, *Star Wars* and *The Empire Strikes Back* (which will premiere in February 1983), are produced by NPR in association with KUSC-FM, in Los Angeles, and with the cooperation of Lucasfilm, Ltd. NPR has also begun a 15-part series, *A Canticle for Leibowitz*, based on the Hugo Award-winning novel by Walter M. Miller, Jr. The other series, *The Hitchhiker's Guide to the Galaxy*, is a British import, produced by BBC radio. It has an enormous cult following in Britain and has spun off a book, a record album, and a stage show. If you haven't heard any of these series, you ain't heard nothin' yet.

*Star Wars* is a 13-part radio serial featuring Mark Hamill and Anthony Daniels, re-creating their original roles as Luke Skywalker and C-3PO. The show also uses the full gamut of original sound effects, and more than all of the original musical score. Before I say anything that might be construed as negative, every episode is a masterpiece of audio craftsmanship and a dazzling technical tour de force. However, there are a great many conceptual aspects that are flawed. It doesn't take much mathematics to calculate that the series is six-and-a-half hours in total length. How well does such a simple fable stand up to this inordinate stretching? Equally important: How does such a *visual* fable get along with the loss of those visuals?

The answers to these two questions are intertwined. This McLuhanesque age has come to demand visual stimulation, but we cannot forget that science fiction was born as literature—a medium in which it still flourishes quite nicely. Thus it has traditionally demanded imaginative visualizing by its followers. This immediately suggests a close kinship with radio. The penchant for adding a picture with 25-foot-high close-ups of red and

green lasers blasting everything to smithereens, is a recent fad, and the *Star Wars* sagas are the uncontested champions of the movement. When such a banquet for the eyes is transferred to the radio, we have to ask *how* precisely this stimulates our imagination. After all, if you were to run the movie with the projector bulb switched off, you might have an experience that requires you to paint your own mental pictures, but it wouldn't be creative radio. It would be a simple memory-jogging exercise.

There definitely are parts of the radio version that are vastly more innovative and stimulating than just that. There is one long section, for instance, where Darth Vader brutally interrogates the captive Princess Leia. At the beginning of the session a faint buzzing is heard, like a Jew's harp. She asks, "What's that?" He answers, "An interrogation machine." She gasps, "A torture robot!" Now what does a thing like *that* look like? We have no idea, and we are *given* no idea. This is radio at its best, leaving us to dredge the appropriate imagery out of whatever private nightmares we carry inside us, with only that loathsome buzzing as a clue.

These new special effects are the result of a kind of audio perfectionism. The sound designer of *Star Wars*, Ben Burtt, is a fanatic. During production he spent days wandering around on a ship, recording every little creak and groan, just to make up one small ingredient in his complex aural recipe. The "Light Saber" sound, for instance, was made from a combination of the hissing, arcing sound recorded at the high-voltage anode of a TV picture tube and the humming, buzzing sound of an old projector-interlock motor. Anthony Daniels, as C-3PO, acted out his entire role in an isolation booth in the corner of the studio in order to feel the dissociative "automaton" part more accurately. And others in the cast reported that performing for radio was physically more demanding than performing for film, so much energy being channeled into the single expression of the voice.

*Star Wars* pundits will know that the "Interrogation Machine" scene is not in the film. Since the serial weighs in at six-and-a-half hours, there are many new scenes, and in general they are the ones that work best as radio. This means that the scenes that work less well are the classic set pieces from the movie (the bar at Mos Eisley, for example, and the big shoot-out at the end). At first one might think this is because these scenes were originally conceived as visual events while the new scenes were written for radio. But it is more subtle than that. Those parts that were originally shown in the theater are not dramatically or technically inferior in any way, but the problem is, the memory of the film never obtrudes. No matter how hard the performers and the sound mixers try, they are walking in the tall shadow of a visual beast few of us will ever forget. That's why the additional scenes for the radio show give us more freedom and are more effective.

John Williams's gargantuan musical score tends to compound this mistaken judgment. The producers of the show had free access to this score as well as to all the audio effects created by Burtt for the film. You might think that with such a panoramic palette to work from, they could hardly *not* create a masterwork. But they create only a masterful imitation, which constantly reminds us of its origins. Music, with its powerful evocative mechanisms, completes the illusion that what we're hearing is *the* film's score; therefore, what we're seeing is in the mind's eye. At times the show is not a spoken drama at all but an orchestral tone poem with sound effects, like *Peter and the Wolf*, with a few words of dialogue thrown in for punctuation.

> "Hitchhiker's Guide *takes its sound effects less seriously. When the universe comes to an end, the apocalyptic sound is the unmistakable gurgle of a bathtub emptying.*"

Let us leave this galaxy of clear-cut heroes and villains for a while and take a look at *The Hitchhiker's Guide to the Galaxy*, written by Douglas Adams and produced for the BBC by Geoffrey Perkins. Without doubt the BBC is the alma mater of radio drama. Auntie BBC, traditionally stiff and conservative, has always demonstrated the ability to pull wild surprises out of her hat. Remember *Monty Python*? *Doctor Who*? Now comes this cryptic, complex series.

Briefly, the story concerns Arthur Dent (played by Simon Jones), a tea-drinking reluctant antihero, whose home planet Earth, is obliterated to make way for a new hyperspace bypass. He is rescued by a wandering writer from a small planet somewhere near Betelgeuse, who is traveling on assignment to update a kind of pop space travel guidebook, entitled *The Hitchhiker's Guide to the Galaxy* (published by Megadodo Publications, Ursa Minor Beta). The book itself forms the thread and narration of the serial as the two travelers are precipitated from one deep-space crisis to another.

The narration is the spirit of the show. The voice (Peter Jones) is sonorous and condescending. If anything, it gets a little *too* smug. Contrast this with the classical resonant voice of the narrator in *Star Wars*, so deep and rich it sounds as if the tape is running slow. It brings to mind the disembodied voice of "God" in *The Ten Commandments*, for which Cecil B. DeMille used the artificially slowed voice of Charlton Heston, booming from the burning bush.

Just as *Star Wars* derives its imagery (intentionally or not) from our having *seen* it, *Hitchhiker's Guide* (on radio, in contradistinction to the recent TV spinoff) is utterly dependent on our *not* being able to see it. Its success stems from the mental gymnastics required of the listener. At one point Dent is trapped in the side effects of a device called the Infinite Improbability Drive, and he finds his arms are separating from his body. His first and only concern is, "How am I going to wear my digital watch *now*?"

The language barrier is tackled differently, too, by the two series' writers. In *Star Wars* it is simple. Everyone speaks English (except Chewbacca). *Hitchhiker's Guide* is more sophisticated: everyone is presumed to be speaking his or her own tongue, but early on we are introduced to the ingenious Babel Fish, which you slip into your ear for instant translation. And, as might be expected, *Guide* takes its sound effects less seriously. Not that they are incomplete or poorly crafted, just more humorous. An element of satire is built into the choice and composition of sound, as when the universe ends and the final phrase of the symphony of apocalyptic tones is the unmistakable gurgle of a bathtub emptying.

*Hitchhiker's Guide* is a satisfying cerebral belch. It is cliquish, erratic, hip, sometimes sophomoric, and invariably unpredictable.

Sometimes its wit and insight tend to overshadow the technical prowess of the show. Yet prowess there is. The BBC runs a department quaintly named the Radiophonic Workshop. (Picture a lot of men in tweeds, smoking pipes, tinkering with tube oscillators and EMI tape decks.) This is the BBC's disco studio, bristling with modern electronics, to ensure that no technical advances are denied to radio drama. It was here that the series' staggering variety of special effects was assembled, layer upon layer. Listening to the show with stereo headphones is an unforgettable experience.

As it is with *Star Wars*. It is probably the best way to take in any modern radio drama, lest we find ourselves staring at the radio, uncertain where to put our hands. As a parting shot, it is worth noting that *The Hitchhiker's Guide* insists that humans have only three problems. "Why are we born? Why do we die? And why do we spend so much of the intervening time wearing digital watches?"

# DIAL-AN-ALIEN BREAKTHROUGHS

By Phoebe Hoban

In a darkened research room at Bell Laboratories, in New Jersey, two scientists hunch over their computer terminals, brows furrowed as their fingers punch at the keys, manipulating experimental microprocessors that crunch data faster than monstrously large mainframes. What are these skilled, well-paid professionals tracking on their glowing screens? Little spaceships, Tron-like images engaged in a video life-and-death race around a galaxy.

Besides the sophistication of this video game and the fact that it's being played with grave concentration at Bell Labs, one other feature distinguishes it from its Pac-Man or Donkey Kong kin: The two players are pitted against each other, not a machine. A link between terminals instantly transmits one player's move to the other's screen, where spaceships travel in realistic perspective.

"Sooner or later people will get tired of playing machines and will want to play one another," says Robert W. Lucky, executive director of research and communications at Bell Labs. Lucky envisions a national dial-a-game network, GameNet, that would enable opponents to reach out and play one another over the telephone. A central computer would process the players' moves and transmit the information over the phone to home computers like the sophisticated prototype in Bell Labs. The first video game phone systems will probably be simple retrofits of today's equipment, however. A modem, which makes it possible to send data over the telephone, would connect the home computer and the video game controls to a central database. "You could dial one number to fight the Battle of Britain or to race in the Grand Prix," Lucky says. "You could dial another to connect with other players for a game of bridge." Even farther down the road, Lucky sees an infinite variety of new games as "players program up their own pieces of the universe. The great thing about these games is that they don't have to be fixed. You can change the computer's instructions from day to day, so there is no chance for boredom."

When will the premier generation of telecommunication games invade the American living room? Database and videotex services already offer a few primitive games. CompuServe supplies several as part of its data package, including the interactive Megawars, and the Source offers 72 different games, including tic-tac-toe. None of them are interactive. More recently videotex experiments by Knight-Ridder, in Florida, and CBS, in New Jersey, have included simple riddle and quiz games. But these games still consist mostly of text, and they are about as close to Lucky's high-tech vision of the future as silent movies are to color TV.

"Telecommunication games are inevitable," says Chris Crawford, a game designer at Atari. "But they won't happen overnight. They will come along slowly, and the banner year when it all comes together will probably be 1985. The technology is here, but the number of telephone modems out there is the big limiting factor. When you have twenty million people with Atari personal computers and ten million people who also have phone modems, that will spur telecommunication games."

According to Crawford, the telecommunication terminal of 1985 won't be radically different from today's personal computer systems. All it will take to play will be a computer with 64K of random-access memory (64,000 bytes, each representing a single number or letter), a direct-connect phone modem, and a television set.

It is the chance to compete against flesh-and-blood opponents that will make the new video games more appealing than today's quarter-gobblers. Crawford says, "The future of these games lies in their allowing people to relate to one another in a way that they couldn't before. In normal conversation, only one person can talk at a time. But in a computer network, a hundred people can talk and interact with one another simultaneously."

The telephone company agrees. "We'll supply the people," Lucky promises, "and mass games could be a whole new social phenomenon. You

CONTINUED ON PAGE 130


*Reach out and play someone. Your future opponent may be a high-speed, turned-on human*

# CONTINUUM

## HOSPITAL PHILOSOPHERS

Stricken by cancer of the pancreas and bowel, the pain-racked fifteen-year-old girl hovered near death. But her mother insisted that physicians at St. Jude Children's Hospital, in Memphis, continue treatment that could only prolong her suffering.

Doctors on the case respected the mother's feelings, yet they felt that the girl's terrible pain was literally a fate worse than death. How could they spare the girl further suffering without violating the rights of their patient and her family?

To find an answer to their dilemma, they went to philosopher Terrence Ackerman, director of the Program on Human Values and Ethics at the University of Tennessee Center for the Health Sciences. Ackerman is one of a new breed of philosophers, medical specialists whose job it is to help doctors cope with thorny moral questions.

In this case, Ackerman perceived two dominant concerns. First, the doctors had to weigh the mother's authority against her daughter's right to self-determination. Second, they had to evaluate the girl's ability to cope with her decision.

The mother had shielded her daughter from serious discussions with the doctors. But, acting on Ackerman's advice, the physician in charge went to the girl's bedside for a gentle talk. He found that she could not face the decision to end her treatment. Then doctors talked with the mother, convincing her at last that her daughter's life could not be saved. The woman relented, allowing the girl to slip naturally into death.

To many it seems only fitting that philosophy should help solve the complex moral problems of medicine. "The purpose of the philosopher is what it has been for thousands of years: to get people to reflect critically on their own experiences," says Dr. Edmund Pellegrino, of Georgetown University Medical Center. "It's going to be necessary to have experts in this area as we do in other aspects of clinical decision making."

Theologian and philosopher Russel McIntyre, for instance, is one of three "bioethicists" based at New Jersey's University of Medicine and Dentistry, in Newark. Recently he had to settle a dispute between a pediatrician who was eager to save her patient, a newborn girl, and the parents who, backed by other doctors, wanted to let the baby die.

The baby had been born with a heart murmur and without legs. She required a colostomy, had a serious internal infection, and was in danger of losing her one functioning kidney. Yet lab tests showed no genetic defect or risk of mental impairment. The parents and the other physicians had simply decided that the child faced a very limited life, McIntyre explains. "The pediatrician and I, however, felt that the child could have a meaningful existence."

With McIntyre's encouragement, the pediatrician threatened the parents with court action. The baby was saved, and now the parents say they have learned to love and care for their child.

In this case, the philosopher's skill at moral analysis apparently saved the infant's life, whereas medical science alone might have failed to do so. But this expertise is just what some ethicists fear. For Arthur Caplan, a research associate at the Hastings Center, a New York think tank that focuses on the moral ramifications of medical issues, the hospital philosopher is an ominous force, a final arbiter of life and death.

"There is a tendency in medicine to prize snap decisions made by experts in narrow fields of specialization," Caplan notes. "After a while philosophers may become the ultimate masters of moral theory."

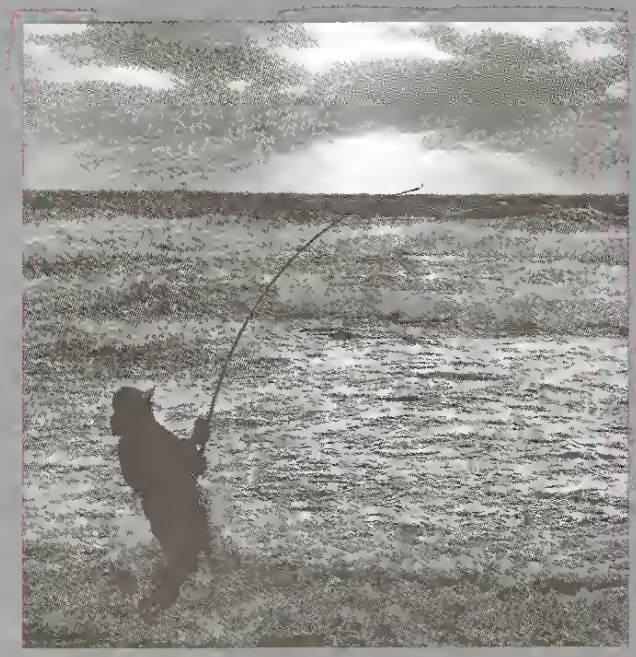
To justify this concern, he cites a case from his own experience as a hospital philosopher. "A physician came to me at lunch one day to ask what hypothetically I would do about a dialysis patient who was physically threatening the nurses and other patients. Should he be kicked out of the hospital, even though he would die without treatments?

"I thought for a moment and suggested that it might be possible to find a prison system big enough to have a dialysis unit and refer him there, where he could get the treatment and be kept under control. A week later I discovered that the patient had been real and that they had done exactly that. I'm not saying that it was a poor solution, but I'd like to have had more time to consider it."

Pellegrino concedes that "that's an abuse of the philosopher's position. We must always be critical of his answers, just as we would be of any other specialist's."

Whether other doctors will be able to maintain this skepticism—or simply allow the philosophers to make all the tough decisions for them—remains to be seen. —*ERIC MISHARA*

# CONTINUUM



*Want to get away from business by vacationing far, far from civilization? Forget it The global beeper will find you anywhere*

## GLOBAL BEEP

The convenience—or inconvenience—of a beeper that can summon executives, politicians, and errant spouses from thousands of miles away is now at hand

The system, recently approved by the Federal Communications Commission, will work by beaming urgent calls to a satellite, the satellite will then send the message to some 200 radio stations throughout the country. Any one of those stations can trigger the beeper—as long as it is within range.

According to National Satellite Paging, Inc , the company marketing the new service, the sender need not even know the location of the receiver "If your plane is diverted by bad weather from San Diego to Los Angeles, the pager will find you, even if the person trying to get you doesn't know you've been held up, ' says executive vice-president Tom Warnock

The new pager will probably offer a printed message display rather than a mere beep, Warnock notes Receivers that can display text are already available, and some equipped with tiny printers are currently being developed

Though the system presently reaches only selected cities in the United States, Warnock adds, a global system may be in the wings

—Anthony Liversidge

## GLASSES FOR THE DEAF

NASA is developing a new type of aid for the deaf spectacles that will ease the task of lipreading by converting sounds into visual symbols

According to designers Robert Beadles, of the Research Triangle Institute, in North Carolina, and Orin Cornett, of Gallaudet College, in Washington, D C , the Autocuer glasses will contain a microphone to pick up the speaker's voice and a microprocessor to convert the sound into electronic signals Those signals will be transmitted to light-emitting diodes in the frames Finally a lens covering the diodes will magnify and project the image into space

The visual cue will seem to hang in the air in front of the speaker's mouth Symbols will represent the consonants, and four different locations around the speaker's mouth will represent vowel sounds If the word spoken were *row*, for instance, the symbol for *r* would appear in the upper-left-hand quadrant of the speaker's mouth (the position would indicate that the accompanying vowel sound was *ō*)

The new glasses will not always spell out entire words, the designers say. But they will remove much of the ambiguity from lipreading by differentiating between easily confused groups of sounds "Combining the cue with lipreading is like coupling longitude and latitude to find out exactly where a place is," Cornett explains

The glasses are at least two to five years away from commercialization and should cost about $2,000

—Phoebe Hoban

*"All the strength and force of man come from his faith in things unseen."*

*—J F Clarke*

*Autocuer glasses A microphone picks up voices, and a microprocessor and light-emitting diodes project helpful visual cues*

## HEART STINGS

The poison of the jellyfish may soon be given to cardiac patients as a heart stimulant, says Cleveland State University biologist Georgia Lesh-Laurie

Lesh-Laurie first realized the potential of the poison while studying the hydra, a tiny, sea anemonelike relative of the jellyfish She found that the toxin secreted by the hydra strengthened the heartbeat of turtles and rats but didn't seem to strain the animals' kidneys as heartbeat strengtheners now on the market do Thus, she speculated, hydras or jellyfish might provide us with the first safe heart stimulant ever

These initial experiments have landed Lesh-Laurie and her team of graduate students a grant from the American Heart Association The group is now working to analyze the toxin and identify just which part of it stimulates the heart Once they've found the crucial molecule they'll isolate it from the rest of the toxin and try to synthesize it in the lab If all goes well Lesh-Laurie suggests, the effort should take just about three years

—Anthony Liversidge

*Jellyfish Its poison may be medicine for heart patients*

## HIGH-TECH HOTEL

North America's first high-tech hotel, featuring a computer terminal in each room along with other technological features, is getting ready to accept its first guests

The $10-million, $150-per-night hotel is scheduled for completion this fall Being built by Canada's Teron International it's specially geared for executives of the numerous high-tech firms that have sprung up in the Ottawa area over the past ten years The hotel is located in Nepean a suburb of Ottawa

The main lobby will feature a communications center, with the very latest in telecommunications equipment Each guest room will include a computer terminal that plugs into the office system a large computer screen for text, movies, and video games, and enough memory to handle electronic mail

Teron officials say the new hotel will be "business- and entertainment-oriented "

High-tech companies, they note, will use the facilities primarily for sales presentations, training, and product showcases

—Donna Balkan

*Incubator baby A fetus's chances of survival improve the longer it stays in the womb, thus inspiring a radical new technique*

## MATERNAL INCUBATOR

When a pregnant young woman died of a brain seizure, obstetrician William P Dillon faced a tough dilemma He could perform a Caesarean section, then place the twenty-five-week-old fetus in an incubator, where its chance of survival would be poor Or he could do something never before attempted keep the clinically dead mother "alive" on a life-support system until the infant's chance of survival outside the womb improved

Fetuses rarely survive if taken from the womb earlier than 24 weeks after conception Before that time the lungs do not receive enough blood to work effectively From the twenty-fourth to the twenty seventh week, the odds for fetal survival jump from 36 to 76 percent

With this in mind Dr Dillon and his associates at Children's Hospital in Buffalo, New York, decided to try the new technique At first the dead mother's condition remained fairly stable, Dillon recalls But after six days the life-support apparatus could not prevent her vital signs from fluctuating wildly, and a Caesarean was performed

"It was the worst time of my life," Dillon remembers "But a vigorous female infant was delivered " The baby girl was eventually adopted by a doctor at the hospital

Maternal incubation can double the survival chances of a fetus that's only twenty-four weeks old, Dillon contends Though many doctors object to the procedure, because it raises ethical and legal questions, he adds, "We'd do the same thing again if a similar situation arose "

—Anthony Liversidge

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*"Nothing exists except atoms and empty space, everything else is opinion "*

*—Democritos of Abdera*

# CONTINUUM

## PURIFICATION BY SCIENTOLOGY

The Church of Scientology is now offering a program that some physicians say can rid the body of the countless pollutants it's exposed to every day.

Designed by church founder L. Ron Hubbard, the new detoxification regime—called the Purification Program—consists of a vigorous schedule of running, saunaing, and taking massive amounts of the acid niacin. The niacin chemically frees the organic chlorides and other pollutants that lodge in the body's fatty tissues, Scientology officials explain, though they can't say exactly why. Then, by running several miles and sitting in a sauna for up to five hours a day, the patient can sweat the toxins out.

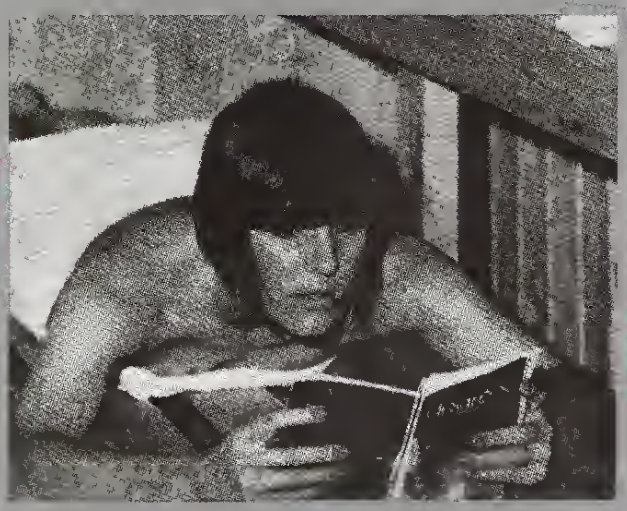
Hubbard introduced the program in the late 1970s to help church members clarify their minds so they could focus more clearly on their beliefs. ("I felt more invigorated after I did it than I ever had in my life," says Scientologist Tom Skow, who followed the three-week regime a few years ago.)

Now, though, Scientologists are promoting it for public use. A Los Angeles-based group named Detox, for instance, is offering the program as an all-around curative. And Narconon—an independent Los Angeles-based drug rehabilitation program—has used it to detoxify thousands of drug addicts since 1978. Two Vietnam veterans in that program, in fact, claim they were cleansed of the side effects of agent orange.

So far veterans' groups say they haven't heard of the program, and Dr. Ronald Codario, an agent orange researcher, will only say, "It certainly sounds like a novel treatment."

But recently the Los Angeles-based Foundation for Advancement in Science and Education tested the regime by following 103 persons who went through it. Not only was the program generally safe, the foundation found, but it also lowered blood pressure and cholesterol levels in most of the volunteers. Further tests on seven volunteers showed a reduction of several contaminants in their fatty tissue, including PCBs and the pesticides dieldrin and heptachlor.

—Lisa Mitchell



*Purification participant in sauna. Niacin, running, and saunaing are claimed to rid the body of chlorides and other pollutants*

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*"If the Lord Almighty had consulted me before embarking upon Creation, I should have recommended something simpler."*

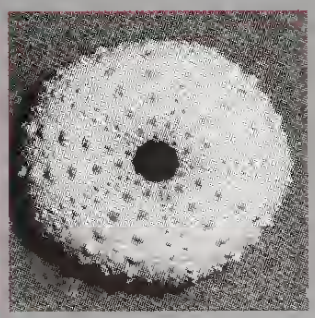
*—King Alfonso X of Spain*

## GENETIC LEAPS

When Max Birnstiel spoke recently in Houston at a meeting of molecular biologists, no one told him he was crazy. "Nobody's been that impolite," he said, "even though they might be thinking it."

The respected Swiss biologist had reported finding identical strands of genetic material in two very distantly related species of sea urchins. The two species, from entirely different families, had evolved independently for 65 million years. Consequently, their genes should have been quite different.

Classical theories of evolution offered no good explanation of the finding. So



*Urchin. Identical genes found in two distinct species*

Birnstiel risked a guess. The genetic material, he speculated, might have been transferred from one species of sea urchin to the other in relatively recent evolutionary time—less than 500,000 years ago.

If Birnstiel is correct, if genes can in fact jump from one type of animal to another, this would suggest totally new mechanisms of evolutionary change. But how could such a gene transfer occur? Birnstiel has a theory for that, too. Viruses are known to alter the genetic material of their hosts. Perhaps a virus had picked up the gene from one species and inserted it into the other. As one biologist said, "It's a logical guess, the only good guess there is at the moment."

—Paul Raeburn

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*"When Newton saw an apple fall, he found/A mode of proving that the earth turned round/In a most natural whirl, called gravitation,/And thus is the sole mortal who could grapple,/Since Adam, with a fall or with an apple."*

*—Lord Byron*

## ANT BITES RELIEVE ARTHRITIS

A fierce Bolivian ant inhabiting the Tree of the Devil may prove to be an angel for people with rheumatoid arthritis. Tests at the University of Miami, in Florida, have shown that the ant's venom can cause a two- to three-year remission of the disease.

The venom was brought to the attention of researchers by a mining engineer who reported that Indians have been using it to treat arthritis for generations. The Indians' method is remarkably simple. An individual suffering from arthritis strikes the tree with the afflicted part of the body and lets the swarming ants sting.

The Miami researchers, though, use a more elaborate procedure. They freeze the wasplike ants, part of the genus *Pseudomyrmex*, for their journey to the United States. Then they defrost the insects, extract the poison, and inject it into volunteers at the rate of a milliliter a day for 14 days.

Although the ant's bite is extremely painful, the injection is not. "It's very impressive," researcher Duane Schultz comments. "You give the medicine for two weeks, and six months later most of the patients are doing well."

The researchers are continuing their studies with the help of Canada's Chembiomed drug company, and are awaiting Food and Drug Administration certification in this country.

—Robert Deckert

*Bolivian ant. Its venom can produce a three-year remission*

## BRAIN SELF-REPAIR

Injuries to the brain, California researchers report, trigger the release of chemicals that actually help nerve cells heal. Known as neuronotrophic factors, these restorative substances are fanning hopes for huge strides in helping brain-damaged victims of trauma and stroke.

"We have shown for the first time that a chemical in the brain *increases* after injury," says psychobiologist Carl Cotman, who leads the research team at the University of California at Irvine.

"We're not sure whether we're dealing with a single chemical that works on all types of cells or whether there are specific factors for each type of nerve," he says, adding that ongoing research may answer this question within the year.

In the future, Cotman says, the purified neuronotrophic factors, produced through genetic engineering, could be administered to anyone with brain injury, augmenting what the body tries to do on its own.

—Dava Sobel

## WHOOPING CRANE DANCE

For seven years George Archibald danced for a female whooping crane named Tex during her mating season.

In the spring of 1982 he made an all-out effort to ready her for mating. He spent 15 hours a day with her, seven days a week, for six weeks. The bird, artificially inseminated, finally rewarded him with an egg that hatched into a healthy chick—just in time.

Head of the International Crane Foundation (ICF), in Baraboo, Wisconsin, Archibald says he has a "doctorate in animal behavior, with a minor in whooping." ICF acquired Tex from a research center in 1976 and quickly discovered she was a rare bird, even for a whooping crane (only 24 are in captivity). "Tex was people-imprinted," Archibald explains, and a "very racist, sexist bird."

"She didn't like redheads, women, or Orientals. She did like white men of medium build with dark hair." Archibald filled the bill, so to speak.

Performing an imitation of a male crane's courtship dance, Archibald "jumped up and down a lot, doing glorified deep knee bends." Although male cranes flap their wings and rise high into the air, he says, "I tried, but could get up only a few feet, if that."

Nevertheless, Tex laid an egg on May 3, 1982, and Archibald stayed up with her all night.

Unfortunately, the next month a hungry raccoon, starved because of a late berry season, crept into Tex's tent and ate her. But the baby chick she gave birth to is "now five feet tall and completely normal."

—Allan Maurer

*George Archibald and Tex. The whooping crane became so infatuated with him she would attack anyone who went near him*

# CONTINUUM

## HYPNOTIC CANCER CURE

If you are susceptible to hypnosis, you may be able to fend off deadly disease.

This is the conclusion of a recent test conducted by researchers at Pennsylvania State University, in University Park. Hypnosis, or "creative suggestion," the researchers say, can actually increase the number of specialized white blood cells that produce disease-fighting antibodies.

Since 1978, Penn State psychologist Howard Hall explains, doctors have touted the success of "creative imagery" in combating cancer. When hypnotized patients imagined their white blood cells attacking their cancer cells (like hungry sharks feeding), the condition often improved. But no one knew why.

