OMNI

MARCH

CRIME BY COMPUTER

RICHARD LEAKEY'S TIME MACHINE

THE CHEMISTRY OF SOUL

NEW NOVEL FROM ANTHONY "CLOCKWORK ORANGE" BURGESS

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OMNI®

MARCH 1983

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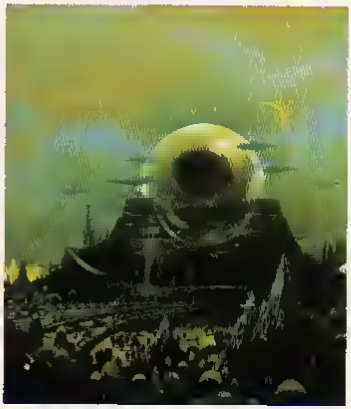

Paul Lehr, a sculptor and science-fiction illustrator, originally created The Power of Blackness *for a book cover. An aura of evil pervades the atmosphere. One wonders what dreadful cargo is being removed from the structure that watches over the workers.*

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FIRST WORD

By Robert W. Prehoda

"Space lottery tickets could be sold at the local post office, and billions could be raised to develop space without any new taxation."

The vast expanses of space are not viewed as a lucrative investment these days. Space industrialization may eventually yield incalculable riches to a visionary government or enterprising company. But few corporate executives today can justify the cost of space development in a world economy ravaged by inflation and high interest rates.

In uncertain times like the 1980s, traditional products and real estate ventures are viewed as more prudent investments. The monetary return on space investment seems just too remote for most companies to consider.

With sufficient vision and leadership however, our government in Washington could allay these corporate fears and lessen the reluctance that has inhibited private space development to this day. NASA budget cuts notwithstanding, a comprehensive Space Industrialization Act, passed as early as 1984, would ensure the early orbital entry of private industry into space.

This act would provide a 40 percent tax credit on all space-related investments. Also included would be a moratorium on all taxes on the sale of goods and resources produced in space—through at least 2000. The tax credit and moratorium should cover techniques and hardware designed to support activity in space. Such incentives have been used in the past by many nations to good effect. U.S. patent, copyright and trademark laws would be extended to cover space-related hardware, software and similar products.

What is also needed, perhaps even more crucially, is a new social invention that would provide large sums of space-development capital without using tax dollars. History provides us with a clue. Zeppelin development, for example, between 1905 and 1912, was made possible through a national lottery sponsored by Germany's Kaiser Wilhelm II, resulting in the world's first passenger airline of a sort. Such lotteries, restricted to advanced technological developments, have been successfully used in the past, as early as the sixth century B.C. by the kingdom of Lydia in Asia Minor.

The most revolutionary feature of my proposed Space Industrialization Act for the 1980s is that it would also include a national lottery to provide the necessary investment capital for extraterrestrial enterprises. Overhead costs could be minimized by selling the lottery tickets at the local post office, and billions in loan funds could be raised without taking one tax dollar from any citizen. All profits from the national lottery would go to a semiprivate Space Bank, which would be restricted to generating capital for space industry. Low interest loans and grants would be paid back as soon as a company's space activities were successful. As opposed to most commercial loans, very long amortization periods will be required for most space endeavors. Hence the need for favorable interest rates.

Assuming that space industrialization were to become highly profitable, the Space Bank would begin to show a significant profit, since outstanding loans could be amortized gradually. Funds could then be diverted to other pursuits, such as medical research.

Present plans call for NASA to operate our space shuttle fleet. There have been recommendations that the shuttles be turned over to a private organization which could operate them and charge a fee for each civilian and military payload. A consortium, perhaps composed of a leading airline and a large aerospace firm, should be able to operate the shuttle fleet more economically than NASA can. Consequently, the first significant loan issued by the Space Bank might be allotted for the purchase of NASA's shuttles by such a group.

Space Bank funds could also be used to develop a new generation of fully recoverable launch vehicles that would greatly reduce Earth-to-orbit transport costs. Reliable studies indicate that such launch systems could place a payload into low orbit for as little as $25 a pound (in 1981 dollars) by the mid-1990s.

Revolutionary ideas are indeed difficult to sell—a fact discovered by Christopher Columbus 500 years ago when he traveled from one royal court to the next. Neither NASA nor private industry speaks each other's language, and private industry is virtually unaware of the potentials of space industrialization and what NASA can offer industry in the way of information and assistance. As part of the Space Industrialization Act, a presidential panel and legislative task force would need to be established to promote exchanges between NASA and private industry.

Naturally, politicians will want to siphon off funds from any national lottery for their own pet projects—especially social and military programs now being cut. The only way to ensure that a lottery law would pass through Congress without its proceeds being diverted from astronautics would be for the President to announce publicly that he would veto any lottery act that diverted funds to any other projects. The President's strong resolve therefore would be the key to a space renaissance made possible through the participation of all the American people.

If our citizens are going to wager, let them bet on the promise of space. With the eventual reindustrialization of America being the final jackpot and a renewed patriotic mission being the most immediate gain, a national space lottery could have only a positive effect on everyone. OMNI

Robert W. Prehoda, a science writer and lobbyist, is the author of Extended Youth *and* Designing the Future.

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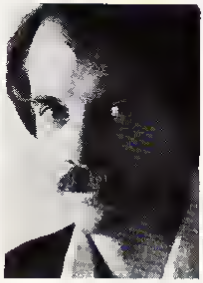
WILLIAMS


OGNIBENE

Many of *Omni*'s readers have recently begun working—and playing—with PCs (personal computers). In fact, almost a third of our readers, according to a market-research study, now own computers, and about half are considering purchasing a PC within the next 12 months. To meet their needs, *Omni* is inaugurating Artificial Intelligence, a new computer column that will cover this electronics revolution and highlight its impact on the future.

Each month Artificial Intelligence will report on new computer capabilities, describe upcoming advances in hardware and software, and profile the fascinating, often eccentric, people behind the complex and imaginative technology.

"We're using the term artificial intelligence to signal that we'll cover machines and software that mimic, and sometimes seem to surpass, human intelligence. But there's nothing mysterious about this technology," says *Omni* senior editor *Gurney Williams III*, who will oversee the project. "Ultimately," Williams continues, "the machines depend for their existence and usefulness on people. Real intelligence turns the machines on, and real intelligence writes the programs and harnesses their output in imaginative, futuristic ways."

In the first column, "Six-Month Syndrome," on page 38, contributing editor and multiple-computer owner *Owen Davies* addresses the potential consumer who is trying to decide whether to buy equipment now or wait until better stuff comes along. Computer experts provide some idea of where the field is leading, what you might gain by waiting, and what you certainly lose by not buying now.

Another side of computing is revealed in "The Keeper of Secrets." Beginning on page 52, Washington, D.C.-based journalist *Peter Ognibene* tells how a sophisticated and massive penetration, *by* computers *on* computers, could destroy the data our society needs to run its banks, hospitals, universities, and businesses. Thanks to the spread of inexpensive computer power, the technology to break codes and pilfer secrets—once the domain only of spy agencies—is now in the hands of individuals. Ognibene, currently at work on a novel about computer terrorism, reports on what is being done to safeguard our privacy against these high-tech vandals.

For our fiction readers, there are three narrative offerings in this month's issue. *Thomas M. Disch*, a highly respected science-fiction writer, presents "The Shirt's Tale/The Shorts' Story," a delightful romance starting on page 132. Bantam Books has just published a collection of Disch's stories, entitled *The Man Who Had No Idea*.

In "The Last Child into the Mountain" (page 62), *Michael Bishop* and *Lee Ellis* tell about a young video-game expert whose keyboard impulses cannot be controlled. Bishop won the Nebula award for his recent novelette *The Quickening* and has just completed a novel, *No Enemy but Time*. Ellis is the creator of the Polygraph McKnight detective stories and the developer of a variation on Rubik's Cube that produces over 42 words when solved.

An extremely versatile man, *Anthony Burgess* has been a professor, composer, and an active participant in the theater world. He has received critical acclaim for 16 novels and 8 works of nonfiction, including *A Clockwork Orange* and *Earthly Powers*. Starting on page 84 is an excerpt from his latest novel, *The End of the World News* (McGraw-Hill), in which Burgess focuses on the classic science-fiction theme of impending disaster and how normal human beings cope with the coming end of the world.

Those of you who expect to survive the holocaust will want to read "Superthreads" (page 124), a survey of new products, either just introduced or still in prototype form, that will affect America's lifestyle. *Phoebe Hoban* and *Marjorie Costello* reveal what's really new in high-definition TV, digital recording, laser discs, and home isolation tanks. Costello, editor of *Videography*, a professional video publication, is completing a book on home-video recording techniques. Hoban, a frequent contributor to *Omni*, covers new technology at *Newsweek* magazine and has written two high-tech children's books about robots. ∞

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MARCH

LETTERS

COMMUNICATIONS

Lucky Thirteen

I thoroughly enjoyed Stephen Robinett's short story "Number Thirteen" in the November 1982 issue. It was a compelling and beautifully constructed piece of fiction. Clinical psychology moved to the laboratory of the stars . . . where human choices remain infinite, fathomless, and unpredictable. "To be, or not to be" on a cosmic scale. Terrific! I hope to see more of Mr. Robinett's work soon.

Ken Dutfin
Guelph, Ont., Canada

Cattle Controversy

In his comments on the science-fiction film *Endangered Species* [Film, November 1982], Bill Moseley lends credence to a number of thoroughly discredited fictions associated with the "cattle mutilation" phenomenon. The only real phenomenon of any scientific interest in evidence here is human gullibility.

Nearly everything that Mr. Moseley says—and apparently believes—about what he calls "the real mutilations" is provably untrue.

Mr. Moseley declares that "most serious investigators now believe that the mutes are the work of radiation-wary extraterrestrials." He attempts to place himself in "respectable" company by citing "Linda Howe's Emmy Award-winning documentary about the real mutilations." This piece of video twaddle merely reminds one that television, even at its best, is a wasteland.

The evidence that the "mutilators" are nothing other than terrestrial predators of limited I.Q. but considerable instinctive cunning is overwhelming. It is true that only one ear is often found missing, but this is attributable to the fact that skunks, coyotes, buzzards, blowflies, and other "night surgeons" have not yet evolved to the point where they can turn a large animal over to get at the unexposed ear. In case after case, the missing ear or eye is the one that is exposed: the tongue is chewed off at the point where it protruded from the mouth; at the time of death, udders and testicles also make for quick and easy snacks.

As for missing internal organs, Mr. Moseley should have a conversation with a pathologist familiar with the biophysics of bloat and the dynamics of gas buildup in the carcasses of horses and cattle.

David Rorvik
San Francisco

Bill Moseley responds: *Like so many others involved with soft-soaping the true mystery of the animal mutilations that have plagued the United States and a number of foreign countries for the past 15 years, Mr. Rorvik insists on writing off this enigma as the snacking of "skunks, coyotes, buzzards, and blowflies." Why then, in the 1,000 or so inexplicable mutilation cases, do these "scavengers" and "predators" leave nary a footprint? How are they able to drain the carcasses completely of blood? How do they bring about the unnaturally rapid deterioration of their victims' internal organs? What do these "night surgeons" do to render their prey free from rigor mortis and repellent to other scavengers? And how does Mr. Rorvik explain the documented reports that lights in the night skies have often accompanied the mutilations? Hungry fireflies?*

While I do not pretend to know all the answers concerning the mutes, I do know that there is more here than Mr. Rorvik, or the government, allows.

A Rose by Any Other Name . . .

I read with avid interest the article "Fateful Names" by Dava Sobel [Continuum, August 1982] and found some interesting examples of this phenomenon among my own acquaintances.

First, my brother-in-law, Michael Foote, is a child podiatrist. Deryl Forrest works in Hinsdale County for the Bureau of Land Management. Paul and David Brewer make some of the finest beer I've yet tasted. R. H. Goldsmith descends from a long chain of jewelers. James C. Gear is a used-car salesman. Then there is my Polish friend Kroka Dungski, which translates . . .

William Cummings
Lake City, Colo.

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.

Digital Mona Lisa

Robert Patton's article "Ooparts" [September 1982] contains some singularly strange reasoning. If the *Mona Lisa* wearing a digital wristwatch turned up would Mr. Patton conclude that the picture was an obvious forgery or that the digital watch technology is much older than anyone had previously thought?

The Piri Reis map supposedly contains information on the Antarctic coastline that was not known until 1949. The map was allegedly drawn in 1513, but it was not "discovered" by Western experts until 1956, seven years after the coastline's contigurations had been updated.

Instead of taking this as clear proof of a not-too-clever forgery, the conclusion was drawn that some pre–Ice Age navigator passed down an accurate map of the Antarctic coastline, which was copied for hundreds of years despite its being outdated by glaciers.

The use of plane geometry and Mercator projection in drawing the map is likewise taken not as an obvious indication of fraud but as proof that these techniques existed long before historians formerly thought.

If a copy of the Declaration of Independence, written in ballpoint pen, was said to be authentic by some "expert," would we not be justified in taking a close look at his credentials?

Philip Plubell
Miami, Fla.

I found "Ooparts" most interesting and enlightening. The scientific world will have to pay more attention to technologies and scientific development that existed in past civilizations.

It was a joy to read this article and to know that there are many pieces of history's jigsaw puzzle that are still left to be defined and resolved.

Walter Gutierrez
San Diego

Speaking Professionally

I loved the article "Medspeak" by Mary Carpenter in the September 1982 issue. Since I'm a registered nurse, I often have to interpret medspeak to my patients. While I respect many of my doctor colleagues, we sometimes have head-on confrontations when I find out that a patient has not been told the whole truth about his or her condition.

I know of an incident in which a doctor entered a hospital room, looked at his patient, and came out to storm at the attending nurses. "My patient's oxygen is off, there's no urine output, and the IV has been stopped. What's going on?" To which one nurse replied, "That's because your patient has been dead for fifteen minutes. Doctor. We've been waiting for you to answer your page. Please, doctors, become one of the team, for all our sakes."

B. J. Schenck
Los Angeles

A report very similar to Mary Carpenter's article could be written about almost any profession. For instance, the National Aeronautics and Space Administration describes a one-to-one individual reciprocating bicuspid plaque-level limiter. "Also, a portable unitized earthwork synthesis system designed to relocate dirt from one pile to another, or even dig a hole, when properly manipulated by the operator."

And everyone knows how easy it is to understand the manuals and forms published by the Internal Revenue Service. Doctors do not have a monopoly on jargon. How many times have you taken your car to be serviced and not really understood the technical language the mechanic used?

Certainly communication is a two-way street, and perhaps doctors and auto mechanics, for instance, should learn to translate their jargon into layman's language, but at the same time, I should learn a bit more about the functioning of my car and patients should learn a bit more about their bodies.

Sylvain Fribourg
Woodland Hills, Calif.

Isn't it time to pick on a different profession? Articles like "Medspeak" are so blatantly biased against the medical profession that I have difficulty understanding why a magazine like *Omni* would publish them.

Is medicine alone in developing a technical lingo? Might there be a reason for the employment of such language other than to create confusion and fear in the patient? I would agree that some physicians have difficulty turning off the medical lingo, but communication is a two-way street. Is it not the patient's responsibility to inform the physician when he or she doesn't understand?

I believe that physicians are dedicated to the care of the patient. They sometimes may not satisfy the emotional or medical needs of their patients, but they do try their best to do so.

Charles Mauldin
Gray, Tenn.

Robotics Booster

I would like to express my appreciation for the article "Alice's Factory" in the August 1982 issue. The advances made in the last few years in CADCAM technology have not received the public attention that is both deserved and necessary. The community of man has come to feel threatened by the community of robotics for no reason, and it is time to clear the air.

As engineers whose livelihood is entwined with robotics and CADCAM, my colleagues and I have tried to mold this new technology to a human world. Many friends of mine work in factories and assembly areas and view my profession as a threat; they fear that I will destroy their careers with my work. This is far from the truth, and only time and such articles as Kathleen Stein's will show the truth.

George Allen
Seattle

PSYCHOLOGICAL FALLOUT

EARTH

By Phoebe Hoban

When Elaine Baczynski looked out her kitchen window this past Thanksgiving morning she glimpsed a dread but familiar sight. Men in bright rubber suits and masks trudging gravely over her lawn as if they were braving land mines or jagged craters on the moon.

On October 12, just six weeks before the Environmental Protection Agency had informed Baczynski and her neighbors in Imperial, Missouri, that they'd been living on land poisoned by deadly dioxin. About a decade ago, it seems, oil accidentally laced with the toxic chemical was sprayed to keep dust down in three nearby horse arenas. Within weeks, birds, dogs, cats, and horses began dying, people reported rashes, headaches, and other sudden ailments. Then, suspecting the oil might be at fault, arena owners had the dirt removed; it was later used for landfill in the residential town of Imperial.

Now federal investigators dressed in high-tech gear were collecting soil samples from the Baczynski yard. When their work was done, the sinister-looking men disappeared without a word. It was not until December that the EPA finally announced its findings. Dioxin levels in the soil had reached 301 parts per billion, hundreds of times greater than levels found at Love Canal.

It is a little late, though, for the Baczynskis to start fretting about the consequences. Mrs. Baczynski, her husband, and their eight children for years have suffered health problems that they now know were caused by dioxin. These range from relatively mild ailments like cramps and headaches to severe bladder, liver, and kidney disorders. Their neighbors report similar symptoms, including rashes and hair loss.

Now the small Missouri community is plagued by a new epidemic: the acute psychological shock of learning about the dioxin exposure. Indeed, instead of easing the community's collective psyche by providing an explanation for the ailments, news of the poisoning has turned life upside down. "The tension became unbearable," says Mrs. Baczynski in a barely audible, trembling voice. "If we were exotic animals, the government would have protected us, but we are not an endangered species, so we've been ignored. The sense of depression is overwhelming." On December 13 the Baczynskis decided they couldn't take it anymore; they left their home of 15 years and moved out of the state.

But even though the Missouri dump site has been left far behind, psychologists say, the emotional distress may be impossible to escape. Victims of man-made disasters—especially those with unknown, long-term effects—suffer from fear, anxiety, and distrust long after the immediate danger is removed. "People become terrified, scared out of their wits," explains California psychiatrist Cecil Bradley, who has served as an expert witness in several toxic-exposure cases. "It's like living under the sword of Damocles. These people walk around with the feeling that there is a time bomb within them."

Such constant stress, Bradley notes, can cause severe psychological reactions: loss of sleep, lack of appetite, headaches, heart palpitations, ulcers, and impaired immunological response. Some researchers say that such stress can even cause cancer. Making matters worse, chemicals like dioxin also poison the nervous system, afflicting the victims with symptoms ranging from dizziness to anxiety to psychosis.

"The brain is a very sensitive organ; it may be one of the first organs to be attacked by certain dump-site chemicals," explains toxicologist Ellen Silbergeld, of the Environmental Defense Fund, an activist organization in Washington, D.C. Lead poisoning, for example, can cause depression and psychosis. Excessive amounts of toluene, a chemical commonly found in paint fumes and explosives, can cause tremors, vertigo, and emotional instability. Trichloroethylene, a substance used in the manufacture of semiconductor components, causes loss of facial sensation and impaired memory and concentration.

For most victims, Silbergeld adds, the distinction between real organic damage and sheer psychological stress is blurry. Martha Rojas, for instance, was working as a chemist at an electronics company in California's Silicon Valley when she first came down with headaches, sore throats, numbness, and a rash. "My whole body felt mushy," she says. "It was almost as if I were intoxicated."

It turned out that Rojas and other suffering coworkers had been poisoned by chemicals pumped into their offices through the ventilation system. The source: the company's fabrication plant. "God knows what we were breathing," Rojas comments. "Fear blurred our sense of reality until we didn't know what was going on. The physical effects were overwhelming, and there was also the anxiety you feel when your body is out of whack and you don't know why. But what is really frightening is that you start to doubt your own sanity. And those who haven't experienced a similar trauma tend to look at you as if you're nuts."

Neil Erlich, a psychiatrist who counsels

Pollution victims harbor a sense of doom

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WAR IN ORBIT

SPACE

By Thomas Karas

If we don't watch out, space could become our Achilles' heel," warns Air Force Colonel Charles Heimach. "There was an argument once that the Joint Chiefs of Staff should conduct a practice operation without using communications satellites. The JCS said, 'It can't be done.' The operation won't be possible.' Yet they won't face up to the fact that the satellite cannot survive an attack. We should either make it survivable or get out of space."

Colonel Heimach, who has spent more than 20 years working on satellite attack and defense for the Air Force and Defense Advanced Research Projects Agency, is not alone in his concern. "War in space is now a practical matter," declares Ronald T. Petty, editor of the authoritative *Jane's Weapons Systems*. Petty believes that space wars using killer satellites, high-powered lasers, and particle-beam weapons are now the deadliest threat to the global balance of power.

Already satellites have become a keystone of military preparedness. We depend on them for warning of a nuclear attack on the United States. And more than three fourths of the international messages sent by the U.S. armed forces travel by satellite. Yet so far the Pentagon has adopted no plan to defend its space hardware or to replace it in wartime.

There is no dearth of ideas about how to protect orbiting sentinels and relay stations. For example, to hit a satellite with a "killer satellite," missile, mine, or laser, the attacker must first find it. The Air Force is looking for defensive countermeasures that would make U.S. military satellites harder to locate. One possibility is maneuver. If attack seems imminent, move the target out of the way. By the time the attacking weapon arrives, where it was aimed, the target will have moved somewhere else.

Other countermeasures are designed to make the target less visible. These techniques are similar to those that will go into the Stealth strategic bomber. There are, for example, paints or coatings that do not reflect radar waves well, making for a smaller blip on the enemy's screens. We might also call upon "deception jammers," powerful radar transmitters on the satellite that fool the attacker into misreading the position of the orbiting gear.

If you can't hide from the enemy, you may be able to confuse him. Decoys, built to resemble the real thing, could force the attacker to waste his weapons on false targets. Or the real satellite itself might become the decoy. If there were "silent" spare satellites stored in high orbits, they could be brought down to replace the destroyed primary satellite.

Yet another defensive measure would be to build lots of redundancy into the whole system. The Global Positioning System, used for navigation, for example, will work with 18 satellites and could use many more. If some of the satellites were lost, planners believe that the system as a whole would "degrade gracefully." The service it provides would be less complete, and the accuracy would be reduced, but it would still exist.

An attack, not yet feasible, on the three U.S. missile early-warning satellites operating under the Defense Support Program would pretty much wreck the whole early-warning system. Ball Aerospace Corporation, in Boulder, Colorado, has suggested that it could build many small missile-detecting satellites, which, combined with decoys, would be almost impossible to destroy. The Ball engineers think they could launch the whole system in one shuttle trip.

Still another way to neutralize an antisatellite attack would be to launch replacements for the destroyed hardware. Pentagon studies refer to this idea as "reconstitutable satellite systems," and usually consider it for use during a nuclear war in which the principal launch centers at Vandenberg Air Force Base, in California, and Kennedy Space Center, in Florida, had been destroyed. Some ballistic missiles, such as Tridents hidden in submarines, might be able to launch small communications satellites into relatively low orbits. If the chief geosynchronous communications satellites had been knocked out, these replacements might restore some

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Up in the high ground of space, military observers argue, this country's defenses are down

IF A CAR IS REALLY AN EXTENSION OF ONE'S PERSONALITY, WHAT KIND OF PERSON WOULD DRIVE A SAAB?

Not long ago, a leading car magazine called Saab owners "the lunatic fringe of the American car-buying public."

Yet according to our statistics, the average Saab owner is male, age 38, college-educated, works in a managerial job, and earns over $40,000 a year. He is married and has 1.2 children.

The fact is, both descriptions are accurate.

The fringe.

Some people call this person a driving enthusiast; others call him a car nut.

Whatever you call him, he buys a car for one reason.

Economy? Who cares. Luggage space? Who needs it.

His attitude is if a car doesn't give you goose bumps when you drive it, what's the point of owning it.

For him, even a drive to the supermarket should be exhilarating.

For that, Saab's front-wheel drive and taut suspension give him the cornering ability of a sports car.

And every time Saab's new APC turbocharger kicks in, he feels like he's just engaged warp drive.

Engineering philosophy doesn't interest him. Results do.

Often, he belongs to a car club.

Not the kind with leather jackets and secret handshakes.

But every month or so, they sponsor an event called an Autocross. Much to the dismay of the local townspeople, club members roar their Saabs against the clock through staid suburban parking lots.

Beyond the fringe.

At the other end of the spectrum is the Saab owner who is largely responsible for the respectable statistics that were cited earlier.

He bristles at Saab's cult car reputation. He thinks of car clubs in the same light as motorcycle gangs.

Nonetheless, he does realize that many of Saab's "radical" innovations like turbocharging, front-wheel drive, and aerodynamic design have broader applications than just blowing your neighbor's BMW off the road.

He sees the safety in high performance every time he merges onto a crowded freeway or passes a truck on a two-lane highway.

And, in a Saab APC Turbo, this performance is attained without sacrificing fuel economy. In fact, the APC system actually improves gas mileage.

He sees the logic of Saab's front-wheel drive and four-wheel disc brakes, especially after the first snowfall. Or the last rainfall.

Even Saab's hatchback design, which some find unconventional, he finds practical, considering that it gives his Saab the carrying capacity of a station wagon.

And not only does his Saab have plenty of room for luggage, it also has plenty of room for people. More, in fact, than many elitist cars.

For those who insist on luxury for luxury's sake, Saab has made one concession. Some turbo models are now equipped with an *Exclusive Appointments Group* that includes leather-upholstered seats and electric sunroofs. (That's really two concessions, isn't it?)

*1983 SAAB PRICE** LIST*

900 3-door	*$10,750*
900 4-door	*$11,050*
900S 3-door	*$13,550*
900S 4-door	*$13,950*
900 Turbo 3-door	*$16,510*
900 Turbo 4-door	*$16,910*

Automatic transmission $370 additional

Even with leather upholstery and sunroofs you don't have to open manually, Saabs have not replaced Mercedes and BMW as the standard-bearer at the country club.

But for Saab owners, whatever type they may be, the experience of driving a Saab outweighs the lure of status.

It has to.

How else could they get a practical car that drives as well as most wildly impractical cars? A car that appeals to their emotions as well as their intellect?

So what kind of person drives a Saab?

A very satisfied one.

**Saab 900 5-speed APC Turbo ②EPA estimated mpg, 34 estimated highway mpg. Use estimated mpg for comparison only. Mileage varies with speed, trip length and weather. Actual highway mileage will probably be less. **Manufacturer's suggested retail prices. Not including taxes, license, freight, dealer charges or options.*

ELECTRIC NERVES

LIFE

By Doug Garr

Dr Terry Hambrecht flips on the video-cassette recorder and a young man in a wheelchair appears on the monitor The man is a quadriplegic—he has no feeling in any limb—buf in a few seconds the camera reveals the results of some remarkable research The man slowly grasps a paper cup with his right hand, gently closes his fist, and raises it to his lips to drink His gingerly movement could not be called graceful yet if is not entirely awkward either

Out of camera range is a PDP-11 computer which commands a system fhat is eventually wired fo the muscles in the patient's forearm The system is known as neural prosthesis and although it has been tested on only a dozen or so quadriplegics in the United Stafes researchers are hopeful that more refined, portable devices will someday restore reasonable mobility to paralyzed limbs—even to the point of walking

The current experiments rely on whaf will ultimately be regarded as a rather cumbersome primitive system where the patient remains tethered fo a computer and must depend on technicians to starf the program Eventually, however Dr Hambrecht plans fo replace his PDP-11 standing frame model with a microprocessor worn on a belt Since most quadriplegics retain shoulder movement they could use fheir elbow to flip on the microprocessor And with furfher advances Hambrecht speculates it may eventually prove possible to design a neural prosthesis that could be voice activated Then a very complicated and sophisticated program could carry out the intricate muscular coordination required for decenf mobility

Hambrecht directs the neural-prosfhesis program at the National Institute of Neurological and Communicative Disorders and Stroke a federal agency His program has existed for only a decade, but he has been dreaming of fhis kind of work since he was graduated from college in 1959 That year his best friend was incapacitated in an automobile accident This prompted him to wonder what could be done to help the paralyzed Hambrecht holds a degree in electrical engineering and is also a medical doctor his dual qualifications make him a natural leader in this relatively new phase of bioengineering In fact he did his infernship in surgery thinking that most neural prostheses would eventually need to be surgically implanted like today s cardiac pacemakers

Happily scientists are already past that stage The actual elecfrodes stainless-steel wires only 600 microns fhick are implanted with hypodermic needles in what is a fairly fast and uncomplicafed procedure The physician inserts the syringe and then applies an elecfrical current to see how the muscles contract When the wire's in the right spot he extracts the needle

The electrodes stay in place because they have a barblike tip that grabs fhe muscle much like a fishhook

Though medical science has known for centuries that muscles confract when electricity is applied the big mystery was how it could be done in a manageable fashion The solution appeared to be far in the distance until the advent of the Computer Age Why not have a microprocessor direct fhe action—bridge the gap so to speak—in the disabled nervous system?

"We discovered fhat the computer could do most of the bookkeeping" Hambrecht says "It could decide how much to stimulafe which muscles and in what order thereby coordinating the intricate pattern of muscular contraction that underlies even the simplesf of movements" The computer gives its directions sending out a pulse that moves the muscles Both the duration and the frequency of the pulse determine how much the muscle will contract

Some of the more advanced neural-prosthesis work is being done at the Rehabilitation Engineering Center at Case Western Reserve University in Cleveland Ohio There Dr Hunfer Peckham the director, has succeeded in teaching patients two kinds of grips with the system One is called the key grip which uses the thumb and forefinger allowing a user

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A paralyzed hand is brought to life with the aid of a computer that sends impulses to muscles

DISASTROUS WARNINGS

MIND

By Barbara Ford

Don't ever mention the word *landslide* in Kodiak, Alaska. In 1978 the U.S. Geological Survey (USGS), which alerts the public to volcanoes, earthquakes, landslides and other geological hazards, notified local officials that a section of Pillar Mountain, just above the city's busy harbor, was likely to slide into the water at some time in the future. The harbor, which is the home of the city's fishing fleet, is an important element in the local economy.

When alerted to the landslide threat, the citizens of Kodiak reacted with fury. Just about that time Dr. Thomas F. Saarinen, of the University of Arizona, a geographer and expert on perception of environmental hazards, was doing a public-attitude survey. He found that the people of Kodiak came up with several names to describe the USGS geologists, the most printable of which were ones like *idiots* and *dingbats*.

This kind of response is not news to government officials. For years they've known that when people are issued a disaster warning, they react in every possible way but the appropriate one. Now social scientists who have been studying this phenomenon think they have some insights into why it happens and, more important, have a variety of suggestions on how they can get the public to pay better attention.

What the experts have found is that when a warning of a severe storm or other disaster is broadcast, few people take precautions. Sometimes the public gets angry at the bearer of ill tidings, as happened in Kodiak. Sometimes the reaction is even more perverse. "The first thing most people do when they hear a tornado warning is go out and look at the sky," says Dr. Fred Ostby, director of the National Severe Storms Center in Kansas City, Kansas. And tornado watching, he adds, can be particularly dangerous, because the twisters are so unpredictable.

Sometimes there is no reaction at all. According to a recent study by University of Minnesota social scientists, the majority of Americans simply fail to heed all warnings. They found only 35 percent of those alerted responded to hurricane warnings, only 18 percent to tornado warnings, and 12 percent to flood warnings. "And by responding, I mean in any way at all," says sociologist Dr. Robert K. Leik, the principal investigator in the study. "The only thing a warning does is start people asking questions."

Colorado State University sociologist Dennis Mileti, who has written a book on the public's response to earthquake predictions, believes that we tend to ignore warnings of natural disasters because for most people natural hazards are rare events. He points out that where natural hazards occur frequently, public compliance with disaster alerts is high. For example, just about everyone in Japan believes he can and will experience an earthquake. Similarly, much the same attitude is found in areas of the United States like Topeka, Kansas, where tornadoes strike with some regularity.

To counter the indifference found in most other areas, though, Mileti says there are some simple approaches public officials can use. His suggestions: Be specific, be consistent, be confirmative, be authoritative, and be personal. By being specific, he means stating exactly when and where the disaster is expected to occur. The identical message should also be delivered through a number of media for maximum effect. "If a little line comes across the bottom of your television screen saying, 'This area will flood tonight,' you probably won't do anything about it," he says. "But if you also hear it on the car radio, you'll be more likely to believe it." Even better is getting the warning from someone in authority, a mayor or governor. "In the Three Mile Island disaster," he notes, "most people believed the governor."

But the best message of all, Mileti says, is a personal one. "During the San Fernando Valley earthquake of 1971 the police rode up and down the street with a loudspeaker, saying, 'This street is subject to flooding. You have an hour to evacuate.' It was very effective."

Saarinen adds that hazard notices for more distant events should also include

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Volcano in action. When warned of natural disasters, few people bother to head for the hills.

THE BODY

By Patrice G. Adcroft

She was a walking time bomb, though neither she nor her doctors knew it. A few years earlier, surgeons had removed a blood clot from the young woman's brain, but the headaches and blackouts continued. She went to five medical centers, searching for an answer. All the tests—X rays of her brain and blood vessels—came back negative.

In the brain there's no chance for a surgeon to finger the furrowed regions the way he can reach in and touch the liver or bowel. Unless brain tumors are extremely large or so close to the surface that they bulge the kid-glove-like dura—the protective covering that drapes the brain—the neurosurgeon operates without eyeing his mark. Guided by CAT scans and angiograms taken before surgery, he tunnels blindly through the delicate tissue to the affected region.

For some patients, including this woman, this procedure could be too risky. Doctors occasionally opt for radiation or drug therapy, with varying degrees of success. Now, however, many doctors are finally seeing into the brain immediately before and even during, surgery, thanks to a development called ultrasound imaging. By removing a small portion of the skull, sometimes no bigger than a burr hole, and by barely touching the ultrasound instrument to the dura, the neurosurgeon can view the brain's internal structure on a TV screen. This technique allowed doctors at the University of Chicago Medical Center to pinpoint and remove two small bundles of abnormal blood vessels—one the size of a blueberry, the other even smaller—buried like deadly land mines in the young woman's head.

Suddenly the most delicate and complex system on Earth, the human brain, has become far more accessible to the pioneers who try to repair it. Using the eyes of ultrasound, "we have performed surgery we would not have dared to do otherwise," says Dr. George Dohrmann III, associate professor of neurosurgery at the Surgery-Brain Institute, University of Chicago Medical Center. Deep-seated tumors—those rooted in such vulnerable areas as the tissue below the speech center—can now be biopsied or excised. Surgeons can plan their descent through the so-called silent areas, where incisions do not harm the patient's functions later, and monitor the deft maneuvers of catheters and cannulas. Through a darkness ultrasound makes visible, they can watch as they drain abscesses and clip aneurysms.

The image that gives the surgeon so much information—the depth of the tumor or cyst, its general size, and the best angle of approach—would reveal little to the rest of us. The slice of brain being scanned appears on the TV screen as only a fan-shaped shadow.

Ultrasound works on the same principle as sonar: bouncing sound waves off objects to determine their location and size. Only the instrument's scanhead touches the brain. This vibrator-shaped, rather intimidating shaft is sheathed in plastic to keep it sterile. The surgeon holds the scanhead's tip, less than two centimeters in diameter, to the skull's peephole, while dripping a saline solution on the dura to conduct the sound waves into the tissue.

It's actually the scanhead's transducers—three hidden crystals, each with a graduated frequency—that send the sound waves into the cavity. The sound travels from one tissue boundary to the next, echoing back some of the energy at each obstruction. When the sound returns, the energy is converted into electrical signals, which a computer processes and translates into grayish images on a TV screen. Because the echoes fire in rapid sequence, you can watch movements in the brain as they occur, from the pulsing of a blood vessel to the insertion of a needle. After surgery, doctors can pause before closing, using the scanner to spot such dangerous complications as hemorrhaging.

By turning the scanhead slightly, the surgeon can view the gray matter in 90-degree arcs throughout the brain, not merely what lies under the peephole. The image can be a few centimeters deep or can penetrate to the other side of

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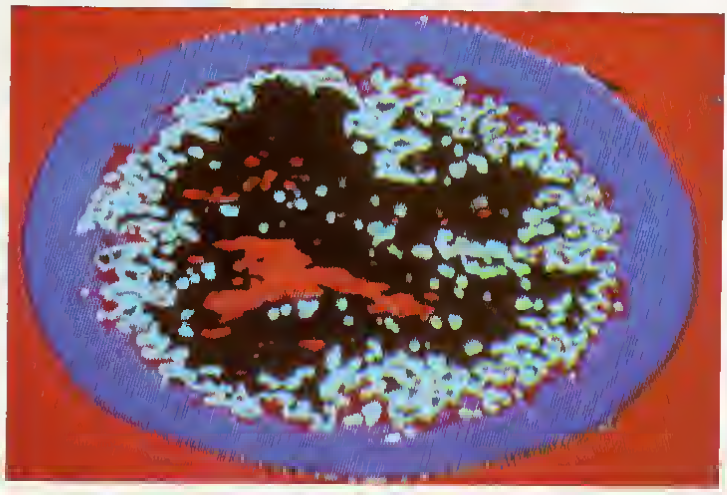
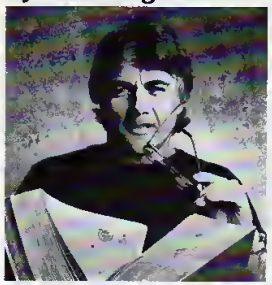


Conventional scan. Helpful, but it still requires the surgeon to tunnel blindly into the brain.

How to spell

By John Irving



International Paper asked John Irving, author of "The World According to Garp," "The Hotel New Hampshire," and "Setting 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	

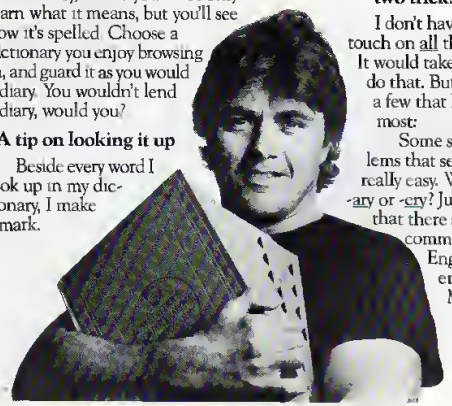
Now the good news

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.



"Love 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 "stricktly." 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 goverment. 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 secure 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

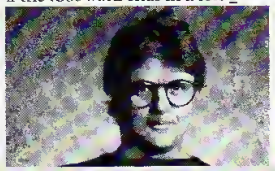
Everyone has a few demon words—they never look right, even when they're spelled correctly. Three of my demons are medieval, ecstasy, and rhythm. I have learned to hate these words, but I have not learned to spell them; I have to look them up every time.

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 e'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 (but remember to drop the final e!): 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.



"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."

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.

John Irving

BOOKS

THE ARTS

By John Clute

British best-selling author Brian Aldiss is in London to talk about his latest novel. *Helicona Spring* a hard science-fiction epic set on a very unusual planet that orbits two suns. As he greets you in the Skyline Lounge of his hotel, you'd never guess that he was once one of those notorious New Wave writers whose chic radicalism and smart-alecky literary experiments offended so many old-order editors and readers

Tall, tanned, conservatively dressed he is clearly at ease with the broadloom and morning vodkas of his chosen hotel, whose picture windows overlook the offices of the government-sponsored BBC where he appears frequently these days both on radio and television. Today he looks like a successful executive enjoying a break after wrapping up a particularly complex project

This is an unusual image for a man who for a brief time in the 1960s held a place in a constantly shifting roundtable of friends and colleagues that centered on Michael Moorcock and the radical magazine *New Worlds*. This magazine gave writers a chance to experiment with everything from the way their stories were written to the themes they tackled. These stories did not have a chance of being published in the United States, because they often contained a depressing vision of the future, an outlook that did not appeal to American editors. Although some of these writers, like Aldiss and J. G. Ballard and Thomas M. Disch and Moorcock himself, had been flourishing as professional writers for years, they managed to shake up the old SF traditions and form a New Wave.

Traditional SF tale-telling was defined by the popular American SF writer Poul Anderson in an essay he published some years ago. In it he laid down the ground rules for creating complete solar systems out of whole cloth. It was not that easy to play God. You had to think and plan before you leaped. Before you peopled your world, you had to make it work; you had to be methodical, obsessive, and rigorously obedient to the scientific requirements of the scheme.

It was this kind of traditional SF writing, ignoring human interest in favor of scientific problem solving, that the British New Wave rebelled against. People, after all, were the real problem. Stick half a dozen adults into a complex environment, and they might solve a few technological puzzles—or they might die trying—but sooner or later the rhythms of human lives and loves will take over the mental foreground. And this is the territory that should be the stamping ground for a real novelist, whether he is Charles Dickens or Larry Niven.

