OMNI

SEPTEMBER 1980 $2.00

CARL SAGAN TOURS THE COSMOS • THE UNBREAKABLE CODE
LIFE ON A NEUTRON STAR • SHAPING TOMORROW'S DREAM CARS
INSIDE THE HALLUCINATING BRAIN • ROBERT SILVERBERG RETURNS

0 778845 09

OMNI

SEPTEMBER 1980

CONTENTS

			PAGE
FIRST WORD	Opinion	Bernard Dixon	6
OMNIBUS	Contributors		8
EARTH	Environment	John J. Berger	16
LIFE	Biomedicine	Bernard Dixon	18
SPACE	Comment	Brian O'Leary	22
MIND	Behavior	Peter Evans	24
BOOKS/THEATER	The Arts		28
UFO UPDATE	Report	Harry Lebelson	32
CONTINUUM	Data Bank		35
ACCELERATIONS	Article	Dean Ing	44
OUR LADY OF THE SAUROPODS	Fiction	Robert Silverberg	50
CARTOGRAPHER OF CONSCIOUSNESS	Article	Brian Van der Horst	54
LIFE ON A NEUTRON STAR	Article	Robert L. Forward	60
C. NORTHCOTE PARKINSON	Interview	Bernard Dixon	68
SPACE WITNESS	Pictorial	F. C. Durant III	72
IN THE HEREAFTER HILTON	Fiction	Bob Shaw	80
UNBREAKABLE CODE	Article	Roger Rapoport	84
THE CURIO SHOP	Fiction	William Kotzwinkle	100
CARL SAGAN'S COSMOS	Article	Jeff Rovin	104
ONLY YOU, FANZY	Fiction	Sherwood Springer	108
PEOPLE	Names and Faces	Dick Teresi	118
EXPLORATIONS	Travel	Ben Mayer	121
STARS	Astronomy	Gregory Benford	123
LIQUID CRYSTAL	Phenomena	James Bell	124
GAMES	Diversions	Scot Morris	128
LAST WORD	Opinion	David E. H. Jones	130

Vienna's master of fantastic realism Rudolf Hausner produced the cover art for this month's Omni. Laocoön in Orbit, done in tempera mixed with resin and mounted on Novopan sheet, visualizes the singularity of progress and space. Born in 1914, Hausner has been painting for 50 years.

OMNI, 1980 (ISSN 0149-0711). U.S. Volume 2, Number 12. Published monthly in the United States and in Canada by Omni Publications International Ltd., 909 Third Avenue, New York, N.Y. 10022. Tel. (212) 593-3301. Printed in the U.S.A. by Meredith Printing Corp. and distributed in the U.S.A., Canada, U.S. territorial possessions, and the world (except the U.K.) by Curtis Circulation Company, 21 Henderson Drive, West Caldwell, N.J. 07006. Distributed in the U.K. by SM Distribution Ltd., 16–18 Trinity Gardens, London SW9, England. Subscriptions: U.S., APO—$24.00 one year. Canada and elsewhere—$30.00 one year. Single copies $2.00 in U.S., APO, $2.25 in Canada. Address changes to Omni Magazine, P.O. Box 906, Farmingdale, N.Y. 11735. Postmaster: Send form 3579 to Farmingdale address. (ISSN 420-1894. Controlled circulation postage paid at Des Moines, Iowa. Publisher disclaims all responsibility to return unsolicited editorial matter and all rights in portions published thereof remain the sole property of Omni Publications International Ltd. Letters to Omni or its editors become the property of the magazine and are assumed intended for publication in whole or in part, and may therefore be used for such purposes.

FIRST WORD

By Dr Bernard Dixon

"Little action has been taken to mobilize the planet's astronomical reserves of microbial talent"

There's no shortage of candidates vying for the title of mankind's greatest lunacy. The nuclear-arms race, religious fanaticism, environmental rape — the list is endless. However, there is one idiocy that would surely strike a visitor from "out there" much more forcibly: our feckless experimenting in building modern industrial society on a single, precious resource. He, she, or it would not see this as simply a political error. Our alien visitor would merely compare our precarious dependence on oil for energy and petrochemicals with our appalling neglect of another, potentially infinite resource: microorganisms. Oil is expensive and unevenly distributed; microbes are inexpensive and ubiquitous. Oil is exhaustible; microbes are virtually immortal. Oil is a limited feedstock for the chemical industry; microbes have unrivaled versatility.

Here we are, celebrating the recent eradication of one microbe — the smallpox virus — while we overlook an astronomically larger population of beneficent microbes. Disease-causing germs are a distinct minority on our planet. Yet these harmful microbes alone, rather than the helpful ones, have been the objects of international initiatives and global action.

There are, of course, signs that we are learning some lessons. The steep rise in the price of crude oil has led to a gradual reassessment of our relationship with microbes, which can be exploited directly as sources of cheap power and can be used to replace energy-intensive fertilizers. The result? We begin to see that reliance on microorganisms for basic necessities is a sounder, cheaper, and ecologically saner policy than a tenuous dependence on oil and petrochemicals.

Gasohol and methane from fermentation are two of the inexhaustible sources of microbial power. Mining with microorganisms is a burgeoning field now that it is economic wisdom to extract precious metals from low-grade ores.

Nitrogen fixation furnishes another excellent case. We use 2 million barrels of oil every day, worldwide, to make ammonia fertilizer. This need is increasing apace — paradoxically, because the high-yield crops of the "green revolution" depend heavily on fertilized soil. A spate of breakthroughs has indicated that nitrogen-fixing microbes might satisfy fertilizer needs more efficiently and less expensively than current methods do. One example reported at this year's American Society for Microbiology conference was the discovery of a strain of *Rhizobium* that, unlike others, thrives in legumes despite drought, salty conditions, and excessive acid or alkali in soil.

Exotic species and genetic engineering apart, existing knowledge could be applied very much more effectively. For instance, a minute quantity of peat, carry-

[illegible] can [illegible] chemical fertilizer. [illegible] of Legume [illegible] at the University of [illegible] way to discover [illegible] are not more [illegible]. [illegible] has now [illegible] just how much [illegible] to maintain [illegible] clues came from the [illegible] that follow when [illegible] used indiscriminately [illegible] their intended targets, but also [illegible] benevolent bacteria. More recent research has revealed that totally [illegible] benefits accrue from [illegible] the body. Scientists at the ASM meeting, for example, reported that some germs in the intestine [illegible] babies against infant [illegible] recognized, macabre cause [illegible] raises the prospect, hinted at 50 years ago, that we can [illegible] ourselves from infectious diseases [illegible] effectively by adjusting the body's own [illegible] population than by [illegible] that may have unwanted side effects.

What we really need is a revolution in our attitude [illegible] the microscopic world. Most [illegible] focus on microbes almost [illegible] as causes of disease, death, [illegible] decay. Nitrogen-fixing bacteria in legumes and the sea remain the odd exceptions. But their contribution, compared [illegible] made by the chemical [illegible] appears [illegible]. For some of us the most persuasive example of microbial [illegible] ment has been the virus that produces [illegible].

The situation is changing, and yet this is still [illegible] no strategy. Despite the initiatives [illegible] being pursued to develop biotechnology, despite the flow of discoveries [illegible] medical perspective on microbes, we have no plan — or even plans [illegible] a plan. Contrasted with the massive world campaign that destroyed smallpox or the global machinery used to chart the spread of influenza, very little action has yet been taken to mobilize Earth's astronomical reserves of microbial talent available to help us.

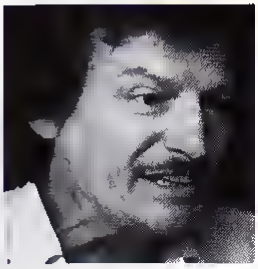
Why? A large part of the answer is our sheer disbelief in the power of primitive creatures that are not visible to the naked eye. The idea that bacteria can induce chemical reactions better than chemical engineers can is as perplexing as the argument that we can often trust in our own microbes rather than in miracle drugs to eliminate disease. But the lessons are clear. Having spent much of the past century developing weapons to deploy against unseen foes, we must think afresh. We need to formulate strategies for working with a vastly greater army of invisible allies. And the need is urgent. ∞

Dr Bernard Dixon, formerly editor-in-chief of New Scientist, is Omni's European editor.

CONTRIBUTORS

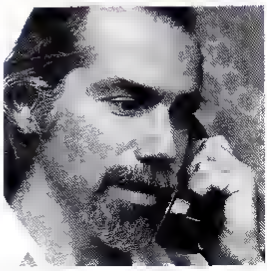
OMNIBUS

VAN DER HORST



ING

FORWARD



SILVERBERG

Focusing on a controversial topic this month in "Cartographer of Consciousness" (page 54), *Brian Van der Horst* profiles the work of experimental psychologist Ronald K Siegel. Van der Horst traces the scientific study of hallucinogens and their effects on human consciousness as recounted by trained 'psychonauts.' With a mischievous tinge in his voice, Van der Horst author of more than 1,000 articles and several books, admits that he finds Timothy Leary–like quests and other drug-related research "passionately intriguing." "Drugs are part of the essential fabric of our society,' Van der Horst says. "They're what make us human. There is not a human being alive who has not employed some consciousness-altering drug, be it alcohol, cigarettes, coffee or whatever."

Van der Horst cites intense scientific investigation of drug potential as the first step toward societal 'enlightenment.' The author himself was once involved in drug research; he began his diversified career as a marine biologist, studying alkaloids. If asked to volunteer for psychonaut duty, Van der Horst says he would gladly participate in the adventure.

Writer *Dean Ing* worships efficiency. While a young aerospace engineer, he was struck by the faulty engineering of standard cars. "I knew damned well cars could be designed a lot better than they were," Ing says. "Any number of people could do better than the auto industry." So Ing took a stab at it himself, creating the Magnum GT Coupe. His article 'Accelerations" (page 44) stresses the functional aerodynamic designs that American and foreign auto companies must soon adopt. "The American companies are pressed almost to the wall right now,' says Ing. "They are beginning to recognize the significance of the fuel crunch and the recession." According to Ing, American Motors will be the new trendsetter as it shares ideas with Renault, creator of the futuristic EVE sedan. Besides designing survival equipment, Ing has written two novels, as well as three short stories for *Omni*.

"I'm a frustrated professor. That's why I write," says *Dr Robert L. Forward*. The physicist, who has written several articles for *Omni* during the past year, has just completed his first novel, *Dragon's Egg* (Ballantine), published in May of this year. The novel is about tiny, dense, intelligent creatures on the surface of a neutron star who live and think a *million* times faster than the humans who study them. The story concerns the attempts of the two cultures to communicate on converging orbits despite immense differences in their rates of thinking. "Life on a Neutron Star" (page 60) is a synthesis of Dr Forward's notes for the novel, which are also incorporated into the book's 5,000-word, 14-diagram appendix.

This month's Earth column, "Greening the Seashore' (page 16), is by renowned environmentalist *John J. Berger*. Author of *Nuclear Power: The Unviable Option* (Dell, 1979), Berger recently published a detailed analysis of the emergency response to the Three Mile Island nuclear accident for a German news anthology. Employed by the Lawrence Berkeley Laboratory, Berger has served as an energy consultant to several organizations and has testified on energy issues before federal and state agencies.

Robert Silverberg ("Our Lady of the Sauropods," page 50) first appeared on the science-fiction horizon in the 1950s. During the last 20 years he has produced a seemingly endless stream of books. Winner of four Nebula awards and two Hugos, Silverberg also served as president of the Science Fiction Writers of America. His more notable works include *Nightwings* (1969), *Tower of Glass* (1970), *Dying Inside* (1972) and most recently *Lord Valentine's Castle* (1980).

Joining Silverberg this month is British author *Bob Shaw* ("In the Hereafter Hilton," page 80). An enthusiastic reader of science fiction since childhood, Shaw tried his hand at writing when he was twenty and sold his first short story to the *New York Post*. After an absence of several years he returned to writing in 1966 with "Light of Other Days," one of the most anthologized short stories in science fiction. In 1967 he produced his first novel, *Night Walk*. Since then Shaw has averaged a book a year, one of which, *Orbitsville*, won the British Science Fiction Award for Best Novel of 1975.

LETTERS

COMMUNICATIONS

Mass-Molded

In her article "Psychographics" [July 1980] Bibi Wein confesses that "the advertising community's reaction was very negative" toward brain wave analysis. Yet the author apparently ignored the moral subtleties involved.

The larger issue of increasing control over public opinion is a complex one and must be carefully evaluated. Where do we draw the line between advertising and brainwashing? To what extent do we want our attitudes scientifically mass-molded?

Propaganda campaigns can lead to frightening conformity and a dangerous lack of individual thought, whether they are conducted in Russia, Nazi Germany or McCarthy Era America. Brain-wave analysis may constitute great progress in advertising, but we cannot allow technology to destroy the freedom of individual thought.

Laura Collins
Winthrop, Mass.

***Bufo* Buffoons**

Say it's true! Tell us there really are giant flying vampire toads [Last Word, June 1980]! It's about time we fought back against the weak-kneed hypocrisy of today's conservationists. Slobbering, slimy green things have rights, too.

Where can we obtain more information about our brothers and sisters the vampire toads? Here in Athens we have been waiting for a worthy cause that we could sink our teeth into. Save the toads!

Athens Friends of the Toads
Athens, Ga.

I read Norman Spinrad's Last Word concerning the giant flying vampire toad (possibly *Bufo bloodsuckus*?) with a great deal of enlightenment.

One solution to the problem of their extinction would be to relocate them to a similar habitat in one of the OPEC nations. After all, turnabout is fair play.

Ray Hermann
Slidell, La.

Not only may the giant flying vampire toad be important as the ultimate ecological awareness test, but it may also be from another world. A U.S. spacecraft carrying one from a distant world returned to Earth last year with an alien on board looking much like the toad. We may be destroying the last of a species from another planet. It may be the only species like it in a billion worlds, including our own.

Steve Conklin
Las Vegas, Nev.

Re: "Save the Toad!"

Confucius say: "He who puts tongue in cheek should beware of biting sarcasm."

Suzanne J. Helder
Gulfport, Miss.

Because of the overwhelming response Omni has received from television and radio stations, newspapers, and libraries, nationwide, the Environmental Protection Agency has asked us to report that it has failed in its efforts to arrest the precipitous decline of the flying vampire toad. Golfing welfare recipients seem unwilling to serve as hosts to the ornery bloodsuckers. —Ed.

Equal Time

Omni quoted Sir George Porter as saying, "If sunbeams were weapons of war, we would have had solar energy centuries ago" [Continuum, June 1980].

In light of the nuclear-energy debate now going on, I would add the following: "and antisolar organizations."

S. W. Peters
Potomac, Md.

Women in Space

In general I have found *Omni* to be a refreshing look at the future through the eyes of the present. Although I have disagreed with some of the contributors' viewpoints, they have been food for thought, sometimes helping me to clarify my own opinions.

I was quite pleased also that here at last was a nonsexist science/science-fiction publication.

I wait in vain for NASA to have "staffed" missions instead of "manned" ones, but NASA is a government agency with its roots in the military.

CONTINUED ON PAGE 120

DIALOGUE

FORUM

In which the readers, editors and correspondents discuss topics arising out of Omni and theories and speculation of general interest are brought forth. The views published are not necessarily those of the editors. Letters for publication should be mailed to Omni *Forum,* Omni *Magazine, 909 Third Avenue, New York, NY 10022*

Not a Religion?

Roane Dantzler and Gregory Trulen insist that TM is not religious [Forum, June 1980]. Maybe they are too close to the forest to see the trees.

No one who reads TM founder Maharishi Mahesh Yogi's book *Transcendental Meditation* (Signet, 1968) can fail to recognize that TM is religious in both theory and practice. The initiation *puja* is a Sanskrit prayer to Hindu deities. Most, if not all, of the TM mantras are the names of Hindu deities. As explained by the maharishi, meditation a la TM is a religious act analogous to Christian prayer or communion.

Further, on February 2, 1979, the U.S. Third Circuit Court of Appeals ruled, upholding a lower court ruling, that TM is so religious that it cannot be taught or promoted in public schools (*Malnak v. Maharishi Mahesh Yogi*). The TMers did not opt to appeal the case any higher.

Edd Doerr
Director, Educational Relations
Americans United for Separation of Church and State
Silver Spring, Md.

I recently visited Maharishi International University, in Fairfield, Iowa, to lecture about theories of the mind. The TM movement respects science, and [its practitioners] have good evidence that TM induces a brain state different from sleep or other common conditions. On this is built an elaborate dogmatic belief that TM connects one with a fundamental consciousness that pervades the entire universe.

TMers collect evidence that would prove that when a group meditates together, the crime rate declines in the neighborhood. When I asked the assembled faculty and students whether there was a single such experiment that did not so succeed, there was a long, unembarrassed silence. If it's true, why should there be any contrary evidence? The students I met could not yet levitate, but they expected to do so soon; others could, they said, but they would not do it merely to impress a visitor.

TMers reward each other for being positive and unconsciously learn to suppress evidence contrary to their ideas. I tried to explain that good scientists are as suspicious of evidence that is too good as of that which is too bad. Science and religion are not so different in the end except that, in science, the ultimate sin is believing too strongly.

Marvin Minsky
Massachusetts Institute of Technology
Cambridge, Mass.

Project Private Enterprise

In *Omni*'s Competition column [June 1980] it was disclosed that the idea most commonly suggested for a prize offering was that a completely privately sponsored astronaut be launched into earth orbit.

Kathleen Stein contributed an excellent piece in the October 1979 issue of *Omni* on Robert C. Truax, of Saratoga, California. Mr. Truax, the father of the Polaris program, has spent five years developing suborbital vehicles to carry the world's first private astronaut.

Volksrocket: first step to manned flights

As a direct result of Ms. Stein's article, a group of about 40 Chicago businessmen has joined Truax in the formation of Project Private Enterprise, Inc. His dream has now become a distinct reality.

PPE, America's newest aerospace corporation, has scheduled its first manned launch for the fall of 1981. Once this is accomplished, Truax will have established the solid economic concepts of space development that he has espoused throughout his splendid career. These concepts include simplicity of design, total vehicle reusability, and use of proven surplus components. We will truly prove that space is available not only to private industry but to the individual in his backyard as well.

John J. Oelerich
Project Private Enterprise
Burbank, Calif.

At the end of June, Truax ran a static firing test in which the rocket was held down while the engines were fired. During the test the engines developed some 4,000 pounds of thrust, enough to propel the rocket at 2,500 mph. While this is not fast enough to attain an orbit (escape velocity is 17,000 mph), it is fast enough for the 15-minute suborbital flight planned. We will watch the program as it develops and will keep readers informed of progress. —Ed

Challenging the Randi Challenge

James Randi's offer of $10,000 for a valid "psychic" feat that cannot be accomplished by "existing technical means" [Interview, April 1980] seems generous, but it is really a double-edged sword. Alas! Would that I had $10,000 to offer Mr. Randi for nothing more than an *example* of *any feat* that could *not* be accomplished by existing technical means!

Cynicism aside, you cannot approach a phenomenon from the backside. Suppose a psychic were to set a steel ball on a tabletop and, after four hours of intense concentration, cause it to roll one quarter of an inch. The scientific implications of

CONTINUED ON PAGE 113

GREENING THE SEASHORE

EARTH

By John J Berger

Immense primordial forests Elk and panthers Fragrant tall-grass prairies Vast flocks of wild geese Sweet-tasting streams Endless kilometers of productive wetlands Shores full of oysters, clams, and crabs North America, before the Europeans came

With each generation, the memory of mankind s environmental heritage dims Some of us forget how the air should smell how the land should be A few scientists have not forgotten One of them is Dr Edgar W Garbisch, Jr a chemist turned restoration biologist who by reconstructing our ravaged coastlines and wetlands is charting a course for the future

Dr Garbisch helped pioneer the infant science of resource restoration The idea is simple Take one eroding marsh truck in landfill plant thousands of seedlings, and then watch them grow

It may sound simple, but Garbisch s first planting, for instance, was destroyed by Hurricane Agnes A passing flock of Canadian geese devoured another planting But when conditions are right the technique works very well indeed

Why reclaim salt marshes? Biologically they are among the most productive areas on Earth More than five metric tons of useful organic matter is generated on each hectare—about twice as much as a cornfield Marshes form the base of an entire pyramid of food supporting bacteria algae, and plankton on up to simple invertebrates, mollusks shore birds mammals and—finally—humans Destroying a marsh destroys this food web at its source the ripple effect is enormous Even remote ocean fisheries are affected when a marsh is destroyed More than half of all commercially useful fish live in coastal waters or use coastal marshes as nurseries hatcheries spawning grounds, or feeding grounds

As a boy Ed Garbisch spent his summers on Chesapeake Bay and later bought a home on the bay One year he decided to try to reconstruct the marshland in front of his home After hand-transplanting cordgrass seedlings (a type of marsh plant native to the Chesapeake), he sat back to wait

Within months the plants began to take root and slowly collect sediments As more silt was trapped the plants elevated themselves out of the water adding new land to the shore

Buoyed by his initial success, Garbisch persuaded the Nature Conservancy to fund a larger project From there it was a short step to Environmental Concern, Inc a nonprofit organization formed by Garbisch to deal exclusively with reclamation Within the next few years he perfected his techniques and supervised 40 of 105 marsh-restoration projects in the United States All but five were successful

The new marshes are popular with a wide range of users government agencies educational organizations, environmental groups public utilities, and private citizens Some property owners use the marshes to protect their waterfront land from erosion or to enhance its appearance and value

Public utilities are especially interested in restoration "They are obliged to agree to it," Garbisch explains "because otherwise they can t get state and federal permits to build in wetland areas Rerouting a pipeline seventy-five kilometers around a wetland could cost a utility millions of dollars "

Because his environmental tampering sometimes makes life easier for large corporations Garbisch occasionally provokes controversy Restored habitats may not be biologically identical to what was there before, despite surface similarities It's better never to disturb a marsh, instead of devastating and later repairing it Even Garbisch's critics agree, however that once wetlands have been obliterated marsh restoration is the only way to transform barren wastelands into useful resources again

The large-scale use of restoration technology like Ed Garbisch's must wait until the process is recognized as a major political and social priority In the meantime, while the debate rages on, the marshes built by Environmental Concern will flourish And future generations—whose images of pristine America will be fainter than our own—can relive the wilderness as it once was, and soon will be ∞

Future generations will relive our natural heritage through the restoration of coastal wetlands

SEA SERPENT SURVEY

LIFE

By Dr Bernard Dixon

Between 1872 and 1885 *Nature* published 19 papers on sea serpents. A century later, despite its editor's decision in 1975 to print Sir Peter Scott's paper that gave a taxonomic name to the Loch Ness monster, the scientific journal no longer deals with such creatures. In the 1980s sea serpents are pretty much beyond the pale. It is doubtful that this year's crop of sightings will be paid serious consideration by any reputable academic journal.

Why? Is it because previous claims have been shown to be bogus? Has the number of reports dwindled, gone the way of such other nineteenth-century fancies as tables and chairs that jerk across the room on their own accord?

The answer is no. And yet the literature keeps on accumulating. If a sea serpent (or the carcass of one) were actually discovered, volumes of source material would be available to help investigators pursue their inquiries. As the history of other bizarre phenomena shows, the fact that much of this information is contained in popular rather than technical publications does not invalidate it. Consider ball lightning. Most descriptions of this phenomenon are anecdotal rather than objective. They appear in diaries and biographies, not in scholarly periodicals. Yet scientists generally agree that ball lightning exists.

The analogy of ball lightning comes forcibly to mind through the work of one whose life interest has been sea serpents, Professor Ron Westrum of Eastern Michigan University. Is not in pursuit of his prey per se. What fascinates him is the way extraordinary claims are advanced and assessed. Tales of sea serpents are a particularly challenging example and thus have become the focus of his research. Already Westrum has exposed some misconceptions concerning the origins of reports about such putative animals. Although we may remain as skeptical as before, we are forced to concede that the case for sea serpent sightings ought to be taken seriously.

The publication of Professor Westrum's survey in a recent book suggests that a community of investigators is already operating free of the constraints that rightly fetter most mainstream scientific research. *On the Margins of Science*, edited by Roy Wallis (Keele University Press, Staffordshire, England), contains several surveys, on subjects ranging from acupuncture to ufology, that indicate a more generous, though still critical, approach to "rejected knowledge."

Westrum defines a sea serpent as "any large, elongated marine creature of an apparently unknown species." The earliest reports (other than folk tales) were made in 1755. But the first serious scientific investigations were stimulated by sightings off the Massachusetts coast from 1817 to 1819. They and other observations from the British ship *Daedalus*, provoked a scientific controversy that continued until the end of the nineteenth century.

If we turn from the literature spawned by this debate to the original reports on which it was based, one interesting fact emerges. Sea serpent sightings occur on an average of three a year—a rate that has remained constant since 1800. In view of the massive growth of population over this period, this is a remarkable finding.

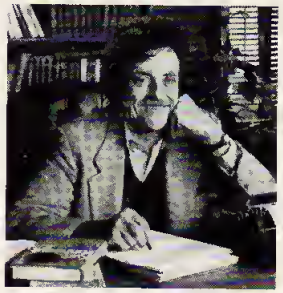
Westrum examined the claim that newspapers, influenced by the summer "silly season," publish and thereby stimulate batches of sea serpent reports at that time of the year. Summer does turn out to be the period when most *sightings* are alleged, more than the other seasons combined. Yet the peak times for sea serpent *stories* are spring and fall. Many reports are retrospective; the time of publication is thus irrelevant. Sightings *are* summer phenomena, not simply a response to the whims of newspaper editors.

Westrum's analysis also shows that information concerning these creatures continues to grow in fits and starts, but it does grow. This pattern is not unlike a scientific discipline evolving toward maturity. And the fact that individual scientists seldom consult witness accounts when making up their own minds about curiosa does not mean they do not exist. All that awaits their legitimization is the discovery of a real specimen, dead or alive. ∞

Sea serpent: legendary beast or real phenomenon? Sightings occur at a rate of three per year

How to write with style

By Kurt Vonnegut



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

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

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

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

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

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

1. Find a subject you care about

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

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

2. Do not ramble, though

I won't ramble on about that.

3. Keep it simple

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

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

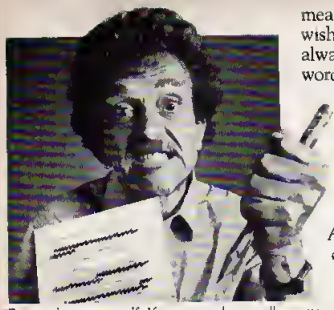
4. Have the guts to cut

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

5. Sound like yourself

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

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



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

and employs a vocabulary as unornamental as a monkey wrench.

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

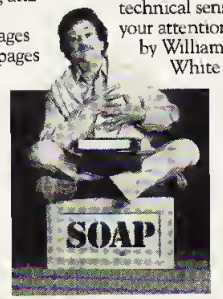
All these varieties of speech are beautiful, just as the varieties of butterflies are beautiful. No matter what your first language, you should treasure it all your life. If it happens not to be standard English, and if it shows itself when you write standard English, the result is usually delightful,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

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

6. Say what you mean to say

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

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



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

7. Pity the readers

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

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

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

8. For really detailed advice

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

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

RETURN TO THE MOON

SPACE

By Brian O'Leary

There has been a lot of talk about satellite solar-power stations space colonies, and removing the limits to growth on Earth by using the staggering abundance of resources and energy available in space Recent engineering studies show that these proposals could solve the finite-Earth problem once and for all The investment would be a mere fraction of the annual U S gross national product, the return would be many times that amount

That is the vision But in reality with the exception of new defense projects we Americans are in a short-sighted thinklittle belt-tightening period NASA has cut back advanced planning to one tenth its 1966 level, and the visionaries now find themselves grappling for meager private funds designing cruise missiles, teaching or writing for scientific journals Many are opening delicatessens or wandering the streets in bewilderment Some of us have done all of these Despite this, at least ten subscriber-funded space-advocacy organizations have been established The public wants more action than our timid space policy offers

So we are challenged to think smaller Can we open the resources of space within NASA's austere plans? The answer appears to be yes

Certain engineering studies reveal that an early return to the moon is a surprisingly cheap and important step Several months ago scientists attending a workshop addressed the question What is the smallest feasible facility that could transport process and manufacture useful products from lunar materials? They found that a rapidly growing self-replicating and cost-effective system could be built launched and landed on the moon with an investment of about $5 billion This is approximately what NASA spends in one year or 1 percent of the annual federal budget

There is no need to invest tens of billions of dollars Apollo-fashion to begin using lunar resources At first we need only land about 60 tons of equipment on the moon and place 90 tons of factory apparatus into a high Earth orbit

The equipment on the moon includes a small electromagnetic mass driver a plant to mine and process silicon from the lunar soil and some self-replicating machines The processing plant produces solar collectors to power the installation and the other machines enlarge the processing plant and mass driver

Raw materials launched from the moon by the mass driver could be collected smelted and fabricated in space At first the products would support NASA and U S Air Force satellites planned for geosynchronous orbit Later they would contribute to satellite solar-power stations and space habitats

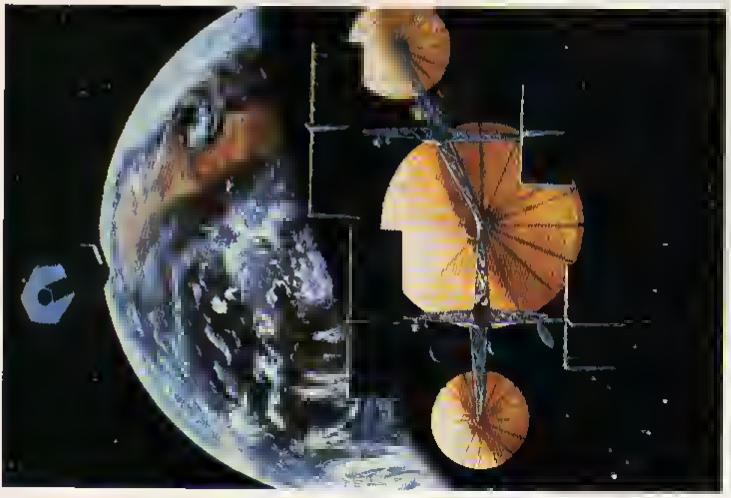
The study found that the mass driver could launch about 1,800 tons of lunar material during its first year of operation This would double every 90 days We could reach the astounding production rate of 100,000 tons per year after only two years

The mass driver and processing plants would produce about 100 times their own mass in one year After three years we could begin to build full-scale solar-power satellites to send energy to Earth

The rewards of this project would far outstrip the costs and—perhaps even more significant—the rationale for investment is a short-term one supporting the relatively modest programs NASA and the Air Force have already planned

During that period we'll be putting a new generation of communications and survey satellites into geosynchronous orbit Hundreds and later thousands of tons of fuel (mostly oxygen), solar collectors (mostly silicon) and space structures (mostly aluminum) will be required These materials must either be hoisted the last two thirds of the way out of Earth's gravity from low shuttle orbits or be produced in space from lunar materials The extra $5 billion it would cost to put a mining facility on the moon would be a small price to pay

Food for thought It appears that we don't need grandiose visions to justify space manufacturing with extraterrestrial materials We can do it now This is good news for those of us who have been waiting so long for an aggressive space program If we can ease communication with the bureaucracy just a bit ∞



The need to build and fuel space projects now planned justifies the creation of lunar mines

STAR-CROSSED MIND

By Peter Evans

What do Lyndon Johnson, Maria Callas, and Martin Bormann have in common? Or Lewis Carroll, Charlie Chaplin, and Richard Nixon? The common denominator, believe it or not, is their exact moment of birth. Not the month or week, but the precise hour.

French psychologist Michel Gauquelin suggests that more than coincidence is at work in the birth of famous people at similar times during the daily planetary cycle. He has compiled an enormous mountain of statistics that indicate the planets "provoke" success based upon their position in the sky at the moment when these people are born.

If a fairground fortune-teller offered this notion, no one would take it seriously. Astrology, after all, is considered far from scientific. But Gauquelin, highly respected in his field, has thrown a statistical monkey wrench into the gears of skeptical science.

Back in the 1950s Gauquelin destroyed any scientific claims for astrology in a classic, massive study. While doing his research, however, he found a separate correlation he couldn't explain. Among his figures were the exact birth times of 500 members of the august French Academy of Medicine. From these Gauquelin calculated the precise position of the planets in the sky when the births took place. Famous doctors, he discovered to his surprise, showed a distinct preference for being born when either Mars or Saturn had just risen or had just reached zenith.

The relationship seemed significant, but Gauquelin insisted upon meticulous statistical results. So he and his wife logged the birth times of more than 20,000 celebrities. They then matched the times with the positions of planets in 12 sectors of the sky.

They found correlations, hard to ignore. The periods just after planetary rising and around the zenith appeared quite influential. The number of scientists born in those critical sectors exceeded chance by odds of 300,000 to 1.

Saturn seemed well placed at the birth of writers and painters. Mars, fittingly, dominated when soldiers were born. Some planets appeared to have negative effects. For instance, only 203 of 1,473 painters were born with Mars in critical sectors, where chance predicted 253. The odds against this were 200 to 1.

Perhaps, Gauquelin concluded, planetary influences and human personality are intertwined in a way neglected by astrology. His six volumes of data made a weighty case to consider.

But there were anomalies in the findings. Albert Einstein, for one, should have been born when Saturn was predominant. He wasn't. His birth at 11 A.M. on March 14, 1879, came just after Jupiter reached its zenith. This position is associated with performers and extreme extroverts. Proponents explain the apparent inconsistency by claiming Einstein wasn't an ivory tower thinker but the Danny Kaye of science, sticking his tongue out at journalists and mocking ritual and pomp.

Despite the soft spots, Gauquelin's speculations raise fascinating questions. If his statistics have uncovered some relationship between personality and planets, what is its nature? Is it truly an influence, shaping our ends, pulling us into certain paths, attuning us to the cosmos? And does the unborn child, then, interact with space and initiate its own birth at the proper instant?

Gauquelin feels there is an influence exerted, but he remains hazy about its form. He doesn't believe in rays of some arcane sort that zap the baby at birth, determining its personality. But he does feel that there is a link between the child's genetic inheritance and the moment it selects to initiate birth. He notes that only natural births establish a correlation. Cesarean—or induced-labor—births produce no significant results.

The basic problem with Gauquelin's theory, though, is the lack of a suitable definition of temperament. His current definition consists of long lists of traits so elastic that they become ambiguous.