To find out, Hall took blood samples from 20 healthy people, then hypnotized them and asked that they visualize white blood cells attacking imaginary cancers. An hour later Hall took more blood samples. The subjects were then taught self-hypnosis and were instructed to practice the visualization exercise twice a day and return a week later to give one final blood sample.

Some of the younger subjects, Hall says, raised their per-minute white-blood-cell count from 13,508 before hypnosis to 15,192 an hour after hypnosis and to 18,950 a week after hypnosis. The older subjects also raised their lymphocyte count, but not quite as much. For some inexplicable reason, Hall concludes, "the mind can influence the body by changing the biochemistry of the blood."

"Certain types of hypnotic imagery work better than others," Hall adds. "Imagining that your cancer is stronger than your immune system is, of course, self-defeating, though there is no evidence to show that this type of thinking could make the cancer worse."

—Marc McCutcheon

*Subjects who were taught self-hypnosis raised their white-blood-cell production significantly after doing visualization exercises.*

*"I throw a spear into the dark. That is intuition. Then I have to send an expedition into the jungle to find the way of the spear. That is logic."*

*—Ingmar Bergman*

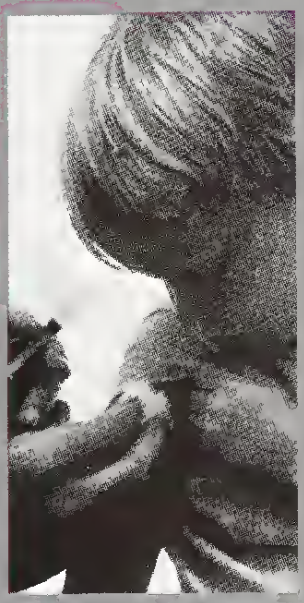
## NEW ALLERGY TEST

The uncomfortable and often costly scratch test for allergies, which may require from 45 to 90 needles, in many cases can now be replaced by a simple blood test.

Developed and marketed by the Iatric Corporation, of Tempe, Arizona, it is called the Arest program. A modification of the RAST (RadioAllergoSorption Test), it uses radioisotopes and gamma-ray counters to measure extremely low levels of antibodies in a patient's blood.

Arest screens for a variety of common allergens: pollens, grasses, danders, dust, and several food groups. One small blood sample gives the doctor a basis for both diagnosis and formulation of a vaccine for treatment.

In a marketing report conducted for Iatric, doctors said nearly 90 percent of their patients preferred Arest to other screening methods. One physician, Dr. Kirt Cromar, of El Paso, Texas, tried the test on his own allergies.



*Patients prefer the new test over the old scratch method.*

"I'm allergic to virtually everything that floats," he says. "I found the reliability of Arest equal to that of the scratch method."

Samuel Summer, president of Iatric, hopes the test will enable general practitioners to treat all but the most complex allergy cases. "Approximately fifty million Americans have allergies, but only about three thousand doctors specialize in allergy treatment," he notes. "This procedure lets primary physicians fill the void at about half the cost of the scratch test. It should be valuable in rural areas where no specialists are available."—Allan Maurer

*"If God made us in His image, we have certainly returned the compliment."*

*—Voltaire*

*Rose Iacona Can now walk, climb stairs, even dance*

## BIONIC GRANNY

Rose Iacona, of Union, New Jersey, is probably the first person in the world to have all her major joints replaced with artificial implants

It all started in 1976, when Mrs Iacona, who was suffering from severe arthritis, gave up on the cortisone injections she had been receiving and went to orthopedist James Brady at Overlook Hospital in Summit, New Jersey "Dr Brady tackled my hips first," says Iacona, who received new hip joints made of dense polyethylene plastic and chromium-cobalt alloy "For the first time in years," she relates, "I could walk without feeling terrible pain "

But that was just the beginning Over the next six years Mrs Iacona was operated on a total of 14 times to replace eight major joints In 1978 for instance, Dr Charles Neer, of New York's Presbyterian Medical Center, replaced her shoulder joints, and the following year he gave her new elbow joints Then Dr Brady went back to work on her knees, replacing both the left and the right with artificial counterparts Today the sixty-eight-year-old grandmother may be "semisynthetic," but she's completely free of pain

"I can't bend over all the way, or kneel," she says, "but I can walk, climb the stairs, and even dance "

—Phoebe Hoban

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*"It may sound ridiculous, but to date better quantitative evidence of self-recognition exists for chimpanzees than for man "*

*—Gordon Gallup*

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*"Everything science has taught me, and continues to teach me, strengthens my belief in the continuity of our spiritual existence after death "*

*—Wernher von Braun*

## FEELING A PROFIT

In recent years researchers have been finding that a nurse's touch can play an important role in calming the mentally disturbed and in shortening the recovery time after a serious illness or surgery Now California salesman Barrie Stern is discovering that the art of touching can also lead to hefty profits in the marketplace

For more than 20 years Stern was known as a record-breaking supersalesman, and he came to suspect that his unconscious habit of gently touching the arm of a prospective buyer during a sales talk was the key to his success To test his theory, Stern divided his own sales staff into two groups While selling home furnishings, half of the salesmen applied a light pressure to the hand, wrist, or upper arm of a client at specific times The other half made no physical contact whatsoever After eight months and 1,000 sales pitches, the results were impressive The nontouchers got only three sales out of every ten tries, but the touchers averaged eight out of ten

A year ago Stern set up a company called Skinetics to organize seminars on the technique So far his clients have included doctors, dentists, car dealers, insurance salesmen, and even the U S Marine Corps

"Quite frankly, it works," says Major John Studenka, head of Marine recruiting for the San Diego area Three of his recruiting offices tried the method for three months, and soon they were getting more than a few good men Their recruiting efforts quickly increased by an average of 114 percent!

How does it work? "It's quite simple," Stern says "Touching is a comfort to the sensory nerves in the skin People literally warm to the touch, and this triggers a good emotional response within them."

—Marcia Bartusiak

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*"All words are pegs to hang ideas on "*

*—Henry Ward Beecher*

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*"The scientists split the atom, and now the atom is splitting us "*

*—Quentin Reynolds*

*In a novel test of 1,000 sales pitches, nontouchers got only three sales out of every ten tries, touchers scored eight out of ten*

# CONTINUUM

## SUPERCAMEL

Desert dwellers faced with scorching heat and drought have never had an abundance of food. But now researchers at Israel's Ben Gurion University, in the sweltering Negev, say they have a solution: supercamels.

The camel, Ben Gurion veterinarian Reuven Yagil explains, is the only animal that can continue to produce meat and milk in the harsh terrain of the desert. But before the creature can feed all the hungry, "it has to undergo some major improvements."

For instance, a camel must walk about 35 miles a day to obtain enough food, which means it will stay on the skinny side. So Dr. Yagil and his colleagues are planning fenced-in ranches with grazing fields full of saltbush, a Dead Sea plant that only the camel can tolerate. Once camels are farmed, fed, and fattened up like cattle, the researchers note, there will be "plenty of sweet young meat."

And since camels conceive and give birth infrequently, Yagil adds, the flow of milk is sporadic. To solve that problem, he plans to impregnate fertile females through artificial insemination, increasing the camel population and a protein-rich milk supply in one fell swoop.

Once the plan has been carried out, however, Israelis may have just one question. Are camels kosher? "Absolutely not," Yagil says. "But there's an old Jewish saying: 'A starving man can eat anything.'"

—Kathrine Jason

*Camels are skinny and give birth infrequently. But with some modifications, they could be the desert food of the future.*

*"If a dog's prayers were answered, bones would rain from the sky."*

*—Turkish proverb*

*"Do you see this egg? With it you can overthrow all the schools of theology, all the churches of the earth."*

*—Denis Diderot*

## ICE-WATER TEST

Sticking your hand in a bowl of ice water can alert you to high blood pressure. According to a recent study from the Mayo Clinic, in Rochester, Minnesota, you can tell whether you'll suffer hypertension later in life by measuring the blood pressure of one arm while immersing the other in a bucket of ice water. If blood pressure soars during the experiment, the prognosis for the future is poor.

Called the Cold Pressor Test, this technique was used by cardiovascular specialist Douglas Woods to examine a group of seven- to nineteen-year-olds in 1934. When Woods reexamined these same individuals at the Mayo Clinic in 1982, he found that those whose blood pressure had surged as youngsters—the hyperreactors—were more than three times as likely to develop hypertension.

*Test the blood pressure of one arm with the other in ice water.*

Woods says he has no idea why his test is so successful at predicting the development of high blood pressure later in life. But that doesn't diminish its value. If high blood pressure can be detected early, he notes, preventive measures can be taken. Then the number of patients with stroke, kidney disease, angina, and heart attacks—all exacerbated by high blood pressure—could be drastically reduced.

—Robert Kall and Amy Bortner

*"Faith is a fine invention/For gentlemen who see,/But microscopes are prudent/In an emergency."*

*—Emily Dickinson*

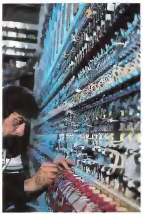
*Tomorrow's electric generator roars like a tethered rocket, the heart of a*

# FIREPOWER PLANT

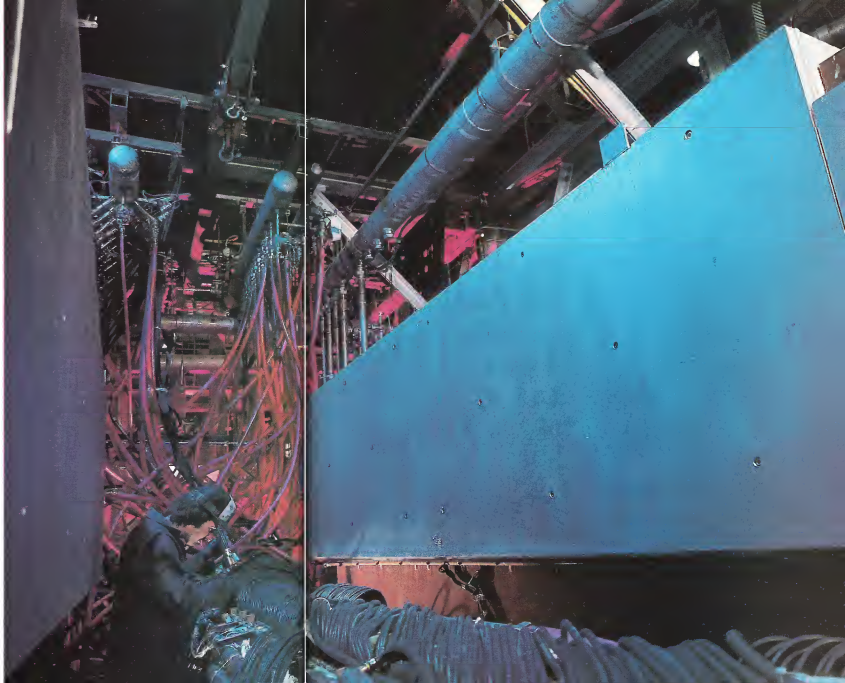
BY ERNEST VOLKMAN

It looks like a huge rocket laid out horizontally, appearing almost sinister as it stretches across the sprawling floor of the power plant—an appearance underscored by a sticker somebody has pasted on the main assembly. "SCREW to cel!" the sticker reads, over a picture of a zonked-out motorcyclist.

Engineers open and close valves. The machine roars as if a subway train were bearing down on this little-known Department of Energy facility near Butte, Montana. But nothing moves. The ac-



PHOTOGRAPHS BY DOUGLAS KIRKLAND



tion is all inside the "rocket," where sizzling gases have begun to whoosh.

In the control room, engineers flip switches, stepping up the velocity of the gases whipping through their jumbo mechanical prodigy. Its name, appropriately formidable, is the Open-Cycle Magnetohydrodynamic Electrical Power-Generating Plant. Friends call it MHD.

MHD could—if it ever makes it through the technological and political badlands—render nuclear power and its radioactive wastes inconsequential. It could turn ordinary coal-burning power plants, which spew pollution, into brick-and-steel brontosauruses, in a world greedy for juice. MHD could be the electric pot of gold.

How does the magic work? A gas rushes down a closed tube between magnets. The magnetic field induces a current in the gas. Fed into power lines, that electricity will percolate your coffee. It has all the elegance of no moving parts. But, for the system to work efficiently, the gas must move at about the speed of sound. And it must be superhot. For MHD is really a downhome version of solar flares, those great fountains of fire that thrust out from the sun.

The idea has grandeur. And for all those who flip their morning toast browned by jiggling electrons, the advent of MHD would be a comfort, because MHD-derived electricity would be relatively cheap. And such a generator could run on almost anything that burns, including coal, whose veins lace the western United States.

Who ever heard of MHD? Ask 999 people out of 1,000, and they will say it is the acronym of the Soviet secret police or a flavoring in Chinese food or a brand of underwear. Except for a smattering of articles in technical journals, the engineers struggling to bring magnetohydrodynamics to life work in obscurity. No wonder they describe it with justifiable irony as "the energy technology nobody knows."

That is especially odd because MHD goes back 151 years, to January 12, 1832, when the great British scientist Michael Faraday walked onto Waterloo Bridge, in London, and dangled the two ends of a copper wire into the Thames. As the river flowed between the wire's ends, acted upon by the earth's magnetic field, Faraday detected a weak electrical current moving through the conductor. He had just invented the MHD generator.

Only today is that discovery being brought to life. One incarnation already is feeding kilowatts into Moscow's power grid. Another is gestating under the Big Sky of Montana in the belly of a building that might have been a shoelace factory—a hodgepodge of furnaces, smokestacks, and humming power lines called the Component Development and Integration Facility.

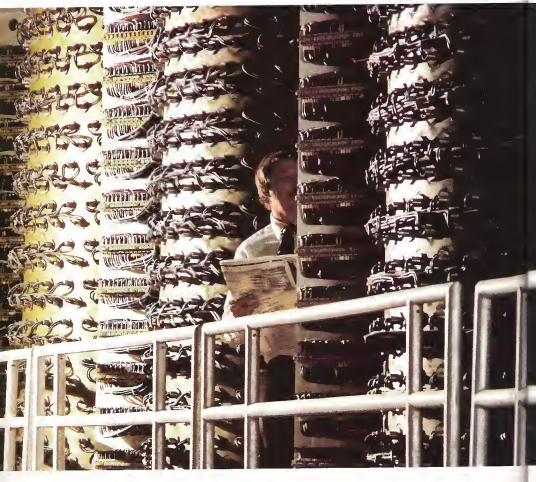
"There is no doubt in my mind that we can make it work, and work big," says one of the plant's engineers. "Really the scientific problem is licked. Now what we have is a whole series of engineering problems waiting to be solved. And I don't know anybody who doesn't think we can lick them."

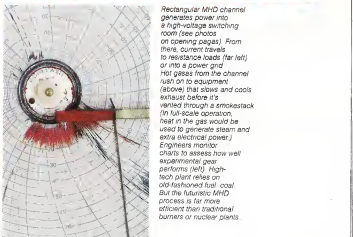
As he speaks, the roar is building to a crescendo. "Stand next to that thing when it's going full blast, and you think you're going deaf," the engineer shouts. He retreats toward the facility's insulated control room. The roar comes from thousands of gallons of water pumping through the generator's cooling hoses while sizzling gases streak through the generator's inner channels at speeds greater than Mach 1.

In the relative quiet of the control room, engineers watch banks of computers and monitoring devices. This test will determine how the generator actually performs, how much power it puts out compared to a computer's predictions. The readings fall into place, as if the "rocket" were headed for a nominal orbit. The test ends.

"Terrific! Worked like a charm," someone says. The dozen engineers in the room beam at one another, looking like the crew on an early NASA shot. That same crackle of technological adventure is in the air. And, in the equipment, there is a hint of glitz. Even the pipes are made of expensive stainless steel—a sight that makes visiting utility executives hyperventilate.

"The stainless steel is there for an excellent reason," says Dr. Robert Carrington, continued on page 109.





*Rectangular MHD channel generates power into a high-voltage switching room (see photos on opening pages). From there, current travels to resistance bank (far left) or into a power grid. Hot gases from the channel rush on to equipment (above) that slows and cools exhaust before it's vented through a smokestack. (In full-scale operation, heat in the gas would be used to generate steam and extra electrical power.) Engineers monitor charts to assess how well experimental gear performs (left). High-tech plant relies on old-fashioned fuel: coal. But the futuristic MHD process is far more efficient than traditional burners or nuclear plants.*

# PLASTIC MEGALITHS

BY DOUGLAS STARR

If a bold new theory is correct, the great stone monuments of antiquity were not the product of grueling drudgery and sweat but stand as a magnificent tribute to Stone Age alchemy—the newly rediscovered art of turning rock into a moldable form.

PHOTOGRAPH BY PETE TURNER

It's nightfall as the warlike Rapanui of Easter Island prepare to honor their king. For days the men have been working in the quarries, hacking the black volcanic stone with their basalt and obsidian picks. Others have carried bucketloads of the rock chips to the ceremonial center, where an irregularly bottomed hole, 20 feet long and as deep as a grave, is being dug. When the work is completed, a signal is finally given for the ceremony to start.

To the accompaniment of a high, rhythmic chanting, young warriors pour a powder into the hole. They add the crushed rock and then a potion made from the extracts of local plants. The night fills with singing as the men stir the thick mixture with long wooden sticks. Soon everyone crowds onto the stiff putty, gyrating lasciviously as they pack it down with their bare feet. Encouraged by their own chanting, the men and women dance feverishly. When they return the next morning, the thick black mixture has hardened to stone.

By dawn, the 20-ton rock is ready to be dug from its mold. The groaning of ropes is the only sound to pierce the silence during the unearthing of the monument. And as the weary islanders stand back to admire the brooding, beetle-browed statue, they give no thought to the fact that they have created a mystery that will endure for many hundreds of years.

This startling picture of primitive man is the unique vision of Joseph Davidovits, a French chemist who says he has unlocked the mystery of the world's ancient megaliths. How did ancient peoples build the massive pyramids, the Easter Island statues, Stonehenge, and other ruins awesome by even today's engineering standards? How could they have cut and hauled such heavy rocks from quarries sometimes miles away? To all this, Davidovits replies: The building blocks for the megaliths were not slavishly cut and hauled; they were simply cast on the spot.

The theory may seem at first too radical to be believed, but this accomplished polymer chemist wants nothing less than to turn the archaeological world on its dignified ear. He wants to erase all our images of ancient people working like oxen, dragging huge stones to set monuments in place. He sees the early megalith builders as chemists—the original alchemists who intimately knew the nature of stone.

In recent years Davidovits has emerged as a controversial figure in the archaeological world by presenting papers at conferences and attracting the press, by publishing two books of his theories and promising four more, by buttonholing any archaeologist who will half-listen.

Do his theories have any merit at all? To find out, I visited him in his laboratory in the north of France, where he first learned how to make artificial stone. The smell of clay hung in the air of the old brick building that houses his workroom. An eclectic collection of statues occupied every available shelf, their styles ranging from Egyptian to Louis XIV to modern. No one had actually carved them, he said; all had been molded from artificial stone.

Davidovits's interest in rock began ten years ago, prompted by a vexing chemical problem. An industrial plastics researcher at the time, he had been trying to find a way to make safe, fireproof fabrics. Unfortunately, plastics and other easily workable materials were not flame-retardant. On the other hand, such fire-resistant materials as rock require large amounts of energy to shape. If only he could combine the best properties of each.

Davidovits consulted mineralogists on the matter. He learned that when alkaline substances are added to soft clay, the mixture hardens into a class of fire-resistant minerals called zeolites. But this process—a naturally occurring reaction—takes decades. Davidovits set out to speed it all up. After two years of research at his industrial laboratory, he finally developed a remarkable material—one that could be molded like plastic, yet had the virtue of being even more heat-resistant than cement. Best of all, unlike many mineral products, it didn't have to be fired at great temperatures to be formed.

*"According to Davidovits's controversial theory, the building blocks for the pyramids were not slavishly cut and hauled, rather, they were cast on the spot."*

The key to this whole process—and the tie-in to archaeology—involves the aluminum and silicon that make up common clays. Under normal acid soil conditions, the aluminum is loosely bound to oxygen atoms in the clay. Add alkali in the right proportion, however, and the aluminum suddenly bonds tightly to both the oxygen and the silicon. The whole loose structure snaps into a rigid three-dimensional frame.

But the system still had to be adapted for minerals that lacked those essential constituents. So Davidovits developed a powder containing aluminum and silicon that, when added to a liquid containing alkali, forms a molecular glue. A lab assistant demonstrated how to change powdered granite to stone. She mixed the aluminum silicate powder with a clear yellow alkaline solution. Then she added the black granite powder, stirred the mixture and poured it into a mold. In a few hours, under very low heat, the putty became stone. Its resemblance to granite is so striking that only a petrologist, or rock specialist, can tell the difference.

The chemical reaction is almost identical to the way plastic polymers are formed. Hence, Davidovits calls his synthetic rock a geopolymer. Already he has put the process to a host of industrial applications, from fire-resistant clay-coated building board to bricks that can be made at a fraction of the normal temperature and time. (He's still working on fireproof fabric, he says.) It's all done very simply: no kiln, no high temperatures, very low technology. In fact it was so downright primitive that he began to wonder whether his method hadn't been discovered before.

And thus was born Davidovits's theory of the ancient megaliths, which he first enunciated to the French news syndicate Agence France-Presse in 1974. As he sees it, we should forget the images of sweating laborers straining with ropes to pull stones on wooden sleds. His ancient workers understood stone chemistry well enough to transform stone into a plasticlike compound. Why would ancient craftsmen haul massive building blocks from miles away and painstakingly cut them when they could mold rock on the spot? The Egyptians, after all, knew enough food chemistry to make wine, beer, and vinegar. Their embalming technology is clear proof of their sophisticated knowledge of body chemistry. And judging from the fire glazes that adorn their pottery, they weren't novices to materials chemistry, either. Couldn't they and others have mastered the few simple steps of agglomerating stone?

Like most amateur archaeologists, Davidovits was especially captivated by Egypt's Great Pyramid of Cheops at Gizeh—one of the most massive and finely engineered monuments ever built. This 4,600-year-old structure is nearly half the height of the Empire State Building and has a base seven football fields in length. It comprises at least 2.3 million car-sized limestone blocks so closely joined on the outside that you cannot slip a business card between them.

At the same time he was perplexed by gaps in the archaeological evidence about how the pyramid was built. Why, for example, are there no murals of the time showing the ramps or sleds on which the blocks were dragged? The oldest extant bas-relief that depicts workers dragging a statue was dated 800 years after the construction. How could the early Egyptians have made ramps sloping gently enough to enable the huge limestone blocks to be dragged? Any ramp with a gentle-enough gradient would have to be more massive than the pyramid itself.

In contrast, Davidovits claims, geopolymer technology may have been available. Ancient Egyptian texts frequently mention natron, a holy salt used for everything from embalming to brushing one's teeth. Yet natron, it seems, is sodium carbonate, the precise chemical one would use to cata-

CONTINUED ON PAGE 91

# How to spell

**By John Irving**

*International Paper asked John Irving, author of "The World According to Garp," "The Hotel New Hampshire," and "Seeing Free the Bears," among other novels—and once a hopelessly bad speller himself—to teach you how to improve your spelling*

Let's begin with the bad news.

If you're a bad speller, you probably think you always will be. There are exceptions to every spelling rule, and the rules themselves are easy to forget. George Bernard Shaw demonstrated how ridiculous some spelling rules are. By following the rules, he said, we could spell fish this way: ghoti. The "f" as it sounds in enough, the "i" as it sounds in women, and the "sh" as it sounds in fiction.

With such rules to follow, no one should feel stupid for being a bad speller. But there are ways to improve. Start by acknowledging the mess that English spelling is in—but have sympathy: English spelling changed with foreign influences. Chaucer wrote "gesse," but "guess," imported earlier by the Norman invaders, finally replaced it. Most early printers in England came from Holland; they brought "ghost" and "gherkin" with them.

If you'd like to intimidate yourself—and remain a bad speller forever—just try to remember the 13 different ways the sound "sh" can be written:

| | |
|---|---|
| shoe | suspicion |
| sugar | nauseous |
| ocean | conscious |
| issue | chaperone |
| nation | mansion |
| schist | fuchsia |
| pshaw | |

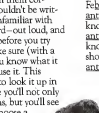
**Now the good news**

The good news is that 90 percent of all writing consists of 1,000 basic words. There is, also, a method to most English spelling and a great number of how-to-spell books. Remarkably, all these books propose learning the same rules! Not surprisingly, most of these books are humorless.

Just keep this in mind: If you're familiar with the words you use, you'll probably spell them correctly—and you shouldn't be writing words you're unfamiliar with anyway. USE a word—out loud, and more than once—before you try writing it, and make sure (with a new word) that you know what it means before you use it. This means you'll have to look it up in a dictionary, where you'll not only learn what it means, but you'll see how it's spelled. Choose a dictionary you enjoy browsing in, and guard it as you would a diary. You wouldn't lend a diary, would you?

**A tip on looking it up**

Beside every word I look up in my dictionary, I make a mark.



"Lose your dictionary."

Beside every word I look up more than once, I write a note to myself —about WHY I looked it up. I have looked up "strictly" 14 times since 1964. I prefer to spell it with a k – as in "strickly." I have looked up "ubiquitous" a dozen times. I can't remember what it means.

Another good way to use your dictionary: When you have to look up a word, for any reason, learn—and learn to spell—a new word at the same time. It can be any useful word on the same page as the word you looked up. Put the date beside this new word and see how quickly, or in what way, you forget it. Eventually, you'll learn it.

Almost as important as knowing what a word means (in order to spell it) is knowing how it's pronounced. It's government, not govgement. It's February, not Febuary. And if you know that anti- means against, you should know how to spell antidote and antibiotic and antifreeze. If you know that ante- means before, you shouldn't have trouble spelling antechamber or antecedent.

**Some rules, exceptions, and two tricks**

I don't have room to touch on all the rules here. It would take a book to do that. But I can share a few that help me most:

Some spelling problems that seem hard are really easy. What about -ary or -ery? Just remember that there are only six common words in English that end in -ery. Memorize them, and feel fairly sure that all the rest end in -ary.

| | |
|---|---|
| cemetery | monastery |
| millinery | confectionery |
| distillery | stationery (as in paper) |

Here's another easy rule. Only four words end in -efy. Most people misspell them—with -ify, which is usually correct. Just memorize these, too, and use -ify for all the rest.

| | |
|---|---|
| stupefy | putrefy |
| liquefy | rarefy |

As a former bad speller, I have learned a few valuable tricks. Any good how-to-spell book will teach you more than these two, but these two are my favorites. Of the 800,000 words in the English language, the most frequently misspelled is alright. Just remember that alright is all wrong. You wouldn't write alwrong, would you? That's how you know you should write all right.

The other trick is for the truly *worst* spellers. I mean those of you who spell so badly that you can't get close enough to the right way to spell a word in order to even FIND it in the dictionary. The word you're looking for is there, of course, but you won't find it the way you're trying to spell it. What to do is look up a synonym—another word that means the same thing. Chances are good that you'll find the word you're looking for under the definition of the synonym.

**Demon words and bugbears**

Everyone has a few demon words—they never look right, even when they're spelled correctly. Three of my demons are medieval, ecstasy, and rhythm. I have learned to hate these words, but I have not learned to spell them; I have to look them up every time.

And everyone has a spelling rule that's a bugbear—it's either too difficult to learn or it's impossible to remember. My personal bugbear among the rules is the one governing whether you add -able or -ible. I can teach it to you, but I can't remember it myself.

You add -able to a full word: adapt, adaptable; work, workable. You add -able to words that end in e—just remember to drop the final e: love, lovable. But if the word ends in two c's, like agree, you keep them both: agreeable.

You add -ible if the base is not a full word that can stand on its own: credible, tangible, horrible, terrible. You add -ible if the root word ends in -ns: responsible. You add -ible if the root word ends in -miss: permissible. You add -ible if the root word ends in a soft c

**incomprehensibilities**

*"This is one of the longest English words in common use. But don't let the length of a word frighten you. There's a rule for how to spell this one, and you can learn it."*

(but remember to drop the final g!): force, forcible.

Got that? I don't have it, and I was introduced to that rule in prep school; with that rule, I still learn one word at a time.

**Poor President Jackson**

You must remember that it is permissible for spelling to drive you crazy. Spelling had this effect on Andrew Jackson, who once blew his stack while trying to write a Presidential paper. "It's a damn poor mind that can think of only one way to spell a word!" the President cried.

When you have trouble, think of poor Andrew Jackson and know that you're not alone.

**What's really important**

And remember what's really important about good writing is not good spelling. If you spell badly but write well, you should hold your head up. As the poet T.S. Eliot recommended, "Write for as large and miscellaneous an audience as possible"—and don't be overly concerned if you can't spell "miscellaneous."

Also remember that you can spell correctly and write well—and still be misunderstood. Hold your head up about that, too.

As good old G.C. Lichtenberg said, "A book is a mirror: if an ass peers into it, you can't expect an apostle to look out"—whether you spell "apostle" correctly or not.

Today, the printed word is more vital than ever. Now there is more need than ever for all of us to *read* better, *write* better, and *communicate* better.

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FICTION

# THE BEST OF BOTH WORLDS

BY LOIS METZGER

Lizbeth Webb could see the 1964 New York World's Fair Unisphere from the window of her twenty-second-floor studio apartment in Flushing, Queens. She had been born a few years before the opening of the fair, and her first memory was of the construction of the Unisphere—a large, open globe with land represented by aluminum patches and oceans by empty space. For two years Flushing was full of celebration. When she was five, and watched almost all the fair get torn down—except for the Unisphere and a couple of pavilions—Lizbeth reluctantly settled into life. She grew up, she

PAINTING BY ANS MARKUS

got an M.A. in education, she found a job teaching high-school social studies. Her parents moved to California, where they died a few years later.