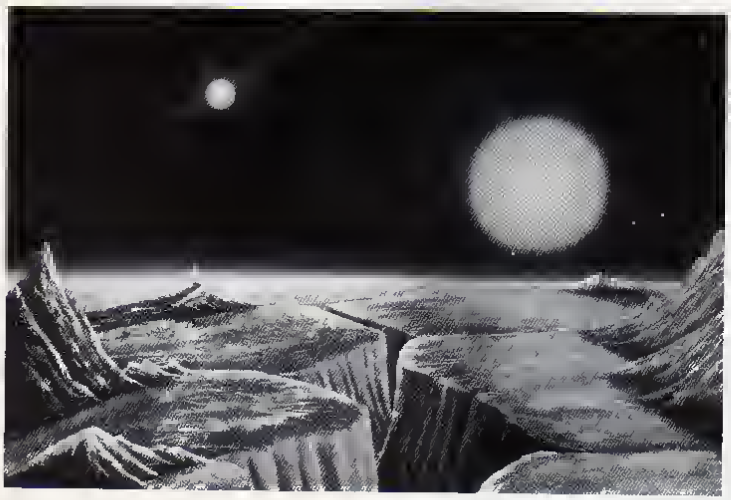
But in *Helicona Spring*, Aldiss has created a binary-star system that burdens its occupants with a year the length of 2,500 Earth years—too long for human memories, or for human cultures to adjust to with any competence. The Heliconians are victims of their untailingly dramatic environment. When your winter lasts 500 years, as it does on this planet, what kind of society can possibly exist?

In answering this question, following his cosmological scheme to the letter and strictly obeying the dictates of his system, Aldiss found himself venturing into territory more familiar to authors like Anderson and Niven, who set themselves a scientific problem and then put their characters to work solving it.

This does not mean that Aldiss has completely forsaken his New Wave humanistic origins. He continues to write as if the human condition were his main concern. It is part of Aldiss's message that his characters cannot grasp their whole world, but they live vividly all the same.

The ultimate influence of the New Wave movement on SF should be measured by the spirit of experimentalism that persists and the conviction that SF novels should be written to expose and dramatize the human condition.

Perhaps if we want people to recognize the difference between a coffeepot and the space shuttle, we have to show them what it has to do with their own lives and those of future generations. Perhaps we need more novels like *Helicona Spring* that can successfully combine the traditional technological schemes with contemporary humanistic values.



Sure you can create your own planet. But do you think you'd really want to live there?

THE ARTS

By Esther Wanning

No, they were very sorry, they said, but the reporter could not see the Painting Computer in action. The reporter certainly might talk to the project head, they added, or other heads. The company would be happy to accommodate her in any way—short of letting her into The Presence. Thus spake the 3M Company, the only producer of scanamurals in the U.S.A.

Scanamurals are, in the world of photography, a giant step. Since 1826 when Joseph Niepcé astonished and delighted the world with the very first photograph, the advances of photography have been multifold. But problems have remained. Size, for one. When enlarged, photographs tend to "break down" (become fuzzy, grainy, and ultimately unrecognizable). This is particularly true of color photographs. And so you don't see photographs the size of *The Last Supper* around, which is a source of chagrin to photographers who would like to compete with painters on every ground, including size. Durability is another problem. Because photographic chemicals have to be light-sensitive, they are delicate. Black-and-white photos may last quite a few years, but color tends to fade at a shocking rate. With scanamurals, you can take a bitty photo, even 35mm, and produce an extra-large, colorfast mural. On canvas. It's a latter-day wonder.

The original invention came out of Japan. The story goes that one day a graphic designer, a Mr. Gisen, had to make a backdrop for a show, and it was going to have to be handpainted. He said to himself something like this: "This is a job for television. A television beams electrons. If I could just get it to beam-paint, I'd have my backdrop." Eureka! He did. Fuji Telecasting then developed the process in Japan, where it's been used mainly to make giant banners that hang from tall buildings advertising movies. In 1975, 3M acquired the license for the United States.

3M adapted the process for the American market and now has three Painting Computers in Canoga Park, California. Management's disinclination to have the reporter personally survey the computer seemed to stem from the facts that the process itself is a secret—and a more mechanical mind than this reporter's might divine how it works—and the work-in-progress is likely to become some corporate ad campaign not yet public. And clearing the press for visiting reporters is not done lightly. We're talking expensive computer time here. The reporter took it well, for she is a reasonable person, with secrets of her own.

This is, however, what the reporter would have seen. An operator wraps a machine-ready transparency, made from the original picture, around an optical tube. A beam reads the picture and splits it into four colors: cyan, magenta, yellow, and black. The color and density are converted into electrical signals, and four sprayheads pointed at a large drum are activated. Material to paint onto (the substrate) has been wrapped around the drum. This material can be of many different flexible types, although canvas is the most popular, and it can be up to 15 feet wide and 10 feet long. The optical tube and the drum roll simultaneously, reading and painting. The Painting Computer can paint a picture in about an hour. The cost is essentially payment for computer time.

And the cost is high. I may wish to blow up a picture of my wedding cake to the size of the dining-room wall, but the bill would run about $2,500. Therefore, I will not. But then again I may, because scanamurals can do things nothing else can. Unlike photographic enlarging, scanamurals get better as they get bigger. With every revolution of the drum, the sprayhead advances two millimeters (1/16 inch). So, proportionally speaking, the more you enlarge, the finer the distinctions. However, fine resolution is not in itself a characteristic of scanamurals. They work best with large pictures, to be seen from a certain distance.

The image can be printed on canvas, polyesters, vinyls, carpeting, and some papers. Vinyl is used in hospitals and food service areas because it can be cleaned easily. There's an antigraffiti coating

DeSana's kinky scanamural. Unlike a photographic enlargement, it got better as it got bigger

that broadens the scanamural possibilities in public places. There's a polyester (Guilford 701) that works for sound absorbency. There's a canvas with a paper backing that makes it hang like wallpaper. Various cotfons give slightly differing looks. Some materials render deeper saturation than others. They can be made fire-retardanf with a spray or be done on a fire-resistant polyester fabric. And thus they conform to the public-building fire codes. This is another insfance of contrast with photographs which are highly flammable.

Not surprisingly, this adds up to a lot of corporate and institufional use. Says Bob Rinehart, of General Graphics, in San Francisco, an authorized dealer: "Scanamurals are not much used in the home market, because nobody has gone after the home market. I'm certainly not going to. It's hard to reach, and there's just not enough money there. Though you need only ask, as Mario Andretti (the racing-car driver) did, and a wall of racing cars can be yours. A staircase of Muppets? Jim Henson, the Muppets creator, has these. Or you might want to cover the walls of an elegant room with garden murals made from eighteenth-century French engravings, as did one of San Francisco's grand hotels, the Fairmont.

Still, it's in trade shows—where $50,000 is not considered a great amount to set up a booth—that the price of scanamurals becomes attractive, in fact cheap. After all, for the price you get something that will fold up easily to go on board an airplane and then can be erected on a nomadic frame. You get an exact representation of your product. You get something that won't burn up. You get something big. You can attach magnets to a scanamural by hanging it against a metal background.

"You'll see some bad, seedy photomurals around," Rinehart says, "but they're not mine. I tell cusfomers when the process will work for them and when it won't. You wouldn't, for instance, want to use scanamurals for an illustrated lecture on the birth of a baby. Scanamurals just don't do detail that precisely. For a picture in the wedge over the fireplace, you can probably do better than a scanamural. But perhaps you're decorating an airport? Miami Airport has 13 scanamurals—all scenics of Florida—along the concourse. They are painted on smooth vinyl and, added together, are longer than three football fields. As they say at 3M, 'Nature didn't make white walls. People did.'"

While Rinehart was demonstrating the finer points of different substrates to me, a television station designer came in with a model in his hand for a broadcasting room he wanfed to set up. The three walls were covered with an aerial shot of the San Francisco Bay Area taken from a U-2 airplane. He needed a scanamural 6 5 feet high and 18 feet wide. And soon.

This, Rinehart says, was a perfect scanamural job. The prints in hand were a little dark, so he would get the original transparency from which to make a machine-ready transparency—that is, one scaled for enlargement. (The machine is programmed to enlarge only by factors of 24, 36, or 48.) And scanamural is ideal for television viewing, because fine resolution isn't a problem. Although the station might appear to have three options in setting up this backdrop, Rinehart later explained, scanamural was the only feasible one. "They could do it photographically, in which case they would have a great number of panels and the joints would show. The optics of lenses make it hard to maintain focus and color balance at the edges. Try matching a sky. Then they could have it handpainfed, which is still done but would be impossibly expensive here. So that

"Someday I'm going to have someone take a full-length picture of me in the nude, which I'll have printed as a scanamural onto canvas. And then I'll have it made into a suit."

leaves scanamurals," he added, "which have no problems."

Many of you are already tuning in to scanamurals. Behind Johnny Carson are not the twinkling lights of Burbank; that's a scanamural. In San Francisco you're not seeing the skyline on Channel 4 news. That's a hanging. And Channel 2 in Salt Lake City has a daytime scanamural of the Wasatch Range, which makes way at night for a vista of the city.

Photographers, painters, and interior decorators have had their fingers up in the air for a long time, waiting for wind of something like this. Nancy Dunn, a photographer, remembers the very day she heard about scanamurals. "I read about them in the *New York Times* in November 1978. I went to a scanamural demonstration and was so impressed by the size, texture, and flexibility. And the sense of them in space. And the look they get from being painted on canvas. When the Palm Springs Desert Museum gave Dunn two huge walls for a show, she realized that she would have a chance to display her scanamurals, if she had any. She does now, and one of them—a picture of flowers with an abstract floating look—is now in the Desert Museum's permanent collection.

Scanamurals have a distinctly scanamural look. The scan lines show, and the texture of the substrate is somewhat rough. Some like it; some don't. Some work with it. Jimmy DeSana, a painter turned photographer, has had great success with what he calls "kinky imagery" (a nude wearing spike heels floating facedown in the water; lovers on the beach, wrapped in aluminum foil). "As just a color photographer, it's almost impossible to think about large-scale, publicly funded works," he says. "I heard of the 3M process two or three years ago and tracked it down to Imero Fiorentino Associates, who are dealers in New York City.

"I'm beginning now to use the scanamural as a ground for painting, but I don't paint over every square inch of canvas. The quality can be disappointing compared with the sharp photos I'm used to, which is one of the reasons I started painting over them. Before they just weren't quite there. Of course the bigger they get, the better they are. Now I'm applying to do a seventy-five-foot-long scanamural for a shopping mall. This would be large, but somewhere in Taiwan there's a scanamural 240 feet long, a history of aviation that was made for Boeing.

Darcy Gerbarg, an artist who does computer paintings, was one of the first to try scanamurals. "I paint directly with light, and what I see on the television screen has no corporeal reality. As a fine artist, I need to have something people can hang on their walls. The only available techniques for turning my paintings into objects have been film and photo enlargement printing techniques—such as silk screen and etching—and now scanamurals." Gerbarg considers scanamurals by far the biggest and best mode available to her at present. "The scale is great, the ink will work on artist's canvas, and from a distance the image is perfectly sharp. You can see one of these from two hundred yards." Her scanamurals are 9′ × 12′ and 8′ × 20′, made from 35mm transparencies which photographically you couldn't print larger than 30″ × 40′.

Gerbarg agrees that scanamurals are expensive, but she points out that a comparable work by a young artist in other media would run in the same price range. She does hers in editions of ten, which don't have to be printed all at once. The saving on ordering multiple copies is not great, since the drum rolls for only one at a time. As Rinehart puts it: "They're expensive compared with wallpaper, but they're cheap compared with hiring Larry Rivers to paint a mural."

Nancy Dunn is sanguine about the scanamural look. As soon as you use any

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ARTIFICIAL INTELLIGENCE

By Owen Davies

To buy or not to buy, that is the question that nags would-be computer owners. If you buy now, you can start to use your computer before the day is out. But if you wait six months or so, the same machine will probably be cheaper, and far more powerful ones will be available.

It's a real dilemma, and this year the problem is at its peak. According to some estimates, new compufers are appearing on the consumer and business market at a rate of about one a day.

Yet most computer users claim that there's really no decision to be made—other than which machine to choose. "At any given moment there's a valid reason fo buy now; it's just a different reason for different people," says Carl Helmers, a widely respected industry analyst who began his career as founding editor of *Byte* magazine, the micro computer world's first mass-market publication aimed at nonengineers.

"It depends on what you want to do," adds science-fiction writer Jerry Pournelle, a veteran computer user, occasional *Omni* contributor, and *Byte* columnist. "If all you want is to play games, it doesn't much maffer when you buy it. If you run any kind of business, you should have bought one three years ago. The point of having a computer is not the hardware it's what the machine will do for you. If you write, if you do any significant financial analysis or record keeping, then the efficiency you gain in the next six months could repay the cost of the computer."

That is, if you pick the right one. It may not be easy. "It's possible fo buy a good machine without worrying about technical data," says Mark Garetz, president of CompuPro, an Oakland, California, computer maker with a repufation for building high-quality equipment for the knowledgeable "hacker." He cautions, though, that "it's also possible to buy really bad machines with specs that sound really good. The 'specsmanship' that people play in this business is really incredible."

Much of the jargon you'll face centers on the microprocessor, the chip that does the actual computing in your candidate computer. A computer's power depends on many factors. Three are built into the processor: the number of bits of information it crunches at a time, its "clock speed," and its "instruction set."

A "bit" is the smallest unit of information, equal to the flip of a single switch in the computer's processor or memory. For practical use, bits are assembled into units of 8, known as bytes, or 16, known as words. One byte is roughly equivalenf to one letter of text. In the computer's binary arithmetic, far larger numbers can be expressed in a word than in a byfe, so heavy number-crunching usually goes faster on a 16-bit computer than if does on an 8-bit machine.

A computer's clock speed is the number of times each second that the microprocessor can flip the switches in which it stores information—the smallesf unit of work it can perform. A microprocessor running at a clock speed of 6 megaHertz, or 6 million cycles per second, can do three times as much work in an hour as an identical processor running the same program at a clock speed of only 2 mHz. Most of the current microcomputers offer speeds somewhere within this range.

By far the most complicated factor is the microprocessor's instruction set—the vocabulary of primitive orders that controls the microprocessor. Ignore if. Promotional fliers often babble about the powerful instruction set of the chip used by the machine being sold, and in general it's true that a large, well-fhought-out insfruction set makes for a more powerful processor, while a limited one makes it difficult to write versatile, easy-to-use programs. But only a skilled programmer will ever nofice its existence.

"How important these technical details are depends on what you plan to do with the computer," Garetz observes. "For simple word processing, a well-designed eight-bit machine is more than adequate. The big advantage of sixteen-bit computers is not that they are more

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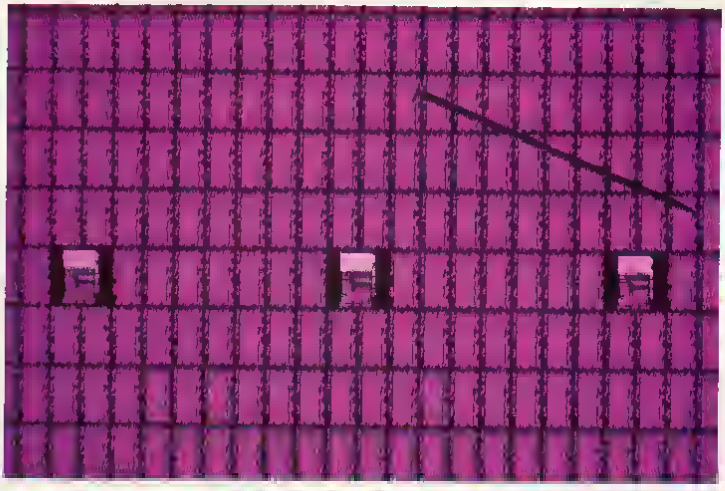

Circuits 'flip switches' millions of times a second, but some are noticeably faster than others

FLY'S-EYE RADAR

BREAKTHROUGHS

By Owen Davies

A new radar-imaging system promises to let air-traffic controllers tive years from now see—trom as much as 20 miles away—whether an incoming plane has lowered its landing gear. Military surveillance aircratt may use the technique to tell triend from foe at far greater distances than is now possible and spy satellites could gain remarkably improved vision

Air traffic-control systems will be the easiest to develop, says electrical engineer Bernard Steinberg, the University of Pennsylvania professor who devised the imaging method. Modern airports are three to tive kilometers across," he explains, "and much of that space is wasted. It we could put perhaps a thousand antennas into those wasted areas, we could get clear images of the airplanes, not just tuzzy blobs."

The key to Steinberg's technique is to make all those small, separate antennas work like a single, much larger one, just as the new "fly's eye" telescopes use multiple mirrors to form a single image. The clarity of radar, he says, varies with the size of the antenna in the same way a telescope image depends on the size of the lens or mirror.

The diameter of a two-inch telescope mirror is 100 000 times the length of a single wave of light. To achieve the same resolution as the little telescope, a conventional radar unit—focusing radio waves roughly a million times as long as light waves—would need an antenna some 20 miles across.

In practice, even it room could be found for such an antenna, its parts would flex so much that it could never be focused. "The position of each point of the antenna must be known to within one tenth of a radio wavelength—as little as half an inch," Steinberg notes.

To get around this, he uses a minicomputer to build a single image from many small antennas, much as radio astronomers create star maps from signals received at many distant observatories. Each antenna has a microchip to calculate its own position.

To keep costs down in his first shoe-string experiment last summer, the inventor used a single antenna, shifting it around periodically and combining the "photographs" later. Yet the results were far better than normal radar could have given. Steinberg reports. In scans of a small town about tive miles from the antenna, buildings, streets, and even a truck could be seen. He says greater detail should soon be available.

For military use, the system's promise is clear. America's Airborne Warning and Communications System (AWACS) and Hawkeye surveillance planes are designed to keep track ot all aircratt in a battle zone, coordinating friendly forces and warning of approaching enemy cratt. Steinberg believes radar-imaging planes could do a tar better job. "The AWACS and the Navy's Hawkeye are exquisite designs, but they date back to the Nineteen Fifties," he comments. "This could be the next generation."

Many small antennas, each the size ot a dollar bill, would be built into the airplane's skin. Images would be processed in the plane itselt by a large fast minicomputer specially designed for the complex mathematics required.

How soon these predictions will come true depends not on technology, he adds, but on money. "An airport installation would cost about five million dollars for the electronics and considerably more than that for ancillary equipment," he notes. "We are ready to design it today. I don't know what a next-generation AWACS system would cost. Most of it would go to designing an airplane with the antennas built into the skin. That is probably ten years ott."

Ironically, the more ditficult and costly application seems likely to come first. Steinberg reports that well-heeled Pentagon otticials are beginning to take notice ot his work, but money for air-traffic satety seems hard to come by.

Thousands of "eyes" could sharpen blips

NEW PRODUCTS

It is only the size of a "boom box," but the Music Processor is actually a compact digital-recording studio for musicians on the run. The portable system includes a double cassette recorder, a graphic equalizer, a two-way detachable speaker system, and a synthesizer keyboard that generates four types of rhythm, three types of tone, and variable tempos and pitches. The Music Processor's microcomputer memory stores up to 340 notes, and the keyboard can be played manually or switched to automatic playback. The machine also features high-speed dubbing and editing functions and can record in analog or digital form. (About $650, from Sharp Corporation, 22-22 Nagaike-cho, Abeno-ku, Osaka 545, Japan.)

The Safe House Personal Alarm looks like a doctor's beeper and clips inconspicuously to a pocket or belt. But this beeper has a string attached. A wire connects it to a thin plastic card stashed in the bearer's wallet or purse. Pickpocketing attempts cause the device to emit a shrill alarm instead ot the standard beep. ($6.95, from Radio Shack, a division of Tandy Corporation, 1800, One Tandy Center, Fort Worth, TX 76102.)

CONTINUUM

WEAPONS BUILDERS SPEAK OUT

It all started innocently enough when at the age of sixteen Warren Davis was 'discovered' in a Ford Foundation hunt for budding scientific minds It was 1958 The Soviet *Sputnik* was orbiting the earth and the space race was on That summer Davis and 40 other whiz kids were placed in an intensive science and engineering program By sixteen, Davis had secret clearance and was assigned to space project research 'I wanted to be a scientist,' recalls forty-one-year-old Davis who as a youth had dreamed of putting man in space, even on the moon 'I loved the work'

But that youthful idealism was sorely tested For although Davis never *wanted* to build tools of destruction some of his handiwork soon ended up in Poseidon and Polaris missiles armed with nuclear warheads Like many high-tech pros, Davis was willing to work on weapons from time to time, in hopes that a strong U S arsenal would actually deter nuclear conflict But when President Ronald Reagan started to say we could actually survive and win a limited nuclear war Davis began to fear that the weapons might actually be used

Until last year Davis worked at the Smithsonian Astrophysical Lab in Massachusetts He was designing a space telescope ten times as powerful as the one soon to be launched by the space shuttle Then in 1981 it was rumored that NASA funding for the project would be replaced by Department of Defense money Davis threatened to quit if that happened 'And when money ran out this summer, he says, "they just showed me the door"

To make sure the weapons he has built will never wreak destruction Davis is now channeling his energies into High Technology Professionals for Peace (HTPP) He is now president of the year-old Massachusetts-based organization, formed to protest the buildup of nuclear arms In addition HTPP operates an employment service that tries to place high-tech pros in non defense-related jobs

'We get about a hundred resumés a month Davis explains They pour in from those who have spent their careers in weapons development and want out And they come from those who find building arms morally objectionable

But these engineers and scientists face a major problem As the Defense budget skyrockets the number of nondefense jobs dwindles- According to a study by a Ralph Nader group, some 50 percent of all the engineering and scientific activity now taking place in the United States is defense-related

HTPP member Josie Stein an engineering graduate student at MIT knows this all too well Last year she worked at the Jet Propulsion Laboratory, in California Happily, her assignment was nonmilitary She was designing an observational device for a spacecraft scheduled to fly past Halley's Comet Then the lab's reins of power shifted into the hands of former Air Force Chief of Staff Lew Allen A major policy change ensued Defense contracts suddenly gained preference over civilian projects, and Stein left She returned to school, seeking a cloistered setting and time to think about alternatives Instead, she found the same moral dilemma Most of the research projects in her department were funded by the Department of Defense That's when she decided to join HTPP

To date, the 1 400-member organization has placed only 2 out of 200 job applicants But a full-time manager has been hired and prospects are looking up Eighty new companies dedicated to nondefense related work have been contacted, résumés are going out daily, and candidates are regularly called for interviews

Why don't all the members sign up for peaceful employment? Some don't believe it really exists 'I signed up last year in hopes of finding a nondefense job,' admits Tom Forman a high-ranking manager at one of America's leading weapons developers (the company's name has been withheld at Forman's request) 'I've spent my whole career in weapons development, and I've always felt reluctant about it But I never believed you could get out' Though HTPP has been unable to place Forman, he often speaks against nuclear weapons for the organization—at the risk of his job "The nuclear-arms race is not a technological issue it's a political issue" he says "More engineers should speak out, but they don't They're protecting their jobs"

Forman fears his colleagues' silence That's how it was" he says, "when I was a student in Germany, under Hitler"

Nevertheless, many high-tech pros in America *are* protesting the weapons buildup and actively seeking alternatives They hope their stance will prevent them from one day having to tell an international war crimes commission that they were "only following orders'—*RICHARD LEVINE*

CONTINUUM

EARTHQUAKE EUPHORIA

Remember the movie *Earthquake*? The hundreds of thousands of panic stricken people clawing and gouging one another their humanity forgotten in their wild surge to escape? Well, if a Colorado sociologist is right you may as well tear up that script According to Dr Dennis Mileti a former research specialist for the California Seismic Safety Commission the real human reaction to earthquakes—and other natural disasters—is not a me first form of panic but a massive neighborly high

"When people go through a disaster Mile'i explains they don t panic they don t loot and try to steal from their neighbors In stead they experience a burst of altruism It goes shooting through their bodies like adrenaline They want to go around rescuing one another

This feeling of good this euphoria is definitely contagious, he maintains You find blacks and whites and Chicanos who may have hated one another before the disaster suddenly becoming the best of friends They even share each other s clothes

Mileti, now an associate professor of sociology at Colorado State University bases his conclusions on a review of more than 300 university studies on reactions to disaster, including the 1971 San Fernando earthquake in southern Cal ifornia In every one of these studies, Mileti says the euphoria response held up 90 percent of the time

But don t expect this rush of benevolence to last During the disaster, ' Mileti asserts 'people do things they wouldn t dream of doing before the disaster occurred And a few days afterward when they ve got things patched together they wouldn t dream of doing them again

—Bill Lawren

The [illegible] Earthquake depicted natural-disaster victims as [illegible] stricken and selfish The truth is something quite the opposite

"The doors of heaven and hell are adjacent and identical both green, both beautiful"

—Nikos Kazantzakis

RAT PATROL

One of the more distasteful tasks a soldier faces is [illegible] go into a minefield to look for mines But for specially trained rats the experience might actually be a pleasure At least that s the hope of U S Army Dr Raymond Nolan who has recently been teaching rats to sniff out mines by associating the smell of TNT with pleasurable brain stimulation

Rat commando Making mine-detecting pleasurable

To train his rodents Nolan first inserts electrodes into an area near the hypothalamus, the brain s pleasure center The electrodes deliver a highly rewarding stimulation whenever the rats press a treadle bar But the rats have access to the bar only while TNT vapors are present After the rats are trained, Nolan can learn just when they smell TNT—and anticipate pleasure—simply by monitoring their brain waves on a computer

Nolan foresees the day when his specially trained rats hooked to a micro computer that analyzes brain waves will be sent to the field in remote-controlled vehicles Every time a rat smells TNT its expectation of pleasure will register on the microcomputer which could then radio back to military headquarters the exact location of the mine

Nolan adds that most mines are now uncovered by foot soldiers carrying electromagnetic detectors through the field "Obviously,' he notes that s very dangerous

—Jim Cavuoto

SETI RETURNS

NASA scientists dedicated to the Search for Extraterrestrial Intelligence (SETI) were sorely disappointed a few years ago when Senator William Proxmire gave their project his Golden Fleece Award for wasting taxpayers' money. The senator's accusation made a big impression on Congress, which decided it would no longer support attempts to detect intelligent radio signals emanating from deep space. By October 1, 1981, NASA was forbidden by law to spend even a cent on SETI.

Defeated, NASA officials and sympathetic scientists began a small-scale lobbying campaign on behalf of SETI. Today that low-key approach has succeeded. Though Proxmire still insists that SETI is 'silly,' NASA will once again fund the quest. In fact, the space agency will spend $1.5 million in 1983 to get its SETI program under way.

NASA's restored SETI program is beginning as a five-year research-and-development effort. Prototype radio receivers specially designed for SETI will be plugged into radio telescopes in an effort to monitor as many as 8 million separate radio channels simultaneously. Specially designed computer systems will be developed to analyze this monstrous amount of data.

At the end of five years, NASA hopes to begin a large-scale, and presumably permanent, program based on equipment and concepts light years beyond the earliest SETI efforts.

—Robert Sheaffer

Radio telescopes will monitor as many as 8 million separate channels in an attempt to find extraterrestrial intelligence

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Science belongs to no one country."

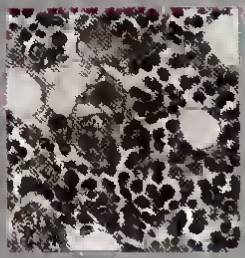
—Louis Pasteur

SUPERBLOOD

A new kind of synthetic blood that carries oxygen with enormous efficiency is being developed at the University of Illinois at Chicago. The still-experimental blood functions so well because it is made from a marvelous substance with just the right properties: real blood.

Researchers at the university and at Chicago's Rush–Presbyterian–St. Luke's Medical Center have succeeded in making the synthetic cells from human and animal hemoglobin, the blood constituent that carries oxygen. The hemoglobin is stored in synthetic capsules made of fatty lipids, and the tiny capsules are suspended in a synthetic plasma.

"Whatever is there inside the red cell we keep, we've just created a new membrane for it," explains bioengineer Irving F. Miller, dean of the University of Illinois graduate school and codirector of the project.



Real blood: A substance with just the right properties

Miller says that besides its superb oxygen-carrying capacity, the substitute can be given to recipients of any blood type and will probably have a much longer shelf life than regular cells have. Moreover, because the synthetic cells have a maximum size of one micron (a tenth the size of an ordinary red cell), they could penetrate areas that genuine blood cells cannot reach. That might be of potential benefit to stroke and heart-attack victims.

Furthermore, Miller says, the capsules stand up to mechanical pumping better than natural cells do. He foresees the day when patients undergoing open-heart surgery will be infused with artificial blood while they are connected to the heart-lung machine. "After surgery, we would put the patient's own blood back into his body and throw ours away." —David L. Dreier

CONTINUUM

An eighty one-year-old woman threatened a maintenance man with a butcher knife and fired a gun through her open front door

GERIATRIC VIOLENCE

The elderly so often the victims of violent criminals sometimes fall victim to psychiatric disorders that make them commit acts of violence themselves A study of 222 patients admitted to a Nashville, Tennessee geriatric psychiatry unit found 18 incidents of assault with deadly weapons by men and women whose average age was seventy-four

Five of these—including an eighty-one-year-old woman who threatened a maintenance man with a butcher knife and fired a gun through the opened front door of her apartment at imagined burglars—were suffering from late paraphrenia a paranoid disorder that usually appears in people over sixty-five Late paraphrenia involves none of the confusion or memory loss that characterizes less dangerous aggressive behavior in the elderly according to Dr William M Petrie, of the department of psychiatry at Vanderbilt University Instead, those who suffer from late paraphrenia are alert and coherent, capable of living alone and carrying out detailed plans such as buying guns to protect their property

But beneath their apparent composure lies a volatile network of paranoid beliefs aggravated by the impaired sight and hearing that typically go with old age This sensory deprivation, Dr Petrie says makes them unable to understand their surroundings fully and they become even more suspicious

"They tend to shoot first and ask questions later,' Petrie adds

The five patients with late paraphrenia were judged the most dangerous Seven other violent patients had brain deterioration caused by senile dementia or alcoholism Another five suffered from known mental illnesses (schizophrenia or manic psychosis), and one had a paranoid disorder that could not be identified

Six in the group had been attacked at home by intruders or mugged on the street in the year preceding their own violent outbursts Petrie believes that this personal history, as well as easy access to firearms combined with paranoid thinking to predispose these people to violence Only one patient had struck out violently before the age of sixty—Dava Sobel

LOCH NESS BOMBER

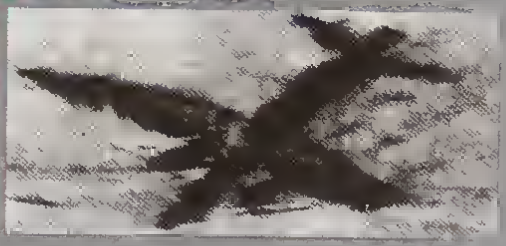
What lies buried under 230 feet of water in the peat sediment of Scotland s fabled Loch Ness? Answer a World War II twin-engined bomber number N2980, now dubbed the Loch Ness Wellington

Ditched in Loch Ness during a training exercise on New Year s Eve, 1940 this is only the second Wellington bomber out of more than 11 000 to have survived until today

The Loch Ness Wellington was first located in 1976 when Marty Klein of Salem New Hampshire was hunting the Loch Ness monster with sonar equipment Heriot-Watt University in Edinburgh has since used a remotely operated underwater television system to examine the Wellington

Recently the Loch Ness Wellington Association was formed to retrieve the aircraft and display it at a museum They hope to rescue the bomber as soon as they raise enough money thus disproving the old Scottish belief that the loch never gives up its dead

—Joseph Zarzynski



Sonar image of bomber in 230 feet of water in the peat sediment of Scotland's Loch Ness A by-product of monster hunting

FOILING OIL RUSTLERS

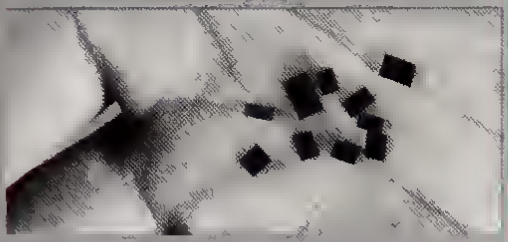
Like the cattle barons who preceded them American oil tycoons are starting to brand crude oil in the hope of thwarting thieves Oilmen from Kansas to California would have taken up the idea long ago, since they swallow multimillion-dollar annual losses from oil theft but oil-branding technology simply wasn t available Now a Pondcreek Oklahoma, man has come up with the idea of tossing hundreds of tiny dots of film into a tank of oil for irrefutable proof of ownership 'One of those little dudes," contends inventor John Farmer, "could put a thief in the penitentiary"

Farmer said the idea came to him when a newspaper reporter covering widespread oil theft complained that owners couldn't put a serial number on their oil ' Well, that got me to thinking ' he explains ' Maybe you could put the serial number in the oil " Soon he was out photographing lease signs on drilling property miniaturizing the pictures and dropping them in oil samples

According to R E Bellows, who, as president of Micro-Dots Inc , in Edmund, Oklahoma, is carrying out Farmer s idea the dots thrive in oil for at least 60 days And since they burn up in the refining process, they do not have to be filtered out at the refinery like the costly dyes and chemicals used in past identification efforts Branding the oil is a simple matter of tossing one or more ' eggs ' of microdots into a tank The egg, a polystyrene cube measuring 1 5 inches on a side, dissolves in seconds releasing up to 500 microdots or enough to label 100 barrels of oil

Computer-generated identification numbers on the microdots are changed regularly as part of the service, Bellows says and would be almost impossible to counterfeit It works out he adds, to about 17 cents per barrel for microdot protection —Dava Sobel

"How to fold a diaper depends on the size of the baby and the diaper"
—Dr Benjamin Spock



Microdots for tagging crude oil "One of those little dudes ' contends their inventor "could put a thief in the penitentiary"

Black rhino Because the rhino s horn is worth $250,000, its numbers have dwindled in Kenya Next stop Glen Rose, Texas

RHINOS IN TEXAS

The black rhinoceros of Africa is one of the most endangered animals in the world Since 1970 its numbers have fallen from 200,000 to fewer than 20 000 In Kenya a former rhino stronghold no more than 800 remain

Now a Texas rancher might be able to do something about the situation Tom Mantzel owner of the Waterfall Ranch in Glen Rose, is ready to take in six Kenyan rhinos by spring

According to Mantzel rhinos roaming a 1 300-acre section of his ranch will be able to flourish in a climate similar to that of Kenya They'll also be free of the poachers who contributed to the decimation of the species in the first place (An eight-pound horn processed to make aphrodisiacs medicines, or ornaments, can bring $250 000) Conservation experts agree that the rhinos will undoubtedly reproduce far more rapidly at the Waterfall Ranch than in zoos, where cramped cages and unnatural environments render breeding difficult or impossible

If the ambitious breeding program is successful, Mantzel adds, some of the rhinos' offspring will eventually be sent to Kenya to restock that country s wilderness —Paul Raeburn

CONTINUUM

PAINT YOUR TEETH

Want a bright white, movie-star smile without the pain and cost of conventional dental procedures? Have your teeth painted

A new technique developed by Den-Mat Inc of Santa Maria California permits dentists to etch teeth with a mild acid attach bonding resins then paint your smile Called Rembrandt, the technique requires some color matching artistry on the part of the dentist but it costs only a third of similar cosmetic work, such as capping

Completely painless the technique does not require injection or drilling A recent clinical test found that the resins used 'do more than fill cavities They seal tis sures cover enamel defects and repair porcelain

Dr Robert Ibsen president of Den-Mat calls the technique 'the crowning touch that makes it virtually impossible to tell that any restorative cosmetic work has been done Once completed a Rembrandt application should last three to five years depending upon the eating drinking and smoking habits of the patient Ibsen says

'The fact that Rembrandt is easily modified or changed is one of its benefits.' Ibsen claims That s one of the chief drawbacks of so-called permanent restorations like caps The teeth in our mouth are part of the same process of change that affects the rest of our bodies as we age What s done at age ten is not going to work, or look the same at age sixty'

—Allan Maurer

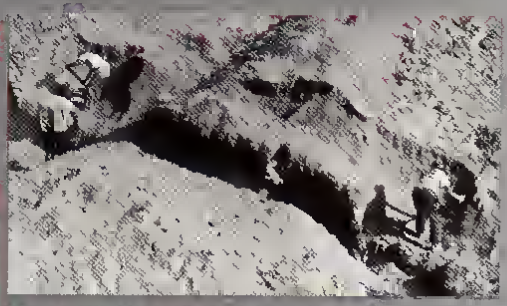
"I have yet to see any problem, however complicated, which, when you looked at it in the right way did not become still more complicated."

—Poul Anderson

They came to a round hole in the sky glowing like fire This, the Raven said was a star

—Eskimo creation myth

Before-and after photos of Rembrandt patient The teeth are etched with a mild acid, treated with bonding resins, then painted



Chimu canals Designers employed concepts of fluid dynamics implemented by Western engineers only in the last 100 years

COLLAPSING CANALS

The Chimu Indians of northern Peru built a huge and highly sophisticated irrigation system more than 3 000 years ago The network a series of canals that carried water from nearby rivers downhill to crops in the field sustained this great society for centuries But about A D 1200 the Chimu were conquered by the Incas and their canals eventually crumbled

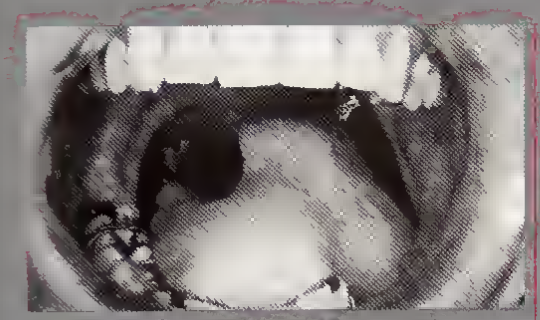
Scientists have long assumed that the Chimu canals failed because of inadequate design But recent research from the Field Museum of Natural History in Chicago, indicates that much of the system might still be standing if not for the continual upward movement of the coastal river basin As the earth s crust crept upward explains Dr Robert Feldman of the Field Museum it prevented water from flowing down to the canal openings—and from there to the crops The failure of the irrigation system Feldman adds, was further accelerated by torrential rains called *el niños*, which occur about once every 16 years

According to Chicago scientists excavating the 400-mile network ancient canal designers employed concepts of fluid dynamics implemented by Western engineers only in the last 100 years In fact the Chimu brought 35 to 40 percent more land into cultivation than irrigation systems do today

Modern irrigation systems, Feldman comments are no more protected from the movement of the earth s crust and *el niños* than the highly sophisticated Chimu system had been Canals can be extended for miles he adds but if the earth s floor is inching upward water will eventually be rerouted and the irrigation system will be doomed to fail —Francesca Lunzer

'If a man can see both sides of a problem, you know that none of his money is tied up in it."

—Verda Ross



Geraldine Gordon's tongue. Inflexible and removable, it attaches to the lower teeth and permits eating without the use of tubes

ARTIFICIAL TONGUE

A California woman may be the first person to use an artificial tongue designed to improve speech as well as to aid eating.

After three years of testing, speech pathologist Rebecca Leonard and dentist Robert Gillis of the University of California Medical Center, created the silicone tongue that Geraldine Gordon now wears. Fewer than ten people wear artificial tongues of any type, but Gordon's, besides increasing the range of foods she can eat, improves her speech as much as 80 percent in intelligibility.

The tongue is one of the most complicated muscular structures in the body," Leonard says. "It contracts at a speed rivaling that of a pupil responding to light. It is also larger than it appears; only half of it is visible. It actually extends down to the meeting of jaw and neck.

Gordon, who lost her tongue to cancer, now uses the twelfth revision of the device. Leonard and Gillis are adding computer simulations to their research in an effort to make an even better artificial tongue.

"We're considering using the patient's mouth and throat muscles," Leonard explains, "to get it to do something predictable every time she rounds her lips, for example. Even a small movement, elevating the tip, say, might lead to a dramatic improvement."

—Allan Maurer

PRESCRIPTIONS FOR DEATH

Large, reputable corporations that push drugs in the Third World promote their products by lying, cheating, bribing, and keeping mum about dangerous side effects, often with fatal consequences. This is the unhappy conclusion of a ten-year investigation carried out in more than 20 countries in Latin America, Africa, and Asia.

The research group headed by Milton Silverman, of the University of California at San Francisco, checked into some 500 drug products—medicine-chest staples like antibiotics, fever reducers, and birth-control pills—marketed in nonindustrialized countries by 155 manufacturers. They found that only four of these drug companies are doing a responsible job in terms of the reliability, accuracy, and honesty of the information they supply to physicians.

"All the rest," Silverman says, "are fudging." He adds that his group could find no significant differences in promotion practices between drug manufacturers in capitalist countries and those in socialist and Communist nations.

American companies, however, influenced by 1977 legislation, are not heavily engaged in bribery. Silverman points out, but the others "bribe like crazy." The most frequent targets of these bribes are government officials who decide which products may be purchased by government agencies and physicians who make buying decisions for large hospitals. It is common for drug salesmen to offer these individuals a free Mercedes-Benz, a new home, a new wing on the hospital, or cash.

"Bribery is a way of life there," Silverman reports. "The trouble is, with drugs, it's a way of death." He mentions the prescribing of appetite stimulants and high-concentration vitamins in Asian countries where most people are too poor to buy enough food. "All these drugs do is make their starvation more acute."

The research report has been published as a book, *Prescriptions for Death: The Drugging of the Third World*, by the University of California Press, Berkeley.—Dava Sobel

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"I have just got scent of some fossil bones of a mammoth; what they may be I do not know, but if gold will get them, they shall be mine."