Still, Gauquelin hopes to find the proper context for his findings. He eschews all horoscopes as irretrievably misguided. Instead he is struggling to produce a convincing case for his findings as solid science. He just may succeed. If he doesn't, it won't be for lack of trying. ∞

Our personalities may be influenced at the moment of birth by the position of stars in the sky

BOOKS

THE ARTS

By Gerald Jonas

There was a time when science fiction, the self-proclaimed literature of the future, had no past. At least, that was my impression in the late Forties when I first discovered *Astounding Science Fiction* and its competitors in the candy-store racks. The writers and editors of that golden age of magazine science fiction certainly recognized a debt to Jules Verne and H. G. Wells. Yet for the most part they did not identify with previous literary traditions, either as a source of inspiration or as a set of conventions to rebel against. They imitated not the classics but one another; they defined their achievements by pulp-magazine standards, and if they thought of antecedents it was in terms of back issues.

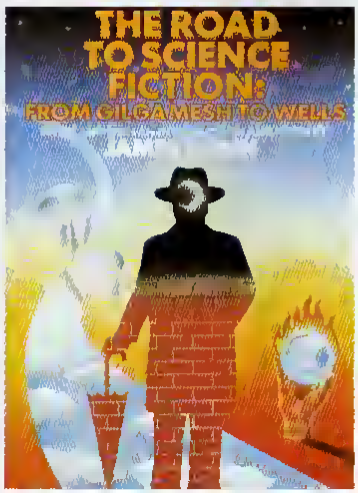
How times have changed! During the last two decades science fiction has been welcomed into academe, both as teaching material and as a subject fit for scholarship. And book publishers have obligingly brought out a number of annotated anthologies aimed more or less at the college market that try to relate contemporary science fiction to the mainstream of literary history. The biggest, the most ambitious and in many ways the best of these anthologies is James Gunn's *The Road to Science Fiction*, available in three paperback volumes from New American Library.

Gunn, an SF writer who teaches at the University of Kansas, has provided a critical/historical introduction for each volume and selection. The first volume begins with an excerpt from Lucian's *A True Story*, a tale of interplanetary war written circa A.D. 170. The third volume closes with Joe Haldeman's Hugo Award-winning story "Tricentennial." In between are bits and pieces from such classics as Sir Thomas More's *Utopia*, Jonathan Swift's "A Voyage to Laputa" from *Gulliver's Travels*, Mary Shelley's *Frankenstein*, and Edward Bellamy's *Looking Backward: 2000–1887*. In addition there are smatterings of Verne and Wells, along with short stories by major figures in and out of the genre including Edgar Allan Poe, Nathaniel Hawthorne, Rudyard Kipling, E. M. Forster, Robert A. Heinlein and Ray Bradbury.

As with any project of this scope, one can quarrel with individual choices. In fact, Gunn's purpose is narrower than the jacket copy implies; he is offering no more than one man's view of the roots of modern American science fiction. No more—but also no less. Seen in this context, his achievement is considerable.

Gunn is aware that science fiction in this country is a strange hybrid. It is both more "intellectual" and "cruder" than contemporary non-genre fiction. Gunn says that science fiction is "most typical when it deals with ideas worked out in human terms." At the hard core of almost every true science-fiction story is an idea—"the quality that makes humanity human is curiosity", "if people only saw the stars every thousand years, they would not adore but go mad"—and the reader who misses the intellectual level of discourse is missing what more than anything else distinguishes science fiction from other forms of fiction."

At a time when serious fiction has virtually abdicated a pedagogic role to nonfiction and journalism, this does indeed allow Gunn to make a strong case for modern SF as a spiritual descendant of More and Sir Francis Bacon. But Gunn does not become so enamored of his definition that he dismisses all good SF stories that fail to meet his criterion. It is also true (as Gunn carefully documents) that American science fiction's exile into the pulp ghetto left it with a strong component of raw, unthinking gut feeling, best represented in this collection by A. E. van Vogt's "Black Destroyer."



Gunn's Road to SF *tracing a genre's roots*

During the first half of the twentieth century it seems certain unpleasant facts about the human psyche that were all but ignored in mainstream fiction could be safely acted out in socially unapproved forms of entertainment: animated cartoons, slapstick comedy, murder mysteries, Westerns, and science fiction.

No wonder outside critics have so much trouble understanding the appeal of science fiction: abstract ideas on the one hand, unexamined emotions on the other. Gunn captures this dichotomy best in the second volume by juxtaposing Forster's brilliant "The Machine Stops," written in 1909 as an answer to Wells's overoptimistic view of scientific progress, and two chapters from Edgar Rice Burroughs's *The Chessmen of Mars*, a 1922 space romance with all the disturbing charm of an adolescent girl's daydreams.

But what about the future of this literature of the future? In a society that lacks a single unifying cultural influence—such as a universal church or a commonly held belief in progress—each serious artist must put the world together on his or her own. Fairly or not, we expect writers to ask the big questions and to point us, at least, toward the answers. Where did we come from? Where are we going? These are questions that in today's world can be most usefully phrased in scientific terms. A contemporary writer who is scientifically illiterate is as handicapped as a writer of Dante's day would have been if he knew nothing of Christian theology. I suspect this will become increasingly clear to both writers and readers. ∞

THE ARTS

By Robert S. Ryan

Einstein on the Beach an opera in four acts is director Robert Wilson's best-known work. To people who make it their business to know such things, Robert Wilson is the theater's future.

His creations are not plays as we now think of them. They exist as nonlinear sequences of images that pass before our eyes like dreams. The massive, hypnotic *Einstein on the Beach*, performed at New York's Metropolitan Opera House in 1976, lasted six hours. Sections of the operatic score, with music composed by Philip Glass, consisted of singers reciting a series of numbers over and over. Another recent work, *Ka Mountain and Guardenia Terrace: A Story About a Family and Some People Changing*, lasted seven days and seven nights and took place over the space of several mountains.

The "operas" are equal part spectacle, dance, architecture, mathematics, music, sound, and image. They are not about anything. These theatrical events are perhaps meditations that allow ample room for an audience's own meditations.

"If you try to follow each line of the play and make a connection, a thread, you get lost," says Wilson. It's not like Tennessee Williams or Edward Albee, where if you miss the second scene, you're lost in the third. They demand your primary attention throughout. In my work, you frequently just float with the situation."

Most of the director's scripts revolve around a historical figure. So far he has touched on Einstein, Freud, Stalin, Queen Victoria, Thomas Edison, and Rudolf Hess. These figures and the "stories" their names evoke provide a springboard to sights and sounds that may have little surface relationship to the protagonists. "Wilson's Edison," wrote *Newsweek*'s Jack Kroll, "is like his Freud and Stalin: not so much a historical figure as a resonator, a magnetic catalyst creating a new gravitational field in human experience."

Wilson's Manhattan loft, in an industrial district overlooking the Hudson River, is spare in contrast to his elaborately conceived productions. White walls border a concrete floor on which are arranged, almost as if for some religious ritual, foot-high, handmade wooden seats. The walls themselves also serve as work space. Sheets of paper line them, marked with sections of dialogue, colored tape to indicate theme, lengths for radio drama, and some striking images: a deep-sea diver and a nineteenth-century portrait.

Here, often working through the night, Wilson develops the sets of instruction, more like an architect's blueprints than a script, that describe every detail of his complex pieces (rehearsals for lighting alone in *Death, Destruction and Detroit* lasted five weeks).

Wilson, thirty-nine, is extremely popular in Europe, particularly in France and Germany, where government subsidies to the arts aid in mounting his mammoth productions. The technical precision and complexity of Wilson's theatricals make them tremendously costly. *Einstein on the Beach*, despite its sold-out box office, cost nearly $90,000 per performance. But the Europeans, unlike the Americans, apparently recognize the value of their investment. The French contributed nearly $500,000 to produce *Edison* (a modest piece by Wilson's standards, lasting only three hours and involving "simple" scenes punctuated by nine blackouts.) The West Germans put up nearly $1 million to present *Death, Destruction and Detroit*, a controversial meditation on American technology. "We did it in Berlin, and it lasted over five hours," Wilson confides. "There was a restaurant and bar downstairs, so people could get something to eat or drink and come back. It's okay if they missed a scene, because each element of the play is independent."

Critics in his native United States are less understanding. *New York* magazine's John Simon described Wilson's first Broadway production, *A Letter to Queen Victoria*, as "merely tableaux vivants done to monotonous music and accompanied by meaningless gyrations. Of course, this misses the point."

"The visual element in my plays is independent of the text," the director explains. "We hear, we see, as on interior and exterior vision screens, and we can alternate between the two. I think it's

CONTINUED ON PAGE 103

Director Robert Wilson. He splits the atom of conventional theater into its component parts.

UFO UPDATE

By Harry Lebelson

Carl Jung, noted psychologist, once linked UFOs to human psychodynamics. In his book *Flying Saucers* (1959) Jung suggested that UFOs were mandalas, the circular symbols of order. Recounting the dream of a six-year-old girl, Jung draws the connection between mandala and flying saucer. 'She dreamt she stood at the entrance of a large, unknown building. A fairy led her down a long colonnade and conducted her to a sort of central chamber. Similar colonnades converged from all sides. The fairy stepped into the center and changed herself into a tall flame.' Jung's dream metaphor parallels many current UFO abduction cases, which fill the files of UFO organizations throughout the country today.

The scenario is familiar. A UFO lands, and an alien appears and escorts a "contactee" into the craft. The vehicle's interior appears large to the contactee once he is inside. The interior seems actually to exceed the outer dimensions of the craft. After being examined by the aliens, the story goes, the contactee is given a tour of the vehicle and is then escorted from the craft. "As the mandala protects and defends the psyche of the girl in the dream, so, too, does it protect the contemporary abductee of UFO mythology," Jung states.

Berthold Schwarz, a New Jersey psychiatrist and advocate of Jungian thought, asserts: "I prefer to work with 'hidden contactees,' those who stand outside the glare of the spotlight. These people have in the past made excellent hypnotic subjects. They are not influenced by such cultural media as newspapers, TV, or movies. By probing their psychody namics, we might well determine the true nature of UFOs."

From years of intensive research, Schwarz concludes that UFO sightings satisfy certain deep-seated human wishes. 'At a time when we are faced with political, social, and ecological extinction,' the psychiatrist comments, "it makes sense for some people to seize upon UFOs as saviors from the sky." Recall the famous Gallup poll in which 68 percent of those who were interviewed said they believe UFOs exist. Furthermore, more than 13 million Americans said they had actually seen such an object. Some of the individual contactee stories are even more bizarre than those of cult groups.

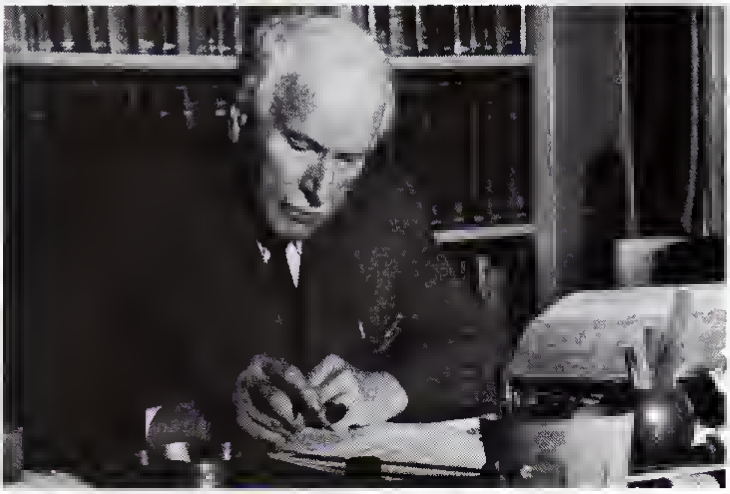
Margaret Ludeman, a Californian in her eighties, is a medium for a spirit entity named Hilarion. Commander of a UFO fleet hovering beyond the moon, Hilarion warns that Earth will soon self-destruct unless mankind ceases using atomic energy. Margaret has been communicating with her alien friend for the past ten years and continues sending his 'word' to those who will listen. She has described events and occurrences far beyond the scope of her eighth-grade education. Unlike some spirit mediums, she does not commercially exploit her abilities. She lives as a retiree in a trailer camp and survives on social security.

A stranger, but equally true, story concerns Lydia Stalnaker, spirit medium, spiritual healer, and UFO contactee. Lydia summoned her spirit UFO entity, Antron, on a recent David Susskind show. Antron apparently speaks through Lydia and reinforces her ability as a spiritual healer. Lydia attempted to cure a member of Susskind's staff, who claimed he had a spot on his lung. This claim was later confirmed by his physician. An examination by an impartial doctor some weeks later revealed that the spot had disappeared. Lydia asserts that her abduction by a UFO when she was eight years old was responsible for the healing power she now possesses. Could she have had a Jungian dream?

One last excursion into the world of other realities concerns Marcia Moore. Co-author of the book *Journeys into the Bright World*, Marcia describes a world of higher consciousness under the influence of the hallucinogenic drug ketamine. Marcia and her husband, Howard Altounian, M.D., former deputy chief of the anesthesia department at the Seattle Public Health Hospital, collaborated on the book, published in 1978 by Para Research, Inc., of Rockport, Massachusetts.

Journeys documents a series of recorded drug experiments. An average of 50 milligrams of ketamine was administered

CONTINUED ON PAGE 111



Carl Jung, author of Flying Saucers, *interpreted UFOs as protective symbols within the psyche*


The future of comfort rests with Jantzen.
JANTZEN

CONTINUUM

THE PLANETARY SOCIETY

For all of human history the planets were wandering lights in the night sky. They stirred our ancestors, provoked their curiosity, and encouraged mathematics and more accurate record keeping. The work of Johannes Kepler and Isaac Newton in the understanding of planetary motion led to the development of modern physics and in a very real sense opened up the modern age of science and technology. In the last 18 years every one of those wandering lights has been visited by space vehicles from Earth. We humans have landed exquisite robot spacecraft on Mars and Venus and have orbited both planets. We have flown by Mercury, Jupiter, and Saturn. We have discovered the broiling surface of Venus, the windswept valleys of Mars, the sulfur rivers of Io, the great polychrome storm systems of Jupiter. We have discovered new moons, new ring systems, puzzling markings, enigmatic pyramids, and have searched for life. Never again will the planets be mere wandering points of light. Because of the effort of the last two decades they will forever after be worlds crying out for exploration and discovery.

Yet the pace of planetary exploration has slackened ominously. After the *Voyager* encounters with the Saturn system in November 1980 and July 1981, there will be a period of more than four years in which no new images will be returned from the planets by any American spacecraft. If we back off from the enterprise of the planets, we will be losing on many different levels. By examining other worlds—their weather, their geology, their organic chemistry, the possibility of life—we learn better how to understand and control the earth. Planetary exploration involves high technology that has many important applications to the national and global economy—robotics and computer systems being two of many examples. Such exploration uses aerospace technology in an enterprise that harms no one and that is a credit to our nation, our species, and our epoch. And planetary exploration is an adventure of historical proportions. A thousand years from now when the causes of temporary political disputes will be as obscure as the cause of the War of the Austrian Succession is to us, our age will be remembered because this was the moment when we first set sail for the planets and the stars.

These arguments are widely accepted. When a specific planetary mission is being considered by the Executive Office of the President or by the appropriate congressional committees, however, planetary scientists hear another story. We are told that it is expensive; although a vigorous program of unmanned planetary exploration would cost about 0.1 percent of the federal budget, the *Voyager* spacecraft, when they are finished with their explorations, will have cost about 1 cent a world for every inhabitant of the planet Earth. But mainly we are told that, although the arguments for planetary exploration are widely understood in government circles, they are not supported by the people. We are told that spending money on planetary exploration—on the discovery of where we are, who we are, what our history and fate may be—is unpopular. I can remember a congressman telling me that the only letters he had received in support of the *Galileo* exploration of Jupiter were sent by people too young to vote.

But there is evidence of enormous support and enthusiasm for the exploration of the planets. We can see it in the popularity of motion pictures, television programs, and books on planetary themes. While we puzzled over this apparent paradox, it became clear to me and a number of my colleagues that the solution would be a nonprofit, tax-exempt public-membership organization devoted to the exploration of the planets and related themes—particularly the search for planets around other stars and the quest for extraterrestrial intelligence. If such an organization had a substantial membership, its mere existence would counter the argument that planetary exploration is unpopular. And so Dr. Bruce Murray, the director of Caltech's Jet Propulsion Laboratory, and I, with a number of colleagues and friends, have established the Planetary Society. Charter membership is $20 a year, for which members receive a newsletter on the latest developments, access to spectacular color photographs taken by planetary spacecraft, notification of local events, talks, seminars, and workshops, and other advantages. If we are successful, we may be able not only to accomplish our initial goal of demonstrating a base of popular support for planetary exploration but also to provide funds for the stimulation of critical activities, for example, in planetary mapping and in the radio search for extraterrestrial intelligence. We would be happy to hear from interested *Omni* readers at P.O. Box 3599, Pasadena, CA 91103. (Like many proposed interstellar radio messages, the box number is the product of two prime numbers, 59 and 61!) —*CARL SAGAN*

CONTINUUM

COMPUTER ERRORS FROM OUTER SPACE

Warning Cosmic rays from outer space may be hazardous to the health of your computer Researchers at Intel and IBM have discovered that subatomic particles can cause a troublesome form of amnesia in high-density computer memory chips The main culprits are alpha particles emitted by tiny amounts of radium and thorium in the chip package itself but particles produced when cosmic rays strike silicon chips can have the same effect If the chip is sensitive enough these particle-solid interactions trigger a "soft fail"

"It's like a genetic mutation," says Tim May, an Intel physicist who first called attention to the problem in 1978 The burst of electrical charge from a single alpha "can mutate a binary zero into a one, or vice versa That can cause data loss or can even shut down a system completely" Even home computers are not immune May calculates that the typical hobbyist microcomputer has a rate of one soft fail every three weeks or so No problem You're likely to cause a failure more often than that by tripping over the power cord

However "smart" cash registers and other remote terminals have been hit rather severely," May says A big European department store recently scrapped its computerized inventory-control system because soft fails were glitching its sales records "The most severe implications are for weapons systems" says May Soft fails might explain some of the recent instances of data loss in military satellites"

Other victims of the lowly alpha may be bank customers most of whom depend on computer memories to keep track of their bank accounts — Dirk Hanson

Surprise — your savings account has been wiped out by a cosmic ray A remote, but possible, new hazard for bank customers

COLD CURES

Continuing our counterpoint to the pills touted by TV ads we now offer the sequel to chicken soup which we described last year as a promising treatment for colds

Our latest candidates are crying and blowing warm moist air up the nose The latter is proposed by Aharon

The Rhinotherm A toasterlike device that blows warm air

Yerushalmi of Israel's prestigious Weizmann Institute of Science

His plan First pour distilled water into a device that looks like a toaster with two nozzles Then put the nozzles into the patient's nostrils Then blow a stream of warm air (43° C) over the water and up the patient's nose According to published reports, half an hour's treatment stopped all nasal secretion and headaches for 85 percent of the patients tested

The device, Rhinotherm AL-101, is called an "instrument for the cure of the common cold" Reached by phone at his Israeli lab Yerushalmi would release few details but he said clinical tests are being conducted in several countries The results are encouraging," he added Published reports say Yerushalmi expects to sell the devices to medical establishments in about two years for $200 apiece

Crying is proposed by Walter A Stewart a Manhattan psychoanalyst and author who says people's susceptibility to colds seems to disappear when they learn to cry freely Why? Dr Stephen E Bloomfield an eye expert at New York Hospital-Cornell Medical Center notes that crying relieves stress — and stress causes the body to produce steroids which reduce resistance to disease

A spokesman for the American Medical Association said there is no officially accepted single cure for the most common of human diseases He added however that some things including vitamin C seem to work for some people

— Stuart Diamond

"No quackery is ever rejected by the American public until a more scientific-sounding but inherently less plausible quackery is ready to take its place"

— H L Mencken

"In science we must be interested in things, not in persons"

— Marie Curie

VEGETABLE VOLTAGE

Remember when plants were being wired in order to discern their emotions? These experiments—in which sensitive houseplants reportedly freaked out in the presence of a plant murderer, and so on—were never well replicated. Now however, a professor in the Southwest is again tuning into vegetable 'EEGs.'

Every plant has a characteristic electrical pattern, says William Gensler a University of Arizona electrical engineer. And the signals vary with the plant's daily rhythms, water needs, and growth status.

In fields outside Tucson, Arizona, Gensler and his students have wired cotton plants and pecan trees by inserting one electrode in the plants' tissue and the other in the soil, forming a closed circuit. A central control box takes readings and radios the data to a receiver at the campus where a computer punches out numbers.

This direct-monitoring system is more accurate, Gensler says, than conventional methods, which focus on the soil. It could skirt agricultural guesswork by pinpointing optimal irrigation times. Crop perfection might also be served by selecting plants whose voltages correspond to maximum growth (or minimal water needs).

"But farmers won't be using this for a couple of years," Gensler notes. "Our problem now is data compression. We need to combine all the numbers into a single number that a farmer can read on his computer once a day or once a week."

So, though your geranium may not be saying, 'I love you,' it could be screaming, "Water me!"—Judith Hooper

The future is a convenient place for dreams.
—Anatole France

Gensler's wired up vegetables. Every plant has an electrical pattern that reveals how fast it's growing and when it needs water.

VIDEO WALLPAPER

Now there are television programs designed specifically to put you to sleep. A company called Nebulae Productions is offering 14 half-hour videotapes of nature scenes with natural sound, such as South Pacific beaches lapped by gentle surf, flowing waterfalls, and forests with songbirds.

The tapes can be played on a conventional television/video recorder; they should be more effective in a few years when new video technology provides large flat screen images. With this potential in mind, Nebulae is marketing its product under the trademarked name Video Wallpaper.

The tapes have already been field-tested in several hospitals and biofeedback centers. Dr. John Garrison, who tested the system at Union Hospital, in Lynn, Massachusetts, found it effective and popular when used to relax patients and groups of businessmen, health classes, and people enrolled in stress-management training sessions.

Video Wallpaper can be combined with another system called VIBES (Video Interface for Biofeedback Systems), which alters its brightness and volume to correspond to changes in a viewer's mental and physical states, as determined by hand temperature.

Viewer watches a beach scene while a technician, at right, monitors his hand temperature to adjust the brightness and the volume.

Nebulae's Roy Kamen said the SF movie *Soylent Green* partially inspired his company. "It made us aware that patients cooped up in a hospital room would rather see nature scenes than four white walls"—an allusion to an episode in which Edward G. Robinson dies while viewing such scenes.

Kamen envisions a time when Video Wallpaper will be "available in pharmacies so doctors can prescribe a specific scene for a patient."
—Allan D. Maurer

CONTINUUM

WOMEN IN LOVE

Having tasted both sides of life, the ancient sage/sex-changeling Tiresias (famous for his dire warnings to Oedipus) pronounced that sex was more fun as a woman. Three millennia later brain researchers may be discovering why.

For men, sex is reflexive, a psychomotor activity, says neuropsychologist James W. Prescott of the Institute of Humanistic Science in West Bethesda, Maryland.

Studies show that when the neurotransmitter dopamine, necessary to psychomotor activities, sinks to pathologically low levels (as in Parkinson's disease), sex is curtailed in men, but not in women. Thus, researchers speculate that female sexual behavior is regulated by different neural pathways.

Psychomotor activity tends to be focused and goal oriented. Women's brains, less "focused during sex, are better equipped to luxuriate in its emotional and spiritual dimensions, according to Prescott.

Female accounts of orgasm often describe sensations characteristic of altered states of consciousness: floating, loss of body awareness, a sense of unity with the partner. Prescott believes the vestibular-cerebellar system, a part of the brain governing balance, touch and movement, may account for these phenomena.

Female chauvinists, take note. According to Prescott, the human female is distinct from her mammalian sisters in experiencing sexual desire independently of estrus. Thus, for women, sex has a purpose beyond reproduction. Men's sexual makeup, conversely, represents no dramatic departure from that of lower mammals.

Findings indicate women can attain altered states of consciousness during sex, while men are on a level with lower mammals.

All this is just speculation at this point," says a more cautious brain researcher, Jaak Panksepp, of Bowling Green State University, Ohio. "The only hard data are the studies with dopamine."

Panksepp's work with rats links dopamine with psychomotor stimulations. Rats with high dopamine levels ran around more, "self-stimulated" (pressed levers for rewards) more, ate more, responded more to the environment, and generally were more "outward directed." Interestingly, women generally register lower dopamine levels than men do. —J.H.

"There is more to life than increasing its speed."
—Mohandas K. Gandhi

TALK AND TYPE

IBM scientists have taken one small step in the direction of eliminating the secretary *and* the typing pool with the development of a machine that takes the spoken word and turns it into type, all without a middleman (or woman).

Still an experimental prototype, the device is a computerized speech-recognition system connected to a microphone. Someone the machine "knows," who has spoken to the machine before, talks into a microphone. The system breaks down the sounds it hears with an acoustic processor into sound patterns.

Another program, called the linguistic decoder, analyzes the sound patterns and comes up with a sentence that it prints out on a computer terminal screen.

Already gauged at 91 percent accuracy, the program for the system was developed by Dr. Frederick Jelinek and the continuous speech recognition research group he heads at IBM laboratories in Yorktown Heights, New York. Ideally, he sees the device as becoming the ultimate dictation machine.

There are a few problems that must be ironed out before that happens, however. Although the device has a decent vocabulary—1,000 words, taken from the text of

IBM's Frederick Jelinek, at left, has developed a computer system that recognizes ordinary speech and turns it into type.

a patent on lasers—it can understand only one person at a time and only after a two-hour orientation session of listening to his or her individual speech patterns The complex process of translating sound into print also takes a long time It takes 100 minutes to analyze and print a sentence that took 30 seconds to speak

Finally there is that 9 percent rate of error A man may say 'Although the invention has been described ' but the machine might print 'All of the invention has been described '

Still Dr Jelinek believes the basic program behind the device is versatile enough to be used in a working prototype of a dictation machine he thinks will be ready in a few years

—Douglas Colligan

NAUSEA IN SPACE

In the zero-gravity world of spaceflight, there's no hanging over the rail if you develop 'space sickness '

NASA researcher is strapped into a motion-sickness machine

Surprisingly, at least half of those already rocketed into orbit including Soviet cosmonauts have experienced motion sickness to a degree nausea dizziness, disorientation or even vomiting A sticky situation at best

But now a means to conquer cosmic queasiness has been suggested by psychophysiologist Dr Patricia Cowings of NASA's Ames Research Center namely biofeed-back

In one test program, Dr Cowings and her research associate, William Toscano taught about 50 earthbound subjects biofeedback techniques to ward off sickness while sitting in a chair spinning ever faster

The subjects learn voluntarily to prevent increased heart rate, sweating, and, to some extent, changes in blood flow," Cowings said

Biofeedback offers advantages over drug therapy which can cause drowsiness 'In order to really survive in space you have to be on top of the situation all the time You can t afford to have a reduction in alertness," Cowings said

Astronauts have taken as much as a week to acquire their space legs With a barrage of seven-day shuttle jaunts planned, more than half of an astronaut's productivity might be lost If such is the case, biofeedback may become more necessity than experiment

—Leonard David

"Science is nothing but trained and organized common sense."

—Thomas H Huxley

Nuclear drinking water David Woodbridge drinks a glass of water that has gone through his special irradiation process

DON'T WASTE IT

An idea that would bring people and radioactive waste closer together is bound to furrow some brows Yet David Woodbridge an environmental physicist with the Hittman Corporation of Columbia Maryland, makes a compelling argument for meeting the water-pollution problem with another pollutant nuclear waste

Woodbridge's plan calls for using the most radioactive elements in spent nuclear-fuel rods to clean up wastewater

With about 6 000 metric tons of spent fuel now in temporary storage, plans for nuclear-fuel reprocessing and permanent storage are at a standstill But isotopes that are pure gamma-ray emitters such as cesium-137 and strontium-90, could be removed at one of the now-idle reprocessing plants and be encapsulated in stainless steel containers, Woodbridge believes These gamma-ray generators could then be used to decontaminate wastewater The irradiation and heat would inactivate viruses and destroy many organic chemical pollutants

Gamma-ray emitters unlike neutron sources leave no residual radioactivity in water and the output could be used directly for energy-producing biomass (animal feed or alcohol) or, with conventional secondary treatment would yield pure drinking water

Woodbridge agrees that reeducation would be needed before nuclear waste is used in industrial or municipal sewage treatment he points with pride to the successful pilot plant that he developed a few years ago While associated with

CONTINUUM

Florida Institute of Technology he used a cobalt-60 irradiator in the pilot project—the same cobalt used in anticancer therapy Now with cesium-137 available in reactor fuel Woodbridge thinks it s wasteful indeed to seal such a useful energy source underground

While the Department of Energy remains hamstrung over nuclear waste Woodbridge s idea may be worth investigating Once gamma-ray emitters are put to good use, Woodbridge says, the remaining waste would reach safe radioactivity levels in 50 years, not thousands of years

—Dean R Lambe

BRAIN EXERCISE

It just might be that thinking makes your brain bigger

Muscle cells grow larger with exercise and get smaller (atrophy) without it And now two prominent neurochemists say that nerve cells behave in the same way

Drs Herman Vandenburgh and Seymour Kaufman, of the National Institute of Mental Health, have developed a method for mechanically stimulating living cells and measuring what happens

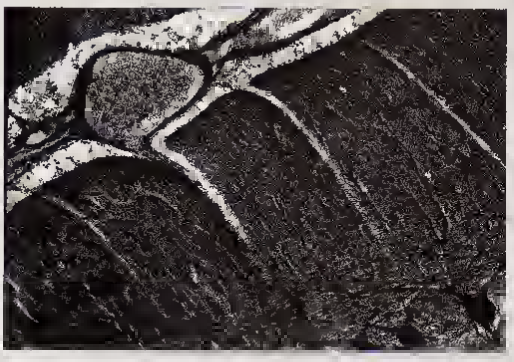
The scientists suggest that exercise and nerve activation stimulate the growth of muscle cells by activating a 'sodium pump' involved in regulating the ratio of sodium and potassium within a cell

What is learned about muscle cells may in turn shed light on the mechanisms of action of nerve cell growth and atrophy perhaps increasing our understanding of the human brain s response to environmental stimulation or the lack of it " Dr Vandenburgh suggests

—Alton Blakeslee

"I don t know about you but I m tired of having to hold my nose every time I enter my polling booth

—Barry Commoner



Nerve cells of human brain Muscle cells grow larger because of exercise now scientists think the same may hold true for the brain

GARBAGE BRICKS

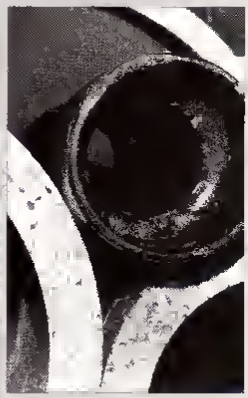
Plastic and refuse, two of modern life s by-products are now being considered to rebuild the society that spawned them

In several states the same material that forms Plexiglas and polyester is being substituted for cement in the repair of roads and bridges Added to sand and stone this clear plastic fluid—called a polymer—binds the mixture in a way that is stronger and longer-lasting than conventional materials

So tough is the plastic that scientists have made bricks and sewer pipes by injecting the polymer into waste products Scientists at Brookhaven National Laboratory, on Long Island, New York, have made bricks by using raw garbage sludge crushed glass and incinerated refuse These 'outhouse bricks' as lab scientist Meyer Steinberg calls them rival their conventional counterparts The problem he added lies in convincing engineers that the new material is as useful and economical in the long run as conventional material

The polymer usually comprises 10 percent of the finished product It can help recycle wastes and save valuable resources It also drastically cuts the time needed for repairs A polymerized road surface sets in as little as an hour—compared to perhaps days for concrete—cutting labor costs and traffic congestion Polymer pothole repairs also last years while asphalt may last less than a season, says John Bartholomew of the U S Transportation Department

Among the results of the department s polymer program are 26 plasticized



Strong sewer pipes can be made from plastic and garbage

potholes on Interstate 35 in Minneapolis a number of bridge repairs in Dallas and polyester patches on the Major Deegan Expressway in the Bronx, New York After several years the patches still look like new, officials say—S D

'There is no question that there is an unseen world The problem is How far is it from midtown and how late is it open?"

—Woody Allen

"It was the failures who had always won, but by the time they won they had come to be called successes This is the final paradox, which men call evolution '

—Loren Eiseley

PETNAPPING

Each year as many as 2 million dogs and cats get petnapped. Many of them, according to the Humane

"Bunchers often use drugged meat to bag a cat or dog

Society, end up as "sacrificial lambs" on the altars of science and industry.

"Unscrupulous licensed animal dealers are doctoring their records and selling stolen pets to labs—and getting away with it!" says Margaret Morrison, of the Humane Society.

Most stolen dogs and cats are used in biomedical research and for teaching medical students and surgeons in training. Others are subjected to toxicity tests. They are exposed to, or infected with, chemical products to determine how poisonous they are.

-Dealing in stolen pets is a profitable business. Cats on average sell to biological supply houses or labs for around $15, mongrel dogs for around $100, and purebreds for around $200.

Typically, two "bunchers" as petnappers are called, work in a ring with a licensed animal dealer. The bunchers cruise a territory in their van and try all kinds of tricks to nab animals, such as using tranquilizer guns, drugged meat, or even bitches in heat. Once there's a big enough haul, they head for kennels across state lines, where the dealer holds the animals before selling them.

The Animal Welfare Act requires that the 6,800 U.S. dealers must keep records of purchase, previous ownership, and sale of all animals sold to labs. Labs must also hold an animal for five days before using it, just in case an animal is traced as lost or stolen. But, says Morrison, the act is poorly enforced. The Department of Agriculture has only a limited number of inspectors responsible for checking the small-animal traffic.

Since the law isn't much help, grass roots organizations have sprung up throughout the country. One, Action 81 of Virginia, started along Route 81, where local residents became aware of a rash of stolen pets. Today the organization has affiliated groups in 40 states.

One thing you can do is tattoo your pet with your social security number, according to an Action 81 spokesman. Thereby lab personnel can distinguish a stolen pet from legally acquired animals and seek ways to reunite the animal with its rightful owner.—Caroline Rob

LASER ROCKETS

For eight years, small groups of researchers have been exploring the possibility of rockets powered by high-energy lasers. Now researchers at Physical Sciences, Inc. (PSI), in Massachusetts, with backing from NASA and the Defense Advanced Research Projects Agency, are moving past theory into experimentation.

In a rocket of this sort, a continuous-wave (CW) or repeatedly pulsed laser would be beamed into the propulsion chamber, heating the propellant and thus providing thrust.