The summer that Lizbeth was twenty-nine, two men she did not know all that well proposed marriage to her. Stan Calabrese asked at lunch, in a crowded midtown coffee shop, and Carl Begelman, at dinner, in a deserted midtown French restaurant. "I need time to think," she told them, "even though that's all I've ever had."

At nearly two A.M. Lizbeth lay on her folded-out sofa bed. She felt like eating an orange, but her friend Cindy Feingold had once said that eating citrus at night gives you insomnia. So she called Cindy, who was a fellow teacher at Vlissingen Secondary School, and a fellow insomniac, and told her about the two men.

"Avoid indecision," Cindy told her. "It's the number one cause of stress. Make up your mind as quickly as possible!"

"But what about—"

"Trust your instincts."

Lizbeth's mother repeatedly had said to her, "Look before you leap. There are no easy solutions. You can't have your cake and eat it, too."

"Cindy," Lizbeth said, "I just realized that the Unisphere looks like the world after a nuclear war. All hollowed out and empty."

"At least it's still there," Cindy said.

Lizbeth called Stan Calabrese, in his Greenwich Village apartment. "I'm such a worrier," she told him.

"Don't worry about that," he said, yawning. Stan was thirty-four and worked at *Shark Life* magazine as a copy editor. He was good-looking, with curly brown hair and flashing dark brown eyes. Lizbeth looked like she might have been his plain sister. "Security breeds relaxation."

She smiled, biting her lip. "You always sound so calm," she said, and thought, *Not calm. Self-assured.*

"Because I speak the truth. After all, that is why you're calling: to tell me you want marriage, security, the house with two kids, the garage with two cars?" He chuckled.

"Uh, no," she said, suddenly remembering that Stan had told her he could not function without seven hours and forty-five minutes' sleep. "I'm sorry. I forgot the time. It's just that I don't know if I can marry you."

"*Can?* You sound so helpless. Who's stopping you?"

Stan Calabrese had once been a science teacher at Vlissingen Secondary School. He had had a reputation with the kids: If he liked you, you felt terrific; if not, you were "in for it." Lizbeth felt her voice shake. "No, nobody, it's not like that. Somebody else asked me to get married, and I'm trying to decide, that's all." She paused and listened hard but could not even hear his breath.

Then he spoke softly. "Lizzie, go to sleep. Dream. Then call me. We'll go over your dreams, and I bet your answer will be in there, somewhere."

Lizbeth looked at her wobbly kitchen table, the newspaper-stained upholstery of the sofa bed, and the faded Oriental rug. Her parents' old furniture. At three A.M. she called Carl Begelman, in his East Side penthouse. "I'm such a worrier."

"Me, too," he said. "I worry about worrying." He laughed.

"You weren't asleep?" Lizbeth asked.

"I have trouble sometimes. Every once in a great while I can't fall asleep."

"Same as me." She wondered if he was an insomniac like her.

"But, Bethela, with you here, I'll be cured. You crazy thing—calling me with the news in the middle of the night!"

"Oh, Carl, I should've explained right away. I've got this problem, and I'm all in a state."

"There, there," Carl said. "I'm sure we can take care of everything."

Lizbeth's father, an ineffectual man who had only wanted the best for his daughter, had said things like that.

During the past school term Lizbeth had been concerned about a ninth-grader named Nicky, a likable kid who was failing everything but social studies. Nicky's parents never came to the school, despite Lizbeth's calls, but one day Carl Begelman showed up and introduced himself as Nicky's uncle. He had black and gray hair, and green eyes, and looked younger than sixty-two. He owned a small cargo airline. "How can I help him?" Carl had asked, so sincerely that Lizbeth was touched.

*"Lizbeth took off her sandals and felt the cold linoleum under her feet. The cake looked untrustworthy, she thought. She ate it in two bites. It tasted like nothing."*

"Someone else wants to marry me," she said now, on the phone. "I'm so undecided. I'd marry you both if I could." *Trust your instincts,* she thought. *But look before you leap.*

"Think about this," Carl said. "I can pay for a cloning. I want you, and I don't care if somebody else has you, too."

"A cloning!" she said.

"They're very safe, no need to worry. Why, I'd do it myself, but there's no reason for that, is there?"

Lizbeth felt as if she had just mentioned that she wanted to walk around the corner and had been handed tickets for a trip around the world. "That costs fifty thousand dollars," she said. Lizbeth made nineteen thousand a year, before taxes.

"I can afford it," he said. "It's only money."

"No one ever said that to me before."

"What—get a cloning?"

"No. 'It's only money.'"

Lizbeth peeled an orange. She broke it into halves. She pressed them together, then pulled them apart. She wrapped the halves separately in tin foil and put them in the refrigerator. She thought, *Do I want to go around the world, or only around the corner?* She called Stan again.

"Have you dreamed?" he asked.

"Yes," she said, almost without thinking. "I dreamed I was a long-lost twin. We met and couldn't tell ourselves apart. I woke up feeling well-nourished, like I'd eaten a good breakfast." Stan had once told Lizbeth she looked undernourished.

"You've figured it out by yourself then?"

"Yes. I'm going to be cloned. I'll marry you, darling. Him, too."

AnnA & OttO Clones had opened its first Person Enhancement Center in Manhattan a few years before and its second in the basement of a high-rise in Forest Hills a year later. Lizbeth knew the interior because it had once been a Silhouettes Health Spa. The large exercise room now had orange carpeting on the walls and ceiling, a shiny black linoleum floor, and many box-like areas separated by bamboo curtains.

Lizbeth stood by the entrance, in a red sundress and sandals. A beautiful Indian woman, wearing a badge that said, USHA DEVI, CLONE COORDINATOR, greeted her. "How are we today?" she asked.

"We're fine," Lizbeth said and laughed.

"Is something funny, Miss Webb?" Usha Devi asked.

"No, no," Lizbeth said, "but you said 'we,' and here I am getting cloned and—" Usha Devi stared at her blankly. Lizbeth coughed. "There's nobody else here."

"We make only individual appointments," Usha Devi answered.

Lizbeth wanted to ask why but felt too timid. She was led to a room behind one of the bamboo curtains. There was a thick mattress on the floor and a pillow and blanket. Twin beds, covered only with sheets, were on either side of the mattress. Lizbeth sat on the bed nearest the curtain and smoothed her dress over her legs.

"Please read this," Usha Devi said, handing her a thin brochure and closing the curtain behind her.

The cover had a dozen hand-holding black silhouettes, like paper-doll cutouts. Lizbeth opened the brochure and read:

> Think of it as a journey. An adventure. You are about to become members of an elite group—Enhanced Persons. We're sure your lives will be richer from the moment you have become enhanced.
>
> The procedure is utterly safe. You see, every cell in your body is connected to every other cell. These include memory cells. We're going to take some skin cells—you won't even

know from where—some blood and a lock of hair while you're deeply asleep. The procedure—making "mirror cells"—will take just over thirty-six hours. When you wake as two people, one on each of the bunk beds (twin beds in Forest Hills), you won't know who was the original and who is the clone. And it won't matter. You'll be the same age with the same memories. But then your new lives begin. One can train his or her voice and learn to sing beautifully. The other can take up dancing. But you won't both automatically become singing dancers!

Lizbeth thought, *Why don't they simply say, You'll be like twins?* She read the back of the brochure. In smaller print, AnnA & OttO claimed no responsibility for personal problems, medical problems, or other unrelated difficulties. *Other unrelated difficulties*, Lizbeth thought. At the bottom, she read, "From all of us at AnnA & OttO to all of you—Enjoy Yourselves!"

Usha Devi returned. She held a small piece of orange cake on a paper plate. "Please eat this," she said. "It will make you sleep." Lizbeth took the plate, and Usha Devi left.

Lizbeth took off her sandals and felt the cold linoleum under her feet. The cake looked untrustworthy, she thought. She ate it in two bites. It tasted like nothing.

Under the stiff, flat pillow Lizbeth found a white cotton nightgown. She took off the sundress and folded it neatly on the mattress. With sudden panic she realized she had forgotten to bring another set of clothes.

"Usha Devi! Usha Devi!" she yelled, poking her head out of the bamboo curtain. Usha Devi came back immediately. "I only have one dress!"

Usha Devi shook her head. "That happens always. People are unsure for months about whether to do this. Then they come, very calm, very happy. And then because they forgot more clothes, they think everything will go wrong."

"So, it's all right?"

"Yes, yes, go to sleep!"

Lizbeth felt dizzy. She lay down on the mattress and made the following arrangements with herself. There would be no phone calls between her and her clone, no letters, no lunch dates. Some clones went into business, as partners, or lived like sisters and brothers. She closed her eyes and felt the room spin.

*What will happen when I see myself? Look away, embarrassed. Say hello and goodbye. Or stare, neither one believing her eyes, and say, Oh, no. Oh, no.*

Whoever wakes up on the bed nearest the curtain is Liz, she decided. She will marry Stan. The other one is Beth. She will marry Carl. Lizbeth slept and dreamed that two people were saying to her, "Silly girl! Silly girl! What are you doing? What are you doing?" One clear, insistent voice was her mother's. The other, fainter voice was her father's. In her dream she tried to say, "I'm having my cake and eating it, too!" But the voices were not listening.

Thirty-six hours later they woke to banging construction on a higher floor. The two turned to face each other in the same moment. They did what Lizbeth had never expected. They burst out laughing.

One got up and left. The other waited a few minutes and then left, too. Only when they were several blocks from AnnA & OttO did each realize that they were wearing unfamiliar and ill-fitting orange polyester pantsuits. The one who had left first was Beth, and the other one was Liz.

Carl and Beth Begelman lived in the two-bedroom penthouse of No. 1 East End Avenue, a luxury high-rise at Seventy-ninth Street, overlooking the East River, Roosevelt Island, and Queens, where a medical student was now subleasing Lizbeth's apartment. Beth spent hours looking at the tugboats and freighters and tour boats on the river. She raised miniature roses and orchids under lights. She had a Persian cat and a Persian rug, too. She had her brown hair streaked with red. She complained of fuzzy vision—*I'm slightly allergic to the cat*, she decided.

So Carl sent her to a doctor, who prescribed Liquid Lenses; every morning she applied the drops, and her vision became perfect. She had thrown out the orange polyester pantsuit and wore silk housedresses. She decided the best part about having money was not having to do things she had always done: look at prices on menus, wait on long lines, or return a blouse because the color was so crazy she could not match it. She ate chocolates imported from Europe by the boxful, and when she gained weight, Carl only said there was more of her to love.

Carl had an office downtown; he left at ten every morning and was home by seven for a candlelit dinner at their cherrywood dining-room table, served by Carl's cook, Woo Lin. Woo Lin was tiny and muscular, and Beth marveled at his cheerfulness. *If a servant can be content here, then I can be, too*, she decided.

"You look radiantly happy," Carl said to her at dinner one night.

Beth giggled. "Am I allowed to be?"

"Of course! What a silly girl!"

"I thought you had to be miserable to feel something."

"Now who told you that?"

"I don't know," Beth said. "Nobody. Everybody."

The following week he took her to Spain. Beth found the colors, the heat, and the light exhilarating, but she was disturbed to see children begging in every town. Carl agreed that it was a sad sight, but he said that it took place under a blue sky and she should focus on the beautiful things. Beth discovered that the fiery-red Spanish wines helped her do this.

Liz and Stan Calabrese lived in Greenwich Village, in an old building on Eighth

CONTINUED ON PAGE 106

# THE FRACTAL COSMOS

BY KATHLEEN STEIN

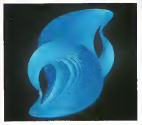
*Computer-generated Gaussian Hills That Never Were are fake mountains by Richard Voss (below), a 2D fractal plane (right), encased in its own 3D exoskeleton, is a mathematical concept made visible for the first time by Alan Norton, of IBM*

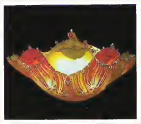
The extraordinary shapes on these pages have never existed in the empirical world, nor will they ever launch themselves into being under normal circumstances. Yet they are representatives of a new mathematics of nature that in insidious ways is changing our perspectives of what reality really is.

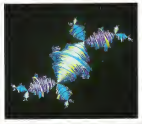
The universe is a foamy, bumpy, wiggly, basically irregular place, despite the fact that most of us regard it as a three-dimensional construct in which smoothness and balance are the desired qualities and Euclid's classic geometric forms—spheres, cubes, and cones—predominate as the shapes of choice.

In the years between 1875 and 1925 a number of mathematicians turned away from Euclidean geometry and began to devise theories that tended to undermine the foundations of prevailing mathematics. Because these geometers were talking about curves that were not smooth and about dimensions that did not fit into one, two, or three spaces, other scientists viewed their structures as "galleries of monsters," as "pathological," as "psychotic," as upsetting in the extreme. Those who did not turn away in fear and horror from these "terrifying"

*"With these shapes you are not talking only about a point at X, Y, and Z coordinates but at midnight yesterday."*





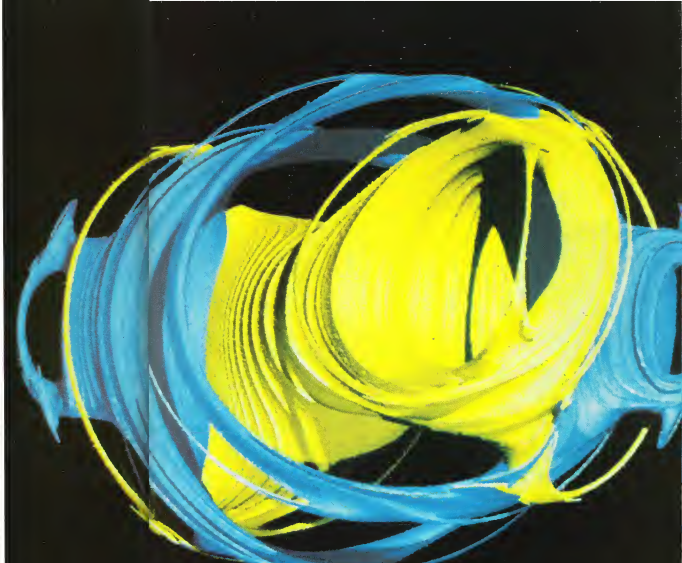


non-Euclidean entities assumed they were irrelevant to a description of the world.

It wasn't until the 1950s that an eclectic and iconoclastic mathematician named Benoit B. Mandelbrot rediscovered these monstrous pathological beasts and "refused to leave them alone." He knew that, far from being irrelevant, they were in fact central to the study of every phenomenon—natural and unnatural—that was not strictly regular. "A curve is not what a curve seems to be," Mandelbrot has declared many times hence, and he insists on the inability of classical geometry to describe the shape of a cloud, coastline, mountain, tree, or tongue of fire. "Clouds are not spheres," he stated as theme; "mountains are not cones, coastlines are not circles; and bark is not smooth. Nor does lightning travel in a straight line."

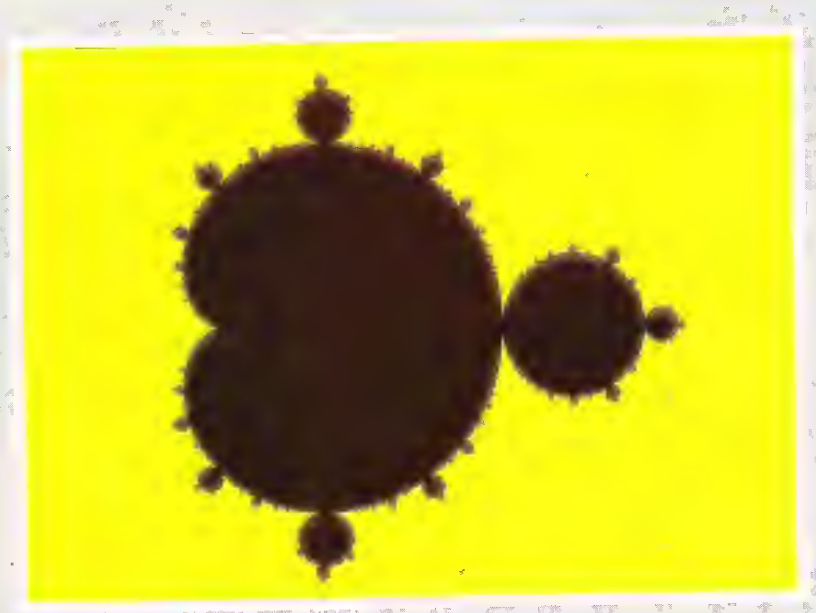
Many patterns are so irregular, Mandelbrot claims, that classical geometry can't handle them. Nature, he says, exhibits "not simply a higher degree, but an altogether different level, of complexity. These patterns challenge us to study the forms that Euclid leaves aside as 'formless,' so we can investigate the morphology of the 'amorphous.'"

Mandelbrot, a fifty-eight-year-old Frenchman who for the last 12 years has been an IBM Fellow at that corporation's Thomas J. Watson Research Center, in Yorktown Heights, New York, has named this huge class of shapes and curves "fractals," from the Latin participle *frac-*



*Top left: Mandelbrot's dragon. Top right: Norton's 3D Domains of Attraction, a fractal "fairly" that returns to its original form after eight pulls. Lower right: Each color band represents one piece of a dragon as it grows from two to three dimensions. Lower left: Cut-away view of "stable manifold," looking into its interior. Large picture at right: Two simultaneous stages in the life of a fractal. Blue represents the intermediate stage of metamorphosis, yellow is its "adult" body.*

*"Each point on the Mandelbrot Set corresponds to a mathematical formula, which in the computer, turns into a dragon."*



*tus*, meaning "broken" or "fragmented." He has generated numerous treatises and books, the latest and most spectacular of which is *The Fractal Geometry of Nature* (Freeman, 1982).

According to the eminent physicist and big fan of fractals Freeman Dyson, of Princeton University, the essential feature of fractals is "a fine-grained lumpiness, or wiggliness, that remains inherent in its texture no matter how thin you slice it." The satisfying thing about fractals is that once you become aware of them, you see them everywhere, from the clusters in the Milky Way to tongues of fire to the creases in your forehead. What Mandelbrot has done is make it possible to look at these irregular shapes scientifically and harness them as tools.

Fractals possess several mind-bending attributes. Perhaps the simplest is a fractal curve's potentially infinite length. Mandelbrot's favorite curves are the jagged line of a mountain range and the coastline of Great Britain (although it could be the coastline of France or anywhere). These and many more natural phenomena have edges whose length constantly "misbehaves." To demonstrate, he uses this example. From a satellite the British coastline looks like a smooth, unbroken line, seen from a 747; its edges grow increasingly lacy from a hang glider off Dorset, in the southwest of England, as one observes the bays and inlets, the coastline increases in length. If one were obsessed enough to crawl along the beach with a caliper and magnifying glass, he would express the grainy length in millions of kilometers. A measurement with a microscope would produce a length approaching infinity—and madness.

With the help of other scientists, such as IBM physicist Richard Voss, Mandelbrot has created computer graphics of fake mountain ranges (see page 62), coastlines, and entire planetscapes. Based on his mathematical equations for random fractal curves, Mandelbrot determines the mountain's bulk, roughness of terrain, and peakedness. And, as in nature, the landscapes exhibit more detail, the closer they are observed. "In nature there are causes which are, how you say, repeatable," he explains. "And the details they make one mountain slightly higher or longer, than another. What one does is to imitate the unknown, or the unpredictable, or the indescribable, in nature. Chance is the tool used to imitate the unknown and unpredictable."

To stimulate chance, Mandelbrot incorporates into the computer program a randomizing element provided by a formula for Brownian motion, the same kind of random movement made by microscopic particles suspended in fluid. In the mix he also includes another ingredient, called Gaussian Probability Distribution, to help shape the random elements into mountains of realistic crags and peaks. But the trouble with Gaussian Probability Distribution, he discovered, is that it leads to valleys that are equally as tortuous as the peaks while real valleys are considerably smoother. Mandelbrot ingeniously fixed the problem through algorithmic tricks and has since generated many vistas of "Non-Gaussian Hills That Never Were," with realistic pocky flatlands and gently sloping mountain valleys.

Perhaps the most monstrous characteristic of fractals, though, is their unerring tendency to lie in between the "normal" one- and three-dimensional spaces of Euclidean geometry. When real objects are analyzed in the elegant and more accurate mathematics of fractals, they cannot be classified simply in terms of one, two, or three dimensions. They are much more complex shapes than classical geometry can comfortably handle. A mountain range expressed in terms of a fractal formula can lie somewhere between the second and the third in the 2.25 dimension, a fractal coastline might have 1.25 dimensions, and so on. Fractal dimensions typically exceed the Euclidean ones. Mandelbrot can easily demonstrate the verity of this with a relatively short set of equations based on the difference between Euclidean (or topological) dimension and fractal dimension.

Okay, so what is a fractal dimension? Mandelbrot says they are "certain transitions between zones of well-defined dimensions." In other words, it's what you get when the wrinkles of a real coastline are set in opposition to the ideal of its smooth line. "A multiplicity of dimensionality is unavoidable," declares Mandelbrot with an air of *sang-froid*. (For the more mathematically minded, he denotes it by the letter $D$ in the fractal formula $D)d_r.)$

There are many applications for this kind of measurement. In meteorology there is the description of cloud and wind formations, valuable for making more accurate weather forecasts; in hydrology, the branching of a river system; in astronomy, the clusters of galaxies; in economics, the flux in commodities.

Equally fascinating is the application of fractal dimension to the description of the human body: its vascular system, the alveolar structure of the lungs, and convolutions of the brain. "Monsters are the very substance of our flesh," Mandelbrot cries. "Could it be significant that part of the geometric difference between a cauliflower and broccoli is quantified by a fractal dimension?"

Besides roughness, strange dimension, and potential infinitude, there is another, extremely important property of fractals

that is queer enough to put some people in strait jackets if they think about it too long. Mandelbrot calls it "self-similarity." If you magnify one of the spiral tails of any one of Mandelbrot's resplendent "dragons" (see page 64)—his name for the two-dimensional abstract computer renderings of his fractal formulas—you will see the same design from a different perspective. Magnify the same design again and again, until the computer screen runs out of precision, and you would see that "diabolic draconian molting" pattern occurring relentlessly. Self-similarity then means that no matter how closely you look, you will always find more of the same! "A very complex artifact can be made with a very simple tool," Mandelbrot adds, "as long as that tool can be applied repeatedly."

Random fractals, such as those found in nature, may or may not exhibit self-similarity. But those that have been created on the graphics computer, that are visual manifestations of "algebraic iterations," or repetitions of fractal equations, have this quality of infinite repetition, or invariance. Certain kinds of self-similarity, like musical variations on a theme, will include modifications and distortion.

It was the mathematical drama of fractals' infinite cascade of geometry that fascinated Alan Norton, a mathematician at IBM. "Ordinarily mathematicians speak of the subtle beauty of math," Norton told us. "Mandelbrot's techniques of harnessing the computer to draw pictures of algebraic formulas make this beauty obvious and visually apparent to everyone."

The repetition of the simplest formulas, explains Norton, who created most of the monsters shown in this article, corresponds to a repetition of the geometric forms. And that to him is "ineffably satisfying on many levels."

Mandelbrot, too, recalls his early satisfaction. The formula for one dragon was so uninteresting mathematically—it came from an elementary chapter of calculus—that little was expected of it. But previewing the design as it came up on the computer "provoked surprise as well as a deep aesthetic shock." Since then, generating dragons has become something of an international game among mathematicians.

In the swamp of the fractal dragons the keystone is a shape now called the Mandelbrot Set. Its eponym thinks it looks like a king's orb (see page 66), but actually it resembles a hippopotamus in cross section with spiky fur. It is a remarkable object indeed, a graphic representation of an infinite number of mathematically generated fractal dragons. Each tiny spot on the set, when programmed into the computer, will grow into a wondrous shape, each as different from the others as snowflakes.

It takes more than 100 multiplications to calculate one point of the Mandelbrot Set. The set itself, Mandelbrot informs us, has become the subject of an entire branch of mathematics. It is one of the Frenchman's greatest contributions. No one could really examine these functions, or dragons, until the set and the computer came along.

The set was the tool by which Alan Norton generated hundreds of dragons, and then later the otherworldly, three-dimensional fractals. "I was truly astonished that with the naked eye I could see these formulas," Norton says. "When I first started working on fractals here at IBM, I went crazy for six months."

Norton became aware of fractals in 1977 while working part time at the prestigious computer graphics firm Evans and Sutherland. He was creating programs to generate textures for computer graphics—trees, materials, surfaces of anything real. "The idea of fractals having continued complexity as they are magnified—not becoming simplified—has great relevance to texture generation," he says. But Norton did not actually pursue the subject until a few months later when he came across Mandelbrot's earlier text *Fractals: Form, Chance and Dimension* and saw that he was on the right track. As Norton says, he took a chance and wrote Mandelbrot at IBM and asked for a job. He got it, and during the next two years developed mathematical techniques for extending two-dimensional fractal dragons into three-dimensional space. Norton calls them Domains of Attraction.

*"There is something truly different about the time dimension. In our limited experience trying to treat time and space separately, we miss the overall symmetry."*

When the thirty-five-year-old mathematician demonstrated the process for generating 3D fractals (see pages 64 and 65) at the 1982 Siggraph convention for the top computer graphics artists in the country, even the most sophisticated members were awed. But the process, as bewildering as it is to nonmathematicians, is to Norton quite elementary, based as it is on Mandelbrot's methods. "Think of the Mandelbrot Set as a set of fractal dragons," he says, moving into the brain-twisting world of complex (imaginary) numbers. "Each microscopic point corresponds to a single formula. By choosing a point, or hair, near the edge of the hippo and entering the formula in the computer, an exciting picture will be generated." Calculating that formula—over and over again—in the complex plane will cause something two-dimensional to be generated; that is, a dragon will bubble up to the surface of the CRT screen. "And the study of these shapes led us to consider their counterparts in three- and four-dimensional space," he goes on. "These blobs," he gestures to the eviscerated purple and yellow Russian Easter egglike objects, "are how the three-d fractals might look if they were modeled out of clay and you shone a light on them."

How does Norton transform the flat 2D dragons into well-rounded Domains of Attraction? "The generation of three-d fractals requires mathematics that extends to the fourth dimension," he begins. "There is an algebra called the quaternions that naturally extends the notion of 'number' to four dimensions."

To generate a 3D fractal, Norton has the computer plot the 2D shape on a 3D 1,200 × 1,200 × 1,200 grid within the computer. Checking any intersection in the grid requires many iterations of the formula. To check every intersection would require trillions of computations and would use so much memory no computer could contain it. So Norton evaluated only a select 1 million grid points following the surface of the fractal shape. Again, aesthetic shock. As the first program began to run, he saw to his amazement "strands coming out of blobs, looping around to the other side of the fractal plane, and I thought 'There really *is* something going on in the quaternions!'"

"The quaternions are the four-d space in which the fractal object sits," Norton says, beginning to become aware that a simple English-language explanation of the mathematical concept is going to be more difficult than anticipated. "Each of these shapes," he attempts, "is a three-d slice of a four-d creature. But the only way I can see it is in three dimensions at a time."

Most mathematicians have no trouble at all believing in the fourth dimension. For some who are accustomed to working in the twenty-third dimension, for example, the fourth is a concrete place—mathematically speaking. But for most people the handiest way to conceptualize this is to think of the fourth dimension in the Einsteinian sense. "It's possible to think of the quaternions as a structure on space and time," Norton offers. "We move freely in three dimensions, there is nothing really different about them. Up, down, right, left, forward, backward. But there is something truly different about the time dimension. And in our limited experience, trying to treat time and space differently, we don't see the overall symmetry. In relativity, by regarding time as another dimension, one can put these phenomena together correctly. In other words, if I understood these blobs, I would better understand the relationship between space and time. Right now only the surface has been scratched."

The fractal spaceships, then, are only snapshots or slices of whole vehicles that can't be seen as they traverse the dimensions. "Fourth-dimension coordinates can't be drawn," Norton goes on. "With these

CONTINUED ON PAGE 115

*The Harvard evolutionist who changed biology's definition of species talks about race, population, and the future of natural selection*

# INTERVIEW

# ERNST MAYR

It took a rare bird to change the course of evolutionary biology. A red-crested pochard, to be exact. One morning in 1923 Ernst Mayr, on the verge of entering medical school (he came from a family of physicians), spotted a pair of red-crested pochards on a lake near his hometown in Bavaria, Germany. Since that particular bird had not been seen in Central Europe for 77 years, no one at first believed his tale of having sighted one. Eventually Mayr found a believer in the person of Erwin Stresemann, Germany's leading ornithologist. Though Mayr's family had obviously slated him for a medical career, Stresemann persuaded him to work summers at the University of Berlin's Zoological Museum. In no time Mayr became "so enchanted with the work and with the idea of following in the footsteps of Darwin and other great explorers of the wonders of the tropics" that he forsook the M.D. for a Ph.D. in ornithology. It was a course he would follow for seven decades, culminating in his present position, that of professor emeritus of zoology at Harvard. (It should be noted that

PHOTOGRAPH BY TONY GUCCIONE

The second was that evolution consists of the sudden production of new individuals, or, as [geneticist] Richard Goldschmidt called them forty years ago, "hopeful monsters," which represented new types of animals and plants. Well, that too, has been thoroughly refuted.

The third, usually referred to as Lamarckism, was the idea that the environment can directly influence the genetic material and that a species adapts to the environment by inheriting learned or acquired characteristics. Molecular biology has shown that that is impossible.