—*Charles Darwin*

Pills in the Third World can be deadly. Appetite stimulants and high-concentration vitamins can make starvation more acute

CONTINUUM

Wrinkled? Shopping for a facelift? Plastic surgeons now say lasers are not the answer, that the beam cannot tighten up loose skin

LASER FACELIFTS DENOUNCED

Claims made for laser facelifts (see Continuum March 1982) are pure hogwash the American Society of Plastic and Reconstructive Surgeons charges

Oddly enough the technique's developer agrees

'We have been unable to find any scientific basis for the medical benefits claimed for laser facelifts says Dr William Portertield president of the society which recently asked the Federal Trade Commission to act against 'false and misleading advertisements touting the technique's benefits Porterfield is joined by Dr Joel M Noe codirector of Harvard's Beth Israel Hospital laser unit in Boston who calls the 'so-called laser facelifts a pure hoax He says the laser beam neither removes nor tightens the loose skin that forms wrinkles

Finally John Amaro the Overland Park, Kansas chiropractor who devised the method concurs Claims that nonsurgical laser facelifts remove eye wrinkles mouth lines sagging skin and bags are unjustified He calls the treatment 'laser toning and he stresses that it cannot replace surgical facelifts But Amaro says it does improve skin tone and reduce wrinkles so that more than 90 percent of his patients see some improvement in their appearance

The Food and Drug Administration has yet to credit the treatment with any effect at all But as long as the laser beam stays out of the eyes they say there is little risk of harm

—Jeff Hecht

Our dreams dream us '
—Anonymous

CITIES MAKE THEIR OWN RAIN

Large cities manufacture some of their own weather University of Illinois scientists have confirmed in a recent study

Urban effects in the Chicago area and other cities of one million population or more can cause rainfall to double in certain types of storms explains meteorologist Stanley Changnon director of the study The Chicago project caps 15 years of research on how large cities affect climate

All big cities change their internal weather in every way you can change weather, Changnon says Inner cities are warmer and windier than the rural areas around them But particularly they increase rainfall

'Air moving into a city looks at the mountain of buildings moves up and around and produces upward air currents Heat from the city adds to this effect The cooling towers of heavy industry add moisture Pollution contributes the small particles on which moisture collects—in essence, cloud seeding Changnon explains

All of these effects together set up convergence zones over cities that become favored areas for cloud development This results in more showers

—Allan Maurer

'He who defines the terms wins the argument
—Chinese proverb

Increased rainfall in cities of 1 million population or more is due to tall buildings heat and cloud seeding pollution particles

THE KEEPER OF SECRETS

Why the new face of computing is not a friendly one

BY PETER OGNIBENE

The State Department official was worried. He had done everything by the book when the department installed a new computer, one designed to store top-secret cables and other sensitive documents. He made sure that there were no telephones near the console to serve as inadvertent antennas and that all the wires connecting the seventh-floor complex to the central processing unit had been shielded with lead. But that was not good enough for the National Security Agency (NSA). A call from the NSA's Fort Meade headquarters curtly informed the State official that the agency was about to conduct a special test of the new system. The NSA was dispatching a special team to see whether they could steal any secrets from Foggy Bottom.

In newspaper stories the agency is almost always referred to as the "supersecret NSA." But these reports rarely deal with specifics. What exactly does the agency do? Even President Harry Truman's 1952 directive that established the agency remains classified 30 years later. After congressional hearings in the mid-1970s revealed that the agency had engaged in domestic spying, the attorney general issued a special set of guidelines governing the NSA's responsibilities; these, too, have remained classified.

PHOTOGRAPH BY PETER ANGELO SIMON

What is known is that the NSA uses an estimated eight acres of computers to break the ciphers of foreign governments—allies as well as adversaries. The agency also routinely intercepts and records telephone and cable communications between the United States and other countries. At home the NSA sometimes runs "black hat" operations under the code name TEMPEST to test the security of computers used for military and diplomatic communications. It was that sort of operation that the agency's special team mounted against the State Department.

Eavesdropping on a computer is not very difficult. Computer-security experts, for example, routinely impress potential clients by showing how a cheap cassette tape recording of the sounds of a computer's transmission signal over a telephone line can be translated into words and numbers. It is somewhat analogous to counting the clicks made by an old-fashioned dial phone to learn the number a person has dialed. For its raid on the State Department, the NSA used more exacting methods.

The State official was expecting the NSA team to arrive in a small, specially equipped van; instead, he saw a tractor-trailer jammed full of concealed antennas and sophisticated electronic listening equipment. Parked conspicuously on the street, the NSA experts were ready to snoop on the department's new computer.

Whenever something is typed on a computer keyboard and displayed on a cathode-ray tube (CRT), the TV-like screen attached to the computer, electromagnetic signals radiate into the atmosphere. Even shielding the computer and the cable with lead will not block out those keyboard signals, which were precisely what the NSA's gear was trying to pick up.

State's new computer passed the test—but for the wrong reason. As it turned out, the console was not properly shielded. Yet there was so much radiation emanating from the building that the computer's electronic pulsations were lost amid the flurry of other signals State was unintentionally broadcasting to the outside world.

A decade ago most of us naively assumed that computers and other elements of high technology were the servants of mankind—the delivery boys of the Information Age. Now we are beginning to realize that computers may also be used as weapons to assault our right to privacy. Today only the NSA and other well-equipped and well-financed organizations can steal computerized secrets from behind closed doors. But technology is advancing so rapidly that what is now available only to a handful of government agencies eventually will wind up in private hands.

"Technology races ahead so quickly," says Leonard Adleman. "What is breakable by the NSA today will be breakable by the kid with equipment from Radio Shack five years from now." With his modishly long hair, open shirt, and jeans, Adleman looks more like a graduate student than a professor of computer science and one of the country's leading experts in the mathematics of cryptography. But as he strolls the sun-drenched campus of the University of Southern California, he has a lot more on his mind than ciphers and machines.

"In the future," he says, "we'll be leaving electronic traces everywhere we go with each financial transaction and each attempt to communicate over the telephone system. A trace on you will essentially be available in real time [that is, instantly]. And I think it will undermine our whole sense of freedom—our freedom to move to be anonymous if we'd like, to communicate with one another."

It is such a beautiful day as we walk across the campus that it's hard to focus on so dark a vision of the future. Yet Adleman is seeing clearly.

Take something as essential to modern life as the telephone system. About 70 percent of all long-distance calls are transmitted by line-of-sight microwave repeaters that can each carry nearly 15,000 voice channels. Because microwave signals fan out, they can be intercepted at nearly any point along the way with the right kind of antenna. Ten years ago, outfitting a vehicle to intercept microwave transmissions would have cost over $1 million. Today an enterprising individual could do it with off-the-shelf electronics for about $50,000.

"A decade ago most of us assumed that computers were the servants of mankind. Now we realize that computers may be used as weapons to assault our right to privacy."

What would it take? I put this question to Thomas Magill, associate director of the Telecommunications Science Center at SRI International, a well-known California think tank. He ran a hand through his gray-flecked sandy hair and smiled. Then, in a casual, rambling style, he described how a well-financed individual or group could assemble the equipment necessary to sweep up hundreds of phone calls.

Well, to start, you'd probably have to go out and buy a Hewlett-Packard spectrum analyzer for about ten thousand dollars to see whether there is a signal being put out, and maybe another few thousand for a multichannel analog tape recorder to tape what you pick up." He leaned back in his chair and put his sneakers on the desk. "Oh, then I'd guess you'd need a van and an antenna. It wouldn't need to be very fancy. You could use a small dish and cover it with a radome, a little plastic cover—so no one could tell what you were up to—and then point it at the [microwave] tower. Then you'd need something to translate its [the microwave's] frequency to a standard frequency."

Where would you get all this equipment? "Just look in a few communications-systems catalogs," he replied.

Of course, not everyone could make such a system work. "You'd have to have a communications engineer behind it," Magill said. And it would become considerably more expensive for someone who wanted to do highly sophisticated eavesdropping. Tracing a call to its origin, for instance, would be both difficult and costly. Yet it is well within the state of the art.

Computers would be required parts of such systems. A machine could be programmed to read the phone numbers—technically known as digital headers—that precede a call and then automatically record only those calls going to specific numbers or exchanges.

With a device called a dial pulse decoder, which reads these digital headers, a foreign agent gathering political intelligence in Washington, D.C., could, for example, program his computers to record all incoming phone calls to numbers beginning with 456 (White House), 224 (Senate), or 225 (House of Representatives). By coincidence—if not downright stupidity—the United States allowed the Soviet Union to build its new embassy on one of Washington's most prominent hills, where its antennas can easily intercept the microwave transmissions not only of Ma Bell but of a special Pentagon channel as well.

Satellite transmissions are even more vulnerable, because when they are beamed down, they cast an enormous electronic footprint on the surface of the earth. A well-equipped electronic snoop could intercept and record thousands of data streams, or conversations.

All that would be necessary, Magill explained, is an Earth terminal consisting of a dish antenna and ancillary equipment. "How big a dish depends on how many channels are multiplexed [combined] together, because you have to have sufficient signal strength to demodulate [sort out] the channels. If they've got a whole bunch of them tied together, then you've got to have a pretty big dish." With the dish, a listener would simply take in a large number of transmissions beamed to Earth.

In the intelligence trade, this is known as the vacuum-cleaner method, so called because it sucks in every transmission in its path. The NSA routinely uses this method to record phone and cable traffic between the United States and other countries; it even has speech-recognition computers that can sort through recorded conversations to single out those in which certain key words or names are spoken. Apparently it was just such an operation that led

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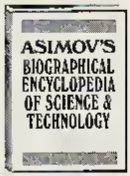

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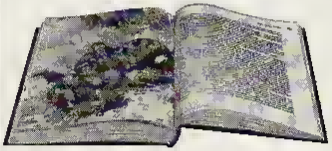

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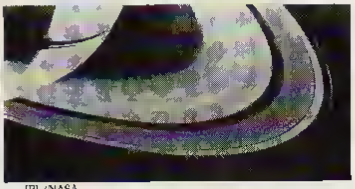

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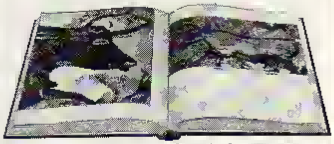

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They say it's fine once you're in!

to the discovery of Billy Carter's behind-the-scenes dealings with the government of Muammar Qaddafi in 1979 and triggered a Justice Department investigation.

The specialized capabilities of computers have also made other kinds of theft much easier. A substantial body of digitized data stored in a computer can be skimmed for information quickly and inexpensively. "If I gave you a thousand-page document and asked you to read it and locate every occurrence of a particular character string [a group of numbers or letters], it would take you hours to do it," says Martin Hellman, an electrical engineer and cryptography expert on the faculty of Stanford University. "But if it were in computer-readable form, it would take only a few seconds." One form of communication particularly vulnerable to this sort of interception is electronic mail.

With electronic mail a message can be sent from one computer over a special network to one or more terminals, where it will be stored until the recipients use their personal electronic key (usually a password typed into the terminal) to gain access to the message. With this system users can communicate instantly with one individual or with hundreds. Several corporations are already developing electronic mail. A leader in this rapidly growing field is GTE Telenet, which links more than 125 companies and 6,000 subscribers in some 275 cities.

Left unprotected, electronic mail would be easy to scan for valuable information, such as a firm's research data or marketing plans. I asked Hellman what it would cost to do this. The bearded, dark-haired engineer leaned forward. "I've made a very rough estimate that with special-purpose equipment that sorts electronic mail for key words you could search a billion words for one dollar. You could then record all the interesting stuff on a cassette tape recorder," he said. "So you see, the cost of spying on computerized data is very, very low. And because the United States is the most computerized country in the world, we stand to lose the most if that information is not protected."

But protecting information as it travels between computers is only part of the security problem. Sometimes it is the computer itself—specifically, its main, or operating, program—that is most vulnerable.

No one knows this better than Robert Abbott, who spends most of his waking hours trying to make operating programs more secure. He does this by subjecting the programs to attack, though he prefers the word *audit*. A large man with an easy laugh and a powerful baritone voice, Abbott is the president of EDP Audit Controls, a computer-security outfit in Oakland, California. He believes that he and his staff of 30 could steal information from almost any computer in use today.

For this reason, government agencies and corporations hire him to discover weaknesses in their computer programs. Given enough time, invariably he does

' During the five years we have had EDP Audit Controls ' he told me ' we have never failed to achieve a breakthrough—a penetration if you will—when we were asked to perform these kinds of assaults '

But that less dramatic term, *audit* is a more accurate description of what Abbott actually does He begins by analyzing a system's software for weaknesses—a process that can entail poring over millions of lines written in COBOL a programming language commonly used in many business systems That kind of work tends to be more tedious than glamorous

Nearly every computer has quirks that make it possible for clever programmers—as well as dull but persistent hackers—to use the operating program in ways the designer never intended Shig Tokubo a vice-president in Abbott's firm described one method

In most programs he explained the end of each distinct block of data known as a "file" is signaled by an "end of file mark" It is to a block of data what a period is to a sentence But with some computers according to Tokubo, if you stop abruptly while you are writing something new into a file—by turning off the machine for instance—the computer will lengthen that file by adding data from another file So by shutting down and starting up his machine over and over a computer operator could siphon more and more information from the system's memory, which he could then read or even change

Usually the operator has little control over what data get appended to his file Imagine letting the stylus of a turntable skip across the surface of a record, and you will have some idea of the haphazard way this works In most cases Tokubo indicated ' you're just randomly scavenging data But once you know where data are being stored and how big the records are you can position yourself to go to data that don't belong to you and you may be able to skip up the file and read things you're not supposed to read

Abbott and Tokubo routinely discover flaws like that when they audit operating programs including some of the Defense Department's most sensitive systems Fortunately for the government they use their expertise to protect computers

There are a number of people however many of them teen-agers who have become the vandals of the Information Age If they live in California and are unlucky enough to get caught they are likely to wind up staring into the rugged countenance of Robin Brown an FBI agent in Los Angeles who is one of the bureau's experts in computer crime

A former Air Force pilot with the frame of a defensive tackle Brown continually monitors underground publications and computerized electronic "B" (bulletin) boards that are sometimes used to exchange information on how to penetrate computer networks or the phone system

The technology and skills for committing computer crimes are no longer rare he has found The vandals Brown has collared fall into two categories computer crashers and computer hackers "The latter" he said, "are people who just like to get in and explore somebody else's computer and see what's there They're sometimes called tourists because they just wander through and look at the data without taking anything or disturbing it But a crasher will come in and erase files and leave obscene graffiti in their place"

He told me of one seventeen-year-old he arrested who had crashed a computer operated by U S Leasing Company in San Francisco Posing as a technician employed by the computer's manufacturer, he called the company and said he was inquiring to see whether the firm was having any trouble with its system In the course of the conversation he persuaded an employee to give him passwords and account numbers that would allow him to gain access to the system by telephone Calling after hours he got into the system and destroyed its computerized records The company which leases a broad range of electronic equipment had to shut down operations for several days

In another case the FBI tracked down a

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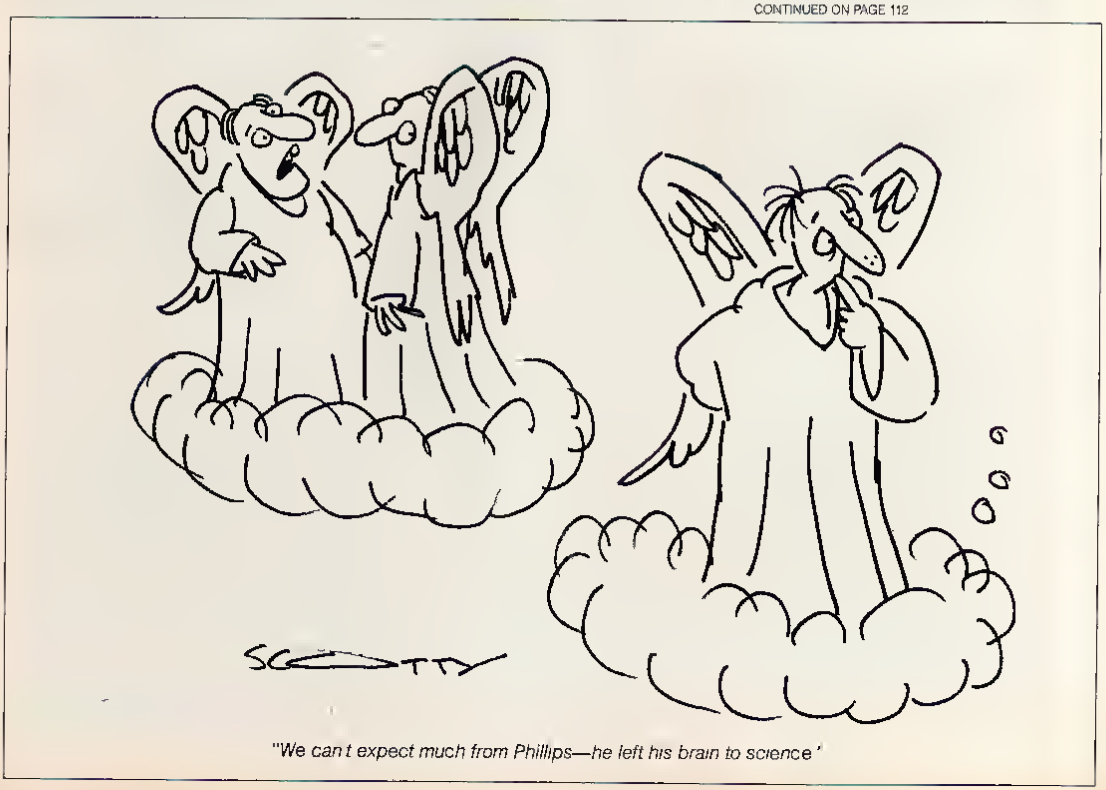

"We can't expect much from Phillips—he left his brain to science'

FICTION

THE LAST CHILD INTO THE MOUNTAIN

BY MICHAEL BISHOP AND LEE ELLIS

Ito and I found the kid in a place called Ozymandias, a pinball and video-game arcade in a shopping mall just outside Tocqueville, Georgia. Greenish fluorescents glowed overhead, ashes and candy wrappers littered the lavender carpet, and a familiar tang in the air told us why some of the locals spelled their town's name Tokeville. Deep inside Ozymandias, the object of our search was hunched over the controls of a Black Hole Blaster machine. Ito and I queued up behind the other onlookers—kids in jogging shoes, Pac-Man T-shirts, designer pantaloons, and so on—to watch their pudgy hero enfilading the video enemy with electronic laser light. "Goll-E-D, wouldya lookitthat!"

PAINTING BY FERNANDO BOTERO

"Way to fire, Chip!"

Chip Sands had no time for their cheers. His luminous blip ship was wafting perilously close to the Black Hole at eleven o'clock. Disregarding the warnings of the crowd, he shot down an approaching Ogre Raider and hyperspaced to safety. His blip ship reappeared in the upper-right-hand corner of the screen, firing salvos of comet-tailed brilliance at the enemy cruisers regrouping between six and nine o'clock. Although several of these blips exploded, scattering geometric debris, another hostile fleet materialized near the Black Hole, spiraling lazily in the lower-right-hand corner. Despite this new threat, a triumphant shout went up.

"What gives?" I asked my partner.

"Chip's just scored more points than this Computakil game can tally," Ito said. "He's gone all the way off the tote board."

"Then he's the one?"

"Listen, Phil, Computakil Recreational Systems are notoriously stingy with their advertising dollars, but don't forget they've already sponsored this kid in two national competitions."

"Both of which he lost."

"Yeah, well, he placed a respectable second in April, the first contest he'd ever entered. And in October, out in Hawaii—"

"I know, I know."

But Ito refused to be interrupted. "Rocket Ruth Lee defeated him in a game for which she'd devised her own program. Five'll get you ten, Phil, the courts uphold Computakil's protest. Vid Lite Industries haven't got a leg to stand on."

"You guys gonna jabber or glom?" demanded an acne-ridden wraith at Ito's shoulder. "Chip's settin' records right 'n' left, but you're mouthin' off like a coupla sfandups at Famine Relief Night."

Ito turned a ferocious stare on the grouser, who lowered his gaze and sidled out of eavesdropping distance.

"Punk," Ito murmured.

Meanwhile, Chip Sands—Captain Video Reincarnate, Jedi Knight of the Sensitized Screen—was disintegrating Ogre Raiders with all the inborn élan of a frog zapping dragonflies.

"Oh, yeah," Ito told me, "he's definitely the One."

Two hours later we were still watching our obese Boy Wonder running up uncomputable points on his original fifty-cent token. My feet and eyeballs ached, but I could hardly doubt that Chip had the Right Stuff. Finally, blessedly, the manager—a muscular young black man in a floppy leather hat—came over to tell everyone that the mall was closing.

"Ten o'clock, Chipper. You gof to stop."

"There's nothin' at ten o'clock, Mr. Dodd," Chip barked. "Can't you see I'm skatin' this mofher's event horizon?" He was too. He was deliberately fempting destruction, his blip ship was riding amazingly close to the rim of a slowly forming Black Hole.

Not counting a pair of baby-faced zombies of indeterminate sex, Ito and I were the only remaining spectators at the kid's machine. Dodd, the manager, looked to us—two sore-thumbed, fiftyish adults—for support. He had my sympathy. I dropped to one knee and unplugged Black Hole Blaster.

The machine made a funny burping sound, and its screen went blank. Time stopped in Ozymandias and seemingly in the entire Tocqueville Commons' Mall.

Chip Sands looked down at me. His eyebrows beetled, his nostrils dilated, and his lip began to quiver. I sfood fo my full heighf, enjoying his discomfort. The boy turned to Dodd.

"I never want to see this man in here again," he declared. "If you let him in, I'll—I'll tell Computakil to stop sponsoring your door-prize nights."

"Chipper," Dodd wearily admonished the kid. "Chipper..."

Ito stepped forward and put his hand on my shoulder. "Chip, this is Phillip Barrett. I'm Yasunari Ito, chairman of Tomioka-Lott Electronics, a Japanese-American computer firm you may have heard of."

"Chip's not a contract breaker like some vidders," Dodd told us warily. "I think you dudes should know that."

"We don't want to steal his endorsements away from Computakil," Ito replied. "This is political business, not business business. If Chip chooses to accept the assignment we have for him, he can return to the professional circuit as both a player and a company spokesperson right after the Christmas holidays."

"What assignment?" Chip asked.

"Let us drive you home," Ito said. "We'll put the proposition to your parents. Thirteen-year-old kids need all the adult guidance they can get."

"How do I know you dudes aren't kidnappers from Vid Lite or Fission Vision?" Dodd demanded, putting an arm around the boy's shoulders.

"Call his daddy," Ito advised the manager. "A prominent business leader like Mr. Sands, he'll have heard of me. No sweat."

Dodd telephoned Chip's daddy. It was no sweat. Ten minutes later I was driving Ito and the kid into a swank residential section of Tocqueville. The name Yasunari Ito had rung a small, silver-plated bell in David Sands's mercantile memory.

"Desperate, I tried to work a britches leg up alternate sides of the small portion of the topmost screen. Chip began rooting for me. Heartened, I pressed my advantage."

How could anyone who reminded you of a Silly Putty sculpture achieve the status of a national hero? Chip Sands's owlish face and schoolboy obesity—well-known to everyone from his television ads—were not especially endearing, and yet the Computakil ad campaign centered on his person had sent the company's sales skyrocketing. Try to figure out the American buying public.

As soon as David Sands opened the door of his family's stately home, I figured out how Chip had come by his nickname. The son was a reduced, three-dimensional Xerox of the father, who greeted us warmly and led us through a vast, antique-furnished sitting room to an elegant Tudor sofa.

"Upstairs," David Sands ordered his son. "It's past your bedtime."

The boy hesitated.

"Your mother and I won't decide anything without consulting you."

Half-jocular, half-menacing, Chip replied, "You wouldn't dare. Would you?" He turned away, then climbed the marble staircase to the long gallery on which his bedroom door opened.

As soon as he was safely behind it, his mother said, "We really don't understand what you want of Chip." Emily Sands was the sort of woman you would expect to find married to a svelte former quarterback rather than to a world-weary Kewpie doll in a three-piece suit. That her husband owned Piedmont United Mills, the area's leading industry, had probably accounted for her initial attraction to the man.

"Mrs. Sands, would you and your husband be willing to give Chip up for the Christmas holidays?" Ito asked. "Maybe a little longer?"

"But he's just come home from a two-week tour for Computakil!"

"The kid just can't stay away from Ozymandias," David Sands said, winking at me. "Says the place recharges his battery, puts him back in touch with his origins as a vidder."

"I'm sure he comes home to see us, too," Mrs. Sands reprimanded her husband. Then, "Who *are* you people, anyway? What do you want Chip to do?"

Chip's father laughed. "Honey, Mr. Ito's the biggest thing to come out of Japan since... well, since the raid on Pearl Harbor, I guess. Last year his computer conglomerate signed a multibillion-dollar contract with the U.S. government. Which agency, or what sort of contract, the *Wall Street Journal* didn't specify." He let his voice dovetail into innuendo. "And, strangely, there's been nothing in the papers or on the television news since."

"That first story was the result of a potentially compromising leak," I told the Sandses. "We took steps to keep it from happening again."

"We?" Mrs. Sands inquired.

Phil troubleshoots for the Aerospace Defense Command," Ito said.

"Computer conglomerate? Arrow Space Command? None of this makes *any* sense, David." Mrs. Sands revolved one hand in the air, as if to stir these revelations into a coherent pattern.

Ito, whose grandparents had died of radiation sickness in a suburb of Nagasaki, explained that the threat of nuclear holocaust grew more and more real every day. Yesterday the Soviet Union had concluded a brutal mopping-up exercise on the gore-spangled docks of Gdansk, and our angry first-term President John-Ernest Farrell had acted on strict Christian-Constitutionalist principle to declare a retaliatory naval blockade of Cuba. This morning a coup had occurred in socialist Yemen, and Farrell had threatened to send our Rapid Deployment Force to the area to prevent the Soviet Union from—

"Yes, yes. I'm aware of all that," David Sands interrupted. "What do you want Chip for?"

Ito told him. Directly. And in detail.

"But he's a mere boy," Emily Sands protested. "Global politics doesn't interest him any more than baseball does, and baseball doesn't interest him at all. His *only* interest in life is video games."

"Which is precisely the reason that we want him," I told her.

"If you can convince him," David Sands said, "Emily and I will reluctantly surrender him for the Christmas holidays."

"David!"

"Joseph and Mary did as much, babe. You can't keep a potential savior under wraps."

"Don't be blasphemous, David."

"It's all for a worthwhile cause, Emily. What's good for Yasunari Ito is probably good for Piedmont United Mills."

When the boy failed to answer our knock, Ito and I opened the door and walked in. Chip did not even look up. He was sitting on the edge of an overstuffed chair, glassy-eyed and winded. It immediately struck me that he was replaying in his imagination the game of Black Hole Blaster on which I had unfeelingly pulled the plug.

"Chip," I said, "could we talk to you a few minutes?"

The kid started and rose clumsily to his feet. "Nothing's sacred to you jerks, is it?"

I told him we wanted to take him on a vacation to Colorado. Ito explained that by coming with us, Chip might be able to help his country preserve its people and its institutions. These things were reasonably sacred to us, importunate jerks.

"What a load of bull-dooky. Besides, I don't *like* vacations. The only thing I never get enough of is vidding."

Ito said, "On this vacation, Chip, we'll give you a shot at a game even more challenging than Black Hole Blaster."

"Is that so?"

To our enormous surprise, Chip took Ito and me by our hands and dragged us to an array of video consoles built into an impressive mahogany bookcase. Here, smirking, he released us.

"Is your game more challenging than Triangle Triumph? Grab those joysticks."

Triangle Triumph, as Chip had called it, involved two distinct levels of competition on a pyramid of three small screens. I had a little rhombus to maneuver while Ito had a tiny ellipse. We took turns using our characters to connect the luminous dots strewn across the three screens. A player's first goal was to keep his opponent from creating a triangle that captured his character. Secondarily, though, each player tried to create the most "pure" triangles—that is, figures that did not enclose a stray dot from the backgrounds of the screens.

As Ito and I shaped our triangles, a digital scoreboard above the screens recorded them. Chip's hostility gradually gave way to immersion in our game. Soon he was murmuring impartial advice to both of us. Despite my combat-win familiarity with the joysticks of supersonic fighter aircraft, Ito was using his stick to hypotenuse me into a bind. Desperate, I tried to work a britches leg up alternate sides of the small portion of the topmost screen still untaken. Chip began openly rooting for me. Heartened by his unexpected support, I pressed my advantage and captured Ito's ellipse. My hands came away from the joystick shaking like mockups in a wind-tunnel test.

"Not bad," Ito said. "I really thought I had you there."

"Keep watching," Chip cried.

Ito's captured ellipse began acting out a preposterously hammy death scene, staggering back and forth inside my triangle and wobbling as it staggered. At last it went horizontal. Its demise triggered an astonishing response from the triangles in all three screens. After falling in symmetrical ranks, they reconstructed themselves into a meticulous blueprint of a kingly mausoleum. Music cut in from the speakers on either side of the screens—the raucously mournful strains of a New Orleans dirge. You could almost see a dixieland band swinging through the French Quarter in spats, striped shirts, and derbies.

> *Once inside the hollowed-out heart of the mountain itself, he twisted on the seat like a visitor from the Stone Age. This gloomy intramontane city he had not expected.*

"Holy cow," said Ito, his eyes widening. "Why hasn't Computakil put this baby on television?"

"It ain't Computakil's," Chip replied. "It's mine."

"Well, it's a little masterpiece of video-game programming," Ito told him, obviously sincere. "By the way, who won?"

I had not thought the matter in doubt. Although the scoreboard showed Ito leading me by better than seventy triangles, surely, as in chess, the fall of your opponent's most important piece decided the game. Indeed, when Chip pressed a button on the control console, our totals instantly reversed, and an additional one hundred thousand points clicked into place on my side.

"You have to count off a *lot* for getting captured," Chip explained. "If you didn't, some players would get caught just so they could have the funeral."

"Ito can't claim any such motive," I pointed out.

He smiled. "How about a rematch?"

Chip let us play again, and Ito thrashed me. As before, the memorial service was stirring, but this time the mausoleum resembled a Mayan tomb, and the music consisted primarily of bells, wood-block percussion, and the haunting glissandos of flutes. A shiver ran through me.

"Triangle Triumph's great," Ito confessed. "But it still doesn't compare to the game awaiting you in Colorado Springs."

The kid made an ugly scoffing noise.

"If you get past our challenge, and if you ever find yourself fed up with the promises and products of Computakil, you've got an executive-level job with Tomioka-Lott. That's a *real* promise, Chip."

"Ito," I cautioned my friend.

"Oh, come on, Phil. I'm not trying to raid a competitor's chickenhouse. I'm just trying to show the kid how much I think of his talents. A paycheck's the sincerest form of flattery."

Chip put his hands in the pockets of his pleated pantaloons. "I'll come," he said. "Christmas around here's a bore, anyway. Last year I had to go caroling with the Baptist children's choir."

Ito and I spent the night in a Ramada Inn on the outskirts of Tocqueville. The following morning we gathered up Chip in our rental car and drove him to Warner Robins Air Force Base, just south of Macon. From there we hopped a cargo aircraft bound for Peterson Field in Colorado Springs, where an Air Force staff car was waiting for us.

Pikes Peak loomed up to the west like a huge stone eagle in a painting by Magritte, snow mantling its head and outspread wings, but our driver took us south on Nevada Avenue toward the ivory escarpments of Cheyenne Mountain, the fortified headquarters of the Aerospace Defense Command. After nearly three months of winnowing candidates, I had finally begun to relax a little. Our prize was in hand.

Chip squirmed excitedly as we passed through each manned security point on our steepening route to the citadel. Once inside the hollowed-out heart of the mountain itself, he twisted on the seat like a visitor from the Stone Age. This gloomy intramontane city he had not expected. I was reminded of "The Pied Piper of Hamelin" when all the children but one have disappeared forever into the mountain. This analogy, which came to me unbidden, made me profoundly uneasy.

Each monolithic building inside the mountain rests on huge iron springs. Their purpose is to cushion the buildings from the shock of any nearby nuclear blast insufficiently powerful to knock out the complex. Chip laughed at the Rube Goldberg whimsicality of these springs. The setup appeared to strike him as unworkable. As for the likelihood of imminent Armageddon, the thought had never deeply impressed itself on his mind. Ordinarily, after all, he lived inside the flickering dimensions of his game screens.

Eventually we got out of the car and walked through a chilly tunnel to the deepest of the ADC buildings. Inside this structure we led the boy past banks of sophisticated equipment to our special arcade. Through a Plexiglas partition, three inches thick, Chip could see an enclosed room whose far wall accommodated five rows of television screens. Fifteen rubber-gripped joysticks protruded from the long console beneath this forbidding arrangement.

"Wow!" Chip exclaimed reverently. "Let me in there."

"You've got to practice first," Ito told him.

"I'll practice when I'm in there."

"Impossible! You'll spoil the program."

"It only works *once*?" the boy asked incredulously.

"We've got a simulator in the cubicle where you'll be sleeping," I said. "You can play the mockup to your heart's content—so long as you take time out for meals and sleep."

Ito explained that once the real contest began, Chip would be locked in our spartan little game room until the game was over. This seemingly peculiar precaution would keep anyone from pulling the plug on his fun.

"Honest?" Chip asked, eyeing me with remembered indignation.

"Honest."

Somewhat mollified, he let us coax him down the hall to the cubicle with the miniature mockup. Here, without even taking off his jacket, he activated the program and began working the finger-sized joysticks like a drummer playing uptempo Brubeck. Hurriedly Ito tried to run down the game's object and scoring.

You won points by destroying enemy blips and bases, just as you did in Black Hole Blaster. By contrast, though, a player could win additional points by preserving the friendly bunkers at the bottoms of many of the screens. These bunkers—with designated values of a thousand to two hundred

CONTINUED ON PAGE 120

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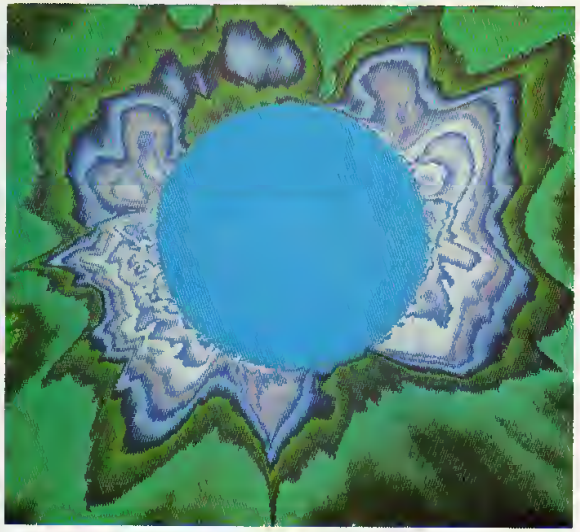
SOLAR SEEKERS

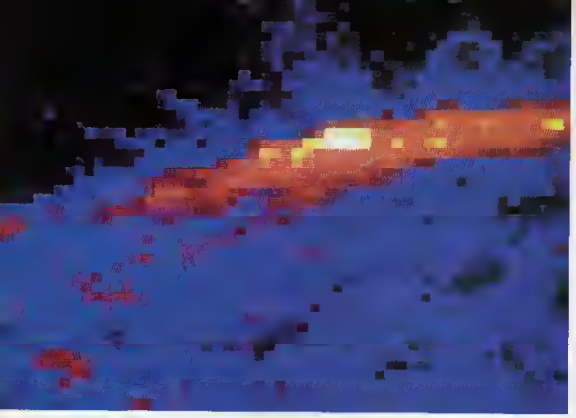
BY MARCIA BARTUSIAK

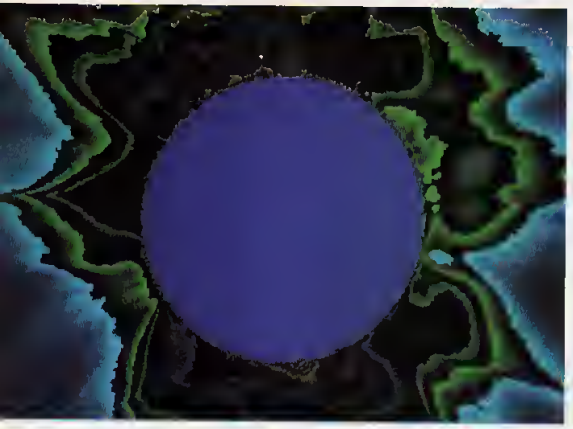


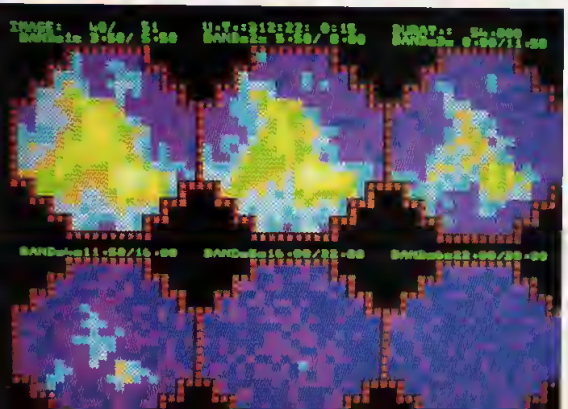
In the cosmic scheme of things the sun is just another middle-aged yellow dwarf star that smolders in the outer reaches of the Milky Way But when viewed close up with the multispectral eyes of the Solar Maximum Mission Satellite the sunscape bursts forth in a fireworks show its corona (above) unveiling some of the stellar secrets in a palette of computer-generated color

Using such exotic equipment as the Solar Max satellite, launched to study the sun during the recent peak of sunspot activity, and a small arsenal of mountaintop solar

PHOTOGRAPHS BY DAN McCOY/RAINBOW







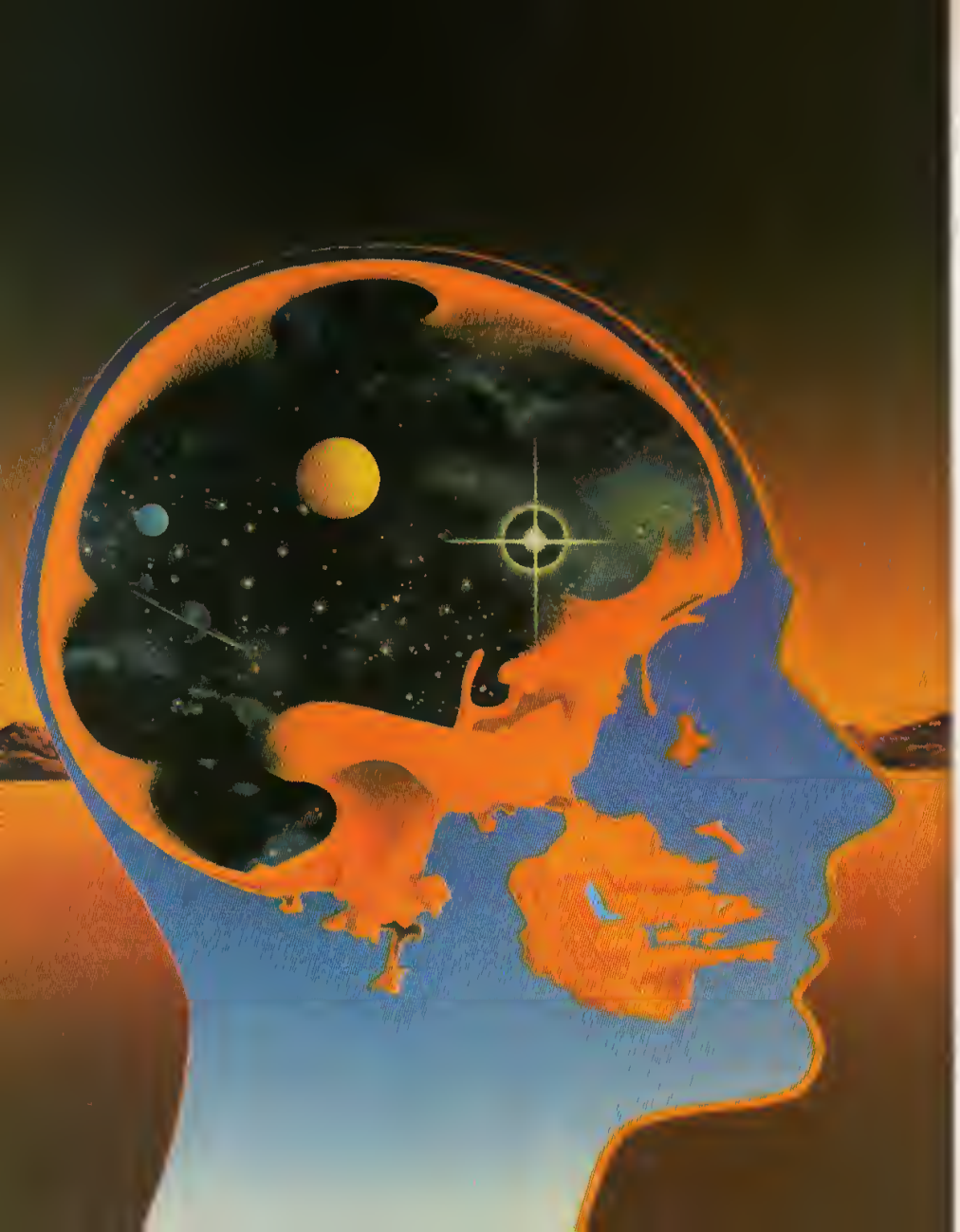
Solar Max's digitized view (top) of a solar flare, the satellite's occulting disc blocks out the sun's bright face (middle), revealing the hot and tenuous coronal gases that extend millions of miles outward. X-ray emission (bottom) during the birth and death of a solar flare. Meanwhile, back on the ground, solar scientists such as Gary Heckmann at the NOAA Patrol Telescope in Boulder, Colorado, maintain their perennial vigil over our closest star. Previous page: Arizona's Kitt Peak solar telescope.

observatories, astronomers have been keeping a faithful vigil over this seething nuclear furnace for decades. And at last their patience is paying off. The last ten years of solar research has shown just what a mercurial personality the sun has: that it 'breathes'—that is, expands and contracts, that it resonates like a giant bell, and that quite suddenly, in a matter of days, it can dim its radiance by a tenth of a percent—a particularly worrisome discovery since it is estimated that an extended 1 percent drop could plunge the earth into an ice age.