A laser-powered rocket would have a definite advantage over a conventional chemically fueled rocket, says Kurt Wray of PSI. "It would have a much higher specific impulse. The rocket could carry more payload," he says.

Right now, Wray reports, PSI uses a trio of lasers to fire a triple-pulsed laser burst of 15 megawatts for a microsecond into a specially designed rocket nozzle.

There's no system yet that will do that indefinitely," Wray notes, "but calculations show that large thrusts are feasible with this concept."

NASA has supported the CW work at PSI for the past four years and has given the company $100,000 to begin experimental work related to the CW system.

Wray says the high-powered lasers needed for a full-scale laser-rocket system probably won't be developed specifically for that use. But PSI intends to continue its "low-profile" development of the concept, to bring it along so it will be ready to use the big lasers if and when they're available.—Joel Davis

"For the people liable to be killed by earthquakes, quake prediction is certainly significant."

—Gordon Rattray Taylor

Nozzle for laser rocket. Scientists are working on the concept but are keeping a low profile until bigger lasers are available

CONTINUUM

ANIMAL VIBRATIONS

Which is better at predicting earthquakes: animals or scientific instruments? Evidence collected so far suggests that your ordinary animal—a dog, a horse, a pig—may give a more reliable warning of an impending earthquake than the expensive apparatus now used by scientists.

In August 1979, 200 instruments along California's Calaveras Fault failed to predict an earthquake so powerful it shook buildings in San Francisco, 130 kilometers away. But in 1974, several months before a massive earthquake struck China, hibernating snakes crawled out of the ground, pigs climbed walls and bit one another's tails, hens would not go to roost, trained German shepherds ignored commands, and barnyard geese refused to fly. The Chinese, heeding these signs, saved the lives of several hundred thousand people by evacuating them two days before the quake occurred.

The ability of animals to sense such natural phenomena is not as puzzling as it may seem at first. Birds, dogs and bats can sense the slightest vibrations in the earth—perhaps even better than sophisticated instruments can—some geologists say.

To be sure, humans are improving their own gadgets, which have found increased levels of radioactive radon in well water just before a quake. The water presumably was squeezed toward the surface by seismic forces far below. And space scientists are proposing satellites, lasers, and even distant quasars to measure movements in the earth's crust. In the past few years, instruments have successfully predicted earthquakes in Mexico and Asia.

But many scientists are taking a cue from animals. The USSR has animal warning centers, and many nations are trying to learn what it is that animals are sensing, so that instruments can be built to detect the same signals. —S.D.

Dogs have ignored commands before an earthquake; snakes have crawled out of the ground, and pigs have climbed walls.

FISH OIL

Huile de poisson groenlandaise? However you say it, it still spells fish oil. Unappetizing, yes, but it could prevent that dread killer cardiovascular disease.

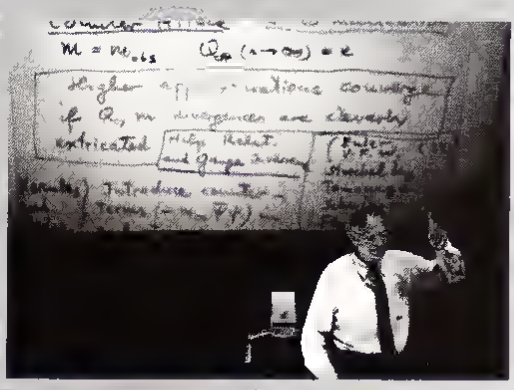
This was the finding of a University of Oregon study, led by Dr. William S. Harris. Ten healthy volunteers ate a typical American diet full of saturated fats for four weeks, then switched to salmon oil (the rest of the menu was unchanged) for the next four weeks.

Miraculously, within a week or two the volunteers' lipid levels—cholesterol and triglycerides—dropped dramatically. (Vegetable oil reduces cholesterol, but not triglycerides.) Their platelet sensitivity also decreased. A high count of platelets, the clotting factor in blood, contributes to atherosclerosis (coronary artery disease).

Fish oil may well be the reason why Greenland Eskimos and the Japanese have a low incidence of atherosclerosis, Dr. Harris notes. The only problem? "Fish oil is so unpalatable, we'll have to find a way to isolate the active compounds before it becomes accepted as part of the American diet." —J.H.

"Acceptance on someone else's terms is worse than rejection."

—Mary Cassatt



"...and that's just the short form!" is not what physicist Victor Weisskopf was saying at a recent Fermilab symposium. But there were some light moments. See People, page 118.

ACCELERATIONS

Tomorrow's cars are sleek mirrors of aerodynamic harmony and consumer desire

BY DEAN ING

Visions of safer sturdier more energy-efficient cars reveal an ideological flip-flop in car making The engineer is beginning to lead while the stylist follows External body projections will disappear, no more boxy tops massive grilles naked undersides, or Byzantine body shells. Slippery shapes improve acceleration and economy Future cars will reflect lessons we re learning from racetracks wind tunnels and OPEC Walter Korff, the American aerodynamicist concluded, "Even at fifty miles per hour there is a clear gain" in the performance of automobiles employing efficient styling Enthusiasts need not fear that enforced speed limits will mean the end of sleek machines Styling will never go out of style

Some of the new shapes may at first look strange, but our guess is that we ll soon think of them as voluptuous even sexy But don t bother looking under the hoods of next year's models for a hint at 1995, unless you peek

Preceding pages: The Ford/Ghia Megastar II suggests slithery underside for easy handling (top). Pininfarina's aerodynamic Modulo minimizes coefficient drag (bottom). Low-alloy steels molded for style in Vector prototype (left), computerized interior of Ford's Probe I (above).

"Future cars will reflect lessons we're learning from racetracks, wind tunnels, and OPEC."

inside the latest sport coupe powered by (ready for this?) Briggs & Stratton.

The most obvious reason for a new automobile awareness is our global oil crunch. But innovation has not lain dormant. We are accumulating a staggering wealth of new data that promise solutions to other automotive problems. NASA and auto manufacturing firms have probed the limits of human tolerances so that we can set criteria for impact loads, instrument layout, and genuine comfort. With computer simulation we can test suspension systems and shell designs before we risk a cent on hardware. Safety studies by auto makers are now scrupulously monitored by the U.S. Department of Transportation. Under their lissome skins, future cars will reflect new imperatives from governments and industry: advances in power plants, materials, and safety.

During this decade we'll see most of the available research money go to powerplant improvement. Synthetic fuels will be expensive, though more of the mix may come from timber slash, desert shrubs, and similar renewable resources. By 1995 cars powered exclusively by heat engines will be a wild extravagance. That's why, after tinkering with diesels and stratified charges for a while, we'll probably turn to more economical power, minimizing the use of fossil fuels.

Electrabouts have obvious advantages: no emissions beyond a trace of ozone, moderate torque, almost eerily quiet, and their energy is cheap. A less obvious virtue is a wide variety of recharging sources. Yet electrabouts until now were limited by the twin vices of short range and long recharge times.

Engineers concede other drawbacks, too. Electric heaters drain batteries at a ferocious rate. Ordinary batteries are heavy and bulky and need a replacement every year or so.

Electrabout buffs claim that every objection can be overcome. It's true that 90 percent of our driving is urban stop-and-go sorties. This is precisely where electrabouts shine. If every family used one, our auto fuel consumption could drop by fully two thirds. One importer of Italian cars expects increasing competition soon from electrabouts. "My guess is the Japanese will market short-haul electrics within three years," he mused. "Japan imports nearly all its oil, so it's primed for the change."

But for long trips, today's batteries won't serve, even with standardized battery packs for quick removal/replacement. The owner of a new 1990 ampwagen won't trade his temporarily exhausted, but brand-new $1,000 pack for one that may be only minutes away from terminal flatulence. Certification by service stations? Few station managers would climb out on such a fiscal limb 200 times a day. Detailed maintenance before certification? Exorbitant facility costs, a huge surcharge for every exchange, and still the knowledge that nothing lasts forever. Clearly, electrabouts need batteries of higher energy density, more watt-hours per kilogram, and faster recharging.

GM's zinc-nickel oxide battery, earlier announced by NASA, and Gulf and Western's zinc-chlorine battery have twice the energy density of older batteries. A lithium-iron sulfide cell under development may quadruple that improvement, but cost and high operating temperatures will delay the panacea battery.

It's plausible to hope for a day-long, 800-kilometer electrabout range by 1995, but we can't depend on this, nor do we have to. The combustion-electric hybrid engine used in a 1908 car but generally ignored since, eliminates both range and recharge problems.

Late in 1979 Briggs & Stratton demonstrated an attractive, compact six-wheeler hybrid coupe, employing two engines, one powered by electricity, the other by gasoline. The third (rearmost) axle supports a massive battery pack that drives an eight-horsepower (for you metric compulsives, that's 600 kilograms per meter per second) motor under the hood. Up on the front axle sits an 18-horsepower gasoline engine. The car can be driven by either or both of its prime movers, that's what makes it a hybrid.

This stylish coupe was designed by Brooks Stevens; it's tempting to speculate what engineers at Porsche or Pininfarina might have done with the basic six-wheel layout. The Stevens exercise for Briggs & Stratton is a functional success, overcoming objections that a hybrid might look frumpy.

That was important to Bud Goodwin, the maverick industrialist whose Fiberfab, Inc., built the awesome police cruisers for George Lucas's film *THX-1138*. Goodwin

once answered critics with "The shape can't just *be* right. It's gotta *look* right, too. I can't sell hidden charm."

By 1990, in all likelihood, we'll have low-slung hybrids. They'll catch on slowly at first, because the hybrid's mass alone rules out the kind of handling and acceleration that made sporty cars such fun. They won't be cheap, either.

The hybrid owner will have the best of it, though, until the panacea batteries arrive. On short trips the engine will use no pump fuel. On a cross-country run the hybrid's driver will have to bite hard on the OPEC bullet and pay dearly for fuel. But this option is the driver's, who can still certainly choose long drives if he can afford it. That element of choice will sell a lot of hybrids in the next 20 or 30 years. The hybrid offers the best solution to our current needs and desires in an era when the price of auto fuel is soaring—which means that by 1990 Americans will have dumped several hundred billion dollars into OPEC's coffers.

There's little point in arguing whether that $200 billion could best be spent on social security, mass transit, the exploration of space, or all three. The choice will not be ours, because the money won't be. But the emergence of hybrid cars will herald our independence from OPEC. The scenario becomes hazier about 2010 with the arguable advent of broadcast or narrowcast power, chassis doubling as batteries, and free mass transit.

Future cars will benefit greatly from aerospace materials, though cost will downplay titanium, metal honeycomb, and stainless. Plastics—for example, sandwich panels filled with semirigid urethane foams—already show promise. While many plastics are petroleum derived, some are recyclable. Major companies like Bayer AG (West Germany) and General Motors have invested heavily in plastic cars, and racing-oriented firms like Chaparral (U.S.A.) and Lotus (U.K.) have produced truly gorgeous winners from plastic.

For a while yet our cars will need rigid chassis, and for mass production that generally means steel. High-strength low-alloy (HSLA) steels are gaining popularity at Ford and GM, since HSLA can do the job of mild steel with less metal, hence less weight. Because there is so small a quantity of nonferrous elements in HSLA, they can be recycled cheaply.

Aluminum will play a stronger role as plastics improve, replacing some steel in engines, radiators, suspensions, cast structural parts, and body panels. Later on, plastics will replace both aluminum and steel in castings, bodies, gears, even springs. However, the Italian firms Bertone and Pininfarina will continue to fit mouth-watering metal shapes over existing chassis. Aluminum is easier to form than steel and lighter, too, though some Italian prototypes now emerge first in handcrafted steel bodies, for instance. Bertone's Sibilo. Limited production copies could cruise the highways as much as 100 kilograms lighter if clothed in aluminum à la Porsche's 928.

Weight reduction is essential for economy since less energy is required to accelerate a smaller mass. Better lubricants and bearings may improve economy by 10 per cent, and improved tires will lower rolling resistance and boost traction.

Pooling our preview of materials with the absolute demand for long-range economy, we can approach a topic dear to our hearts: appearance. For two reasons we needn't fear that the car in our crystal ball will be ugly. Bill Lear and Bud Goodwin gave the first reason in typical plainspoken fashion: Manufacturers can't afford to market cars that have no external charm. Styling studios, like Paris couturiers, try to shape—or at least anticipate—our tastes in cars, and they build models of all sizes for major auto firms. Ghia works with Ford. Calty in California is sponsored by Toyota, Bertone is often linked with Alfa and Lancia, Pininfarina with just about everybody. Some big firms (GM, Ford, Daimler-Benz, Volkswagen, Renault, and others) maintain their own stylists even as they contract for fresh ideas with independent studios.

> *"The most startling changes will take place in the interior. Door locks, ignition, and steering will operate only for those who know the code and are sober enough to use it."*

The second reason why we can expect breathtaking cars is that the most efficient shapes at freeway speed tend to be aesthetically pleasing (though many pleasing shapes are woefully inefficient). A car's frontal drag coefficient (CD in Europe, CX) is the measure of its slipperiness through the air. A big sleek car of low CD, like the Pininfarina-derived Citroen CX sedan, can have lower total drag than a smaller car with a high CD. Thus a styling studio with real wind-tunnel engineering expertise can develop prototype cars that are lithe, efficient, and roomy.

Daimler-Benz tested cars in a Stuttgart tunnel many years ago. Then some U.S. companies began to use the Cornell University tunnel. Now Volkswagen has one, too, but Pininfarina's own wind tunnel in Turin gives that firm a tremendous advantage in melding art with engineering.

Under contract to Consiglio Nazionale delle Ricerche (CNR), Italy's national research council, Pininfarina has evolved a sedan design that is an odds-on favorite as the trendsetter for the Nineties. The CNR sedan, its computer-generated shape modified to reflect necessary shell discontinuities, was funnel-tested. Its final configuration gave rise to the nickname "Banana Car," from the subtle bowing of its underside, which minimizes aerodynamic drag.

The French government-sponsored Renault EVE sedan and the Uni-Car, jointly funded by West Germany and several technical universities, reflect affirmation of similar new shapes. There is evidence that in 1982 AMC-Renault may test some of these engineered shapes in the market.

If frontal-drag coefficiency were the only important criterion we might expect a dismal sameness to infect our future car choices. But this needn't be the case when we buy for different reasons. Some design teams will focus more on pedestrian and occupant safety, others on energy efficiency, some on interior room. The shapes will reflect these options, but most will approach that voluptuous, nearly unbroken line from nose to tail. The bobtail feature is already popular, proceeding from the work of Dr. W.I.E. Kamm, who proved in the 1930s that a long, tapering tail creates higher induced (turbulence) drag.

Both size and shape affect vehicle safety. Thanks to new studies, we know how much space occupants need for protection. We know a car's front end should be designed to catch, rather than propel, a pedestrian. We also know that the car's balance point, or center of gravity, permits good handling under poor conditions.

Future cars will likely be designed to cruise near the "double nickel," our national 55-mph speed limit (approximately 90 kph), since aerodynamic drag begins to be costly in that range. Drag is a square function. Double your speed and drag jumps four times. It's a steepening energy penalty that costs roughly half again as much at 110 kph as it does at 90 kph.

Motor racing may seem an unlikely road to economy, but the less energy a car uses, the less weight it has to carry. We'll still profit from racing in 2010 if we revive the Index of Performance as a criterion. The Index is a measure of fuel economy in a race and was once important in road racing. The sooner we bring it back, the sooner brilliant amateurs (and Porsche's professionals) will test every aspect of it.

Another innovation extracted from racing—external airfoils—was suggested to Ferrari years ago by American test driver Richie Ginther. Shortly thereafter foils were thoroughly investigated by Caltech-trained Texan Jim Hall, whose Chaparrals race-proved a dozen engineering innovations and blew past opposition like Texas tumbleweeds. Quick. What won the 1980 Indy?

One measure of Hall's thoroughness is his attention to driver comfort. Air vents, pedal placement, and lumbar support all received careful thought in trendsetting cars like Chaparral and Porsche. Form follows function on the inside, too.

Interior layouts will be resilient and com-

fortable (*vide* Ford's Probe I) though not particularly roomy because foam protection and frontal drag militate against wide open spaces. Commuter cars can be more spacious inside. Hideaway armrests can double as restraints for toddlers—restraints inexcusably omitted from today's practical family cars.

The most startling changes in the interior will be electronic. Door locks, ignition and steering will operate only for those who know the punch code and are sober enough to use it. The onboard computer will monitor systemwide sensors: no bearing will overheat, no brake pad will fail, no relay will stick without automatic diagnosis including an oral or video report to the driver. Sensors can compare road-surface conditions and nearby objects with acceptable standards, alerting the driver to impending trouble.

The car's radar system need not depend on embedded rails to monitor a trip, because tiny dipoles can be embedded in paint and dipole length can be an information code. Tomorrow's car may just follow the white line, turning off the highway when it reads the dipole code of a roadside sign. Given priorities and destination, the car can query distant transmitters for weather and traffic data, follow a least-time or least-energy route, continuously update the estimated time of arrival, and seek the best offramp if refueling or repair is necessary. Robert A. Heinlein's sultry-voiced onboard computer (*Omni*, October 1979), keyed to voiceprint and full of randy one-liners, might be an expensive option in some ten years. The driver will be able to turn the chores over to *her* computer, select the latest Atari video game, and play while the machines work.

Any system smart enough to permit safe front-seat video can give us more than games. The driver with a tiny headset can attend a video class on one display while her passenger reads or writes a book on another, using foldaway consoles, light pencils—in fact, the entire panoply of equipment available for household computer use.

We won't need to inspect the hardware of future cars very often, and so we might miss some subtle improvements. A 20-horse hybrid's diesel engine may be so small that it can be replaced by muscle power in a few moments. Computer-adjusted suspension with instantly variable caster, camber and toe-in can improve tire adhesion for off-road forays and might let us employ revolutionary, highly flexible chassis to rival a cheetah's. The military uses of such an agile vehicle make its development fairly likely by such corporations as AMF and Lockheed, which have already studied articulated off-road vehicles.

Peering past 2010, we risk a few broad forecasts. When local line-of-sight power transmission becomes practical, we'll be able to reenergize hyperstrength flywheels without pausing, so that power plants can be dirt cheap. Magnetohydrodynamic and

CONTINUED ON PAGE 99

FICTION

Death was waiting among the dinosaurs – until she found a purpose for her life

OUR LADY OF THE SAUROPODS

BY ROBERT SILVERBERG

21 August 0750 hours Ten minutes since the module meltdown I can I see the wreckage from here but I can smell it bitter and sour against the moist tropical air I've found a cleft in the rocks a kind of shallow cavern where I ll be safe from the dinosaurs for a while Il s shielded by thick clumps of cycads and in any case it s too small for the big predators to enter But sooner or later I m going to need food and then what? I have no weapons How long can one woman last stranded and more or less helpless aboard Dino Island a habitat unit not quite fifteen hundred meters in diameter that she s sharing with a bunch of active hungry dinosaurs?

I keep telling myself that none of this is really happening Only I can't quite convince myself of this

My escape still has me shaky I can t get out of my mind the funny little bubbling sound the tiny powerpak made as it began to overheat In something like fourteen seconds my lovely mobile module became a charred heap of fused-together junk taking with it my communicator unit, my food supply, my laser gun and just about everything else But for the warning that funny little sound gave me I'd be so much charred junk too Better off that way most likely

When I close my eyes, I imagine I can see Habitat Vronsky floating serenely in orbit a mere one hundred twenty kilometers away What a beautiful sight! The walls gleaming like platinum the great mirror collecting sunlight and flashing it into the windows the agricultural satellites wheeling around it like a dozen tiny moons I could almost reach out and touch it Tap on the shielding and murmur, "Help me, come for me rescue me" But I might just as well be out beyond Neptune as sitting here in the adjoining Lagrange slot There s no way I can call for help The moment I move outside this protective cleft in the rock I m at the mercy of my saurians and their mercy is not likely to be tender

Now it s beginning to rain – artificial like practically everything

PAINTING BY FRANK FRAZETTA

else on Dino Island But it gets you just as wet as the natural kind And just as clammy Ptaugh

Jesus, what am I going to do?

0815 hours The rain is over for now It'll come again in six hours Astonishing how muggy dank thick the air is Simply breathing is hard work and I feel as though mildew is forming on my lungs I miss Vronsky's clear crisp everlasting springtime air On previous trips to Dino Island I never cared about the climate But of course I was snugly englobed in my mobile unit a world within a world self-contained self-sufficient isolated from all contact with this place and its creatures Merely a roving eye traveling as I pleased invisible invulnerable Can they sniff me in here?

We don't think their sense of smell is very acute And the stink of the burned wreckage dominates the place at the moment But I must reek with fear signals I feel calm now but it was different when I got out of the module Scattered pheromones all over the place I bet

Commotion in the cycads *Something's coming in here!* Long neck small birdlike feet delicate grasping hands Not to worry Struthiomimus is all—dainty dino fragile birdlike critter barely two meters high Liquid golden eyes staring solemnly at me It swivels its head from side to side ostrichlike click click as if trying to make up its mind about coming closer to me *Scat!* Go peck a stegosaur Let me alone

It withdraws making little clucking sounds Closest I've ever been to a live dinosaur Glad it was one of the little ones

0900 hours Getting hungry What am I going to eat?

They say roasted cycad cones aren't too bad How about raw ones? So many plants are edible when cooked and poisonous otherwise I never studied such things in detail Living in our antiseptic little L5 habitats we're not required to be outdoors-wise after all Anyway there's a fleshy looking cone on the cycad just in front of the cleft and it's got an edible look Might as well try it raw because there's no other way Rubbing sticks together will get me nowhere

Getting the cone off takes some work Wiggle twist snap tear—*there* Not as fleshy as it looks Chewy, in fact It's a little like munching on rubber Decent flavor though And maybe some useful carbohydrate

The shuttle isn't due to pick me up for thirty days Nobody's apt to come looking for me or even to think about me before then I'm on my own Nice irony there I was desperate to get out of Vronsky and escape from all the bickering and maneuvering the endless meetings and memoranda the feinting and counterfeinting all the ugly political crap that scientists indulge in when they turn into administrators Thirty days of blessed isolation on Dino Island! An end to that constant dull throbbing in my head from the daily infighting with Director Barber Pure research again! And then the meltdown and here I am cowering in the bushes wondering which comes first starving or getting gobbled by some cloned tyrannosaur

0930 hours Funny thought just now Could it have been sabotage?

Consider Barber and I feuding for weeks over the issue of opening Dino Island to tourists Crucial staff vote coming up next month Barber says we can raise millions a year for expanded studies with a program of guided tours and perhaps some rental of the island to film companies I say that's risky for the dinos and for the tourists, destructive of scientific values a distraction a sellout Emotionally the staff is with me, but Barber waves figures around, shows fancy income projections and generally shouts and blusters Tempers running high Barber in lethal fury at being opposed barely able to hide his loathing for me Circulating rumors—designed to get back to me—that if I persist in blocking him he'll abort my career Which is malarkey of course He may outrank me but he has no real authority over me And then his politeness yesterday (*Yesterday?* An eon ago!) Smiling smarmily telling me he hopes I'll rethink my position during my observation tour on the island Wishing me well Had he gimmicked my powerpak? I guess it isn't hard if you know a little engineering and Barber does Some kind of timer set to withdraw the insulator rods? Wouldn't be any harm to Dino Island itself just a quick compact localized disaster that implodes and melts the unit and its passenger So sorry terrible scientific tragedy what a great loss! And even if by some fluke I got out of the unit in time my chances of surviving here as a pedestrian for thirty days would be pretty skimpy, right? Right

It makes me boil to think that someone would be willing to murder you over a mere policy disagreement It's barbaric Worse than that it's tacky

1130 hours I can't stay crouched in this cleft forever I'm going to explore Dino Island and see if I can find a better hideout This one simply isn't adequate for anything more than short-term huddling Besides, I'm not as spooked as I was right after the meltdown I realize now that I'm not going to find a tyrannosaur hiding behind every tree And even if I do tyrannosaurs aren't going to be much interested in scrawny stuff like me

Anyway I'm a quick-witted higher primate If my humble mammalian ancestors seventy million years ago were able to elude dinosaurs well enough to survive and inherit the earth, I should be able to keep from getting eaten for the next thirty days And with or without my cozy little mobile module I want to get out into this place whatever the risks Nobody's ever had a chance to interact this closely with the dinos before

Good thing I kept this pocket recorder when I jumped from the module Whether I'm a dino's dinner or not I ought to be able to set down some useful observations

"I'm a quick-witted higher primate If my humble mammalian ancestors were able to elude dinosaurs well enough to inherit the earth I should be able to keep from getting eaten for thirty days"

1830 hours Twilight is descending now I am camped near the equator in a lean-to flung together out of tree-fern fronds—a flimsy shelter—but the huge fronds conceal me and with luck I'll make it through to morning That cycad cone doesn't seem to have poisoned me yet and I ate another one just now along with some tender new fiddleheads uncoiling from the heart of a tree fern Spartan fare but it gives me the illusion of being fed

In the evening mists I observe a brachiosaur half-grown but already colossal, munching in the treetops A gloomy-looking triceratops stands nearby and several of the ostrichlike struthiomimids scamper busily in the underbrush hunting I know not what No sign of tyrannosaurs all day There aren't many of them here anyway and I hope they're all sleeping off huge feasts somewhere in the other hemisphere

What a fantastic place this is!

I don't feel tired I don't even feel frightened—just a little wary

I feel exhilarated as a matter of fact

Here I sit, peering out between fern fronds at a scene out of the dawn of time All that's missing is a pterosaur or two flapping overhead but we haven't brought those back yet The mournful snufflings of the huge brachiosaur carry clearly even in the heavy air The struthiomimids are making sweet honking sounds Night is falling swiftly and the great shapes out there take on dreamlike primordial wonder

What a brilliant idea it was to put all the Olsen-process dinosaur reconstructs aboard a little L5 habitat of their very own and turn them loose to re-create the Mesozoic! After that unfortunate San Diego event with the tyrannosaur it became politically unfeasible to keep them anywhere on Earth I know but even so this is a better scheme In just a little more than seven years Dino Island has taken on an altogether convincing illusion of reality Things grow so fast in this lush steamy

high-CO_2 tropical almosphere! Of course we haven t been able to duplicate the real Mesozoic flora but we ve done all right using botanical survivors, cycads and tree ferns and horsetails and palms and ginkgos and auracarias, and thick carpets of mosses and selaginellas and liverworts covering the ground Everything has blended and merged and run amok It s hard now to recall the bare and unnatural look of the island when we first laid it out Now it s a seamless tapestry in green and brown a dense jungle broken only by streams lakes and meadows encapsulated in spherical metal walls some five kilometers in circumference

And the animals the wonderful fantastic grotesque animals

We don t pretend that the real Mesozoic ever held any such mix of fauna as I ve seen today stegosaurs and corythosaurs side by side a triceratops sourly glaring at a brachiosaur struthiomimus contemporary with iguanodon a wild unscientific jumble of Triassic Jurassic and Cretaceous a hundred million years of the dinosaur reign scrambled together We take what we can get Olsen-process reconstructs require sufficient fossil DNA to permit the computer synthesis and we ve been able to find that in only some twenty species so far The wonder is that we ve accomplished even that much to replicate the complete DNA molecule from battered and sketchy genetic information millions of years old to carry out the intricate implants in reptilian host ova to see the embryos through to self-sustaining levels The only word that applies is *miraculous* If our dinos come from eras millions of years apart so be it We do our best If we have no pterosaur and no allosaur and no archaeopteryx so be it We may have them yet What we already have is plenty to work with Someday there may be separate Triassic Jurassic and Cretaceous satellite habitats but none of us will live to see that I suspect

Total darkness now Mysterious screechings and hissings out there This afternoon as I moved cautiously but in delight from the wreckage site up near the rotation axis to my present equatorial camp sometimes coming within fifty or a hundred meters of living dinos I felt a kind of ecstasy Now my fears are returning and my anger at this stupid marooning I imagine clutching claws reaching for me terrible jaws yawning above me

I don t think I ll get much sleep tonight

22 August 0600 hours Rosy-fingered dawn comes to Dino Island and I m still alive Not a great night s sleep but I must have had some because I can remember fragments of dreams About dinosaurs naturally Sitting in little groups some playing pinochle and some knitting sweaters And choral singing a dinosaur rendition of *The Messiah* or Beethoven s Ninth I don t remember which I think I m going nuts

I feel alert inquisitive and hungry Especially hungry I know we ve stocked this place with frogs and turtles and other small-size anachronisms to provide a balanced diet for the big critters Today I ll have to snare some for myself, grisly though I find the prospect of eating raw frog s legs

I don t bother getting dressed anymore With rain showers programmed to fall four times a day it s better to go naked anyway Mother Eve of the Mesozoic that s me! And without my soggy tunic I find that I don t mind the greenhouse atmosphere of the habitat half as much as I did

Out to see what I can find

The dinosaurs are up and about already the big herbivores munching away the carnivores doing their stalking All of them have such huge appetites that they can t wait for the sun to come up In the bad old days when the dinos were thought to be reptiles of course we d have expected them to sit there like lumps until daylight got their body temperatures up to functional levels But one of the great joys of the reconstruct project was the vindication of the notion that dinosaurs were warm-blooded animals active and quick and pretty damned intelligent No sluggardly crocodilians these! Would that they were if only for my survival s sake

1130 hours A busy morning My first en-

CONTINUED ON PAGE 94

Ron Siegel probes the hallucinating brain to chart hidden features of our mental landscape

CARTOGRAPHER OF CONSCIOUSNESS

BY BRIAN VAN DER HORST

Ronald K. Siegel removes the tiny vessels from a heavy safe in his laboratory. "This is a bottle of the original solution processed in Switzerland for Albert Hofmann," he says. "This is the last bottle manufactured by Sandoz for Timothy Leary. This is an Oriental batch produced especially for me." He might be a connoisseur of wines talking about great vintages. But these three vials, each the size of a pencil stub, contain enough LSD-25, psilocybin and opium to turn all of Los Angeles on.

An experimental psychologist at UCLA's Neuropsychiatric Institute, Ron Siegel probably knows more about how drugs work than anyone else alive. He uses science to determine exactly what people see during a drug experience. His trained "psychonauts" traverse inner space and report back what they see. This enables the psychologist to chart elusive features of the mental landscape.

"We now have a map of all hallucinations in terms of form, color and movement," Siegel notes. "While visual, our mapping techniques can be applied to auditory, olfactory, tactile and probably emotional states. We've begun to see that the subjective world is just as worthy of serious research as the objective world."

Siegel's work with the hallucinating brain promises to reveal important new information about how the human mind functions. Far beyond the obvious benefits it will bring in the improved use and manufacture of pharmaceuticals, scientific drug use may demonstrate enormous potential in expanding our mental abilities.

"Much of the information stored in the brain is in the form of images," he explains. "By studying hallucinations, we are learning about the storage-and-retrieval process of those images. We will eventually be able to control the retrieval of information almost at will—including thought imagery, daydream imagery, sleep imagery or hallucination imagery."

Siegel (left) maps the meaning of drug induced art (above)

PHOTOGRAPH BY NORMAN SEEFF

Certain key aspects of cerebral behavior have emerged through Siegel's research. "We know that hallucinations correspond to patterns in the structure of the optical system and to storage information in the brain's cortical cells," he says. "That information is stored in geometric arrays which form the structure we see played on the visual screen during hallucinations. Structural interpretation is idiomatic for each person, but the structure itself reflects the common wiring of the human brain."

In addition to delineating the visual format of hallucinations, Siegel examines the question of where and how these visions originate. The most integrated explanation he has found is "perceptual release." This theory of hallucinations was first formulated by British neurologist Hughlings Jackson in 1931 and was updated by Siegel's colleague Louis Jolyon West.

Normal memories, the theory assumes, are suppressed by the flow of sense information from the outside world. "New information," West writes, "inhibits the emergence and awareness of previously processed information. If the new input is decreased or impaired, while awareness remains, stored images may be released and experienced as hallucinations or dreams."

In other words, hallucinogens temporarily stem the blinding flow of sensory information that pours into the brain, enabling the individual to explore the awesome depths of his own infernal universe. Psychologically, physiologically and neurochemically, Siegel found, hallucinogens can be described as mirrors of the mind.

Unraveling drug visions is the result of painstaking preparation and exhaustive experimentation. Contrary

to the widespread belief that the U S government suppressed hallucinogenic research in the Seventies, Siegel maintains. "This simply wasn't true. If you wanted to go through the logistics of getting permission, you could get it. I think expressions like 'The government's hassling me,' 'red tape' and 'roadblocks' are unreasonable assessments of what I consider some rather good procedures for ensuring safety and experimental rigor."

The first step was to select his all-important psychonauts. Volunteers were recruited through advertisements in West Coast newspapers and alternate life-style publications. Siegel was not allowed to use naive subjects but did select those who had a minimum number of previous drug experiences. "We didn't want them reliving old trips on our drugs," he says. "We wanted to give them all their trips."

Siegel plied his volunteers with agents ranging from LSD to psilocybin, mescaline, PCP, and old-fashioned marijuana, supplied by the government or pharmaceutical companies. But before a subject inhaled a single toke, Siegel trained him with thousands of slides to identify instantaneously a veritable jungle of visual forms.

These forms were selected from a system devised by Heinrich Kluver in the 1920s. Kluver identified four types of consistent hallucinogenic images: gratings and honeycombs, cobwebs, tunnels and cones, and spirals. Variations in color, brightness, and symmetry provided finer gradations of experience.

For Siegel, this little-known system proved to be a Rosetta Stone of human hallucination. "We constructed a list of eight forms from lines to kaleidoscopes, eight colors, and eight patterns of movement. Then we trained volunteers in each of the forms.

"For example, in training related to tunnel forms, we showed hundreds of slides of tunnels so that subjects would have a broad concept of the form."

In essence, Siegel ran a psychedelic boot camp, drilling his psychonauts until they could identify the minutest changes in form. They would not only report that "There's a yellow spiral checkerboard coming at me from twelve o'clock," but that the yellow was 570 millimicrons in wavelength.