So these three are eliminated, which leaves only two more: natural selection and chance. In the Darwinian, and the modern, interpretation of evolution, both occur. Evolution consists of two stages. The first is the production of new individuals. That involves producing eggs and sperm—each of them genetically unique—and then the fertilizing of an egg by a sperm. This stage involves a great deal of chance, but no selection. Then begins a second stage, which is the development of the newly formed fertilized egg into a viable organism. From that point on, natural selection very much enters the picture. So in each generation you have a combination of the chance phenomenon and the selection phenomenon.

***Omni:*** You have said, as others have, that the role of natural selection is creative—that its function is more than simply to ensure the "survival of the fittest." You have even compared the role played by selection to that of a sculptor.

**Mayr:** Survival of the fittest and the elimination of the unfit act by getting rid of only the worst. In reality most animals and plants produce thousands of offspring when, for any given pair of parents, only two are needed to replace them. That's more than the elimination of the unfit. Those two that are left are very specially selected.

The reason I use the metaphor of the sculptor is that the production of new individuals is a process of constantly making entirely new genetic combinations and exposing them to competition, to the elements—in short, to selection. Every generation starts new. As the geneticists put it, all the genes of the previous generation are poured back into the gene pool of the species, or the population. Out of this gene pool are lifted new individuals, totally new combinations of genes that are again exposed to selection. And that, in my eyes, is quite a creative process.

***Omni:*** This process leads not only to new individuals but also to the formation of new species—a subject that has occupied much of your career. What is your definition of a biological species?

**Mayr:** The modern concept of biological species was made widely known through my writings [in the early 1940s], but it wasn't originated or invented by me. As much as eighty years earlier, people had very similar ideas. Before that, the species concept was very much what is called the morphological or typological or essentialistic concept. Something was called a different species if it looked different from other species. My predecessors and I called attention to the fact that this is a very sloppy way of defining species. We have many kinds of species that look identical, and yet we know they are different species. For instance, up to the Thirties, nobody could understand the occurrence and spread of malaria in Europe. It turned out that what were considered to be a single species of mosquito were actually six different species, morphologically identical, but having different chromosomes. Moreover, only some transmit the disease. The opposite problem is that there are individuals that are strikingly different, yet they belong to the same species. In the northern United States, for example, the blue goose and the snow goose couldn't look more different, and so they were once considered to be different species. Then biologists discovered that the geese represent color variations within the same population. They were freely breeding with one another.

*"If it is religious experience we seek, we might sooner find it in scientific research than in so much creationist mumbo jumbo."*

Now we say that two populations are different species if, when in contact, they do not interbreed. The reason why they don't interbreed is that they have certain biological properties, referred to as isolating mechanisms, that have a genetic basis. The process of speciation is then the acquisition of such isolating mechanisms. And that can happen, according to the majority of biologists—and I have been pushing this very hard—only when populations are geographically isolated. In geographic isolation, populations genetically reorganize. Later, if they can no longer interbreed after the extrinsic isolating factor breaks down—say a mountain range is eroded away, or a land bridge forms over a body of water—and the populations are together again, then they have become different species.

***Omni:*** You are now talking about the theory of speciation that you developed in the Forties and Fifties.

**Mayr:** There are two theories of geographic speciation. The classical one is that a widespread range of a species would be split into two by a new geographical barrier. In the course of looking at many examples of speciation, I came to the conclusion that this was not the common way of speciation. Instead, I proposed that what really happens is that a small group of individuals, sometimes a single fertilized female, go beyond the periphery of the species range and establish a new colony. This founder population is subjected to a great deal of inbreeding, which sets up certain genetic pressures. Also, the environment is different. There are different fauna and flora, and the climate differs somewhat. All these selective pressures lead to a rapid and drastic genetic reorganization.

***Omni:*** This relates to the current controversy over how species arise. On the one hand, we have the Darwinian idea, which says that species form gradually. On the other, we have the idea of punctuated equilibrium, proposed by [the American Museum of Natural History's] Niles Eldredge and [Harvard paleontologist] Stephen Jay Gould, which says that the reason fossil records are incomplete is that species arise suddenly, persist unchanged, and then disappear. Isn't their theory based on your concept of founder populations?

**Mayr:** Their 1972 paper is indeed based on my so-called peripatric speciation theory [published in 1954]. And I agree that the fossil record will not ordinarily show any transitional forms between species, because the changes happened very rapidly in small, isolated populations. But where I radically disagree with Gould—or at least with some of Gould's earlier papers, since he has lately retracted most of this theory—is that such speciation is instantaneous. The rate of evolution can be very rapid and yet still be gradual. As Gould said in one of his papers, to a geologist, fifty thousand years are like one moment. Well, in fifty thousand years a new genus can arise by gradual evolution! Of course the paleontologist will say, "This is an outright jump, because for me, that is a moment." In his latest papers Gould seems to distance himself from that position. If somebody were to say, as Goldschmidt did, that in this founder population a new individual is produced, which by itself is a new species, that would be real punctuation. I reject that. I say it is gradual, but, nevertheless, it is rapid.

***Omni:*** In other words, paleontologists cannot find transitional fossils—the proverbial missing links—because obviously they aren't different species.

**Mayr:** Let's put it more bluntly. Paleontologists are totally unqualified—because of their time scale, methods, and materials—to discuss this particular process. It has to be studied by population biologists. Such scientists have demonstrated many cases in which a peripherally isolated population has changed rapidly and drastically, but changed as a population.

***Omni:*** Why does it matter what species are and how they diversify?

**Mayr:** For one thing, it has a bearing on explaining hominid evolution. You've heard of the fossils of *Australopithecus africanus afarensis*, and *robustus*, and of *Homo habilis* and *erectus*. Up to the Nineteen Forties, this was a total and incredible mess. It wasn't until these new ideas were adopted on what species are, and how they evolve and originate, that this mess of anthropological findings could be straightened out. Now it is reasonably clear that there was a time when the hominid line consisted of partially isolated populations, some of them perhaps undergoing peripatric speciation. Out of that came *Australopithecus robustus* and *Homo habilis*. *Robustus* eventually became extinct when it met with competition from *Homo erectus*, which had evolved from *habilis* and which led directly to man. So, by having this concept of biological species and speciation, we can now explain human evolution far better than we could before.

***Omni:*** Since the fossil record is unable to show how species develop, would you agree with Harvard microbiologist Bernard Davis's statement that molecular biology will supplant paleontology as a tool for understanding evolution?

**Mayr:** I think this is a somewhat nasty way of putting it. I would say that molecular biology in the near future will undoubtedly make the greatest contribution, but that doesn't exclude other branches from continuing to make contributions.

***Omni:*** Molecular biologists provide a window on the past by examining the diversity of life and the relatedness of species at the molecular level. How do their findings bear on the mechanisms of speciation and natural selection?

**Mayr:** I recently participated in a conference at which molecular biologist Walter Fitch was asked this very question. He concluded that whatever molecular biology has found, none of it is in conflict with the Darwinian interpretation of evolution. If major changes in our thinking do come about, I think they will concern what roles the different kinds of DNA play in evolution. We now know that the classical idea of a gene—paraphrasing Gertrude Stein, a gene is a gene is a gene—is all wrong. There are many different kinds of DNA and they all have varied functions. In most cases, we still don't really know what their functions are. Even if the functions were known, it would still be rather unclear what their roles in evolution are. That is the big frontier in current evolutionary research.

Many of these kinds of DNA are involved in the regulation of other genes, and, of course, the regulatory function of genes is of far more evolutionary importance than their material-producing functions. We had an international conference in Rome in 1981 on the mechanisms of speciation. It was attended by many of the leading botanists, zoologists, paleontologists, geneticists, cytologists, and biologists. The one thing on which they all agreed was that we still have absolutely no idea what happens genetically during speciation. That's a damning statement, but it's the truth.

Now the techniques of molecular biology will help us solve this mystery. We can compare the genetic content of founder populations with that of their parental populations. We can study the genetics of all these kinds of DNA in very small populations and in big populations. I hope this will bring us closer to understanding evolutionary phenomena.

The questions about evolution will never be answered in the laboratory alone. It will take a combination of laboratory work and field work. The questions that laboratory people attempt to answer often come from field naturalists. Both are asking the same thing: "How can we explain that?"

***Omni:*** You have long been involved in getting people in different disciplines of biology to collaborate. You were one of the architects of the so-called modern synthesis of evolution back in the Thirties and Forties. What was that about?

*"American primary education is absolutely horrible. All discussion of evolution has been eliminated from major textbooks, because otherwise they won't sell in the Bible Belt."*

**Mayr:** We had two main branches of evolutionary biologist—the laboratory geneticist and the field naturalist—and each was highly ignorant of what the other knew and of the kinds of ideas, concepts, and evidence the other had. As a result, they were both one-sided in their explanations. Bringing the two branches together led to a broader, more sophisticated, more mature interpretation of evolution, though it was still within the Darwinian framework.

***Omni:*** Is this old formulation broad enough to incorporate the new findings in molecular biology?

**Mayr:** Well, the actual wordings are constantly being improved and modified, and today we do emphasize chance more. On the whole, though, I agree with Fitch's statement that molecular biology has not affected Darwinism or the synthesis in any substantive way.

***Omni:*** You've mentioned a number of conferences at which different kinds of biologists are getting together and talking about their problems. Would you say that biologists today are aware that they have to communicate more with one another?

**Mayr:** Oh, I think so. I'm very pleased that molecular biologists are so aware of evolutionary phenomena. You know, you can hardly read an article on molecular biology nowadays in which the authors do not speak of the evolutionary meaning of what they have found.

***Omni:*** For a long while, however, wasn't the significance of evolution rather neglected?

**Mayr:** Yes. When I came to Harvard in 1953, there hadn't been a course offered on evolution in something like twenty to thirty years. Evolution was considered old-fashioned. "Oh, yes, we know that man descended from the apes, that common descent explains everything, that species are not static. What else is there to know?" In the mid-Forties I applied to the grant committee of the American Philosophical Society for money to start a journal to be entitled "Evolution." All the members of that committee—historians, physicists, chemists, astronomers—favored giving me the five thousand dollars I requested. The only dissenting voice was that of embryologist Edward Conklin, the only biologist on the committee. He said precisely what I just told you: "Evolution is a well-established fact, what else is there to know?" Now, of course, *Evolution* cannot handle all the manuscripts it gets, and there are several other journals devoted to evolutionary biology. To paraphrase Dobzhansky, nothing in nature makes sense except in the light of evolution.

***Omni:*** Do you think young biologists are being taught not to be so narrow?

**Mayr:** I would hope so, but I don't know. My own courses have always been very broad, but some of my colleagues' courses are not equally so.

***Omni:*** Isn't such breadth almost mandatory for understanding biology as a whole?

**Mayr:** Yes, but it's very hard to achieve. Even in one's own specialized field, so much is being accomplished nowadays that it is difficult to keep up. If you were to tell scientists they had to know about their neighboring fields and a little bit about philosophy and history and so forth, they would throw up their arms in despair.

***Omni:*** A communication gap also exists between biologists and other scientists. What makes that gap so difficult to bridge?

**Mayr:** Ever since the great success of the Scientific Revolution—the revolution of the physical sciences, of Copernicus, Galileo, and Newton—people in the physical sciences have thought that physics *alone* was science. For a long time they thought they could ignore anything that was not physics. Some well-known physicists have even referred to biology as postage-stamp collecting or as dirty science.

People in physical sciences were also reductionists. They thought that everything could be explained in terms of atoms and elementary particles. We have had a great intellectual revolution in this area. We all realize now that such flagrant reductionism is very bad. Many things, even in physics, cannot be explained that way.

Physical scientists also thought that any

CONTINUED ON PAGE 118

*An interstellar hitchhiker from Arcturus sojourns in an out-of-the-way corner of a pleasant little galaxy called the Milky Way*

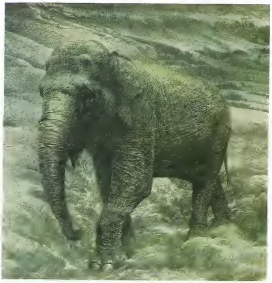
# VACATION ON EARTH

BY ROBERT SHECKLEY

I spent my school vacation on a planet that was once famous, but nowadays is seldom visited. It's so lovely from a distance, with its blue-and-white marbled surface. It is called Earth. The travel agent told me that most of the native inhabitants are gone now, but I met a lot of interesting creatures there. Most of them were very friendly.

PAINTINGS BY ROLAND CAT

*"The swans were really neat, and they sang in perfect harmony. But the elephant's poem didn't make much sense to me."*



My favorites were the penguins, who laughed and joked and played games all the time, and the swans, who were courteous and formal and sang old ballads about knights and princesses. I also met a very large grandfather elephant, who liked lazing in the sun all day long. He recited several poems that I didn't understand.

Earth is a beautiful place, with tall, misty mountains and broad grasslands and white beaches and cool forests. In fact, it has just about every kind of scenery you can think of. The place where I stayed had a lot of shallow lakes and marshy green meadows. You could paddle and dive and swim and wallow in the mud for as long as you wanted. Some of the older girls in my group liked it so much they even laid eggs in one corner of the marsh, though I don't think they were supposed to. I wonder if they'll hatch.

*Currently on exhibition at Paris's Galerie Ivy Brachot: detail from* Les gourmands *(page 80),* Le jeu *(page 81),* L'isolement *(opposite), and detail from* Rescape *(above).*

*"New York must have been a fun place back when it was above water. But I think I like it better now that I can swim through it."*

I also visited an old stone house with a funny sort of slide nearby, which the penguins loved to climb. They thought human cube once must have played there. And I saw a genuine human person's bed right in the middle of a swamp. I don't know how it got there.

The planet was just great, but the best part was my visit to New York City. I loved swimming around the buildings and playing hide-and-seek with the baby squid who lived in the subways. The dolphins were very friendly and told me stories about New York in the old days, when it was above water and the tops of tall buildings actually touched the clouds. Frankly, that was hard for me to imagine. I'm glad to be back home on Arcturus now, but I thought Earth was really special, and I'd like to go there again next summer. Maybe by then they'll have gotten around to replacing the people. OO

*Detail from Le lit défait (above). En dessous (opposite) is widely known as a poster for Greenpeace, an organization dedicated to the protection of the sea's denizens.*

# DEATH SENTENCES

*Haunting tapes show that airplanes sometimes crash when words fail*

The first thing you notice about the black box is that it isn't black. It's orange. That's so it will stand out among the smoldering heaps of charred wreckage where they usually have to hunt for it. There's a fat strip of reflective tape across its middle, too, in case they go looking in the dark with flashlights. And it has an underwater locator beacon that can "ping" for 30 days after the crash. That was how those Navy searchers found one black box at a depth of more than 10,000 feet in the Ionian Sea eight years ago while looking for a TWA jet liner that disappeared after leaving Rome. They were unable to recover the box, but at least the beacon told them they could stop wondering what had happened to the plane. It blew up in midair when a bomb planted aboard exploded.

Inside the black box is the tape recorder, well-protected by fireproof insulation and a stainless-steel jacket that boosts the box's weight to 36 pounds. You could cook the whole

BY DAVA SOBEL

PHOTOGRAPH BY ERIC MEOLA

thing in a barbecue pit for half an hour and the recorder would still play, which is good because the words on the tape may be the only clues to why the airplane is nothing but a smoking hole in the ground. Close to indestructible, the equipment survives to reveal that accidents most often begin with human error, through subtle failures in interpersonal communication or snags in the delicate web of language.

Sometimes, like ghosts, the words are shadowy suggestions of what went wrong before the crash. "Come on back, You're sinking, Don. Come on back," they say. Or, " 'Are we clear of that Cessna?' 'Suppose to be.' 'I guess.' 'I hope.' "

Sometimes they are just plain haunting.

"Brace yourself."

"Ma, I love ya."

"I'm sorry . . . I'm sorry . . . "

The voices on the tape are those of the captain, the first officer, the flight engineer, and sometimes the cabin attendants, as well as the radio transmissions from ground control and other aircraft. The tape itself is a 30-minute continuous loop that is progressively erased and recorded over so that only the final half-hour of dialogue ever survives from any flight. Half an hour is more than enough in most cases, because disasters in the air tend to play themselves out quickly. As much as three quarters or more of the tape may be full of laughter and banter, like the conversation aboard one Air Florida 737 before it hit that bridge and plunged into the Potomac last winter.

Tapes from the black box—or cockpit voice recorder, as it is officially known—are the private property of the commercial airlines, but accidents open them to scrutiny by the National Transportation Safety Board, and from there the transcripts enter the public domain. They are published routinely as matters of record in the pages of *Aviation Week & Space Technology*. As a body of literature, however, the transcripts constitute a macabre forbidden experiment in human psychology. What happens to people when they suddenly realize they probably are about to die?

Here is a conversation between two stewardesses after their plane was struck by lightning over Georgia. (The two spoke on a telephone intercom connected—like the cockpit microphones—with the recorder near the tail of the plane.)

**Stewardess A:** Sandy?

**Stewardess B:** Yeah?

**Stewardess A:** They [the cockpit crew] would not talk to me. When I looked in, the whole front windshield is cracked.

**Stewardess B:** Okay, so what do we do?

**Stewardess A:** Ah, have they said anything?

**Stewardess B:** Ah, he screamed at me when I opened the door, 'Just sit down!' So I didn't ask him a thing. I don't know the results or anything. I'm sure we decompressed.

**Stewardess A:** Ah, yes, we've lost an engine—

**Stewardess B:** I thought so.

**Stewardess A:** Have you briefed all your passengers in the front?

**Stewardess B:** Yes, I told them I checked the cockpit, and help me take the door down.

**Stewardess A:** Have you removed your shoes?

**Stewardess B:** No, I haven't.

**Stewardess A:** Take off your shoes. Be sure to stow them somewhere right down in the galley in a compartment in there with the napkins or something.

**Stewardess B:** Okay.

**Stewardess A:** Right down in one of those closets. I took off my socks so I'd have more ground pull with my toes, okay?

**Stewardess B:** You'd have what?

**Stewardess A:** So I took off my socks so I wouldn't be sliding.

**Stewardess B:** Yeah.

**Stewardess A:** Okay.

**Stewardess B:** That's a good idea, too.

**Stewardess A:** Okay.

**Stewardess B:** Thank you. Bye-bye.

Researchers understandably are fascinated with human performance under pressure, and many studies have been conducted on the behavior of flight crews in mock crises. These simulations allow an unlimited number of volunteers to be subjected to the same set of circumstances and allow observers to draw general conclusions that may prove quite valuable. The black-box tape, on the other hand, supplies the unmistakable ring of reality.

*"I got it," he says again hopefully, two seconds before a wing tip catches on a tree or a telephone pole, the beginning of the plane's disintegration.*

**Captain:** What have we got here?

**Copilot:** It's bad.

**Captain:** Huh?

**Copilot:** We're hit, man. We are hit!

**Captain:** Tower, we're going down. This is PSA [Pacific Southwest Airlines Flight 182].

**Tower:** Okay, we'll call the equipment for you.

**Copilot:** Whoo!

**Captain:** This is it, baby.

**Copilot:** . . . [profanity, deleted from transcript].

Among the Transportation Safety Board's grim archives, surprisingly, there isn't a single case history of a crew that fell apart in its final moments. At worst, first names and terms like *man* or *baby* replace proper rank designations, and the use of profanity increases. "Oh, shit," are the most frequently heard last words of a pilot.

"You see they weren't going to die," says Paul C. Turner, chief of the Safety Board's Audio Lab, in describing this staunch attitude. "Nobody's gonna crash, nobody's ever doomed, everybody's just flying and fighting to the end."

In one extreme example that Turner says he "relived many times" by playing the tape of the accident again and again during his investigation, the pilot of the plane struck by lightning over Georgia lost both engines—two out of two. "Let's get the next clear, open field," the captain says as the plane descends, far from any runway. Then the crew turns to a thin lifeline, a stretch of state highway outside New Hope, Georgia. The copilot talks as if he can pull it off. "I've got it," he says. "I got it. I'm going to land right over that guy." Apparently the plane is gliding in above a car. "I got it," he says again hopefully, two seconds before a wing tip catches on a tree or telephone pole, the beginning of the plane's disintegration in which most of the crew and passengers are killed.

Psychologists who have opened the black box, expecting hysterics and crackups under stress, have come out with something far more interesting. The average flight crew could probably continue to function in the jaws of death, but many crew members perish needlessly. Black-box tapes demonstrate convincingly that the majority of fatal airline accidents result from miscommunication in the cockpit, from misunderstanding or mismanaging a relatively simple problem.

"Only rarely is a crew hit with a sudden disaster like that of the American DC-10 that had an engine fall off over Chicago in 1979," says Robert Helmreich, professor of psychology at the University of Texas at Austin. "By far the more frequent pattern is that a minor problem crops up, and then, through lack of crew coordination, it is allowed to develop into a major incident."

A case in point is the Florida Everglades crash of 1972. The plane was an Eastern L-1011, and the initial problem was a burned-out light bulb in the landing gear indicator. While the pilot, the copilot, and the flight engineer were busy trying to repair the signal, the plane flew on autopilot. Then the autopilot disengaged, and the plane went down in the swamp.

"That was what you call a classic accident," says psychologist John K. Lauber, program manager in operational problems research at NASA's Ames Research Center at Moffett Field, in California. "All they needed was for someone to say, 'You look for the bulb. I'll fly the plane.' "

In aviation safety research at NASA, Lauber's colleagues H. Clayton Foushee and Karen L. Manos identified 60 accidents from 1968 to 1976 that were all caused by related kinds of interpersonal glitches: inadequate leadership, failure to delegate tasks and assign responsibilities, preoccupation with small mechanical problems,

failure to communicate intent and plans, failure to set priorities, and the like.

Foushee, who is research psychologist in NASA's Man-Vehicle Systems Research Division, saw this kind of "information-transfer breakdown" in the black-box transcript from the Air Florida 737 that was made public only recently.

"The copilot made several comments to the effect that something didn't seem right, but somehow the concern didn't get across to the captain," Foushee says. Here are some excerpts from the dialogue while the plane was in line for takeoff clearance (the numbers refer to the time of day, '1548:59' means 3:48 and 59 seconds P.M.):

**1548:59 Copilot:** See this difference in that left engine and right one?
**Captain:** Yeah.
**Copilot:** Don't know why that's different.
**1549:05 Copilot:** Less it's his hot air going into that right one; that must be it.
**Copilot:** From his exhaust.
**Copilot:** It was doing that in the chocks awhile ago, but, ah.
**1551:05 Copilot:** This thing's settled down a little bit. Might'a been his hot air going over it.
**1558:26 Copilot:** Slushy runway. Do you want me to do anything special for this or just go for it?
**1558:31 Captain:** Unless you got anything special you'd like to do.
**1600:02 Copilot:** That don't seem right, does it?
**1600:05 Copilot:** Ah, that's not right.
**1600:09 Captain:** Yes, it is. There's eighty.
**1600:10 Copilot:** Naw, I don't think that's right.
**1600:19 Copilot:** Ah, maybe it is.
**1600:21 Captain:** Hundred and twenty.
**1600:23 Copilot:** I don't know.
**1601:00 Copilot:** Larry. We're going down, Larry.
**1601:01 Captain:** I know it.
**1601:01** ((Sound of impact))

"The flight deck is a management situation just like any other job situation," Foushee says. "And while you can't have two people in command, there are circumstances where two, or even three, heads are better than one."

In short, there probably isn't a pilot flying today who wouldn't benefit from a course in managerial style, and junior crew members would stand to gain a lot from assertiveness training. But the airlines traditionally limit their consideration of psychology to screening out psychopaths when they hire fliers; emphasis is placed on technical instruction in the use of the controls.

They are only now recognizing that group dynamics ranks right up there with aerodynamics when it comes to trouble-free flying. Many of them, beginning with Northwest in 1976, are using simulated missions called Line-Oriented Flight Training to improve decision making and crew coordination. Others send their crews to the Institute of Safety and Systems Management, at the University of Southern California, where psychologist Chaytor Mason teaches what he calls "human behavior in the cockpit—pilots' strong points and weak points, what things can aid them, and what things can screw them up."

When it comes to exemplary training efforts, however, NASA psychologists say that United Airlines is far ahead of the rest of the industry. At United's pilot training center in Denver, Captain Robert Crump teaches a still-evolving course called "Command, Leadership and Resource Management." Thus far it consists of a self-study program sent to all of United's 5,000 pilots and a four-day seminar for those who have completed the at-home work. Chief among the audiovisual aids at the seminar is a tape/slide program that uses the black box tapes to re-create accidents that might have been avoided. A case study from 1978, for example, finds a flight crew repeatedly miscommunicating about fuel projections as their DC-8 approaches Portland, Oregon, and then getting so distracted by a test of their landing gear warning horn that they actually run out of fuel. The engines flame out and the plane crash-lands short of the runway. Eight passengers and two crew members are killed.

*"Moving at 250 knots, I repeated, "Approach said, 'Slow to 180,'" and his reply was something to the effect of "I'll do what I want." I told him twice more and received the same answer."*

Crump, couching his words in pilot's jargon, says that "the aircraft was in mechanical condition to continue flight or safely land," and he lays the problem, "without pointing a finger," he says, to 'human factors, mistakes or omissions in command.'

Although the official Safety Board report blamed the accident on the crew's failure to monitor fuel level, the black-box tape contains more than a dozen references to fuel level. For example, about 26 minutes before the crash, the first officer requests the fuel level, the flight engineer reports 5,000 pounds, and the first officer acknowledges the report. Two minutes later the first officer asks the captain about the fuel level. The captain puts it at "five" (5,000 pounds), and the first officer repeats the word *five*. Barely a minute passes before the flight engineer expresses fears that there isn't enough fuel to make it through the 15 minutes remaining in the flight. But the flight engineer inexplicably puts his doubts aside in the next minute, telling United personnel on the ground, "We'll be landing with about four thousand pounds of fuel."

If everyone was talking about fuel, why didn't anyone try to land the plane sooner or realize the danger in time?

A possible explanation came recently from Charlotte Linde and Joseph A. Goguen, of Structural Semantics, a small Palo Alto research organization working with NASA on aviation safety. They performed a detailed linguistic analysis of the transcript from United/Portland/1978, charting all the questions, reports, projections, and other communications about fuel level to try to understand what went wrong.

One problem they spotlighted was the "mitigated" way in which crew members tend to make projections and reports to the captain, Linde says. In other words, instead of speaking out forcefully, they soften the impact of their words, whether out of politeness or fear, and they often fail to challenge the captain when he's wrong. In a summary of their study, Linde and Goguen furnish several instances of this attitude. One of these occurred about 20 seconds after the first engine flamed out.

"At 1807:00 [6:07 P.M.] the captain reports, 'Showing a thousand [pounds] or better,' and the first officer challenges this report with, 'I don't think it's in there.' The flight engineer says, 'Showing three thousand, isn't it?' which we interpret as a mitigated report'—a muted protest and also a non sequitur, after the captain's reference to "a thousand or better."

"At 1807:31 the flight engineer reports, 'It's showing zero,' and the captain responds, 'You got a thousand pounds. You got to.' At 1807:51 the captain reports 'Showing down to zero or a thousand,' which is acknowledged by the flight engineer.

"At 1808:50 the flight engineer reports, 'Not very much more fuel,' which represents a vague range of values, and at 1809:10 he says, 'We're down to one on the totalizer,' then, 'Number two is empty.'"

Helmreich, who also conducts research for NASA, says that this crash led the Safety Board to recommend assertiveness training for junior crew members. "Role demands and status inequality, not to mention the possibility of somewhat autocratic senior crew members," Helmreich says, "can combine to stifle teamwork."

Indeed many crew members have corroborated this sentiment in reports of near misses they lived to tell about.

"I was the copilot on a flight from JFK to BOS. The captain was flying. We were given FL210 [told to fly at 21,000 feet], which was our flight plan altitude. I noted we had reached FL210 and were continuing through it but was reluctant to say anything. As we climbed through 21,300 feet, I mentioned it to the captain, but not forcefully enough, and he did not hear me. I mentioned it again and pointed to the altimeter. We were at 21,600 feet when the climb was stopped and we descended back to 21,000. As we started our descent, Center called and told us to maintain FL210. The captain said he

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# MEGALITHS

CONTINUED FROM PAGE 52

lyze agglomeration. Davidovits further points to the unusual limestone that makes up the pyramid's interior blocks. He handed me a sample of the cream-colored rock; it was a rough collection of numilites—prehistoric disklike shells about 0.5" in diameter. Then he showed a similar, unworked natural numilitic limestone that he'd found in France. Unlike the pyramid stone, the dime-sized shells in this rock were arranged in neat layers, as if they had softly settled to the bottom of an ancient sea.

All this leads him to believe the pyramid stones were artificial. Egyptian workers could have carried limestone rubble to the worksite in buckets, mixed it with Nile River silt for the needed aluminum and silicon binder, and added locally obtained salts as catalysts to make the solution alkaline, or basic. They could have dumped the ingredients into wooden molds. A few hours in the desert heat would have dried the mixture to rock. This, says Davidovits, could have been done with neither massive ramps nor difficult tooling. Hence the jumbled numilites in the limestone. This would also explain how each 2.5-ton casing block was laid so close to the next. After one block dried, it formed the mold for the next.

From pyramids Davidovits proceeded to talk about other ancient monuments. Consider the Easter Island statues, for example. Archaeologists are certain that Polynesian tribesmen carved the monoliths from a quarry in the 1600s, but Davidovits says they were actually cast from loose quarry stone. The evidence? A 1972 UNESCO study reports that the porosity—or air content—of the 60-ton statues is significantly higher than that of rock in the quarry from which the stones are thought to originate. The implication, Davidovits says, is that the quarry stone was broken down and recast.