Most recently, solar astronomers from the National Oceanic and Atmospheric Administration (NOAA) and elsewhere have discovered rivers of magnetism coursing around the sun. It's believed that when these magnetic rivers punch through the surface, sunspots appear as great looping arches of flame.

The final chapter on solar astronomy is not written, but solar scientists are not pressed for time. The sun is not expected to burn out for several billion years. ∞

"The sun breathes, it resonates like a giant bell, and, quite suddenly, it can dim its radiance."



Behavior is spawned in seas of neurochemicals whose ebb and flow are drawn on

CHARTS OF THE SOUL

BY JUDITH HOOPER

My mother still has a phrenologist's map of her skull, dating from a consultation in her early childhood. Fortunately for my siblings and me, the "love of progeny" area is well-marked, as are her "marriage" and "philanthropy" bumps. (A slight prominence in the region of "cupidity" scarcely mars the picture.) From our vantage point, my mother's head chart recalls one of those quaint, sea-monster-infested medieval maps of the world, for nowadays the *Journal of the American Medical Association* would no more run a phrenology advertisement than it would trace a patient's troubles to a "bilious humor." Ironically, though, the old pseudoscience of detecting the soul in the language of the body could become one of tomorrow's exact sciences.

The "new phrenologists" are neither fortune-tellers nor quacks, however. They make no pretense of omniscience. Sometimes they astonish themselves with their own prognostications. The bare facts are that a vial of blood or spinal fluid or the serpentine trail of an electroencephalogram can reveal quite a lot about *character*. The scientists studying these signs would use other, less Victorian terms, of course, but the upshot is the same.

Here is a sampling of some of their recent findings:

• Neuroscientists in several high scientific sanctums are closing in on what appears to be a biochemical marker of suicide. If their hunches prove right, future chemical tests will

PAINTING BY PETER GOODFELLOW

spot the suicidal and even forecast whether a patient will try a drug overdose or a leap from the Golden Gate Bridge. A suicide prevention pill could also be in the works.

• Violence seems to have its own particular neurochemical fingerprints. So far evidence has turned up in two groups of violent insubordinate sailors and marines and among murderers and other criminals.

• "Sensation seekers" are born, not made, according to a University of Delaware psychologist's 20-year investigation. Much as medieval physicians distinguished the "phlegmatic" temperament from the "sanguine" using putative bodily humors, real biological markers today can separate the James Bonds from the Walter Mittys.

• Many teen-aged street-gang leaders may be creative artists gone astray, one educational psychologist proposes. High creativity and juvenile delinquency are two sides of the same biological coin: an underaroused nervous system. The opposite extreme, *hyper*arousal, might be the hidden cause of autism and schizophrenia.

• At a home for delinquent boys in Wisconsin, a simple series of physiological tests foretold with frightening accuracy which young inmates would run away—and how long each would be on the lam.

But if *Clockwork Orange* visions of brain-tampering doctors loom before you, rest assured that the biology of temperament field really isn't a field at all. Or at best it's a decidedly fragmented one. Half of the practitioners are psychologists who spend their days probing the autonomic nervous system for degrees of "arousal" and similar phenomena, while the other pieces of the puzzle belong to hard neuroscientists. For the most part the behavioral researchers and the "neurohardware" people don't speak the same language or swap references in their papers.

To the scientists who track radioactive chemicals in liquefied gray matter, the old-fashioned autonomic geography of electrodermal readings, salivation rates, and "orienting responses" to stimuli seems a land of vapors too distant from the cortex to make a difference. To the stimulus-response psychologists on the other hand, the brain is a forbidding swamp filled with largely nameless flora.

You might say that modern personality typology was born the day when Ivan Pavlov noticed that some of the dogs in his early conditioning experiments were preternaturally frisky. Constantly sniffing around and quickly bored by repetition, they stood apart from their fearful, docile and more easily conditioned cage mates.

Borrowing from the ancient lexicon, the father of stimulus-response psychology christened the first type of canine "sanguine" and the second "melancholic," attributing their dispositions to "strong" (unreactive) and "weak" (excitable) nervous systems respectively. Variously reincarnated, these personality types went on to haunt the human scene.

Since Pavlov, temperament typologies have come and gone, some with the fleeting flash of Paris fashions. Remember the jolly *saftig* endomorphs, thin, brainy ectomorphs and muscled, aggressive mesomorphs of pop-psychology fame? Coined by Harvard scientist W. H. Sheldon around 1940, these categories haven't fared well in subsequent research. The thin man isn't always bright, nor the fat lady jolly.

Hans J. Eysenck came along in the 1950s to divide mankind into introverts and extroverts, on the basis of nervous-system differences. But the introversion-extroversion school is a bit too vague to be hard science, either.

Why this lepidopterist-like urge to classify human temperaments along biological lines? Shall we leave that to the astrologers and the party-game psychologists and get on with real science?

On the contrary. The quest for fundamental correspondences between psyche and soma is no more metaphysical than microsurgery is. It is, in fact, the *hardest*

> *"The researchers seem to have stumbled onto a provocative fact: The rampages of Jack the Ripper are distinct from the quiet homicides of a brooding euthanasiast."*

of the mind sciences these days. And interpreted with sophistication, the research has the potential to save lives.

SAILORS, SUICIDES, SEROTONIN

"Ernie"—a composite of several real sailors—was the sort of hyper- semiweird character whose eyes you instinctively avoid in an all-night diner. His love-em-and-leave-em romances, sketchy job history, bar brawls and hair-trigger temper made a lot of people in his hometown nervous, and no one least of all his bewildered parents, minded too much when he left home and joined the Navy. But Uncle Sam couldn't seem to make Ernie shape up either. High-strung and unpredictable as a traumatized laboratory animal, the young sailor routinely thumbed his nose at authority, got drunk and pulled a knife on strangers in a bar and cooled out more than once in the brig. One night Ernie got an urge to load his rifle, go AWOL and shoot out the windows of a passing train.

After his dishonorable discharge, Ernie landed in the hushed wards of the National Naval Medical Hospital, in Bethesda, Maryland, where psychiatrists took down his life history and gave him a few standard psychological tests. There his condition was diagnosed as a borderline personality disorder, psychiatric shorthand for the baffling cases that are neither simple sociopathy nor psychosis—the gist being that Ernie was sometimes troubled by delusions and jumbled thoughts but was not truly psychotic. Then, in a scenario remote from the flyblown pool halls of his youth, Ernie went on to make medical history.

The trouble with Ernie, brain researchers from the nearby National Institute of Mental Health (NIMH) divined, was a biochemical jinx not unlike diabetes. And while no one has yet concocted a cure for what ails him, his case could lay the groundwork for a future suicide antidote. But this is getting ahead of our story.

In a series of well-documented studies, the brains of violent lab animals have betrayed defects in serotonin transmission, usually related to abnormally low levels of this neurochemical. (Serotonin is one of about 30 known substances in the brain that spurt from nerve cells, carrying chemical messages that excite or inhibit neighboring cells.) But because scientists cannot peer into the living human brain, the chemical basis of *Homo sapiens* violence has remained unfathomed—until recently.

Serotonin—as it is metabolized—breaks down into a chemical called 5-HIAA, which shows up in a person's blood, urine and cerebrospinal fluid.

NIMH neuroscientists Gerald Brown and Frederick Goodwin reasoned that spinal fluid 5-HIAA levels might tell them something about aggressive human beings. Working independently of the psychiatrists who had made the clinical diagnoses, the researchers assayed the spinal fluid of a first group of 26 aggressive and maladapted servicemen at the naval hospital in 1978 and found low 5-HIAA levels. When Ernie's gang of 12 turned up two years later, the scientists had refined their tools and a stark picture emerged.

Not only did the truculent sailors have generally low 5-HIAA levels, but the more violent each one's life history and psychiatric profile, the lower his 5-HIAA. So elegantly did biochemistry mirror personality that a graph of 5-HIAA levels and "mean aggression scores" on tests approached a perfect inverse relationship.

Statistics this clean are rare in the infant science of psychobiology, and the researchers' second finding was more experimental manna. Quite a few of their wild bunch had also attempted suicide; it turned out. When Drs. Brown and Goodwin looked more closely at the suicidal seamen, low 5-HIAA turned up once more, and a neurobiological buzzer sounded. Was this the telltale chemical fingerprint of hostility toward others *and* hostility toward self?

If a man was very aggressive, he was likely to have low 5-HIAA. Brown summarizes: "If he was suicidal, he was also likely to have low 5-HIAA. If he was both aggressive and suicidal, he was almost

certain to have unusually low 5 HIAA.

A psychoanalyst-cum-brain researcher Brown takes a certain philosophical pleasure in his figures. Since Freud proposed back in the pre-psychopharmacological era that suicide is actually aggression turned inward, the theory has floated in the pale penumbra of psychoanalysis, of little practical concern to researchers exploring brain hardware. "But my work has convinced me that Freud was right," Brown confides. "Suicide and aggression have the same source in the brain."

"Just the other day," he offers by way of anecdote, "I got a letter from a woman who wants to be a subject in our next study. She wrote that she will commit suicide on November 28. If we haven't started our study by then, it turns out that November 28 is the day her boyfriend plans to leave on a hunting trip. I'd bet you she's plenty angry about that. Not depressed, angry."

That volcanic rage should seethe beneath the stone-gray surface of suicide makes sense to scientists familiar with the anatomy of despair. The isolated, mother-deprived monkeys in psychologist Harry Harlow's classic experiments protested first and only later seemed to despair, illustrating how anger precedes angst. "Rage is a more basic emotion. I think a primary discharge of the limbic system," Brown muses. "Depression, guilt, despair, and suicide are secondary; they are learned behaviors." (The limbic system, a set of nerve structures forming a loop around the inside of the brain, controls emotional behavior from ferocity to apathy.)

By itself, the NIMH study would be only a small island of lush data. You cannot make bold generalizations about human behavior from the bodily fluids of 38 disgruntled sailors and marines, nor can anyone say with precision just how closely the metabolite 5-HIAA mirrors the state of serofonin in the brain. But the violence/low-5-HIAA link has just reared its head again in three studies of European criminals, suggesting that it is no mere laboratory curio.

A group of intractable, rule-breaking French prisoners (the possessors, also of the crime-fainted 47 XYY chromosome abnormality that has been a *cause célèbre* in courtroom psychobiology) another group of extremely violent Finnish murderers and a third group of Swedish mass murderers were all found to have low spinal fluid 5-HIAA levels. As a macabre footnote to the Swedish mass-murder story (which is so recent it is still unpublished), a single culprit had normal 5-HIAA. But he was not your garden-variety mass murderer: he was a mild nursing-home attendant who had calmly performed over two dozen mercy killings of aged patients. The researchers, headed by Karolinska Institute neuroscientist Marie Asberg, seem to have stumbled upon a provocative fact. The rampages of a Jack the Ripper are neurobiologically distinct from the quiet homicides of a brooding euthanasiast.

And what of socially acceptable kinds of aggression? "I wouldn't be surprised if we find slightly lower than average 5-HIAA levels in successful aggressive people such as courtroom lawyers and business leaders," Brown reflects. "We know there are normal people—neither antisocial nor suicidal—who have low 5-HIAA. Though interestingly, we've yet to find anyone with high 5-HIAA who is impulsive and aggressive. The question is: What else is going on to mitigate the effects of low 5-HIAA in these people?"

Such speculations stir up another old Freudian ghost: the concept of "sublimation." This process, wherein lower emotions like rage are channeled into patriotism or a crusade for social justice, might occur at the neurochemical level, Brown thinks. "In most brain tracts serotonin is inhibitory," he explains. "Inhibition is one of the basic biological principles governing our apparatus. Without it, you can't regulate your biochemical pathways, and things go awry. This was the case if you will, with our impulsive, antisocial servicemen. Freud saw inhibition as the basis of civilization. In order to have judgment, you need to pause, reflect, delay."

Meanwhile, there's more news on the suicide front. The first inkling that low 5-HIAA might be a hidden suicide warning was serendipitous. Two years before the first Brown-Goodwin study, Asberg and L. Traskman were analyzing the neurotransmitter metabolites—products of chemical breakdowns—of depressed patients. The researchers turned up an unexpected correlation between 5-HIAA and a history of suicide attempts. Now the grimmer sequel: The men and women with the lowest 5-HIAA, it turned out, had almost invariably tried to do away with themselves violently—with a shotgun, say, rather than a run-of-the-mill drug overdose. When the scientists split the group in two on the basis of 5-HIAA levels and returned to them two years later, they found to their horror that 25 percent of the low-5-HIAA bunch were already dead: the victims of successful—and violent—suicide.

Add to all this necrology a new autopsy study just published in *Science*. Knowing nothing about the Brown-Goodwin studies, pharmacologist Michael Stanley of Wayne State University in Michigan compared the brains of nine suicide victims with those of nine matched patients who had died of other causes. In the suicides' brains he found unmistakable signs of a serotonin disorder. For the first time the biochemistry of suicide was tracked into human gray matter itself.

What Stanley and his colleagues at Lafayette Clinic in Detroit actually did was to "count" the serotonin receptors—the active target sites where serotonin fits into the neurons—with a technique called fritiated imipramine binding. Imipramine is an antidepressant popularly known as Tofranil. When tagged with tritium, a radioactive isotope of hydrogen, imipramine binds to the serotonin receptors and per

mits scientists to estimate their number and "stickiness." The receptors in the suicides' brains were sparse. These self-destructive people, Stanley deduced, suffered from a functional serotonin shortage—a finding that echoes Brown and Goodwin's report of low spinal fluid 5-HIAA in would-be suicides. And, although Stanley hadn't set out to gauge degrees of violence, he did notice that the brain with the fewest serotonin receptors was that of a man who had jumped from a window in a tall building.

"But the which-came-first question still begs answers," Stanley cautions. "Did low serotonin cause these people to commit suicide? Is it an actual 'marker,' or just a by-product of a temporary state?"

And if low brain serotonin is a biochemical marker for suicide, how exactly does that translate to 5-HIAA levels in cerebrospinal fluid? At what precise level of 5-HIAA does a person fall into the high-risk category? Since serotonin is only one of a grand sea of neurochemicals that affect the psyche, what other chemicals are mixed up in the suicidal pattern?

These are some of the nuts and bolts to be tightened before a simple chemical test for suicide risk becomes a reality. More practically until a simple blood or urine test supplants the spinal tap as the mode of diagnosis, psychiatrists won't spot suicide-bound patients the way today's internists catch incipient diabetes. But that day may not be so distant. Both the NIMH and the Detroit teams are launching follow-up studies to identify the suicide-prone and they'll assay 5-HIAA levels in blood plasma as well as in spinal fluid.

The beauty of our findings, and those of Brown and Goodwin, is that we're no longer dealing with a diagnostic category like schizophrenia or depression," Stanley tells me. "We're looking at a specific behavior, suicide, and finding this common biochemical thread that cuts across psychiatric descriptions. That's the wave of the future, and it's very encouraging."

Where there's a cause in bioscience, a cure can't be far behind. So I asked Brown about the likelihood of future suicide-prevention drugs. He mentioned trazedone, a brand-new tricyclic antidepressant that blocks the reuptake of serotonin at the synapse—the point of contact between nerve cells—making more of the chemical available to the brain. "Since trazedone's effects appear to be short-lived, I don't think that by itself it will be a suicide cure," he points out. "However, a pharmacologist at Eli Lilly has just published an animal study in which a drug similar to trazedone had long-term serotonin-enhancing effects when combined with tryptophan, an enzyme that is a serotonin precursor. I don't want to raise anyone's hopes prematurely, but something like trazedone in combination with tryptophan may turn out to be an antisuicide agent."

When they contemplate an antiaggression pill, however, red flags wave in most researchers' heads. Few wish to propose a Big Brotherish pharmacologic fix for Ernie the Sailor's headstrong ways, though in one experiment the antimanic agent lithium (which increases brain serotonin, among other things) did turn chronic prison rule-breakers into model felons. "It's possible that a customized serotonin-boosting agent will one day make a better treatment for human violence, but as Brown puts it, 'We'll have a suicide treatment a lot sooner than I can tell you.'"

THE ANATOMY OF SENSATION SEEKING

If is easy speaking of murder and mayhem, suicide and senseless violence, to imagine biochemical forces at work in the mind's storm-tossed outposts; harder somehow, to visualize their influence on Main Street. But other research confirms that biology holds sway over such behavioral trifles as eating habits, hitchhiking and perfume preferences.

Why, for instance, do some people feel an urge to climb Annapurna while others get their kicks from reruns of *Charlie's Angels*? This is the sort of Middle American koan that fascinates personality psychologists, not excepting the University of Delaware's Marvin Zuckerman, who is the patron saint of sensation seeking theory. It was Zuckerman who, in the early 1960s, fathered the widely used Sensation Seeking Scale (SSS)—with its colorful subscales Thrill and Adventure Seeking (TAS), Boredom Susceptibility (BS), Experience Seeking (ES) and Disinhibition (Dis). As Fodor is to travelers, so Zuckerman's SSS is to modern-day temperament theorists.

A few samples from the questionnaire: "I dislike all body odors/I like some of the earthy body smells." "I dislike swingers/I enjoy the company of real swingers." "I would not like to try any drug that might produce strange and dangerous effects on me/I would like to try some of the new drugs that produce hallucinations." Other questions explore the test-taker's attitudes toward parachute jumping, nonconformist friends, spicy foreign cuisine, trips to the upper Amazon, sexual variations, hitchhiking, gambling, extreme heat and cold, amusement-park rides, life insurance, adultery, motorcycles and hypnosis.

So what? you may ask. Well, it turns out that your SSS score can accurately predict a few things about you. Whether you're a political liberal (high SSS) or conservative (low SSS), for instance. Whether you go in for scuba diving or automobile racing (high SSS) or intercollegiate bowling (low SSS). Whether you're likely to be a social worker (high SSS), a conscientious student (low SSS), an encounter groupie, a jazz aficionado, or an avant-garde art connoisseur (high SSS). If you're a jogger, you're probably not much of a sensation seeker, but if you've ever streaked, your SSS score is probably in the upper octaves.

Furthermore, you can now toss out your daily zodiac and your astro-compatibility charts. The well-known like-marries-like law that psychologists call "assortative mat-

ing" has lately been proved as true of sensation seeking as of I.Q. And if you do choose a mate with a comparable SSS score, you'll be better off, a recent Zuckerman survey of compatible, and troubled couples indicates. The worst of all possible marriages, on the other hand, is the Madame Bovary syndrome of a high-SSS female wedded to a low sensation seeker.

By Zuckerman's theory, marriage counseling for the Bovary family will be difficult. Sensation seeking, he suggests, is a "basic biological trait" related to exploratory behavior in other species, like rodent maze running. It is programmed in our very genes. Actually, what our genes apparently encode is the biological or chemical machinery—specifically certain "juices" in our brains' emotional pathways—that propels us toward life's jagged peaks or its more level plateaus.

Zuckerman's latest theories depart from the latter-day extroversion-introversion school, which basically views sensation seeking as a variation of extroversion and traces it to a chronically underaroused nervous system. The idea made sense to Zuckerman, too, at first. Then, initiating sensory-deprivation experiments, he noticed that his volunteers were clustered near the high end of the SSS continuum. According to the reigning doctrines, sensation seekers should *hate* extreme understimulation. So why were they volunteering for a sensory void? High sensation seekers, Zuckerman decided, didn't need external stimulation per se, but situations that triggered new kinds of internal sensation. And the isolation chamber, like psychotropic drugs, launched the mind's own Folies Bergère. By 1969 he shifted his focus from the autonomic nervous system to the array of brain chemicals that govern our desires and loathings, our hopes and fears.

Why should some brains be more reactive to intense stimuli while others apparently have a built-in damper? The answer seems to involve MAO, or monoamine oxidase, a brain enzyme that breaks down the monoamine neurotransmitters—dopamine, norepinephrine, and serotonin—at the synapse, preventing their accumulation. The animal kingdom provided the first hint of MAO's surprising soothsaying abilities. Blood-platelet levels of the enzyme predicted the personalities of monkeys in a social colony. NIMH researcher Dennis Murphy discovered a few years back. While low-MAO monkeys rough-housed and socialized, the high-MAO monkeys skulked in the corner. Human beings, only an evolutionary notch above monkeys, follow similar behavioral patterns; subsequent studies have linked low MAO with human ego strength, optimism, high activity, mania, even club and organization affiliations, and high MAO with solitude and depression.

In light of the evidence, sensation seekers ought to have lower MAO levels than non–sensation seekers, and that seems to be so, Zuckerman says. If MAO is indeed a neurochemical damper, what does that mean? To put the case a little crudely, the brains of sensation seekers, especially their monoamine-rich limbic areas, may be a good deal "juicier." Brain scientists now believe that chemicals coursing through the limbic (motivational) pathways make up the brain's internal reward and punishment systems. And that belief gives Zuckerman ideas that might spawn future research.

Maybe, he suggests, sensation seekers and non–sensation seekers differ not in overall arousal but in the relative strength of the neural reward and punishment systems. Does the prospect of exploring the Amazon basin stir up "pleasure" chemicals in the born sensation seeker and anxiety juices, or perhaps nothing at all, in the low sensation seeker?

MAO's alchemy is by no means precisely understood. Now is not the time to plan your life, or that of your loved ones, around this humble enzyme—as a Salt Lake City housewife who recently phoned Zuckerman discovered. "I read about these MAO levels," she told him, "and wondered if there was any way to raise them in my son."

What was wrong with her son? "He does dangerous things like riding his skateboard downhill at thirty miles an hour, and he's having an affair with an older woman." When the son turned out to be nineteen years old, Zuckerman explained that his behavior didn't sound pathological. "But that's not how he was raised," the distraught mother objected.

There might be a lesson here somewhere. Maybe some parent-child conflicts are rooted in biological differences. MAO levels do tend to rise with age, while sensation-seeking scores decline from the age of approximately twenty-five on. Zuckerman suggests. Is biochemistry the hidden cause of the generation gap?

"How much a parent can discourage a high sensation seeker or encourage a low one to be more adventurous is still an open question," he adds. "We've found that first-borns tend to be high sensation seekers. Parents who assume that lots of early stimulation is necessary to future intellectual development may create future sensation seekers rather than intellectual giants."

Nobody in this business claims that biology works like a rigid Sophoclean fate, and unquestionably sensation seeking is shaped by environment as well as genes. "If you're middle class and have these sensation-seeking tendencies, travel and risky sports like skiing are available to you," he notes. "But if you live in a restricted, lower-class environment and work at a dull factory job, say, you're liable to find an outlet in drugs or alcohol."

DELINQUENT MOZARTS

Frank Farley goes a step further. The University of Wisconsin educational psychologist sees a biosocial message in the bored assembly-line worker

"Look at the cases of industrial sabotage in Detroit—the workers who throw a wrench in a Cadillac transmission. I think that these are sensation seekers who are unable to tolerate the routine," he says.

Pity the poor General Motors saboteur. If Farley's theories are correct, he may be a creative artist gone rotten, an inner-city Cezanne never given a box of paints.

The reasons Farley explains are biological. At the core of the sensation-seeking theory he subscribes to is the notion of physiological arousal. Sensation seekers, according to this school of thought, crave stimulation to compensate for a low level of neural arousal, while high-arousal types eschew overwhelming stimuli.

Hyperactivity and many learning difficulties are actually "disorders of severe underarousal," Farley notes, or they are sensation seeking gone amok. At the other end of the spectrum are autistic children and schizophrenics, whose too-arousable nervous systems are likely to lead them to withdraw from the hustle and bustle into wan private chambers of flat affect and understimulation.

If Farley had his way, educators would map students' "biological aptitudes" and teach them accordingly. His classroom of the future would look much like this. While the high-arousal children (who shun stimulation) read Keats's reflections on a Grecian urn in a quiet library, the low-arousal kids would study to the tune of punk rock hits with a television set blaring in the background to boot. A disciplinarian presiding over orderly rows of desks would teach stimulation avoiders to memorize Boyle's law, while those who crave stimulation would learn Boyle's law inductively, generalizing from specific examples. All of the children would spend a great deal of time at computer terminals, where they would learn about European monarchs while the computer simultaneously monitored their fidgetiness, pupil size (an index of interest), heart rate, and other physiological signs. When Johnny lingered over certain highly charged material, the computer would note it for the school psychologist; when Jennifer started to squirm, the silicon instructor would pick up the pace or move on to the next lesson.

In the meantime, Farley warns, some of the most creative children are hot-wiring cars and running numbers, especially if they happen to have been born to the wrong set of parents on the wrong side of town.

"I believe that high creativity and delinquency spring from the same source," like Janus, an underaroused nervous system, Farley says. "So few good things are said about delinquents. But I work with a lot of delinquent kids, and I think of them as an untapped natural resource of creativity."

The evidence? First, there's a connection between the low-arousal sensation-seeking temperament and the thought processes that underlie creativity. Farley answers. Low-arousal people tend to do very well at parallel (simultaneous) information processing, associative, nonlinear logic, and something called "hypostatization and transmulation" (the ability to translate from the abstract to the concrete and back again). "Take the discovery of DNA structure," Farley says. "Watson and Crick had to work with the mathematics, the theory, the crystallography, and so on, but they didn't arrive at the answer until they built the little model of the double helix. They transmuted the abstract into the concrete. It's not unlike metaphorical thinking, which is essential for the highest levels of creativity in art or science."

Farley has, in fact, analyzed the nervous systems of visual artists with a tool called the two-flash threshold technique, which measures the brain's response to light flashes. A panel of art critics meanwhile rated the subjects' paintings. When biological readings and aesthetic critiques were compared, the low arousal artists were judged the most creative.

Now for the darker side of the story. Many studies have found a connection between the low-arousal, high sensation-seeking physiology and adolescent smoking, drinking, drug dabbling, sexual promiscuity, delinquency and other excesses, Farley reports. To add to this research file, the psychologist and his colleagues toted their two-flash gizmos into an institution for delinquent boys in Milwaukee, where they stumbled upon a *1984*-ish phenomenon.

Dividing the group into two on the basis of arousal scores, the researchers discovered that the low-arousal sensation seekers were a full seven times more likely to run away from the detention center. Did their physical makeup demand the sights, sounds, and razzmatazz of street life? Probably, says Farley. And his second finding was the icing on the cake.

"We figured that among the kids who escaped, the lowest in arousal would be out the shortest time because their tremendous stimulation hunger would get them into trouble right away," he relates. "That was the case. The runaways with the lowest arousal scores were picked up after only three or four days on the average. The higher-arousal kids, in contrast, were gone about a hundred days. When the boys' home study was repeated at a center for delinquent girls, virtually the same pattern showed up."

What makes some low-arousal types creative and others criminal?

Farley wanted to know, too. "We've just completed a study of low-arousal kids, in which we divided the group into high and low socioeconomic classes," he explains. "We found exactly what we expected. The probability of delinquency was greater in the lower-class group, of creativity in the higher-class group."

"I think that upper-middle-class families can provide for the low-arousal child's stimulation in socially acceptable ways," he extrapolates. "A lower class child with

CONTINUED ON PAGE 137

"I think I see my paycheck."

FICTION

THE END OF THE WORLD NEWS

BY ANTHONY BURGESS

Val Brodie woke to daylight and near tranquility, to find Willett, half-Scot, half-American hunter, looking down on him. "How do you feel?"

"A little bit better. That really was one hell of a night."

"Yes. I'm aching all over. So are the others, I should imagine. Oh, you mean the tide. I think we've had the worst of it now. Time and the hour run through the roughest. Perhaps I've given you that citation before. Shakespeare. Shall I bring you breakfast, or do you think you could manage to walk to the Pickwick Coffee Shop? A Mrs. Williams and her daughter are running it, enjoying it, too. It's on the floor below this."

"I'd better wash first."

And so they ate breakfast, in cheerful enough company. There seemed to be a general feeling among the breakfast crowd that

Part One of a two-part excerpt.

PAINTING BY
JEAN-MARIE POUMEYROL

New York the world for that matter had seen the worst Val held his peace After breakfast he would talk to Willett

He talked to Willett up in the living room over a bottle of Presidio cognac 'You know" Val said or I think you know—

"Yes?"

'That it's all going to be over"

Willett nodded vigorously with even a sort of satisfaction. The satisfaction of not having to leave the party before it finished?

"What precisely is going to happen?"

"There's going to be a brief period of peace and calm Optimistic clearing up, I suppose and a lot of free money around A lot of goods to be used up The sensible will know the worst from the fact of the general prosperity No more future to save for no virtue in thrift after all No money spent on war defense feeding the starving half of the world

'How about the moon?" Willett asked

"The moon?" It seemed on the face of it, a frivolous question "The moon" Val said. "is I think already being drawn into the gravitational field of Lynx Lynx's mass is very much greater than Earth's We'll miss the moon during our period of tranquillity No more destructive tides No poetry either No popular songs A lot of our literature will become meaningless"

"Not meaningless" Willett said 'Just sad My son" he said "is on the moon I used to get letters from him I don't suppose there'll be any more letters Has there been trouble on the moon?"

Moonquakes? Without a doubt And now the moon is dragged away from us But it will be back'

"With Lynx?"

"With Lynx" Val traced ellipses and circles on the coffee table with a brandy wet finger "Lynx is entering into its first year as a member of this planetary system It will be a brief year not much more than two hundred days There seems to be some ancient inexplicable law about distances having to be maintained between planets I've had it explained to me but I was little the wiser Remember I'm only a writer of fantasies not a scientist at all *Am*" he then said bitterly "Why do I keep saying *am*?

'Go on about Lynx"

"Remember that Earth itself goes round the sun Ironically enough our present position is favorable to us We could have been much closer to Lynx But in the fall the two solar orbits will be very close indeed The gravitational pull of Lynx which we're feeling already will be irresistible"

'I take it." Willett said "that this place where you were going was not exactly what you said it was"

"No A spaceship taking civilization in microcosm into the great darkness looking for a new light a fresh habitable planet"

'But you don't know where it is?"

"No and I don't care where it is You and I stay together"

Periodically in this fine tideless summer weather they would go out onto the balcony and look down at the rapid restoration of the old civic pattern The bone-dry streets had been cleared of the dead and other debris by a kind of pressed militia under brutish men with guns and mouths ever ready with insult and obscenity

Val and Willett were subsisting not too tastily on canned goods they had lugged from various hotel storerooms

In the clothes closets of their two bedrooms they had the entire spectrum of Hiss Soups Seth Low Tasty Stews Mensch Spongemeats Piccirilli Pasta Yums Moschowitz Kosher Puddings They had cases agony to manhandle of hard liquors and Marquis de Lafayette Good American Wines as well as some genuine vinous relics of dead France Spain and Italy The question, much debated over these same was What were they going to do?

"Frame's eyes looked poisonously on Bartlett an instant, and then they looked on nothing His head collapsed on his shoulder Dr Adams led the few who shed a tear"

Willett grunted not unkindly and said 'We might risk a stroll through the city I wonder if there's anything *really* happening down there' He went to the balcony to peer down at the street scene below People no cars "Christ" he said "there are lights coming on"

Val came to see

Somewhat furtively they went out into the corridor locking the door with the lockcard that had been kindly awaiting them on the hallway table when they first entered It was perhaps no surprise to find the elevator working This did not however elate Willett he did not altogether relish the end of the days of anarchy But in the reception area below they found nobody Some quirk of a time switch somewhere had brought light and power back to the hotel Cautiously they went out onto the sidewalk They walked south of a very green though treeless Central Park and found a few people walking dogs 'Mad mad" muttered Willett uneasily "It's almost as though it never happened' They saw signs of reconstruction work men working nights floodlamps already flooding On West Fifty-seventh Street they entered Jerry Towle's Bar and Grill a hostelry they could not recall having seen before It smelled of a very damp grave but there were drinkers and a cheerful barman

'Scotch" Val said "Very large"

"Very expensive," the barman said "There won't be no more scotch when existing stocks is finished friends There ain't no more bonny Scotland"

'Jesus" said Willett with awe "Look at that It's a television"

The other drinkers had been watching a blank crackling screen waiting Then there came the cheerful face of the President

'Christ he looks old" Val breathed

The President said "My friends I speak to you from the White House, Dallas Texas the present center of government until such time as a certain other White House in a certain city in the District of Columbia has been rebuilt and restored to its former glory We have had to say the least difficult times Now we count our dead in resignation to the will of heaven and in obedience to the law of life start to reconstruct our shattered country You will hear rumors put about by the forces of subversion for its own sake to the effect that the worst is not yet over that the destructive planet Lynx will plunge back into our alas now moonless sky and resume on a greater scale than before its wanton work of destruction This rumor is wicked and false"

Willett and Val looked at each other over their whisky One never believed a politician Or did one? Some of the drinking watchers were believing

Warmth warmth human warmth flooded in Scotch was fifteen dollars a shot Girls came in and Willett with famished speed had his arm round one gat-toothed giggler 'Honeybunch" he called her 'piggesnie heartsease bedworthy bundle-snuggle" and so on She giggled Then two men in uniform came in one with a clipboard the other with a pistol in a verdigrised holster Their uniforms were a sort of overwashed blue denoting some store that the floods had got at They wore cloth brassards which said NYC CLEANUP

"Work card?" said the man with the clipboard He was the overbearing sort who never learns humility not even from cosmic disaster

Never heard of work cards" Willett said 'Sounds like an unwholesome innovation I am an actor Freelance naturally I work when I'm able to work My friend here is a university professor"

Work card?

"What *is* all this? Val asked

'If you've no work card you get temporarily drafted into the city clean up force Thirty dollars a day and anything you find"

"What do we have to do? Val asked, capitulating

'Wait outside there with Officer Grogan till we collects ten Then you march"

In Sloansville Kansas lying quiet in a little white room in the CAT (Center of Advanced Technology) hospital his respira-

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tor plugged into the mains (the camp of course had its own generator) often under sedation. his heart action kept steady if faint through Dr. Sophie Haas Fried's administration of the drug Diegerficon 5. Professor Hubert Frame was informed regularly as to the progress of the great work by his daughter, Vanessa, who also told him frankly about the unhappiness of the team, the fervent and growing dislike and fear of Boss Cat Bartlett.

"I heard some story of exemplary harshness. I'd like to know the truth about poor young Nat Goya."

"Bartlett says it was the military going too far. But now there's O'Grady ready to try the latest astunomological techniques on dissidents. Maude Adams has been turned into a most efficient automaton. I never saw the necessity of an astunomotogist on the team."

"Hmm." Frame went in the faint voice that was nearly all exhausted breath and very little glottis. "It comes from the Greek for 'policeman.' *Policeman* sounds horrible of course. O'Grady is highly skilled in techniques of pacification."

"That sounds horrible, too."

"Yes. You think O'Grady ought to go?"

"I think Bartlett ought to go."

"We're not in charge of the project, Vanessa. We invented it."

"You did."

"But we're not in charge. We don't tell anybody to go. I think, however, I ought to have Bartlett in here."

"You won't *have him in*, Father. He's not a schoolboy, and you're not a school principal. He might one of these days *deign* to come in."

"I think I have certain rights. Perhaps if you told him I'm going to die. I am, of course."

"I'll ask. Request. Bow humbly and beseech him."

"I ought to have a talk with him. The Bartlett file—it just doesn't give any real idea. Does any file? I've been thinking of someone else—someone with a useless file. Val. I mean. Before I—go—"

"Don't talk about going. Don't talk about Val." She held back a sniff.

"He wouldn't have lasted five minutes with Bartlett, from all you tell me of Bartlett. Or—mad, isn't it?—Bartlett might not have lasted five minutes with *him*."

What a strange thing to say. You never liked Val. You despised him.

"I suppose I despised in him what I despised in myself—self-indulgence chiefly. My self-indulgence—tobacco, this project. His? Drink, fornication, science fiction. Perhaps I should have fornicated more and smoked less. Val at least had the grace to keep his science fiction between hard or soft covers. Do ask Bartlett to come and see me. I shall have to sleep soon."

When Vanessa was admitted to Bartlett's room she found him affable. "A drink?" he said, going to his fruit and vegetable juice cabinet. She shook her head and told him her father's request. "Yes," he said thoughtfully. "He has a certain claim on my time. Though he must have read the progress reports."

"He finds reading increasingly difficult."

"I'll go now. No need for you to come." He gave Vanessa no time to confirm or contest but marched out. When he got to Frame's room in the hospital next hut to Project HQ, he entered without knocking.

"Good of you to come, Bartlett. Do sit down."

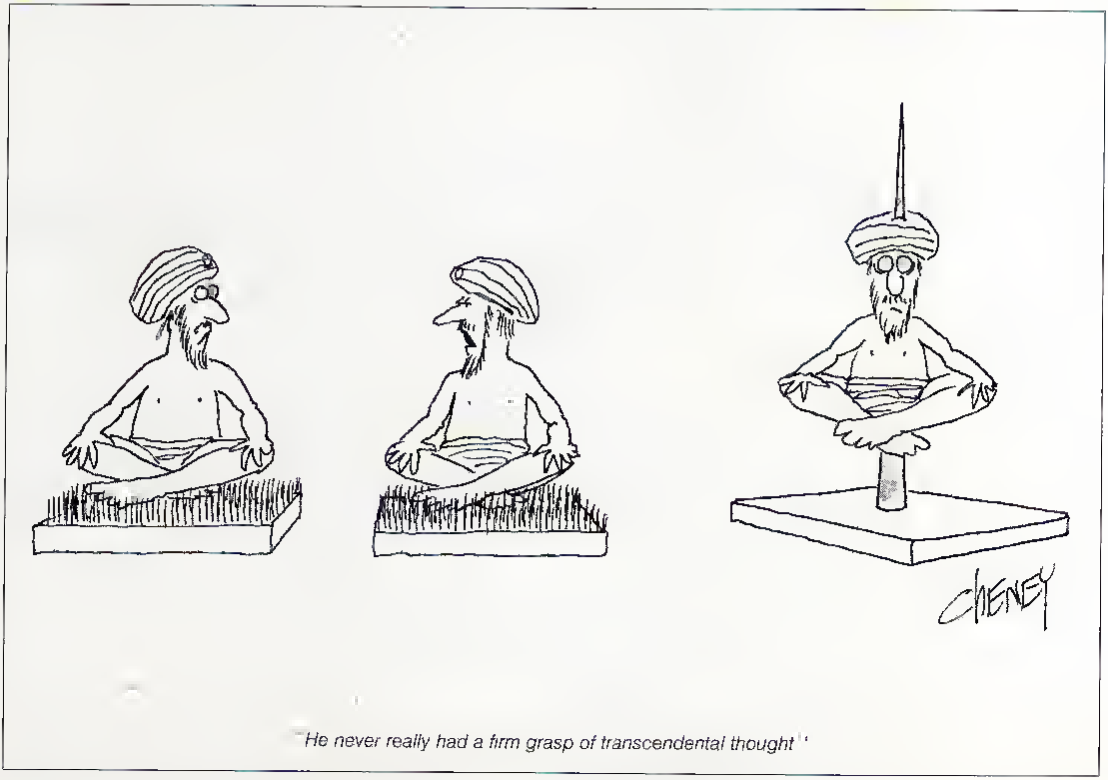
Barflett remained standing. He said, "Was there anything particular you wanted to see me about?"

"When will you be ready?"

"Six weeks to the day by my calculation. Everything is going as planned, except for some extra work still to be done on the gravity apotha. It seems to be a matter of accepting natural pull in the initial stages and then effecting a tangential glance-off, using Jumel's megaproagon."

"I've no doubt of your having every technical aspect of the venture under your iron control." Frame sighed. "Have you, however, ever considered what the venture is really for?"

Bartlett smiled meagerly. "The salvaging of Western civilization in microcosm. Your phrase, I think."



"He never really had a firm grasp of transcendental thought."

Ridiculous isn't it Bartlett? Bartlett smiled still though less easily How much do you believe about that civilization nonsense? When I spoke to the President months ago eons ago I spoke of man's achievements in science art architecture music philosophy False political rhetoric What do I care about such things? What do you care? Bartlett held his smile but let the uneasiness out like a slowly expelled breath This project was designed for the glory of Hubert Frame scientist and smoker But who will give him the glory?

When our *America* reaches America Nova the name Frame will be given to the first community established there That is already laid down in the conspectus

Again I ask what do you care? What's in it for you Bartlett?

I was chosen I do my duty

You do your duty Frame echoed with all the sarcasm his dyspneal voice could emit But what reality do you serve? Beauty? Love? Truth?