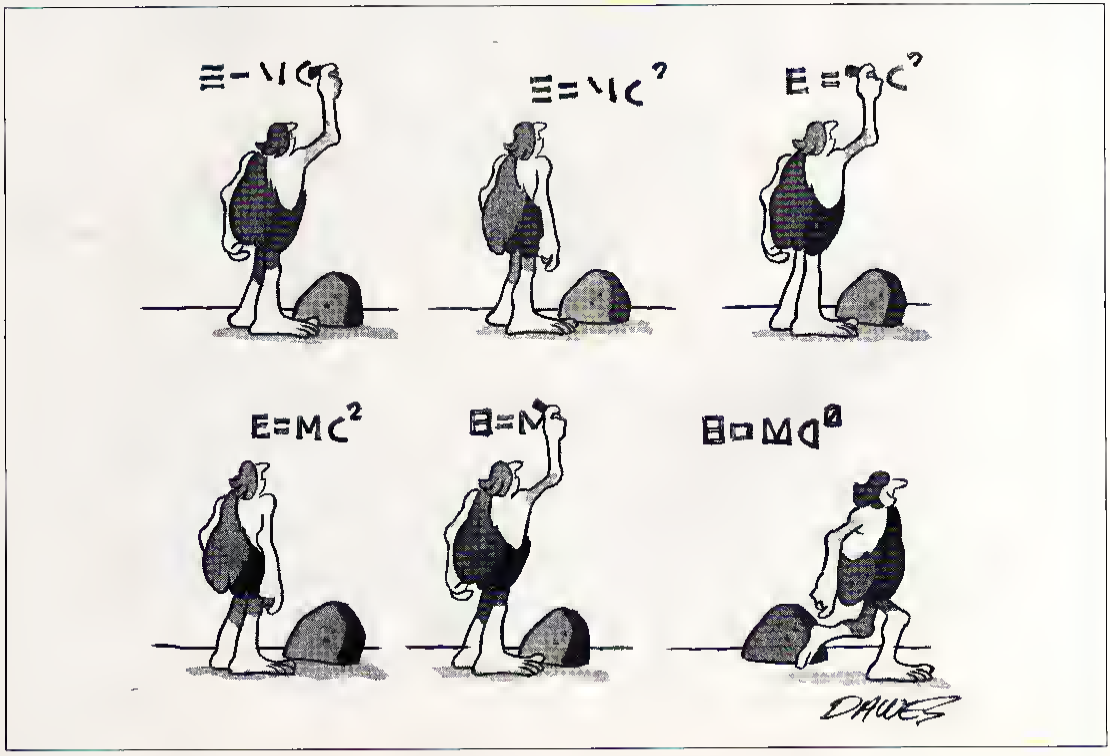
When Siegel's explorers were finally administered drugs in isolation chambers, their unprecedented visual education enabled them to report an average of 20 times a minute, compared to only 5 times a minute with untrained subjects.

What did they see? Placebos, amphetamines, and mild depressants produced nothing but black-and-white random forms moving aimlessly. The hallucinogens, however, produced more vivid descriptions. First, organized, geometric patterns appeared. Slowly they took on blue tints and began pulsating. Thirty minutes into the voyage, lattice and tunnel forms increased significantly, along with some kaleidoscopes. When nearly two hours had passed, colors shifted to red, orange, and yellow. Explosive, rotating lattice tunnels predominated, overlaid by complex images drawn from the subject's life. The scenes and forms all danced together around a bright light in the center of the image.

Many psychonaut voyages recalled childhood memories and embellishments of strong emotional scenes. During peak hallucinatory periods, subjects frequently crossed the Rubicon of complete hallucination. They described themselves as actually becoming part of the imagery and stopped using similes in their reports, asserting that the images were real. In this state, images changed as frequently as ten times per second. But even at the height of phantasmagoria, constants appeared among psychonauts.

A review of 500 LSD experiences revealed that between 62 and 72 percent of the subjects saw similar simple-form constants, while more than 79 percent reported similar complex images.

We are finding correspondences of chemical and electrical properties in the brain, linked with what the individual sees in his mind's eye," Siegel says. "We're showing that the subjective world is capable of being mapped and understood, despite the billions of pathways and neurons present in the nervous system. This will ultimately—perhaps in fifty to one hundred



years—allow us to have complete mastery over a scientifically engineered inner world We will be able to recall thoughts and images at will and to interpret dreams by objective criteria With that also will come better mental health through new ways of communicating with the mentally ill The hallucinating schizophrenic for example may not be dissimilar to the hallucinating drug patient with whom we can now communicate very effectively

For most scientists achieving the first full understanding of hallucination would be an all-consuming task but not for Siegel Besides his studies this Renaissance man teaches at UCLA serves as an editorial referee for nine prestigious journals runs a forensic-medicine practice specializing in drug-related deaths and is a volunteer at UCLAs Veterans Administration Hospital

He has also found time to write classic papers on the effects of such herbal remedies as ginseng kola and nontobacco cigarettes and reports of experiments with the imaginary playmates of young children As an avocation Siegel owns a research and-development company called Moshka Laboratories which investigates new sources of drugs—including a cocaine chewing gum He writes prizewinning poetry is a capable artist and has even invented a machine that projects hallucinatory images directly onto the retina of the eye In early trials of FOCUS (Flexible Optical Control Unit Stimulator) subjects couldn t tell the machine s images from reality What s more, subjects demonstrated the same bodily responses as they would have by taking a drug FOCUS seems to turn people on without drugs

In recent years Siegel has become one of the leading forensic authorities on drug abuse He was consulted on such landmark cases as the Leslie Van Houten "Helter Skelter" trials where LSD intoxication was a major issue and *Massachusetts* v *Miller* in which cocaine laws were declared unconstitutional for the first time Today Siegel is consulted constantly in drug cases "I probably get called on one drug-related homicide a day and many rapes and robberies" he reports "This year alone I ve been called to testify in court for over seventy cases"

Robert C Petersen assistant director of the National Institute on Drug Abuse holds Siegel in the highest esteem "Ron s a highly imaginative creative psychologist and one of the most competent guys in his area" he says

In the middle of this cyclone of activity Siegel a dedicated vegetarian somehow manages to keep in good enough shape to run 3 15 marathons And he looks it

Siegel s lean compact frame moves quickly around his apartment which is filled with rare drug books Huichol yarn paintings iridescent oils by an artist stoned on yage (a hallucinogenic plant found in South America) and sketches by clinical subjects strung out on LSD The psychologist s knife-edged face green eyes and sandy longish hair are reminiscent of a younger more penetrating Dick Cavett He is thirty six years old

Over a dark steaming cup of coffee—the only drug he uses personally—Siegel digresses about the drugs he deals with so intently in the lab "I d like to see laws more in tune with psychopharmacological reality There is a notion in our country today that drugs are magical elixirs that will transform people into either geniuses or maniacs They re not There are dangerous homicidal combative people who take drugs however and become more so But it s not the drug it s the personality The drug triggers the underlying personality and any pathology that may be there It never ceases to amaze me how much resistance we have built up to accepting that very simple fact

"One can make a very strong evolutionary historical argument that our species as well as others has always used these compounds to alter our states of arousal and our moods"

This forms the premise of *Natural Intoxication* a book Siegel is now preparing "We are not the only animal that turns on" he observes Since the days of the dinosaurs—whose demise Siegel attributes in part to drug overdoses from prehistoric vegetation—a host of animals have pur-

posefully intoxicated themselves

Elephants eat the fermented fruits of several trees which contain 7 percent alcohol Some grazing animals live for years on hallucinogenic jimsonweed Birds in Hawaii ingest the mescaline containing San Pedro cactus Chimpanzees gobble marijuana Cats nibble catnip Boars, porcupines and gorillas trip out on plants containing the psychedelic ibogaine Reindeer feed on *Amanita muscaria* mushrooms and virtually everyone has heard the story of how humankind discovered coffee by observing Abyssinian goats getting frisky after eating the fruit of the coffee tree

Siegel paints his discoveries about the pervasiveness of drugs in near-Darwinian hues What he asks, is the tendency of many animals and most mammals is *toward* intoxication and the consumption of psychoactive drugs? If that is true, might there not be an evolutionary drive toward intoxication rather than sobriety? Perhaps as species respond to increasingly complex environmental and social stresses intoxication becomes a most natural state of affairs in the animal kingdom Our societal respect for sobriety may be an unnatural cultural restraint on natural evolutionary tendencies

In *Natural Intoxication* Siegel says "I'm exploring why we have drug use, how it's naturally evolved and why it will probably always be with us It doesn't have to be abuse and it doesn't have to be detrimental to the individual or society This book will illustrate that intoxication is a natural behavior, acceptable in our species and perhaps essential for our survival."

The human drive toward intoxication, Siegel believes is an outgrowth of "our pure curiosity We've always explored both our interior and our exterior universes We've been explorers—and adventurous ones—utilizing every tool at our disposal Interest in intoxication is a natural outgrowth of our inner compulsion to try new things, to find out about our environment

If drugs are a natural compulsion how should they best be used? Right now, Siegel admits, "there is no medically accepted use for them Therefore they remain classified under the Controlled Substances Act of 1970 There are some medical uses that are generally not accepted Marijuana has some use in the treatment of glaucoma as an analgesic for cancer victims, and as an antiemetic in chemotherapy There are some research data that suggest LSD and other psychedelics may help terminal patients and alcoholics I think these suggestions should be more fully explored and researched in clinical practice

"In terms of recreational use, I think drugs have potential as an educational tool They let us experience a wide range of mental and emotional phenomena that provide a rich substratum for learning."

Unfortunately, Siegel declares, hallucinogens today aren't being put to any good use not even good hallucination

According to the eleven street drug analysis labs scattered across the United States we know the average potency of an LSD dose is fifty micrograms less than the threshold needed to elicit a full psychedelic experience

People are using LSD today just like beer They spend the day at Disneyland or go to a movie I'm not saying this isn't fun But I think it's a misuse of a very potent agent I fear that psychedelics have lost that philosophical message that came with their widespread introduction in the Sixties People today often have no regard for the potential of psychedelics for the doors of perception they can open in the mind I think this is almost sacrilegious

In the future drugs will become legal, more natural and much more specialized, Siegel expects "When we talk about natural intoxicants and recreational drugs we'll probably have a variety of them to appeal to different types of personalities We'll probably need a stimulant, a tranquilizer

"Siegel believes we crave intoxication Our curiosity creates an evolutionary drive toward drugs, a natural behavior, acceptable, even essential for survival"

and a euphoro-hallucinogen Safe psychedelics that go beyond caffeine, aspirin, alcohol and nicotine I don't think we have a suitable stimulant Cocaine comes close, but a better product would probably be some kind of coca preparation to keep the dosage down We don't really have a natural tranquilizer although kava root from the South Pacific may be useful As a euphoro-hallucinogen, psilocybin, which comes from mushrooms, looks extremely exciting But none of these have been adequately investigated, and certainly our molecular chemists can design even better drugs

"These new drugs will perform the same general function as their current counterparts," Siegel believes, "but they'll do it better, safer, cleaner We'll be able to eliminate the physical side effects, the bad trips The perfect drug will get in and out of the body quickly will have few bodily effects and will affect only those centers of sensation and perception we want affected."

In this way drugs will become less frightening, more controllable and far more useful to the general population Siegel feels They will change the way we think and the way we live

Sophisticated psychopharmacology opens exciting new vistas in the development and control of mental activities "These drugs will give us control, and through control we will achieve power," Siegel predicts "We shall also achieve greater insight to temper our expanded mental abilities."

The most valuable outgrowth of Siegel's research though may have more to do with brotherhood than with brain control His cross-cultural studies of drug visions have found that the constants of hallucination transcend cultural boundaries Everyone has the same basic experiences

Weston LaBarres, a Duke University anthropologist, notes the importance of such findings "Anthropologists are so used to cross-cultural differences that when we see something physiologically similar we prick up our ears I like and respect Siegel's work

"There is a universal common denominator of behavior," Siegel asserts "It's something similar to what Jung called the collective unconscious typified by symbols like the mandala Whether you use that kind of labeling or choose to call it something else the fact remains that given an infinite variety of stimulations the brain seems to respond in finite ways

"Fever delirium epilepsy, syphilis, photostimulation sensory deprivation extreme hunger cold or thirst, crystal gazing, swinging in the witch's cradle hypoglycemia, and a variety of drug intoxications all make the brain respond in patterns that are definable predictable and explainable in terms of where they came from and how they were produced."

Siegel feels that religious exaltations such as satori and samadhi yoga follow similar descriptions as do other, more far fetched experiences

Life after death? "The experiences recorded by people who have allegedly suffered a clinical death and have been subsequently resuscitated are virtually identical with hallucinatory drug images"

UFOs? "We've found an uncanny parallel between the experiences of UFO abductees and the phenomena of drug-induced visions

"That's not to detract from the romanticism or novelty of these visions or their utility in inspiring creative endeavors or giving support to transcendental experiences But it is to say that they are very similar for all people I think this reflects the common biological wiring of *Homo sapiens* The specific content may differ, but the geometric format of these visions—the colors, tints, saturation, brightness, movement—will be the same for Huichol Indians or residents of San Francisco

There is a harmony in the interior landscapes of all people the cartographer of consciousness proclaims "We are very much the same and that should increase fraternity with our fellow humans There is a brotherhood of man subjectively as well as objectively"

LIFE ON A NEUTRON STAR

It's faster than a speeding bullet, but weaker than a locomotive—and very heavy

BY ROBERT L. FORWARD

Life. It's everywhere. From the mouths of boiling mud pits to the farthest depths of the sea, our planet is acrawl with it. It's a basic rule: If there's a niche to support them, living creatures will be there.

There seems no limit to the fertile places. Life, after all, is the pattern, not the cloth. Though we know only of organisms that use carbon, hydrogen, oxygen, and nitrogen, life can build itself from many ingredients. As we grow older and wiser, we will inevitably learn of other materials that evolution has adopted as its own.

It is remarkable enough that life formed here on Earth. It would be no more amazing if it had appeared on a neutron star. Frank Drake, now director of the Arecibo Observatory, in Puerto Rico, once used the image of life forms to bring the earthlike features of neutron stars home to his lecture audiences. There may have been more to Drake's fantasy then he knew.

Not even stars live forever. Like creatures on the planets that orbit them, stars are born, live out their lives, and die when their time comes.

If a star is much bigger than our sun, it races through its short life in an overheated fervor. Its end is a supernova that sears the interstellar blackness. The star dives down into its own core and wraps space-time around its naked mass. It retreats inward, shielded forever by slowed time and curved space—a black hole.

If the star is the size of our sun or smaller, it heaves and swells as the fuels within it become more active. Like a feverish patient in the last throes of a fatal disease, the star inflames, bloating in its final days. Throwing off its outer layers, it expires as a dwarfish lump, cooling slowly by radiation into the night.

A medium-sized star also metamorphoses in

PAINTING BY GEOFFREY CHANDLER

a terminal explosion but its end is neither a black hole nor a white dwarf. What was once a large, red ball of glowing gas with a weak magnetic field threading its center is condensed into a white-hot, rapidly spinning ball of ultradense neutrons with stiff magnetic appendages stretching out on either side. Surrounding this tiny shocked ball of neutrons are the diaphanous outer layers of the original star. Thrust by its magnetic field away from the cast-off shell, the neutron star flies off into the blackness to start a new life—as a planet.

It's not a promising start for something you'd describe as earthlike, and the differences are enormous. Although hotter than most stars and more massive than its dull white dwarf neighbors, a neutron star is not a star. Stars are huge balls of burning gas, warm and fuzzy on the outside and hot and dense on the inside. A neutron star has a hot, dense interior, but it is a ball of liquid neutrons, not gas. The outside does not have the soft atmosphere of a normal sun. Instead, it has a hot, glowing, crystalline crust of iron nuclei.

The neutron star has a mass half that of the sun, but a diameter of only 20 kilometers. The gravity field at its surface is about 70 billion times as strong as Earth's. When first formed, the star spins at more than 1,000 revolutions per second, but it slows rapidly. After a few thousand years it revolves only about five times per second. (The fastest-spinning neutron star known is the one at the center of the Crab Nebula, the remnants of a supernova that happened on July 4, 1064. It is spinning at 30.22 revolutions per second, slightly faster than most electric motors.)

If the original star had a magnetic field of a few hundred gauss, as our sun does (Earth's is only half a gauss), the field is trapped in the hot gases and concentrated as the star collapses—to a strength of 1 trillion gauss. Since a star's magnetic fields are not near the spin poles, as they are on planets, but poke out of the sunspots near the equator, the neutron star's magnetic field also sticks out at odd angles.

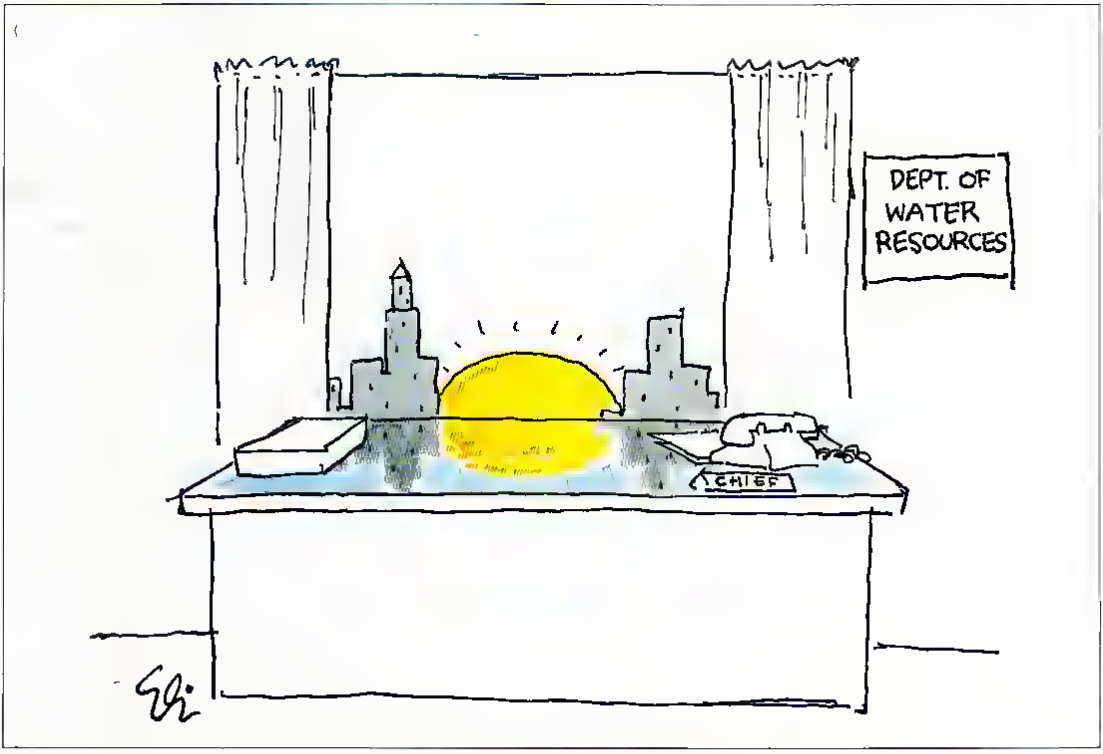
At the star's center is a 14-kilometer core of liquid neutrons with a density of more than 700 million tons per cubic centimeter. Over this is a two-kilometer-thick mantle of crystalline neutrons and nuclei. Already the density has dropped to 1 million tons per cubic centimeter. Here the pressure is low enough for some of the protons and neutrons to combine into atomic nuclei. Most are elements from the middle of the periodic table—manganese, iron, nickel and zinc.

The crust consists of neutron-rich nuclei, mostly iron. The density near the surface is only seven tons per cubic centimeter, a drop of 140,000 times in only one kilometer. As the star cools and shrinks, the crust wrinkles as it attempts to fit itself to the liquid interior. Mountain ranges raise their masses many centimeters high against the tremendous gravity. It takes a billion times as much energy to raise a bit of the neutron star's surface ten centimeters as it does to lift a rock ten kilometers over Earth.

Above the crust is an atmosphere of metallic vapor that thins rapidly with height. Atop the tallest mountains, fully 15 centimeters high, the atmosphere's density has dropped to one twentieth of surface pressure.

Cracks tens of meters long and a kilometer deep rend the crust, releasing volcanoes of liquid neutrons laced with electrons. Iron-vapor clouds rise to the stratosphere almost 15 centimeters overhead, brightening the countryside for meters around. Because temperatures increase with depth and the liquid neutrons undergo radioactive decay as they rise to the surface, the lava releases enough energy to maintain its flow against gravity. Volcanoes build up lava shields many millimeters high and hundreds of meters across, slowly changing the weight distribution of the neutron star. Finally they cause starquakes.

Starquakes change the height of a lava shield or mountain range by a few millimeters in the star's 70-billion-g gravity field. Because the neutron star is rotating, its magnetic field gives off pulses of radio waves each time it comes around, just like the lamp in a lighthouse. The star's enormous rotational inertia keeps the pulses very regular: they can be timed to parts in a



billion When a dense range of mountains rises or falls in a starquake the star s inertia and spin speed change We have detected these changes after quakes on neutron stars up to 5 000 light-years away

Mountain ranges volcanoes, quakes an atmosphere—these are very earthlike features to find in an environment so alien Is there any reason then to rule out the presence of life as well? Probably not And the similarities between our environments combined with the basic needs of life itself might well give us much in common with these alien beings

One of life s most characteristic features is complexity this is especially true of intelligent life There is plenty of opportunity for complexity on a neutron star Compare possible neutron-star beings with man A 70-kilogram human composed of an estimated 10^{25} atoms shows some signs of intelligence An intelligent neutron star being could probably get by with 10^{25} nuclei Since most of an atom s mass is in the nucleus such a being would also weigh about 70 kilograms

While terrestrial life forms are made of carbon hydrogen nitrogen oxygen and traces of other elements, neufron-star life would be formed mostly of iron nuclei the predominant element in the crust To provide complexity there would be many isotopes of iron, some more neutron-rich than others and traces of elements near iron in the periodic table

The atomic nuclei would not have captive electron clouds to keep them isolated from one another Instead they would share a sea of free electrons The nuclei would be so near one another that they could exchange neutrons forming "nuclear-bonded macromolecules" as easily as human atoms join by trading electrons Since a typical atomic nucleus is about one millionth the size of an atom nuclear molecules will react about a million times faster than the atomic molecules in our bodies do

One possible form for an intelligent neutron-star being would be a flat amoebalike creature about five millimeters in diameter and half a millimeter high Packing 70 kilograms into this volume gives a density 7 million times that of water equal to the star s crust

Life on Earth exists because of the sun Photons come pouring down onto the leaves of plants and the chlorophyll molecules capture some of their energy to make food Some of it becomes waste heat which the plant empties into the atmosphere through the transpiration pores in its leaves Then at night the atmosphere releases its load of heat into the dark sky which has a temperature only three degrees above absolute zero

For neutron-star life the situation is reversed The plants instead of spreading their leaves to catch the hot sunlight must use them to see the cold sky With a taproot into the hot neutron rich crust and a strong supporting stem to lift the top portions off the hot surface "plants" could run a food cycle by using the temperature difference between the crust and their cold topsides

Picture life on a neutron star The powerful magnetic field dominates all movement everywhere on the star The flow of volcanic lava the fall of a landslide and the passage of vibrations through the atmosphere or crust all travel preferentially along the magnetic-field lines

Even the nuclei that make up the star s crust and inhabitants are affected Inside each atomic nucleus there are positively charged protons in rapid motion Magnetic fields exert a force on moving charges and the field of a neutron star is so strong that it is many times easier to move along the magnetic field lines than across them The usually spherical iron nucleus is stretched into a cigar ten times longer than it is wide A neutron-star being at a magnetic pole is ten times taller than one at the equator A being at the equator is ten times wider toward the magnetic poles than transversely However since their eyes are affected in the same way the beings do not notice the distortion

The creatures themselves find it many times easier to travel along the magnetic field lines than across them Moving across the magnetic field sets up electrical cur-

rents in their bodies that cause a magnetic 'drag'. It's like trying to force a path through a room strung with rubber bands. If the beings push hard enough, the field lines move aside to let them through, yet still resist with considerable force. The minute the beings stop moving, the currents die away and the magnetic field reenters their bodies, pinning them to the field lines like beads strung on a wire.

Vision is quite different for neutron-star beings. Since they are tiny, their eyes are so small that they must see by ultraviolet light and soft X rays. Living on a neutron star is like living in the middle of a charcoal fire. There is no sun or moon overhead; the "light" comes from the hot crust of the star itself. Everything is whitish-yellow on the bottom, shading to deep red on top, where the surface faces the cold sky. The beings themselves glow white-hot, and their eyes are raised on stalks to avoid being blinded by their own internal radiance.

Since the star's gravity is what keeps the beings dense enough to exist, they will have a hard time developing spaceflight. If a neutron-star being were placed in free fall, the repulsion between their positively charged protons would drive the nuclei apart. As the distance increased, the electrons, which under pressure flowed as a "liquid" around the nuclei, would attach themselves to specific nuclei, forming normal atoms. Soon the creature would have expanded by a factor of 100 in each direction, its density dropping by 1 million, until it had been transformed into a weirdly shaped and very dead chunk of glowing nickel-iron alloy.

To leave home without blowing up, the neutron-star beings will have to take their own gravity with them. They must either invent a lightweight gravity generator for their spacecraft or take some miniature black holes along.

A nucleonic space cruiser big enough to hold three or four dozen neutron beings and their equipment would be a sphere the size of a golf ball. If the ship had a stiff shell of neutron-star crystal with a black hole of 11 billion tons mass in the center, the gravity on the surface, though far below that of the neutron star, would be enough to keep its passengers from exploding. Small flitters designed to carry just one being at a time need be only about five millimeters in diameter—the size of a mustard seed. They could use miniature black holes of only 200 million tons mass.

The large space cruiser would have to stay well away from human beings. Its gravity field, even 15 meters away, would be one-third g. Any closer than that and the person would be sucked onto the spacecraft. The smaller sphere could come within a meter, so that an observer could actually see the glowing-hot being astride it. Even at that, the gravity field on the person's nose would be three gravities!

We could never visit the surface of a neutron star, of course, but the two cultures might meet in orbit around the star. Looking at a human, neutron-star beings would see a huge "violet" skeleton with gaping holes for eyes, each larger than the caldera of a neutron-star volcano. Between the eye sockets, a cavern deeper and longer than a neutron-star Grand Canyon would slash down toward two rows of dense, violet-white teeth standing like two mountain ranges, one atop the other. Flesh and hair would appear as a "blue-white" short-ultraviolet outline surrounding the skeleton, with clothing showing up as a faint "reddish-yellow" wisp in the long-ultraviolet part of the spectrum.

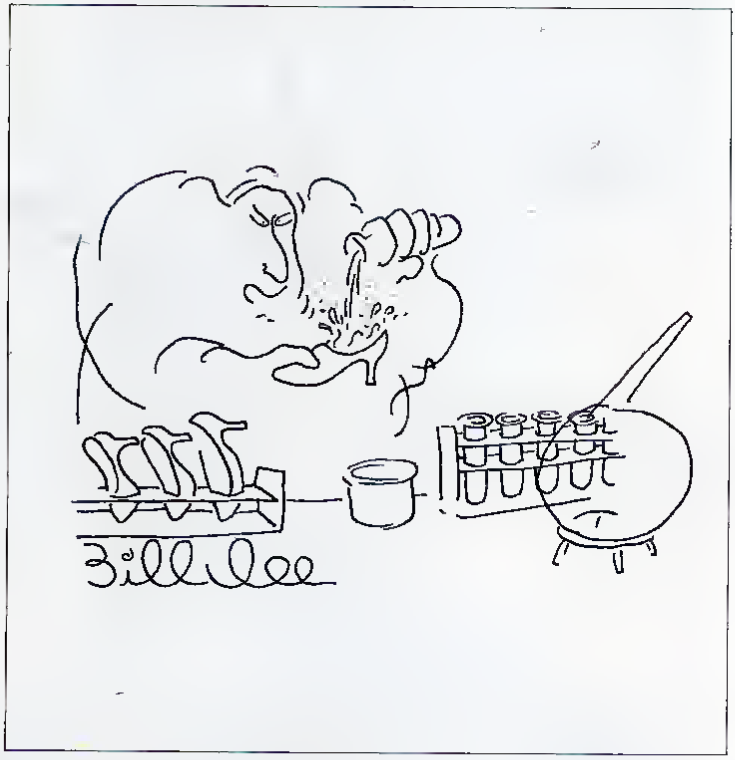
Since the molecules in a neutron-star being react a million times faster than ours, the beings would live, think, reproduce, and die a million times faster than we do. A human year would be equal to a million of their years—enough for their species to evolve. One human day would equal 2,500 of their years, enough for the rise and fall of great empires. Thirty human minutes would cover the life span of a neutron-star being, with perhaps only 15 minutes available for conversation with our scientists during the creature's adult phase.

A chat with the slow-witted, slow-moving humans would try the most patient of the neutron-star beings. A human word would take a day, a sentence a week. We could learn a great deal from a life form that knew as much about nuclear physics as we know about molecular chemistry, but we had both better use computers to speed the actual dialogue.

The time difference also means that we could not spend very long in useful discussion. If we were fortunate enough to meet a neutron-star race when they had just started to develop intelligence, they would be interested in talking with us for only a few days. After that, they would have progressed the equivalent of thousands of years ahead of us. They could inadvertently ruin our civilization by telling us more than we could handle, either physically or emotionally.

Life on a neutron star? Some would say it is impossible, since there are no seas to form the primordial soup and the temperature of even a white-hot neutron star is close to absolute zero, as nuclear energies go. But it is not hard to "prove" that life cannot exist on Earth. The intense ultraviolet radiation from our sun is enough to break any molecular bond that has the temerity to form, and everyone knows that oxygen is deadly to hydrocarbon life. What oxygen doesn't poison, it burns, especially when triggered by the terrible lightning storms that ravage the globe. Life on Earth? Ridiculous!

So, if one day you see a ball of light pass rapidly overhead, then find yourself pulled off balance by the gravitational tug of an incandescent golf ball many meters off, just wave to it. The crew doesn't have all week to waste listening to you say, "Hello! Welcome to Earth!" OO



There are some marvelous benefits ahead for mankind. But along with every benefit will come a whole new set of problems.

Champion is a forward-looking forest products company. We plant seeds for a living. Seeds that take from 25 to 50 years to become mature trees. Therefore, we think a lot about The Future of the forest. And, of the people who will be around to buy our products in the years to come.

So, during the coming year, in magazine ads like this, we will continue our program of discussing some of the potential cultural and sociological impacts of future technology and change—to help you make intelligent choices.

You might say, we're planting seeds of thought for tomorrow.

The Future is coming.

But only you can decide where it's going.

Lord Kelvin, the eminent nineteenth century physicist, once predicted: "X-rays will prove to be a boax"; "Aircraft flight is impossible"; and "Radio has no future."

Octave Chanute, an aviation pioneer said in 1904: "The [flying] machines will eventually be fast, they will be used in sport, but they are not to be thought of as commercial carriers."

Henry L. Ellsworth, U.S. Commissioner of Patents in 1844, a man who should have known better, said: "The advancement of the arts [of invention] from year to year...seems to presage the arrival of that period when further improvement must end."

In a comment on this kind of "technological pessimism," science writer Arthur C. Clarke, in *Profiles of the Future,* said: "When a distinguished but elderly scientist states that something is possible, he is almost certainly right. When he states that something is impossible, he is very probably wrong."

Obviously, we can't leave The Future *just* to the experts. As intelligent and well-informed as they are, they are not infallible.

Collectively, we all have to take responsibility for the future. It doesn't just *happen* to us. We must learn all we can from the past. And use it to help us in the years to come.

The human race is now making choices that may well determine our long-term future. No one knows the precise nature of these choices, but futurists agree that our actions today will reverberate throughout the years ahead.

As a company whose entire being is based on the tree, a renewable resource that takes from 25 to 50 years to mature, we have always been particularly concerned about the prospects of future generations of forests and of future generations of people.

So it seems only natural for us to consider some of the situations that futurists foresee for the coming generations. And to discuss some of the choices that will have to be made.

In magazine pages like this, we will continue to look at some of the major issues that can affect us all in the years to come.

If you have any doubts about The Future remember this: many of the supposedly "unsolvable" problems of past generations have been very successfully solved. For example, we now have insulin for diabetics, ships that fly to the moon and an effective polio vaccine.

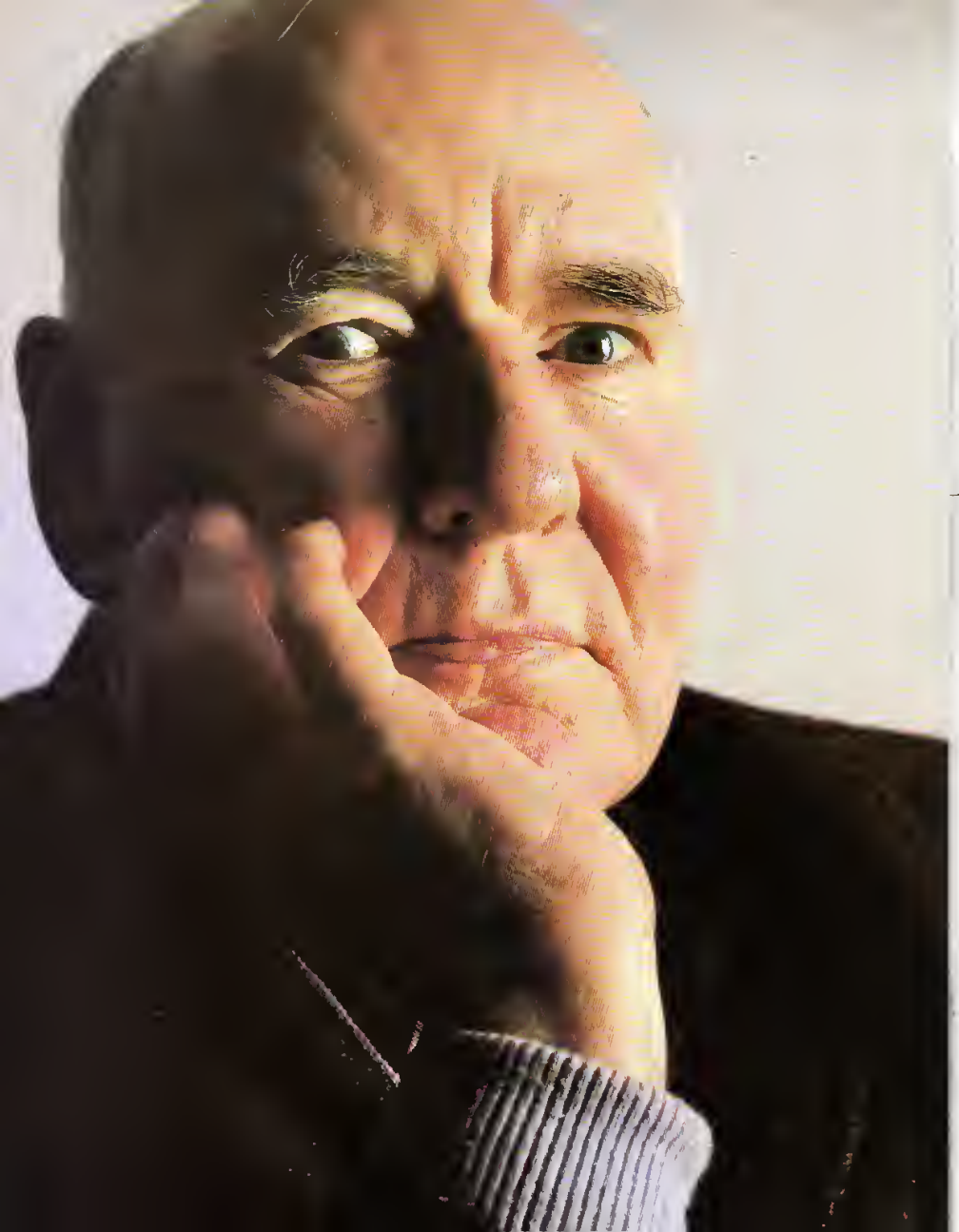
If you agree that The Future consists of a variety of alternatives, that choice is unavoidable and that refusing to choose is itself a choice, you have taken the first step toward a more active role in your own future. You can learn more by sending for a free brochure about the critical issues we face in The Future and a bibliography for further reading. Write:
Champion International Corporation
Dept. 200N, P.O. Box 10143
Stamford, Connecticut 06921

Champion—
a forest products company with its roots planted firmly in the future.