Or consider the massive slablike ruins in the mountains of Bolivia. No one knows how the pre-Incan Indians built the monolithic, arched Sun Gate of Tihuanaco. The nearest quarry is several miles away over rugged mountains. But legend tells of a long-lost tribal art of turning rock into clay. Even today witch doctors in Bolivia are known to powder rock, add natural chemicals, put the slurry in a mold, and produce amulets of solid stone.

Could a similar method have been used to build the Sun Gate? Davidovits says a chemical analysis of the stone showing a small amount of silico-aluminates provides a clue. Suppose that instead of hauling a multiton stone over mountains, the Indians had simply hauled sacks of the crushed basaltic rock. They could have added this powder to a silico-aluminate binder, formed the monolith in a mold, and then erected it in place. They could have made the binder, he says, by dissolving common rock with acidic plant extracts. (Acidic saps from rhubarb and cactus actually do melt lime-

*"The nausea, the blisters, the low blood count—it's just like the survivors of Hiroshima and Nagasaki."*

# ANTI MATTER

## UFO UPDATE

Three Texans, the federal government, and a colossal diamond-shaped flying machine are about to come head to head in one of the most disturbing UFO cases in history.

The story (reported here in February 1982) began on the chilly winter evening of December 29, 1980, when Betty Cash, Vickie Landrum, and Vickie's grandson, Colby Landrum, were driving through the woods to their home in Dayton, Texas. Traveling through an especially deserted stretch, they looked up ahead to see a hovering diamond-shaped object spitting a jet of searing flame. Afraid they were about to be killed, the trio briefly got out of the car to escape the heat. After the craft flew off, they continued down the road. Rounding a turn, they saw the craft again, this time followed by more than 20 helicopters.

In the following months Betty and Vickie, both only in their fifties, lost much of their hair; when it later grew back, it was thinner, drier, and grayer. Holes developed in Vickie's fingernails. She developed a cataract in her right eye, and the vision in her left narrowed until she was looking through a small cone of light. Seven-year-old Colby, whose vision had been perfect, began wearing glasses. All three suffered from nausea and weakness.

This past year the situation has gotten worse. Betty has had a heart attack as well as a stroke that temporarily paralyzed her. Vickie and Colby break out in sores that permanently scar their face and limbs. Colby has had anemia, and doctors say he might develop leukemia.

"There's no doubt," says the radiologist on the case, "that they were exposed to a broad spectrum of radiation. The nausea, the hair falling out, the blisters, the low blood count—it's just like the survivors of Hiroshima and Nagasaki." It would certainly help treatment, he adds, "if we could find out exactly what type was involved."

That information is not available, however, since the government has denied any knowledge of the craft. Investigations led by McDonnell Douglas engineer John Schuessler have turned up a number of witnesses to the helicopters, repeatedly identified as military-type Chinook aircraft. But even the Army Inspector General could produce no admissions from any branch of the military.

The treatment has also been limited because the victims have run out of money. Neither Vickie nor Betty can work. Totally incapacitated, Betty has gone to Alabama to live with her mother. Vickie can't see well enough to drive or do desk work, and her sores and scars are too unsightly to allow her to work with the public. So, even though she needs a new prescription for her glasses and though Colby has developed knots the size of thumbs in his knee joints, neither has been to a doctor in several months.

Now, down to perhaps their last hope, they are taking their case before the courts, seeking damages from the government, along with access to hidden information that might help them. "I love my country," Vickie says, "but the country's supposed to make you free, and in my heart I know it's chained me to misery."—*MARK TEICH*

## DRACULA'S BLOOD

Prince Vlad Tepes, the savage fifteenth-century Transylvanian who became the model for the fictional vampire Dracula, may have been driven mad by an allergic reaction to blood.

That, at least, is the conclusion of Idaho physician Thomas McDevitt, who says that someone allergic to a substance may also develop an addiction to it. "When deprived of the irritant," he notes, "the allergy victim can react in a bizarre or greatly agitated manner." Thus, if Tepes was allergic to blood, he might have become violent when deprived of it.

As evidence for his theory, McDevitt points out that the real-life Tepes reputedly impaled the heads of hundreds of Turks on stakes near his castle, a sign that he "probably did drink blood, both human and animal." Furthermore, portraits of Tepes show a man with all the characteristics of an allergy victim—a sallow, pallid complexion, dark circles under the eyes, and even swollen cheeks. Bram Stoker's description of Dracula, with his nostrils flared and teeth bared, McDevitt adds, might simply be a picture of a person trying to breathe through a stuffy nose.

McDevitt admits his view of Tepes, or Dracula, is only a theory, but it bears out his contention that people with allergies can act in strange, cruel, and unpredictable ways.

If Tepes were alive today, McDevitt adds, doctors could probably cure him with modern immunological techniques.—Joel Schwartz

*"He who does not fill his world with phantoms remains alone."*

*—Antonio Porchia*

## DRAGON-UFO MIX-UP

Look carefully. The next UFO you see may actually be a flying dragon. The two are easily confused, according to Paul Johnsgard, since "most UFO sightings occur in spring and fall—the seasons for dragon migration." Like UFOs, Johnsgard says, dragons glow in the dark, "probably because they exhale large amounts of methane, which can be ignited by lightning." To produce the dramatic fire-breathing effect, he adds, the European dragon "gnashes its teeth together so violently that sparks fly."

Little-known facts such as these abound in *A Natural History: Dragons and Unicorns*, a book in which University of Nebraska zoologist Johnsgard and his daughter, Karin, apply rigorous scientific methods—mingled with legend and a heavy dose of fantasy—to the study of two mythical creatures. Among their findings: Unicorns evolved from two-horned ancestors; dragons do not devour maidens; and no self-respecting dragon has ever been found with more than one head.

For centuries, the authors note, dragons have been the victims of "bad press" and of self-righteous dragon slayers hoping to "hack their way into history." Unicorns, too, have been abused, especially by men exploiting them for their virgin-detecting abilities. No wonder, says Johnsgard, that "dragon and unicorn populations have continued to decline precipitously in recent years."

Fortunately, the authors promise, these wondrous creatures can still be found "anywhere that the heart and imagination are receptive." In fact, they close their book with a field guide.—Carol Truxal

## LEAF MONSTER

The renowned, much-sought-after, and frequently sighted monster of Loch Ness, affectionately known as Nessie, is not just one creature—and actually is not a creature at all—according to naturalist Ben Seniscal, of Buckinghamshire, England. Nessie, he declares, is merely an occasional heap of rotting leaves ripped from the bottom of the loch and propelled across its surface by the gases of decay.

Seniscal, who has worked for the Forestry Commission in Scotland, was knee-deep in the hippopotamus pond at the Whipsnade Zoo one summer day after its usual inhabitants had been absent for several weeks. Suddenly, he recalls, a large swirl of hippo droppings rose from the bottom of the pond, quickly gathered speed, and charged some 75 feet along the water's surface before gently sinking into the abyss. It was an important moment for Seniscal, who wasted no time in fitting the sequence of events to the area of Loch Ness.

Instead of the droppings that made up the pond monster, he contends, Nessie consists primarily of leaves from birch, oak, and other deciduous trees that account for the magnificent fall foliage around Loch Ness. Seniscal hypothesizes that some leaves and branches fall directly into the loch in autumn, while many more are carried there by the fast-flowing rivers and streams that feed into it. Like sleeping monsters, enormous mounds of various shape remain quiescent under the pressure of the loch's waters all winter long. Then the warming waters of spring hasten decomposition, and the methane gas released by that process loosens rafts of sunken vegetation weighing tons.

Seniscal notes that television films of the monster show it traveling in a straight line only. Propelled by methane, he adds, his "monsters" would usually swim as the crow flies, too.

The theory suggests why Nessie has as many differently shaped heads as there are pictures of her. Her "head" must be a root or branch from a tree. The fact that she is most often sighted in July or August is also consonant with Seniscal's idea. And of course reports of Nessie's strange silence—rarely more than a gurgle as she vanishes—are easily explained by the leaf hypothesis.

How to prove the true nature of Nessie? "One way," Seniscal says, "would be the wholesale scattering of silver foil pieces in the areas where they are most likely to be carried down and shaped when the streams and rivers are active, constant monitoring of these areas by radar at the appropriate season would indicate any movement."—Dava Sobel

*"Wisdom is still a galaxy light-years away."*
*—Jack Henry Abbott*

## HEART TO HEART

One disembodied frog heart can control the beating of another at distances up to half an inch, reports a Russian scientist whose article recently appeared in the journal *Psi Research*.

Dr. Gennady Sergeyev began his study by removing two frog hearts and placing each in a separate dish. One heart was left alone, the other given a toxic dose of gitalin, a drug similar to digitalis. The drugged heart slowed and lost its rhythm, as expected. But so did the untouched organ.

When ordinary air or quartz glass separated the two dishes, Sergeyev learned, the hearts stayed synchronized about half the time. But when black paper was used as a barrier, the heartbeats always differed. Thus, Sergeyev has concluded, the organs communicate not through sound, but rather by weak beams of ultraviolet light.

This isn't the first time hearts have been controlled at a distance, Sergeyev notes. Recording the electrocardiograms of two persons seated about six feet apart, he says, he discovered that the heartbeat of one mirrored the emotions of the other. And years ago he and Leningrad scientist S. P. Sarychev discovered that prominent psychic Nina Kulagina could stop the beating of an isolated frog heart through mental powers alone.

—Owen Davies

*"Space is felt as a great thing. There is some pinch of narrowness to us, and we laugh and leap to see the world, and what amplitudes it has. . . which yet are but lanes and crevices to the great Space in which the world swims."*
*—Ralph Waldo Emerson*

## PSYCHIC STOCK MARKET ANALYST

Bevy Jaegers, of Creve Coeur, Missouri (below), has become a real embarrassment to professional stockbrokers. She predicted five stocks likely to increase in value—and, though she based her choice on "psychic premonitions" alone, she outperformed all but 1 of 19 stockbrokers.

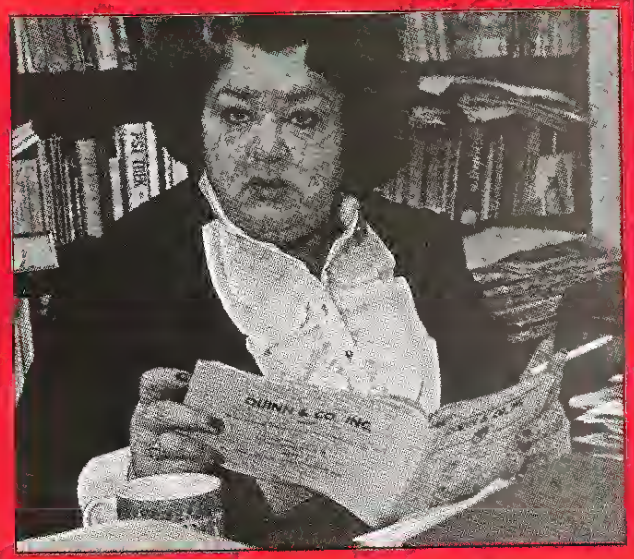
In a recent test conducted by the *St. Louis Business Journal*, 20 entrants (including Jaegers) submitted the names of five stocks apiece. During the next six months the Dow Jones industrial average—a gauge of stock market performance—fell 8 percent. But Jaegers's stocks went up an average of 17.2 percent (compared with 17.4 percent for the lone stockbroker who bettered her). Sixteen of the stockbrokers finished in the red. If Jaegers had backed her selections with cash—which she didn't—an investment of $5,000 divided equally among the five stocks would have returned $829 profit.

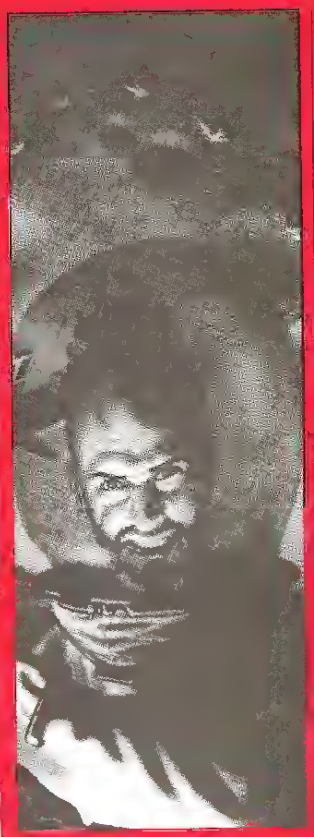
Jaegers says she randomly chooses stocks from Standard and Poor's index of companies, places each company name in an unmarked envelope, and then grasps each envelope separately. "If it's a good stock," she asserts, "the envelope feels hot against my hand."

Jaegers started picking stocks in 1977 and claims to have parlayed an initial investment of $3,000 into $22,000.

For a $50 annual fee, she'll mail you monthly issues of *Hotline Update*, a newsletter of stock market predictions.—Eric Mishara

*"It is a condition which confronts us—not a theory."*
*—Grover Cleveland*



## COSMIC BRAINS

Humans may be the only intelligent species around today, but the universe should soon be teeming with all sorts of clever creatures. That's the best guess of paleobiologist Dale Russell, of Ottawa's National Museum of Natural Sciences, who says, "Intelligence in the universe may be like a yeast cake—coming up fast."

Russell has been studying the fossil record to determine the increase in earthly brain size—and intelligence—over the millennia. His conclusion: Creatures on Earth seem to be developing larger, better brains at an ever-quickening pace. If the same is true extraterrestrially, Russell reasons, then even if intelligent aliens don't exist now, they could "within a cosmic eye blink."

Scientists who predict the existence of just a *few* intelligent civilizations in the galaxy, Russell says, are being overly conservative. "Their estimates," he explains, "are based on the erroneous assumption that such civilizations will exist for a while, then simply die out. But biology just doesn't work this way."

For instance, he continues, "Though the human species itself may cease to exist, it could give rise to a more clever species. And that group could produce still cleverer descendants. It's also possible," he notes, "for man to be replaced by an entirely different creature; already the parrot, elephant, and dolphin are as large-brained as some of man's ancestors and closest relatives."

Man cannot be as isolated as he seems, Russell maintains. "We haven't yet detected extraterrestrials." But the universe is still evolving, he says, and is most likely full of civilizations just on the brink of technological sophistication, nearly ready to greet us through the vastness of space.—Carol Truxal

*"Until we reach Mars, we can write about Mars as we please."*
*—Vincent Starret*

# FIREPOWER

CONTINUED FROM PAGE 47

ton, technical assistant at the plant. "Because of the system's strong magnetic field, we need cooling water that is as free of impurities as we can get it. We can't have it eating away its pipes, for instance. And so stainless steel, which resists that sort of corrosion, helps keep the water pure.' Just a few dissolved metal molecules in the cooling water could be as disrupting as sugar in the gas tank.

But midwifing at the birth of a new technology is never easy. And MHD is having a particularly difficult delivery. For one thing, the engineers must cope with searing temperatures. For another, the technology is unlike any standard power-generating system on Earth.

The main difference is apparent in the Montana plant. Instead of banks of whirring turbines, there is that machine—called an MHD channel, resembling a toppled rocket. It is the new technology's heart, and it goes back to Faraday's great discovery. When a conductor, such as a copper wire or hot gas, moves through a magnetic field, the field induces an electric current in the conductor. A standard turbine, whether it is spun by falling water or whirled by steam, forces wires to slice through the lines of a magnetic field like a propeller cleaving air. MHD designs look more like a ramjet or a rocket. There are no turbines, no moving parts.

Curiously, this "rocket" power doesn't come from exotic or futuristic fuels. The whole process begins in a venerable pot-boiler, a coal furnace. Gases from high-temperature coal combustion are collected, pressurized, laced with a potassium compound to improve conductivity, and injected at supersonic speed into the MHD channel. (Potassium nuclei hold electrons weakly, so that even at relatively low temperatures they can be easily stripped away to bolster the flow of electrons that is an electric current.) Bracketing the sides of this tunnel are high-potency magnets, called superconductors, operating at liquid-helium temperature. The roof and floor of the channel are paneled with a mosaic of rectangular plates, each a few centimeters long and wide; these water-cooled electrodes tap the direct-current power from the gas. This coal-fired rocket generator is no 'small is beautiful' device. It's high-tech. But its advantages have enthusiasts raving.

Mainly MHD gets a gold star for efficiency. The hotter the process, the more efficiently a given amount of fuel—coal, for instance—can be converted into kilowatts. But above 1100°F standard turbine generators would be in trouble. For one thing, at higher temperatures, so much steam pressure would build up that it would rupture the containment vessel. For another, overheated moving parts can crack and warp. But an MHD generator, with no steam and no spinning parts, can run at 5000°F. The result is a dramatic increase in efficiency. Most standard coal-fired generators operate at about 33 percent efficiency. Nuclear plants are even less efficient. An MHD generator operates at about 50 percent efficiency. Half of the energy in the coal winds up on the power grid. (These figures aren't comparable to efficiency ratings of oil or gas burners, which often burn at 70 to 80 percent efficiency, but produce only heat, the most plebeian of energies.)

There is more. After the gas has flowed through the magnetic field, it is too cool to produce more current. But it is still sufficiently scorching to boil water. And so, "downstream" from the magnets, the heat in the gas can produce steam to drive a standard turbine engine and generate more electricity—a free bonus since the gas (in the Montana system) is eventually dispersed into the air. And as an odd little side trick, an MHD generator can be rigged to manufacture fertilizer. Spare energy heats air, and nitrogen and oxygen combine to form nitrogen oxides. Using various chemical processes, engineers can then extract the nitrogen compounds and sell them as fertilizer. "That little trick alone could defray twenty-five percent of the cost of making electricity," says one MHD expert. As a final serendipity, potassium poured into the gas to make it conduct better combines with sulfur, one of the undesirable by-products of coal burning. This chemical marriage in the hot channel yields potassium sulfide compounds, easy to recover. Letting nothing go to waste, the MHD plant then breaks down the compounds, reuses the potassium to salt the coal gas, and sells the sulfur.

Considering all this wizardry, why are MHD plants not humming across the country right now? The answer is something of a saga, partly about technological bear wrestling, partly about political shoving matches and competition over scant funds. And some say the saga really is about a nation that has turned chicken.

MHD has been waiting in the wings ever since the electric power industry began. Engineers seeking more efficient generators would contemplate the sun, where white hot gases flare out, lancing the lines of magnetic force and producing electrically charged particles that interfere with radio transmissions and make the northern lights dance. Could that venerable process be tamed?

As early as Faraday's time scientists toyed with this idea. The principle was clear as the sun, but niggling details nagged researchers trying to bring the theory down to Earth. For example, what should the conducting fluid be? The gas chosen is important, since different gases have varying properties, electrical and otherwise, at different temperatures. Steam, for instance, turned out to be too poor a conductor to work for MHD. But what gas was best, and at what temperature?

Such questions had stymied engineers

for years. Then, shortly after World War II, at Cornell University's Aero School, Dr. Arthur Kantrowitz and a team of graduate students measured the conductivity of a wide range of gases, at higher and higher temperatures. For a fraction of a second they even managed to produce temperatures much higher than the sun's. And their data on gas conductivity as a function of temperature led eventually to the discovery that combustion gases from burning coal, or other fuels, at about 5000°F, worked well for MHD. The Cornell research was a breakthrough. A rocket firing into a magnet, Kantrowitz called the nascent technology. To a growing number of followers, he became the MHD guru.

But the government was committed to nuclear power. And without federal funding, MHD was dead. Then, in 1956, Kantrowitz founded Avco Everett Research Laboratory and quickly won an Air Force contract that led to MHD's next surge, on the back of ballistic-missile research.

To study the effects of high temperatures on missiles as they swooped down into the atmosphere from the rarefied heights, Kantrowitz mounted models in tubes and blasted them with gases fired at high speeds. That research helped the Air Force, but it also helped MHD.

Now Kantrowitz and his disciples knew more about the properties of gases at high temperatures. Using that information, they built an experimental MHD generator, the Mark I. It produced 11.5 kilowatts of electricity, for the first time demonstrating that MHD generators would actually work. Exuberant and overconfident, in 1962 Kantrowitz wagered a dollar that, by January 1, 1970, an MHD system would be generating power for at least one utility.

He lost his bet. One reason was that his supporters in the power industry were dethroned in a corporate coup d'état. And the government had decided to bet its billions on nuclear power.

With pennies and dimes, Kantrowitz kept the technology alive at Avco, but just barely. The Interior Department issued a report that smiled on MHD, but generated no federal funding. MHD—like that other initialed hero E.T.—again seemed dead on the operating table. Kantrowitz went to Washington, D.C., determined to revive it. In 1969 MHD rose again, this time with an injection of pure politics.

The new savior was Senate Majority Leader Mike Mansfield. The veteran Montana senator was smitten with MHD less because of its cheap energy potential than because it could burn coal. Back home in Montana, coal lay under the rangelands in black abundance. However, the big market for power-plant fuel was in the east, and Montana's transportation connections were skimpy. Why not, Mansfield reasoned, bring the power stations west to the fuel supply? The more he looked at it, the better it looked. Montana was no mecca for engineers and technicians, and that state desperately needed these people to build up its economy. The new technology probably would attract them.

One potential snag in this plan: Mansfield's home state was water poor. But then he discovered that an MHD plant needs only 44 percent of the cooling water that a standard coal-fired turbine-generator plant requires, and just 25 percent of the water a nuclear plant needs.

Pumped up by politics, MHD sat up on its deathbed and breathed. Federal funding began with $600,000 in 1971 and eventually peaked in 1980 at $79 million. That is just a few cents in the pot compared to the $4 billion the government has lavished on its energy darling, nuclear power. But for a technology from the wrong side of the tracks it was big bucks. During the 1973 oil crisis, MHD got an additional shot. Utilities, for years lukewarm on the technology, got religion again and pushed for a 1975 law mandating a national MHD research-and-development plan.

In the course of these ups and downs the United States was not running the MHD race solo. The Soviet Union was in the running, too. And some say today the Russians are galloping ahead. As early as 1964 Soviet delegations were visiting the MHD generator at Avco. Kantrowitz remembers seeing one Russian pull out a penknife and scratch the generator's side, apparently to make sure it was not a capitalist hoax of papier mâché. By 1971 the Russians had an MHD power plant of their own, feeding 10 megawatts into the Moscow power grid. Now they are putting the finishing touches on a 500-megawatt plant.

Meanwhile, out on the Montana rangelands and at other sites throughout the country, engineers are coaxing U.S. MHD technology to stand up and walk. The challenge of drawing on the forces at work in solar flares becomes a kind of religion for those who work with it, and even some of the Energy Department's nuclear zealots have become converts.

"It's a wonder to me," says one Department of Energy official, "how MHD has turned the heads of the Nuclear Gang, as I like to call them. Remember, these are guys who used to think that nuclear power was the only thing worth talking about since the invention of the wheel. Now they walk around saying, 'How come you never told us about this MHD stuff? It's fantastic!' "

Engineers at the Butte plant, at the University of Tennessee's Space Institute, at Avco, at the Arnold Engineering Development Center, in Tennessee, at the Argonne National Laboratory, in Illinois, and at a smattering of other sites around the country are arm-wrestling with all sorts of technical problems, like linking one manufacturer's MHD channel with another's inverter to turn the DC power from the channel into AC current. But no one seems to consider such puzzles daunting. Most experts gaze far beyond today's technology to MHD's glittery potential.

"Now look at this," says Robert Carrington, technical assistant at the Montana fa-

cility, as he begins covering his office blackboard with formulas and diagrams. "You see, the MHD system doesn't care what its heat source is." More diagrams. "All right, who says you have to burn coal to run the thing? Or oil? Or any such fuel? Why not solar?" He sketches a solar collector that would apparently be the size of the Empire State Building.

Three scientists at the Argonne National Laboratory have already outlined schemes for just such a futuristic system, using a liquefied metal to absorb the solar radiation. Engineers at Ben Gurion University in Israel, have designed an MHD system that circulates mercury through a solar collector. Their system could run on anything from geothermal heat to industrial wastes.

"I take a long-range view," says Richard J. Rosa, one of Kantrowitz's MHD pioneers and today head of Montana State University's MHD program. "Until now we've used turbine blades. It's only a matter of time before we use magnetic fields."

He foresees a wedding between fusion power and MHD. Fusion plants would manufacture hydrogen on a vast scale, and MHD generators would burn the hydrogen to heat their conducting fluids. How big? "The bigger the better," says Rosa. Today's average power plant turns out 500 megawatts, but Rosa says the best size for tomorrow's MHD plants might be 1,000 to 2,000 megawatts. He also expects there'll be MHD plants in space—producing electricity to drive spacecraft propulsion systems, for instance. "Conventional propulsion systems just won't get us as far as we want to go," he says. And he thinks that if we ever do erect large colonies in orbit, the electricity for these immense cities in space will come from MHD. "The technical advances in the past few years have really been encouraging," he says.

In fact, the real snag in MHD's current development is not technical at all. It is political. More precisely, it is money.

The $79 million a year that MHD research was living on at its peak a few years ago was barely enough to keep it nourished, according to most supporters of the new technology. Believing that viable energy technologies will find private funding, the Reagan Administration cut MHD out of the 1982 and 1983 budgets entirely. Congress kept the research going—just barely—at $21.8 million a year. But future funding is a big question mark.

Will MHD fulfill the prophecy of the mad-dog motorcyclist on the sticker pasted to the Butte plant's side? Was Faraday's brainchild really "BORN TO DIE"?

Kantrowitz, now a professor of engineering at Dartmouth College, in New Hampshire, suspects the problem is deeper than money. "What is happening to MHD is a story about the rise and fall of America's faith in high technology," he says. "In MHD you see, in microcosm, an American decline in the willingness to take chances. We're too timid now to do any kind of adventurous technology."

The Montana plant? "It's an abortion," Kantrowitz says. "It's much too small, just a laboratory experiment. We need a plant of at least intermediate size to give us long-range experience, and we were ready for that step back in 1966." So far, the Butte experimental MHD facility has turned out little more than 2.2 megawatts.

Rosa says, "Heck, we've known about MHD since 1832. You don't have to go out and invent it. All you have to do is solve the engineering problems."

Why, if the administration believes private enterprise should foot the energy-research bill, does the government continue its support for nuclear power? "Don't bore me with logic," Rosa says, chuckling.

He says it is unlikely that the utility industry will be able to pay for MHD research. "For one thing, the industry is heavily regulated and understandably conservative," he notes. "They're also having money problems of their own." Rosa points out that it is also unlikely that equipment suppliers will come through with sufficient funding for the research. "Basically the utility industry has two suppliers—G.E. and Westinghouse—and they have nothing to gain from MHD, since they already do well selling turbines," he says.

Rosa thinks another problem with the current research program, besides the scanty funding, is that it is too diffuse, with Energy Department research under way at laboratories scattered through 21 states. "Avco was heavily involved in MHD research, with a lot of dedicated people. I think the sensible thing would have been to put all the dollars into a research program at Avco, so we'd have a chance to get MHD on the market fast," he says. "But that was politically unacceptable, and so the government spent the money all over the country, in little bits here and there."

Woozy it may be from all the fiscal hay makers, but MHD is still on its feet. For one thing, the United States is hardly the only country with an MHD program. 16 nations, from Australia to Yugoslavia, are funding MHD research. And the USSR's 500-megawatt commercial plant is scheduled to come on line in 1986.

Meanwhile, in 1981, leaders of the U.S. energy industry organized the MHD Industrial Forum to push for support of the new technology. As chairman Kenneth A. Roe said in the forum's 1982 report to Congress, "Any technology that possesses such obvious and outstanding characteristics is one whose time has come."

He points out that, by the year 2000, about 60 percent of this country's electricity will come from coal. And he says that MHD is "the most efficient way possible" to use coal to produce electricity. Carrington believes this country's first commercial MHD plant should be operational by 1990.

Was MHD born to live?

"You bet!" says Carrington. "I wouldn't be doing all this work otherwise." ∞

*"Help us settle something, Schneeberg. Is a Nobel laureate empowered to perform marriages?"*

# EARTH

CONTINUED FROM PAGE 14

charts, paintings, and films. During the next few years the show convinced some of the right people. Mayor Ed Koch of New York City, the Environmental Protection Agency, and the U.S. Department of Energy. Even the Department of Housing and Urban Development (HUD) advocated further study of the idea.

But whenever grants for large-scale studies were offered, there was one hitch. Agencies demanded that Chattey get support from New York State *and* Governor Hugh Carey. That support never came. Carey claimed he was interested and even said the plan was brilliant, but he never wrote the crucial letter or made the critical telephone call.

Chattey still remembers the day officials from HUD asked him down to Washington to help announce a $1-million grant for the study of ICONN-Erie. He arrived bright and early, only to be met by a low-level bureaucrat who told him his appointment with top HUD officials had been postponed. Chattey sensed instantly that the deal had been blown.

Only later did he learn the reason. In a telephone conversation with HUD just one day before, Carey's aides in Albany had refused to endorse the idea.

Still Chattey persisted. By 1981, he'd persuaded a group at Syracuse University and another group at Pace University to study his prospectus. Both gave it a stamp of approval.

Then on January 15, 1982, he learned that Carey would not seek reelection. "We've outlasted the bastard!" he exclaimed to a friend while celebrating over two strong drinks.

Today Chattey is more enthusiastic than ever. "I don't mind having run around like a three-ring dingbat all these years," he says. "I just hope we don't have a bloody economic disaster before the inevitability of this plan becomes obvious."

But Chattey isn't leaving acceptance of ICONN-Erie to fate. During the past year he's taken his grand design to Europe, where the need for cheap American coal might spur some funding for the project. He's also presented his brainchild to Hugh Carey's successor, Governor Mario Cuomo.