Power Bartlett said without hesitation Power is the reality Manifested at so many levels—the power of one heavenly body over another of one man over many—

Fifty men and women Frame said showing no surprise at Bartlett's avowal Not many to have power over

You're wrong A race of my making will colonize America Nova wherever it is

So your fellow astronauts are in for an unhappy time At least you don't give me the hogwash you give to them or so my daughter informs me A time of totalitarian discipline to be followed by an endless era of happy freedom

Unhappy said Bartlett having picked out that one word and disregarded the rest of Frame's breathy flow Human emotions are a great nuisance I have fine brains and fine bodies working for me—for the project I should say—but their emotions are a great nuisance a damnable source of ultimate sabotage Soon there'll be leisure to eliminate emotions—love hate that sort of hindrance that sort of nonsense What we take with us into space is not the whole of human experience just a part of it the useful part No literature music art Those are disruptive the stuff of dissidence Man will have a new chance A chance to understand the nature of power

God help them God help me I can't give you my blessing Bartlett But there are other ships going into space Bartlett other *Americas* Remember that

Space is very big said Bartlett Big enough for more than *Homo bartlettianus* Well then I go without your blessing Have you anything more to say?

No more commerce between us Bartlett None

You're probably ready to die I should think Bartlett said coolly Shall I—pull the plug on you? A corporal work of mercy as the Christians put it Pull out the plug wait five minutes push it back in again Professor Frame is dead A grand burial with the buglers blowing taps

"I should like" Frame said with equal coolness "to see the great ship before I go See what might better have been left as a dream—a hunk of science fiction Will you grant me that?

"Gladly Some day next month?"

"If I m still alive "

"Oh that can be arranged Keeping people alive is one aspect of power And with no more words he left

Edwina Goya was with her Aunt Melanie in Eort Worth Texas Aunt Melanie was a widow of pre-Lynx vintage not badly oft living for the day a player of bridge a great skeptic who called that big light in the sky *our* moon circling about it a lot of wicked nonsense She saw little of Edwina

Edwina kept to her bed nursing her belly (everything going just fine little lady Dr McBean said) and reading devotional po etry thinking in a confused way about Nat and what might have happened to him doubting totally that she would ever see him again She repeated to herself the name of the town Nat had uttered on the tele phone Sloansville It meant little as there were some fifty Sloansvilles in the United States And the trouble was that with the growth of the child in her womb the mem ory of Nat became dimmer in inverse pro portion To resume love Nat and herself for the brief time left? Less important than to ensure the survival of the child she car ried Otherwise what colossal wicked waste A child crushed in the ultimate ruins

Edwina Aunt Melanie said one morn ing bringing her ungrudgingly her break tast tray—cotfee toast papaya juice— ' Edwina Jonathan's coming home "

Jonathan?"

"Oh come child, *my* Jonathan your cousin Jonathan Private First Class Jon athan Putnam *my son* Now you'll have somebody your own age to talk to"

Jonathan was not Edwina s age he was somewhat younger demonstrating youth in pimples and gawkiness Edwina came down from her room to the fine homecom ing dinner Aunt Melanie had prepared

"Come dear eat" said Aunt Melanie 'Remember you ve two to feed "

Jonathan was slow at taking in the meaning of this He was still only a private first class in the Engineers But then his face beamed "Gee that s good news he said And when do we get a look at your husband Eddie?"

'Never as far as I can tell " Edwina sniffed "Never Excuse me I think I ll go to bed She got up from the table

' Oh come girl said her aunt But Ed wina could be heard running upstairs

What happened to him?" Jonathan asked ' Was he in the coast floods?

"No he was in a thing called Cat or something, and they wouldn't let him out She hasn t heard from him Of course as I keep telling her Jonathan he may be alive and well and get furlough ' Jonathan's mouth was open wide "Don t show what you re eating dear It s not nice "

'Cat you said? C A T? The moonship project? Gosh, Mom that's where I was "

"But you said you were working on elec trical generators in Kansas, dear "

"Yeah I know Mom I didn't say more cause it's still supposed to be you know Top Secret TS, as they call it We were told no talking about it on furlough But that's what it was the moon job Finished our work so off we march So that s where he is was Small world kinda What s his name?"

"A Spanish kind of name Not Jewish I know that just the opposite There was some great artist with it Edwina tells me Goya I said before Jonathan dear don t open your mouth like that "

"But I know about the guy Doc Goya He got out "

"So Edwina said He got out and tele phoned to this very house Then it seems like they took him back in again "

"Yeah they did that all right And then I was on the incinerator party He s dead Mom Gee that s terrible Eddie s hus band There was a lot of you know talk about it This guy they had in charge Boss Cat they called him, gosh he was terrible "

' I think she ought to know Jonathan You re the one who knows the truth You re the one to tell it, dear

Two evenings later Edwina consented to go out with Jonathan in his Poe Speedbird Edgar Allan as he called it and as other Poe owners called theirs

The Florentine Hotel was massive gaudy, not at all Florentine Its Italian connections were not at all northern It was after all owned by Gianni and Salvatore Taglia ferro who were very southern "I like it" Edwina said brightening as she sat at the huge leather-bound bar in the main gam bling hall People were gambling away C notes like quarters

A handsome broad sleek man in his thirties in space-depth-blue tuxedo white-toothed abundant black hair, armed with a controlling vitality she found disturbingly familiar came up to the bar and said to the head barman ' Put the new price plan into operation at nine-thirty Jack All brands

"Check Mr Gropius "

' Everything okay Jack?'

'Everybody thirsty Mr Gropius

The man laughed and turned away from the bar Edwina put a hand out and touched He turned politely smiling

' Your name ' she said ' is Gropius?

'That s right miss or madam Dashiel Gropius at your service Is everything all right?

'Are you " she could hardly get the words out, ' any relation of?

"I'm always getting that question " Gro pius said "The answer is yes My father is tor his sins or mine or somebody s the great Calvin Gropius "

And smiling sardonically but pleasantly

About these toy bombs what is their pretend-kill capacity?

CONTINUED ON PAGE 128

The famous "Leakey Luck" has guided this young fossil hunter to a find that may provide the missing link in the mystery of human origin

INTERVIEW

RICHARD LEAKEY

In November 1982 Richard Erskine Leakey, middle son of human paleontologists Louis and Mary Leakey, announced a new discovery 14-million-year-old fossils of a humanoid creature Only a few weeks earlier colleagues collaborating with Leakey had found fossils that were 8 million years old Both finds lie in the Samburu Hills a fossil-loaded area north of Nairobi, Kenya Either group of fossils could lay to rest one of science's most controversial issues the origin of the human line This is not Richard Leakay s first stroke of genius Starting with his conception, he seems to have been in the right place at the right time Like his father, Richard was born in Kenya, with Kenya in his blood

Louis Leakey was born of English missionaries in a mud-and-thatch hut in Kabete As a boy he had learned the bushcraft of the Kenyan grasslands from local Kikuyu playmates and was initiated into the Kikuyu tribe, among whom he earned the respected name White African In 1935 Louis married Mary an archaeologist and for the next 38 years this remarkable team unearthed hundreds of East African fossil treasures and toppled existing theories of human evolution

No less was expected of Richard As soon as he could walk he trailed behind his parents through the badlands of Olduvai Gorge, in neighboring Tanzania sometimes even crawling over desolate rock escarpments to search for early signs of man Louis and Mary encouraged him to track wild animals, build his own traps, or sit quietly and study the activity at a termite mound a bird's nest, or a waterhole Then at night Richard played beneath the camp lantern as his parents fingered their newest finds talking fervently of bones, stones, and human origins

By the time he was a teen-ager Richard was a competent naturalist, fluent in Swahili skilled at bushcraft an ardent Kenyan

PHOTOGRAPH BY ANTHONY WOLFF

patriot. But he was not a student. He preferred the out-of-doors and dropped out of high school to spend his days escorting visiting scientists around his parents' dig at Olduvai. Then, to become independent of his heritage, he entered the safari business. But this didn't last. Shortly after his twentieth birthday he set off to investigate some deposits in northern Tanzania and found a hominid fossil bone. He returned home an anthropologist.

Over the following months Leakey completed his last two years of high school and passed exams for entrance to a university in England. As restless as his father, however, he again skipped school to join one of Louis's research teams. But this wasn't satisfactory, either. As he recalls, "I wanted my own show."

In 1968 Richard's break came. He had accompanied his father to Washington, D.C., where Louis was presenting his plans to his sponsors, the Research Committee of the National Geographic Society. When the business was over, Richard astonished everyone by mapping out his own plans for a new dig in an unknown area of Kenya—around Lake Turkana. Then he asked his father's sponsors to foot the bill. Agog, they did, but with this warning: "If you find nothing, you are never to come begging at our door again."

If Richard Leakey is endowed with his father's perspicacity, he also acquired what has become widely known as "Leakey's Luck." Lake Turkana soon became a motherlode of fossil bones. And the same may be true of the new site in the Samburu Hills. In his own words, "It may provide the turning point in our science."

Leakey might be right again. For the recently uncovered fossils were deposited at particularly thrilling times in human history. It is known that our tree-dwelling ancestors, the dryopithecines, had died out 17 million years ago and that between 14 million and 8 million years ago new creatures, the ramapithecines, appeared. Anthropologists have long wondered whether the ramapithecines descended from the trees. Leakey's new fossils, dated 14 million years ago, may finally answer that question.

The 8-million-year-old fossils found by teammates in the Samburu Hills may prove even more exciting. Between 8 million and 4 million years ago there is a blank, a void in the fossil record. And directly after this void there are fossils proving that our ancestors walked fully erect. Thus the mystery period between 4 million and 8 million years ago may contain within it the day when our hominid lineage branched off from the ape stock and started down the road toward the modern human. This divergence from the apes was a key event in human history, and the 8-million-year-old fossil from the Samburu Hills may explain how such a divergence occurred.

Leakey is reluctant to talk about these new-found fossils for reasons of politics and protocol. But he readily discusses a second riddle: the events that happened after the fossil void. About 2 million years ago two varieties of hominids lived in Africa—*Homo* (the direct ancestor of present-day man) and *Australopithecus* (a hominid contemporary of *Homo* that eventually died out). Today among anthropologists there is a significant controversy over which group appeared first after the fossil void, *Homo* or *Australopithecus*.

This controversy, which the newspapers portray as a bitter argument, began in 1976 when Mary Leakey found footprints and fossil bones in Laetoli, Tanzania, that were over 3.5 million years old. She thinks both footprints and fossil bones represent the genus *Homo*.

Don Johanson, a paleoanthropologist and director of the Institute of Human Origins in Berkeley, California, does not agree with Mary Leakey. In 1974 Johanson looked for fossils along the Hadar River in the Afar Triangle area of Ethiopia. There he unearthed about two fifths of an ancient skeleton, which became widely known as Lucy. Some months later Johanson found the "First Family," remains of 13 individuals who he claimed had died together in some swift disaster. All were originally dated 3.6 million years ago (Mary Leakey's fossils date from that same time period). But Johanson thinks his bones from Hadar are early *Australopithecus*, not *Homo*.

Months later he examined casts of Mary Leakey's fossils from Laetoli (the ones she thinks represent early *Homo*) and announced that they resembled the fossils he had found in Ethiopia, *Australopithecus*. He categorized the fossils from both areas together and dubbed them a new species, *Australopithecus afarensis*. If Johanson is right, then Mary Leakey is wrong and her fossils can't be those of early *Homo*. Of course Mary Leakey has disagreed strenuously with Johanson's interpretation.

As does her son, although as you will see, for different reasons. And there are several reasons why Johanson's claims are disturbing. He has given the fossils a new name, thus fixing them in a new taxonomic category that would be difficult to change even if it were incorrect. More specifically, this new category represents Johanson's theoretical point of view that *Australopithecus* appeared first and then later on evolved into *Homo*.

And in the *New York Times* in December 1982 New York University anthropologist Noel Boaz reports that new dating techniques indicate that Lucy may be as much as 700,000 years younger than earlier estimates—2.9 million instead of 3.6 million years old. This could mean that the bones were wrongly classified. Johanson, however, stands by his original hypothesis and states that the new dating does not diminish Lucy's significance as a member of a distinct and more primitive species.

Richard Leakey steadfastly asserts that the First Family fossils vary too much to be those of one species. And the new dating methods add weight to his side of the Lucy controversy. It is possible now that Leakey's new discoveries in the Samburu Hills will answer some of these questions and end the controversy.

Leakey is not just good at finding bones; he has his parents' farsightedness as well. Although the press magnifies the glamour and mystery of fossil hunting, it also exposes the academic backbiting and jockeying for access to precious fossil-rich sites. Leakey has put an end to this competition in Kenya. Realizing years ago that Kenya has a national resource in paleontological remains, he influenced the Kenyan Parliament to establish a procedure through which non-Kenyan expeditions work in conjunction with the National Museum of Kenya. "This way," he adds, "there is a cooperative endeavor in all this."

When Leakey is not out digging for bones, he is the director of the National Museum of Kenya. Africa's largest natural history museum. He has set up a United States–based research foundation, FROM (Foundation for Research into the Origins of Man). "There are many young people in the U.S., Kenya and Europe who need money, and it is my hope to set up a source of support for them." It was during a recent visit to FROM that Leakey spoke about the Samburu Hills and other prehistoric subjects with anthropologist Helen E. Fisher of *Omni*. It strikes me that we might be on the verge of establishing when man

and the ancestors of the apes diverged and in what respect human beings have evolved. Do you think that's so?

Leakey: I think both mysteries will be solved during this century. I'm sure of it. The only thing I would ask is whether in fact man and the apes ever really did diverge. It is perfectly obvious from the genetic story, the molecular story, and the evolutionary story—documented by fossils—that the only things that really distinguish us from the chimpanzee and the gorilla are that we walk upright and that the present-day species of human is more intelligent.

We have much more complicated technology, of course, but the biological differences are so small that I wonder whether we should really consider ourselves as having split or whether it is just a question of documenting bipedalism [walking upright] and encephalization [brain expansion] in our hominid ancestors.

Omni: "Fossil of Humanoid Creature May Fill Major Evolution Gap" was the heading of a *New York Times* article last September [1982] discussing the discovery—made by you and Dr. Hidemi Ishida of Osaka University—of a jawbone and some teeth at a new site in Kenya. What exactly did you find, and does it fill a significant gap in human evolution?

Leakey: For three years Dr. Ishida and his team have been working in conjunction with some of my own people on the eastern side of the Rift Valley north of Nairobi, in an area that goes under the general designation of the Samburu Hills. It's a very large and rugged area and has a very complex geology, pockets of sediment in which there was the potential of fossil finds. And here Dr. Ishida discovered a piece of upper jawbone and five teeth, two premolars and three molars.

Omni: What is the present dating on them?

Leakey: Approximately eight million years.

Omni: That could be the critical transition period in human evolution during which the hominid lineage may have diverged from its ape ancestors. Are the teeth heavily enameled, indicating the change in diet associated with the adaptation to living on the ground as opposed to living in trees?

Leakey: The specimen is unlike the earlier dryopithecines. But I can't go into too much detail about it, because it hasn't yet been studied or compared. My concern is that Dr. Ishida should write up his discovery before anyone talks about it. It was his effort; it should be his credit.

Omni: What significance do you think the discovery will have?

Leakey: It may prove to be one of the more important fossils we've found in that it may provide a link in the relationship among the dryopithecines, the ramapithecines, and the later hominids. I say it *may*. I don't know whether it will, but it certainly has a morphology suggesting that it is quite unlike anything we've found before. More than that, I simply won't say because I don't want this to get carried away. But I will tell you that we now have a second site in the Samburu Hills that is older—probably about fourteen million to fifteen million years old. And we have recently unearthed twenty fossils—mostly teeth and jaws.

Omni: Who found them?

Leakey: A member of my team.

Omni: So you can talk about it?

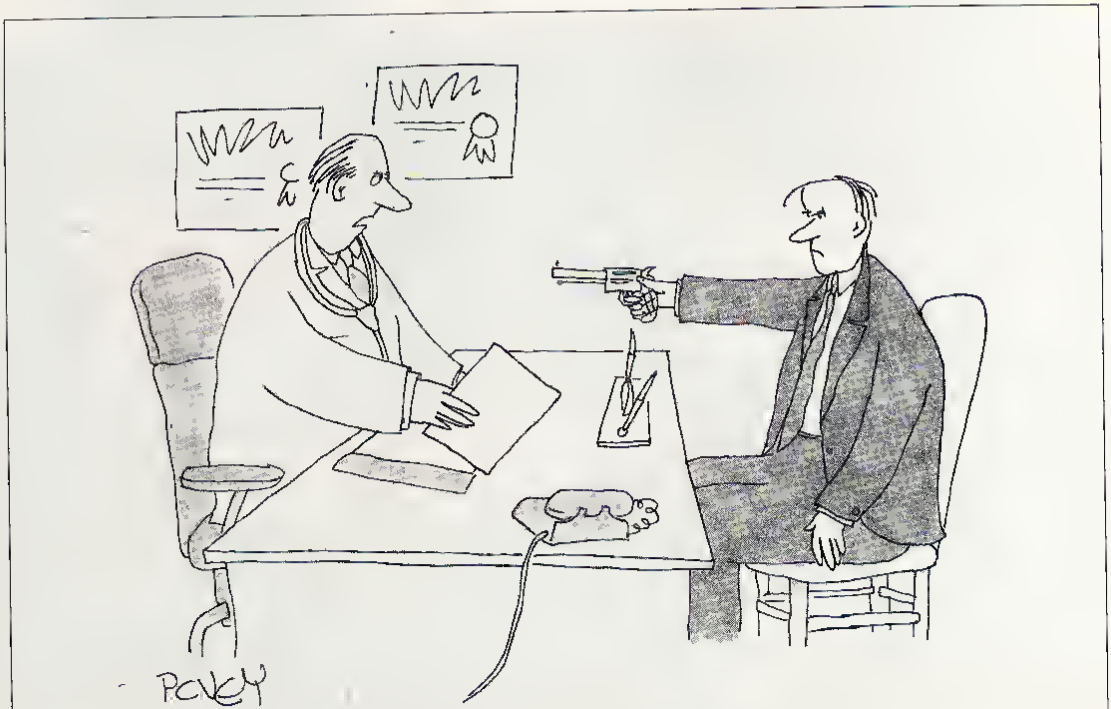
Leakey: No. But this is going to be a very, very exciting area. There are a lot of higher primate fossils there, and we may solve the question as to what *Ramapithecus* is.

Omni: It has recently been suggested that the Asian ramapithecines are ancestors of the orangutans. Do you plan to reinstitute the term *Kenyapithecus*, which your father originally proposed, for the fossils you have recently found?

Leakey: Yes. Other colleagues suggested it as a valid African genus, so we have begun to use the name *Kenyapithecus*.

Omni: Could your new kenyapithecine fossils be the earliest hominids, the so-called missing link?

Leakey: It's too soon to say. They could turn out to be a four-legged ape or an incipient hominid. They are quite unlike the Asian ramapithecines, though their teeth do display thick enamel. The environment in which the fossils were deposited may turn out to have been forested. More I will



"Okay! I'll give you six months more to live, but that's it!"

not say except that we've now finally got the site where we're going to obtain evidence to answer your question

Omni: Why are you so reluctant to talk about your own site?

Leakey: Because I don't think we need too much popular dramatization of discovery at this stage. It gives the public at large quite the wrong impression of what we're trying to do. This isn't a grand competition among egocentric scientists. It really is an attempt by serious scientists to sort out human origins. Although we have used publicity to try to raise money the publicity is so often wide of the mark in terms of the importance of the issues. I simply want to cool it.

Omni: Speaking of grand competitions, you probably didn't see the November fifteenth [1982] issue of the *San Francisco Chronicle* in which Jon Kalb—the geologist who discovered that the Awash Valley area of Ethiopia was rich in fossils—accuses colleagues of falsely portraying him to Ethiopian security agents as a CIA spy. Kalb has been absolved, but his career is on the rocks. Kalb hasn't mentioned any names, but his long-standing disagreement with Don Johanson is known to anyone who has read Johanson's recent book *Lucy*. And it was Johanson who took over Kalb's sites after Kalb was ousted. Moreover, in this same article Kalb claims that when Johanson found the famous three-million-year-old knee joint—which proved that by that time some hominid was walking totally erect at Hadar—he concealed it from his teammates, then announced it at his own press conference in Addis Ababa [the capital of Ethiopia].

Now the Ethiopians have proclaimed a moratorium on all digging. In fact, they asked more than one American paleoanthropologist to leave their country last summer. No one can get into the Awash Valley. What are the Ethiopians doing?

Leakey: Basically, the philosophy of Ethiopia is the same as the philosophy of Kenya. We are young developing countries facing great economic difficulties. We have very few resources, and we simply don't want the resources of paleontology and archaeology—part of the cultural heritage of our country—to be overexploited by foreigners all at one time. In Kenya we welcome foreign groups to carry out research, but it must be done in a way that is acceptable to our national philosophy of development. I think Ethiopians are very similar to Kenyans in this respect. As I understand it, they are simply thinking through appropriate legislation—appropriate procedures that will enable the Ethiopian government to monitor the exploitation and development of this scientific material.

Omni: What is your reaction to this Kalb-Johanson incident?

Leakey: I think it is tragic to have to fight about this issue in the popular press. And if one is criticizing another person for being unethical, it doesn't help to be unethical oneself. To attack Don in the press won't

help scientific research in Ethiopia

Omni: You and Don have had your own conflicts. Do you think the press made too much of them?

Leakey: Certainly far too much. But I'm not sure that the press was unaided. I don't know. I certainly have always refused to talk about this issue to the press. I have never studied the Hadar material. I've simply expressed the professional view that Johanson has one explanation of its significance, but that there are other explanations. I've always felt that the material simply didn't warrant a dogmatic position.

Omni: I remember one moment—on Walter Cronkite's television program, *Universe*—when you reacted to Johanson's theory. Johanson had just diagrammed his model of human evolution. Oldest in his scheme were his *A. afarensis* fossils—Lucy and the First Family—as antecedents of *Homo* and the later australopithecines. Then, according to his diagram, *A. afarensis* split off, leading to *Homo* on the one hand and to the ultimately defunct australopithecines on the other. You drew an X through the whole chart. Did you do so because you feel that *Homo* occurred earlier than this—that all of the australopithecines, including *A. afarensis*, are a sideline that never led to man?

Leakey: No. I don't think that's the position that was taken, and yet I do think there has been a misunderstanding of it. My concern is simply that the sample from Hadar is large. There are many individuals, and there is a lot of variation among the individuals within the samples. It's been lumped with the sample from Laetoli, a thousand miles away. But there is so much variation within the collection that it is difficult to accept all these bones from such distant places as a single species. Furthermore, we are told that all these fossils represent a single species because the reputed First Family assemblage all died together because of some catastrophic event. How does Johanson know this? These fossils could have been deposited at different times, over a period of months or years, by a carnivore that was selecting this particular species, or this particular group of a species, to feed on. Certainly this assemblage doesn't speak to me of a single family that all died in one place simultaneously.

Omni: So, in other words, *Australopithecus afarensis* could be

Leakey: Two species instead of one.

Omni: Which two?

Leakey: I don't know, but if you've got two species later on, maybe these are the antecedents of both later species. All I've said is it's too soon to be dogmatic. Moreover, I have never, not for one moment, suggested that what we are calling *Australopithecus* wasn't ancestral to *Homo*. What I've said is, we seem to have one australopithecine contemporary with *Homo* at Lake Turkana from around three million years ago. This one clearly cannot be the same one that is the ancestor of both man and *Australopithecus*. You have to go further back to find the earlier australopithecine type that will be the common ancestor of man and later *Australopithecus*. Don claimed he found it. I said maybe he did and maybe he didn't. So, to adjust to that, he pushed back the dates of his fossils.

Omni: And apparently these dates now have come forward again. How do you feel about that?

Leakey: Well, I think we'll go back to dating originally proposed, which placed some of the Hadar material at close to three million years old, and some—like Lucy and the First Family—at a slightly younger age, perhaps 2.5 million or 2.4 million years. If those new dates turn out to be correct, then it becomes very difficult to accept the notion that one species runs from 2.4 million to 3.7 million years with all that variation. It is also difficult to accept that it represents a single common ancestor of *Homo* and of the later australopithecines, particularly as, by approximately 2.5 million years ago, we also have other hominids in East Africa (later australopithecines) that are as old as the youngest parts of the Hadar sample, but are different. With the new dating, I think the whole theory falls apart.

Omni: Casts of the Hadar material are apparently beginning to circulate among other anthropologists. What is most interesting is that they are looking at exactly the same bones and arriving at entirely different points of view.

Leakey: This always happens if your sample is too small. The story of human evolution is one of how our knowledge is gathered. There is discovery, then debate, further discovery and the debate lessens, further discovery and certain things are accepted. It's only when the fossils have been fully described and casts have been distributed that the debate begins. That's where we are now. I think more fossils will be found, perhaps at the Hadar, and I hope elsewhere as well. The sample will increase, the debate will crystallize, and subsequently more precision will enter into the discussion.

Omni: Why hasn't anything been found dating between four million and eight million years ago—the period many believe to be the critical time for the divergence of the hominid line?

Leakey: The sites are not well exposed in the part of the world I'm from, primarily because heavy rainfalls in prehistoric times have washed away or covered up a lot of the earlier deposits.

Omni: Where are they exposed?

Leakey: We don't know. I have a feeling it's up in Ethiopia. But the sites are somewhere, and we will find them.

Omni: Do you think the next five years will be fruitful?

Leakey: I think the next five years are going to be as exciting as the last ten in terms of new thoughts, new discoveries, and clarification. Yes, I'm sure of that.

Omni: Would you trace your theory of the

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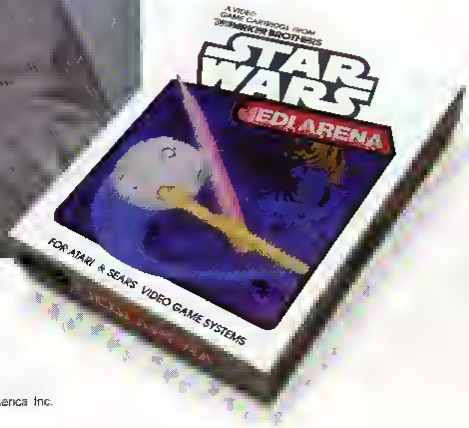

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evolution of bipedalism and brain reorganization, starting with the environment of twelve million to fourteen million years ago?

Leakey: Much of Africa—and particularly East Africa, which is now characterized by desert scrub, a few forests, mountains and rivers—was probably much wetter then. It probably had much more vegetation and although there were probably areas of marsh grass and swampland in the lowlands, the habitat was really better suited to forest animals than to open-country animals. But during this stage there apparently were some significant changes in weather. These were perhaps brought about by global changes—partly by the uplifting of East Africa to create major mountain zones. Whatever the cause, the effect was to create a number of new econiches in a period of just less than twelve million years. So some twelve million to nine million years ago, the savannas were appearing. Into this niche moves one of the large apes. Presumably it will evolve and change form. And I would think the first adaptation would be bipedalism. I think we have to look somewhere between five million and seven million years ago for the development of bipedalism, because it is so well established from both the Laetoli footprints and the Hadar remains, as having existed by four million years ago. Finally this adaptation ties in with the development of the antelopes and pigs, some of which went through a series of similar speciations around five million to six million years ago.

Omni: Why do you suppose man adopted bipedalism?

Leakey: It wasn't for any one reason. I think it was an intricate complex of evolutionary behaviors. First of all, those early hominids were probably preadapted to it. Their ancestors had lived in the trees where they had spent most of their time upright, manipulating objects with their hands. On the ground they may have stood on their hind legs to hurl projectiles or to brandish branches at predators. Surveillance would be another antipredator behavior that would tend to favor an upright stance. If they stood up on their hind legs, they would of course have had a wider view of their surroundings. A third element was an improved ability to carry objects. Walking upright, they had free hands. The same stick waved at predators also could have been used as a tool to dig up roots. And gradually as they became more bipedal—for several interacting reasons—the very changes in the feet and pelvis would have forced them to evolve even more in that direction.

Omni: Noel Boaz recently suggested that an increase in relative cranial capacity occurred among hominids about five million years ago. This would coincide with your dates for the beginning of bipedalism. Do you think encephalization started that early?

Leakey: There could have been a general increase in relative brain size to go with bipedalism. But I'm not sure that bipedalism necessarily calls for being smart. So if there was initial encephalization around five million years ago, as Boaz suggests, it certainly wouldn't have done any harm. But I think that encephalization—the speciation event that I think led to the development of *Homo*—came later, perhaps about three million to four million years ago.

Omni: What do you think stimulated brain expansion and produced the *Homo* line?

Leakey: I think it came about because of increased meat eating after initial scavenging. You can't eat sufficient amounts of meat to survive unless you've got sharp implements to cut with, because you can't get through thick carcasses. I think the regular use of stone tools—in fact, the origin of technology and culture in a human sense—is related to that change from scavenging.

Omni: What do you think made those hominids turn from scavenging to hunting?

Leakey: The unreliability of other hunters and the fact that predators sometimes contracted feline flu or other feline diseases and then died off. Suddenly our ancestors were left without any source of meat. So they had to start supplying it for themselves. And finally perhaps the feedback from eating meat, making tools, looking for food, and selectively scavenging from successful carnivores got civilization truly under way.

Omni: When do you think language began to evolve?

Leakey: I would think speech was being selected for at about the same time.

Omni: So you would place the development of *Homo* somewhere earlier than three million years ago and the divergence of the hominid line from the ancestors of the apes somewhere earlier than four million.

Leakey: I suspect between eight and four is probably the time. My preference is around six. It's just a hunch.

Omni: As you know, Vincent Sarich and Allan Wilson, of Berkeley, have developed a method of isolating blood proteins of related species, counting the look-alike qualities and establishing when similar species separated. Through this technique they originally established that man and ape had diverged four million years ago. They have been in the lab looking at DNA while you have been in the field looking at bones. What do you think of their method of tracing what's called the molecular or biological time clock?

Leakey: I think the technique is intriguing. As scientists start looking at some of the microstructures—the DNA molecules—we are going to understand early man better. Moreover, their calibration point is very far back. Apparently the clock started ticking at about the time the prosimians [a major group of small furry primates] diverged from the rest of the primate stock. That's forty million to fifty million years ago. So the fudge element of one or two million years doesn't worry me. We are not in disagreement. Perhaps when the technique was first put

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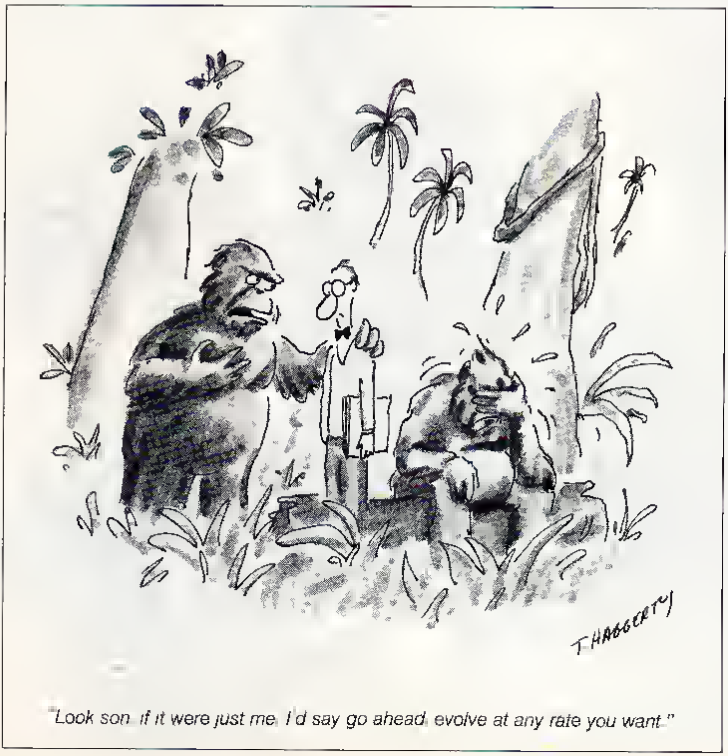

"Look son, if it were just me, I'd say go ahead, evolve at any rate you want."

FROM RUINATION'S FIRES

BY DAVA SOBEL

In the aftermath of the war, I am searching for one hope or, failing that, for honor

PAINTINGS BY TONY ROBERTS

Your Highness, it grieves me to report that we have lost the recent war. Missiles from the new world built by descendents of Earth's East exploded the star nearest our planet, and too many of our number could not escape the ensuing fire storm. Our outpost armies were made to age precipitately by a process I do not understand, becoming blinded and enfeebled in a few moments of our ordinary time. Also, those of our ships that were disabled in flight became immediately mired in their own trailing rot. I can only hope that those of you at the highest levels of command are aware of these weapons and can defend yourselves. Such reconnaissance work as I have been able to accomplish con-

vinces me that nothing salvageable remains here. Not even a foundation upon which to dream of rebuilding. Survivors carrying this message to you are colonizers who rescued most of our seed stocks and selected frozen embryos from the best herds and flocks. Although I cannot assume any credit for their success, I did take the precaution of advising them to prepare our largest transport when I noticed aberrant signals coming from the direction of one of the pulsars we regularly observe. I myself, of course, cannot participate in the resettlement of our people. I have stayed behind, as is right. If I am captured, it is what I deserve. I will do what I must. I feel your eye upon me. ∞

SECRETS

CONTINUED FROM PAGE 56

New York businessman who was using a computer terminal in his office to steal information from a rival firm in California. By using a password that had been supplied to him by a member of the firm, Brown said, "he was able to get into a special time-shared network and read his competitor's marketing surveys, budget forecasts, pricing plans—all the things that are extremely sensitive and would give a competitor a marketing edge."

The California company first realized something was wrong when an employee noticed it was being billed for network use at 4:30 A.M. Local police brought in the FBI. "We were able to trace it to New York," Brown recalled. "So, when we saw him on the line, we went to the office with a search warrant and arrested him."

The task of keeping up with computer criminals can only get harder. To date, most have relied on deception, conning gullible employees into giving them passwords and account numbers, for example. As computer security improves, the opportunities for small-time crooks will diminish. In the future, however, more ingenious individuals may find ways to crack even some of the best-guarded systems.

Experts emphasize that there is no such thing as a closed computer. Or as Donn Parker, a computer-crime specialist at SRI International, puts it, "The perfectly secure computer is one you can't use." Any computer that has been programmed can also be reprogrammed or deprogrammed, if you know how to gain access.

Many computers are vulnerable to manipulation through something called remote diagnostics, that is, using one computer to troubleshoot problems in another. Because it is costly to train technicians and keep them in the field, many computer manufacturers now diagnose the ills of a customer's system over a phone line. When a purchaser's machine goes down, it can be connected by phone to the manufacturer's computer for a complete diagnosis and prescription. This keeps the machines running and at the same time holds down maintenance costs. But remote diagnostics can also serve an unscrupulous operator as a cover to extract information that might later be sold to a competitor.

One specific danger is that the diagnosing computer could implant subversive instructions into its patient. It could search out a crucial bit of information, for example, and hold it for an infiltrator until the next time he returned to do maintenance.

For these and other security reasons, the Pentagon prohibits remote diagnosis on any of its computers that handle classified information. Machines that process top secret data must be housed in special rooms completely lined with copper. For power, either they must tap an inside source or technicians must prepare a commercial line so that the electric circuit does not inadvertently transmit information outside the room. No telecommunication links of any kind are allowed; all data must be carried into and out of the computer room by hand. As a further precaution, the machine's memory must be purged three times after a classified program has run to be sure no secret data remain in the system.

The NSA and the Pentagon can afford the luxury of security measures like copper-lined rooms. But what can the rest of us do to protect our data and our privacy?

Adleman believes cryptography holds the answer. Indeed he foresees a day when encryption will be absolutely indispensable in protecting our freedom of speech. "But," he adds, "the control of that encryption must be in the hands of the user."

Adleman is one of several researchers (Stanford's Martin Hellman is another) who have been working on a fascinating concept called public-key cryptography. (See "Unbreakable Code," September 1980.) With most ciphers the decoding key is simply the inverse of the encoding key. The beauty of public-key systems is that the encoding or public key is so different from the decoding key that one does not have to keep it secret. You could publish it or transmit it openly. Anyone could use it to send you an encrypted message, but only you would be able to decipher it. Think of it as a strongbox locked with one key but requiring a second key to open it again.

Public-key cryptography is still in the conceptual stage, where new schemes are being suggested and old ones are being tested and sometimes broken. Last year, for instance, one mathematical formula for public-key cryptography advanced by Hellman in 1976 was cracked by Israeli mathematician Adi Shamir with some assistance from Adleman. Former NSA director Admiral Bobby Inman also revealed his agency had similar success in finding the flaws in it. Though disappointed, Hellman was philosophical. "It only helps to emphasize what I've said before when people were calling my system unbreakable. The important thing we have to do with new systems is test them."

This discovery did not invalidate the public-key approach. Inman himself has said there are public-key systems that the NSA still considers "very secure."

Will encryption be enough? Abbott reflected for a moment, then said, "So you encrypt your file to keep me from stealing it. Well, it turns out that I don't have to steal it. All I have to do is get in there and encrypt the data all over again." He was grinning now. "Then I'll offer to sell you the key—maybe for a million dollars."

So anyone with important data in his computer must be on guard constantly. If we, as a society, fail to protect our right to privacy in the future we could see our freedom jeopardized, perhaps even lost. "In such a future," Adleman said, "we'll be on the wrong side of a one-way mirror, and we'll never know who's watching us." ∞

PHOTOGRAPHY

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process, you change the art as it was conceived in the camera. You must accept what comes from it." To her, scanamurals are in themselves a new art form and one that has great possibilities for public art. "Every wall could be a living museum."

The prospects for reproducing the world's art treasures on a massive scale are awe-inspiring. Shopping centers now can, and do, have Renoir's *Boating Party* in a size that can be seen from the ends of their parking lots. Impressionists reproduce well because they're loose. Images and the scan lines don't show. An Old Dutch Master, with its fine-pointed texture, is apt to be rendered less accurately, though it could be winsome nonetheless.

Scanamurals lend themselves to outdoor displays better than photographs do, because they fade so little. The marquee for *Evita* in New York City was done by scanamural on paper, pasted onto plywood paneling and thoroughly laminated. It shone for months. Outside the Metropolitan Museum of Art, in New York City, a year ago there waved a scanamural of great size, proclaiming the "Turfan Exhibit" with an image from a fresco. It was done in a spirit of experiment, and it appears that further experiment will be required. Although coated and waterproofed, the material sagged and ripped, beaten by the New York wind. The lettering was not as clear as in an appliqued banner. But the National Gallery in Washington did splendidly with a Gauguin banner, and the future for masterpieces appears bright.