We are in the forest products business. We plant trees, grow trees, harvest trees. And from trees we make wood building products. Plus fine paper for printing and business. And paper packaging for shipping and selling.

Because we make our living from the forest, our success depends, in one way or another, on the future. And we're planning—and planting—for it.

Champion
Champion International Corporation
Planting seeds for the future



Photograph by Robert Dowling

The foremost critic of bureaucracy discusses his unorthodox views of big government, population, and a new campaign to end forced retirement

INTERVIEW

C. NORTHCOTE PARKINSON

"Work expands to fill the time available for its completion." The wit and simplicity of this law, first published 20 years ago in *Parkinson's Law, or the Pursuit of Progress*, made C. Northcote Parkinson famous the world over. His law made the labyrinths of bureaucratic process understandable to a generation. Then a history professor at the University of Malaya, Parkinson became suddenly fashionable as people grew more conscious of the pitfalls of bureaucracy. Since publishing his law, Parkinson has held visiting professorships at Harvard and the universities of Illinois and California, and he has lectured at the French and U.S. naval academies. Celebrated author, historian, and journalist, Parkinson, now seventy, lives in semiretirement in Guernsey. He still travels widely, particularly to Scandinavia, where he is regarded as a prophet of bureaucratic reform; Great Britain (whose prime minister, Margaret Thatcher, is a committed Parkinsonian), and the United States, where he often appears on television. Parkinson is a professor emeritus at Troy State University, in Alabama. He has published two books recently: *The Law Still in Pursuit* (John Murray, 1979) and *The Law of Longer Life* (written jointly with Dr. H. LeComte, Troy State University Press, 1980), in which he turns from criticism of waywardness and waste to an argument in favor of research on longevity.

"We need to revise the whole process of government finance," Parkinson wrote in *The Law and Profits*. "Ministers should not begin by ascertaining what their departments need. They should begin by asking what the country can afford to spend." That is what Mrs. Thatcher is trying to do in her U.K. administration. During one of Parkinson's visits to London, *Omni*'s European editor, Dr. Bernard Dixon, spoke to the professor about his law, economics, the social sciences, and his ideas on longevity. One of the most precious human resources, Parkinson says, is the wisdom and expertise vested in the elderly. Yet we tend to let those talents atrophy. The purpose of an antiaging potion would be to maintain, and thus harness, such skills.

Omni: Have you modified your analysis of bureaucratic waste since *Parkinson's Law*?

Parkinson: Nothing has happened to change my views on staff proliferation and committology—that is, the needless and wasteful growth in the size of committees and cabinets. In fact, there's now even more evidence to show how right I was in the first instance.

Omni: Most of the examples you put forward then were British. Can you cite any American cases?

Parkinson: Yes. When the bridge connecting San Francisco with Oakland was built, a team of painters was hired. This was to be a permanent job. They would start at one end, finish at the other and go back to the beginning again—a good job with a pension. Twelve men were employed, but they soon came back and said they needed reinforcements. So their number was increased to fourteen, which I suspect is the right one. Some twenty or thirty years later, though, the figure had risen to seventy-seven. At the same time, the job had been mechanized and simplified by the introduction of paint sprayers. I should perhaps emphasize that it was the same bridge. Oakland and San Francisco remained exactly the same distance apart. Then along came Governor Reagan, who started off with the very best of intentions as a reforming, economizing governor, and all his efforts sufficed to bring the number down to about fifty-five. What has happened since, I don't know, but I suspect the number of men has probably again risen to seventy-seven or maybe beyond.

The disturbing thing about this statistic is that it concerns manual, not clerical, work. It raises an awful suspicion that the same law that I discovered for administration twenty years ago may apply to manual work, too.

Omni: Does this phenomenon extend beyond the United States?

Parkinson: The real distinction is not between countries but between businesses with balance sheets and those without. So long as there is no balance sheet and government does not produce one, there is nothing to combat proliferation. Similarly, there is nothing to prevent proliferation of monopolistic, rather than competitive, businesses.

Omni: How little competition constitutes a monopoly?

Parkinson: I suspect that when the number of companies in a given industry is as few as five, they probably will have agreed with one another on wages, prices, qualities and everything else.

Omni: Have you noticed the same sort of waste and inefficiency in science, which is now increasingly concerned with international corporations, big machines, big science and, therefore, inevitably, bureaucracy?

Parkinson: Yes. I see considerable waste in two areas. First, the majority of people holding scientific posts are quite incapable of any important research in their own subjects. They are busy, of course, but those actually contributing to science are relatively few. Meeting scientists, I have found one interesting rule to be applicable. A mediocre scientist is interested only in geophysics, microbiology, or whatever, while a really good scientist invariably has a wide range of interests, probably extending to art, literature, or music. I first noticed this with higher ranking officers in the armed forces after World War II. The excellent general or admiral was always somebody who had far wider interests than merely soldiering or sailoring.

Second, there is an absurd multiplication of scientific journals. I first realized this when I was working at an American university, a first-rate place, and I talked to the librarian about his problems. He said that a large part of his staff did nothing but file and cross-index astronomical numbers of scientific journals. As an example, he subscribed to seventy journals in dentistry alone. I found this mind-boggling for a subject that would appear to be of rather limited scope.

Omni: But why hasn't the market put this right? More journals are now published by commercial publishers on behalf of learned societies, and budgets are tight for librarians and individuals.

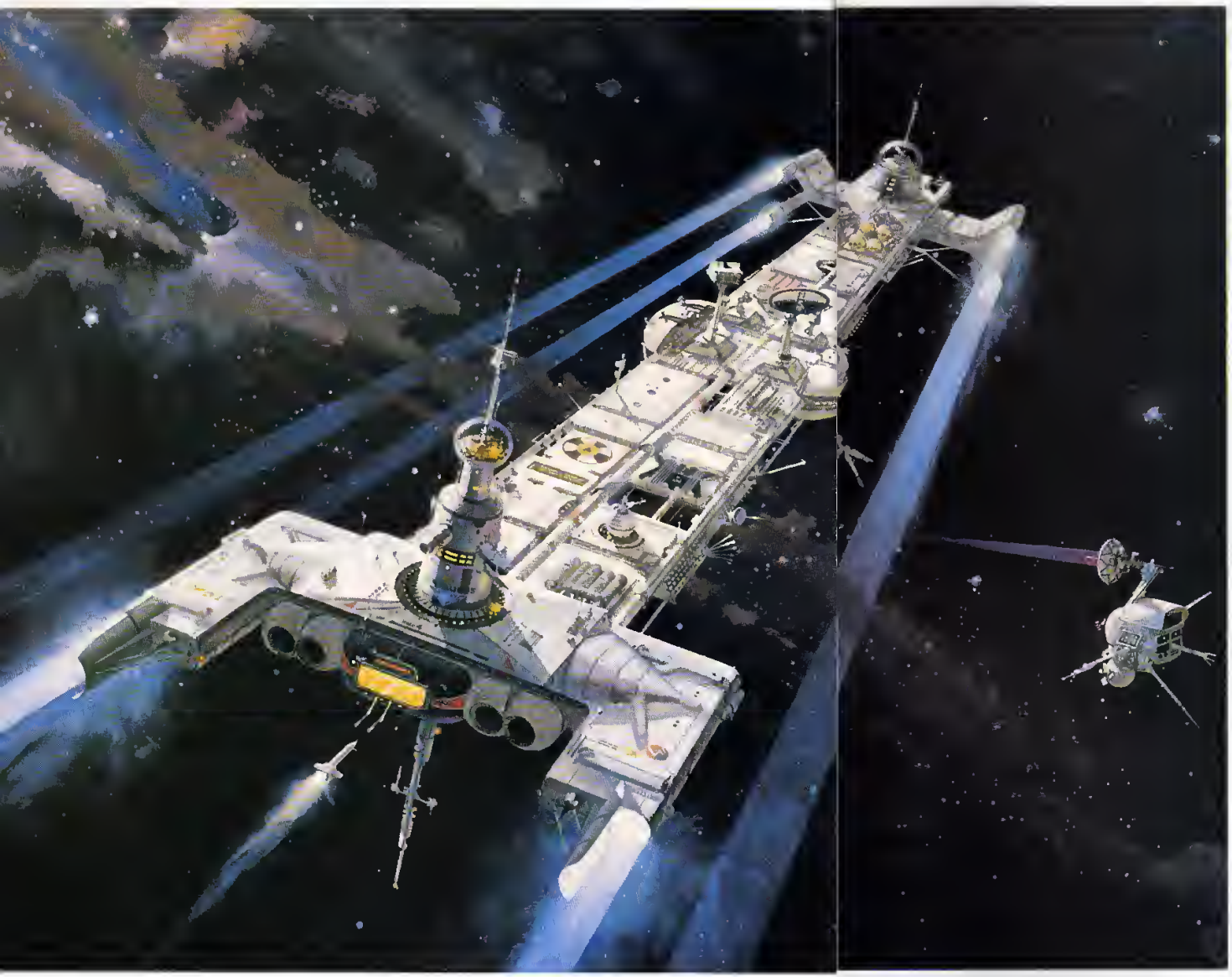
Parkinson: Scientific journals are not intended to be read. They are printed to support the prestige of their contributors. Despite the austerity you mention, in the academic world the motto is still "Publish or perish." To support your position as an associate professor, to forward your ambition of someday becoming a full professor, you must regularly publish articles in your subject. Imagine that the accepted journal in dentistry, nuclear physics, or whatever, refuses your articles. The best answer is to start a new journal with yourself as editor, thus yielding a very fair chance of getting your articles accepted. Of course, there are others whose articles are declined by your journal, so they set up their own. Eventually you have successive collections of articles rejected by earlier journals in the series, and presumably the articles are getting worse and worse. Like speeches made at annual conferences (which people don't listen to, because the real business takes place in the bars and saloons around the fringe), the great thing is getting the credit for making a speech or presenting a paper.

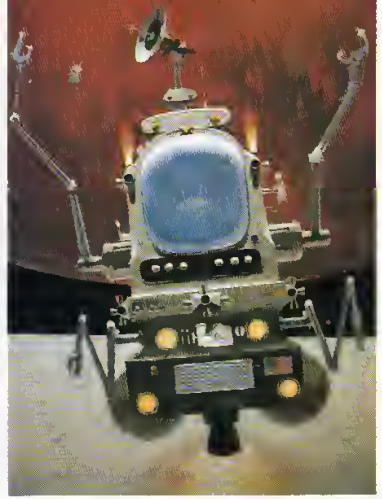
Omni: One feature of the past two decades has been the growth of United Nations agencies and of mammoth international conferences on such subjects as the environment, food, and Third World development. Do you think they do useful work?

Parkinson: Here, too, we are stifling ourselves with paperwork and documentation. Our respect for science leads us to imagine that we can't decide on a solution of a problem until we comprehensively understand it. So we must collect statistical and other data. Say that you have riots breaking

CONTINUED ON PAGE 88

"I have seen the promised land. It's going for three hundred dollars an acre."





SPACE WITNESS

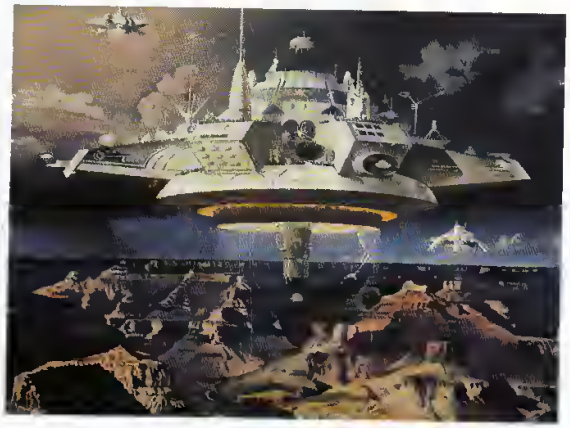
If anyone paints in space, it should be Bob McCall. He's all packed

BY F. C. DURANT III

Artist in residence—in space? Why not. Eventually an artist will record the wonders of space firsthand while spending a week in orbit aboard the space shuttle. Prime candidate for this honor is space artist Robert T. McCall.

More people have bought more reproductions of McCall's work than of any other space artist's. Usually the owner turns it over, licks it, and mails it to someone else. Six U.S. commemorative postage stamps issued in the past ten years bear McCall reproductions, among them *Skylab*, *Apollo/Soyuz*, the *Pioneer* flight to Jupiter, and the *Viking* missions to Mars. His *Decade of Achievement* double stamp was hand-canceled on the moon by astronaut David Scott during the *Apollo 15* mission. McCall is working on another stamp right now.

The heroic mural McCall designed for the National Air and Space Museum, in Washington, D.C., has been seen by 40 million visitors. Two other large murals were completed by the artist at NASA centers in California and Texas. McCall helped interpret the beginnings of the Space Age for *Life* magazine by rendering dozens



of on-the-spot paintings from his vantage point at Cape Canaveral, Florida, and later became a key contributor to the NASA art program. He created the promotional art for Stanley Kubrick's *2001: A Space Odyssey* and submitted futuristic concepts for such films as *Star Trek* and *Meteor* and for Walt Disney studios.

McCall wants to go into orbit. Broad-shouldered and now sixty, he keeps fit and exercises purposefully so that he can accept the NASA invitation if and when it comes. Comfortably dressed for work in a faded jump suit splashed with vivid daubs of paint, he asserts, "Of course I want to go. I want to see how the view and perspective change when you're not standing on Earth . . . and to experience

Preceding page: Concept of spaceship for Black Hole, *one-man space robot. Above:* Metropolis 4000, *Disney studios' giant space station. Right: Astronaut firing maneuvering unit*

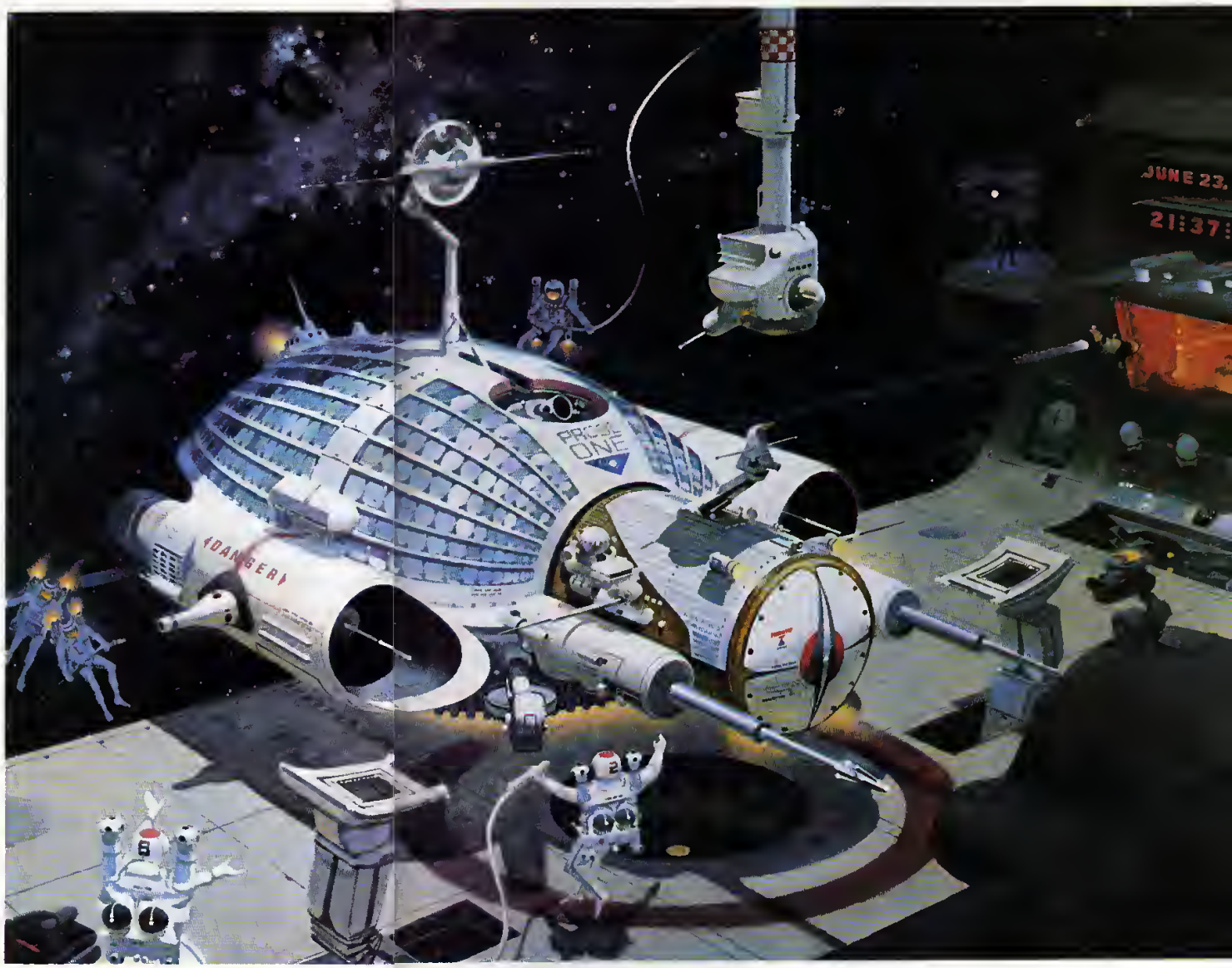
"I'd like to communicate the sense of what it's like up there."

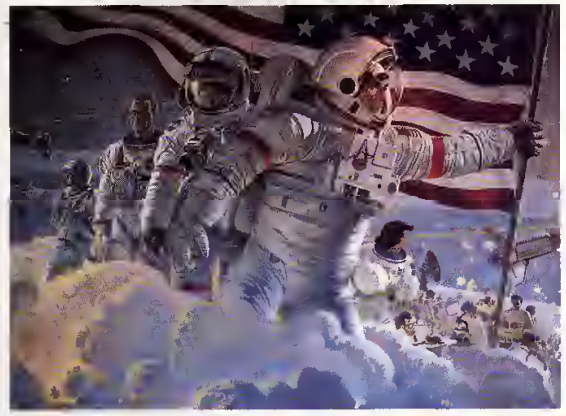
weightlessness, observe others, to sort out the emotional impact of being in space and to put it on canvas. I'd give it my best."

McCall's best has always been outstanding. Born in Ohio, he won a scholarship and studied at the Columbus Art School. "As a kid, I liked airplanes because they were dramatic and moved fast. I drew knights in armor, and I guess my paintings of astronauts in space suits are analogous—adventurous men risking everything, facing new challenges."

As an illustrator in New York in 1949, McCall worked for *Collier's*, *Saturday Evening Post*, and several advertising firms. His interest in flight did not abate. He sent a "To Whom It May Concern" letter to *Life* magazine together with a portfolio of his World War II combat illustrations. "I told them I believed man would be going to the moon, that I wanted to watch the launch and represent them when it happened," he recalls. *Life* eventually acknowledged the artist's query with a "we'll keep you in mind." They did. A year later he was commissioned to do 20 paintings in observance of the fifteenth anniversary of the attack on Pearl Harbor. *Sputnik* was launched the next year. *Life* soon required illustrations depicting the expanding space program. Kubrick's assignment for *2001: A Space Odyssey* followed.

"Future generations should feel proud of our accomplishments in space. . . . We are destined to explore and colonize the universe."





The talented space artist is astonished that "so few educated people appreciate the immensity of space and know so little about the cosmos." A neophyte astronomer who owns a three-inch reflector telescope, McCall is well aware that the view from space is a deep inky black. The mural at the Air and Space Museum, however, is painted "as beautiful and inviting rather than black and ominous. To me, the adventure in space offers incredible opportunities and rewards.

"Wernher von Braun hoped to fly in space. He wanted to be 'the world's first orbiting grandfather.'" McCall paused. Then, softly, "I'd give anything to be ∞

Preceding page: Mars astronaut, fueling port. Left: The Future in Johnson Space Center mural. Above: Shepard, Grissom, and Young in mural detail, manned rockets from NASA/Dryden

McCall's enthusiasm for science reflects faith in the future.

FICTION

It was an exclusive hotel—you had to kill someone to get in. Only the jury could check you out

IN THE HEREAFTER HILTON

BY BOB SHAW

The apartment was neat, stylish and comfortable—not at all like a machine designed for killing people.

For a few seconds after the entrance door had locked itself behind him Renfrew stood perfectly still, taking stock of the place, trying to identify the most likely sources of death. The kitchen—always the most complicated room in any habitat—was one area that obviously had to be avoided. Every particle of food and drop of liquid was suspect in case poisons had been administered, the appliances could have been wired in such a way as to electrocute the unwary user, and the bright-lettered canisters could be bombs that would explode on removal of their lids. Even the simple act of opening a cupboard door might release a cloud of instant-acting gas into his face, and one startled intake of breath would be enough to—

If you want to stay alive, Renfrew thought, *keep out of the kitchen.*

From his position near the entrance he could see into the bathroom, and that also looked dangerous—too many chrome fittings that could spring bad surprises. He was going to survive the mandatory seven days in the apartment—of that much he was sure—but to do so, he would have to be fantastically careful. The best plan, the one he had already decided upon, was to make himself as comfortable as possible in the center of the living-room floor and to remain there until the seven days were up. It would not be easy or pleasant—the matter of bodily functions alone would see to that—but it was a straightforward choice between life and death, and Renfrew much preferred being alive.

He walked into the living room and checked it out against his requirements. It measured roughly ten by ten, had blue wall-to-wall

SCULPTURE BY SHIRTSLEEVE STUDIOS

carpeting and was furnished with a good-quality settee easy chairs and occasional tables Several original abstracts adorned the cream-colored walls The room could have belonged to a youngish intelligent not excessively trendy person living just about anywhere between New York and Los Angeles—except for two atypical features One was the complete absence of windows and the other was the display tube in the wall above the artificial fireplace

On the screen in pulsing amber sans-serif lettering were two words JURY OUT

Renfrew examined the room critically and decided at once that the largest table positioned near the middle of the floor would have to be moved against one of the walls to give him the clear central space he needed When the room armed itself against him he was not going to risk even the most fleeting contact with any of the artifacts it contained For all he knew every piece of furniture would begin to ooze contact poison as soon as the jury returned the verdict of guilty and he wanted to be sure he would not roll over in his sleep and touch something

The table was surprisingly heavy when he tried to move it and for a moment Renfrew feared it was anchored to the floor He changed tactics pushing instead of lifting and this time the table slid fairly easily creating deep furrows in the carpet When it had come to rest against the wall he stepped back with widespread arms and gauged the size of the area he had cleared It appeared ample for his needs

This seems a shade too easy he thought his confidence faltering Nobody knew what percentage of condemned murderers actually lasted out the week—it was the practice for humane reasons, to whisk survivors off to colony worlds in total anonymity and secrecy—but if the system could be beaten merely by camping out in the center of a room would they not modify it? Was there a chance that the carpet itself could become toxic? Or that rapiers would zip upward through the floor during the night?

No that wouldn't be fair Renfrew decided his fears abating somewhat That way the apartment would be nothing more than an execution chamber and the whole point of the Capital Punishment Reform Act of 2061 was that it removed the awful foreknowledge of death—the feature of earlier systems to which humanitarians had most strongly objected There had to be some prospect of getting through the week alive If was simply a matter of intelligence determination and self-control And of lasting seven days without a drink of water

The prison micropedia had been annoyingly imprecise about how long a man could survive on zero liquid intake Some of the quoted authorities had avoided giving any estimate at all and others had been content to state that death would occur after seven to ten days The spread, Renfrew supposed was due to such factors as the size weight and general health of the subject and the rate of water loss from the tissues and in that respect he was doing all he could to tip the balance in his favor He was naturally pudgy around the middle and throughout the four days of his trial he had loaded all his food with salt and had drunk copiously of tea coffee milk and water His tendency to retain fluids something he had often bemoaned in the past had enabled him to increase his body weight by approximately five kilograms—equal to four liters of life-giving liquid

That alone would probably be sufficient to ensure his survival but Renfrew had gone further Knowing in advance that he would be stripped of all personal possessions before being installed in the apartment he had taken time after breakfast to spray most of his skin with an antiperspirant which fortunately was quite odorless He suspected that its effectiveness would fade rather quickly but closing his pores and preventing evaporation for even part of a day gave him that extra edge in the battle for life Only two more measures remained to be taken

Renfrew glanced at the screen above the fireplace checking that the jurors were still deliberating He had been in the apartment less than five minutes but his defense had gone so seriously awry that he was half prepared for a verdict to be reached in record time Fortesque the young, state-appointed attorney had tried to make capital from the fact that the store security guard shot by Renfrew had himself been indicted for the manslaughter of an unarmed kid who had tried to run off with a fray of gold rings The proposal had been that Renfrew was defending himself against a trigger-happy zealot but it was obvious to Renfrew that the jurors were in favor of trigger-happy zealots and would have been pleased to employ teams of them to safeguard their own property At that point he had begun thinking very hard indeed about ways of surviving for a week in—to give the apartment one of its more popular labels—the Hereafter Hilton

The first of the remaining precautions was to reduce evaporation of bodily moisture even further by turning the heat down Renfrew located the thermostat and adjusted it to its lowest level He then went into the kitchen filled a tumbler with water and began sipping it with the intention of increasing his fluid reserves The notion of filling all available vessels and laying in a week's supply of water was tempting but too dangerous Any microscopic bubble in a glass could be a poison container to be opened by remote control as soon as the jury had voted A low but insistent chiming sound filled the apartment He set the tumbler down, went back into the living room and saw that the wording on the screen had changed

It now said JURY VOTING

"Vote early and vote often" Renfrew said

CONTINUED ON PAGE 98

Au revoir adios auf Wiedersehen good bye addio

UNBREAKABLE CODE

Were you the sort of kid who loved to fiddle with a secret-code ring? Do you send messages that you wouldn't want business competitors to intercept? Perheps you cringe at the thought of a tax audit. If so, you're going to love this.

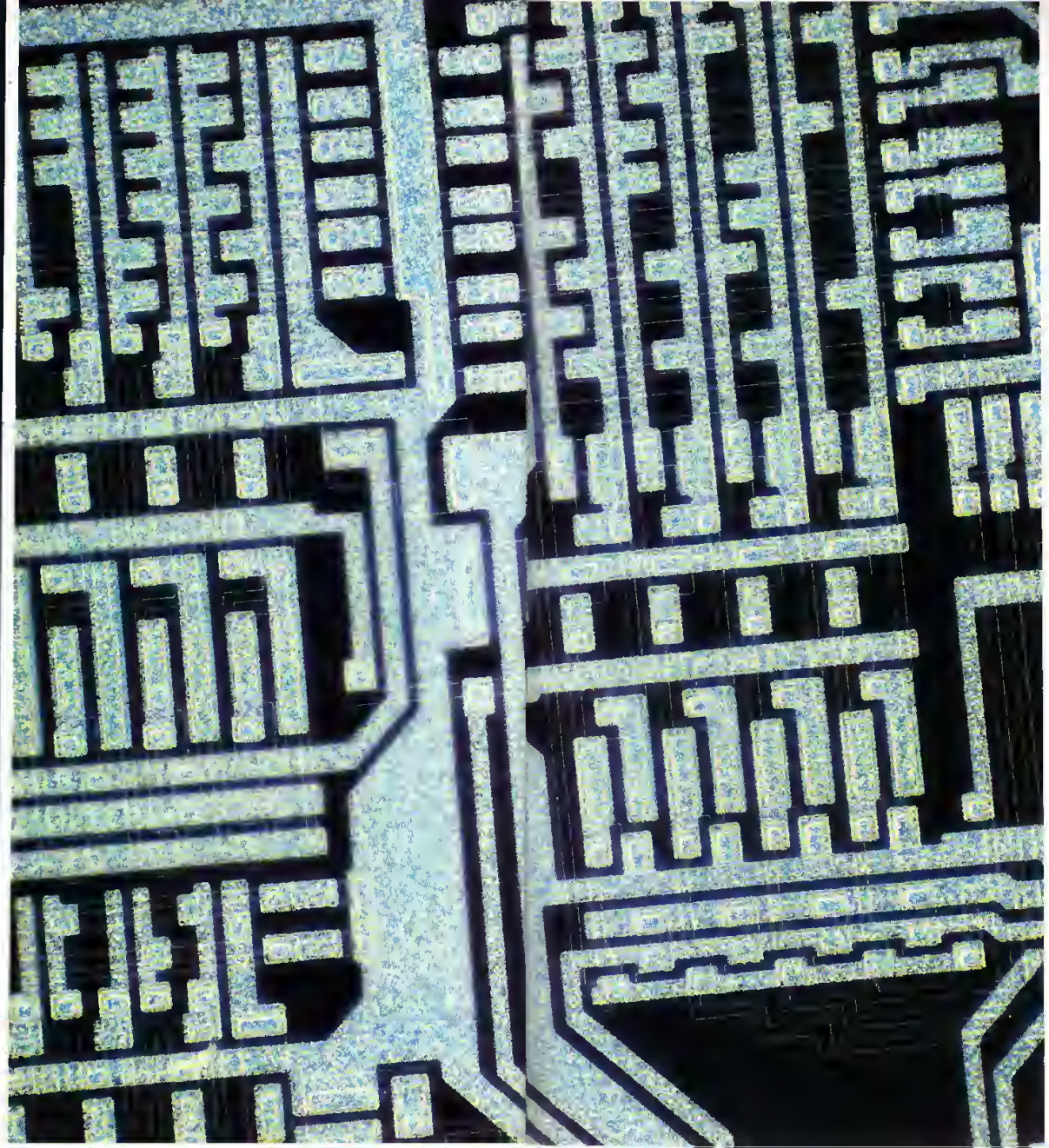
For years now it's seemed that the Silicon Revolution would leave us all naked to the world. Anyone with enough nosiness, gall, and the price of a big computer can build an electronic data base that contains more information about us than we can remember ourselves. The insurance industry has done it. So have the credit bureaus. Some government agencies do little else.

Now the computers that helped rob us of our privacy are giving it back—with interest. Two cryptographic geniuses have made the breakthrough that code builders have dreamed of for centunes: They've invented a practical code that can't be broken. Once you've coded your information, no one—not the CIA, not the NSA, not even the IRS—can figure it out unless you've told them how. With the right programming, most home computers could code and decode messages. But without the key, even IBM's biggest number crunchers could work far into the next century without unscrembling them.

It's enough to make professional snoops weep. In fact, they've spoken out publicly against nongovernmental code research, interfered with patent applications, and even threatened university-based cryptographers with prosecution under the State Department's International Treffic in Arms regulation. Now the Defense Department is seeking the power to review articles on cryptography and to ban publication of any that it considers too informative.

This round in the battle between pnvacy freaks and code breakers got started when Martin Hellman, a thirty-three-year-old Stanford University professor of electrical engineering, linked up with another code junkie, Whitfield Diffie. Schooled in symbolic mathemat-

BY ROGER RAPOPORT



With this new cipher system, any home computer could hide your secrets from the best spies and nosiest bureaucrats

ical manipulations at MIT's Artificial Intelligence Laboratory, Diffie had left an industry job in California to search informally for the perfect code. After studying the classical literature, he camped his way across the country, visiting all the major centers of cryptographic research. Each night he examined the latest technical papers from university and corporate labs by firelight.

At IBM's Yorktown Heights, New York, lab, a scientist suggested that he look Hellman up back in California. "When I arrived in Palo Alto," Diffie recalls, "I called Hellman, and we each immediately found the other to be the most informed person in this field not governed by federal security regulations."

The problem they were trying to solve is lodged deep in modern code practices. Most coded messages these days are sent from one computer to another over telephone lines. For confirmation, they are also sent by couner. But that doesn't come cheap, and it often means deleys when long distances are involved. A computer-wise thief who's wormed his way into a bank's message network can vanish with millions of dollars before anyone realizes that his orders to transfer the money weren't authorized. Worse yet for government cryptographers, there's always a chance that the courier will be intercepted or will defect with the message.

Then there are the electronic eavesdroppers. The National Secunty Agency has computers tied into long-distance telephone links all over the world. The moment a phrase suggesting a topic that interests the agency appears in a conversation, the NSA's tape recorders kick in. Similar equipment monitors data-processing lines here and abroad. Anytime someone makes a call or sends a wire, the NSA can listen in. New equipment will soon enable the agency to read mail, even before it's sent, by catching and interpreting an electnc typewriter's vibrations with remote sensing equipment. And virtuelly anything the NSA

PHOTOGRAPH BY PHILLIP HARRINGTON

can record, the agency's computers can decode

Hellman and Diffie concluded that the major obstacle to secure transmission of data over teleprocessing networks lay in distributing the key, the instructions that tell the recipient how to decipher a message. "Traditionally," Hellman explains, "keys have been moved by couriers or registered mail. But in an age of instant communications it was unrealistic for computer manufacturers to expect customers to wait days for the code to arrive. What was needed was a system immediately accessible to users who may never have had prior contact with each other."

The idea of sending coded messages to total strangers seemed impractical at first. "In the past," Diffie says, "cryptography operated on a strongbox approach. The sender uses one key to lock up his message and the recipient has a matching key that unlocks the meaning. As Hellman and I talked, we became intrigued by the idea of a system that used two different keys—one for enciphering and a second for deciphering. This method would operate like a twenty-four-hour bank teller. Any depositor can open the machine to put his money in, but only the bank has the combination to unlock the safe."