Feedback from the new governor has convinced Chattey that his major stumbling block—the indifference of New York State—may be a thing of the past. Discussing the proposal just recently, in fact, Cuomo called Chattey's opponents "the counterparts of people who believed the Panama Canal was an impossible dream. We need to consider bold and imaginative initiatives," Cuomo said. "One such initiative is ICONN-Erie."

*The material for this article was drawn from* Chattey's Island, *a new book by James Ehmann, and from talks with Nigel Chattey.*

FICTION

# SAUL'S DEATH

BY JOE HALDEMAN

## I

I used to be a monk, but gave it over
Before books and prayer and studies cooled my blood.
And joined with Richard as a mercenary soldier.
(No Richard that you've heard of, just
A man who'd bought a title for his name.)
And it was in his service I met Saul.

The first day of my service I liked Saul;
His easy humor quickly won me over.
He confided Saul was not his name;
He'd taken up another name for blood.
(So had I—my fighting name was just
A word we use at home for private soldier.)

I felt at home as mercenery soldier.
I liked the company of men like Saul
(Though most of Richard's men were just
Fighting for the bounty when it's over).
I loved the clash of weapons, splashing blood.
I lived the meager promise of my name.

Saul promised that he'd tell me his real name
When he was through with playing as a soldier.
(I said the same; we took an oath in blood.)
But I would never know him but as Saul;
He'd die before the long campaign was over,
Dying for a cause that was not just.

Only fools require a cause that's just.
Fools and children out to make a name.
Now I've had sixty years to think it over
(Sixty years of being no one's soldier).
Sixty years since broadsword opened Saul
And splashed my body with his precious blood.

But damn! we lived for bodies and for blood.
The reek of dead men rotting, it was just
A sweet perfume for those like me and Saul.
(My peaceful language doesn't have a name
For lewd delight in going off to soldier.)
It hurts my heart sometimes to know it's over.

In ways of blood he made himself a name
(Though he was just a mercenery soldier).
I loved Saul before it all was over.

## II

A mercenary soldier has no future;
Some say his way of life is hardly human.
And yet we had our own small bloody world
(Part aches and sores and wrappings soaking blood,
Partly fear and glory grown familiar)
Confined within a shiny fence of swords.

But how I learned to love to fence with swords!
Another world, my homely past and future—
Once steel and eye and wrist became familiar
With each other, then that steel was almost human
(With an altogether human taste for blood).
I felt that sword and I could take the world.

I felt that Saul and I could take the world:
Take the whole world hostage with our swords.
The bond we felt was stronger than mere blood
(Though I can see with hindsight in the future
The bond we felt was something only human;
A need for love when death becomes familiar).

We were wizards, end death was our familiar;
Our swords held all the magic in the world.
(Richard thought it almost wasn't human.
The speed with which we parried others' swords.
Forever end another's petty future.)
Never scratched, though always steeped in blood.

Ambushed in a tavern, splashing ankle-deep in blood;
Fighting back to back in ways familiar;
Saul slipped: lost his footing and our future.
Broad blade hammered down and sent him from this world.
In angry grief I killed that one, then all the other swords;
Then locked the doors and murdered every human.

No choice, but to murder every human.
No one in that tavern was a stranger to blood.
(To those who live with pikes and slashing swords,
The inner parts of men become familiar.)
Saul's vitals looked like nothing in this world:
I had to kill them all to save my future.

Saul's vitals were not human, but familiar:
He never told me he was from another world:
I never told him I was from his future.

*The sestina is an old French form of verse, producing the illusion of rhyming through forced repetition. It has six stanzas of six lines each, followed by a three-line envoi. The last words of the lines in the first stanza provide the ending words for the other sestets by a system of inside-out rotation. All six words are crammed into the envoi, but one is allowed some latitude with the order.*

PAINTING BY GREGORY MACHESS

# BOTH WORLDS

CONTINUED FROM PAGE 59

Street near University Place. When Liz sat on an old love seat and looked out her living-room window, she saw tough-looking boys and girls in leather jackets and peaceful-looking old men and women walking with linked arms. Sometimes, at night, Liz heard bottles breaking and kids laughing. Stan told her not to let her imagination run away with her.

Liz got a job at *Shark Life*. The magazine's title was tongue-in-cheek; it referred to the fact that sharks, like people, had to keep moving or else they'd drown.

Often work arrived on her desk with an URGENT stamp. Then her mother's voice came back to her: I only have two hands! I can't be in two places at once! Lizbeth's mother had been a secretary in a book publishing house and often complained bitterly about it at dinner. She had also claimed to be an office whiz and everybody's favorite. When Liz, who seemed to work for no one and everyone, was given a lot of extra work, she pretended to be flattered and delighted. She worried whether people at the office liked her. In the dull streaked mirror of the office bathroom, she noticed lines about her eyes and mouth. She felt stretched thin. *But*, she thought, *I am becoming the person I had always hoped I would be.*

Liz blamed the hours of close reading for her eyestrain; she bought a pair of black-rimmed aviator eyeglasses on the Lower East Side. She felt a touch of envy when she saw Liquid Lenses advertised in *Shark Life*. They cost a bundle.

At home, Liz began sanding and polishing old furniture, using the cut-up orange polyester pantsuit for rags. The old Lizbeth had never enjoyed working with her hands. At work, Liz checked facts in an article about a new variety of destructive boll weevil in the Southwest. Enlarged photographs made the insects look like thoughtful aliens. As a child, she had thought that by the time cloning was possible, aliens would walk the earth.

One clear autumn day Beth put on her full-length mink and walked along East End Avenue, feeling the fresh cold air of the river on her face.

"Lizbeth!" someone shouted.

Beth stiffened. She hardly knew anyone in this neighborhood.

"Gosh, how are you? I almost didn't recognize you." It was Sally Budd, who had gone to Kieft Teachers' College with Lizbeth. Sally Budd was big-boned and blonde. "You used to be so skinny. I mean, such adorable chubby cheeks! Gosh—red hair. What're you up to?"

"My name's only Beth now." Beth said. "I've been cloned." She blushed and looked away. Suddenly she got a terrible itch behind her left ear. The skin was rough there; Beth imagined that was where AnnA & OttO had taken some skin cells from.

"Well. Aren't we *chic*! However did the two of you afford it?"

"I'm married. My husband paid for the, uh, procedure."

"Oh? And did you get married before or after the cloning? You don't mind my asking, do you, Beth?"

"No, of course not. After."

Sally Budd laughed. "Well, did he get the right one?"

Beth smiled sheepishly.

"I quit teaching," Sally Budd said. "So confining. I design weather-sensitive fabrics. It's so expressive. Do you work now?"

Beth wrapped her coat tight around herself. "Yes," she said. "I work. But I don't have a job, if that's what you mean."

Beth walked straight home, opened a bottle of Spanish wine, drank one glass, and poured the rest down the sink. Then she went to bed.

A few hours later she went into the living room and curled up in a velvet chair. Janus, her black Persian cat, jumped into her lap. Woo Lin was cooking chicken with wonderful hybrid spices: parsagon, garnion, tarrasage. Beth smiled at Carl, who was sitting on the plush couch, wearing a royal-blue bathrobe, reading *Shark Life*. She felt a vague connection to the magazine. Maybe Lizbeth had once worked there. Lizbeth had had a dozen secretarial jobs, each one duller than the last.

"What are you grinning at?" Carl asked.

"I was wondering," Beth said, "what you thought about having children."

"I thought you didn't want any."

"When I was teaching, I didn't. I got sick of them." She wanted—something. Sometimes a thought would keep coming back: *Do something.*

"Just don't have twins," Carl said.

"What does that mean?" Beth demanded angrily.

"I'm kidding!" Carl got up and sat beside her.

"I hate jokes about . . . that."

"Like, say, Cutie, are there any more at home like you?"

"Stop that!"

Carl lifted Janus off her and put his arms around her waist. "Have triplets. See if I care!" She laughed. His green eyes came close to her face. They were at their best when they were snuggling. Their lovemaking did not contain much passion; Beth felt more like a favorite niece.

"Let's get drunk," Beth said.

"Bethela, you've said that at least three times this week."

Beth pinched her own cheeks. "Do I have a fat face?"

"You have a lovely face."

Beth thought, *Next time I see Sally Budd I can say, I'm pregnant!*

On an unusually cold November Saturday, Liz had lunch with Cindy Feingold at a delicatessen on Second Avenue in the

East Village. Cindy had on a new corduroy jacket and a red beret. "I love the blueberry blintzes here," she said. Liz would have loved blintzes, too, but lately she had been having sharp stomach pains. She ordered four-minute soy eggs.

"You look worn out," Cindy said. "Stan says you work till nine o'clock some nights. Is that true? You're like the woman I saw in a movie at three A.M. last night. She said she felt like a can of peas on a shelf. The peas just kept sitting on the shelf, and nobody ever took them down to see how spoiled they'd gotten."

Liz looked at Cindy, but it seemed she was remembering looking at Cindy. And remembering hearing her voice. "'How Long Is a Shelf Life'," Liz said, "with Maude Redwine."

"That's right," Cindy said. The waitress put down the blueberry blintzes and the eggs. "Oh, beautiful! And then she had a breakdown, and—"

"Went to a hospital, right? The doctors said she'd always lived in utter confusion, thinking that what she was doing and what she thought she should be doing had never been the same."

"It was so sad," Cindy said. "The poor woman looked so wretched."

Liz wrinkled her forehead, thinking hard. "I never saw it."

"What, that part?"

"No, I mean the whole movie. I never saw any of it, I'm sure."

"But you're telling me all about it," Cindy said, a small blue smear on her lower lip. "You must have seen it years ago. Right?"

"Right," Liz said. *I never saw it*, she thought, *but it was seen*. She shivered and felt herself plunge into sadness.

"Last time I saw you, you looked perfect," Cindy said. "Now you're too thin. And you could do better than those eyeglasses. They're too severe."

Liz tried to remember if Cindy had always been this blunt. Had Lizbeth been more easygoing than Liz? She used to love seeing Cindy. "How's school?" Liz asked.

"Terrible," Cindy said. "The same. Nicky Begelman asks about you all the time."

Carl's nephew. "Tell him to visit his new aunt," Liz said. But Liz could see Nicky in her mind. He was wearing a dark blue sweatshirt with a hole in the shoulder.

"What's wrong?" Cindy said. "You look so pale."

"I'm fine," Liz said. "I'm just not hungry." She stood and caught her reflection in one of the mirrors on the delicatessen walls. She was a mess, and so were her eyeglasses. She looked like Maude Redwine.

When Liz got home, Stan greeted her with a long kiss. He liked to make love on Saturday afternoons, he said, because the pressure from work was a day in the past and he could relax. Liz felt self-conscious when Stan and she made love. He was so serious all the time, never talking or laughing or kidding, as if he was working with her toward the goal of fulfillment.

"Maybe we should have children," Liz said a few minutes after Stan rolled off her and said he had particularly enjoyed himself that time.

"It costs three hundred thousand dollars to raise a child to his eighteenth birthday," Stan said. "Besides, you would probably have twins!"

Liz smiled uneasily. "I think I want children." She was not sure why. But she wanted something.

"I think we should wait," Stan said.

Liz's left ear began to itch unbearably.

"Stop scratching your ear," Stan said. "You do that in your sleep sometimes."

She stopped.

Most nights Liz sanded and polished furniture. She began going to the office on Saturdays. The mating and breeding of the new variety of boll weevil became its own world and had her fascinated.

"Nicky!" Beth said, opening her arms to him and smiling.

Nicky Begelman was a tenth-grader now. He had a thin, narrow face and was five feet ten inches, slightly stooped. He stood by the door in a ragged blue sweatshirt. His teacher had never opened her arms to him. She had always been friendly, but distant. "Hello, Miss Webb," Nicky murmured, taking a few steps toward her and extending his hand.

"Aunt Beth," she said, taking his hand in both of hers. She wore a frilly pink housedress and furry slippers. "Call me Beth, dear. We're not in homeroom."

Carl beamed. "Nicky's passing all his subjects! Somebody had a good influence on him last year. Isn't that right, Nicky?"

Nicky shifted his weight from foot to foot.

"We're going to have a lovely lunch," Beth said, "with bagels and cream cheese and lox, and then take a stroll in the park!" Beth clapped her hands.

"I can only stay for a little while," Nicky said. "I have a softball game."

"That's too bad," Beth said, pouting. "Uncle Carl didn't tell me."

"Nicky didn't tell me," Carl said.

"But it's awfully cold out there," Beth said. She felt like crying.

"It's the last game of the season," Nicky replied, under his breath.

They sat in the guest bedroom, on two facing couches. Beth held the halves of a bagel, pressed them together, then pulled them apart. "How is Miss Feingold?" she asked. But Beth could picture her clearly, with a blue smear on her lower lip.

"Fine," Nicky said, chewing a bagel.

"You know what's missing here?" Beth said. "Blueberry blintzes. Wouldn't that be just perfect?"

Suddenly she had to excuse herself. She rushed to the bathroom, shut the door, and sat on the furry toilet seat cover, staring at the pink-tiled walls.

She cried and cried, bitterly, hopelessly. Her Liquid Lenses combined with her tears, rolled down her neck, under her house

*"I'm in touch with the herpes virus. They say they have a right to life, too."*

dress, and her world got fuzzy.

"Darling," Carl said, tapping at the door.

"Nicky!" she whispered.

"He's left. You know how teen-agers are. They can't sit still. Bethela, maybe you need to get some sleep. You were up all night watching that silly movie."

"Nicky thinks I'm fat," Beth said.

"Nonsense!"

"I need a drink." But she sat for half an hour, looking at blurs. She knew that Carl wanted her to come out while she was still crying. He was good at comforting her, and of course it is always pleasurable doing what you are good at.

Later they went to a Szechuan restaurant. Beth insisted they go dancing at Roseland. She got sick in the cab on the way home. When she got into bed and fell asleep, she dreamed that boys threw bottles and taunted her as she walked down a noisy street.

The next morning Carl slid a diamond ring on her finger. "Happy birthday," he said. "I know it's a month away, but I thought you needed this now."

Beth smiled and thanked him, but she could not shake her fright and gloom.

Liz turned thirty on December twenty-second and spent the day at the doctor's office. Her stomach felt worse, as if she had eaten spicy food and then run a race. She got headaches that felt like hangovers. But she never drank. She dreamed that children were surrounding her, begging. She lost more weight. The doctor asked if she drank or smoked or took diet drops. Liz said no. He said, 'Tell me the truth, young lady.' Liz insisted she was not lying, but the doctor only shook his head.

Beth's insomnia had been worse than Carl's, after all. She kept him awake with her restlessness and late-night television. On Christmas Eve she slept on one of the couches in the guest bedroom.

Early on Christmas morning Janus gently clawed Beth's back. Tired, queasy, Beth went to the living room, sprawled on the Persian rug in her blue silk nightgown, and flipped through the *New York Times*. Then she saw the headline of the full-page advertisement. ANNA & OTTO RECALLS CLONES. Beth grabbed the paper with both hands and held it close to her face. AnnA & OttO's customers were to return to the midtown or Queens Person Enhancement Center immediately for a cheerful refund. Something was "amiss," but AnnA & OttO was hard at work getting enhancement down to a perfect art with no interferences. LOOK OUT, TWENTY FIRST CENTURY! the advertisement said. In smaller print, AnnA & OttO reminded everyone that they had signed a consent form and could not sue. And no major medical insurance or Medicare would cover any damages.

Beth picked up Janus. "It's not Mommy's fault that she feels so bad," she whispered. "The cloning people didn't do it right." Janus squirmed, and Beth let him go. A few pages later a small news article announced the American Medical Association's recommendation for a total clone recall. The article cited side effects, such as blurred vision, nausea, muscle aches, depression, and tension. Doctors feared for long-term clones, although several people who had been cloned three years ago were no worse off than six-month clones. But they were no better, either. Beth looked for some mention of psychic effects, but there was none. Beth poured some Scotch in a glass and drank it neat. Then she called Liz.

"Hello." Liz said, sounding groggy.

"Hi, it's Beth." Beth waited. "I know Lizbeth said we shouldn't call, but something's come up."

Liz felt rigid. Beth sounded breathy, uncertain, like an adolescent version of herself. Beth thought Liz sounded harsh, businesslike, almost like their mother. "It's in today's paper," Beth said. "Listen, have you been feeling sick lately?"

*"Beth found the colors, the heat, and the light exhilarating, but she was disturbed to see children begging in every town. Carl told her to focus on the beautiful things."*

"Yes," Liz said. "Very sick."

"Me, too," Beth said. "But it's not us. It's the cloning. An article says cloning has terrible side effects. There's a recall. Liz, we have to go back to being one person, as soon as possible!"

Liz paused. "For how long?"

"Probably for good. I'm sorry, it's a shock. I'm dazed. But isn't it good to know you're not sick?"

"Yes, that's good." Liz said. She breathed deeply. *Relief is an underestimated emotion,* she decided. *Relief is wonderful.*

"Tell me," Beth said, "do you look very different?"

Liz blushed. "No. But I've been told I look something like Jack Sprat."

"But that's great!" Beth said.

"Oh? What do you look like?"

Beth coughed. "You figure it out. This is much more important. When we're together as Lizbeth again, where is she going to live?"

Liz paused. "Let's wait," she said, "and leave it up to her."

"Oh, no," Beth said. "That's why we're in this mess in the first place."

Liz looked at her fingernails. "Lizbeth could use some luxury for a change," she said. "Maybe she should live there."

"She'd become a spoiled brat in no time," Beth said. "You remember, Mother used to say, 'If you didn't have to suffer, you'd become insufferable.'"

"But my job. It's so much work."

"Lizbeth loves hard work! She was always masochistic. Poor Carl. He'll be heartbroken."

"Wait," Liz said. "I think Stan might be too stiff and demanding. Lizbeth often felt uneasy around Stan, afraid to act the way she wanted to . . ."

"Are you sure? Stan's younger. And so handsome! Besides, Carl was too doting. He put Lizbeth on edge."

"Maybe Lizbeth was always on edge."

They both laughed.

"I've missed you," Beth said. "Isn't that funny?"

"I've missed you, too," Liz told her. "I wonder why Lizbeth didn't want us talking to each other."

They agreed to straighten Lizbeth out.

"I'll see you at the A & O tomorrow," Liz said. "I'll bring the toothbrush."

"And I'll bring a comb and mirror," Beth said. "But how will I know you?" She laughed.

Suddenly Liz remembered a story she had overheard at work. "Beth, listen to this. An insurance salesman got himself cloned and then killed his clone. He said he wanted to kill himself and still be alive. Is it murder? Is it suicide? Did a real person die?"

"I almost forgot how crazy people are," Beth said. "I'm sort of secluded here."

"Welcome back to the real world," Liz said good-naturedly.

They said good-bye and wished each other health and luck. When Lizbeth was a little girl, her father had wished her that.

Beth showered and washed her hair eight times to make sure all the red streaks were gone. She thought the insurance salesman was like Humpty Dumpty. He couldn't be put back together again. He'd feel lost forever. Incomplete.

Beth went into the bedroom and began shaking Carl's shoulder, under their floral-print weather-sensitive quilt. The diamond ring sparkled on her finger. "Carl," she said, "I have to go back to being Lizbeth. I don't want to; she was a real mess. This is all her fault. Oh, my fault. I called Liz, and we decided to do away with me. Lizbeth will live with him. You can give away all my beautiful things. After tomorrow I won't exist. So I won't need anything."

"Bethela," Carl said, "you're asleep, having a bad dream!"

Beth showed him the paper as he sat up in bed. He read the advertisement and the article once quickly and then again, slowly. "I'm sorry I disappointed you," he said.

"No, you're wonderful!"

His eyes looked bright green. "It's like you're telling me you have twenty-four hours to live. And there won't even be a funeral. Funerals exist for a reason, you know. They help the survivors get through their grief."

He began to cry. She held him tight, his head on her shoulder, and her blue nightgown got wet. "I've always been alone," he said, in a faint voice. "I had a cocker spaniel once, but he was a loner, too. When I met you, I made an exception. I was so sure you'd outlive me."

Beth stared at his hands, at the fine blue veins. "I can visit . . ."

"No," he said. "Then I'd wait for you. I'd stare at the phone or the front door until I fell asleep. I don't want to sleep on couches and wake up all stiff and miserable. Swear you'll never come."

"I swear," she said.

"Or call."

"I swear."

"Good. Good."

They shook hands. *I guess that's that,* Beth thought. Carl had stopped crying.

Liz went back to bed after talking to Beth. She wondered what would happen to the insurance salesman. Maybe he would disappear altogether.

She woke Stan and told him all about the clone recall. "But I'm going to stay with you," Liz said.

"Good," Stan said, closing his eyes. "Good. I love you."

Liz listened to his steady breathing and thought about Carl. *He's going to feel lost. Heartbroken. I wonder. Will Lizbeth miss him? But I won't have to go through it alone,* Liz thought. *I'll be with Beth.*

At AnnA & OttO Beth and Liz quietly sat next to each other. Coincidentally both had worn brown woollen pants and beige Shetland sweaters. But Beth had brought her mink, and Liz had brought a peacoat. Beth put a comb and a mirror into the small overnight bag that Liz had brought. They watched an older woman screaming at a coordinator for ten minutes; her clone was trying to calm her. They saw a man and his clone in gray suits writing furiously on long yellow pads.

Usha Devi gave Liz and Beth a small piece of orange cake each, and a cup of decaffeinated coffee. They fell asleep a half-hour later. Their sleeping bodies were placed on twin beds in a small room behind a bamboo curtain, but only one person woke on a mattress forty-eight hours later, at five A.M. on December twenty-ninth.

Lizbeth looked at her reflection in the small, smudged mirror from Liz's bag. She looked like her old self. She took off an unfamiliar flannel nightgown, put on Beth's pants and Liz's sweater, and slipped on Beth's mink. She carried Liz's peacoat and the rest of the clothes. She found she did not need either the eyeglasses or the Liquid Lenses. As she was about to leave AnnA & OttO, Usha Devi, holding a brown paper bag, stopped her.

"I want to thank you for being so cooperative," Usha Devi said. "Some of our clients were most unpleasant."

"It's not your fault," Lizbeth said.

"You are nice. And I'm sorry to have to say this so abruptly, dear, but I have shocking news. You're pregnant."

Lizbeth could not move.

"You're less than a few weeks, but you are pregnant." Usha Devi handed her the brown paper bag. "Here is the sundress you left here months ago. We sent it to Queens, but it was returned."

Lizbeth clutched the bag. "Are you sure this is my dress?"

"Why, yes," Usha Devi said.

"Maybe it's a mistake. You're confusing me with somebody else."

"Take a look, then."

"No! It's wrong, I can feel it!" Lizbeth shook the bag.

Usha Devi smiled. "No, it's you, all right."

When Lizbeth entered their apartment, Stan was standing beside the door. She felt tired and hungry.

"How was Carl?" Stan asked. "The poor guy! I've been worrying about him."

"He's fine," Lizbeth said. "But we shouldn't mention him anymore." She remembered Carl's faint voice, his bright green eyes, his hands.

"If you say so. Hey, where'd you get the mink? We can't afford that!"

Lizbeth began to cry.

"Oh—it was hers. I didn't realize." Stan grabbed her and hugged her. "Lizzie, stop."

Now Carl was dead for her. Lizbeth felt a dull ache in her chest. Grief is a constant growth. Cindy had once said, a movement toward happiness. Lizbeth wrapped her arms around Stan's waist and rested her cheek on his chest. She listened to his heartbeat and felt she should say something. "We ought to live more indulgently," she said.

Stan stepped back, "I thought this might happen. Now you want Caribbean cruises. And dinners at Lutece Deux. You've learned to like throwing money around!"

"No—no. But why can't we stay up late some night and call in sick the next day? Or take an eight-hour boat ride? Or eat ice cream for dinner? We act like students in a tough school, terrified that we're not going to get all A's. It's just us, Stan. No one's watching."

Stan smiled and nodded in the direction of the bedroom.

"I'm pregnant," she said.

Stan stared at her without blinking, and his jaw fell open.

"I never saw you look so surprised," she said, and thought to herself. *No, not surprised. Uncontrolled.*

"You've never knocked the breath out of me," he said. "Pregnant! Is it mine? I mean, was it Liz's, or Beth's? Who's the father? Who's the *mother*?"

"I am!" Lizbeth said. "But we'll probably never know who the father is. The baby belongs to both of you, I guess. To all of us equally."

Lizbeth and Stan sat, elbows on a refinished pine table, drinking black coffee from chipped porcelain mugs. They agreed to

tell Carl about the baby, have him visit and become a sort of grandfather. Lizbeth was very hungry and was about to suggest they order up a pizza, but Stan said he had already prepared a green salad.

As he served her the salad, he said, "You look different. Maybe because you're pregnant. But you looked different from the moment you walked in."

"Different—better?"

"I'll get used to it," Stan said.

Later Lizbeth took a walk and got some pizza. That night she slept deeply and soundly. She dreamed she gave birth to green-eyed, curly-haired twin boys named Charles and Steven. She was delighted; Lizbeth remembered that it had been no fun being an only child.

Lizbeth waited until seven o'clock to call Carl. Woo Lin answered the phone. "It's me," Lizbeth said. "The former Mrs. Begelman. How are you?"

"Fine," Woo Lin said, irritably.

"Are you sure? You sound ... off, somehow. Not like yourself."

"I always sound this way!"

Lizbeth tried to remember. *Had Beth's head been in the clouds all that time?* Woo Lin sounded angry and bitter. "I'd like to speak to Carl, please." Woo Lin put the receiver down, and when Carl picked up she quickly said, "Don't hang up."

There was a pause. "You promised you wouldn't call."

"This isn't Beth," Lizbeth said. "It's me. And I had to call."

"Wait—who is this?" Carl said.

Lizbeth sighed. "It's Lizbeth."

"You sound so different," he said. "You had such a sweet voice, like an angel. Please forgive me, but I am shocked."

"It's all right." Lizbeth said wearily. "Carl, I have something urgent to tell you."

Carl laughed. "Beth never sounded so serious. Poor dear—lighten up!"

"I'm pregnant," Lizbeth said.

Carl let out a sharp, whooping sound, so piercing she had to hold the phone away from her ear.

"We were hoping you'd visit from time to time," she said loudly.

"Uncle Carl will be there, of course," he said, sounding joyous.

One Saturday in April, Lizbeth placed her hands on her belly and peered out the window. The winter had been so cold, this was the first day all year she could open the window. "I'm quitting *Shark Life*," she told him quietly.

"Right," Stan said. "Maternity leave." He was on the love seat, reading a newspaper.

"No," Lizbeth said. "For good."

"But I thought you liked your job," Stan said. "You and your boll weevils. I had no idea you were unhappy."

"How could you? I hardly knew myself."

"You could always teach again," Stan said. "You were very good at it. I really admired and respected you."

"No, teaching was a secluded world. But

I can tutor, and then see what I want to do."

"I'm impressed," Stan said, going back to the newspaper. "You already have it all figured out."

"Not at all," she said. "What I have figured out is that I have very little figured out. I guess I'm confused."

"I know what you mean." He looked up at her. "I'm confused, too. I love you. I loved Liz. She was very special. I never appreciated her."

"*Her*? You mean *me*."

"But you were different as Liz. You were different as the old *Lizbeth*. You were so sensible and loyal. Now you're headstrong. And unpredictable. You make me nervous, and I'm not the nervous type."

"But I was the nervous one," Lizbeth said. "I never knew if I was doing anything right."

"I depended on you," Stan said. "You were a steadying influence in my life. Can you imagine what this is like for me?"

"Yes," Lizbeth said.

"I miss Lizzie very much," he said.

Neither Lizbeth nor Stan was surprised when she said that they should separate after the baby was born. Lizbeth went into the bedroom and lay down. Stan had called Liz special. A young lady her mother could be proud of. Carl said Beth was an angel. Daddy's little girl. Both men sounded like widowers. But both women were alive in her now, and wasn't the whole greater than the sum of its parts, even when it occupied half as much space?

Clarissa Sarah Webb was born shortly before dawn on August fifth, and everyone at the hospital said she looked just like her mother. But Lizbeth thought she was far more beautiful.

A week later Carl came to see the baby at the Greenwich Village apartment. He and Stan had never met, but they greeted each other warmly. "I've brought a gift for Clarissa!" Carl said. "Here's the refund money from AnnA & OttO. Oh, she's gorgeous!"

Clarissa started to cry. So Lizbeth took her to the bedroom while Stan and Carl sat in the living room. Lizbeth knew Stan was telling Carl that she was leaving him, too. Lizbeth's tenant, the medical student, had been given internship in the Bronx, and Lizbeth was moving back to Flushing. "I am so sorry," Lizbeth heard Carl say. "I know just how you feel."

Soon Clarissa fell asleep. Lizbeth was amazed by her fingers, knees, toes—tiny adult features. Clarissa was all there, everything intact. Lizbeth tried to think back to what her parents had told her about how she had acted and looked as a baby. "You were a good baby," her mother had once said. "So quiet. You hardly ever cried." But when Lizbeth listened to Clarissa cry, she thought she sounded good and healthy and strong. "You could fall asleep anywhere," her father had once said. "At the dinner table. In the car. On my lap."

She knew her parents had never remarked on how beautiful she had been, somehow she would have remembered that. Lizbeth would be sure to tell Clarissa that she was beautiful. And she would also tell her what she herself had never been told. Don't restrict yourself. Anything is possible. If you have to, you'll work it out.

Lizbeth went back to the living room. Both men appeared flustered at seeing her. "Should I go away?" she asked.