The possibilities for scanamural use have only begun to be explored. For instance, we have yet to see one of San Francisco dealer Bob Rinehart's little projects: "Someday I'm going to have someone take a full-length picture of me in the nude. Rinehart muses, 'which I'll have printed as a scanamural onto canvas. And then I'm going to have it made into a suit.' Here's lookin' at ya, Bob. On you, or on the walls, scanamurals have made photography life-sized at last. ∞

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"Three silver-suited aliens hovered above the ground in a beam of light and conversed with an American"

ANTI-MATTER

UFO UPDATE

On the night of December 30 1980 a spaceship supposedly crashed in the forest near the Bentwaters / Woodbridge Royal Air Force Base a NATO installation in England Three silver suited aliens, each three feet tall and hovering above the ground r a beam of light repaired he damaged raft while conversing with an American base commander Four hours later repairs complete the spaceship shot off at tremendous speed

A year later local UFO bu Brenda Butler learned of the incident from two U S Air Force men stationed at the base One claimed to be an eyewitness the other said he had been dispatched to the scene after the spaceship lifted off and could offer only hearsay

In fear of losing their jobs both men asked Butler to hide their identity but she couldn help revealing the unlikely tale to her friend housewife Dot Street a member of the British UFO Research Association (BUFORA)

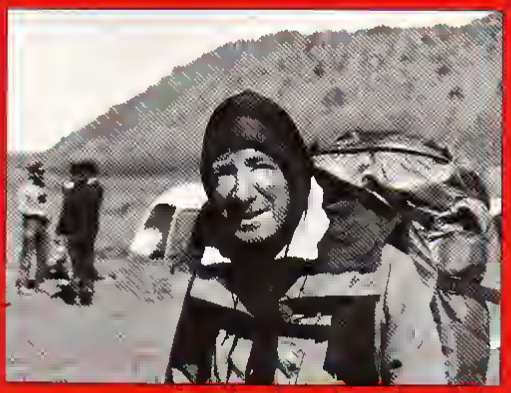
Intrigued and hoping to confirm the report the two women interviewed area foresters and farmers who reported strange lights and loud bangs over the air base the day of the crash They also met Woodbridge s British liaison officer Squadron Leader Donald Moreland He says I told them I didn t know anything and they went away

But Moreland now concedes there was a minor incident one that he reported to the British Ministry of Defence a couple of years ago 'There were a few lights flipping amongst the trees ' he notes but any talk of humanoids is just absolutely ridiculous

Colonel Ted Conrad the base commander alleged to have spoken with the aliens has a more dramatic version of the story At 10 30 on that fateful night he recalls five Air Force policemen spotted lights from what they thought was a small plane descending into the forest Two of the men tracked the object on foot and came upon a large tripod-mounted craft It had no windows but was studded with brilliant red and blue lights Each time the men came within 50 yards of the ship Conrad relates it levitated six feet in the air and backed away They followed it for almost an hour through the woods and across a field until it took off at "phenomenal speed

Acting on the reports made by his men, Colonel Conrad began a brief investigation of the incident in the morning He went into the forest and located a triangular pattern ostensibly made by the tripod legs He claims that he never observed any aliens but he did interview two of the eyewitnesses and concludes Those lads saw something but don t know what it was

Conrad s chat with his men was the only official probe ever mounted and it seems unlikely that we ll ever learn more But when Dot Street of BUFORA was asked whether she believed this incredible tale she opined ' I ll stick me neck out and say yes ' Street s colleague BUFORA director Jenny Randles ventured a theory of her own however The alien spaceship she suggests is just a fiction leaked by the U S Air Force to cover up the crash of a plane carrying nuclear bombs —*ERIC MISHARA*



IN SEARCH OF THE REAL NOAH'S ARK

Colonel James B Irwin (above) was the daring young astronaut who drove the lunar rover along the surface of the moon i 1971 Today back on Earth he is pursuing an equally challenging mission searching the cliffs of Mount Ararat Turkey for the ark allegedly built by Noah

The *Apollo 15* veteran founder of the High Flight Foundation a Christian faith ministry in Colorado Springs began looking for the ark after meeting Eryl Cummings of Farmington New Mexico Cummings who has spen 40 years seeking biblical artifacts thought that Irwin s fame would persuade the Turkish government to permit an expedition He was right The Turks even provided a military escort up Ararat, which is j ist a few miles from the border between the USSR and Iran

Originally I thought d teke eight people with me Irwin says since eight traveled in the ark But he wound up selecting a party ot 2 men with whom he combed the north slope of Ararat three separate times

Irwin was injured during the first trip last August Cut off from his group he was apparently struck on the head by a rock and then fell o the bottom of a canyon where he lay unconscious for about five hours He came to long enough to crawl into his sleeping bag and the others found him the next morning He recovered sufficiently to return in September, though his energy ' wasn t up to par " and the third trip in October was cu short by a heavy snowfall

"The ark thus far has eluded us," Irwin admits but next summer Lord willing we ll search the northeast side

Dava Sobel

' What are we here for?
—Calvin Coolidge

CONTACTING THE DEAD

You don't have to go to a seance to speak with the dead Those who have passed on speak with us regularly during the course of our daily lives

That at least is the startling implication of research recently completed by Julian Burton ot the West Side Center for Growth and Counseling in Los Angeles Burton, who saw a vivid apparition of his mother shortly after she died, discovered the universality of such visions when he conducted a poll on the subject The psychologist whose work earned him a doctorate from the International University of Los Angeles began by distributing questionnaires to psychic-research groups Ot those who returned the questionnaire a whopping 76 percent reported a postmortem contact at some point in their lives

Thinking that perhaps his population was biased Burton distributed another group of questionnaires to students in several psychology departments at Los Angeles County colleges These results were comparable In tact no fewer than 55 percent of the students at one rural Christian college reported contacts with the deceased And older respondents reported such experiences only slightly more commonly than did people aged eighteen to sixty

Burton reports that most people glimpsed the visitation in the form of a subjective impression or an especially meaningful dream Yet close to 20 percent said they saw apparitions and some 11 percent heard the voices of the dead speaking to them As might be expected most of the informants reported that the experience markedly changed their attitudes about the possibility of life after death

Burton is still not sure what his data mean Instead of trying to determine whether these contacts are really communiqués from the dead he suggests we ask why so many people are having these experiences and why they so commonly consider them valid —D Scott Rogo

' It is better to understand a little than to misunderstand a lot

—Anatole France

VENUSIAN GARDEN

Venus was long considered the garden planet, a world of rain forests, gigantic tree ferns, mermaids and towering clouds. But years of research clearly refuted that image, revealing instead a scorching wasteland burdened by enormous pressures, temperatures reaching 900°F and deadly quantities of carbon dioxide.

Now, however, a French space scientist says he can convert Venus into the Eden we once believed it was. All we need to do, says astronomer Christian Marchal, of the Ecole Polytechnique in Paris, is shield the planet from the sun until it's cool enough to support life. How? Just place the hostile orb in the shadow of clouds formed by exploding asteroids.

According to Marchal, scientists can get an asteroid near Venus by vaporizing part of its interior with small nuclear bombs. The vaporized rock would then escape as gas, propelling the asteroid forward with a type of nuclear jet engine. Once steered into position between Venus and the sun, the asteroid could be blown apart with larger nuclear bombs. The resulting dust cloud would block the sun and cool Venus down by a few degrees a week, making it temperate enough for human habitation in a decade.

As the planet cooled, he adds, most of the lethal carbon dioxide would drop out of the air, combining with Venusian rocks to form earthlike quartz and calcite.

The only task left then would be creating breathable air—easy enough once genetic engineers developed microbes that could secrete oxygen.

Eventually, Marchal concludes, the dust cloud would settle, casting a shadow over the planet's central latitudes. But two lush sunlit regions, each about the size of Europe, would be left at the poles.

—Judy Redfearn

"I do not think that the whole of the Creation has been staked on the one planet where we live."

—Sir Arthur Eddington

LIFE IN HOLLYWOOD?

The first sign of early *Homo sapiens* was discovered in 1868, when scientists stumbled across the bones of Cro-Magnon man in a rock shelter near Les Eyzies, France. The 35,000-year-old remains were buried alongside chisellike tools and stunning works of art—sure proof of prehistoric civilization. When researchers later found similar specimens nearby, they concluded that intelligent life may have evolved in southern France.

Now Arizona archaeologist Jeffrey Goodman (above) has another theory. He claims that Cro-Magnon-like men, and civilization itself, evolved in Hollywood, California—or at least a stone's throw away. His evidence? Fossils and tools that indicate the presence of intelligent life in the Los Angeles area as long as 47,000 years ago.

Goodman notes that archaeologists on California's Santa Rose Island, for instance, recently unearthed a barbecue pit containing charred mammoth skeletons, spearheads and carving tools. When UCLA radiocarbon dating expert Rainer Berger analyzed the remains, he found that they were at least 47,000 years old.

Since then, Goodman contends, archaeologists have also begun to "raid California museums filled with fossils discovered long before radiocarbon dating was ever developed. Researchers scavenging the San Diego Museum have thus far found one 47,000-year-old Cro-Magnon-type skull from Del Mar Beach and another said to be 45,000 years old from nearby Oceanside.

To New York City anthropologist Helen Fisher, Goodman's theory is ridiculous. *Homo sapiens* like Cro-Magnon man, she says, "probably invaded North America when the Bering Strait—a narrow waterway between Siberia and Alaska—froze to form an ice bridge tens of thousands of years ago.

But Goodman, who expects skeptical scientists to scoff at his theory, says, "America is still number one. Heck, we were the first intelligence on the moon. So why shouldn't we be the first intelligence on Earth, too?"—Peter Rondinone

"You must become an ignorant man again and see the sun again with an ignorant eye and see it clearly in the idea of it."

—Wallace Stevens

FLATLAND REBORN

Imagine a hair-thin disc floating in a universe with only two dimensions—length and width. Then picture the rim of that disc swarming with inhabitants from cats and people to juniper trees.

This sort of two-dimensional fantasy planet was first suggested in 1884 when London clergyman Edwin Abbott Abbott published his satirical novel *Flatland*. Though the book revealed almost nothing about the nature of life on such a world, it *did* pique the imagination of Canadian computer scientist Alexander Dewdney who several years ago created his own 2-D planet and named it Astria. After hours of intensive thought Dewdney managed to give the 2-D planet its own laws of physics and chemistry, its own ecology, and even a race of Astrians.

Creating a universe in two dimensions, Dewdney reports, was not easy. Screws, for instance, can't exist without all three dimensions, and neither can wheels with axles. "You can't even design animals with a normal digestive tract," he notes, "because in two dimensions any opening that passes all the way through the animal cuts it in half."

Given such stringent ground rules, Dewdney remarks, the planet of Astria could only be an infinitely thin pancake of molten rock. A single flattened continent surrounds most of its rim, and an ocean covers all the rest.

The Astrians themselves (one of them is standing with Dewdney in the picture at left) are perfectly triangular with two legs at the base and one eye on each side of the upper point. Without three dimensions they can't walk around one another; therefore, when two of them meet, one must climb over the other to pass by. Their social order centers on the question of who climbs and who is climbed upon.

Though Dewdney did most of the early work on his planet, many others have contributed. English physicist Roger Penrose devised an ingenious set of gears to operate 2-D machinery. Gerontologist Alex Comfort created 2-D beings that could move with ease. Others added a flat steam engine and a chess game using only the king, knight and rook.

One critic pointed out that Astria's inhabitants had fatal flaws. So Dewdney redesigned them a bit. To mark the change, he also renamed the planet; it is now called Arde.

Dewdney's notes about Arde have now grown enough to fill a book, and soon they will. As yet untitled, his account of Arde will be published next autumn by Poseidon Press and Washington Square Press in the United States and by Pan in England.

—Doug Payne

"The number of ways for persons to occupy time is probably more unlimited than the number of ways in which matter occupies space."

László Moholy-Nagy

[illegible] NATION ON FILM

Psychotic hallucinations have been called demons of the mind. But now news from the Soviet Union indicates they may be more than that. Psychiatrist G. P. Krokhalev says he has successfully photographed the visions of the insane.

Dr. Krokhalev's techniques are simple. He places skin-diver's goggles over the eyes of his actively hallucinating psychotic patients, then covers the goggles with a camera. The patients are instructed to concentrate on their hallucinations while photographs are taken of their eyes.

The resulting prints, Krokhalev says, show shadowy forms that resemble the contents of the hallucinations. Though the forms are not well defined, he contends, a trained eye can recognize them.

Krokhalev's critics charge that these "forms" are only Rorschach-like misinterpretations. But after visiting Krokhalev in his office in Perm, Dr. Stanley Krippner of the Saybrook Institute, in San Francisco, has concluded that, while the forms may not be produced by the cornea, they *do* warrant more extensive examination.

Krokhalev says he's meeting this challenge. He's trying to tape-record his patients' auditory hallucinations. He's also eager to find out whether he can project visual hallucinations onto a television screen.

—D. Scott Rogo

LAST CHILD

CONTINUED FROM PAGE 67

thousand points—appeared in vivid combinations of purple, pink, puce, red, lemon and turquoise. Ito deliberately refrained from telling Chip that the bunker labeled 200,000 represented Cheyenne Mountain.

In the kid's first round, undertaken even before these explanations, he lost at least a dozen bunkers. By his third game, though, he was incinerating enemy blips with patented Chip Sands abandon, and Ito and I left him to his obsession.

So it went for four days. As Chip maniacally twisted the controls of the mockup, Ito and I monitored intelligence bulletins from the CIA and its Japanese and Western European counterparts.

From Helsinki came a report that a group of right-wing Danish terrorists was threatening to explode a nuclear device in Leningrad. They demanded the release of several hundred Russian dissidents confined in prisons and mental institutions. Worse, the Soviet news agency Tass had accused the United States of supplying the terrorists with enough fissionable material to build their evil "blackmail bomb." Meanwhile in the Caribbean and around the Persian Gulf, angry rhetoric had already yielded to sporadic exchanges of gunfire.

Cheyenne Mountain began to seem less like a mighty fortress and more like a big granite bull's-eye.

"Ito, this can't go on."

"It won't, Phil. Any day—any hour—my company's computer-linked defense system is going to have to prove itself."

Whereupon Chip Sands appeared beside us, his expression eloquently accusing. "I'm bored," he whined. "You guys promised me a challenge. I'm sick of playing those postage-stamp screens."

I understood. His disenchantment paralleled my own heightened anxiousness. Taking him by the arm, I led him down the corridor to the defense room and directed him inside.

"Take a seat, Chipper. But you can't touch a single joystick until you see enemy blips invading the screens on the top row. Firing beforehand disqualifies you. Got it?"

He made a contemptuous face. Of course he got it. Hadn't he played our cruddy mockup umpity-hundred times? Grimacing, he sashayed into the room and ensconced himself in the console chair. I slid the door closed.

Ito approached, and we stood outside the big thermoplastic window, trying to estimate how long Chip would have to sit there before the "game" began. More than likely he would give up within the hour—in which case we would be damned lucky to prod him back to that wall once the situation truly demanded his presence there.

Surprisingly though, Chip assumed that waiting for enemy blips was an integral part of the game. He sat vigilantly at his post for nearly six hours. Then, told that Ito or I would alert him to invading blips, he paused to devour two cheeseburgers and a milkshake. This meal he followed with a lengthy nap—all without ever leaving the console and its ominous regiment of joysticks.

Over the next eight to ten hours international tensions eased a little, probably because of the season. No blackmail bomb went off in Leningrad, and in the Caribbean a moratorium on both hot talk and actual gunfire made it appear that negotiation rather than mayhem might prevail. The Middle East was still one noisy popcorn popper, though, and low rumblings of revolt in Eastern Europe had the Kremlin's fur-bearing bigwigs singing their old songs of foreign incitement and swift retribution to "thugs" and "parasites."

During a telephone call to Tocqueville early on the twenty-fourth, I learned from Emily Sands that their family traditionally opened their packages on Christmas Eve rather than on the morning following Santa's arduous gift-dispensing rounds.

> *"Ito explained that once the real contest began, Chip would be locked into our little game room. This peculiar precaution would keep anyone from pulling the plug on his fun."*

"Chip has *always* known David was Santa Claus," Colonel Barrett—the woman said, chuckling nervously.

Acting on this advice, that evening I led a small group of coworkers into the defense room to bestow on Chip a number of gaily wrapped packages. Predictably, most of these contained batteries, electronic games, and Computakil video cassettes. Chip unwrapped his gifts with one eye on the top level of screens. (Ito, a lapsed Buddhist, was elsewhere in the building.) In the press of our self-conscious festivities, Neil MacAdams, my communications aide, accidentally nudged a joystick. A warning klaxon sounded in the little room. Outside the room, other alarms went off.

"Damn it, MacAdams!" I cried. "Watch what you're doing!"

Shaken, my aide nodded at what Chip had already noticed. Radar blips suggesting both long-range bombers and ballistic missiles had appeared on two of the topmost screens.

"Now?" the kid asked. "Now?"

"MacAdams, you've provoked a retaliatory response! You've just launched a battery of European-based IRBMs with that slip, and the Russians are shooting back!"

"Sir, the timing's coincidental. Even the most sophisticated Soviet warning system couldn't pick up the exact instant of launch."

MacAdams was probably right. All I could think of now was the magnitude of my *own* stupidity. Against every dictate of common sense I had packed the defense room with five sentimental adults. Now, whether in sneaky preemptive assault or lightning response to our own bungling first strike, the Russians were definitely coming. The myriad horsemen of the Apocalypse were streaking across the sky in the guise of radar blips.

Now, Colonel Barrett? *Now?*

"Commence Operation Slingshot!" I ordered the boy, whose patience these last few seconds had been Jobian. "Everyone else, get out! Out! Right now!"

My colleagues and I retreated behind the three-inch thickness of the Plexiglas. Chip's door slid to, automatically locking him in, and Ito, summoned by the alarms, came hustling up from another section of the building. As in Ozymandias, Chip had a retinue of transfixed spectators hanging on his every deadly twist of every toggle.

Back and forth through torn wrapping paper and discarded bows the kid swiveled his chair, a tubby dynamo showering sparks. He was in his element again. The room's topmost screens were glowing like radioactive fire opals.

"Sir," said MacAdams, clutching his headset to his temple as if it were an ice pack, "one of our advanced AWACS aircraft over the Arctic Circle reports that Chip has knocked out at least twenty Backfire III bombers and maybe twice that many intermediate-range Savage missiles targeted on Western Europe."

"That's fine," Ito said. "But the next wave's taking evasive action." He tapped his finger on the window. Some of those streaking blips I knew stood for harmless decoys electromagnetically enhanced to resemble bombers or warhead-bearing missiles. Chip had no choice but to take these out, too. You could not tell the decoys from the real McCoys.

"An AWACS aloft over the Tasman Sea reports a barrage of fractionally orbited Scarp IVs coming in over the South Pole," MacAdams declared.

I cursed. The Russians were avoiding our Ballistic Missile Early Warning System (BMEWS) in Britain, Greenland, and Alaska by looping the Scarp IVs over Antarctica and guiding their several detachable warheads to target before the end of their first orbits. Theoretically, no cause for worry. The defense system devised by Tomioka-Lott was supposed to thwart even this ingenious tactic. It employed discriminating satellite radar for detection purposes and cableless electromagnetic pulses to transmit the information. It gave the operator in our Cheyenne Mountain hideaway primary launch control of eighty percent of the silo-based IRBMs and ICBMs in Western Europe and North America, along with sec-

ondary access to surface-to-air and air-to-air weapons at various sites around the Soviet perimeter.

Unfortunately, despite his seasoning as a vidder and his practice on our mockup, all the zigzagging blips suddenly seemed to be confusing Chip. He was fumbling for handholds like a beginner.

"He's not adjusting!" I told Ito frantically. "He's not going to be able to do it for us!"

"Maybe you'd like to take his place."

"But I can't get in there!"

"Exactly," Ito said. "Calm down, Phil."

It was hard to calm down. Chip was losing points. Portions of the bunkers assigned to his protection were disintegrating like gemstones under continuous laser bombardment. Tiny facets of red or turquoise or lemon—glowing brightly, then (poof!) gone. Those bunkers stood for cities and their suburbs, and the points Chip was losing included a staggering number of human lives.

"Settle down," Ito crooned through the audio hookup.

Chip settled down. He reasserted control and ran off a fierce retributive blitz. MacAdams and the others began to cheer—a shout of triumph much like the one Ito and I had heard in Ozymandias.

Although Chip did not know it, he was now receiving support from Strategic Air Command bombers, European interceptor squadrons, and missile-carrying submarines in the Mediterranean, the Gulf of Finland, the Norwegian and Barents seas, and the Indian Ocean. To keep from overloading the defense-room operator with data, Ito's company's system did not register these forces on the ADC screens. The kid was therefore free to concentrate on enemy blips and bases.

For thirty minutes—forty minutes—an hour—the combat raged. MacAdams reported that President Farrell and his cabinet had long since evacuated to a hardened shelter in Maryland. That was good, because Washington, D.C.—a ruby-red bunker worth a hundred ninety thousand points—no longer existed. Too much enemy firepower had been sent against it for Chip to deflect. Besides, he had worked hard to spare the bunker labeled 200,000.

"There's a hit on Raton, New Mexico," MacAdams told me. "That's as close to Cheyenne Mountain as the Russians have been able to come."

Indeed, Chip had prevented the complete demolition of all but six of the blocks assigned. Scores of over a hundred thousand points—major cities on the North American continent.

"How'm I doin'?" he cried at intervals. "What's my score?"

No one bothered to tell him that three quarters of industrial Russia lay in ruins, that fourteen of Europe's most populous cities had taken direct hits, and that not even the United States had escaped blistering nuclear havoc and the certainty of lingering contamination. He was too busy to listen, anyway. Even a call from President Farrell's shelter in Maryland urging him to terminate Operation Slingshot made no impression. Although we patched Farrell's voice directly into the room, he seemed not to recognize it. As his mother had said, he appeared completely ignorant of politics and politicians.

"What's my score? What's the world record? How'm I doin'?"

"Stop." I told him through the audio hookup. "You've won. Even the President wants you to stop."

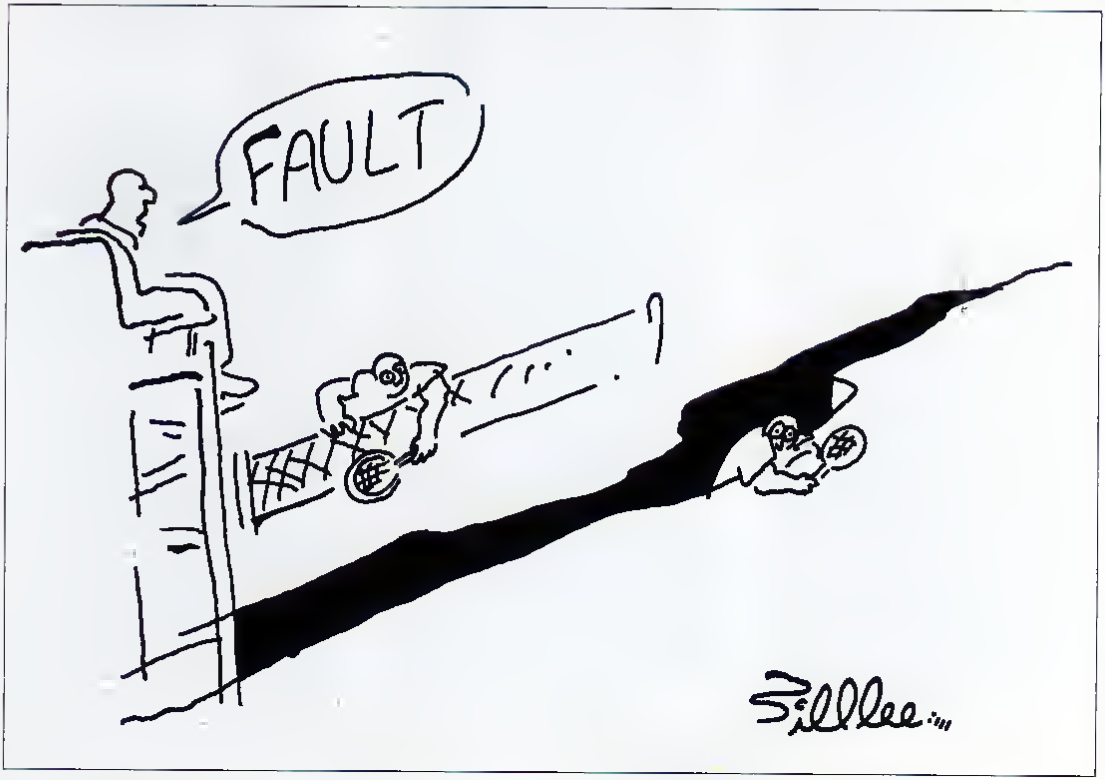
At this juncture many of the blips representing Soviet bombers and missiles either turned homeward or self-destructed. This development enraged Chip because it deprived him of points.

"Dirtydamn trick!" he screamed. "Dirtydamn chickenbleepin' trick! You guys never let that happen in practice!"

"The game's over, Chip," Ito said. "You've broken the world's record."

"There's lots of points left in the blocks on the upper level. I'm not gonna lose 'em. I'm gonna keep blastin' away. Mr. Ito, till your whole crazy program breaks down."

To prove this assertion, Chip directed another battery of ICBMs into the quadrant of a screen representing a large area of the southern Urals. Good-bye, Magnito-



gorsk Good-bye Chelyabinsk Good-bye hundreds of thousands of people

"Damn you, Chip!" I shouted. "You've already *got* the record!"

"I'm gonna put it outta sight. Nobody'll ever break it. Maybe *I'll* never break it."

Ito hurriedly punched in a code requesting any camera-equipped aircraft in the skies over America's blasted landscapes to transmit TV pictures of the devastation to Cheyenne Mountain. All the screens whose targets Chip had completely destroyed went blank, and within two minutes the first of these horrifying pictures began to appear on the blanked screens. Without yet ceasing to work his joystick, Chip paused to look at the grainy transmissions.

"Washington, D.C.," Ito said. "Wichita, Kansas. Lincoln, Nebraska. San Diego, California."

"Looks like burning day at the dump," Chip observed.

"The game's over, Chip," I said. "These are real pictures of places in your country destroyed by Soviet nuclear weapons. You're doing the same thing to scores of *their* cities."

"Neat visuals. They look real."

Before I could reiterate what I had just said, Ito intervened. "We crown you world champion forever, Chip. No one's ever going to play this game again, I promise."

"You really mean it? You're retiring the whole program?"

"Just release the joysticks."

"But there's points to win yet, enemy bases to blast."

"Just release the joysticks."

"Okay, okay. Geez, though, you guys are real partypoopers. Even in Ozymandias I didn't get this kind of hassle from the fans."

As a parting shot, he slapped one of the sticks (thereby launching a last fusillade of missiles) and shoved his swivel chair away from the console. Then he swaggered to the door, tripped the automatic lock, and joined us outside the pane of Plexiglas.

"That's an okay game," he announced. "Too short, though. Computakil wouldn't touch it. Black Hole Blaster's got it beat up one side and down the other, even with only one screen. Shoot, even Triangle Triumph's classier, and I started making that one up when I was ten." He put his hands in the pockets of his racing-striped pantaloons. "You guys gonna let me go home tomorrow? It'll still be Christmas."

I had no idea what to answer.

What made the children of Hamelin follow the Pied Piper into the mountain? What kind of melody did he play? And who would want to live in such a place forever? The novelty quickly wears off, and the cold and the darkness settle down over you like a shroud.

We are all children here. All that keeps us huddling together in these granite catacombs is our desire for warmth and our fear of the outside. Outside is alien territory. Ito manages an occasional enigmatic smile, but the rest of us are amazed. ∞

SUPERTHREADS

BY PHOEBE HOBAN AND MARJORIE COSTELLO

Products made of gossamer components provide a lock grip on tomorrow

PHOTOGRAPH BY MICHAEL FURMAN

Unscrew your standard new product and you won't find too many nuts and bolts. Inside most high-tech hardware is a miniature maze of "superthreads"—lightweight, slender semiconductor circuits that perform a variety of heavy duty functions. Almost as fast as computers crunch numbers, these Lilliputian links are changing the way we live, work, and play.

This one-page catalog includes more than a dozen devices, from prototypes to finished products, that expand our communication capabilities, shrink our offices, and convert our homes into computerized castles (or electronic cottages). Whether they are ferrying billions of bits of data through gossamer-thin channels or are simply switching miniature light shows on and off, microelectronics are the super components that will connect today's technology to tomorrow's.

One of the earliest forms of consumer electronics—the humble television set—is evolving into a whole new line of products. Technology is turning the boob tube into an intelligent machine by merging miniaturized video, audio, and computer components into a single, versatile system. Tomorrow's television screen may have twice as many lines of resolution as today's sets do, giving a sharper, clearer image. Sony, Panasonic, NHK (Japan Broadcasting Corporation), Ikegami, also in Japan, and CBS in America are promoting High Definition Television (HDTV) as the "future of television and cinema." Increasing the scanning lines from 525 to 1,125, this technology packs more information into each frame. HDTV offers the image quality of 35mm film and provides the perfect screen for displaying computer data—or Direct Broadcast Satellite (DBS) programs.

Last summer the Federal Communications Commission established the initial regulations for DBS technology—a new generation of higher-frequency, higher-power satellites that feed signals straight to small, cheap dish antennas without the need for a cable. One prototype dish, developed by Satellite Television Corporation, a division of COMSAT, measures only two feet across. About a dozen other companies have applied for DBS licenses, and by 1985 millions of miniature dish anfennas may be sprouting like upside-down mushrooms from rooftops nationwide.

ITT (International Telephone and Telegraph Corporation) has just come up with a different way to improve the programming and processing power of television. The company has built the prototype of a digital television called the Digivision. A set of eight powerful semiconductor chips replaces some 400 conventional components. Digital televisions receive standard TV signals, convert them into binary data, enhance the images, and then display them on home sets without flicker or ghost.

But video technology does not have to stay at home. By merging video-cassette recorders and cameras into one miniature machine, Sony, Matsushita, Hitachi, and others have created portable units called camcorders. They weigh less than five pounds and record on high-density micro-cassettes. When they become available in the next year or two, camcorders are expected to make 8mm cameras obsolete.

Whatever happened to that much-heralded phenomenon, the video disc? NHK recently announced a breakthrough—the first working model of a laser video-disc system that not only plays but also records. Sharp Corporation has reported a similar programmable system.

A simpler video disc is being developed by Grolier Electronic Publishing Company. Using today's technology, Grolier plans to create an electronic encyclopedia consisting of video entries, not printed ones. Instead of just reading about Beethoven, for instance, you could see and hear a performance of his Fifth Symphony or study a reproduction of the original score.

"With an electronic encyclopedia, instead of reading about Beethoven, you could see and hear a performance of his Fifth Symphony or study the original score."

Video-disc technology has already produced one promising spinoff—digital audio-disc (DAD) systems. Sony and Philips have developed Compact Disc technology which uses a solid-state laser stylus built into a portable-cassette-recorder-sized unit to play a 4¾" record. The DAD holds a full hour of music on one side only. These futuristic stereo systems will sell for anywhere from $500 to $1,000.

But one company, Digital Recording Corporation, has come up with a radically different design that might be much cheaper. The technology replaces the disc with a small piece of ordinary film on which audio information has been recorded using standard darkroom techniques. An optical scanner in a cigar-box-sized unit plays the 3" × 5" digital card. The products won't be on the market before 1984.

While everyone is still excitedly waiting for digital audio discs to arrive at the dealer, digital audio equipment is already available in the form of sophisticated cassette tape recorders. Both Sony and Technics make Pulse Code Modulator systems that digitally record and play back any input—from live music to radio programs to digital audio cassettes.

One last disc fits into neither the video nor the audio category. The $150 Emergi-Call system, made by People Protection Products, looks like a computer toy. But the electronic disc automatically dials emergency calls to the police, fire department, or medical center, transmitting a 25-second programmable message.

If you can manage to tear yourself away from your electronic cottage, there is a whole new assortment of technology-to-go. The Walkman and the Watchman (Sony's tiny TV) make it possible to take your living room with you. So why not your office? The Microwriter is a word-processing system that fits in the palm of your hand. Its 8K memory stores up to 8,045 characters, which are displayed on a 16-character liquid-crystal display (LCD) readout. Its unique, human-engineered five-finger keypad generates a full set of alphanumerics, punctuation, and even a few technical symbols. A sixth key controls editing and correction functions.

For stock-market watchers on the move, the palm-sized Pocket Quote, made by Telemet America, picks up trading information broadcast on an FM radio band. Its keypad furnishes the personal touch. It can be programmed to display an electronic portfolio that tracks as many as 20 stocks, options, or futures. The battery-operated monitor ($300, plus a $20-a-month subscription fee) even beeps when Wall Street gets bullish.

For tongue-tied travelers, the Walking Dictionary, from Casio Inc., is a wristwatch/translator. The watch has two buttons. One calls up a word on the LCD display; the other supplies the translation.

And here are two more for the road. The Calfax Horn-A-Plenty does more than protect your car; it offers a bit of comic relief. The combination musical car horn and security system greets would-be crooks with an eerie electronic "Hello" or "Alarm armed" before triggering a shrill siren and a radio pager. Its extensive repertoire includes such sound effects as a chugging locomotive, a raging bull, a sinister laugh, and four James Cagney impersonations ("You dirty rat") not to mention 99 melodies.

Want to feel like an airline pilot in your own car? Honda Motor Company in Tokyo has the right stuff: the Electro Gyro-Cator, a dashboard microcomputer that tracks your course on a series of road maps. The price ranges between $900 and $1,400, road maps are $90 for a set of five (currently available only for Japanese roads).

Finally, a Colorado company, Float to Relax Inc., is offering a sophisticated isolation tank. But its $5,600 unit will hardly isolate you from technology. Features include a TV monitor, a video-cassette recorder, and a stereo sound system. OO

Photos on the previous page illustrate three new or upcoming consumer products. Film (left) from Digital Recording Corporation captures audio data with photo-darkroom techniques. Electro Gyro-Cator (center) continuously displays a moving auto's location on a dashboard chart. Casio watch (right) is a push-button translator.

WORLD NEWS

CONTINUED FROM PAGE 92

he reentered the smoky brilliant electric gambling area

Jonathan said, 'Eddie there s something I have to tell you But not here Over at that table there See that guy's leaving

'Very mysterious Why can't you tell me right here?'

"You may want to be someplace you know dark and quiet If s bad news Eddie Does Cat mean anything to you? You know C A T Center for Advanced—I mean I was there My outfit was there doing the dirty work We weren t supposed to know where it was but it was Hays Hill Kansas It s about well I guess you know who it's about don t you Eddie?

"He s dead, is he?'

'Doc Goya he was known as Sorry

Val and Willett were employed on the ghoulish work of unblocking the Ghersom Tunnel which ran under the Hudson and connected along with other tunnels and battered bridges now under repair Manhattan with the New Jersey mainland Ghoulish because the blocking had been done by cars with bodies in them as well as bodies without cars Val and Willett operated a Marquet truck on which cadavers were piled They drove it to Dump 4 they tipped their freight into the great hole to which at the end of the day s work Lynx and moon in their crescent phase rising fire was lavishly set There was an unofficial team that stripped the bodies of whatever was unspoiled and still useful rings watches dental bridges money credit cards and the like This was the ultimately ghoulish No not quite the ultimately There was a dribbling mad necrophile who had to be kept away from fleshly mauling He was eventually shot by Murphy the man in charge of Dump 4

It was Murphy who during the lunch break one day came up to Val and Willett and their bread and cheese and beer rations He had a little book in his hand and he said to Val 'This you? He thrust the book a lumpy wavy water-spoiled paperback at Val s nose Val saw his own picture on the back cover

Good God he said taking it I'd almost forgotten this existed The title was *Not to Call Night* The blurb said This brilliant first novel by one who bids fair to become a great name in world SF

I had a look in it Murphy said Ain't nutting doidy in it This seemed to be a reproach

Willett jocosely grabbed the book from Val opened it at random and began to improvise Panting with desire she seized him and said Now now I can t wait Then she His voice faded out He looked at Val frowning 'When did you write this?'

The date s opposite the title page 1990 Maybe 1986 A hell of a long time ago

You remember what it's about?

'The blurb says surely About a heavenly body preparing to hit the earth isn t it? False alarm A lot of earthquakes though Is that right?'

Listen Willett said 'Listen carefully There s a character here called Dr Bodley Does that ring any bells in the corridors of your creative skull? This Dr Bodley says 'If I had to choose a site comparatively immune from seismic shocks however hard they hit the rest of the American terrain I d opt for a little place called Fordtown in the state of Kansas midway between Hays and Hill City Where did you get that information? Guesswork? Pure fiction?

I used to work pretty hard on background Val said brows knitting trying to remember The critics were always quick to leap on writers who hadn t done their homework I should think that's a chunk of exact information Why?

Idiot Willett bawled Shitabed lobnoddy foolish loggerhead Your turd-strewn catcamp is in such a place Didn t they ever talk about the kind of site they were after? Your wife your wife s old man?'

"A spot Val pondered comparatively immune from seismic activity

"That s where we re going " Willett said chucking the resf of his bread and cheese to a spotted loll-tongued pooch that had joined their party some days before

You guys are going said Murphy, who had been listening intently but without comprehension back to work

Dump 4 was on the New Jersey side of the tunnel At three in the afternoon Val jerked the lever for the last time and sent his last freight of corpses thudding into the great smoky hole The scavengers frisked about like rats opening dead mouths tugging at dead fingers 'Okay ' cried Val Willett let in the clutch They were off

Near Reading Pennsylvania they ate ham and eggs and cheesecake in a diner and stocked up at a hypermart on canned goods at a liquor store on liquor At a motel outside Pittsburgh they stayed the night It had been a long drive but the truck was speedy They lay on the twin double beds of the room they shared smoking long turd-colored Columbus panatellas

Rain suddenly burst from a million simultaneously pricked bags in the Pennsylvania sky When like a brilliantly organized hissing high violin effect it had played a few measures in moderato tempo lightning performed jaggedly on the skyline visible through the wide uncurtained window and hundreds of drummers thumped thunder Then there were as from extra orchestras hidden in the wings deeper thumps and grumbles from afar The Coke bottles on the middle bedside table clanked together and their contents danced An earthquake Willett guessed North of Pittsburgh We got out of New York just in time The tides will be starting again

They were determined to get some sleep on this trip Val had a bottle of five hundred

"Our employees are very highly trained Jenkins roll over and play dead!"

Aupnia tablets They took three each sluicing them down with shaky Coke and settled down to slumber Sleep came tardily but it came Their portable alarm digiklok woke them at six Crescent Lynx and moon setting the rain ceased the distant seismic rumbles audible still with flashes on the horizon They got up wearily and stiltly Let s try that one over there He meant an Abaco station wagon in high gloss aubergine It started like a dream and they were on their way

They breakfasted at a diner just over the Ohio border five miles or so from Wheeling and made Columbus easily by midday Again as they sped on with full bellies the sky yawned open and vomited haily rain Lightning did its act with thunder trundling grumbling after Just beyond Dayton the car broke down

In Kansas Professor Hubert Frame had his respirator batteries charged and was ready to examine what was the final concrete expression of his theoretical studies He could not of course walk O Grady s strong arms lifted him without effort from his bed into the solitary wheelchair that the camp clinic possessed His daughter stood by sniffling

Stop blubbing girl he said Nothing to cry about Bartlett in smart black with a CAT brassard on his left arm (a stylized puss back view sitting up straight) was ready to escort him Frame as he was trundled through the twilight gibbous Lynx and moon newly arisen admired the wide sky which he had not seen in its fullness for many months The increase in size he breathed almost inaudibly Astonishing Double acceleration of course He was taken to *America* great hugely elegant where the whole team waited He Bartlett Vanessa and O Grady got into the elevator and were lifted gently onto what was known as Level A When the dying professor appeared on the ring concourse as it was called most of the team clapped in a subdued manner Frame waved feeble acknowledgment

He was taken round elevated to Level B then to Level C There was no doubt of Bartlett s efficiency alas alas alas The concentration on living space the human need for sheer spatial freedom had not entailed any skimping on technical essentials The ploiarchal area for instance where Drs McGregor and McEntegart flicked their switches in demonstration made their screens glow set talking their radiocommunication devices was positively palatial Frame admired the three-layered hospital the incredible foodfields the ample dorsal area, which when the population began to grow would still be ample He saw the library functional and wholly technological and the audiovisual facilities dedicated to knowledge not diversion He admired the automated foremater which would fabricate a garment in a microsecond after digesting the designational input He frowned at the appearance of Dr

Maude Adams the two bibliothecologists others They looked dead like automated dead matter going through programmed motions He said with a sharpness that was clearly and painfully audible to Bartlett, "Have you been pacifying?"

"It was necessary"

Frame asked for a microphone He said into it, "Ladies and gentlemen, we ought to toast our enterprise Is there any champagne aboard?" There wasn't Bartlett frowned O Grady shook his head frowning Frame grinned bitterly and produced from a roomy side pocket a leather-bound brass flask "Whisky" he said A token sip, doctor?" he said to Dr Adams O Grady tried to intervene Bartlett put out an arm, saying "Alcohol is expressly forbidden to certain crew members A matter of—"

"A matter of depacifying," said Frame "Its effects of course, can be dramatic Drink doctor Drink I insist" She drank dead-eyed An automatic drinker To Vanessa he said "A word in your ear my love This is it I may as well go here"

"No!"