For a long time now, messages have been translated into high-security codes by converting the words into numbers and then scrambling the digits mathematically. What dawned on Hellman and Diffie was that a class of extraordinarily difficult mathematical problems, known as one-way functions, acted like their bank machine. A practical code could be built on them. Users would be able to list their encoding keys in a directory so that anyone could send them a coded message. Yet only they would have the decoding key. Eavesdroppers would have no hope of ever decoding the transmission.

What made this practical was the work of Ralph Merkle, a young student at the University of California at Berkeley. Fascinated by the notion of a public-key system, he began working in one of his undergrad courses on a one-way function that could be applied to a code. Lying awake at night, he visualized a technique that would permit authorized users to decrypt messages that baffled eavesdroppers.

"The idea," he says, "was for A to send B a message in a million pieces. One of those pieces would be tagged so that B could use it to find the decoding key. But anyone else would have to sort at random through all the pieces to find the right one."

Merkle's approach did not impress his instructor, who considered public-key distribution "impractical." Unable to convince his Berkeley teacher of the system's promise, Merkle dropped his computer course. Then he wrote up his ideas for a computer journal. It rejected them as complete trash. "When I read the referees' criticisms," Merkle recalls, "I realized they didn't know what they were talking about."

In the summer of 1976 he finally found a sympathetic reception in the Stanford electrical engineering department, and his work contributed to the breakthrough paper on the public-key system. Published that November, the article, called "New Directions in Cryptography," conceded that sending out a million pieces to foil spies searching for the one that carried the key would be too expensive. Hellman and Diffie remedied this problem by letting each user place his encryption key in a public file, at the same time keeping the decoding procedure a secret.

Since then Ronald Rivest, an MIT computer-science professor, and his colleagues Adi Shamir and Len Adleman have made the code breaker's job even more difficult by using a new set of one-way functions. Their method builds encoding keys out of the product of two large prime numbers—numbers that can be divided only by themselves and by 1. This generates a figure hundreds of digits long.

"A practical code built on one-way functions would work like a bank machine. Anyone could put a message in, but only the recipient could get the meaning out."

In order to find the decoding key, it is necessary to "factor" this giant figure—break it down into the original numbers. It can't be done. Not even the largest computers can factor the product of two numbers with more than 50 digits. Only the recipient who knows the prime numbers used to build his encoding key can retrieve the message.

The public-key system also solves the other problem in sending coded messages. How do you know the signal does not come from an impostor? The Stanford and MIT teams have both produced a forgery-proof digital signature.

The encoding and decoding keys, though complex, are really just mathematical instructions that reverse each other. If the code were built on a simple arithmetic problem, instead of on a one-way function, they might say something like "multiply by five" or "divide by five." The procedure can be used in either direction.

So to sign a coded message, you just reverse the process. Encode your name with the secret key you ordinarily use to decode messages. The recipient then looks up your public encoding key in the directory and uses it to *decode* the signature. Since no one but you could have used the secret key, the recipient can be sure it was you who sent the message. And since the keys are based on a one-way function, the recipient still can't find your secret key.

This makes it possible to sign contracts over a computer network. If the sender tries to renege on the deal, the recipient need only produce a copy of the digital signature to back up his claim in court.

When the first public-key ciphers were announced, they dropped like bombs into the middle of a running battle. Six years ago the National Bureau of Standards decided to help out the banks, insurance companies and others that were desperate for a way to keep their proprietary information secret. The NBS invited computer experts to develop a "data encryption standard." DES (algorithm for computers. (An algorithm is the set of instructions by which you use the key to turn plain text into code and then decode it again.) And they invited the spooks from the NSA to evaluate the ideas.

The NSA, of course, couldn't be expected to have much interest in codes that it could not break, and a good many critics complained that letting the NSA work on the DES was like putting the fox on sentry duty around the hen house.

Their uneasiness grew when the NSA persuaded IBM, which developed the winning algorithm, to withhold the working papers used to develop it. The NSA insisted that this was only a security precaution in the best interests of all users, but it looked, to many as if the government was simply trying to lock up the algorithm's mathematical roots.

When computer scientists tried to publish papers suggesting that the new DES was breakable, the NSA tried to classify their work. One of the agency's employees, a man who once proposed to keep tabs on the 20 million Americans with criminal records by wiring them with transponders, even attacked the critics' patriotism in an engineering journal. The NSA finally agreed to meet with dissenters, then promptly destroyed all tapes of the confrontation. Inventors working on cryptographic devices found their patent applications classified and were threatened with prosecution for even discussing the equipment.

The NSA claimed it would take 91 years of computer work to break the DES key. According to Stanford's Hellman, however, "DES could be broken by an enemy willing to spend twenty million dollars on a computer that could test all the possible keys in less than a day." The DES key is a string of 0's and 1's, known as bits. It is 56 bits long. All you'd have to do to make it unbreakable would be to switch to a key with 128 or more bits. Since it wouldn't make the DES device much more expensive, why was the government being so stubborn?

"It occurred to us," Hellman says, "that the NSA wanted an algorithm that it could

CONTINUED ON PAGE 92

CONTINUED FROM PAGE 70

out in California While some of us would think the first response should be to *stop* the rioting the first response is usually to count the rioters and accumulate information about the causes of the riots *Investigation* takes the place of action—and indeed often takes the place of thought If you get buried with information you will arrive at no conclusion because you haven t even time to read all the documents

Omni Can you offer another example?

Parkinson A friend of mine was the late Mr Vernon Bartlett who was almost the last independent member of Parliament When he first came into Parliament he believed that he must read all the information about every measure under consideration make up his own mind and vote according to his conscience Then he found that his desk was piled daily with inches, nay feet of documentation that he couldn t conceivably read If he did he would have no time to sleep or do anything else So he decided that as he hadn t digested most of this material he couldn t vote at all Then he found a new embarrassment—that everyone else when the division bells sounded went confidently into the chambers looked toward their whips on their own side voted on a measure perhaps not even knowing *what* measure and then rushed back to finish their drinks at the bar On these occasions Bartlett found himself alone in the smoking room He found this so embarrassing that he used to hide in the lavatory until the vote was completed and he could emerge again

Omni How accurately do the social sciences pinpoint our behavior—in rioting for example?

Parkinson The social sciences are almost wholly bogus We could simply scrub them out of the syllabus of any university with great advantage to everyone concerned, partly because of the undesirable people they bring onto the campus There is no field in which money is being squandered more recklessly Mind you the students are finding this out for themselves they are gradually deserting the social sciences because they realize they are drivel even if the teachers don t

Education is a subject you can scrub straightaway There is nothing in education that need detain anyone for more than a very brief period

There are people who teach and they are called teachers There are those who organize teaching who can t teach and they are called educators Then there are people who produce books about teaching they are educationalists Finally there are lecturers in the subject and these are educationalizers I think all but the original teachers could be abolished at once without any loss at all to the school and with considerable savings of time and money

Omni Let us turn to some contemporary issues What are your views on the introduction of microelectronics and its social repercussions?

Parkinson My view is that in the most immediate area of application—communications—the technical means of disseminating information matter less than the art of lucidly explaining it, which is a verbal technique I think that the content of a program is more important than the technology Consider the spread of television now the main means of communication People now take their view of life not from teachers but from television I think the habit of reading among the young is not very widespread and is probably decreasing

Omni What of the impact of microelectronics in education? Instead of having a teacher who may be very good or not so good or mediocre—one teacher and thirty pupils—we can now have individual terminals individual interactive systems, so that pupils can learn at their own rate

Parkinson Well that is valuable in itself in that pupils can possibly have a good teacher rather than have a bad one Our system has more or less ensured that a bad teacher is the normal daily experience of most pupils

Omni Are you talking only about England?

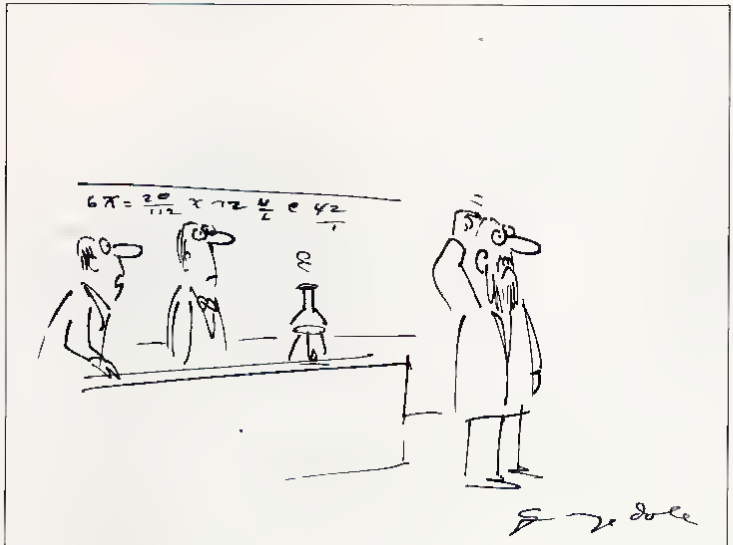
Parkinson I am talking about England as contrasted with Scotland The latter much to its profit decided long ago that teachers had better be really skilled—above all that ordinary primary teachers at the village level must be graduates England has never recovered from the original mistake of turning the dame schoolteachers into the present primary-school teachers who seem largely to be old women of either sex

Omni What about the United States?

Parkinson The American system is appalling because it has followed the English example New Zealand by contrast has followed the Scottish example with sensational results in the level of literacy In the smallest town in New Zealand you will find probably three excellent bookshops whereas in the American equivalent there is usually no bookstore at all—just a few blood-and-thunder and sex paperbacks in a drugstore The final judgment on their system of education is that this is all it produces at the end

Omni Are you speaking from direct experience?

Parkinson Yes indeed I put one of my children into first grade in an American school where he learned nothing Indeed the main effort was to prevent him from learning anything because if he did so he would learn by the wrong method That is educationalism He went on from there to a different state where he couldn t go into first grade because he was too young So he attended kindergarten there and it didn t make any difference Then as a visiting professor I taught an undergraduate class at a state university where I met people who had passed through kinder-



He knows the origin of the universe but he can't remember where he put his umbrella "

garten, grade school, junior high, high school, junior college—heaven knows what else—and at the end they were plainly illiterate. And when I say *illiterate*, I am not talking in a snobbishly classical way. These were people who couldn't spell and who should never have been admitted to a university at all.

Omni: Turning from education to economics, it often seems that economists, like epidemiologists, are better at explaining what has happened *after* an event than at making worthwhile predictions. Do you agree with this?

Parkinson: I don't believe economics is a science at all. There is a sense in which my own field of organization and method could be described as a high technology. But the economists' powers of prediction have so far been unimpressive, and their powers of analysis little better.

Omni: The most striking recent economic development was the stiff hike in the price of crude oil. Why were we taken unawares by that turn of events?

Parkinson: I would add to that a further question—about President Carter, who, having become aware of the energy crisis, produced his energy program two years ago. Why did he fail to consult the people who knew about oil? I was attending a conference at that time in America, and the speakers included people like the chairman of Standard Oil of California, and they assured me that the President had never consulted with them.

This sort of mistake was repeated in Britain by the last socialist government. Politicians tend to be guided by political considerations and their own ideology about these things, and they fail to consult experts who actually know about a particular subject. We have a potentially useful institution, for example, in the House of Lords, and recently there has been some silly talk about electing people to it. The *whole point* of the Lords is that nobody has been elected. Its potential value is in collecting together in one house as much expert opinion and professional distinction as we possibly can gather.

What we need to do now, as a matter of urgency, is to reform the House of Lords by strengthening it with, shall we say, the three greatest physicians, the two greatest surgeons, the four greatest engineers, the five most distinguished architects, chartered accountants, and so on, until we have collected a body of people who could always form an expert committee at any time.

Omni: There is, of course, no counterpart to the House of Lords in the United States.

Parkinson: Unfortunately, the Americans made the mistake of creating another elected house. What is the point? We have an elected legislature, and anything that this can achieve, it has already achieved. I would rather have a legislature in which the oil magnates, for example, were present. Even if their speeches weren't very eloquent, at least they could not say afterwards that they hadn't been consulted.

Omni: How do you see that policy working in such areas of research as genetic manipulation, which rightly or wrongly cause much public anxiety?

Parkinson: On the subject of genetic manipulation and public opinion, I believe the notion of democracy that has been current over the last seventy-five years has no real relevance to the world in which we live. We are still telling each other that public opinion should decide all the major issues of the day, when on many issues the public has no opinion at all and doesn't pretend to have one.

Omni: But the public increasingly feels that it ought to be consulted.

Parkinson: I know, but it reminds me of those awful scenes when, as we are about to devalue the pound or make some other highly technical maneuver, television stations will send out interviewers who waylay bystanders and ask them 'What do you think about devaluing the pound?' And the unfortunate victim stutters something incoherent. The public seldom has any opinion at all except what it derives from television, radio or newspapers.

Omni: What of public influence on issues such as energy policymaking—for example, decisions about where the next nuclear-power station should be built?

Parkinson: Well, we are all agreed about that. If there must be a nuclear-power station, it mustn't be anywhere near us. A new airport for London is highly necessary, but it must be somewhere else. This sort of public opinion is not really of any value. Whether we should be developing nuclear energy is a question relatively few people are in a position to understand. I am certainly not competent on such matters. I wouldn't venture any opinion at all.

Omni: Are you saying that you would be happy to leave all such issues to the experts, to nuclear engineers in this case?

Parkinson: Yes, as long as you have brought them into the legislature to act as an integral part of it. You can't just select some outside experts and take their views before a subcommittee in order to produce the policies of the administration. I don't believe in this approach, because the government has probably excluded anyone who seemed likely to be awkward. I want to see awkward people in the legislature of the future, getting up without being invited at all and saying what they think about technical problems.

Omni: How concerned are you about the nuclear arsenals of the world? And how do you see the future of the global economy? I believe you anticipate some sort of cataclysmic political event in the short term in Britain. But are you optimistic or pessimistic on the international front?

Parkinson: I am not being pessimistic in saying that the present system in Britain is bound to end in a cataclysmic disaster. It is bound to happen, and we can't make any progress until it has. We need to sweep the cards off the table and start again. I would be *more* pessimistic if I could imagine our

system of parliamentary government going on another fifty years That is equivalent to blowing out your brains isn't it?

On the global issue of nuclear weaponry I am not impressed with the danger at the moment of the USSR and the United States exchanging bombs over Afghanistan They are plainly going to do nothing of the kind The Russians although obtuse in some ways are not quite as obtuse as that Nor are the Chinese They already have a nuclear potential, and their rate of acceleration is far greater than that of the Russians and relatively far greater than that of the West The upturn curve shown by Chinese technology is sensational when you think of the level from which they started

My concern is with nuclear weapons in the hands of people of quite terrifying instability I would specify Iran at the present time where we see a country run by a person or people whom we might describe—not unkindly—as more or less imbecilic and visualize a future when people as stupid as that may acquire these weapons I don t think we are going to see this happening for another ten years, and I would like to think that by then the people who have acquired the technology will also have acquired the wisdom but there is nothing in history to suggest this

Our biggest basic difficulty in the West is that while our technology and science have advanced dramatically, our politics is still the politics of the horse and buggy Some of the toys the politicians have been given to play with are extremely dangerous while the politicians are themselves relatively uneducated and unintelligent people When you imagine giving Ayatollah Khomeini nuclear weapons to play with you have a desperately unnerving picture

Omni Aren t you being somewhat pessimistic about most of the more significant issues of the day?

Parkinson Perhaps but there is one tiny contribution that I have tried to make to current affairs in my new book on geriatrics One development I would like to see in the future is an extension of human life By this I mean life extension for a certain number of people of their own choice not for everyone In a scientific age it takes longer and longer for anyone to master all that is known about a given subject and then begin to contribute I remember a professor who answered a question not with I don t know but with That is not known He had reached the point where he could confidently say that I would say that today you would probably need to be fifty to achieve such a position in some subjects

I believe it is possible to extend the period of vigor so that someone could still be active at ninety as *some* people are already George Bernard Shaw was still writing plays at ninety-two He finally died of boredom having broken his hip and being confined to bed If a scientist is not in a position to contribute anything of significance until the age of fifty then to retire him at sixty-five and boot him out of the laboratory in order to bring in somebody else is dreadfully wasteful

I suggest that people who are in a position to contribute should decide for themselves—and be encouraged by others—to live actively until they are say ninety or a hundred The decision to do this must be their own because it is philosophical

Omni But if there were a technique or pill to make that possible you would presumably also get a lot of people wanting to go on spending more time at the racetrack

Parkinson They wouldn t though because the philosophic side *is* important We now decide that someone must retire at sixty-five or seventy and he says At last I can enjoy myself The standard answer among Americans particularly is to take a year s voyage around the world Then you try to get your golf handicap down Then maybe two more years doing crossword puzzles A man can t go on doing that he dies of boredom

My father once discovered that the system of pensions for schoolteachers was splendid from the government s point of view because schoolteachers lived an average of only eighteen months after retirement People die of boredom more than of anything else Correction They die of boredom and because other people expect them to die A longer active life would put a stop to this ∞

UNBREAKABLE CODE

CONTINUED FROM PAGE 86

crack That would prevent anyone else in the country from using a foolproof code

With that controversy to prepare their way the public-key codes have received a warm welcome from just about everyone but the government Some New York banks have already decided to reject the NSA backed 56-bit encryption standard An officer at Banker s Trust Company said his company refused to go along with the federal plan because it "did not meet all the bank's requirements" Bell Telephone has also rejected DES on security grounds

These corporations may be better served by private companies now hoping to market coding devices based on the systems MIT and Stanford inventors are trying to patent "Since we would share some of the royalties," Hellman says "some government people suggest our opposition to DES is motivated by self-interest Sure we would benefit if public-key systems go into widespread use But the facts are that our method provides real protection and DES can be broken '

Rivest is already consulting for companies that hope to market foolproof systems "What we want" he says "is to develop an add-on encoding device for computer terminals that any user could afford We re building a prototype now and working to see that it ends up in the marketplace" Bell Northern Labs a subsidiary of the Canadian phone company has hired Diffie to help make electronic eavesdropping more difficult At the company s Palo Alto research facility, he is leading a cryptographic research group that wants to show callers how they can mask their identity

Some computer experts, such as George Feeney who invented the concept of EDP time sharing and who heads Dun and Bradstreet's advanced technology group voice concern about the practicality of these promised systems ' The unbreakable code is a brilliant piece of conceptual work " Feeney says "These inventors have done an incredible job But some of us wonder whether the process may turn out to be beyond the current state of the computer art We still don t know how long it's going to take to get this dream going and whether the cost will be realistic "

The NSA though has already begun to whine about the prospect of companies and private individuals communicating over toolproof lines The agency s director Vice Admiral Bobbie Ray Inman is so anxious that he recently broke official policy to go on record about this sensitive matter

"There is a very real and critical danger that unrestrained public discussion of cryptologic matters will seriously damage the ability of this government to conduct signals intelligence and protect national security information from hostile exploitation" he complained "The very real concerns we af NSA have about the impact of nongovernmental cryptologic activity cannot and should not be ignored Ultimately these concerns are of vital interest to every citizen of the United States since they bear vitally on our national defense and the successful conduct of our foreign policy '

Another NSA employee Joseph A Meyer has warned his colleagues in the Institute of Electrical and Electronic Engineers that their work on public-key cryptography and data encryption might violate the International Traffic in Arms regulation This law which the government uses to control the export of weaponry and computer equipment, can even be invoked to thwart basic code research

As a result people like University of Wisconsin computer-science professor George DaVida who recently tried to patent a new cryptographic device, have run into trouble Although his work was sponsored by the federally funded National Science Foundation the Commerce Department told DaVida that he could be arrested for writing about or discussing the principles of his invention A similar secrecy order was issued to a Seattle team that had invested $33 000 to develop a coding device for CB and marine radios

Protests from the scientific community persuaded the government to lift its secrecy orders in both these cases At least for now, academics and inventors can continue to write and confer on cryptographic schemes But the threat of renewed government harassment has complicated further research Universities have agreed to defend professors against federal prosecution related to code research but they can t protect students As a result some students have decided not to contribute papers to scientific conferences In at least one instance Hellman had to shield two of his graduate students at Stanford by reading their reports for them at a meeting of the Institute of Electrical and Electronic Engineers

It's too soon to know whether the government will move to block use of the public key but Hellman and his colleagues fear that young cryptographers may be scared away by Inman s tough admonitions This could hold up the practical refinements necessary to make the unbreakable code widely available A real chance to stop crime in the electronic society might be postponed indefinitely With computerized theft increasing every year and computers controlling more of society's daily activities, this doesn t seem wise But this issue appears secondary to Washington cryptographers who sound as if they would like to reserve the public key for their own use

"I m not suggesting government agents want to listen in at will" Diffie says "but I m sure they don't want to be shut out For them the perfect code is the one only they can break"

SAUROPODS

CONTINUED FROM PAGE 53

counter with a major predator

There are nine tyrannosaurs on the island, including three born in the past eighteen months. (That gives us an optimum predator-to-prey ratio. If the tyrannosaurs keep reproducing and don't start eating each other, we'll have to begin thinning them out. One of the problems with a closed ecology—natural checks and balances don't fully apply.) Sooner or later I was bound to encounter one, but I had hoped it would be later.

I was hunting frogs at the edge of Cope Lake. A ticklish business, calls for agility, cunning, quick reflexes. I remember the technique from my girlhood—the cupped hand, the lightning pounce—but somehow it's become a lot harder in the last twenty years. Superior frogs these days. I suppose. There I was, kneeling in the mud, swooping, missing, swooping, missing, some vast sauropod snoozing in the lake, probably our diplodocus, a corythosaur browsing in a stand of ginkgo trees, quite delicately nipping off the foul-smelling yellow fruits. Swoop. Miss. Swoop. Miss. Such intense concentration on my task that old T. rex could have tiptoed right up behind me and I'd never have noticed. But then I felt a subtle something, a change in the air, maybe, a barely perceptible shift in dynamics. I glanced up and saw the corythosaur rearing on its hind legs, looking around uneasily, pulling deep sniffs into that fantastically elaborate bony crest that houses its early warning system. *Carnivore alert!* The corythosaur obviously smelled something wicked this way coming, for it swung around between two big ginkgos and started to go galumphing away. Too late. The treetops parted, giant boughs toppled, and out of the forest came our original tyrannosaur, the pigeon-toed one we call Belshazzar, moving in its heavy, clumsy waddle, ponderous legs working hard, tail absurdly swinging from side to side. I slithered into the lake and scrunched down as deep as I could go in the warm, oozing mud. The corythosaur had no place to slither. Unarmed, unarmored, it could only make great bleating sounds, terror mingled with defiance, as the killer bore down on it.

I had to watch. I had never actually seen a kill before.

In a graceless but wondrously effective way the tyrannosaur dug its hind claws into the ground, pivoted astonishingly, and, using its massive tail as a counterweight, moved in a ninety-degree arc to knock the corythosaur down with a stupendous sidewise swat of its huge head. I hadn't been expecting that. The corythosaur dropped and lay on its side, snorting in pain and feebly waving its limbs. Now came the coup de grace with hind legs, and then the rending and tearing, the jaws and the tiny arms at last coming into play.

Burrowing chin-deep in the mud, I watched in awe and weird fascination. There are those among us who argue that the carnivores ought to be segregated—put on their own island—that it is folly to allow reconstructs created with such effort to be casually butchered this way. Perhaps in the beginning that made sense, but not now, not when natural increase is rapidly filling the island with young dinos. If we are to learn anything about these animals, it will only be by reproducing as closely as possible their original living conditions. Besides, would it not be a cruel mockery to feed our tyrannosaurs on hamburger and herring?

The killer fed for more than an hour. At the end came a scary moment. Belshazzar, blood-smeared and bloated, hauled himself ponderously down to the edge of the lake for a drink. He stood no more than ten meters from me. I did my most convincing imitation of a rotting log, but the tyrannosaur, although it did seem to study me with a beady eye, had no further appetite.

> *Carnivore alert! The corythosaur obviously smelled something wicked this way coming, for it swung around between two big ginkgos and went galumphing away. Too late. Treetops parted.*

For a long while after he departed I stayed buried in the mud, fearing he might come back for dessert. And eventually there was another crashing and bashing in the forest—not Belshazzar this time, though, but a younger one with a gimpy arm. It uttered a sort of whinnying sound and went to work on the corythosaur carcass. No surprise. We already knew from our observations that tyrannosaurs had no prejudices against carrion.

Nor, I found, did I.

When the coast was clear, I crept out and saw that the two tyrannosaurs had left hundreds of kilos of meat. Starvation knoweth no pride and also few qualms. Using a clamshell for my blade, I started chopping away at the corythosaur.

Corythosaur meat has a curiously sweet flavor—nutmeg and cloves, dash of cinnamon. The first chunk would not go down. You are a pioneer, I told myself, retching. You are the first human ever to eat dinosaur meat. *Yes, but why does it have to be raw?* No choice about that. Be dispassionate. Love. Conquer your gag reflex or die trying. I pretended I was eating oysters. This time the meat went down. It didn't stay down.

The alternative, I told myself grimly, is a diet of fern fronds and frogs, and you haven't been much good at catching the frogs. I tried again. Success!

I'd have to call corythosaur meat an acquired taste. But the wilderness is no place for picky eaters.

23 August 1300 hours. At midday I found myself in the southern hemisphere, along the fringes of Marsh Marsh, about a hundred meters below the equator. Observing herd behavior in sauropods: five brachiosaurs, two adult and three young, moving in formation, the small ones in the center. By *small* I mean only some ten meters from nose to tail tip. Sauropod appetites being what they are, we'll have to thin that herd soon, too, especially if we want to introduce a female diplodocus into the colony. *Two* species of sauropods breeding and eating like that could devastate the island in three years. Nobody ever expected dinosaurs to reproduce like rabbits—another dividend of their being warm-blooded, I suppose. We might have guessed it, though, from the vast quantity of fossils. If that many bones survived the catastrophes of a hundred-odd million years, how enormous the living Mesozoic population must have been! An awesome race in more ways than their mere physical mass.

I had a chance to do a little herd thinning myself just now. Mysterious stirring in the spongy soil right at my feet, and I looked down to see triceratops eggs hatching. Seven brave little critters, already horny and beaky, scrabbling out of a nest, staring around defiantly. No bigger than kittens, but active and sturdy from the moment they were born.

The corythosaur meat has probably spoiled by now. A more pragmatic soul very likely would have augmented her diet with one or two little ceratopsians. I couldn't bring myself to do it.

They scuttled off in seven different directions. I thought briefly of catching one and making a pet out of it. Silly idea.

25 August 0700 hours. Start of the fifth day. I've done three complete circumambulations of Dino Island. Slinking around on foot is fifty times as risky as cruising around in a module, and fifty thousand times as rewarding. I make camp in a different place every night. I don't mind the humidity any longer. And despite my skimpy diet I feel pretty healthy. Raw dinosaur, I know now, is a lot tastier than raw frog. I've become an expert scavenger—the sound of a tyrannosaur in the forest now stimulates my salivary glands instead of my adrenals. Going naked is fun, too. And I appreciate my body much more since the bulges that civilization put there have begun to melt away.

Nevertheless, I keep trying to figure out some way of signaling Habitat Vronsky for help. Changing the position of the reflecting mirrors, maybe, so I can beam an SOS?

Sounds nice, but I don't even know where the island's controls are located, let alone how to run them. Let's hope my luck holds out another three and a half weeks.

27 August 1700 hours. The dinosaurs know that I'm here and that I'm some extraordinary kind of animal. Does that sound weird? How can great dumb beasts *know* anything? They have such tiny brains. And my own brain must be softening on this protein-and-cellulose diet. Even so, I'm starting to have peculiar feelings about these animals. I see them *watching* me. An odd, knowing look in their eyes, not stupid at all. They stare and I imagine them nodding, smiling, exchanging glances with each other, discussing me. I'm supposed to be observing them, but I think they're observing me, too, somehow.

No, that's just crazy. I'm tempted to erase the entry. But I suppose I'll leave it as a record of my changing psychological state, if nothing else.

28 August 1200 hours. More fantasies about the dinosaurs. I've decided that the big brachiosaur—Bertha—plays a key role here. She doesn't move around much, but there are always lesser dinosaurs in orbit around her. Much eye contact. *Eye contact between dinosaurs?* Let it stand. That's my perception of what they're doing. I get a definite sense that there's communication going on here, modulating over some wave that I'm not capable of detecting. And Bertha seems to be a central nexus, a grand totem of some sort, a—a switchboard? What am I talking about? What's happening to me?

30 August 0945 hours. What a damned fool I am! Serves me right for being a filthy voyeur. Climbed a tree to watch iguanodons mating at the foot of Bakker Falls. At the climactic moment the branch broke. I dropped twenty meters. Grabbed a lower limb or I'd be dead now. As it is, pretty badly smashed around. I don't think anything's broken, but my left leg won't support me, and my back's in bad shape. Internal injuries, too? Not sure. I've crawled into a little rock shelter near the falls. Exhausted and maybe feverish. Shock, most likely. I suppose I'll starve now. It would have been an honor to be eaten by a tyrannosaur, but to die from falling out of a tree is just plain humiliating.

The mating of iguanodons is a spectacular sight, by the way. But I hurt too much to describe it now.

31 August 1700 hours. Stiff, sore, hungry, hideously thirsty. Leg still useless, and when I try to crawl even a few meters I feel as if I'm going to crack in half at the waist. High fever.

How long does it take to starve to death?

1 September 0700 hours. Three broken eggs lying near me when I awoke. Embryos still alive—probably stegosaur—but not for long. First food in forty-eight hours. Did the eggs fall out of a nest somewhere overhead? Do stegosaurs make their nests in trees, dummy?

Fever diminishing. Body aches all over. Crawled to the stream and managed to scoop up a little water.

1330 hours. Dozed off. Awakened to find haunch of fresh meat within crawling distance. Struthiomimus drumstick, I think. Nasty sour taste, but it's edible. Nibbled a little, slept again, ate some more. Pair of stegosaurs grazing not far away, tiny eyes fastened on me. Smaller dinosaurs holding a kind of conference by some big cycads. And Bertha Brachiosaur is munching away in Ostrom Meadow, benignly supervising the whole scene.

This is absolutely crazy.

I think the dinosaurs are taking care of me. But why would they do that?

2 September 0900 hours. No doubt of it at all. They bring me eggs, meat, even cycad cones and tree-fern tronds. At first they delivered things only when I slept, but now they come hopping right up to me and dump things at my feet. The struthiomimids are the bearers—they're the smallest, most agile, quickest hands. They bring their offerings, stare me right in the eye, pause as if waiting for a tip. Other dinosaurs watching from the distance. This is a coordinated effort. I am the center of all activity on the island, it seems. I imagine that even the tyrannosaurs are saving choice cuts for me. Hallucination? Fantasy? Delirium of fever? I feel lucid. The fever is abating. I'm still too stiff and weak to move very far, but I think I'm recovering from the effects of my fall. With a little help from my friends.

1000 hours. Played back the last entry. Thinking it over, I don't *think* I've gone insane. If I'm sane enough to be worried about my sanity, how crazy can I be? Or am I just fooling myself? There's a terrible conflict between what I think I perceive going on here and what I know I ought to be perceiving.

1500 hours. A long, strange dream this afternoon. I saw all the dinosaurs standing in the meadow and they were connected to one another by gleaming threads, like the telephone lines of olden times, and all the threads centered on Bertha. As it she's the switchboard, yes. And telepathic messages were traveling through her to the others. An extrasensory hookup, powerful pulses moving along the lines. I dreamed that a small dinosaur came to me and offered me a line and, in pantomime, showed me how to hook it up, and a great flood of delight went through me as I made the connection. And when I plugged it in, I could feel the deep and heavy thoughts of the dinosaurs, the slow, rapturous philosophical interchanges.

When I woke, the dream seemed bizarrely vivid, strangely real, the dream ideas

lingering as they sometimes do. I saw the animals about me in a new way. As if this is not just a zoological research station but a community, a settlement, the sole outpost of an alien civilization—an alien civilization native to Earth.

Come off it. These animals have minute brains. They spend their days chomping on greenery, except for the ones that chomp on other dinosaurs. Compared with dinosaurs, cows and sheep are downright geniuses.

I can hobble a little now.

3 September 0600 hours. The same dream again last night, the universal telepathic linkage. Sense of warmth and love flowing from dinosaurs to me.

And once more I found fresh tyrannosaur eggs for breakfast.

5 September 1100 hours. I'm making a fast recovery. Up and about, still creaky but not much pain left. They still feed me. Though the struthiomimids remain the bearers of food, the bigger dinosaurs now come close, too. A stegosaur nuzzled up to me like some Goliath-sized pony, and I petted its rough, scaly flank. The diplodocus stretched out flat and seemed to beg me to stroke its immense neck.

If this is madness, so be it. There's a community here, loving and temperate. Even the predatory carnivores are part of it. Eaters and eaten are aspects of the whole, yin and yang. Riding around in our sealed modules, we could never have suspected any of this.

They are gradually drawing me into their communion. I feel the pulses that pass between them. My entire soul throbs with that strange new sensation. My skin tingles.

They bring me food of their own bodies, their flesh and their unborn young, and they watch over me and silently urge me back to health. Why? For sweet charity's sake? I don't think so. I think they want something from me. More than that, I think they need something from me.

What could they need from me?

6 September 0600 hours. All this night I have moved slowly through the forest in what I can only term an ecstatic state. Vast shapes, humped, monstrous forms barely visible by dim glimmer, came and went about me. Hour after hour I walked unharmed, feeling the communion intensify. I wandered, barely aware of where I was, until at last, exhausted, I have come to rest here on this mossy carpet, and in the first light of dawn I see the giant form of the great brachiosaur standing like a mountain on the far side of Owen River.

I am drawn to her. I could worship her. Through her vast body surge powerful currents. She is the amplifier. By her are we all connected. The holy mother of us all. From the enormous mass of her body emanate potent healing impulses.

I'll rest a little while. Then I'll cross the river to her.

0900 hours. We stand face to face. Her head is fifteen meters above mine. Her small eyes are unreadable. I trust her and I love her.

Lesser brachiosaurs have gathered behind her on the riverbank. Farther away are dinosaurs of half a dozen other species, immobile, silent.

I am humble in their presence. They are representatives of a dynamic, superior race, which but for a cruel cosmic accident would rule the earth to this day, and I am coming to revere them, to bear witness to their greatness.

Consider. They endured for a hundred forty million years. In ever-renewing vigor. They met all evolutionary challenges except the one of sudden and catastrophic climatic change, against which nothing could have protected them. They multiplied and proliferated and adapted, dominating land and sea and air, covering the globe. Our own trifling, contemptible ancestors were nothing next to them. Who knows what these dinosaurs might have achieved if that crashing asteroid had not blotted out their light? What a vast irony: millions of years of supremacy ended in a single generation by a chilling cloud of dust. But until then—the wonder, the grandeur.