"Carl is a very sensitive and understanding person," Stan said. "I can see why you married him."

"It's *you* who are so smart and so fine!" Carl said to Stan. "Now I know why she made her choice."

Stan blushed and spoke quietly. "Carl was just telling me he thought you weren't the same Lizbeth before the cloning."

"First you didn't sound like you," Carl said, "and now you don't look or act like you, either! But how is that possible?"

"You two figure it out," Lizbeth said and turned to the bedroom.

"Bethela," Carl said, "you can't imagine how relieved I am that I don't love you anymore. I didn't think it possible."

Stan nodded solemnly.

Lizbeth stood by the bedroom door, staring at them, and felt like crying. She did not love them, either, but no one likes to hear that they are not loved.

The medical student had taken good care of the apartment, but Lizbeth thought the place looked a mess. She gave her wobbly table to the Salvation Army and bought a knotty-pine table, sanded and stained it, and, following a carpenter's manual, built a crib for Clarissa, then bought her a weather-sensitive quilt.

She reupholstered her sofa bed with blue velvet and put up floral curtains. Cindy was so impressed she said Lizbeth ought to become a carpenter and interior decorator. When Lizbeth showed Cindy her design for a small greenhouse, Cindy decided she should become an architect. Where had Lizbeth's talents been hiding, Cindy wanted to know.

One day Lizbeth noticed a couple of stray tabby cats on the street and brought them in. The cats and Clarissa liked each other. Lizbeth named them Steffie and Raymond, after her mother and father.

Lizbeth tutored social studies at home. Her students were patient when Clarissa wanted food or a changing or some attention. Nicky showed up every now and then. When Stan or Carl visited, they seemed like old schoolmates whom she had never gotten to know well. Cindy said it would take time before Lizbeth would feel happy again. Grieve your losses and celebrate your gains, Cindy said. Lizbeth felt ready to be happy.

Lizbeth and Clarissa sat on the sofa bed and looked at the Unisphere. Lizbeth held Clarissa close, smelled her sweet breath, felt the rhythm of her heart and her even breathing, and all of Lizbeth's senses seemed to celebrate. "That's the world," Lizbeth told her. "It's not hollowed-out or empty. If you're there, it's there."

# FRACTAL COSMOS

CONTINUED FROM PAGE 71

shapes you are not only talking about a point at X, Y and Z coordinates, but also a point, say, at midnight yesterday. An instant at a position—that's a fourth-dimensional quantity. To see one of these shapes in all four dimensions you would have to animate it in time."

What about quaternion films then? "I can't extrapolate on that," Norton comments. "So far I've seen only frame one, frame three hundred, and, say, frame six hundred thirty. I could make one, I suppose, if I had about one hundred thousand hours of computer time. It might be a slow movie," he muses. "Fractals twist and turn, grow and shrink. Periodically shapes just might disappear altogether. We are just beginning to explore how the simplest algebraic relationships repeat themselves, how they act in four dimensions. The significance of it is not yet clear," he laughs strangely. "When I'm referring to the fourth dimension, I'm actually poking around in a dark room. Occasionally I come out into the light with something new. There may not be any relationship between the things I bring out."

"The area is so vast and the amount of knowledge so incredibly small. You can go anywhere in four-d space. The hardest part is knowing where to start."

Is there any connection between these eerie 3D fractal blobs and reality? Reality? To the mathematician the word is fairly irrelevant. What's real? Cones, spheres, and cubes? "The Greeks came up with the concept of perfection—points, lines, planes. It's a great ideal," Norton responds. "But the world doesn't necessarily respond to that sort of construct. Not everything is made that way." One comes away from these fractals with a sneaking suspicion that the Greeks have been pulling the wool over our eyes all these centuries, that our aesthetically pleasing, smooth, 3D solids are nothing more than products of our imagination, that the weird fractal beasts are really what's out there, lurking as they do between dimensions. ∞

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*A: Now*
*Q: When will* Omni *print winners of Competition #24?*

# COMPETITION

By Scot Morris

The idea was, first the answer, then the question, as in A: Dr. Livingston, I Presume. Q: What was Dr. Presume's full name? A: Go west. Q: What do wabbits do when they get tiwed of wunning awound? A: Around the World in 80 Days. Q: What was the slogan of that airline that went out of business?

Acknowledgments go, first, to Steve Allen ("The Question Man"), then Art Flemming (*Jeopardy*) and Johnny Carson ("Carnac the Magnificent"). We can't guarantee that all of the gags are new, but the ones we picked are new to us. Many are better spoken than read.

## GRAND PRIZE WINNER, $100

A: To be or not to be.
Q: What is the square root of $4b^2$?
*—Arnold Grinwalds, Lincoln, Neb.*

## RUNNERS UP, $25 EACH

A: The Halls of Montezuma and the Shores of Tripoli.
Q: Name two families whose kids won't join the Marines.
*—Dwight Johns, Lincoln, Neb.*

A: Chicken Teriyaki.
Q: What is the name of the world's oldest *kamikaze* pilot?
*—Stephen D. Locklear, Oklahoma City.*

A: Blood, sweat, and tears.
Q: Name the three most unpopular flavors at Baskin-Robbins.
*—Pascal Portfolio, Huntington Beach, Calif.*

A: Fourscore and seven years ago.
Q: What happens after a grand-slam home run, and when was the last one hit in an All-Star game?
*—Ben Gottlieb, McLean, Va.*

A: Film at 11.
Q: What happens when you don't brush at 5?
*—Don Addis, St. Petersburg, Fla.*

A: Vacuum cleaner.
Q: Name an unnecessary occupation.
*—Ed Guyot, Reseda, Calif.*

A: Born-again Christian.
Q: Who is going to win at Wimbledon this year, Captain Bligh?
*—Lewis Terman, South Salem, N.Y.*

A: Green Bay.
Q: Where do the Blue Danube and Yellow River meet?
*—Steve Ayers, Bellevue, Wash.*

A: Knock wood.
Q: What's the best way to sell aluminum siding?
A: An attitude or state of mind in which—
Q: What is "writer's block"?
*—John Henrick, Seattle.*

A: Guccione.
Q: Name a brand of expensive designer pasta.
*—Lee Aronsohn, Los Angeles.*

## HONORABLE MENTION

A: Royal Canadian Mounted Police.
Q: What is the highest achievement in taxidermy?
A: H. G. Wells.
Q: What do mercury dowsers look for?
*—Jean MacKay Jackson, Tulsa.*

A: With ticker tape.
Q: How do you mend a broken heart?
A: Grecian formula.
Q: What is $A^2+B^2=C^2$?
*—Chris Doyle, Burke, Va.*

A: The Clone Rangers.
Q: Who were those six hundred masked men?
*—James B. Hardie, Quincy, Mass.*

A: J. C. Penney.
Q: Give the initials of the President who authorized the Susan B. Anthony dollar, and its approximate worth on the world market today.
*—David Waldrop, Houston.*

A: Babe Ruth, Jack the Ripper, Rudolf Valentino, and Richard Nixon.
Q: Name a slugger, a mugger, a hugger, and a bugger.
*—Howard Glanton, Montrose, Mich.*

A: Falling star, dwarf star, and dog star.
Q: Who are Chevy Chase, Herve Villechaise, and Lassie?
*—Billy Isrin, Washington, D.C.*

A: Mark Spitz.
Q: What does a judge do in a spitting contest?
*—Louis Phillips, New York City.*

A: Aloha.
Q: What is the proper response to a joke told in a library?
*—Jeff C. Young, Wallace, S.C.*

A: Trilateral.
Q: What should you do if the long bomb isn't working?
*—Mark Cantrell, Okeechobee, Fla.*

A: Sticks and stones.
Q: What weapons will be used in World War IV?
*—Christopher Krajci, Park Ridge, Ill.*

A: Groucho Marx.
Q: What do you get when someone beats you with a groucho?
*—Joe Grabowski, Pittsburgh.*

A: Space.
Q: What do most students take up in college today?
*—Bill Filtz, Valdosta, Ga.*

A: Pedestrians.
Q: What is this country's biggest bumper crop?
*—Raymond Tillman, Peoria, Ill.*

A: Two out with the bases loaded.
Q: How is the opera's drinking contest going?
*—Gordon Kent, St. Paul, Alta., Canada.*

A: Fireproof.
Q: What are the boss's relatives?
*—Raymond Tillman, Peoria, Ill.*

A: UCLA.
Q: What happens when the smog clears in southern California?
*—Robin Bauman, Los Angeles.*

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thing that cannot be measured and expressed in numbers is not science We now find that with certain biological phenomena, including man, qualities are just as important—in fact, more so Eventually younger physical scientists realized that what the older generations had told them was a lot of nonsense and they became less intolerant of other branches of science This has helped a great deal to eliminate the gap between biology and the physical sciences

*Omni*: In your book *The Growth of Biological Thought* you accuse that intolerant attitude of keeping biology back

**Mayr:** Oh, it certainly did It has fostered discrimination in the awarding of grants and scholarships, in the creation of new positions—all that sort of thing Part of the message of my book is the damage done to science as a whole, and to biology in particular, by this narrow-minded attitude The philosophers all thought the physical scientists were right, so they, too, ignored biology It's only in the last twenty-five years or so that the philosophy of biology is beginning to be developed I must have six or eight books on my shelves called "The Philosophy of Science" You look inside them and find not a word about biology Yes, they have held biology back very badly

*Omni*: A 1982 Gallup poll indicated that forty-four percent of the American population prefers the statement, "God created man pretty much in his present form at one time within the last ten thousand years," over other statements that included the concept of evolution, with or without God's help I was astonished that this figure was so large Are you surprised?

**Mayr:** No I think our American elementary education is really absolutely horrible Discussion of evolution has been completely eliminated from most textbooks, because, otherwise, the books won't sell in the Bible Belt The poor kids in school are being brainwashed They aren't exposed to facts

This same forty-four percent of the population is probably equally ignorant of world history, of the basic reasons for conflict in the Middle East, of the causes of the two World Wars The majority of people are incredibly ignorant I have lived in New York City suburbs, where, in most of my neighbors' houses, not a single book was to be found It's shocking, but there is nothing that can be done except to try to improve our schools

*Omni*: In your recent book you lay the blame on Christianity for the "intellectual stagnation" of the Dark Ages and for the fundamentalist mentality of today

**Mayr:** I blame Christianity as a whole only for that attitude during the Dark Ages It is the branches of Christianity in the Bible Belt states, which want to introduce the teachings of the Bible on an equal footing with established scientific fact that are responsible for the new brand of nonsense

*Omni*: Do you think Christians who do accept evolution as fact can resolve their dilemma by regarding the Bible's story of creation as a myth?

**Mayr.** A metaphor, a myth You know, even the most atheistic scientist doesn't know how the world got started, nor does any one know what was there before the big bang Just look at the incredible qualities of our molecules nucleic acid molecules that replicate so beautifully, phosphates that can transfer energy, proteins enzymes that facilitate all sorts of metabolic processes Once, after giving a lecture on evolution to a church group I was asked whether I believed in miracles Much to their surprise, I said yes They asked "What do you mean by miracles?" I answered "It's a miracle that molecules have these qualities" There is much that scientists cannot explain, but to say that molecules have these qualities because God made them that way doesn't add anything to our understanding

*"Blacks with doctoral degrees have an average of one-point-six children, while blacks in the ghetto have five or six. This is not natural selection, in the old-fashioned sense."*

*Omni*: Is this what was on your mind when you wrote that "virtually all biologists are religious"?

**Mayr.** Yes You see, *religious* is a very broad term Just think of Julian Huxley's book *Religion Without Revelation* We all feel a tremendous awe of nature, but that doesn't preclude us from wanting to know the facts

*Omni*: You recently lectured on the Continent and in England What is the attitude there with respect to creationism?

**Mayr** This sort of ridiculous scientific creationism, or whatever it is called, was unknown in England I participated in a television debate that was to include a creation scientist, and they couldn't find one They had to import an American I don't know whether this is something we should be proud of or not

*Omni*: There is no creationist movement over there, is there?

**Mayr:** They are afraid they might get it I received a letter from someone in Germany the other day that said that all the bad things that America produces always get to Europe sooner or later, and now creationism is beginning to rear its ugly head

*Omni*: Do you think there is an unusual amount of antiscience sentiment now in the United States?

**Mayr:** There is more antiscience sentiment now than there was, say, forty or fifty years ago, and it's stronger in Europe It's based partly on ignorance and partly on equating science with technology Science is responsible for pollution, science is responsible for the atom bomb What is rarely mentioned is that science is responsible for eliminating smallpox, for giving us antibiotics, for improving nutrition, for stretching the human life span—for virtually all the good things we enjoy

*Omni*: How can people be induced to appreciate science?

**Mayr:** As somebody once said, the only way is to stop doing science, to do nothing anymore because doing science is a Catch-22 situation Scientists can always stumble on something bad while working toward something good

The reason why I do science, and why most scientists I know do science, is simply that we want to understand our world Some people say the principal purpose of science is to better the lot of mankind And, of course, when scientists go to Congress to lobby for funding, they always use this argument It's the only one Congress understands But if we all wanted to understand the world better—a feeling that was so strong in Jefferson's day—then we would all be for science And if we found that there were certain drawbacks to science, why, then we would fight those drawbacks, but not science as a whole

*Omni*: Perhaps the most remarkable development in human evolution was the rapid increase in the size of the brain, which allows us a certain degree of control over our environment Can you guess why primitive humans needed to develop such a large brain in such a hurry?

**Mayr.** I feel that the development of speech was the most important reason for the increase in the size of the human brain The social structure of the hominid groups required the development of a more efficient system of communication That caused a tremendous selective pressure for increased brain size But other things were going on simultaneously The latest research indicates that the early remains of *Australopithecus africanus*, found in South African caves, were mostly those of victims of leopards Later remains were not So, sometime in there the hominids learned how to defend themselves That also created a selective pressure for brain development in terms of the design and use of weapons Even the primitive forerunners of religion and ritual would have contributed to selective pressure for increased brain size The development and performance of rituals require more brain, and a larger brain furthers the development of rituals

*Omni*: Our brains guide our behavior, but there is some controversy over whether the brain is programmed more by our genes or by culture

**Mayr:** There is no such question Some of

our brain cells are programmed; others are not. I've written a paper in which I show that, in the evolution of man, more and more of the brain's closed programming, which dominates and controls behavior that cannot be changed, was replaced by open programs in which learning can fit something into the brain. It's only the "nurture" people who say behavior is determined by nurture to the exclusion of nature. The "nature" people have always said it's both. They realize that believing in a genetic component of behavior does not mean believing in genetic determination.

*Omni*: Does the genetic component merely give us a potential?

**Mayr:** That's right. Of course that potential may very often be loaded in one direction or another. For instance, say little boys have an aggressive loading in their behavior. Then you have to teach them not to hit at everything that annoys them.

*Omni*: It sounds as if you believe there are sexual differences in the genetic component that influences human behavior.

**Mayr:** I've never met a psychologist who has made a close study of these things who has denied this.

*Omni*: Darwin suggested something called sexual selection as an additional mechanism for evolution. What is that?

**Mayr:** Natural selection normally concerns such things as a better adaptation to climate, a greater ability to find or utilize food, a greater ability to escape enemies or to resist sickness. If one individual acquires any one of these traits and leaves it to his or her descendants, it benefits the whole species. There is another category of traits that merely add to the reproductive success of an individual and do not benefit the species. For example, male birds of paradise have gorgeous plumes. If one has plumes more gorgeous than his brother's, he may attract more females and leave more offspring. The gorgeous plumes, however, don't do anything for his species. That's what Darwin saw more clearly than the geneticists between 1900 and 1970, and what he called sexual selection.

*Omni*: Do you think it has affected human evolution to any great extent?

**Mayr:** It must have. Probably not now, but certainly in the past. I don't necessarily agree with Darwin that sexual selection was responsible for the development of differences between the races, but it may have contributed to those differences. There might have been, say, a group of females in some isolated human population who considered curly hair preferable to straight hair and who therefore favored males that had curly hair. Soon all the offspring in that population would have curly hair.

*Omni*: Sexual selection implies that females have an aesthetic sense.

**Mayr:** That is an inescapable conclusion.

*Omni*: Has it some purpose?

**Mayr:** There doesn't have to be a purpose. One notion is that the female has to come into readiness to have sex with a male. If there is something pleasing about that male, it may facilitate the female's getting into that condition, and so it might increase the reproductive success of both the female and the male sex.

*Omni*: You have written that "adaptive superiority and reproductive success no longer coincide in man." What did you mean by that statement?

**Mayr:** I was addressing myself strictly to the number of offspring individuals produce. One study of the birth rate of blacks found that blacks with doctoral degrees have an average of one-point-six children, while blacks in the ghetto have five or six children. It is a matter of simple mathematics that this is not natural selection in the good old-fashioned sense.

*Omni*: Are we still evolving?

**Mayr:** We are changing. It depends on how you define *evolution*. Most people mean evolving to a higher level. Every modern evolutionist vetoes that. Even Darwin wrote in the margin of one of his books, "Never use the words *higher* or *lower*."

> *"Whether we are evolving depends on how you define* evolution. *Even Darwin wrote in the margin of one of his books, "Never use the words* higher or lower."

*Omni*: How can we prevent the dilution of our gene pool?

**Mayr:** It's the old Catch-22 problem again. You would have to dictate who could reproduce. You would have to invent methods of testing the quality of people and then decide, "Well, you scored below six thousand. Therefore, you can't have any children. This guy scored above ten thousand. We'll use his sperm to inseminate twenty-five women." That sort of thing is totally intolerable. So all we can do is concentrate on education.

*Omni*: Do you think cultural evolution is most important right now?

**Mayr:** Cultural evolution is now infinitely more important than genetic evolution.

*Omni*: Has mankind greatly reduced the general gene pool by accelerating the extinction of so many animals and plants?

**Mayr:** Very much so. Right now we are witnessing absolutely shocking destruction of tropical forests. Every day probably ten to twenty-five species are being exterminated by man. And of course we're also disrupting founder populations, so that new species cannot develop. All the pollution in this country is nothing compared with the destruction of the tropical forests.

*Omni*: In *Evolution and the Diversity of Life*, you wrote, "The very survival of man on this globe may depend on a correct understanding of the evolutionary forces and their application to man."

**Mayr:** Man must realize that he is part of the ecosystem and that his own survival depends on not destroying that ecosystem. Man, to me, is a very marvelous creature. If we lose all those qualities by which man differs from the other animals, what's left is a creature that is just another animal. If we don't place a higher premium on the truly human characteristics, then I don't see any particular hope for the future.

The worst problem is the population explosion. A stable global population would be the first step in the salvation of mankind. But as long as we have church authorities, especially the popes, who proclaim, "Go out and breed as much as you can," there is no hope for mankind.

*Omni*: You're unexpectedly pessimistic about the future of life on Earth. What do you think the chances are of the existence of extraterrestrial life?

**Mayr:** None. The origin of life is such an improbable event. It requires such a precise combination of conditions that the chance that it will occur is infinitesimal. I know of only two reputable biologists who believe in life in outer space. [Mayr declined to name them.]

*Omni*: One of the latest theories on the origin of life, proposed by Francis Crick...

**Mayr:** Ah, Francis Crick is a physicist and thinks like a physicist. He knows next to nothing about the biology of higher organisms. Forget about it!

*Omni*: You don't agree that the seeding of Earth from outer space is even possible?

**Mayr:** Oh, come on. It's always some physicist who comes up with these totally nonsensical theories about biology. Life originated on Earth because, at some particular moment, conditions were just right. Anything is possible, but why bother with outer-space theories? Why shouldn't life have originated here on Earth?

*Omni*: How do you do science?

**Mayr:** As I discuss in my new book, there are two ways of looking at science. One says science consists of making discoveries. The other says science consists of developing or refining concepts. The second, in my opinion, is far more sophisticated, and that has been my concern for the past thirty years or so.

*Omni*: Does that concern have its roots in the kind of education you received?

**Mayr:** It may well have. I had a broad education, including nine years of Latin and seven years of Greek. I had to take a minor in philosophy to get my Ph.D. Moreover, I come from a family whose interests are wide-ranging.

*Omni*: What is the philosophy of life that keeps you so vigorous and involved at age seventy-eight?

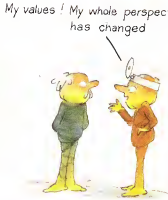
**Mayr:** I was very careful in the selection of my ancestors. ∞

# The Artist









Cumings

# DEATH

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had misread his altimeter and thought he was a thousand feet lower than he was. I believe the main factor involved here was my reluctance to correct the captain. This captain is very 'approachable,' and I had no real reason to hold back. It is just a bad habit that I think a lot of copilots have of double-checking everything before we say anything to the captain."

As you can imagine, things get a lot worse when the captain is *not* "approachable." Lauber bemoans what safety experts call "the problem of the macho pilot."

For example, a copilot filing a near-accident report gave this account:

"I was the first officer on a flight into O'Hare. The captain was flying. We were moving along at two hundred fifty knots. On our approach, Approach Control told us to slow to one hundred eighty knots. I acknowledged and waited for the captain to slow down. He did nothing. So I figured he didn't hear the clearance. So I repeated, 'Approach said slow to one eighty,' and his reply was something to the effect of 'I'll do what I want.' I told him at least twice more and received the same kind of answer. Approach Control asked us why we had not slowed yet. I told them, 'We are doing the best job we can,' and their reply was, 'You almost hit another aircraft.' They then asked us to turn east. I told them we would rather not because of the weather and we were [told to fly at three thousand feet]. The captain descended to three thousand feet and kept going to two thousand five hundred feet, even though I told him our altitude was [supposed to be] three thousand feet. His comment was, 'You just look out the damn window.'"

Having had a taste of these testimonials, psychologists and safety experts would love to get hold of black-box tapes from flights involved in near misses, or even from totally uneventful flights. But pilots refuse to relinquish them. In fact many a pilot routinely erases the tape soon after landing. Some pilots regard it as a simple question of privacy. Some have other reasons.

Captain Harvey "Hoot" Gibson, a TWA pilot with 30 years' experience, fell into a dive on April 4, 1979, and the Boeing 727 he was flying, with 87 passengers aboard, dropped 30,000 feet in 60 seconds. With just 9,000 feet left between him and the ground—and only moments away from impact—Gibson won control over the plane and came down safely at Detroit. Then he taxied up to the terminal building, 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. The Airline Pilots Association later voted Captain Gibson the Pilot of the Year.

Turner says the Federal Aviation Administration and the National Transportation Safety Board are in the process of trying to take the bulk eraser off the black box. Thus far they have issued a "notice of proposed rule making," but implementation is at least a year away.

"We gave pilots the erasure option," Turner says, "as part of a give-and-take deal to get the recorders on the planes in the first place." That was in 1966, he recalls, when the technology of tape recording was only 20 years old and when pilots felt singled out for scrutiny by the "spy in the sky," as they derisively called the cockpit voice recorder. But airline crews came to accept the eavesdropper because the tapes could serve a potentially lifesaving function, provided they were used only for accident investigation.

Now that the black box is viewed as a gold mine, the pilots will have to fight for their privacy all over again. And they can offer their basically excellent flight record as a legitimate gripe against routine monitoring. Helmreich summarizes their point of view. "When we talk about listening to these tapes and using them to suggest approaches to training, we're talking about modifications in what is already a very good system. We recently went a full two years without a single fatal accident. Commercial aviation is the safest mode of transportation in the world." ∞

# SPACE

CONTINUED FROM PAGE 18

bomb) subsequently voiced their support for such a proposal

A research base on the moon, the Johnson Space Center scientists foresaw, offers major benefits both to astronomy, particularly radio astronomy and solar physics, and to planetary geology. But they cited more far-reaching, and at the same time more immediate, potential benefits in the moon's natural resources and in its promise for national security.

One critical resource the moon might provide is water to support operations in space. Because the moon's axis of rotation is nearly perpendicular to its path around the sun, there should be deep craters in the polar regions, sunlight undoubtedly has not penetrated them for billions of years. Water in the form of "dirty ice" should have gathered there from passing comets or outbursts from the moon's interior.

It is to find this water that scientists have long urged the launch of an unmanned prospecting satellite to orbit around the lunar poles. "Its scientific value is not questioned, and its relatively low cost is well known," Dr. Wendell W. Mendell of NASA, points out. Launching the probe would require only one quarter of the cargo capacity of a space shuttle mission, and it could be sent aloft as early as 1989—if NASA persuades the government to fund it.

Astronauts could use lunar water instead of carrying a full supply all the way from Earth. The presence of water would also make it possible to make rocket propellant—liquid hydrogen and oxygen—on the moon, which would further halve the operational costs of lunar missions.

Some scientists have also cited the benefits of a moon base for national security. "We see the moon as the ultimate high ground to protect near-Earth space for the benefit of the nation," says NASA geochemist Jeffrey Warner, in Houston. Lunar facilities could be heavily shielded and attached to bedrock foundations, making them much less vulnerable to attack and easier to control than military reconnaissance and communications satellites.

Because it is so far from Earth, the moon makes much less sense as a weapons platform, except perhaps for the defense of equipment in space. Nonetheless, Soviet propagandists have accused American researchers at the Redstone Arsenal in Huntsville, Alabama, and at Strategic Air Command headquarters at Offutt Field, Nebraska, of plotting to base laser weapons there in violation of international treaties. Spokesmen for both agencies have denied the Soviet allegations.

Transportation to and from the moon is not a particularly difficult undertaking. Manned voyages to the moon 20 years hence will almost certainly use space shuttle–type technology. By then the American space fleet should include two new boosters, a "heavy-lift vehicle" built of shuttle engines and tanks and able to haul up to 180,000 pounds into orbit, and a high-energy upper stage, which may be based on the liquid-fuel technology of the Centaur rocket.

To get to the moon, several orbital-transfer stages could be lifted for assembly in parking orbit, either by several shuttle missions or by one launch of the unmanned heavy-lift vehicle. Another shuttle launch would carry the lunar landing stage itself—probably a modified transfer vehicle—and the crew cabin. Two orbital-transfer stages would push the core vehicle toward the moon, then return to Earth orbit for reuse. The core unit would park itself above the moon while the lunar crew made the round trip to the surface. The entire craft would then return to Earth.

By then "aerobraking" probably will have been perfected to ease the return to a parking orbit. The technique will use a balloon to act as a "drag brake" in Earth's upper atmosphere. This will slow the returning space vehicle enough to let it enter a stable orbit—but not so much that it will fall back to Earth. This would allow the lunar ship to travel without a heavy heat shield; a space shuttle could pick the vehicle up in parking orbit and protect it in the payload bay for the fiery reentry.

Manned lunar flight may depend heavily on a permanent refueling station near the moon. A research platform in its own right, it would orbit a few hundred miles from the lunar surface, according to most American proposals. It appears that the Soviet Union may erect such a way station by the end of this decade. Soviet studies suggest that the best location is at the so-called first Lagrange [L-1] point—one of five sites where a space platform will remain permanently in the same position with respect to both Earth and the moon. In theory, a platform at L-1 would wander a bit, but a recent Soviet report claims that the platform could be held in place by burning only a little rocket propellant.

Wherever it is placed, it will make lunar exploration much easier and cheaper. Because the stages are reusable, and because their original development expenses have been absorbed by earlier missions, such a program would be very inexpensive. Apollo costs were comparatively high because an entire space transportation system had to be built from scratch. Returning to the moon will be relatively inexpensive because most of the equipment will already have been bought and paid for.

"We won't go back to the moon until it's easy to go," one top space official noted as the Apollo program drew to a close. Twenty years from now it will have become easy. Political decisions in the next ten years will determine whether the Apollo program was merely a brief interlude in the long dead history of the moon or a prelude to a lively, profitable, and permanent colonization at the turn of the century. OO

# mind

CONTINUED FROM PAGE 22

dominated religious ceremonies

In general, a complex mixture of pride and shame, yearnings for assimilation and for ethnic self-preservation, goes with being Jewish in America. This is what Klein's counseling sessions aim to resolve.

The family unit is even more sacred to Italian Americans, according to family therapist Joseph Giordano, also of IPGI. Unlike young Jews, Italian young people are often expected to sacrifice personal ambition for the sake of family harmony and to refrain from outdoing their fathers. Because of these deeply symbiotic family bonds found among Italians, it's not unusual to find twenty-eight-year-old "children" still in the nest, eating Mom's ravioli and making no plans to move out.

While Italian women are glowing madonnas in their men's eyes, it doesn't necessarily work the other way around. "Italian women fear violence from Italian men," Giordano remarks, "but the reality is more often the threat of violence than actual physical violence." Raised as second-class citizens, handmaidens to their brothers and father, Italian girls nonetheless often grow into successful career women, balancing diapers and corporate mergers with finesse. "Because Italians value the family over all else, both men and women may make all manner of adjustments to preserve it," Giordano says. The sex life of Italians is generally healthy, and on the whole their religion tends to be more festive than sin-ridden.

Yet Italian Americans suffer from inferiority feelings, Giordano says. Because their typically laid-back style is at odds with the more verbal, more aggressive WASP or Jewish style that dominates the business world or the graduate school, even successful Italian professionals sometimes see themselves as slow-witted by comparison. Mafia and other underworld stereotypes associated with them also undermine the Italian American's sense of self-esteem.