"Yes One thing is still on my conscience I lied to you I said that Val was dead He may be of course by now I'm sorry I didn't want him on the project I think I was wrong I'm sorry He may be alive he may be trying to reach you I have a dying man's hunch" He nodded grimly at Bartlett who had taken the flask with some difficulty away from Dr Adams "Hope, my dear Hope that he'll come to you" Vanessa very white put her hands to her face She couldn't even sob To the assembly at large Frame now said "Ladies and gentlemen, I have lived a full life and now I am going to end it A full life but not a successful one I know much of science but nothing of life Now it is too late to learn But it is remember now time for you to begin If you want a motto to blazon over that screen there the one that will show you the pulsing universe you are to travel through, that is now showing you Earth and Lynx moving inexorably to collision, the motto might be this *Scientia non satis est* Knowledge is not enough Let us now see how well your cadaver-recycler works Eat me drink me Rather sacramental isn't it?" He smiled switched off his respirator breathed desperately out good-bye wide-eyed blue-skinned His eyes looked poisonously on Bartlett an instant and then they looked on nothing His head collapsed onto his right shoulder There was a silence Dr Adams led the few who shed a tear Bartlett was efficient as always

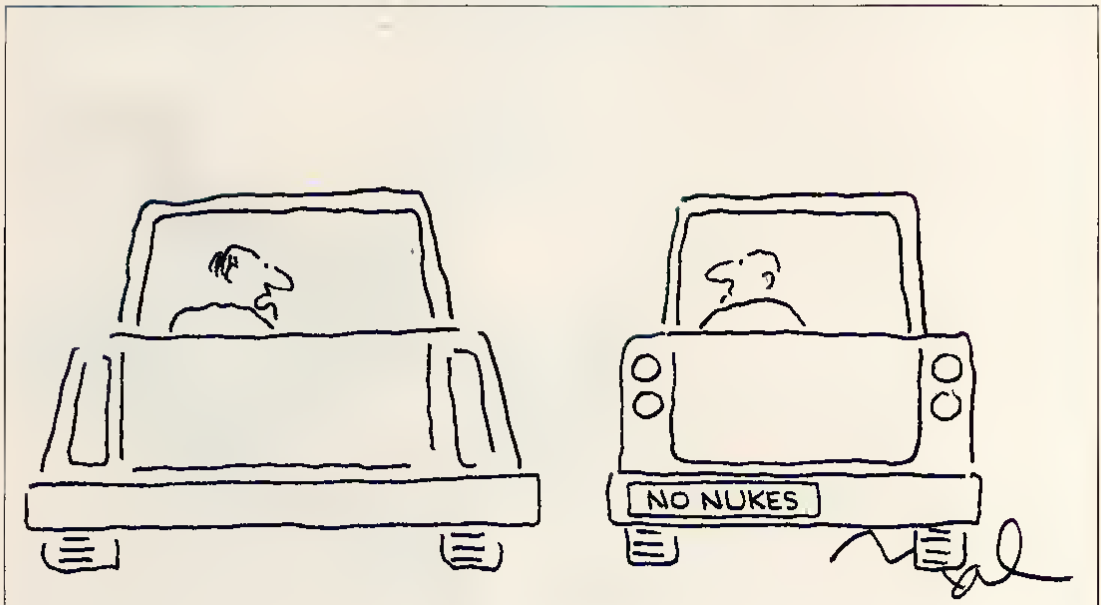
He ordered Dr Durante "You heard what the professor said Trundle him into the recycler Not the wheelchair That may still be needed" Pale Dr Durante obeyed The recycler was to the left of the foodfields It was a simple matter of disengaging with the help of Dr Sara Bogardus the spent body from its chair and pathetic apparatus and then introducing the mere chunk of morphology to the atomizing chamber They did this shut the heavy doors then set the apparatus working There was no sound no flashing of lights Silently the task of salvaging protein, carbohydrate phosphorus, fluids cleansed and potable and converting waste to fuel for the ancillary heating engines was consummated Frame would live in them and for them

Bartlett said with the brutality that they now knew was stitched into his nature, "So much for the past Our work is nearly at its end our work of the present We now pause to take a deep breath and prepare for our work of the future There will be a general meeting this evening after dinner Twenty-one thirty the usual place Very well dismiss" They dismissed

Dr Adams said to Vanessa "I don't feel at all well" and leaned on her

"Come to my quarters" Vanessa said She gunned the frowning O'Grady with her eyes the eyes of a woman just bereaved "I'll look after you"

After dinner at the general meeting the team watched Boss Cat take his place on the dais They feared with justice if past experience were to be trusted new curtailments of amenity and longer working hours Instead he said "The time has come as I have already intimated to think of the future To think indeed of more than our



"Hey mister, I disapprove of what your bumber sticker says but I will defend to the death your right to display it!"

own future of the future of the race We have to breed a race, ladies and gentlemen he said, frowning as if breeding were a hard necessity imposed upon them by the stern daughter of the voice of God "Before we breed we must mate As soon as we are under way into shallow space the mating process will begin Some of them began to stare at him open-mouthed He said "I have spent time and close study on the question of mating I have not consulted any of you on this matter indeed there is no one properly to consult since we do not possess a professional zeugaromatologist on our team But I have completed a final list in which I am confident that every relevant factor has been taken into consideration I would ask you all to pay close attention as I read out the list and to note carefully the mate chosen for each of you I do not imply any derogation in putting male names first After all the mating process is traditionally initiated by the male "The open mouths opened even wider Not a breath was heard The thumping earth muffled by the soundproofing was forgotten So then ' Bartlett said In alphabetical order

"Dr David T Abramovitz will mate with Dr Jessica Laura Thackeray Dr Vincent Audelan will mate with Dr Gianna da Verrazzano Dr Paul Maxwell Bartlett head of project will mate with Dr Vanessa Mary Frame Dr Miguel S Cézanne will mate with— The first one to snigger was strangely, Dr Adams Bartlett looked down at her in total surprise Please Dr Cezanne as I say will mate with Dr Guinevere Irving Dr Douglas C Cornwallis will mate with Dr Minnie Farragut— But now the single snigger had opened the door to laughter Some laughed then others It was a hell of a time since any of them had had a good laugh They laughed some more more still O Grady frowned Bartlett was frankly puzzled and looked for a cause of laughter an open fly a cat micturating against his table leg He tried to continue "Dr John R Durante with Dr Kathleen Orlinda Eastman Dr Mackenzie Eidlitz— But he could not be heard The laughter was very nearly total Even the clinically pacified were laughing Laughing it seemed was a solvent of even the most potent chemical conditioner Bartlett white horrified yelled Silence Silence Silence That only made it worse

Dr Eidlitz was bellowing like a sealion Bartlett picked on him and said 'Dr Eidlitz, control yourself Mating is a serious business ' For some reason that began to touch off a risory nerve in Dr O Grady Bartlett did not at first notice O'Grady sat somewhat to his rear He said ' If of course there are any compatibility problems Dr O Grady will be only too happy to supervise the clinical staff in effecting adjustments He looked at O Grady and found shocked horrified that O'Grady was showing big horse teeth and howling Bartlett could hardly be heard "O Grady— Dr O Grady—" O Grady did not respond

Bartlett turned to Dr Greeley the diastemopsychologist yelling his head off in the front row and going through the classic parameters of risory near exhaustion hand on ribs finger pointing blindly at the excitatory cause "You Bartlett said you damn you ' and he came down from the dais He hit at tear-blinded Greeley Then the laughter stopped very abruptly Greeley hit back The two men tussled Bartlett cried O Grady put this man under close arrest O'Grady got up straight-faced and went down and over to the two fusslers without conviction Then seeing open mouths and pallor where he had recently seen universal joy he burst into a huge cackle This primed Jovian laughter on the back row "Put everybody under arrest Bartlett cried That was it Howls screams and what used to be called hysteria

It was only Bartlett who saw the main door open and Lieutenant Johnson head of the residual platoon come in Johnson looked in astonishment at the fifty-fold or nearly laughter and was forced by reflex to relax his own face to a smirk Then he recollected the apparent seriousness of his mission and said something into Bartlett's ear Bartlett was hardly able to look grimmer than he already did 'About two hundred sir Johnson said ' Some have gloves and wirecutters and are cutting through the electric fence We're unarmed Request permission for arms to be issued sir '

Silence Bartlett yelled anew at the wildly laughing "Silence Silence I have disturbing news *This* will stop your stupid laughter ' But it didn't not yet ∞

To be concluded next month

FICTION

THE SHIRT'S TALE, THE SHORTS' STORY

BY THOMAS M. DISCH

Ah, what a fine day it is, thought the blue chambray shirt as it burst from the closet one bright May morning. It stretched its arms with pleasure, did up its buttons briskly, and made its way down the stairs and out to the street without even sprinkling crumbs of toast over itself for breakfast.

The street was bustling with clothes of all ages, classes and conditions of wear. There were T-shirts, pleated skirts, blue jeans, fashionable camouflage combat jackets, and antiquated but indestructible fringed leather vests. There were even a few topcoats and bulky sweaters that had not grown weary from the spring's warmth and curled up inside wooden trunks for their long estivation in summer's mothballs. But most of the clothes on the street seemed, like the blue chambray shirt itself, to have just that morning fought their way up from the bottom of drawers and out of the back of closets, responsive as grass to the warmer weather and longer afternoons. They were bright, lightweight garments that zipped along with a speed and a swing that made the drab old winter clothes look like refugees from Good Will Industries.

A beautiful day, assuredly—but a Tuesday for all that—

PAINTING BY DONALD ROLLER WILSON

and the blue chambray shirt could enjoy the splendid weather only for as long as it took to reach the Amalgamated Bank ten blocks uptown from its apartment. There, with a sigh, it fitted its plastic penholder into its left pocket and prepared itself (crossing its arm over its chest) for the moment when the gray uniform would open the doors and the first clothes of the day would form in a line alongside the loops of velvet rope—a line forever depleted and forever renewed until the doors were locked again at three o'clock.

Usually the shirt was able to function more or less automatically at its station behind Window 8, thinking at the steady tempo and low intensity suggested by the bank's Muzak. Usually it regarded the constant procession of clothes passing before its window as nothing but a flow of deposits and withdrawals, not as individual items of clothing like itself. Usually it didn't resent the freedom of the bank's clients to go off when their transactions were completed to enjoy the wide world beyond the bank's glass doors.

But today wasn't a usual day. The shirt felt constrained, stifled, woebegone. It might as well never have left the closet, it told itself morosely. It looked at an orange web belt sporting a Sony Walkman and thought *I want to move, I want to groove, I want to get out of here!*

The shirt looked up at the big clock on the wall. The time was exactly 9:26.

At ten o'clock the flow of business slowed to a trickle and then to a dead stop. The turquoise pantsuit at Window 7 signaled that it was sneaking off to the employee lounge for a cigarette, and when the pant suit got back five minutes later, the shirt decided to follow suit. Only instead of going to the lounge, which was windowless and only slightly cheerier than a toilet stall, the suit decided to take its break in the vest-pocket park across the street from the bank. And if the polka-dot bow tie at the front desk didn't like it, then the polka-dot bow tie could lump it.

As it happened, the polka-dot bow tie had gone off to check the balance of a pair of corduroy pants applying for a loan, and to make the shirt's good luck better, the gray uniform was also otherwise occupied in explaining the automatic-deposit machine to a suede jacket.

The class of clothing hanging about in the park was of a very different character from the class of clothes frequenting the bank. The shirt suspected that many of the overcoats and dirty trousers now sprawling on the benches had spent the entire night here. Perhaps trousers are not to be held responsible for not having a closet to call their own or for not going to a dry cleaner's from time to time, but the shirt, which kept itself spotlessly clean and never lacked for buttons, was not disposed to take such a lax attitude. The shirt believed all clothes should be held responsible for their own cleanliness and that when they were past mending, they should be quietly retired or, as the shirt was pleased to put it, turned to quilts.

But it was a waste of good weather to think about such things. So the shirt turned its attention from the ragged denizens of the park to the bright, variegated flow of clothes passing along the street. It marveled at a lovely pleated-front dress of creamy Qiana that looked as if it had stepped right out of a Bloomingdale's window. Such a dress was no doubt out of the shirt's league, but dreams are free. Advancing from the opposite direction, not like a dream but a nightmare, came an overanxious ochre dress that virtually had 'Quarantine' stitched all over it. Behind the ochre dress, poking along at half the speed, came a dowdy black dress as old and changeless as all Italy.

Just as the shirt had decided to head back to work, it spotted a pair of glossy red shorts jogging on the elliptical path that formed a kind of miniature racetrack about the park. There are certain signs and signals that naturally denote the beginning of a season: the first cuckoo of spring, the turning of the leaves in the fall, the first snowflake of winter. For summer it's the first pair of shorts.

The shirt, though basically of a retiring disposition, not to say shy, couldn't resist the impulse to express the high spirits that the red shorts had inspired in it. As the shorts bounded by, it turned sideways and saluted, as an official might salute a parade. Had the shorts noticed? Impossible to tell from the sinuous, shifting, heart-shaped curves of the shorts retreating view, but somehow the shirt believed they had.

It watched entranced as the shorts continued their circuit round the park.

As the shorts approached them, the dirty trousers and ragged overcoats would stir to life, as though a strong wind had swept over them. *So foolish*, thought the shirt protectively, *for the shorts to choose this park to jog in.* Though, on second thought, would it have wished them to jog anywhere else? Such beautiful shorts they were, and such a brilliant red—the red of red-hot candies, of Valentine chocolate boxes, of the lightning bolts on high-voltage warning signs, of August tomatoes, of all things ripe and succulent.

On their second circuit past the shirt the shorts called out to it, "Hey there, chambray—shake it!" Taking this to be an invitation, the shirt fell into a comfortable stride beside the shorts.

The shirt said that the weather was lovely. The shorts agreed.

It complimented the shorts on their appearance. The compliment was returned.

There was no putting off the next step. The shirt had to decide whether to admit to the shorts that it was on a break and had to get back to the bank, hoping the shorts would be willing to come back later in the afternoon. Or it could simply abscond from the bank (at the risk of getting

"It's an analgesic, a decongestant, an antihistamine, and a cough suppressant."

fired) and pretend to be leisurewear.

Reluctantly the shirt heeded the call of duty—and was rewarded with the shorts' phone number and a promise to return at 3:45 to meet by the waterless fountain in the center of the park.

No need to describe the rest of the shirt's working day. It flew by in a haze of daydreams or crept along in a traffic jam of anxious what-if's. What if the shorts weren't there at 3:45? What if the cash in the drawer didn't tally with the figures on the machine and the shirt got to the fountain late? What if the phone number the shorts had given wasn't their real number?

But the cash did tally, and the shorts were there, and the weather was even more glorious than it had been that morning.

Broken bottles in the gutters glittered like jewels. Whirlwinds made newspaper ballets at every street corner. Motorcycles raucously revved their engines as they idled at red lights.

"Do you know what would be great?" said the shorts.

"What?" said the shirt, knowing very well.

"A movie," said the shorts. "We could still get in at the matinee price if we went somewhere around here."

It had not been the shirt's first idea of what would have been great, but on the other hand it didn't entirely contradict that idea, either. So they got a newspaper and looked through the movie ads for something they hadn't both already been to. In the immediate neighborhood there was a choice between a Western, starring various famous pairs of Levi's and Stetsons, and a musical comedy about top hats and evening gowns. The chambray shirt's natural preference was for the Western, but the red shorts said they were in the mood for something more romantic, and who could argue with that?

From the shirt's point of view it was an ideal movie. The musical numbers were either high-spirited or sexy or both, while the plot was so simple (hat meets gown, hat loses gown, hat gets gown) that it demanded only twenty percent of one's attention. The shirt let its left sleeve droop casually from the armrest and brush against the shorts. Is there any sensation so delectable as the passage of soft cotton across a slithery nylon/polyester blend? But we say no more. At a certain point if words don't fail, they must be censored.

They left the movie frazzled with pleasure and with no clear idea of what to do next. The hour (just past six) and the presence of a good, inexpensive Mexican restaurant on the corner decided them. A wasp-waisted black velvet vest showed them to a table at the back of the restaurant and took their orders for taco combination plates and a pitcher of sangria.

The shorts nestled coyly out of sight behind the red-checked tablecloth, and the shirt planted its elbows on the table and proceeded, a little nervously, to tell the shorts about its job at the bank and the various difficulties it had in relating to the demands of three-piece sharkskin suits and polka-dot bow ties. The shorts were sympathetic but not too interested. They explained that they'd spent all their life at college or simply having fun. They'd never worked at any job, even for the summer.

The shirt's high spirits faded somewhat learning this. It began to ask itself the discouraging question: What could a blue chambray shirt possibly have in common with red nylon/polyester shorts? It grew nervous and talked too loudly, so that it began to attract the attention of ties and blouses at nearby tables. It laughed at its own jokes immoderately. Then, when their tacos had been reduced to a rubble of lettuce shreds and grated onion, the shirt, in reaching across the table for the pitcher in order to replenish the shorts' still-half-full glass, knocked over its own glass. The glass's contents spilled with fatal precision down the front of the blue chambray shirt. The black velvet vest hurried over with a wet napkin, but it was already too late. The damage had been done. The napkin served only to spread the stain, it didn't noticeably, lighten it.

The shirt regarded itself with dismay. Sangria is essentially red wine, and red wine doesn't wash out of cotton. It was ruined. It would spend the rest of its life a recluse in a bottom drawer, ashamed to face the light of day. If such an existence could be called a life! Better simply to become a rag wadded up in a plastic bucket with sponges and brushes and bars of yellow soap. Hopeless, hopeless!

In its distress the shirt had completely forgotten about the shorts. So it was somewhat nonplussed when they got up from the table and, all on their own initiative, took the check for the meal to the cash register and charged it on their own Visa card.

"Come on," said the shorts, beckoning. "We're getting out of here."

"What?" said the shirt, though it followed the shorts willingly out of the restaurant.

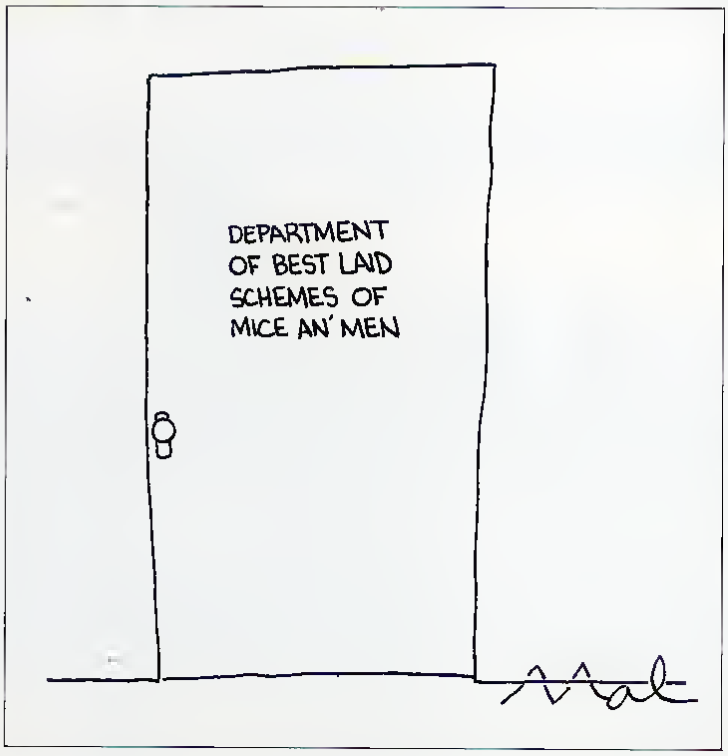
"My place is right around the corner. You've got to get that sangria off before it's dry—right?"

Hope contended with despair. Indeed, hope did so well that by the time the shirt stood outside the shorts' apartment door, waiting for the last key to turn in the last lock, it had almost forgotten its misfortune with the sangria. Already it was back in silver-lining territory.

In the bathroom the shorts quickly filled the sink with cold water, added a capful of Woolite, and then, eagerly and hungrily, unbuttoned the shirt's buttons and plunged it, gasping, into the sinkful of suds.

The shorts hesitated a moment. Then they, too, slowly slid down to the floor and bounded up into the sink.

The recommended time for soaking garments in Woolite is three minutes. The shirt and the shorts spent the rest of the night together in the sink, and it was the happiest night of their lives. OO



CHARTS

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the same needs may hit the streets join a gang run away or get into trouble Criminologists take note Correctional institutions misguidedly treat juvenile delinquency, Farley says by directing the wayward youngster into predictable trades like carpentry or factory work the very sort of routine a sensation seeker loathes

Low-arousal folks can take heart though for their promised land the Age of Arousal is at hand "We live in an age of stimulation an increasingly smelly speedy eye-straining age " Farley remarks Low-arousal people may thrive, but what about their high-arousal cousins? "Crowding, noise, and omnipresent communication may cause them overarousal disorders—like autism, schizophrenia withdrawal and anhedonia (the avoidance of pleasure)—because pleasure produces arousal Farley says This may be one reason for the isolation of the elderly who tend to have a high-arousal physiology

Seductive as these theories may be neuroscientists like Gerald Brown don't pay much heed to the science of flash responses and arousal "Physiological psychologists he says 'are taught to do all sorts of autonomic-nervous-system testing—examining galvanic skin responses and so on The trouble is there is no good way to relate that to central-nervous-system functioning When they talk about people being underaroused I don't know what that means Even in the psychological brotherhood itself consensus hardly reigns Farley's theories fail to convince Marvin Zuckerman, who doesn't subscribe to the simple underarousal theory of sensation seeking Experiments just haven't uncovered a difference in *baseline* arousal between high and low sensation seekers " he points out Yet some of Farley's statistics like the sevenfold higher escape rate of low-arousal delinquents astonish Surely they mean something

"Like Kansas tourists marveling at the strange hyperkinetic rituals taking place on the New York Stock Exchange floor we await explanations The biochemical equations of murder suicide and madness neatly solved we imagine the mind-chart makers will go on to conquer painful shyness callousness, nameless dreads world weary funks phobias and the thousand great and small maladies of the soul

Perhaps they will Consider the complicated saga of Parkinson's disease "Until fairly recently it was a 'shaking palsy of unknown cause " Brown says "Then it progressed to a neuropathology with basal ganglia alterations Now we can trace Parkinson's disease to a dopamine deficiency in specific brain regions and possibly to a dopamine-acetylcholine [another neurotransmitter] imbalance

So too may the 'brain palsies' of our age be patiently demystified

BODY

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the brain To peer deeper the surgeon changes the frequency There s still a problem with this however High frequencies can t scan deep areas effectively low frequencies can but they don t deliver sharp images The difficulty lies in finding the best compromise

Ultrasound is not new to medicine In 1950 Dr Lyle A French of the University of Minnesota found a tumor in an autopsied brain with the aid of an ultrasound detector A number of unsophisticated scanners have been around for more than 20 years But older machines were technically limited Instead of a decipherable image they simply showed a squiggle on a screen when the sound wave hit an obstruction such as a cyst When the CAT scan arrived ultrasound was relegated to screening cardiac abdominal and other problems

Then in 1979 Drs George Dohrmann and Jonathan Rubin now assistant professor of radiology and chief of ultrasound services at the University of Chicago Medical Center began to use ultrasound imaging during brain surgery (A few other doctors throughout the country had also renewed their interest in the concept) Working with a company named Advanced Technology Laboratories in Bellevue Washington they developed an instrument called the Neurosector A compact ultrasound imager it has now been used effectively in hundreds of operations including 250 performed by Dohrmann and Rubin

"Now it s almost unlimited in the things it can image during surgery Rubin claims These images help minimize risks disclose hidden dangers prevent needless surgery, and in some cases reduce the number of operations a patient must undergo For this reason doctors consider the $44 000 machine cost-effective

Dohrmann recalls one typical case in which an elderly woman operated on for a brain tumor was probably spared a massive stroke when ultrasound revealed that the cancerous growth had hijacked part of an artery "Had we entered the tumor as originally planned " the surgeon says " we would have gone right into that artery"

Unlike CAT scans or angiograms which emit radiation, ultrasound poses no health risks Rubin adds During studies conducted at the University of Michigan Medical Center and at hospitals in New York Louisiana Florida and even Tokyo there s been no evidence of infection or brain damage from ultrasound imaging

In more recent months the technique has been used as a window to the spine during back surgery An extension of the brain the spine is also riddled with vulnerabilities so it s critical that doctors manipulate it as little as possible during surgery Ultrasound presents vital information on the exact location of the trouble "An incision one millimeter in the wrong direction can mean loss of motor function and loss of bowel or bladder control It can affect the sexual organs says Dr Barth Green associate professor of neurological surgery at the University of Miami and attending surgeon at Miami s Jackson Memorial Medical Center and the Veterans Administration Medical Center This way you know exactly where to go to find the pathology It reduces the chance of error

This has proved particularly helpful when gunshot victims are to be operated on Ultrasound easily identifies metal objects so doctors no longer have to hunt for bullet fragments It gives us the X-ray eyes of Superman says Dr Green

At Jackson Memorial Green has applied ultrasound imaging to disc removal a fairly common operation Because the surgeon can scan for stray cartilage (a cause of repeated operations) before finishing the chances of a successful one-time operation are improved

Not all brain and spinal surgery requires ultrasound imaging though It s more than a toy but less than a necessity according to Dr Rand Voorhies assistant professor of surgery at the New York Hospital-Cornell Medical Center Often tumors are either very large or fairly near the surface Dr Voorhies explains We bring out the imaging equipment only when we think it s going to make a difference

Right now neurosurgeons disagree about how often—and in which circumstances—ultrasound imaging can benefit surgeon and patient Some even contend that the image won t add to their knowledge of the tumor s boundaries Others retort that ultrasound can often outline a tumor s general limits "That s not saying it can tell you where every last tumorous cell is That s impossible But it can give us a good sense of the borders Dohrmann says This information becomes important when a doctor does a biopsy (the best samples are obtained from the tumor s core) or when a surgeon tries to find out whether most of the tumor was removed

Furthermore a few surgeons believe that ultrasound imaging will facilitate many other types of surgery As the resolution sharpens and the scanhead shrinks doctors may learn to pinpoint problems throughout the body more easily "We may even be able to use it in corrective surgery such as shunting hydrocephalus [releasing water on the brain] while the baby is still in the womb Dr Green speculates

Infants heads are readily scanned with ultrasound (the soft spot means doctors needn t remove any bone) so for the past several years surgeons have used the technique when placing catheters and shunts in babies heads In other areas ultrasound imaging still meets with some skepticism One surgeon said "You know I can biopsy brain lesions blindly I don t need your ultrasound I can just find them"

Dohrmann agrees that in many instances this is so "But wouldn't you rather be able to see it?" he asks

LIFE

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to pick up a key or a coin The other is called palmar-prehension in which the thumbs, index fingers and middle fingers can actually grasp an object such as a phone receiver "When you think about opening and closing your hand that s simple " Peckham notes "But if a person has no feeling then it s really complex"

Still another research team in Yugoslavia is working on a neural-prosthesis system for the lower extremities one that might someday eliminate the wheelchair But that is at least a decade away Right now Hambrecht and his colleagues would simply like to develop a reliable totally implantable system that would allow a quadriplegic to perform basic chores unaided "The biggest clinical problem we face is that we have wires going through the system and into the muscle " Peckham says "One of the next breakthroughs would be a wireless system It certainly isn t impossible to envision a transmitter sending the computer s messages to electrodes implanted in the muscles In fact Peckham says it has been done already in some animal experiments

Another phase of neural-prosthesis research involves something that might be called artificial feeling How does the patient know how hard to grip a paper cup without crushing it? Could such a system sense temperature as well as pressure? Dr Andrew Schoenberg and his team at the Utah Biomedical Test Lab are developing artificial sensory transducers to measure tissue compression so that the force exerted on an object can be precisely quantified Current experiments involve the use of a very thin (28 microns thick) polyvinylidine fluoride film with the trade name Kynar (something like Mylar) This material made into a glove would bounce pulses off objects much the way bats use ultrasonics to navigate When the reflected signal hits the surface of the film it will oscillate at a specific frequency providing the glove wearer with an artificial sense of touch

Even this proposal is less than ideal for someone must put the glove on the patient And that raises the toughest barrier of all Technology cannot hope to re-create *real* feeling only simulate it When healthy arms are lifted the brain messages are second nature For the quadriplegic the brain must always consciously dictate what it wants the limb to do As Peckham points out "The patient has to learn to communicate with his nervous system"

A neural prosthesis may never restore the instantaneous fine-tuned muscle movement that normal individuals take for granted But for the 200 000 Americans now confined to wheelchairs—and others all over the world—it could mean greater self-sufficiency and the ability to accomplish tasks once thought impossible

EXPLORATIONS

By Anthony Wolff

A shore fit for Pandemonium," remarked Captain Robert Fitzroy of H.M.S. *Beagle*'s first landfall in the Galapagos Islands 600 miles off the coast of Ecuador in September 1835.

"Nothing could be less inviting than the first appearance," agreed Fitzroy's friend and shipmate Charles Darwin, the *Beagle*'s twenty-six-year-old naturalist.

The *Beagle* was already almost four years out from Plymouth on what had begun as a two-year survey of the South American coast. Not only was young Darwin homesick, but he suffered from almost perpetual seasickness. The 90-foot-long *Beagle*, topheavy with accommodations for as many as 74 people, tended to rock and roll excessively. Despite his discomfort, Darwin had written to his sister from Lima: "I am very anxious for the Galápagos Islands. I think both the geology and the zoology cannot fail to be interesting."

A century and a half later the Galápagos annually attract 25,000 visitors who come to see the place where Darwin "discovered" evolution. With all the scientists, nature lovers, and undifferentiated tourists, it is becoming increasingly difficult to observe the unique Galápagos landscape and its flora and fauna the way Darwin saw them. With a little planning and the help of a good guide, however, a visitor can still avoid the crowds and find the islands and their native inhabitants almost as uncorrupted as they were 148 years ago.

Darwin himself spent just a month in the archipelago, visiting only 4 of its 13 principal islands. His theory of evolution by natural selection did not come to him in a sudden epiphany. Only later, as he labored over his collections and his notes for the *Journal* he published in 1840 and for *Origin of Species*, which did not appear until 1859, did Darwin fully appreciate the unique importance of his brief Galápagos sojourn.

Darwin's Galápagos visit was one of those serendipitous cases of the right person in the right place at the right time. The years on the *Beagle* had transformed the amateur entomologist—a rich country gentleman destined for nothing more exciting than a quiet, respectable parsonage—into a versatile and dedicated natural scientist. He was a quick, sharp observer of whatever he saw. Insatiably curious, he set out in pursuit of exotic sights or specimens, despite danger and discomfort.

On the theoretical side, his readings in geology, especially the new works of Charles Lyell, impressed him with the controversial notion that the processes that shape the earth have been in continuous operation for an immeasurable time. The idea that minute but immensely powerful changes, accumulating for eons, could account for the geological phenomena that Darwin saw in South America may have carried over in his mind to explain the zoological and botanical diversity that was nowhere more evident than in the Galapagos.

"Most of the organic productions are aboriginal creations found nowhere else," he noted, "there is even a difference between the inhabitants of the different islands." This last point struck Darwin as especially remarkable. "I never dreamed," he confessed in his *Journal*, "that islands about fifty or sixty miles apart, and most of them in sight of each other, formed of precisely the same rocks, placed under a quite similar climate, rising to a nearly equal height, would have been differently tenanted."

The British vice-governor in the islands (Ecuador had only recently laid claim to them) pointed out to Darwin that any of the various giant tortoises, *galápagos* in Spanish, could be assigned to its native island according to its size and the conformation of its shell. Of 38 plant species peculiar to the Galápagos that Darwin collected on James Island, fully 30 could be found on no other. Likewise, 22 of 26 aboriginal Galápagos plants were found to be peculiar to the island of Albemarle.

Though different from one another, the islands' creatures "all show a marked relationship with those of [South] America," Darwin noted. This led him to conclude that the originally bare islands had been seeded by "a few stray colonists."

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A masked booby makes eyes at the intruding camera on Daphne Island, off limits to tourists.

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INTERVIEW

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forth there was a little more dogma attached to it to make it a little more dramatic Sarich is a very strong personality and one respects him for being strong
Omni Do you think paleoanthropologists are unusual for being so dramatic?
Leakey I think some are
Omni What do you think there is about this field that attracts dramatic personalities?
Leakey People on the front edge are often quite dramatic In any field people who are leaders became leaders because they are unusual Maybe they are bold or maybe they do strange things I think if you examine physics medicine or any other science you will find the same holds true It is just that, because anthropology is a smaller field one is more aware of these personalities There just seem to be proportionately more in this profession
Omni What did you think of your parents profession when you were a child?
Leakey Well I enjoyed the out-of-doors but I never really thought I would go into anthropology because I wanted to be independent I wanted my own career and my own identity
Omni Your mother is still active?
Leakey Still digging at Olduvai
Omni Would you say that your father was a very strong forceful personality?
Leakey Both my parents were very strong and very charismatic Both in their own way were great people
Omni Did you get along with them?
Leakey I don t know whether one would say that I got along very well or very badly It was a good relationship but one based on a great deal of independence
Omni The story is that you had conflicts with your father and then reconciled with him before he died
Leakey Well it makes good copy We did fight on numerous occasions There were intellectual battles There were parental conflicts with the errant son And there were administrative problems
Omni Were you the errant son?
Leakey Sometimes one is errant One doesn t always follow straight I was involved in administering the museum my father had started I was doing things differently from the way he had done them And as he was working in the museum that I was running I think at times he wanted things done differently I simply said that I m running it and we are doing it this way That s the sort of problem that led to the story of our conflict It was never as serious as it was made out to be and indeed during the last nine months of his life we got on extremely well
Omni What do you consider to be your father s greatest achievement?
Leakey He will be most remembered for his pioneering work in drawing attention to Africa—particularly to East Africa—as the place where fossils of human ancestors would be found in great number He also pioneered in demonstrating that you could observe primates in the wild and that they would become habituated to behaving naturally in the presence of observers
Omni Yes he encouraged Jane Goodall to carry out the first long-term study of wild chimpanzees Then she was just a young girl following them in sneakers with binoculars and a note pad Lo and behold, Goodall saw the chimps staging cooperative hunts for meat begging for pieces and sharing them using tools to fish for termites and weapons to bluff their opponents in status duels Your father encouraged not only Goodall but also Dian Fossey who spent some thirteen years with mountain gorillas in East Africa and Birute Galdikas who is still living among orangutans in the jungles of Borneo From their work we know that humans and apes share remarkably similar behavior patterns Besides we have a vastly clearer perspective on how our ancestors may have acted Their work and that of others has changed the landscape of anthropology Did your father realize that so much would come of his good idea?
Leakey I think he did yes
Omni It was also his idea to send interdis-

"Okay everybody, move one step to your right."

ciplinary teams into the field In fact you adopted that technique in your earliest field expeditions

Leakey I think most people do that now I'm often credited with having organized the first group expedition but in fact I didn't The first team was organized in 1967 by anthropologist Clark Howell of Berkeley I was part of it I took the idea from him You have to draw upon the expertise of several disciplines if you're going to solve complicated problems

Omni What got you into anthropology?

Leakey You must remember that I'm not in anthropology

Omni What do you mean?

Leakey I've worked as the director of the National Museum of Kenya since 1968 The museum is probably the largest and most comprehensive scientific institution in all of Africa We have research departments in all the natural sciences—botany ornithology entomology ichthyology mammalogy and primatology to name a few And I have a staff of about four hundred persons Ninety-five percent of my day and year is not devoted to anything that has to do with bones or anthropology If is concerned with totally different things I have a working knowledge of a number of scientific disciplines As a result I'm probably as qualified or as experienced in paleontology—particularly human paleontology—as anyone else

The point is that degrees don't help one understand fossil bones What is needed is a thorough knowledge or background on which to base one's interpretations I would warrant that a lot of the academics being produced by schools today simply don't have such experience Indeed some of the mistakes that have been made and are being perpetuated at the moment are made simply because people aren't experienced and haven't got that practical background

Omni What mistakes *are* being made?

Leakey Well, for example I think Owen Lovejoy's ideas on the origin of bipedalism and the relationship between males and females that developed through food gathering and provisioning are preposterous If Lovejoy spent even six weeks in the field watching baboons or chimpanzees in their habitat and had a feel for the way the real world works it would become quite clear to him that his ideas simply don't work

Omni My understanding of Lovejoy's ideas is that early hominid males and females switched from a sexual strategy of promiscuity like that of chimps to one of monogamy In this new strategy the female stayed in a small safe home area while the bonded male ranged farther and farther and carried meat back to her Because of the extra nutrition provided by the male, the female ovulated sooner after delivering her child therefore she had more babies So bonding increased human fecundity making our species more successful than the apes which do not bond Why do you feel that this is illogical?

Leakey Because essential to Lovejoy's theory is his idea that chimps in the forest are not successful It is simply not true Chimps are very successful

Omni In your book *Origins* you say that by two million years ago men and women were engaging in long term pair bond relationships What are your thoughts on this?

Leakey I said they may have been, I didn't say they were But I do think we've got to account for the obvious fact that human infants are inadequately equipped to survive if left unattended There must ultimately be some father care for the young Or if not father care then group care Anyway in *Origins* the theory was offered as a scenario rather than as an explanation

Omni I think I have an explanation I have advanced the only other recent theory on the evolution of male female relations—specifically the pair bond It is the matrix of my book *The Sex Contract The Evolution of Human Behavior* My theory is that bipedalism produced radical changes in the protohominid skeleton Most important was the shrinking of the size of the birth canal In other words because of bipedalism the birth canal became smaller Because of this obstetrical difficulty I think most females died while delivering their young But undoubtedly there were a few females who bore premature young as there are today These females lived Their young lived And through differential selection early hominid females began delivering premature young This would explain why human infants are so premature in contrast to the infants of other mammalian species

Needless to say, females were burdened with young that needed extra care during a longer infancy It must have become much harder for these females to gather to catch their own small mammals even to keep up with the group Those females who were able to engage a male in an extended consort survived better than the others So did their young And with time there was selection for our human proclivity to bond There's a lot more to this but that's my theory in a nutshell.

Leakey I have no real problems with that I wish we had a little more information about whether there was a shrinkage in the diameter of the birth canal It would seem that there was but we have remarkably little evidence of it I do agree that the care and rearing of large primate infants is a difficult matter This is unquestionably a central issue I think the basic idea is well worth following up Lovejoy shouldn't be clobbered either He is courageous to come out with his ideas Indeed while I was making my BBC film *The Making of Mankind* he was the only person I knew who was prepared to stand up and be filmed telling the world what he thought

Omni Speaking of new ideas we have a few heated debates going on in the United States to which I would like your reaction The first has to do with sociobiology As you well know sociobiologists hypothe-

size that there is a biological component to behavior that behaviors like altruism and belligerence evolved just the way our teeth did by differential selection. They believe that some human behavioral patterns are genetically determined. What are your perceptions of sociobiology?

Leakey: It is a very big question. The story of social insects such as bees and ants is quite fascinating, and I think much has been said that is quite close to the mark. But you run into problems when you then apply the same ideas and principles across the board to humans and other mammals. I think it is better to think of human behavior as *developing* rather than as *evolving*. The processes are different. For example, the development of culture isn't evolution in the sense that an organism evolves with genetic changes and genetic drift. The development of culture relates to things that can be passed from one generation to another through learning.

How this relates to genes, I don't know. But the most important thing to remember is that our culture gives us the ability to override genetic messages as bees and ants cannot. And I think there is very little of human behavior that can't be overridden. Perhaps there is a genetic base for the instinctive smile of an infant. The human laugh may have a genetic base, too, but laughter is prompted by different situations in different cultures.

It is a very complicated issue, and I think it is being grossly oversimplified. There is always the worry that if you start saying behavior has a genetic base, then you have to say that people are never going to be able to do anything but what they are doing. Just as misleading, I feel, you get into the whole debate about inferior and superior races and social classes. I do think there are differences among groups, but I think all human beings have the same innate ability to override those differences given proper education.

Omni: There is some new evidence that chimpanzees scout the border of their territory for so-called enemies, then raid neighboring areas, kill the resident chimpanzees and usurp their territory. This isn't too different from twentieth-century world affairs. Do you think that this behavior in chimps is learned, in other words, cultural?

Leakey: It might be. You've got to remember that very few animals left in the world are living in their original habitats. A lot of this behavior may ultimately be learned because of the environment we've created—an environment that confines them within certain boundaries.

Omni: Another issue these days is creationism. What do you say to people who bombard you with creationist jargon?

Leakey: My position on this is very clear. The Christian religion has played a very important role in human society, and I think it will continue to do so. It should in no way be undervalued as a matrix of life. But the Bible was not intended to be taken literally, and I would think that ninety-five percent of the intelligent followers of the Christian faith have never taken it literally. They wouldn't dream of it because if they take that literally, they are going to have to take an awful lot of other things literally, and this simply doesn't work. You can't live that way. It seems to me that creationists are an ultraconservative group singularly limited in their intellectual breadth. Their attempt to introduce scientific creationism, as they call it, into schools on an equal level with the teaching of biology and other natural sciences simply has got to be rejected. Creationism in my view is rubbish.

Omni: Why do you think it has blossomed recently?

Leakey: Because this is a time of uncertainty. There is economic hardship. In times of adversity all human societies go to extremes. They swing left or right. You are seeing a society that is at the moment attracted to very conservative ideas because people feel that this will bring them security. I'm quite certain that when the economy improves and people start thinking about other things, this will disappear.

Omni: Has your knowledge of Swahili and of Africa contributed to your understanding of ancestral cultures?

Leakey: Yes. I think that growing up in Af-

rica and being a naturalist have enhanced my ability to perceive and interpret some of the evidence we have found

Omni: It seems to me that you are counterbalancing a trend toward specialization with a generalistic approach

Leakey: Well, it was not a deliberate effort but I think that a natural history museum is an important place to do research. The tendency in America has been to put these studies into the rarefied intellectual atmosphere of university departments. In a museum such as the Smithsonian, the American Museum of Natural History, the British Museum, or our museum in Nairobi, one gets the interaction of a number of specialists in the natural sciences who have a better feel for the matrix of life. Naturalists usually are more reliable in understanding the biological sciences.

Omni: What do you read?

Leakey: I read scientific papers pertaining to subjects that interest me, but I do not read any novels, nor do I read classics or history. Most of my waking day is taken up either with administration or with travel.

Omni: What do you think about being a public figure?

Leakey: I think being a public figure is fun. But it seems like more fun before you are a public figure and while you are becoming one than it actually is once you are one. Being surrounded by admirers is initially very good for one's ego. But after a while the public expects you to be somehow different and do special things. And I don't do special things. I am a perfectly ordinary, normal person who does normal, ordinary things. The other problem is that when one says something, no matter how innocent it was intended to be, it can quickly be misconstrued or sensationalized. Comments made at lectures take on meaning that is weighted, which makes one very cautious about what one says. I have no doubt that, as a result of the level of public attention I've received in the last decade, I have become a much more private person. I value the intimacy of family life. While I'm at work, I'm a public figure. I work in a public office, and I'm available to anyone for anything. But once I leave my office, I am extremely difficult to reach.

Omni: What do you do in your spare time?

Leakey: I work a lot. But cooking is my greatest love. I don't cook from recipes. I use my imagination. My dishes tend to be very French and usually quite rich.

Omni: Can you give me a Leakey recipe?

Leakey: No. They are far too complicated, but I will try to give you an impression. The other night there were two of us for dinner, and I cooked a sauce. I used shallots, garlic, butter, and three quarters of a bottle of very good red wine that reduced through simmering to less than half a cup. I also included fresh Devon cream from England, which I prepared gently with the juices of chicken and marrow beef that I had simmered the day before. This I poured on a small piece of steak very quickly pan-fried so that it was very well cooked on the edge but very rare in the middle. Then I served it with French bread that I had also made.

Omni: Who does the shopping?

Leakey: I do.

Omni: Does your wife enjoy cooking?

Leakey: She enjoys eating.

Omni: Since you travel the world on business, what do you do for a vacation?

Leakey: I pursue my other hobby, sailing. I've got a thirty-eight-foot sloop, and I like distance sailing—blue-water ocean sailing. No telephone, no contact, and once I'm gone, I'm gone.

Omni: As a second-generation Kenyan, what do you think of tourists?