> *"I am drawn to her. I could worship her. Through her vast body surge powerful currents. She is the amplifier. By her are we all connected. The holy mother. From her emanate healing impulses."*

Only beasts, you say? How can you be sure? We know just a shred of what the Mesozoic was really like, just a slice literally the bare bones. The passage of a hundred million years can obliterate all traces of civilization. Suppose they had language, poetry, mythology, philosophy? Love, dreams, aspirations? No, you say, they were beasts, ponderous and stupid, that lived mindless, bestial lives. And I reply that we puny, hairy ones have no right to impose our own values on them. The only kind of civilization we can understand is the one we have built. We imagine that our own trivial accomplishments are the determining case, that computers and spaceships and broiled sausages are such miracles that they place us at evolution's pinnacle. But now I know otherwise. Humans have done marvelous, even incredible, things, yes. But we would never have existed at all, had this greatest of races been allowed to live to fulfill its destiny.

I feel the intense love radiating from the titan that looms above me. I feel the contact between our souls steadily strengthening and deepening.

The last barriers dissolve.

And I understand at last.

I am the chosen one. I am the vehicle. I am the bringer of rebirth, the beloved one, the necessary one. Our Lady of the Sauropods am I, the holy one, the prophetess, the priestess.

Is this madness? Then it is madness, and I embrace it.

Why have we small, hairy creatures existed at all? I know now. It is so that through our technology we could make possible the return of the great ones. They perished unfairly. Through us, they are resurrected aboard this tiny globe in space.

I tremble in the force of the need that pours from them.

I will not fail you. I tell the great sauropods before me, and the sauropods send my thoughts reverberating to all the others.

20 September 0600 hours. The thirtieth day. The shuttle comes from Habitat Vronsky today to pick me up and deliver the next researcher.

I wait at the transit lock. Hundreds of dinosaurs wait with me, each close beside the next, both the lions and the lambs, gathered quietly, their attention focused entirely on me.

Now the shuttle arrives, right on time, gliding in for a perfect docking. The airlocks open. A figure appears. Sarber himself! Coming to make sure I didn't survive the meltdown, or else to finish me off.

He stands blinking in the entry passage, gaping at the throngs of placid dinosaurs arrayed in a huge semicircle around the naked woman who stands beside the wreckage of the mobile module. For a moment he is unable to speak.

"Anne?" he says finally. "What in God's name—"

"You'll never understand," I tell him. I give the signal. Belshazzar rumbles forward. Sarber screams and whirls and sprints for the airlock, but a stegosaur blocks the way.

"No!" Sarber cries as the tyrannosaur's mighty head swoops down. It is all over in a moment.

Revenge! How sweet!

And this is only the beginning. Habitat Vronsky lies just one hundred twenty kilometers away. Elsewhere in the Lagrange belt are hundreds of other habitats ripe for conquest. The earth itself is within easy reach. I have no idea yet how it will be accomplished, but I know it will be done, and done successfully, and I will be the instrument by which it is done.

I stretch forth my arms to the mighty creatures that surround me. I feel their strength, their power, their harmony. I am one with them, and they with me. The Great Race has returned, and I am its priestess. Let the small, hairy ones tremble! ∞

HILTON

CONTINUED FROM PAGE 82

aloud in jocular tones, trying to neutralize the spasms of alarm he had felt on realizing that his very existence was now being laid on the line. He took a cushion from a chair and set it in the middle of the floor, then hesitated, frowning. A cushion was just as much an artifact as a microwave oven, just as capable of being booby-trapped. He skimmed it back onto the chair and squatted on the carpet, his face turned toward the screen as he waited for the final announcement. In addition to his fear he could feel powerful undercurrents of excitement, and it came to him that the provisions of the 2061 act had been successfully implemented in the present system. He was about to be sentenced to death. Yet he had absolutely no sense of imminent doom.

The inevitable reaction to the steady increase in violent crime had begun in the last quarter of the twentieth century with one state after another reintroducing the death penalty. By the middle of the twenty-first century capital punishment had become almost universal, coast to coast, and the moral dilemma facing the legislators had grown in proportion. How could one condemn killing on the one hand while going on taking human lives with the other? Variations in the actual method of execution had been tried, but the principal objections to legalized killing had remained the same. It was totally inhuman to tell a man exactly when and how he was going to die, then leave him to sweat out his time. And if the state was inhuman, could its citizens be expected to be otherwise?

It was basically a question of how to be cruel in a kindly way—and a workable answer had come along in 2061. The lengthy, soul-destroying delays of earlier systems had been eliminated by direct implementation of the majority vote of a thirteen-man jury, and the dreadful certainty of death had been replaced by the challenge of a week in the apartment. Not only were the exact time and method of execution decently shrouded in mystery, but there was also a ray of hope that the grim event could be avoided altogether. And that made all the difference.

Renfrew found that he was tense, alert, stimulated, and—above all—confident that he was going to beat the system. There remained only a trace of furtive, niggling doubt. His idea seemed foolproof, but it had been rather easy to conceive. It had, in fact, been the first scheme to blossom in his mind, and he knew perfectly well that he was anything but a genius—if he could come up with a successful plan, anybody could. Did this mean that nobody but the occasional moron ever paid the supreme penalty? Or was there some other inconspicuous factor he had overlooked?

There was another chiming sound, and the message on the screen was replaced by a new set of words scribed in raw crimson: VOTING COMPLETED—AWAIT VERDICT.

On the lower part of the display a sweep hand began remorselessly erasing a sixty-second clock. *I'm going to be all right*, he thought. *All I've got to do is stay put for seven days.*

His gaze picked out two vertical cracks in the skirting board of the wall opposite him. It looked as if a small, flap-type door had been built into the base of the wall. He stared at the door, feeling oddly threatened as he tried to guess its purpose. It had nothing to do with ventilation, too awkwardly positioned to be an electrical-system access hatch, too small to be a cupboard. Renfrew's eyes widened as he noticed the slightest trace of wheel marks fanning out across the carpet, and understanding blossomed in his mind.

Robotic cleaners!

The apartment was as immaculate as only an automated cleaning system could make it, which meant that at night, when the occupants were asleep in bed, silent little machines came out of the walls and scavenged every speck of dirt. But he wasn't going to be in bed! He was going to be laid out on the floor while the busy robots came nosing and nuzzling around him, and any one of them could be capable of killing him in a dozen different ways. How fast did they travel? How many were there? Could he avoid them?

Renfrew looked at the clock. Twenty seconds until the apartment declared war.

He half-rose, his face turning toward the kitchen. Was there time to run in there, snatch up the lightweight table, and get back with it? Would he be safe squatting on top of the table? What if—?

His hands fluttered to his mouth as he heard the final chime that signaled the jury's verdict. He glanced involuntarily in the direction of the screen, then froze, his chin sagging with incredulity as he read the three words electronically emblazoned across the face of the tube:

VERDICT: NOT GUILTY

The breath left his body in a noisy, quavering sob. He pushed a hank of hair away from his forehead, as if giving himself a better view of the glowing words might change their import. The message remained the same. He was a free man!

Renfrew got to his feet, suddenly conscious of how much he had been dreading the ordeal that had lain ahead. He took a last look at the apartment, gave a low chuckle of relief, then strode to the door with a buoyant tread, keyed up for his first taste of liberty in many months.

The doorknob did not turn when he grasped it.

Instead it fired a cloud of poison through the skin of Renfrew's palm, a poison so swift-acting that he had no time to realize he had been tricked by executioners who, in their determination to be humane, were not above telling a little white lie. ∞

8.03: test subject lost interest in watching Happy Days *and is now engrossed in tactile sensations*

ACCELERATIONS

CONTINUED FROM PAGE 49

nuclear power aren't good bets for cars before 2020 if ever. By that time we may have pushed piezoelectric power orders of magnitude higher than we can get from crystals today.

There's faint hope for Stirling and Rankine engines. A Stirling's piston is forced back and forth by rapid expansion and contraction of a working fluid trapped in a chamber. Fuel is burned outside the chamber, its heat conducted to and from the fluid. Through very high heat-transfer rates (liquid lithium? Peltier effect?) a Stirling can be astonishingly efficient but too big and expensive for its modest output. Stirling power just might be the best surprise of the 1990s but the odds are long and time is short.

The Rankine layout—a steam engine with recirculation condensers, for example—yields tremendous torque, and pollutants can be almost nil. But it doesn't promise to triple our fuel mileage. The more powerful ones might run into buyer resistance unless stylists find a way to make huge condensers appear attractive.

Bill Lear dropped his Rankine-powered police cruiser project because, among other things, "They would have looked ridiculous. I couldn't afford that," he told *Omni*. "Sure they'd do the job, but those heat exchangers would've stuck out like elephant ears." Lear's own choice of cars? His gullwing Mercedes coupe. A basket case, he admitted, but I love to look at it.

Only when power plants of high energy density become cheap and nonpolluting can we expect to make general use of personal hovercraft. It will probably still require less energy to roll on bearings than to ride on an air cushion, and energy efficiency will still be crucial enough to keep hovercraft in the special-use category.

Though our cars will be far better engineered, they may become less numerous as we begin to polarize our attitudes about them. If cars grow more expensive while mass transit grows better and cheaper, many people may give up owning cars. This is already happening increasingly in urban cultures. And the better our communications, the less our need to travel, even for business. Wraparound home video may further popularize social dating by electronic links so that many mixed sex pairs aren't, strictly speaking, linked at all. This could curb population growth as conversation becomes more verbal and less carnal; we can save energy both coming and going.

Beyond the initial polarization between car people and non-car people, we might expect further schisms between those who use a car to reach a destination and those who keep one primarily to enjoy the ride. By 2020, however, our automotive foolishness will be largely deliberate and wholly affordable by those not addicted. ∞

FICTION

The Collector could see the bauble was old, but was it authentic or just a piece of junk?

THE CURIO SHOP

BY WILLIAM KOTZWINKLE

"Now here, sir, is a lovely—and might I say, traditional—example." The Seller pointed a finger at the decorative sphere, set against a velvet background cloth.

The Collector leaned on the edge of the counter and studied the bauble. Its workmanship might be good, but it was hard to tell, owing to large, sooty stains on its surface and, beneath that, what appeared to be rust or some fatal corrosion that had permanently marred the interior.

"I'll let you have it cheap," said the Seller, spying the critical look of the Collector. Business wasn't good; the shop was seldom visited anymore.

"Is it"—the Collector touched at it with his monocle, studying the piece more closely—"still enchanted?"

"The occasional wail, sir. You know the phenomenon, I'm sure."

"The true spirit, or merely an echo?"

The Seller sighed. He couldn't misrepresent the piece. He'd like to, naturally. He needed the sale. But he couldn't afford to offend an important customer. "It no longer contains a true spirit, sir, I regret to say."

The Collector nodded, turning the trinket slightly with the edge of his monocle.

"But," the Seller continued, a trifle urgently, "the echo is authentic, sir."

"I'm sure," said the Collector with a sideways glance, his eyes showing only a momentary flicker of contempt.

"Well, sir," said the Seller defending himself against the glance, "there are clever copies in existence. The ordinary collector can be deceived. Not that you, sir"—he hastened to correct himself—"are an ordinary collector."

"Happy that you think so." The Collector turned the ball in his hands, examining the portions of the surface not corrupted by time and bad handling. It was shameful the way certain pieces deteriorated. But the work was authentic, he didn't need the Seller to tell him that. You could see the little original touches all over the object, though they were badly encrusted. Unfortunately, you couldn't clean the damn things, no matter how you worked at them; once the corrosion began, it couldn't be reversed. He wondered sometimes why he bothered with them at all. But then, it was always amusing when company came and one had a new piece to show. He could have it put in a gold mount, that'd show it off to better advantage. Or hang it from a chain in his study, where the lighting was usually muted and the defects of the sphere wouldn't show too badly.

"Let me... please, sir..." The Seller pulled out a cloth from his pocket, attempted to shine the tiny patch of transparency on the ball. But as the cloth touched it, the wailing came forth, long, low, and chilling. Echo or not, it went right through the Seller's soul.

"The echo is fresh," said the Collector, smiling for the first time. "The spirit must have departed only recently."

"So I'm told, sir." The Seller resumed his bit of dusting on the surface, more confident now, for he'd seen the smile and knew he had a sale. "That's precisely what the Caravan Master said when I bought it from him, sir—the spirit has but recently departed."

The Collector squinted through his glass, savoring the moment, knowing the piece must be his, for the wail was strong. He could listen to it at his leisure and learn the story of the bauble, who had made it and when. All that would still be in the echo. Pity the true spirit had fled—that would have been a find!

"Well, I suppose I'll have to have this," he said. "My wife will hate it, of course."

"Because of the wailing, sir?"

"Puts her off. Gives her the creeps."

The Seller continued his dusting. "I must admit, it gives me the creeps, too."

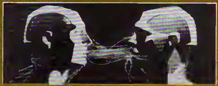
"You don't know how to listen," the Collector said. "You must get past the superficial sound and hear the traces of its inner voice."

"You have the knack for it, sir, that's clear." The Seller masked his own contempt behind a cheerful smile. He'd be glad to have the cursed thing out of the shop and be done with its bloody wailing.

"Much to be learned, much," said the Collector, aware that he was revealing too great an excitement and

SCULPTURE BY NICK ARISTOVULOS

NEXT OMNI



LANGUAGE

TECHNOLOGY

CURVING T[illegible] A NEW AGE—[illegible] October *Omni* will be two years old. The future never [illegible] A spectacular issue will mark the occasion of *Omni*'s second a[illegible] [illegible]ntral theme will be the evolution of the human race, not the history of th[illegible] [illegible] myriad ways in which future generations will evolve. One hundred tw[illegible] after the publication of Darwin's *Origin of Species*, that single word [illegible] on a crucial new meaning. Today, for the first time [illegible] kind [illegible] to take control of its own destiny through science. In next [illegible] [illegible]ar cast of distinguished thinkers and writers will chart [illegible] brave [illegible] [illegible]rrow as it hurtles relentlessly toward the present. [illegible] [illegible]ed sci[illegible] [illegible]d Rorvik reveals how new recombinant DNA tech[illegible] will bec[illegible] tools with which we can deliberately alter the forms and [illegible]s of ou[illegible] Genetic engineering will help to end the attack on human [illegible]ion by p[illegible] longer lives through permanent immunity from disease. [illegible] Pfeiffe[illegible] of *The Emergence of Man*, tracks the future path of human [illegible]ies as an ac[illegible] rising world population, growth, huge geometric technology and [illegible] s[illegible]es of food force the human race into new patterns of culture. [illegible] st James Albus portrays a world in which no one will ever have to wo[illegible] [illegible]n, an automated world in which robots will provide abundance [illegible] allowing us to grow socially and explore the universe around us. [illegible]caster Edwin Newman charts the future of the English language, reveal[illegible] how it will change in decades to come, and [illegible] why Newspeak and [illegible]terspeak may be the languages with which we communicate tomorr[illegible]

[illegible] *Omni* presents the future dreams and nightmares of an international ga[illegible] [illegible]ent personalities, from Lowell Thomas, Otto Preminger, and Dr. Joyce [illegible] to Neil Simon and the Dalai Lama. These personalities will reveal the [illegible] of future they would like to inhabit—and the kind of future they fear most.

[illegible]CE FICTION *Omni* presents Cyril M. Kornbluth's "The Marching Morons," the most prophetic science fiction story of all time, [illegible] first published in [illegible] Other tales of future glory, including Philip K. Dick's [illegible] story [illegible] *[illegible]ara's Case*—await readers of the second anniversary *Omni*. Don't miss it!

knowing he'd suffer in the bargain, but he didn't care at this point. The wailing had thrilled him. These little ornaments were always filled with surprises, even when they were as old as this one and all that remained of their glory was a fading echo.

"Microbes," he said, inspecting the ball with his glass again. "They say that's what causes the deterioration."

"I've heard the same, sir. Tiny organisms that feed upon the workings."

"Once it was brand new," the Collector said, holding the ball up to the light. "Can we ever conceive of the beauty it must have contained? How splendid its workmanship was? If the spirit that once inhabited this ball were still present, it could tell us more than just who made it and when—" He paused, his eyes shining with the intoxication of the connoisseur. "It would engage us in deep discussion, whisper to us of the wondrous workings of its mechanisms, give us the secret of its maker. It would grant us, in short, the favor of its enchanting company, but"—he placed the ball back on its dark velvet cloth—"this is a lifeless trinket now."

The Seller concealed a sneer behind his polishing cloth. These collectors were such pompous old bores. Listening to their twaddle made him sick. "You saw my sale sign, sir. Fifty percent off all items in the shop."

"Yes," said the Collector, disappointed at his failure to kindle true appreciation in the Seller. But what did these merchants know of subtlety? And in any case, once he was home and visitors came, then he could expand fully, then he'd have his fun in the comfort of his armchair in the study with the fire crackling and the bauble suspended on a suitable chain in the shadows by the window, perhaps. "All right, how much do you want for it?"

"As you can see, sir, through this bit of transparency the center is filled with jewels—"

But surely that's not unusual—

The takes, sir, are glass-filled—

The Collector adjusted his top hat, turned up the collar on his cape. The bauble was in his pocket, and a thin smile played upon his lips. He'd driven a hard and cunning bargain.

The Seller graciously held the door, sly satisfaction in his eyes. He'd gotten twice what the trinket was worth. These foreign collectors often think they know it all.

"Do you remember perchance," asked the Collector, drawing the sphere from his pocket as he stepped into the bright street, "what the Caravan Master called this thing when he sold it to you?"

"A peculiar name, sir," replied the Seller. "He called it Earth."

"Earth. I see. Very well then, my good man. I shall undoubtedly visit you again."

"My pleasure, sir, always."

The Seller closed his door and watched as the Collector walked on down the glittering, milky boulevard. ◘◘

THEATER

CONTINUED FROM PAGE 30

possible in theater to alternate more frequently between these interior and exterior impressions to make new views of reality.

"For instance, if you are watching television and there is a newscaster who says that President Kennedy was assassinated today, you don't notice that the newscaster is wearing a black suit with a red and blue tie. But if you turn the TV's sound off and turn on the radio and listen to Mozart, or something else, perhaps you look at the picture more intensely or listen to the music more intensely or both at the same time. It's difficult to see and hear at the same time, but I think it's something we're going to do a lot more of."

Einstein on the Beach revolves around several recurring visual images, each having its own thematic music and dances. Trains. The boy trains of Einstein's boyhood segue to the trains later used as analogies to explain the theory of relativity. The trial scene, according to critic Robert Palmer, "resonates with the awesome implications of his discoveries. The stunning vision of the spaceship ... 'representing perhaps the potential for liberation and transcendence that Einstein also unleashed."

But there is no way to convey the complex interrelationship of images as Einstein himself wanders the stage at times or stands apart from the action, violin in hand. Its elements are formed into a coherent plot only in the mind of the listener/viewer.

It is difficult, too, after being raised on high-school productions of *Our Town* and on Broadway musicals, to envision the theater of Robert Wilson. What is drama when meaning and emotion, its most conventionally important aspects, are taken away?

Wilson splits the atom of conventional theater. What remain are the component particles—lighting, costumes, sound, sets, dialogue, music—all independent, all traveling along randomly convergent paths. Without the usual strictures of text, plot, and subplot, we're freed to explore the individual drama of each component.

"In the Sixties a friend of mine made some sixteen-millimeter films of mothers and their babies," Wilson recounts. "When a baby cried, the mother would pick him up and comfort him. My friend slowed down these films and looked at them frame by frame. He found that in three out of eight cases the initial reaction of the mother in the first three frames is that of attacking the baby. And in the next three frames she demonstrates another emotion; in the next she's doing something else again. When the mother saw the film, she said, 'But I love my child.' That's not what's really happening, which is very complicated. In that split second there are many different emotions, many physical reactions. We can't illustrate what we're feeling. It's too complex."

Communication and the nature of speech itself have been central concerns of Wilson's theater. Personal speech difficulties overcome in adolescence led him to devote a great deal of work and attention to the problems of brain-damaged children. He taught painting and body movement classes and later involved many of his students in his productions.

Christopher Knowles is a student and friend who helped to write certain passages in *Einstein on the Beach*. Knowles, autistic from birth, has grown to become an accomplished poet and graphic artist with Wilson's guidance and support. He has collaborated on some of Wilson's major works and has influenced Wilson's own theories of sound and the spoken word.

"We're all blind and deaf all the time," Knowles says. "If you blink your eyes, you're blind for that time. What do you see? If you are blind, you have a feeling or impression of sight. The body sees—feels—the vibration of color. If you're deaf, you don't hear, but your body does."

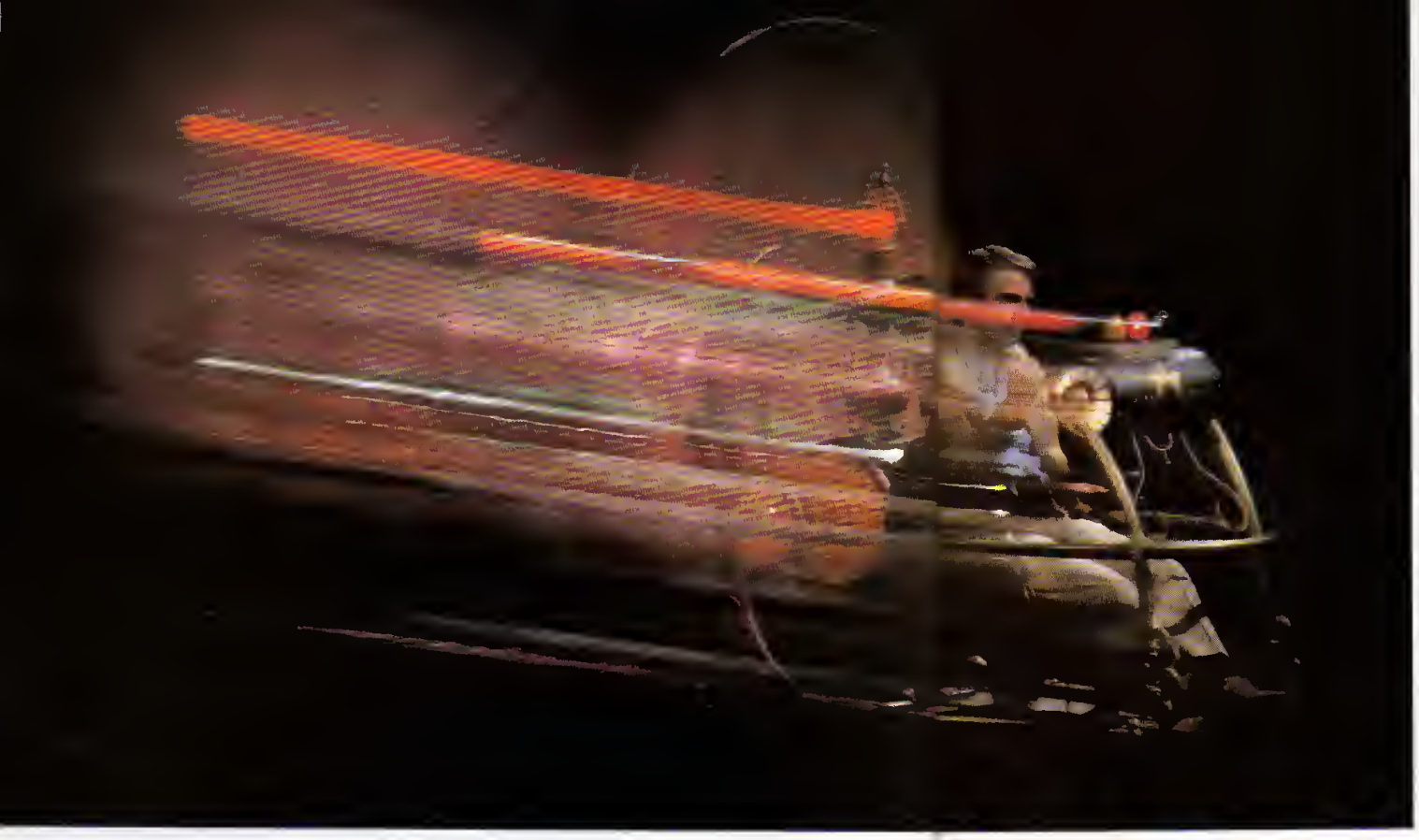
In Knowles's script for *Einstein on the Beach*, the recitatives take on an incantatory tone through the repetition of phrases and thoughts. Language is dissolved into its primary components of sound. "I'm interested in separation," says Wilson. "In *Edison*, the actors were hooked up to radio mikes so that their voices came from speakers placed in back of the audience, from a source other than the one that was seen. In addition to these mikes, there were sometimes as many as sixteen different tapes happening simultaneously."

Currently at work on a six-and-a-half-hour program for West German TV—to be broadcast at 11:30 PM and run through the night—Wilson sees television as the dramatic medium of the future. "Television's scale is so different from theater's. The space, time, texture, color—everything is different. TV happens quicker. In the theater I can spend half an hour walking five feet. In a performance in Belgium I did almost that, and seventeen hundred people sat and watched. On TV they never would have. TV is about close-ups, the movement of the eye. Impact."

Wilson's future may be today, but you'll have a hard time seeing it in the United States. *Einstein* and *Edison* sold out in a matter of hours in New York, but popularity could not offset production costs. Lacking government subsidies, Wilson can rarely mount one of his productions.

"In Europe I'm already part of the mainstream," he says. "But here we're dealing with a young country, only two hundred years old. But it's about to grow, to change."

There are hopeful signs. Wilson has been awarded a Guggenheim Fellowship and a modest production of his latest work, *Dialog/Curious George*, played seven days in New York. The tide is changing for this director, whom Eugène Ionesco has called "America's most important dramatist."



Carl Sagan takes a trip in "The Time Machine" (from the George Pal movie of the same name) At right at Lowell Observatory, Sagan retraces the martian canal controversy and how it led to the Viking exploration of Mars

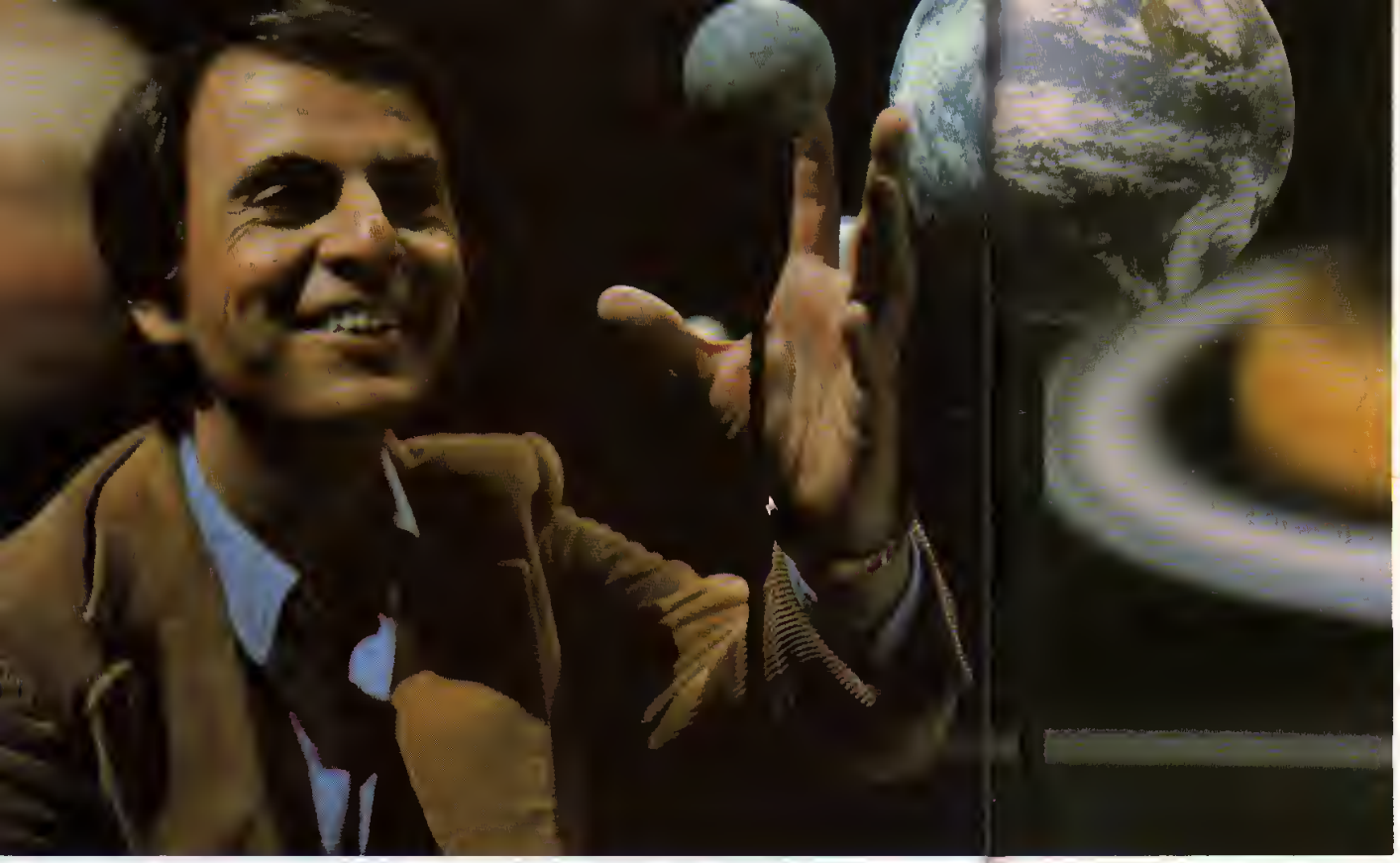
CARL SAGAN'S COSMOS

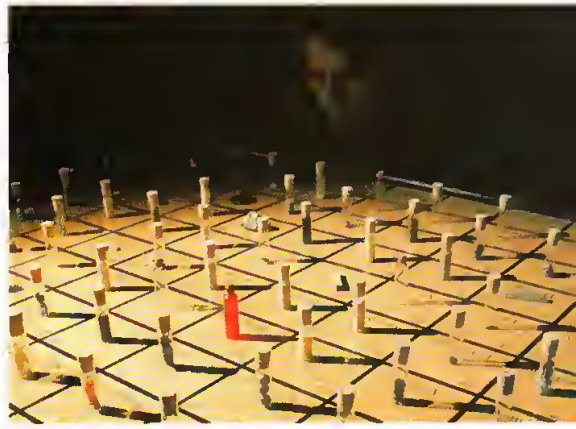
This intergalactic TV saga takes the scare out of science

BY JEFF ROVIN

We are racing through space, plunging through faraway galaxies, spiraling foward the Milky Way Stars blur past until one dot in particular grows from a fuzzy speck to a sphere of soft-blue and green The globe expands, landmasses become distinct clouds part, and the surface nears After a flight spanning millions of light-years, we come gently to resf, gazing out on Alexandria and Egypt, and we find the Greek scientist Eratosthenes busily computing the circumference of planet Earth

This is the prelude to an ambitious new television series called *COSMOS* A saga of scientific discovery, the $8 million Public Broadcasting System presentation claims to be the first TV program to blend sfate-of-the-arf special effects with nontechnical language in an effort fo take some of the scare out of science The 13-part series, scheduled fo begin Sepfember 28, takes fhe form of an epic journey The viewer is carried along on a four of fhe universe, conducted from the comfortable seaf of a qualnf almost cafhedrallike, Wellsian spaceship whose pilot—the host and principal writer of the series—is Carl Sagan





In COSMOS, among the worlds Carl Sagan reaches out for the moon (top) and walks through the inner solar system (lower right) in one of the more than 100 sets and locations in the new TV series. In a discussion of the curvature of space, he holds up a three-dimensional projection of a four-dimensional hypercube, or tesseract (top right), in program 10, devoted to cosmology. The 92 naturally occurring chemical elements — all but hydrogen and helium made in the insides of stars (right middle photograph).

According to Sagan, the distinguished astronomer and Pulitzer Prize-winning author, *COSMOS* was born four years ago while he was a scientist attached to the *Viking* Mars mission. Deeply annoyed by the bland, uninformed reporting that dogged that historical event, he established Carl Sagan Productions, whose purpose, in his own words, "is to bring science to the public in an accurate, enthusiastic manner." *COSMOS* is the first tangible by-product of this commitment. The program is also an opportunity for Sagan to drive home an important cause of his: the exploration of our solar system. (See page 35 for Sagan's plan on how you can participate in urging our government to continue planetary exploration.)

Sagan is assisted in his odyssey through time and space by some innovative video wizardry. Among the many special effects in *COSMOS* is a 25-minute journey from the realm of remote galaxies 8 billion light-years away past quasars, exploding radio galaxies, black holes, pulsars, interstellar clouds of gas and dust, the Orion Nebula, and all the planets in our solar system. There is also a dramatic re-creation of the great Library of ancient Alexandria, a representation of Sagan's Cosmic Calendar (which compresses the 15-billion-year history of the universe into a single cosmic year), a plunge into the living cell with the most accurate representation of DNA function ever attempted, and an excursion into the human brain.

The secret behind the special effects is a new camera system linking computers to cinematography. Microprocessors simulate motion through space, and the computer can place as many as six galaxies in correct spatial relation to one another.

Sagan is convinced *COSMOS* will enlighten a large audience because the program is entertaining rather than pedantic. "I enjoy popularizing science," he declares. To those critics who say the casual personality of *COSMOS* undermines its intellectual integrity, Sagan counters, "Popularization, it must be remembered, is not the same as vulgarization."

FICTION

ONLY YOU FANZY

He could afford the best, but this one was on the house

BY SHERWOOD SPRINGER

Throughout the habitable domes of the solar system from Venus to the moons of Jupiter there are beings who will tell you if the subject comes up, that the Titanians as a race are shrewd crafty opportunists of a high order

This of course is a myth True there are natives of Titan who may possess these characteristics, but they are probably no more numerous relatively speaking than similar inhabitants of any other clime If pressed for an example, however, one might bring up Mr Lefkoviz

One evening, at the tail end of a business trip to Mars Mr Lefkoviz rode a rackshu along the silicon streets of Crater City until finally he reached the D2 Mescence Mall Fanzy's Place was third on the left

Mr Lefkoviz banged on the door with his muggerstik Through a peephole a pair of purple eyes gave him the once-over The door slid sideways, and Mr Lefkoviz crossed the threshold

"Can I help you?" the girl asked Clad only in sandals and a simple yellow tunic that was draped to a point fifteen centimeters below her navel, she was obviously a Callistan, violet skin and all

"I'm looking for Fanzy," Mr Lefkoviz said

"You have an appointment?"