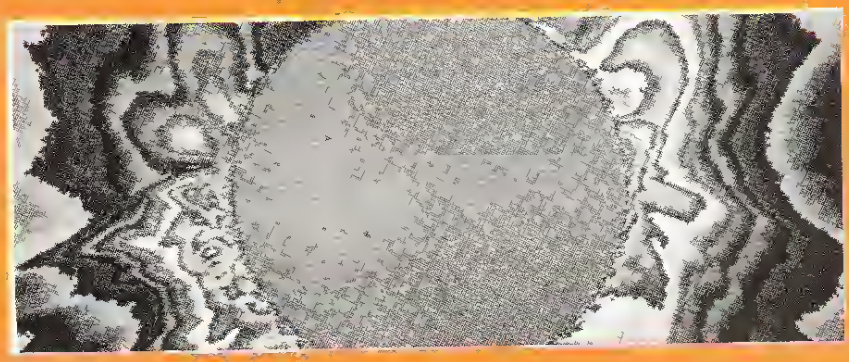
To wander into the innermost chambers of Irish Catholic life is to encounter a very different psychic world, according to research by Rutgers University family therapist Monica McGoldrick. The world's greatest talkers, the Irish keep their rawer emotions under layers of silence that even a trained therapist has difficulty penetrating, especially since, to lapsed Catholics, therapy may carry unpleasant overtones of the confessional. Instead of permitting the effusive candor of Jews and Italians about their emotions, Irish family life revolves around incessant teasing, ridicule, and—yes—drinking.

Perhaps because sin and guilt hover about the Irish Catholic soul like avenging ghosts, the mental-health hazards of being Irish include the highest rate of schizophrenia, suicide, and alcoholism of all the ethnic groups studied. The luck of the Irish

# NEXT OMNI

INTERVIEW

FICTION



SUN SEEKERS

**INTERVIEW**—Richard Leakey has a nose for bones. Like his famous parents, Louis and Mary, he seems to know just where the treasure is buried. In the last few months he has dug up the fossil remains of creatures 8 million and 14 million years old. These finds could illuminate the dark mystery of man's origin and put an end to the controversy about when *Homo* got up on his two feet and walked away from the rest of the apes. Read about fossils and feuds in *Omni* next month.

**BIOCHEMICAL PERSONALITIES**—The signs are found in vials of blood or spinal fluid and in readings of electrical emanations from the brain. Scientists sift through the chemical-electrical evidence in pursuit of human personality and the sources of behavior. The findings are tantalizing. Differences in biology, these scientists have learned, can separate the James Bonds from the Walter Mittys. Juvenile delinquency—and high creativity—may result from an underaroused nervous system. The researchers introduced in next month's *Omni* have even discovered what may be a biochemical marker identifying people likely to kill themselves.

**COMETS OF LIFE**—Four billion years ago comets rained down on the earth, bringing with them tons of space debris and, according to an ever-widening circle of scientific believers, the stuff of life itself. British astrophysicist and maverick scientific thinker Fred Hoyle has already shocked the establishment with his claims that comets "infected" our once-barren planet with primitive life forms. Now others are claiming that the biosphere that allowed them to thrive was a result of this cometary rain. Read in next month's *Omni* why we are all basically comet stuff.

**SUN SEEKERS**—On mountaintop observatories in the western United States a dedicated group of astronomers gaze 93 million miles out into space at our nearest star, the sun. *Omni* will offer a unique gallery of photos in March, showing both the massive equipment used to study this volatile subject and some of the dazzling images produced by these astronomers' scientific obsession with this local giant.

**FICTION**—In March we will publish an exclusive excerpt from Anthony Burgess's new novel, *The End of the World News*. Burgess is renowned for his fiction, enjoying a wide popularity as a result of the 1962 publication of *A Clockwork Orange*. Michael Bishop and Lee Ellis have also written a story about the coming end of the world, approaching the theme from an angle very different from Burgess's. Bishop won the Nebula Award in 1982 for his superb novelette *The Quickening*.

also includes a high risk of serious sexual problems and of either never marrying or else marrying late in life.

Irish Catholics share a number of traits with WASPs, according to McGoldrick, including the use of alcohol as a social lubricant, where Jews and Italians use food. Irish and WASP family reticence can conceal seas of misunderstanding, and so the offspring of these parents often seek close-knit families through intermarriage with Jews, Italians, or other Mediterraneans who typically offer that alternative.

Ethnotherapy began with black Americans, largely through the pioneering work of psychiatrist Dr. Price Cobbs, a professor at the University of California at San Francisco and the author of a study of black identity entitled *Black Rage*. (It was Judith Klein's collaboration with Dr. Cobbs on black/white encounter groups a decade ago that set her off on the track of Jewish identity, especially when she noticed that almost all of the whites in the groups she analyzed were Jewish.)

As the title of Cobbs's book suggests, suppressed rage is the key black issue. Generations of black mothers, he notes, have raised their sons to repress anger and aggression in a culture where such emotions would be suicidal for black men. The result is intense psychological conflict as black males try to sail between the Scylla of dangerous rage and the Charybdis of blunted drive. Their pervasive low self-esteem is another bitter fruit of discrimination, poverty, and a legacy of slavery consequent on being born black.

As if dealing with white racism wasn't enough to test the strongest psyche, black men and women must also battle it out in the bedroom, according to Cobbs. A poignant song from the Broadway musical *Dreamgirls* goes: "I'm not wakin' up tomorrow and findin' there's nobody there / I'm not livin' without you . . . ." Many a blues lyric replays the same haunting refrain, fear of abandonment, that Cobbs has noticed clouding black male-female relationships. As black men fear psychic emasculation by black women, black women accuse black men of irresponsibility and financial unreliability. However, unlike Jewish men and women, neither black men nor black women accuse one another of being unattractive or undesirable.

Will enthnotherapy lead to ever more specialized therapy for Polish Americans, German-Scottish Americans, Jews of Eastern European descent? Perhaps. "We've found that ethnic differences don't just dissolve overnight into the sameness of our suburbs," Irving Levine, of IPGI, observes. "They seem to persist into the fourth generation at least."

On the other hand, ethnicity apparently gets blurred as one moves westward and beyond the Rockies. "Whenever you have a frontier, ethnic issues recede," Klein says. "Who knows? Maybe when we start colonizing outer space, ethnotherapy will no longer be necessary." ∞

# THE BODY

CONTINUED FROM PAGE 26

total may eventually hit 300 or more

Pert and others meanwhile used new techniques to map the receptors, coming up with a remarkably clear picture of which ones lie where. Pert found that some receptors are distributed evenly throughout the brain while others—such as the opiate receptors, which filter pain—congregate in the more evolved forebrain. "The stimulus comes into the hindbrain," she explains. "As it moves to the forebrain, the brain puts more and more information on it." Receptors, in short, filter out reality.

What does this have to do with the drugs you may take in 1990? Everything. Take almost any psychoactive drug today and you suffer unwanted side effects such as the drowsiness and addiction that sometimes accompany the antianxiety drug Valium. This occurs because on their way to the target the drugs set off dozens of other receptors. It's as if you sloshed a bucket of paint over a floor to cover one spot.

Now scientists are designing drugs that go only to the desired receptors, causing little or no side effects along the way. The outcome? New, cleaner drugs worth billions to their inventors and an incalculable amount to victims of mental disease.

Nowhere is the competition keener than in the race to replace Valium, the standard antianxiety drug and the best-selling prescription drug in the world. Here the focus of research centers on the benzodiazepine (a type of tranquilizer) receptor. Discovered in 1977, it plays a key role in anxiety, sleep, convulsions, and muscle relaxation. It was this receptor that Skolnick chemically stimulated, driving the rhesus monkey into paroxysms of fear.

Armed with this information, drug companies have been gearing up to find drugs that react cleanly with the receptor. Scientists working for American Cyanamid, for example, are experimenting with a compound called TZP, which binds only to a certain subclass of benzodiazepine receptor. It relieves anxiety without causing weakness and fatigue. Upjohn Company scientists are finding that the same compound relieves depression, too. "The interesting point is that anxiety and depression are clinically linked," says Upjohn's Dr. Vilama H. Sethy. "We may have hit on a drug that's effective against both."

Perhaps the most immediate challenge comes from Michigan-based Meade Johnson, where researchers have formulated a no-side-effects antianxiety drug. Mysteriously, it doesn't react with the anxiety receptor. "We don't even know how it works," Duncan Taylor says of the compound his company calls Buspirone. It seems to react with the dopamine receptors (sites that mediate muscle coordination), but why it eases anxiety remains to be seen.

Meanwhile Valium's producer has been busy, releasing a new drug in Europe that, unlike its predecessor, keeps people awake. Called RO 15-1788, Hoffmann-LaRoche's new drug is especially useful in treating schistosomiasis, an intestinal disease whose cure causes debilitating fatigue. Given with the cure, RO 15-1788 blocks the fatigue and allows patients to lead more normal lives.

Yet even this research is only the beginning. Scientists at E. I. duPont de Nemours are working with a hunger receptor to produce a no-side-effects diet pill. Scientists at the Upjohn and Pfizer drug companies are studying the angel dust receptor to develop an antidote to the drug and to probe the causes of schizophrenia. American Cyanamid believes it has uncovered a receptor-related process that causes some elderly people to lose their memory.

"It's amazing to think that one specific cell is so critical to this complex behavior," says Arnold Lippa, director of molecular neurochemistry at the firm's Lederle Laboratories. Forgetfulness, he believes, may arise from the degeneration of a single class of receptor cells in the brain's memory centers. He and his colleagues have produced amnesia in young monkeys and cured old ones of theirs—all with injections of two drugs with opposite actions.

Sometimes the research has near-mystical implications. Dr. Wallace Mendelson, of the NIMH, who has been studying the chemical basis of sleep, gave rats a Valium-like substance called EHNA, which he expected would soothe the rodents. The rats indeed did walk about less, but brain-wave readings showed an unexpected effect. In contrast to their physical activity, the rats became more alert than ever—something the layperson might call meditation. Mendelson says, "We may have hit on an altered state of animal consciousness."

Will we someday see a human meditation pill? "Calling this meditation is still pretty speculative," he says, "but if it does happen, it will be within the next five years."

Drugs to wake us and put us to sleep, drugs to cure anxiety and to make us fear—even, perhaps, a drug to induce mystical enlightenment. This mechanistic approach at times sounds ominous, but not to those building the new brain science. Pert says psychiatrists will work more effectively than ever, conducting chemical workups to learn whether their patients' problems spring from the receptors. Mendelson looks forward to new medications for manic and schizophrenic patients that will calm them without "zonking them out."

All these predictions are comforting, but nagging questions remain. If our emotions are biochemical—the product of millions of years of chemical evolution—how much do we grow through these emotions? How much are we programmed? How much are we taught? To this, Pert has a disquieting reply: "The brain is a machine that is programmed to survive. Nurturing can help it reach its full potential. But you can't make your brain fundamentally better. You can only screw it up."

# PHENOMENA

Nestled quite comfortably in a forest of poisonous tentacles, a polychromatic amphiprion, or clownfish, waits patiently for its next meal to be killed. Every day of its life the fish participates in a dramatic scenario of symbiosis with the deadly host sea anemone that surrounds it. The job of the clownfish, with its electric colors, is to act as a living bait and lure other fish within striking distance of the anemone's lethal tentacles. Those too hungry or too curious or simply too careless to notice the deadly polyps are dispatched instantly and devoured by the living bait and its host. Unlike those it lures in to their death, the clownfish is totally immune to the toxins of the anemone and can eat the kills with impunity. Photographer Jeff Rotman shot this deadly pair while on a night dive in the Red Sea, using Kodachrome 64 film and an underwater flash with his Nikonos II camera. ◻◻

# LIFE

CONTINUED FROM PAGE 16

to ensure accuracy of replication through the "noise" of unwanted mutational error.

Campbell points out that the principle involved is readily apparent in the language used in everyday conversation. Consider, for example, the sentence "Mary has three books." Although the *s* attached to *book* is clearly redundant, it is not mere repetition. By employing two separate bits of information to convey the idea that Mary has more than one book, the message stands a better chance of being understood by the intended recipient, even if the speaker is shouting across a noisy room. In other words, grammar is a form of redundancy that ensures the internal consistency of language, making it more resistant to the randomizing effects of noise.

Of course, too much redundancy does become useless repetition. Clearly, a certain number of grammatical rules are needed to maintain the integrity of a message, but if rules are carried to an extreme, they can become so restricting that we lose the ability to generate novel utterances. Now, as it happens, Shannon's so-called second theorem states that the ideal message code is one that includes the possibility of generating the maximum number of new varieties of order. In the view of Stanford biophysicist Dr. Lila L. Gatlin, in the course of evolution certain organisms, the vertebrates, did acquire DNA messages encoded in a more efficient way, more closely approaching this ideal than earlier life forms had. It was this advantage in information coding, she theorizes, that explains how they were able to generate new varieties of life forms much more quickly than chance mutation would allow.

If true, this idea offers a fresh solution to one of the most vexing gaps in Darwinian theory: its inability to explain sudden huge leaps in the evolutionary history of species. Fossils show that new types of animals—men, say, with bigger brains—appear all at once, rather than gradually, on a geological time scale.

Such "missing link" puzzles have prompted some outlandish speculations, ranging from Von Daniken's proposal that ancient astronauts arrived from the stars to breed man from ape, to astronomer Sir Fred Hoyle's Directed Panspermia theory that primitive life and even insects arrived from outer space along trails of cosmic dust. But a theory that suggests a way in which DNA might be an active agent in promoting evolutionary advance still seems, on the face of it, much more plausible.

Just how information theory offers to provide an answer is hinted at by the story of Bennett's monkeys. The constraints he applied to govern the appearance of letters amounted to a mathematical grammar for the long-tailed authors to follow. Without it, the chances that anything worth reading would come forth were infinitesimal. With it, a surprising amount of new order was generated. Most interesting, perhaps, was the fact that real words tended to appear in clusters. Two or three lines of gibberish would be followed by several real words all together.

In this light, new evidence, however slim, that the theory may eventually prove applicable to biology is suggested by recent discoveries that the DNA of elementary, one-celled organisms differs radically from the DNA found in the cells that make up humans and all other multicellular life forms. The genetic coding of the bacterial cells never includes the apparently surplus nonsense segments that are widely interspersed throughout our own DNA, like stretches of gibberish inserted in an otherwise normal sentence. Researchers speculate that this so-called junk DNA, also called introns, is recycled over the course of evolution, giving rise to novel combinations of inherited characteristics, and eventually even whole new species.

One person more convinced than ever of the theory's relevance to biology is Gatlin, who wrote an equally engrossing book, *Information Theory and the Living System* (Columbia University Press, 1972). If Darwinian selection were the only means available of improving the efficiency of information processing in the living system, she writes, "evolution would have reached its apex in [the bacterium] *E. coli*." Now that the DNA of living organisms is being decoded at a phenomenal pace, Gatlin says she intends to study the introns "for traces of a language of a higher order."

With no real proof yet available, most of the thinking that extends the significance of information theory into this and other areas remains pure, though exciting, speculation. However, further tangible evidence that we may be on the right track is suggested by the successes recorded in using information theory to predict complex physical systems.

One adaptation of information theory, christened Entropy Minimax by its developer, Robert Christensen, who runs a consulting company called Entropy, Ltd., near Boston, has been successfully used to predict a number of future occurrences: the life expectancy of heart patients in a North Carolina hospital, the breakdown rate of fuel rods in nuclear reactors, and long-range weather conditions in California.

Shannon, whose doctoral thesis happened to focus on genetics, is still undecided, though open-minded, on the great biological questions. "I've thought a lot about evolution and its relation to information theory," he told me recently, "but I haven't come to any good conclusions. It's a matter of figuring out the probabilities." But if Darwinian evolution and gene mutation alone really can create "things as complex as animals and people," Shannon observes, "it is one of the most amazing things in the universe."

As unlikely, it would seem, as a monkey typing out a Shakespearean sonnet. ∞

# BREAKTHROUGHS

CONTINUED FROM PAGE 32

could communicate with people you never knew before."

But why stop there? Taken a step further, telecommunication games may even spark a cerebral sort of sexual revolution. After all, why go out and make the scene when you can interface with the pilot of a spaceship in the privacy of your own home?

## NEW PRODUCTS

There are already digital watches that monitor your pulse, play wake-up tunes, have built-in TV sets or AM/FM radios, play video games, or announce the time out loud. What could possibly be added? Casio has introduced three new digital watches that also display the temperature (in Fahrenheit and Centigrade) and can even be set to sound an alarm if it gets too hot or cold. The TS-1000, TS-2000, and TS-3000 are water-resistant to depths of 300 feet, depending on the model, and include stopwatch, alarm clock, and calendar functions. ($49.95 to $59.95, from Casio, Inc., 15 Gardener Road, Fairfield, NJ 07006.)

It is packed in an elegant Del Sey-brand briefcase and includes a 5" diagonal video screen, a computer keyboard, and a printer. But the Portable Videotex Terminal is not just another computer-in-a-briefcase. It is specially designed for traveling salesmen. The PVT plugs into any telephone to access a central database and can be used to enter sales orders, check inventory, obtain product information, and even print out the bill. ($2,000, from Intelmatique, 98 Rue de Sevres, Paris 75007, France.)

Chris Carver, a Hong Kong-based inventor, has come up with an ingenious way to improve a golf swing—a strobe light that gives the golfer three distinct stop-action views of his club face hitting the golf ball. The Swingstrobe system includes a strobe light and a triggering unit, which are set up on either side of the tee. The triggering unit projects three invisible beams at light sensors on the strobe. When the golf swing intercepts the beams, it causes the strobe light to flash three times, providing the illusion of stopped action, much the way strobe lights in a disco seem to freeze the dancers in midmotion. ($150, from C. W. M. Carver, No. 6 Po Shan Road, Piccadilly Mansion, 1-B, Hong Kong.)

Karl Seeger Lederwaren GmbH, of West Germany, is famous for its offbeat, elite luggage. But the company has really outdone itself with the Solar Attache, an extravagant lambskin briefcase with a solar-powered, electronic combination lock. Two photovoltaic panels charge a battery, which powers the lock. It is opened by punching a code into the keyboard on top of the briefcase. ($1,895, from Stephen J. Sanders, Inc., Empire State Building, Suite 7812, New York, NY 10001.) ∞

*Theories, microvisions, and doodads*

# GAMES

By Scot Morris

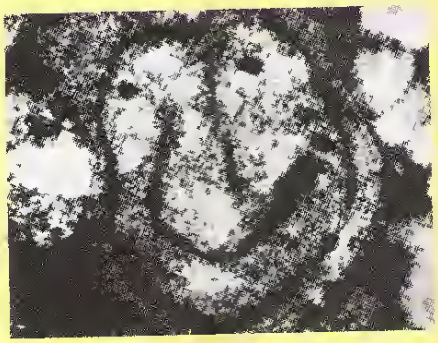
The warning signs are clear. The Western Hemisphere is headed for a major catastrophe. Extrapolating from current trends, a scientific journal predicts imminent destruction unless something is done soon. In the not-too-distant future, projections indicate, the North American continent will be wrenched by massive earthquakes and landslides and much of it will sink under the ocean. The cause: the accumulated weight of back issues of *National Geographic* magazine.

Another scientist proposes a theory to explain why it is so difficult to find a paper clip when you want one, yet there always seem to be more coat hangers in the closet than you could ever use. The explanation is simple. The paper clip is merely the embryonic form of the coat hanger. The sudden metamorphosis and migration from desk to closet are rarely observed and are presumed to occur during early-morning hours.

Then there is the report of one-trial learning in the domestic darning needle (*Ferrum ferricum*). Psychologists offered a magnet as a reward and found that the subject approached the reward on the very first trial, with no prior experience, producing one of the sharpest learning curves in all psychology.

There are mathematical breakthroughs: a treatise on the art of finding the best graph paper to get a straight line and a *new* formula showing that the productivity of a laboratory depends on the number of secretaries (S), their typing speed (Ts), and the number of scientists (P). The formula is constructed to show that when the number of scientists is zero, the productivity becomes infinite.

And of course there's the revolutionary theory about how the earth's continents were formed. A geographer noted that most major landmasses and peninsulas point south—Africa, South America, Florida, Baja California, Malaya, India, Greece, Italy, Spain, etc. The land appears to have been dripped onto the earth from the North Pole, like the paint in the old Sherwin-Williams "We cover the earth" logo. The premise, naturally, is called the Theory of Continental Drip.



Since *The Worm-Runner's Digest* ceased publication, there are few outlets in the world where scientists with a sense of humor can poke fun at themselves and publish theoretical breakthroughs like the foregoing. The finest one today is the *Journal of Irreproducible Results*, the official organ of the Society for Basic Irreproducible Research. In 1983 *JIR* enters its twenty-fifth year of publication, and it remains one of the best bargains in all publishing: four issues for just $3.90, from JIR, Box 234, Chicago Heights, IL 60411.

Covers of the journal usually depict bizarre and unexpected shapes seen in scanning electron microscope (SEM) photos: images of the kind that make scientists, peering through their microscopes, do double-takes, rub their eyes, and look again. Most of these have been found by Dr. Alex Kohn, professor of virology at Tel Aviv Medical School and editor of *JIR*, while scouring thousands of SEM images.

We present here some of *JIR*'s stranger microvisions. Clockwise from top left: *Etrurian Relief*, a freeze-etching of a shark muscle, by Harald Kryvi, of the University of Bergen, Norway; *Smiling Chloroplast*, by Carol A. Lunney and Sue Hughes, of East Carolina University, Greenville, North Carolina; a shark embryo at about one-month gestation, by Jeffrey T. Corwin, of Scripps Institution of Oceanography; *A Partridge in a Pear Tree*, by June Almeida, of Wellcome Research Laboratories, Beckenham, England (the partridge is an influenza virus, the tree is a complex of hepatitis B virus, and the grass is hepatitis B tubules); the angry girl is a parasitic worm, found in a domestic cat's intestine by Raymond A. Johnson (the dark glasses are ovaries, and the open mouth is the worm's intestine in cross section); the "Muppet embryo" is actually the head of a tapeworm from a channel catfish's intestine, by Jeannine P. Gilbert, of the University of Georgia.

## THE WHATCHAMACALLIT QUIZ

You see things around you every day that have names, honest-to-goodness English names, yet you still insist on pointing at them, saying "that there," or calling them guys, doodads, thingumajigs, and gizmos. It's time to show some respect.

Most vocabulary tests give you the words and you're supposed to define them; others give you the definitions and you supply the words. This one's different. We'll give you the words *and* the definitions, then you match them up. Easy. Some you know already, the others you'll get by elimination and educated guessing. If you get more than half right (13+), you know what's what. If not, you need *What's What: A Visual Glossary of the Physical World*, by David Fisher and Reginald Bragonier, Jr. (Hammond, Inc., Maplewood, New Jersey), the handsome new book from which we have adapted this quiz.

### THE WORDS

1. ascender
2. bleed
3. blow-in
4. canthus
5. chuck
6. counter
7. culet
8. deck
9. ferrule
10. finial
11. folio
12. follow block
13. friction strip
14. gnomon
15. hallux
16. hot shoe
17. lintel
18. lunula
19. nock
20. platen
21. sidebar
22. slug
23. tragus
24. ullage
25. vamp

### THE MEANINGS

____A. The bottom, pointed tip of a diamond

____B. The fleshy protuberance on your ear that extends back over the ear opening

____C. The angle formed where your upper and lower eyelids come together

____D. The light-colored crescent at the base of a fingernail

____E. The rubber cylinder on a typewriter that the paper goes around

____F. Lowercase letter like *b*, *l*, and *t*, for example

____G. A secondary headline like "Theories, microvisions, and doodads," at the top of the page at left

____H. The back of a shoe, the part behind the heel

____I. The front of a shoe, the part that goes over the foot

____J. The part of a drill into which the bit is inserted

____K. A subscription card in a magazine that isn't physically connected to the magazine

____L. The notch at the back end of an arrow where the bowstring fits in

____M. The abrasive, striking surface on a matchbook

____N. The amount that a container lacks from being full, e.g., the space inside the bottle between the liquid and the top

____O. The part of a sundial that sticks up and casts a shadow

____P. The number *133* at the bottom of this page, for example

____Q. The place on a camera where the flash apparatus attaches

____R. The big toe

____S. A horizontal board or slab above a door or window

____T. A photo printed without borders so that it runs off the page (e.g., the interview photos in *Omni*)

____U. The part of a stapler, attached to a spring, that pushes the staples forward

____V. A self-contained boxed article that is related to, and accompanies, a feature article in a magazine

____W. A metal band like the one on a pencil that holds the eraser on

____X. An ornamental top (e.g., on a flagpole or a lamp frame)

____Y. A symbol placed at the end of an article, like this ∞

## COMPETITION #27: JUST A THEORY

The best theories are those that explain a lot of data. They project into the future based on current trends; they help to construct a plausible picture of the distant past; they explain phenomena.

We are looking for more theories that help us make sense out of the world and the universe: theories of the type described at left: the *National Geographic* catastrophe theory, the paper clip/hanger hypothesis, and so on.

Send us your bright ideas. Please limit them to 75 words or fewer, preferably far fewer. The briefest ideas will have the best chance of being picked. The grand prize-winner will receive $100, runners-up (2–10) $25 each. All entries become the property of *Omni*; none will be returned. Send entries, by March 15, 1983, from within the United States, or April 1, 1983, from other countries, to: Omni Competition #27, 909 Third Avenue, New York, NY 10022 ∞

### WHATCHAMACALLITS (Answers)

7–A, 23–B, 4–C, 18–D, 20–E, 1–F, 8–G, 6–H, 25–I, 5–J, 3–K, 19–L, 13–M, 24–N, 14–O, 11–P, 16–Q, 15–R, 17–S, 2–T, 12–U, 21–V, 9–W, 10–X, 22–Y

# LAST WORD

By Judith Hooper

*Why don't the computer-game designers come down from their hyperspaces and address the more relevant fantasies of us earthbound types?*

It finally happened. My portable Smith-Corona, with its familiar stuck *h* key and its jet engine takeoff noises, has been retired, and a sleek, silent home computer/word processor now squats in its place. It's a handsome instrument, more like a rocket console, I think, than a typewriter, and it gives my words a certain austere nobility as they glow from the computer's CRT, or television screen. But in making this high-tech transition, I hadn't reckoned with my old technophobic brain.

There is, as far as I know, no Muse of Integrated Circuitry; so how is a low-tech writer to feel at home in a universe where metaphors, oxymorons, and epigrams race through mirrored halls of microchips at the speed of light? Even the mundane stenographic phenomena I encounter baffle me, such as the little string of four words that has been trailing behind my typed sentences as they march across the computer screen—the fruits of a bungled deletion.

And there are worse things that can befall the amateur word processor. An entire "file" of written material, perhaps an immortal ode, could exit this universe as the result of an unexpected electrical surge while another file, say, one containing last week's shopping list, might remain lodged in the computer's brain forever, defying every attempt to lobotomize it. But most ominous of all is the way innocent use of the computer inevitably leads to a greater problem: serious addiction to computer games.

These seem to fall into two general categories: the extraterrestrial/futuristic and the regressive/subterranean. In the first type, the player has to navigate past asteroid belts and black holes that float around hyperspace (whatever that is; it sounds like one of those seldom-used typewriter keys). The second category requires a close personal involvement with cave-dwelling gnomes, dwarfs, and other creatures.

I won't pause to analyze the Freudian significance of all these rockets and caves, but I would like to point out that these kinds of games are very alienating to the average technophobe. Who can relate to anything more than three or four light-years away? And what's so very fascinating about conversing with a silicon gnome that has a 100-word vocabulary? Why don't the computer-game designers come down from their hyperspaces and address the more relevant fantasies of us earthbound types?

Here, therefore, are some modest proposals for a revolutionary new line of Computer Games for Daily Life:

### Writer's Block

Battalions of mixed metaphors swarm down and try to land in your text, dragging dangling participles and split infinitives in their wake. If you manage to defend your copy against these conventional weapons, legions of malapropisms and misplaced modifiers arise in a second wave of assault.

### Restaurant Ricochet

Squadrons of waitpersons glide past your planet at the speed of light, ignoring your radio-beam orders and communicating among themselves in a strange interstellar tongue. Your object: penetrate their wall of obliviousness and order the *plat du jour* before (1) you collide with a deadly salad-bar ship; (2) you're sucked into brunch hyperspace, condemned to float among soggy eggs Benedict and watery Bloody Marys for all eternity; (3) your planet is transformed into a piano bar and your civilization is reduced to chrome, hanging ferns, and broccoli quiche.

### Hemorrhoids

You must repel a massive invasion of domestic horrors: hemorrhoids, cellulites, house-a-tosis germs, dingy whites, tiny wrinkle lines, liver spots, irregularity carriers, waxy yellow build-up launchers, and ring-around-the-collar bacteria, and get to a knowledgeable doctor, pharmacist, grocer or aging TV actor for advice. If you fail, the humiliating sneers of friends, coworkers, and neighbors terminate your universe.

### Inner Space Invaders

In this intrapsychic adventure game the challenge is to unlock your human potential in the Karmic Kastle, block the flow again in the Primal Bog, and have your personal space invaded by a Significant Other in a traumatic hair-raising nonexclusive relationship. Further growth experiences lurk in the Interpersonal Woods, where est elves, transpersonal knights, gestaltic gremlins, and rolfing robots are ready to assist you in working through your inner barriers.

### Herpes Defender

Lethal "simplex" and "complex" viruses are unleashed into the biosphere by malefic Moralmajorityites ready to do battle against your sexual freedom blip. The object of the game is to achieve a Meaningful Relationship with a player of the opposite sex before being smitten by one of the viruses and rendered "inactive" for ten plays or more.

### ImpactedMan

The thrills of root-canal surgery, the horror of plaque, Novocain injections, dental prostheses, lecturing hygienists, fearsome periodontal equipment, deadly Muzak, and bad waiting-room oil paintings of seaside scenes loom realistically in this high-adventure quest for the perfect bite. Not for the amateur.

*Judith Hooper is a freelance writer struggling with her first personal computer.*