Leakey: I think tourism per se is a most fascinating aspect of contemporary society. It has its place in development and is important to Kenya. The difficulty is the heavy price we pay, both in terms of foreign exchange for maintaining the luxury that visitors want and in terms of emphasizing the gap between tourists and a population that doesn't have the apparent affluence of the tourists. This can lead to changes in values and can have a demoralizing effect. It can in fact directly affect morals in the society. Traditions that used to be simply a part of society's activities become commercially oriented. So I think tourism is both good and bad on balance. What we really need to do is regulate tourism to the extent that it won't damage our nation's internal development.

Omni: Provided we solve our global problems of war and pollution, could you tell me what you think man will look like a few million years from now?

Leakey: I don't think it requires any imagination at all. If we are correct in understanding how evolution actually works—the process by which we retain continuity within a given species—and provided we can survive the complications of war, environmental degradation, and possible contact with interstellar planetary travelers, we will look exactly the same as we do now. We won't change at all. The species is now so widely dispersed that it is not going to evolve except by gradualism. And gradualism is going to be ruled out by medical science. We will grow bigger because of better food, but there are not going to be any new physical adaptations. Parts of the anatomy that are no longer used at all may disappear. But if we survive, we will survive unchanged.

Omni: What about the brain?

Leakey: The brain is continuing to be used to a greater extent than it was in previous generations. We have more technology, more culture, more complex societies because of our intellect. But I don't think the size of the brain will change.

Omni: You are still a young man and you have already made a tremendous contribution to anthropology, to other sciences, and to the education of the general public. What do you hope will be your greatest achievement in life?

Leakey: To continue enjoying it. I'd like to die happy. I think I will. ∞

EXPLORATIONS

CONTINUED FROM PAGE 140

from the continent which had subsequently—somehow—diverged from the original type. Among the specimens that he took back to England, Darwin discovered a number of small, dull brown finches, all resembling the South American finch but distinguished as species by the perfect gradation in the size of the beaks, according to the feeding habits of each. One might really fancy, he wrote in the *Journal*, "that from an original paucity of birds in this archipelago one species had been taken and modified for different ends."

Just two years off the *Beagle*, he was already that close to the heart of the matter. We seem to be brought somewhere near to that great fact, he wrote, that mystery of mysteries—the first appearance of new beings on the earth.

It took him more than 20 years to work out most of the details and to marshal the evidence. New beings on the earth—that is, new species—originate when spontaneous variations in individuals of a species are naturally selected for their survival value. Only those novel traits that increase the individual's chances of surviving to breeding age are actually passed on to succeeding generations. The slow accumulation of new traits eventually results in a new species. In the isolated Galapagos, still quite young in geological terms, lack of competition encouraged the development of variations in immigrant species. This allowed successful genes—still unknown, unsuspected—to propagate rapidly through the island population.

The process of natural selection in the Galapagos was already subject to human interference in Darwin's day. On Charles Island he found several hundred "people of color," political exiles from Ecuador, subsisting on tortoise meat and on the feral goats and pigs descended from breeding stock brought by earlier whalers and fishermen. These introduced species, as well as feral dogs, rats, even a species of fire ant, continue to upset the vaunted ecological and evolutionary integrity of the Galapagos. Programs to extirpate the intruders have been too little, too late, and only partially successful. The growing numbers of both permanent settlers and visitors also threaten the islands' continuation as a unique living laboratory where scientists can study evolutionary biology.

In 1937, when Karl Angermeyer, our Galapagos guide, arrived with three of his brothers from Germany to become the leading citizens of Puerto Ayora, the main Galapagian settlement, it had a total population of perhaps two dozen. By 1964, a visiting journalist estimated the number at about 100, plus a few burros, a couple of horses, and one jeep. When he returned in 1977, there were 800 people, with cars, trucks, and motorbikes. Today the population is several times as large and still growing. Most of the local fishing fleet has been converted into tourist transports.

Ostensibly dedicated to both economic development and environmental protection in the Galápagos, the Ecuadorian government lacks the resources and/or the reach to do much of either. The Galapagos National Park, with jurisdiction over the uninhabited 88 percent of the archipelago's land area, cooperates with the internationally funded Charles Darwin Research Station on a variety of projects to assess and reverse the damage already done to the islands and to avert new problems. They do a lot, but they lack adequate personnel, boats, and money.

The trouble with the tourist traffic is not so much ecological as aesthetic. The great majority of those who go to the effort and expense of making the trip are fully conscious of the values at stake and mindful of the rules against taking foreign organisms to or from any of the islands, collecting so much as a seashell, or straying off the marked tourist trails. Just by the effects of their numbers alone, however, tourists cannot but alter and diminish the experience they are enjoying.

It is possible to avoid the crowds by passing up the package tours put together by travel agents in favor of a chartered yacht shared by a family or a small group of friends. There are several boats of various configurations and degrees of comfort at Academy Bay, available at rates ranging upward from about $250 per day for a party of four—little more per person than the package tour rates—including everything from food and fuel to soap, suntan lotion, and snorkeling gear. Assuming that the boat floats, the crucial choice is the captain, who usually serves as naturalist, guide, cook, and on-board entertainer.

Karl Angermeyer, for example, is a treasure worth any price. Never mind that his boat, the 38-foot, 45-year-old *Symbol*, is no more comfortable than absolutely necessary and makes more noise and fewer knots than one might wish. Angermeyer knows the name, address, and visiting hours of almost every bird, beast, and green growing thing in the Galapagos. He's almost seventy, weathered and waterlogged, but he can go anywhere. In his long day he's guided Prince Bernhard of the Netherlands, Thor Heyerdahl, and several other very important tourists; he's captained the Darwin Station's research ship *Beagle III*; and he's grown slightly famous and prosperous. In the cool of the equatorial evenings, after a hard day of nature worship, he tells long, dramatic, mostly true tales about his adventures and the islands' history in a Franglo-German accent complete with engaging smiles and conspiratorial winks. His cooking is adequate. He is often booked months ahead, and he threatens to semiretire, but if he can't take a charter, he'll pass it on to one of his brothers or a nephew or perhaps a friend who will serve almost as well. Just write to Karl Angermeyer, Santa Cruz, Galápagos, Ecuador. ∞

EARTH

CONTINUED FROM PAGE 16

PCB victims at the PCB Project in Sonoma County California concurs He compares the attitude toward exposure victims with the attitude toward rape victims ten years ago "There is no sensitivity to what the person has gone through There is in stead the sense that somehow they have brought the tragedy upon themselves The victims end up feeling like a cross between a guinea pig and a leper "

"It s like someone opened our mouths and poured drugs down our throats that no one knows anything about says Lor raine Ross who learned last winter that the drinking water in her Los Paseos California community had been contaminated by a chemical leak from the nearby Fairchild Camera and Instrument Corporation "We feel as if we had been experimented on— as if we are the casualties of high technology And when we try to go through all the proper channels to get information we re treated like hysterical housewives

Psychiatrists agree that the first step toward easing the psychological distress of toxic exposure is to provide the victims with accurate factual information The next step is to examine both their physical and their psychological complaints seriously

Such complaints have been studied intensively in the Three Mile Island area in Pennsylvania where a nuclear-power plant broke down spewing radioactive gas that could have endangered thousands of res idents One researcher Maryland-based psychiatric epidemiologist Andrew Baum has recently found that today nearly four years after the much publicized accident local residents continue to experience high blood pressure and other physiological symptoms of chronic stress

"Technological disasters like Three Mile Island says Baum produce a different response than natural disasters like floods or hurricanes "In a natural disaster Baum explains a victim feels that he has been hurt by something that is inherently be yond his control But technological disas ters create the feeling of a loss of control over something that used to be controlla ble "We think of technology as our ser vant says Baum "When the situation is reversed it throws us off balance"

Ironically the accident at Three Mile Is land recently produced some positive fall out On November 1, 1982 the Supreme Court agreed to hear a case that will de termine whether or not it is necessary for the Nuclear Regulatory Commission to consider the "psychological impact" of the Three Mile Island accident before the re actors start up again People Against Nu clear Energy (PANE) the community group filing the suit claims that continued worry since the accident has caused skin rashes and aggravated ulcers If PANE wins its case, it could be one small step for the victims of pollution

The Artist

INTELLIGENCE

CONTINUED FROM PAGE 38

powerful but that they usually have a larger memory. This can be important when you have a lot of data to work with—running an accounting program, for example. If you are doing that kind of computing, you will also need high-capacity floppy disk drives—or perhaps even a hard disk—to store your information permanently.

"The way the machine and software are designed is just as important, though. A poorly designed sixteen-bit machine is not likely to perform as well as a well-designed eight-bit computer. And software that's inefficient or hard to use can undermine the best computer equipment."

Garetz suggests setting up a personal "bench mark" against which to measure the computers you consider. "Figure out a typical use for your computer, and try running that program on different machines. Then take a closer look at the ones that seem best at what you intend to do. This won't necessarily find the best machine, but at least it should help you rule out any that are wrong for you."

While you're doing that, of course, you'll run across all those new computers just about to enter the market, and the six-month syndrome will set in again. This year's generation of digital gear could make the dilemma even more acute.

"Look for a bunch of new portables," Carl Helmers advises. "They'll have plenty of memory, a flat-screen display, and two micro-floppy disk drives that store fairly large quantities of information. They won't weigh more than ten or twelve pounds, and they'll cost only three thousand to four thousand dollars—about half the price of the closest equivalent now available."

If you can stand to wait longer, he adds, the advantages of delay will seem even more attractive. "Five years from now, Helmers believes, computers will shrink to the five-pound range, yet carry the memory of today's largest micros—half a million bytes or so—and the number-crunching power of a much bigger machine."

But be honest. You may not need all those wonderful new features. One writer here dithered for two full years, waiting to see what would come next, then recently settled on a computer that had been on the market when he first began his deliberations. The manufacturer's reputation for quality and speedy repairs, he finally decided, meant more to him than state-of-the-art technology.

Helmers continues: "My company, North American Technology, bought several Apple computers three years ago. We're still using them, and I expect them to be in use five or ten years from now. We'll have other, more up-to-date computers as well, for things that the Apples can't handle. But what difference does that make if the older machines still perform the work for which we bought them?

"People are going to have to get used to the way this field is growing," Helmers concludes. "There will be a new crop of computers every year. As soon as you understand that, it no longer matters that yours isn't the latest. Just be sure to get a computer that suits your needs."

NEW WARES, HARD AND SOFT

The ground shook under American chip makers when Japanese competitors announced the first 256,000-bit memory chip. Now Nippon Telegraph and Telephone has developed a 1-million bit chip, with just eight of these a computer can store more than 100 pages of *Omni* articles. Built of the elements gallium and arsenic instead of silicon, the device operates twice as fast as other memory chips and uses less power. Look for a new generation of superportable computers using it around the middle of the decade. (Nippon Telegraph and Telephone Public Company.)

The sleek, futuristic-looking MAD-1 is one of the first computers to adopt Intel's new 80186 microprocessor, big brother to the 8088 found in IBM's personal computer and many others. The machine also offers 128K of working memory, one or two floppy disk drives, detached keyboard sculptured for comfort, and a 12" green screen. Even more impressive than the hardware, the company says, are the programs expected a year from now. Based on artificial intelligence techniques, they will, it's claimed, make today's micros seem as primitive as the slide rule. (About $3,000 to $6,000. Mad Computer, 3350 Scott Blvd., Building 13, Santa Clara, CA 95051.)

Two new speech-technology development systems can digitize spoken words, then regenerate them for playback. Used with a 256-word fixed vocabulary, the V4000 and V5000 correctly identify spoken words 99+ percent of the time after one or two training sessions to accustom the machine to the user's voice, compared with roughly 80 percent for other voice-recognition systems. Salesmen could use the device to check inventory and place orders for customers from any telephone—without human help from the home office. Pilots of the future will "talk" to their aircraft to pick up data on fuel, location, and terrain conditions—without having to look at instruments or radar screens. (Votan, 4487 Technology Drive, Fremont, CA 94538.)

The five superchips in the new HP 9000 scientific computer pack the equivalent of more than 2 million transistors, the largest alone carries more than 600,000 transistors—roughly 25,000 in the area of a pinhead. No larger than most personal computers, the 32-bit number cruncher could theoretically hold some 4 trillion items of information in storage. Expected use for the $30,000 unit is in computer-aided design and other mathematical simulations. (Hewlett-Packard, 3000 Hanover Street, Palo Alto, CA 94304.) ∞

SPACE

CONTINUED FROM PAGE 18

connection among surviving commanders and their submarines and bombers

Colonel Steve McElroy space-launch research and development chief at Air Force Headquarters in the Pentagon explains his unofficial ideas about how such an 'advanced space-launch capability might supplement the space shuttle During peacetime we require certain space assets to do our missions I submit that we don't really need all that in wartime To all intents and purposes with space systems we're really at peace up until total nuclear war Until the point where we have a nuclear interchange it's reasonable to think that our satellites are in sanctuary because the Russians need their satellites as badly as we need ours So we use the shuttle to get up those regular assets for the peacetime missions and then make sure we can launch the smaller payloads during or after a nuclear attack

Unlike McElroy Colonel Heimach does not dismiss the possibility that the Russians would make limited attacks on U.S. satellites *before* full-scale nuclear war broke out But he envisions countering plans for such attacks by putting up many smaller simpler satellites to do the jobs now done by big ones Once this network is in place the Russians would have to launch a massive attack to have any military effect With a major assault on satellites the Russians would signal the United States that war was imminent—and cause this country to mobilize its forces perhaps even to launch a preemptive attack

But Heimach doubts that the Pentagon will carry out the measures he thinks are necessary to help U S military-satellite systems survive an attack The problem is he says we have been unable to articulate the function that space can have for the military and what it can do for them He doesn't think there's much point in trying to alert the rest of the military community to the importance of satellites It's just too difficult there are too few of us

Here I am at the National War College and there isn't a lecture on the schedule associated with space

There's little question that satellite systems play an important role in the peacetime operations of the U S military The Russians also rely on satellites though perhaps to a lesser extent If the United States were involved in a nonnuclear war anywhere on the globe satellites would surely provide useful perhaps vital services to our armed forces The question is How likely are we to become involved in a large-scale war with the Soviet Union that does not very soon turn nuclear?

mind

CONTINUED FROM PAGE 24

some estimate of how likely the occurrence of the disaster is—a risk factor element. Otherwise people would have no way of gauging their reaction to the danger. If some sort of risk assessment had been given for the Kodiak landslide, for example, Saarinen believes public acceptance would have been much better.

He also recommends that scientists responsible for long-term warnings take on the job themselves of educating the public instead of leaving it all to the media, with their penchant for drama and controversy.

That message is getting across to the scientists who must alert the public. The USGS, Saarinen found, made a particularly strong effort to inform the public about the risks surrounding the Mount St. Helens eruption, with excellent compliance as a result. And every year a group with the long-winded name of the Natural Hazards Research and Applications Information Center, located at the University of Colorado in Boulder, holds a meeting attended by scientists who deal with natural hazards and by social scientists who study the public's reaction to them. The social scientists describe their findings and offer hints to a very receptive audience.

One regular attendee, Dr. Neil L. Frank, director of the National Hurricane Center at Coral Gables, Florida, says he has already made changes in hurricane warnings as a result of what he's learned. "We used to say something like, 'Everybody in low-lying areas along the coast should evacuate,' " he notes. "But nobody knew whether or not they lived in low-lying areas! So now we might say 'Everybody east of U.S. 1 along the coast should evacuate.' And we name localities."

The biggest natural disaster that scientists in the United States will ever have to face is the 8.3 Richter scale earthquake experts say has a better than 50 percent chance of striking southern California in the next 30 years. Even though an 8.3 earthquake is about as powerful as earthquakes get, most Californians aren't very worried because the time frame is so broad. If seismologists were to narrow down the forecast to say a year or two from now, there could be problems. Based on interviews with people in quake-prone areas, Mileti has drawn up various hypothetical scenarios that show the economic consequences of such a near-term prediction would be considerable—perhaps even more devastating than the quake itself. In anticipation of the disaster, housing values in the target area would plummet, companies would lay off employees, and sales of earthquake insurance would soar to the point where it would no longer be sold.

As if to illustrate this point, Dr. Brian Brady of the U.S. Bureau of Mines predicted at a 1980 scientific meeting held in South America that three major earthquakes would take place in Peru during the summer of 1981. As the first date approached, some of the economic consequences drawn out in Mileti's scenarios actually occurred, but the earthquakes never happened and the U.S. government ended up apologizing to the Peruvian government for the whole mess.

Actually, a one- or two-year earthquake prediction for California is very unlikely, and although the Chinese did predict a major earthquake several years well in advance, American seismologists have no confidence they can do the same. Even if they could, SCEPP, the Southern California Earthquake Preparedness Project, set up to develop both a prediction system and a preparedness plan, will not make the mistake that was made in Peru. It recommends that no near-term predictions be made public—an approach that is already being followed by government officials in earthquake-prone Japan.

Right now several social scientists, including Mileti, are working with SCEPP to develop warnings that should encourage a maximum response. So if and when Californians hear an earthquake warning, it will be one that is strictly short-term, giving them days, not months, to get ready. ∞

SPACEWAVE

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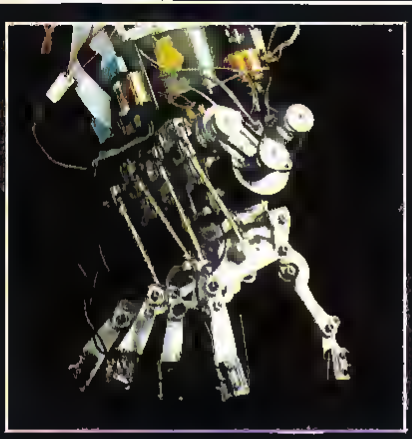
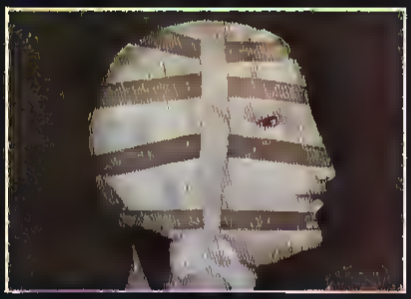
NEXT OMNI

ROBOTS



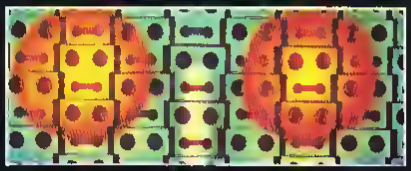
The era of the robot is just beginning, and to help you cope with it, *Omni* has devoted next month's issue to the fascinating field of robotics. Among the topics to be explored are: artificial-intelligence expert John McCarthy's personal vision of what the robot of the future will be like; a glance at the first generation of domestic robots now being built and what we can expect from the next generation; a hard look at the effects of the robot's expanding role in society—as worker, as helper, even as rival in the workplace; an examination of the peculiar challenge facing a new breed of specialist, the robopsychologist, an expert in incorporating behavior in intelligent machines; and how the ultimate robot, a self-replicating machine, could construct energy farms in a desert wasteland, allow us to conduct mining and manufacturing operations on the moon without a human in sight, and help us to colonize the far reaches of the universe in self-contained habitats or spacecraft.

FICTION



In April the conclusion of our two-part excerpt from Anthony Burgess's *The End of the World News* climaxes with various groups converging on Sloansville, Kansas, the location of a spaceship built to save mankind from an oncoming collision with the wayward planet Lynx. Burgess, a respected literary figure in Great Britain and the United States, is renowned as much for his mainstream novels as for his science fiction. And Jack Dann, last year's Nebula Award finalist for "Going Under," returns to *Omni* with another powerful story, entitled "Blind Shemmy." This chiller is about a man with a dangerous compulsion to gamble who finds a unique casino to satisfy his need.

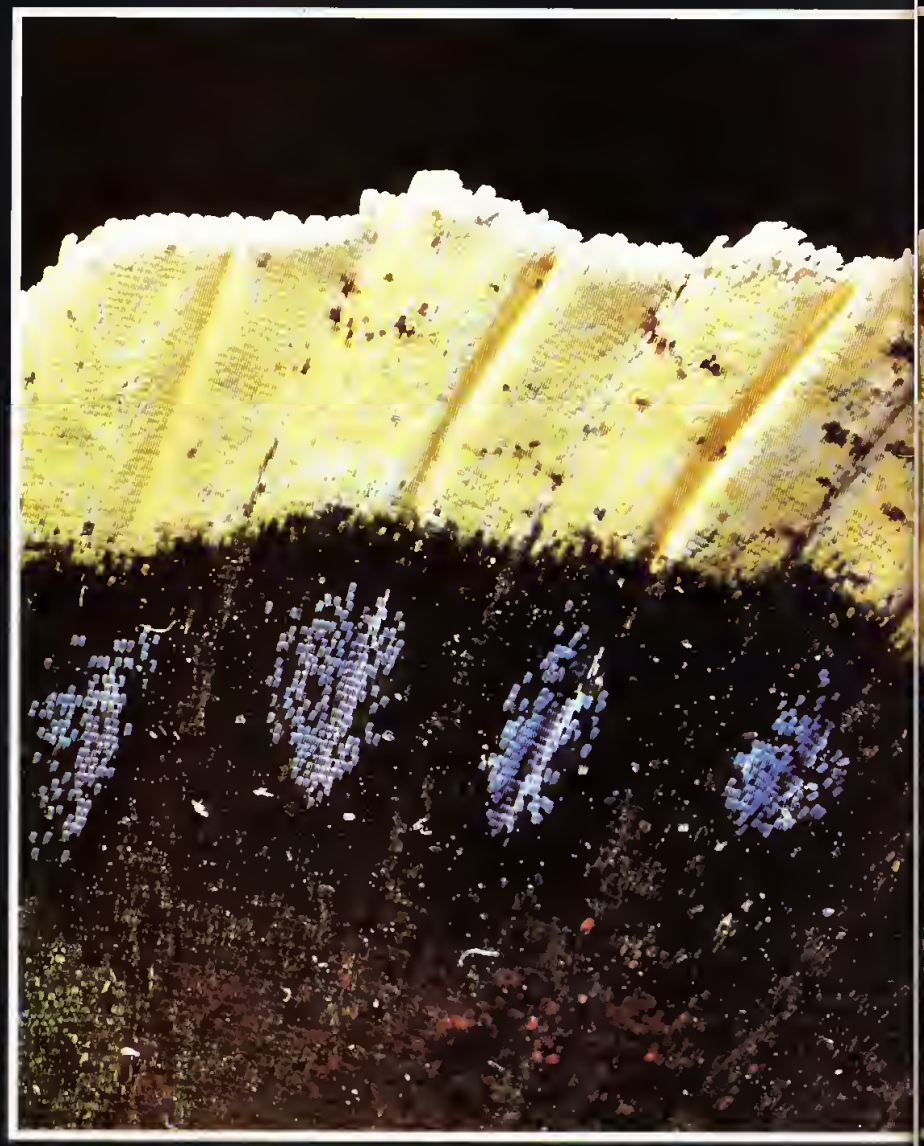
FACT AND FANCY



For years we have been reading about robots in the great science-fiction classics or seeing them portrayed on the silver screen. Now the machines are a reality, and in a dazzling gallery of images in the next issue of *Omni* we will compare the robots of science fiction with their counterparts in real life, showing how fact can sometimes prove to be even more stunning than fiction.

GENETIC HARVEST

Some scientists have grown a bigger mouse; others have implanted brick-red eye coloring in a line of fruit flies that otherwise would have had dull brown eyes. On the drawing board are dreams about abundant meat and milk, the flow turned on by a simple addition to the cows' drinking water. This is the near-future harvest of gene research. But it may be merely a backdrop for further genetic manipulation—on human subjects. *Omni* shows how work in laboratory farms brings us closer to the genetic engineering of a human embryo. The report outlines the awesome implications of work that could cure the diseases of future generations—even before they're born.



PHENOMENA

When viewed from a distance of a few millimeters, the smooth wing surface of a morning cloak butterfly (*Nymphalis antiopa*) shifts dramatically into another dimension of textures and subtle colors One of the more common lepidopterans of North America, the morning cloak seems at first glance an unremarkable specimen But close inspection, says photographer Dennis McFarland, reveals not only the intricate structure of the tissue-light wing but also other amazing surface features. The scales, which rub off as colored powder when a butterfly is handled, are laid out like microscopic shingles in overlapping rows They vary in texture from smooth to hairy, and on some males they also serve to give off a distinctive scent To get this intimate photo, McFarland brought the specimen to his studio and recorded the image on Kodachrome 25 film. His camera was a Nikon F equipped with a bellows unit and a 55mm Micro-Nikkor lens ∞

COSMIC DUST

STARS

By Andrew Chaikin

For nearly a decade space scientists have been interrogating true extraterrestrials. These travelers from outer space tell of their distant origin only under the closest examination. But persistent researchers are learning the secrets of cosmic dust.

Once, astronomers could only speculate about cosmic-dust particles. It was not until the mid-1970s, when University of Washington astronomer Donald Brownlee sent up modified U-2 spy planes with special collector plates, that adequate samples of cosmic dust became available. The program continues with high-altitude bombers that soar into the stratosphere from California's Ames Research Center.

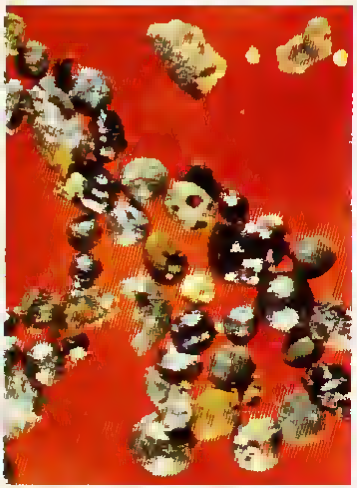
In the stillness that exists at 60,000 feet, where infalling dust can remain aloft for several days, Plexiglas collectors coated with highly viscous oil are deployed from the planes' undersides. After tens of hours of exposure, they come back, dotted with specks no more than a few ten thousandths of an inch across. Most turn out to be airborne pollutants, including particles of rocket exhaust and flecks of volcanic ash, but a precious few are clearly neither man-made nor terrestrial.

Brownlee's group has built up a large collection of samples from space and has set up a special ultraclean laboratory to house its pristine finds. This room-within-a-room at the University of Washington resembles a biological research lab; in fact, much of the technology it uses was originally developed for germ-warfare studies. Yet this collection may someday hold the key to the origin of the solar system.

Within the Plexiglas and stainless-steel walls, the dust samples are first examined and prepared for study with implements no wider than the grains themselves—pipettes a slim five microns in diameter and hair-fine, 10-micron-thick glass rods engineered to microscopic precision for manipulating the particles. Each grain is studied under a conventional microscope and then carefully cataloged according to size, shape, and appearance. But it is only under the powerful scrutiny of the laboratory's scanning electron microscope that the particles' true nature becomes readily apparent.

"They're unlike anything we've ever seen before," says Brownlee. Most particles are aggregates of smaller grains, each one perhaps a few millionths of an inch across, arrayed in what researchers call the "bunch of grapes" morphology. Individual "grapes" possess an extremely fine crystal structure; in fact, an average-sized grain may consist of a million individual crystals.

Under a barrage of high-energy electrons, the dust particles emit a telltale X-ray spectrum that serves as a chemical fingerprint. Not surprisingly, this has revealed that the exotic grains contain many ordinary substances—iron, magnesium, silicon, and other elements common in terrestrial minerals—but often in proportions that resemble the relative abundances seen only in the sun itself. Scientists interpret such unearthly compositions as evidence that the cosmic-dust samples are extremely primitive material, virtually unchanged in the eons since the formation of the solar system. Scientists also believe that the dust has not been continuously exposed to space since the solar system was formed. Free-floating particles could probably survive for at least about 10,000 years before they would be destroyed by repeated collisions with one another. Thus, Brownlee explains, some source must be constantly supplying new particles, or else they would have vanished long ago.



Cosmic dust: extraterrestrial bits of history?

It seems certain that the dust grains have survived for billions of years as parts of larger bodies. These bodies must have been fairly small, perhaps no more than a few miles across, and deficient in the radioactive isotopes whose decay would have heated the grains and erased all signs of their primitive nature. Also, they must have aggregated on the fringes of the solar system, far from the orbits of Jupiter and Saturn, whose gravity would otherwise have pulled them toward the sun. In these distant reaches beyond the warmth of the infant sun, both interstellar dust and ice would have survived completely unaltered. In short, the materials in this collection are believed to have served as the diminutive nuclei of comets.

The thought that these specks that sit cataloged in laboratories are actually cometary material is not as farfetched as it at first seems, Brownlee explains. "If we assume that our collection is a representative sample of extraterrestrial particles, then, from a statistical standpoint alone, it's very unlikely that none of the dust comes from comets." Comets, Brownlee says, are almost certainly major sources of interplanetary particles shed during their brief visits to the inner solar system. And the fragile, porous grains that Brownlee has collected are what astronomers might expect to find as residue from a cometary chunk whose ice had evaporated.

If comets are the archivists of the solar system, as many astronomers think, then cosmic dust offers a momentous chance to study the building blocks from which the sun and the planets arose.

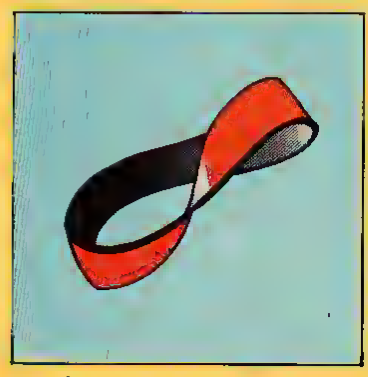
GAMES

By Scot Morris

A burleycue dancer, a pip
Named Virginia could peel in a zip,
But she read science fiction
And died of constriction
Attempting a Mobius strip
—Cyril Kornbluth

In our Last Word column of September 1982, Frank Kendig wrote about the invisible priesthood of mathematicians those seekers of 'pure' knowledge who build castles in the air for the sheer beauty of the structure with no thought of practical applications. Perhaps centuries later, Kendig wrote, someone comes along, pulls down the castle, and scraps it for the parts he needs. As John von Neumann put it, "It is as if one bought a top hat for a wedding and discovered later, when a tire broke out, that it could be used as a water bucket."

When August Ferdinand Mobius, the German astronomer and topologist, first described his familiar Mobius strip in 1858, it was a pure mathematical curiosity. An ordinary surface has two sides, but Möbius showed there are surfaces with only one side. To make the simplest example, cut a 1" strip from the edge of a sheet of typing paper. Bring the two ends together and give them a half-twist (180°), then join them with tape or glue to form a closed loop. This creates a one sided surface (below). If you try to paint only one side of the paper and not the other, you will fail. Draw a line down the center of the strip until you return to your starting point, and you'll find you have marked both 'sides' of the paper, though your pencil never crossed an edge. Moreover, there is only one edge on this surface. It is a single closed curve. If you formed this curve out of wire and dipped it in bubble solution, the resulting soap film would have only one surface—a Mobius bubble.



Cut a Mobius strip down its center, lengthwise, and it stays in one piece. It becomes a narrow strip with two full twists, having twice the circumference of the original. This is against intuition, and is rarely predicted by anyone unfamiliar with it. The topological surprise is commemorated in this anonymous limerick:

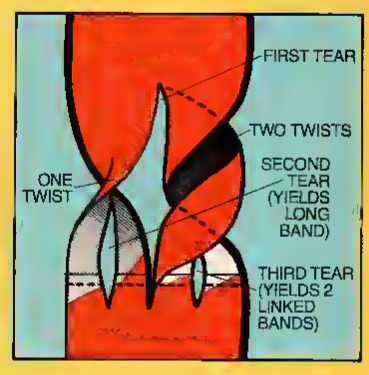
A mathematician confided
That a Mobius band is one-sided
You'll get quite a laugh
If you cut one in half,
For it stays in one piece when divided

If you cut this long loop down *its* middle, you might now expect you'll get an even longer loop, but you won't. You get two large loops that are interlinked.

Instead of bisecting a Mobius strip, you can trisect one. To do this, start the cut a third of the way in from an edge. The cut will go twice around the strip before it returns to the starting point. The result is a thin Möbius band (the central third of the original), linked with a double-sized band that is of the same shape as the one produced by cutting the original band in half. This longer interlinked band has two full twists and two sides.

GADGETS AND STRIP SHOWS

Of what use is a Mobius strip? A few practical applications have been found, none very earth-shattering. The B. F. Goodrich Company has patented a rubber Mobius conveyor belt that lasts longer because it wears equally on both "sides." In 1923 Lee De Forest received patent No. 1,442,632 for a Mobius film strip on which sound could be recorded as a single soundtrack on both 'sides'—an idea that has also been applied to a continuous-loop recording-tape cartridge that will play twice as long. There is a 1963 patent for a dry-cleaning-machine filter belt that needs to be cleaned on only one "side."



Afghan Bands: magic trick with a twist. Bolts for the fat lady and the Siamese twins

For many years the chief use for Möbius's discovery was as entertainment, and some of the earliest students of its strange properties were magicians. Magic tricks based on the Mobius strip have been performed for over a century. The most famous presentation is called the Afghan Bands, a name used by magician Professor Hoffman about the turn of the century. Why this name was chosen is not known, quite possibly just for the exotic sound and the air of mystery it created. (The name Chinese checkers probably has a similar origin, reflecting an intended mystique rather than any historical connection.)

At first the Afghan Bands trick was done with scissors and a huge paper ring about 8" wide and 12' in circumference. (The previously prepared twists aren't noticeable in this large size.) Nowadays it is more commonly done with red muslin, which can be ripped lengthwise down the middle. This touch makes the trick more colorful, dramatic, and faster to perform.

The Great Blackstone used a version similar to this still sold by magic dealers A long band of muslin is prepared (as shown at left) The magician tells a story about working for a carnival sideshow and being asked to produce belts for the fat lady and the Siamese twins The magician tears the wide band down the middle to form two bands The band on the left is then torn down its center to produce one long band—the belt for the fat lady—and the band on the right is torn to produce two interlinked belts for the Siamese twins

A TEST-TUBE TWIST

At long last the work put in by topologists, for the sheer enjoyment of studying an unexplored area and by magicians for the purposes of mystifying audiences is being reviewed by a few organic chemists They are pulling down the Mobius castle and scrapping it for the parts they need

Last year David M Walba and his colleagues at the University of Colorado in Boulder synthesized "the first molecular Mobius strip " The molecule called tris-THYME pictured in the colored model below was the outcome

Molecular Mobius strip In this space filling model of tris THYME created by Colorado scientists hydrogen atoms are white oxygen atoms are red and carbon atoms are black

of research with crown ethers—crown-shaped molecules—in the hope of creating synthetic enzymes that could break down sugars The Colorado group started with long molecular strips having two ends that tended to join each other head to tail, to form loops In about half the cases they found the loops had a half-twist The molecules were Mobius strips When the loop forms without a twist as a cylinder the resulting material is a crystalline solid The Mobius version of the molecule is an oil So far the researchers have successfully performed the first magic trick They have cut the Mobius molecule lengthwise (ozone O_3 is used as the scissors to cut the three carbon-carbon double bonds that hold the ring together) As topologists and magicians predicted they got a molecule with twice the circumference of the original They have yet to perform a chemical equivalent of that second cut down the middle which would produce a molecule of two interlinked rings

At this point the researchers know of no practical use for their chemical curiosity but since the chemical reactions a molecule can enter into are often determined by its shape there may well be combinations that can occur only with single-surface molecules

Other molecular magic tricks are being attempted Starting with more complex strips Walba hopes to get them to form loops with more than one half-twist With two such twists, a cut should produce two interlinked rings With three twists the result will be a molecule with a knot in it!

There are two mirror-image forms of a Mobius strip—with either a right hand (clockwise) or left hand (counterclockwise) twist The Boulder group's soup is a 50-50 mix When knotted molecules are made, they will also come in two forms—right-hand knots and left-hand knots No one yet knows whether twisted or knotted molecules of a given handedness will differ significantly from their mirror-image forms, but it is a good bet that they will since the asymmetrical shapes of other molecules (DNAs right-handed helix for example) often directly determine

chemical properties of those molecules

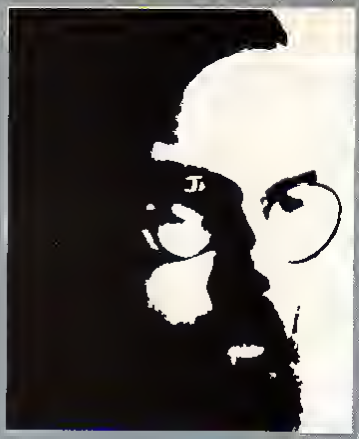
Whether the molecular research will lead to other branches of topological tomfoolery we don't know Perhaps someone will create a molecular analog of the Afghan Bands A better bet is that someone will re-create the curious three-ring configuration shown above To topologists these are known as the Borromean Rings—after the coat of arms of a noble Italian family To the rest of us the shape is recognized as the logo of Ballantine beer The rings have an unusual relationship in that while all three rings are linked no two of them are linked That is if any one ring is removed the two others are found not to be joined If any chemist can create a molecular version of this concatenation we'll treat him or her to a beer

CORRECTION

In October there was a misprint in the answer to the 'Four Fours problem The example of using a decimal point, with four *4*'s to equal 19 should have read

$$19 = \frac{4 + 4 - 4}{4}$$

In the published version the decimal point had been removed from the denominator The error was not our copy editors' but that of an overzealous printer who trying to tidy up a page proof, cleaned off one too many spots!



LAST WORD

By Ted Mann

What other sorts of animals might serve as low-cost alternatives to dope-detecting dogs at airports and prisons? Let us consider the tortoise

Last September the *New York Times* reported that Canadian customs and correction officials needed some sort of detection system to spot drugs being smuggled through border checkpoints and prison gates. At first they considered the usual drug-detecting dogs, but those animals were ruled out as too expensive and too troublesome. Dogs eat a lot, and dogs that eat a lot must be walked a lot. Dogs also bite, shed, and drink water. And dogs that drink water have to be walked a lot.

Then somebody had what must have seemed a good idea. Train a squad of gerbils to be drug detectors. Gerbils have a highly developed sense of smell and could be trained to sniff out cocaine or marijuana on a passerby. Also, gerbils eat little seeds and suck water from little bottles, and when they have to be walked, they can do it themselves on the little spinning wheels that are conveniently built right into their cages.

So a University of Toronto zoologist taught eight gerbils to detect drugs. The animals learned to push a button when they smelled narcotics. That in turn released a rewarding seed or two and activated a red light to alert drug enforcement officers.

But before the gerbils could be deployed, tragedy struck. By accident, or perhaps by criminal design, the eight rodent team was given contaminated water. A short time later the animal detection specialists were found, paws up, on the bottom of their cage/barracks. Undeterred, the Canadian Correctional Service, which conceived the project, has continued its experiments, the *Times* reported, this time under a cloak of the utmost secrecy.

What sort of animals might serve as low-cost alternatives to dope-detecting dogs at international airports and provincial prisons?

Let us consider the tortoise. Admittedly it is an animal of notoriously limited intelligence: it learns almost as slowly as it travels. But on the positive side it has a very long life span, which may make it possible, after several decades of training, to teach a tortoise to distinguish the odor of narcotics from, say, the odor of old socks. Also, tortoises require little attention and can subsist on a diet of flies, possibly supplemented from time to time with some of the marijuana seized as a result of their efforts.

Skunks also have, well, not much, but a little to recommend them. For one thing, they come complete with their own distinctive black-and-white uniforms. For another, they would also command the fear and respect of drug smugglers. In fact they would command the fear and respect of just about everybody. And as for the question of whether skunks can smell, the answer should be obvious.

Parrots and other talking birds might prove to be another real deterrent to drug smugglers. What criminal could maintain that steely eyed professional calm essential to successful criminal enterprise while a 25-pound, multicolored macaw flapped about his head shrieking, "Polly wanna joint?"?

How about tarantulas? Many a drug runner would confess on the spot rather than have his person searched by trained tarantulas. (So would most other people, but they could always be released later if they weren't carrying anything illegal.)

A team of chameleons would be ideal for working under cover, slinking up a pair of madras shorts unobserved by the wearer, crisscrossing flowered Hawaiian shirts in search of contraband. When they found any illegal substances, they could then turn international safety orange alerting human law-enforcement officers nearby to their discovery.

Frogs may not at first seem a good prospect; yet they, too, have a considerable number of qualities to recommend them. They are waterproof, pocket sized, and fast. For drug-enforcement purposes there is also a variety of Andean frog that, in addition to being familiar with alkaloids derived from the coca leaf, can secrete a deadly toxin through its skin. My understanding is that this natural poison is so virulent there is no need, say, for the frog to jump directly into the smuggler's mouth in the event of an arrest. Simply hopping onto the criminal's hand should be sufficient to paralyze the class of person who travels with mirrored shades and a false bottom in his suitcase.

It may not even be necessary to go to the trouble of training frogs for this job. Consider how many potential criminals are probably deterred from attempting construction-site robberies by huge signs reading, "These premises protected by dozens of vicious trained attack dogs." Often the sign is enough. There is no need for the dogs to be vicious, to be trained or even to exist at all.

Likewise, imagine the deterrent effect of signs in airports warning, "Highly Trained Drug-Detecting Attack Frogs on Duty 24 Hours." Daunting indeed.

Whether the Canadians will choose to employ one of the animals suggested here will not be known for some time, the ultrasecret animal-agent development program is still in progress. But law-enforcement agencies in the United States would do well to keep an eye on what new developments result from the Canadian program. It may be that one day we shall see hamsters or fruit bats on customs duty at Kennedy Airport.

Ted Mann is an animal lover and senior editor on the staff of the National Lampoon