"No appointment

"Can you tell me the nature of your business?

"In such a place there is another kind of business?'

"Oh,' the girl said 'In that case *I'll* show you around "

"No, I have to have Fanzy'

"I'm sorry That's impossible

"Why impossible?'

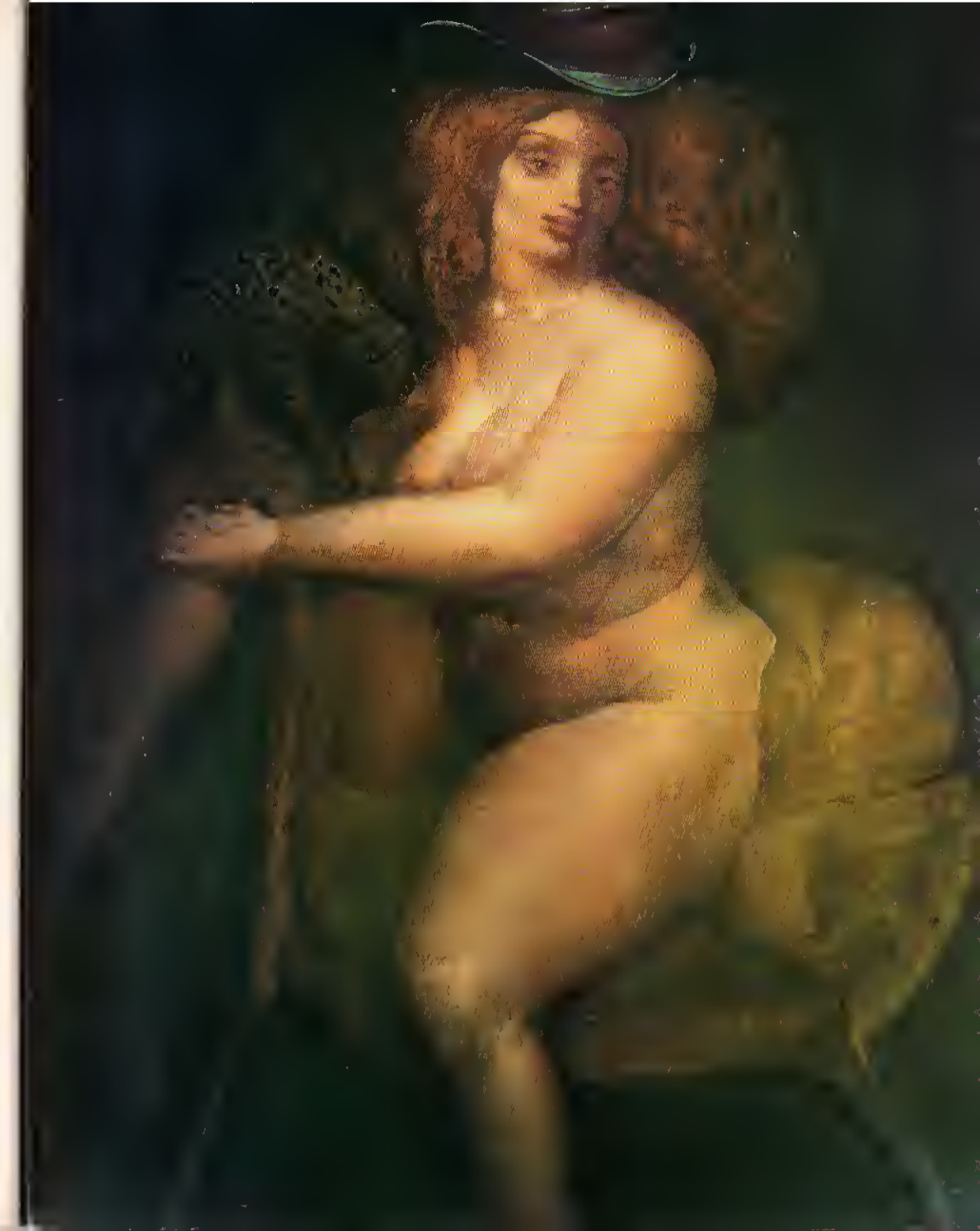
"For one thing Fanzy's not one of the girls She's director here And for another she's retired From floor duty, that is

"*That* she can be telling me herself Tell her Mr Lefkoviz is here

Persistence may indeed be the most powerful force in our society It was obvious the violet-skinned filly was not going to dissuade Mr Lefkoviz from reaching his objective She decided to let her boss handle the situation

The director was working on government forms when Mr Lefkoviz was ushered into her office If one liked his females ample Fanzy was ample What was more even a critical connoisseur of

PAINTING BY ERNST FUCHS



amplitude would have been forced to admit that Mother Nature in overendowing, had used fine judgment in contouring the landscape.

"What do you want?" Fanzy asked.

"I want you, Fanzy."

"Are you some kind of nut or something?"

"Is it only a nut, Fanzy, that would ask for you?"

At this, she dropped the papers on to her desk and looked at Mr. Lefkoviz with mild interest. Middle-aged, balding a little on top, a certain thickening at the belt line, and apparently an outlander with antecedents not dissimilar to her own. Mr. Lefkoviz in no way turned her off physically. In addition, he had that air of assurance, quiet humor and flattering determination. He also was—

Fanzy slapped a lid on her thoughts. She already had an adequate lover. As for business going back on the floor was just retrogressing.

"Mr. Lefkoviz, it's out of the question. One of my delightful playmates will take care of you. Have you ever been caressed by a furry wogglie from Ceres? She's soft as a teddy bear."

"No, Fanzy. A wogglie I don't want."

"How about a mermaid, then? They do it too, you know. You just have to know which scales to lift."

"Oh? Every day I learn."

"How about trying one of our rare woo woo androids, imported from Stateside?"

"Among other things, she'll blow your mind."

"No."

"Well, then we come to the giant vulva plant from Venus. You can slip into her up to your armpits. Believe me, the massage you get from her is the living end. I mean *ultimate*."

"It's no use. My mind is made up. For you I've got plenty of robles. How much do you want?"

There is no shaking this clown. Fanzy thought. Her simplest course was to name a figure so outrageous the poor john would have to beat a retreat. She stood up, stretched her arms out to the side, and gazed down at her extensive mammary architecture.

"We're looking at five hundred robles, Mr. Lefkoviz," she said.

Mr. Lefkoviz was also staring at the architecture. Then, pulling out a small roll of currency, he peeled off five crisp hundred-roble notes and placed them on the desk in front of her.

"So who haggles?" he said.

Fanzy took a deep breath and let it escape through her teeth. There was no way out for her now, but—what the hell, she thought, five hundred robles was five hundred robles. As she picked up the money and placed it in a desk drawer she couldn't help wondering what the current record was in the *Guinness Book*.

An hour later she accompanied him personally to the door. It certainly had been an interesting evening. Maybe she *should* keep her hand in occasionally just for practice. Too bad Lefkovizes came along only once in a lifetime.

In that, Fanzy was wrong.

Early the next morning the door in D2 Mescence Mall was again hammered by a muggerstik. There stood Mr. Lefkoviz.

"All night I couldn't sleep, thinking of you," he said to Fanzy, who hadn't yet got the blanket fuzz out of her eyes.

"My God, Mr. Lefkoviz, it's the crack of dawn. Can't we have some coffee?"

"So fine, bring coffee."

Fanzy looked at him with suspicious eyes. "My price, you know, is no cheaper this time."

Without a word Mr. Lefkoviz brought out what was left of the roll and handed it to her. She leafed through it and found it precisely correct. They dawdled through coffee, and Fanzy led him upstairs.

This time, at leave-taking, she held onto his hand. All things considered, clients of his caliber should be tendered some appreciation.

"When am I going to see you again?" she asked.

"Who knows?" he said. "I'm going back to Titan today."

"Titan? Why, what a coincidence! My mother lives on Titan."

"I know," said Mr. Lefkoviz. "She gave me a thousand robles to give to you." ∞

Take your partner all in a row, allemande left, and do-si-do

UFO

CONTINUED FROM PAGE 32

daily to both Marcia and her husband. Tapes of the experiments were made from April 1976 through February 1978. During session 6, on November 8, 1977, Marcia described her first contact with extraterrestrials. "I seemed to be in a place of wheels. It was being made manifest that all creation is based on some form of rotary motion, whether axial or around a greater center. There are whole hierarchies of archetypes descending from abstract to concrete realms of being, and this was the place where these patterning principles are given their initial momentum."

An all-too-familiar thread weaves its way through yet another of Marcia's inner journeys. "I strongly sensed the quality of benign beings, who for the sake of discussion can be labeled aliens. The unexpected conclusion of tuning in on the vibratory frequencies of these aliens was the recognition that they were us! Or at least we were being used as tools of their reconnoitering."

This conforms to Jung's interpretation. As our dreams show very clearly, the psychologist writes in *Flying Saucers*, "UFOs come from the unconscious background, which always expresses itself in numinous ideas and images. This strange phenomenon ... suggests that consciousness has lost its balance, enabling a one-sided view to prevail. If consciousness loses its balance, then man views things from one angle only and reduces them to a single principle involving a superior intelligence. Civilized man, like primitive man, is mindful of the gods, of the spirits, and of fate and the magical qualities of time and place."

While Moore's drug experiments appear to support Jung's hypothesis, an ultimate proof remains elusive. Could these cerebral UFO experiences indicate the need to search for a new psychology of being? Do we all desire to go beyond the material and social aspects of life? Lyall Watson suggests that man is undergoing a revolutionary change in consciousness, a heightening of awareness in the psychic realm, which may explain UFO phenomena.

One who disagrees is Desmond Morris, anthropologist and author of the best seller *The Naked Ape*. "I don't believe man is now developing new psychic properties," Morris declared. "Man has inherited ancient psychic abilities that, until now, have lain dormant owing to a preoccupation with scientific and analytical modes of thinking. Morris believes this highly developed specialization could be brought to light if science reevaluated its significance.

"Slowly the scientific community is becoming more open to psychic thought, but it is not totally convinced of its genuineness. Rather than speculate on its origins, what's needed is to promote advanced research into new areas of physics and biology, which may lead to a better understanding of what UFOs are all about."

fusion

Plasma Physics Laboratory has a definite commitment to search for solutions to mankind's energy problems. We are one of the world's leading laboratories involved in the development of magnetic fusion energy as an inexhaustible, safe and environmentally acceptable means of generating electricity for the long-term. Plasma Physics Laboratory is engaged in the design, construction, fabrication, testing, and control of the PLT, PDX, and TFTR tokamaks.

Only with a team of dedicated, talented professionals can we ensure our continued success. Enter our world of professional challenge and fulfill your career aspirations.

We offer a stimulating and unique hands-on technological environment, salaries fully commensurate with your experience and a comprehensive benefit package that includes 24 days vacation per year.

For prompt consideration, please forward a detailed resume and salary requirements to: Chris Legaard, Plasma Physics Laboratory (Princeton University), Post Office Box 451, Princeton, New Jersey 08544. An Equal Opportunity/Affirmative Action Employer M/F/H

creating fusion energy... the ultimate source

Plasma Physics Laboratory

Princeton University

FORUM

CONTINUED FROM PAGE 14

such a small feat would be immense, yet Randi would have no difficulty whatever in duplicating the feat by no less than several thousand existing technical means. Would Randi's duplication disprove the existence of a psychic force? Did the invention of the automobile disprove the existence of the horse? No. There is more than one way to get from point A to point B. The transition is made just the same.

Randi's proposition puts the true psychic (if one exists) at a disadvantage. Deform or break a remote object. (Microwaves? Particle beams?) Divine the presence or nature of a concealed substance. (Oil company geologists do it with seismic waves.) Isn't invisibility merely a light-refraction trick? The ten of diamonds weighs more than the ace because it carries more ink.

If any true psychics exist, Randi's challenge is superfluous. One day Randi's bank balance will decrease by $10,000, and no one in the data-processing department will be able to explain how it happened.

C. J. Anderson
Burnsville, Minn.

James Randi replies: *I am puzzled by your comments. My offer is for a "psychic" demonstration. The "psychics" claim that these are not tricks, that they work, and that they happen in a manner not ordinarily explainable by regular science.*

As for moving a steel ball: if the conditions were correctly set up and if the psychic could indeed cause the steel ball to roll, he or she would collect the prize. The fact that I could also do this stunt by trickery would not invalidate the win. It is up to me to see that I allow no "ordinary" forces (magnetism, gravity, heat, etc.) to be used to move the ball. The requirement is that the ball move without these ordinary, normal forces being used—in other words, by paranormal force. I don't know where you got the idea that duplication of the phenomenon invalidated the demonstration.

Incidentally, the weight of the ink used to portray nine diamond shapes on a playing card is minute—so minute that it falls well within the average difference in weight of any two playing cards. Thus, your ten-heavier-than-ace statement is neither pertinent nor correct.

My offer is now more than 15 years old. My money has never been safer.

Oberg vs. Cooper

An interesting conflict occurred in *Omni*'s March 1980 issue. In the UFO Update article, James Oberg, as usual, chose to "debunk" a questionable tabloid UFO-sighting story. This is of course easy for any informed UFO researcher is aware that these tabloids tend to supersensationalize observations of UFOs.

At variance with this, a sighting is mentioned in *Omni*'s interview with former U.S. astronaut Gordon Cooper, who was asked about a UFO that he allegedly saw in the skies over Germany in the 1950s. He said that he and others sighted, and tried to pursue, groups of metallic, saucer-shaped vehicles at great altitudes over the base." He claims that this continued for "several days in a row." Unfortunately these objects outmaneuvered the pursuing fighters and sped away each time.

It would be very interesting to have Mr. Oberg interview Mr. Cooper and bring out the details of this sighting. A trained and respected man such as Mr. Cooper would make a very credible witness.

Mike Bucker
Richmond, Va.

In the interview with Gordon Cooper, he is quoted as saying: "I think we could very likely bring together the talent to build a time machine," and later, "I do believe UFOs exist and that truly unexplained ones are from some other technologically advanced civilization."

Putting these two ideas together, is it not reasonable to think that the UFO may be a time machine from an advanced civilization right here on Earth, say, 100 years hence? Thus, UFOs would be vehicles not from outer space, but from "outer time"—possibly crewed by little green robots.

Peter H. Adams
Wentworth Falls, N.S.W.
Australia

Was Gordon Cooper just pulling our limbs or was he unwittingly suggesting something rather strange?

I was particularly struck when I combined two statements Cooper made: (1) that it was theoretically possible to construct a time machine, and (2) that he doubted that some UFOs were from "anywhere on Earth" because of their "performance capabilities."

Since it has been speculated by others ("Dark Sanctuary," May 1979) that any interstellar travelers would find some difficulty in withstanding Earth's gravity after living and evolving in a zero or fractional gravity during the time required to traverse interstellar space, and since they could quite easily resupply themselves from the asteroid belt or from Jupiter and its satellites and would have no need to visit Earth, I am led to believe that these smaller craft that Cooper allegedly pursued over Germany were not interstellar in origin at all, but in fact *are* from somewhere here on Earth.

That is, they may be time-traveling ships that *will have been developed* from the very technology hinted at by Cooper.

If so, then Cooper and *Omni* should claim credit for all the UFOs we've supposedly been sighting.

Richard E. Bridges
Kalamazoo, Mich.

The Age of Science Fiction

I beg to differ with Jeff Rovin's Film column [March 1980]. Rovin's first mistake was in

labeling films like *Star Wars* *The Black Hole* and *Star Trek* as science fiction Their own creators admit them to be science fantasy *Star Wars* especially They are obviously not high-brow films—because they were not intended to be

Though I thoroughly enjoy literary science fiction like *Dune* (by the way films based on *Dune* and *Childhood's End* are in the works, and we've already had *The Martian Chronicles* and *The Lathe of Heaven*) I find the films mentioned also enjoyable Besides the audience for true science fiction is still small compared to the numbers of fans of films like *Star Wars* thus making really good films uneconomical But this situation won't last long Since *Star Wars* ushered in the present science-fiction/fantasy boom sales of *all* kinds of science fiction at bookstores have gone up People who started by reading novelizations of films are drawn into the world of classic science fiction

Rather than berate them for their lack of characterization we should be thankful that these films are introducing science fiction to the masses The Age of Science Fiction is just getting started

J Michael Smith
St Bruno P Q
Canada

Human Guinea Pigs

As a human guinea pig I feel I must comment on a letter submitted by Kathleen Sommers [Forum March 1980] Without experimentation on humans no new medicines no new vaccines and no new surgical procedures would be available to people who most certainly would die without them

Abuses have occurred I concede but I submit that for each test-tube baby destroyed hundreds—no thousands—of babies have escaped the ravages of polio smallpox and diphtheria

I am currently involved in a hepatitis B vaccine study that if successful will save many health-care professionals (not to mention dialysis patients diabetics and drug addicts) each year

I am not well paid but I am very happy to be a part of this work

Ron Halbert
Baylor College of Medicine
Houston Tex

Ms Kathleen Sommers says that HEW was funding research into the fertilization of hamster eggs by using human sperm This erroneous statement should be corrected The object of these tests is not fertilization but the fertility of the male donors involved

In the past the only test of male fertility was a microscopic examination of the sperm to determine numbers shape and motility This process has proved very inaccurate both as a positive and as a negative indication of fertility The only true indication of male fertility is the ability of sperm to penetrate an egg Since the technical problems inherent in obtaining human ova are great not to mention the legal and ethical barriers animal ova must be used

Two years ago researchers in Hawaii found a way to treat hamster ova by removing the outer layer so as to allow human sperm to penetrate The ova being of a different species die immediately There is no long-term evidence as yet but there is a strong indication that this test is much more reliable than sperm examination

This test is currently being used in a study of DES sons who seem to show a higher rate of infertility than the general male population but who show no deviation in sperm analysis It is also hoped that this test might be used as an alternative to the expensive and uncomfortable tests that are now being given to married women who evince infertility problems This should be a desirable goal for someone concerned with human life which Kathleen Sommers professes to be

Dennis S Murray
Kent Wash

New Manhattan Project

The end of economic prosperity as we have come to know it in this country is looming on the horizon The reason is energy Using and wasting vast quantities of energy we are forced to import vast quantities of expensive oil from the Arabs

Jane S Wilson suggested [Continuum May 1980] that we undertake a Manhattan Project for energy Specifically she suggested full-scale development of fusion power Once fusion power is realized on a commercial level our energy appetite will be satiated for centuries to come There was an interesting implication in Ms Wilson's article As an alumna of the Manhattan Project she seems eager to participate Perhaps those from the fission-power project who are still alive could lead the way in a fusion-power project We should call on them Perhaps they could unite and ask the President to give them and the many others who would be needed the opportunity to reach yet another scientific milestone

Let's take the $30 billion the generals want to spend on the MX and give it to the scientists to spend on energy independence

Robert W Ford Jr
Rock Hill S C

Stewed Mice

As an avid reader of *Omni* I was somewhat surprised to see the Educational Alcohol item [May 1980] among the usually excellent pieces in Continuum

Drs Ronald L Alkana and Elizabeth S Parker conclude from their research that mice given ethanol remember an unpleasant experience better than sober mice do They base this finding on the results of tests in which sober mice repeatedly moved toward a dark hole wherein a mild electric shock awaited them in less time than drunken mice did

A mouse that is given alcohol and then

THE PAST IS GONE. THE PRESENT LOST AS IT ARRIVES. THERE IS ONLY TOMORROW.

OMNI is more than a magazine It is a time ..and a place It is the realm of imagination and the era of our destiny
Journey to OMNI Explore the boundaries of the mind Venture beyond. Discover worlds and epochs that defy understanding and tantolize curiosity
There have been two years of tomorrows in OMNI All that remains is the future Share it Subscribe now and begin your journey to tomorrow with OMNI's special second anniversary issue on "Human Evolution This is one of your last chances to get OMNI at its current low rate so don't hesitate Tomorrow waits for no one

OMNI THE SECOND ANNIVERSARY

Photograph by Robert Dibue

OMNI
OMNI Subscription Dept.
P.O. Box 908, Farmingdale, N.Y. 11737

Send me one year of OMNI (12 issues) at $6 off the newsstand price Here's my check ☐ or money order ☐ for $18 (For United Kingdom subscriptions send payment of £11 to 2 Bramber Road London W14)

Name_____

Address_____

City_____

State_____ Zip_____

Print clearly please Rates for U S APO, FPO and U K Canada and elsewhere add $6 to U S subscription rate Payment must accompany order Allow 6-8 weeks for delivery of first issue Offer void after March 31 1981 00980

moves more slowly than one that is given saline is only proof that alcohol is a depressant.

Dr. Alkana's claim that memory is enhanced could be better supported with more conclusive testing, e.g., one in which the mice that remember better must react and move faster than control mice do.

It is not valid to draw conclusions based on insufficient testing, as any seven blind men prove on the subject of elephants.

Robert M. Sonnicksen
Chicago, Ill.

Dr. Ronald L. Alkana replies: *The mice were not under the influence of alcohol when they were tested, as implied in the article (paragraph 5, lines 8–12). The mice were trained, injected with alcohol immediately after training, and then tested for their memory of the shock one week after the alcohol injection. Therefore, there was no alcohol in their systems to slow them down when they were tested. The longer retention latencies in the mice that received alcohol cannot be explained by an effect of alcohol on their mobility.*

Time Travelers

I just finished reading "How to Build a Time Machine" [May 1980], and I am thoroughly fascinated. Up to now I had no idea that there was any feasible way to build a real time machine. However, there is one very important paradox that I think Dr. Robert L. Forward should have gone into. This paradox is simply this: If you went through the time machine, when you reached your destination would you meet yourself?

Think about it. Say you had been given an Acme Superdeluxe Time Machine (built for the sake of argument a month ago) and you wanted to go back to yesterday. If yesterday you had been where the time machine was at the time you teleported back, would you be there waiting for you?

Some people would consider this to be an unsatisfactory condition. Not so. What better friend could you possibly have than yourself? Here's another prospect. Suppose a person wanted to take over the world, and suppose this person had all the ships and missiles and laser cannons (?) needed for such a task, but not enough followers loyal to his cause. Now picture this person getting into his time machine and traveling back one minute, picking up the version of himself in this time zone, and going back another minute. Imagine him doing this 2 million or 3 million times (going backward and forward in time). He would have an army more loyal than any in history. What if Hitler had had a time machine?

A terrifying concept, as you can see. I believe, if we develop the technology to make a time machine, we should take a look at all the ramifications of such a thing.

Mark Holt
Richmond, Va.

Hog Love

As an animal, man forms a distinct category—that of a volitional, rational animal. *Volitional* means "capable of self-directed action." *Rational* means "dealing with the environment primarily by the use of conceptual faculty." This means that man is not a Skinnerian gremlin whose actions and feelings are determined by his immediate environment but rather that he chooses to perform his actions in accordance with his values.

Because man is mortal, he must have values; hence the concepts of good and evil. If man were not mortal, such distinctions would not be necessary. It is a metaphysical given (i.e., it exists in reality necessarily) that men will value some things highly and others less, but *what* they value *must be chosen*.

The source of values is man's mind. He is above all *not* an instinctive animal. He must discover what it is he should value by the same means that he uses to rule his life—by his conceptual, rational ability.

Kathleen Stein's item "Scent of Sex" [Continuum, April 1980] distressed me quite a bit. What she and the "scientists" fail to realize is that one feels sexually attracted toward someone whom one values and that these values are chosen; they are not metaphysically determined. One wishes to engage in sex with someone who meets one's standards of value, not because he or she smells like a hog.

This kind of error arises when one confuses the metaphysically determined (reality) with the chosen (artificial).

Bruce Douglass
Eugene, Ore.

Tuning Up

I found the problem involving the piano tuner [Games, June 1980] particularly interesting. Though your answer is quite correct, you might find it interesting that pianos are purposely tuned slightly out of tune to allow for the varying string gauges involved. If a piano has each string "perfectly" tuned, chords played on it will sound like mud. A truly perfectly tuned piano is one that has each string precisely out of tune. Thanks for the intellectual challenge each month.

James D. Port
Menomonee Falls, Wis. ∞

PHOTO CREDITS

Page 6, Tony Guccione; **page 8,** Diane Jackson, Cliff Olson, Jay K. Klein; **page 14,** Douglas Kirkland; **page 16,** Dan Morrill; **page 18,** Bettmann Archive; **page 22,** David Eggo; **pages 24 and 28,** Robert DiBue; **page 32,** Princeton University Press; **page 36 left,** Mark M. Griggs; **page 37 left,** W.G. Gensler, Department of Information, Office of Water Resources and Technology; **page 38 left,** Dianora Nicolini; **page 38 right,** IBM; **page 39 left,** NASA; **page 39 right,** David Burnett, Contact Images Press; **page 40 left,** Manfred Kage/Peter Arnold; **page 40 right,** Kimberly Green; **page 41 left,** Mark M. Griggs; **page 42 left,** Antonio Mendoza; **page 42 right,** Fermilab; **page 44 top,** Giancarlo Perini; **pages 44–45,** Rich McBride; **page 45,** Rich McBride; **page 47,** Giancarlo Perini; **page 102 top,** Gregory Manchess; **page 102 lower left,** Douglas Kirkland; **page 102 lower right,** courtesy Unimation, Inc., Danbury, Conn.; **page 118,** Florida State University; **page 119 right,** Malcolm Kirk; **page 121,** Ben Mayer; **page 123,** U.K. Birr Castle, Earl and Countess of Rosse; **page 123,** U.S. Jean J. Lorre, Hale Observatory, JPL; **page 130,** Colin Cuthbert/*New Scientist*


achon

PEOPLE

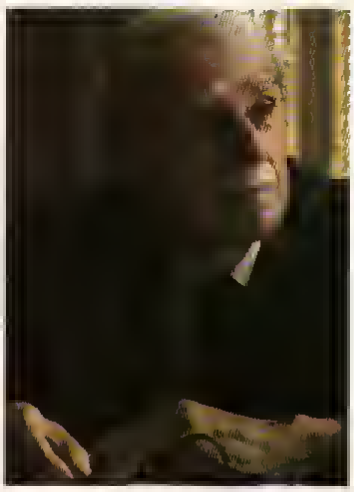
By Dick Teresi

Robert Oppenheimer, the man who headed the team of Los Alamos scientists that gave us the atom bomb, was a superlative physicist, but his arithmetic was awful. His sloppy calculations sometimes affected the validity of his results.

Carl Anderson won the Nobel Prize for his discovery of the positron at the age of forty-two, but he had to wait seven more years before obtaining full professor status at the California Institute of Technology.

Tidbits such as these enlivened the Symposium on the History of Particle Physics, held recently at the Fermi National Accelerator Laboratory (Fermilab), in Batavia, Illinois, and attended by many of the pioneers who had made that history. They included Nobel laureates Paul Dirac, Willis Lamb, and Julian Schwinger.

Dirac, at seventy-eight, was the grand old man of the symposium. He spoke for an hour and a half without notes about the development of his theory, which revolutionized the concept of quantum mechanics, providing the theoretical background for much of the past 50 years.



Paul Dirac: No postulation of positrons

Anderson was too ill to attend in person, so his paper was read by someone else while he listened in via telephone hookup from California. Anderson remarked that anyone could have discovered the positron in a single afternoon simply by following Dirac's theory. When Dirac was questioned about this—why had he, himself, not postulated those positively charged electrons?—he replied, "Because I did not have the courage."

Want to make big bucks in space? Now there's a college course that tells you how. This fall at The New School, in New York City, Mark R. Chartrand III, chairman of the Hayden Planetarium, will be teaching a class entitled "Working Space: A Primer to Extraterrestrial Profits."

Chartrand will explain how money is already being made with communications satellites and in spinoff areas, such as the insurance business that has grown up around the satellites. He'll also explore some up-and-coming technologies, such as the manufacturing of drugs and optic fibers in space.

Chartrand sees his potential students as businessmen, interested laymen, and people who might want to invest in space industry—"the guy who wonders whether he should sell his Con Edison stock because he heard the solar-power satellite is going to put him out of business."

The 14-session course begins Thursday evening, September 25.

In this country we always associate the psychedelic drug LSD with Timothy Leary, who promoted the drug's use in the 1960s. But the real father of LSD is Albert Hofmann, the seventy-four-year-old retired director of natural products research for Sandoz, Ltd., the Swiss pharmaceutical firm. Hofmann took the world's first acid trip, by accident, on April 16, 1943—while riding a bicycle through the streets of Basel, Switzerland. "I kept pedaling harder and harder," Hofmann recalls, "and thought I was locked into a spot. Finally I got home and everything had changed. had become terrifying. My neighbor came in and looked like a horrible witch. My assistant's features grew twisted. I became very anxious because I didn't know whether I would be able to come back from this strange world where I didn't know where I was, because it was the first time. . . ." Hofmann had taken a very tiny dose of LSD earlier at his lab and had not expected any real effects.

Mark Chartrand: Big bucks in outer space

Hofmann was in New York recently to promote his new book, *LSD: My Problem Child* (McGraw-Hill), and the inevitable question of Timothy Leary came up. Hofmann was direct: "I was always suspicious of Leary. I had the feeling he was naive. He was so enthusiastic that he wanted to give it [LSD] to everyone, every young person. I told him, 'No, give it to people who are prepared for it, who have strong, stable psychic structures. Don't give it to young people.'"

Leary, of course, ignored this advice. Even so, Hofmann feels the youth culture of the 1960s compared favorably with what's happening today. "It is a crazier time now," he said, "but in quite another direction. I think in the Sixties there was more of a psychological revolution, more

of a search for another kind of reality, another aspect of life. Now there is always anxiety about the terrible things that could happen, the fear of war and destruction of nature, the economy—more rational questions and problems. There was a more mystical component in the Sixties.

We'll tell you much more about Albert Hofmann in an upcoming *Omni* interview.

Fairfax County, Virginia, has given new meaning to the expression *poetic license*. Residents there actually need a license to write and sell science fiction. One such resident is **Alice Sheldon**, better known to SF readers as the Hugo and Nebula award-winning James Tiptree, Jr., and Racoona Sheldon, two pseudonyms she writes under.

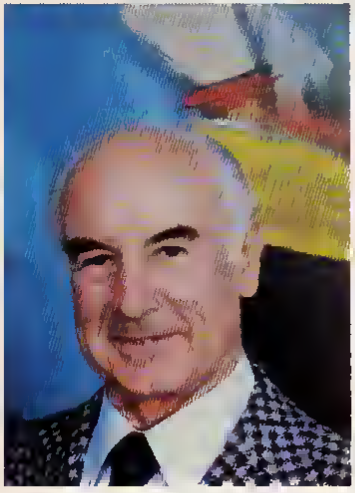
The reclusive and publicity-shy Sheldon was notified in May 1979 that the county considered her a business and expected her to apply for a "specialized occupation license." She refused, thus risking a fine of up to $300 and/or 30 days in jail for each day of noncompliance.

Essentially, Sheldon fears that once writers and artists are granted a license, they face the possibility that it might be suspended. "The only way a license can be withdrawn is if the business in question ceases to operate," retorts Paul Smith, director of the Fairfax County license division of the Office of Assessment. "It is not a regulatory license. There are no restrictions on practice. It is for revenue or tax purposes only."

In a letter to *Locus*, the newspaper of the SF field, Sheldon noted this attitude satirically, writing: "Their position is that their license is a revenue-raising formality. They claim that no such license has ever been denied or revoked on substantive grounds. Never mind if you are a cosmetician being sued for turning your client's hair into green tentacles, or an undertaker who is chairman of the Coven of Practicing Vampires. You still get your license by return mail."

Although she probably does not earn enough by writing science fiction to owe a tax, Sheldon is pressing onward with the fight as a matter of principle. She has joked that she "might train a skunk to carry the application in," and in reality she is ready to go to jail if necessary.

County Assessment Director Smith notes that he is not aware of anyone ever being prosecuted under the ordinance. "But it is still on the books," he says, "and I imagine there are situations where it could come to the point where someone would go to jail."

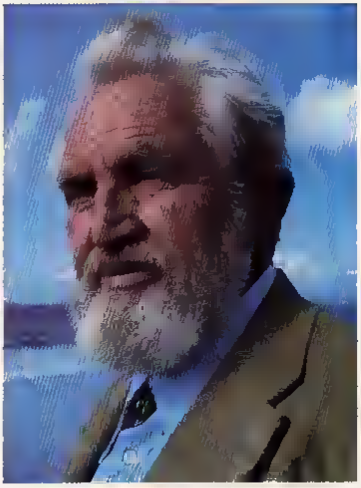


Albert Hofmann: New thrills on a bicycle

John D. Isaacs, perhaps the premier oceanographer in the world, died of cancer June 6 at his home in Rancho Santa Fe, California.

Isaacs, former director of the University of California's Institute of Marine Resources and a professor of oceanography at Scripps Institution of Oceanography since 1948, was featured in an interview in the August 1979 *Omni*.

Isaacs was one of science's Renaissance men. He proposed, in 1949, the idea of towing icebergs from Antarctica to drought-plagued areas. He also developed ideas for a skyhook technique of using the earth's rotation to help lift objects into space. He made headlines several years ago when he pointed out that the American habit of driving on the right side of the road increases the number of tornadoes in the United States. Amazingly, Isaacs held no Ph.D.—only a bachelor's degree in engineering.



John Isaacs: A mind's eye beneath the waves

Roger R. Revelle, director emeritus of Scripps, said: "John Isaacs had more original scientific ideas every month than most scientists have in a lifetime. John's ideas didn't simply spring full-blown out of his subconscious, but rather out of perceptive observation of the ocean and its creatures and out of a profound, almost intuitive, knowledge of the laws of physics and chemistry. In his mind's eye he seemed to be able to see the actual motions of the ocean's waters beneath the surface and the ways fish actually behave in their struggle to survive."

Isaacs's own favorite saying was: "When I meet the Maker of the universe, I would like to be able to tell him a little of how it works."

He was sixty-seven. ∞

COMMUNICATIONS

CONTINUED FROM PAGE 10

I find it ironic that an agency that will invent different sets of terms to describe the orbit of a craft going *to* Luna as opposed to the orbit of one lifting off *from* Luna (remember 'Apolune/Perilune, Apocynthion/Pericynthion'?) cannot replace the word *manned* with *staffed*. Someday I suspect, the private sector will discover the wisdom of women in space as a matter of economics. Our smaller mass, our ability to concentrate on trivial detail, and other advantages will give us our place when private business phases out NASA. Someday.

Mary H. Watson
Austin, Tex.

What's in a Title?

Communications [June 1980] included a temper tantrum by G. Gerard Massimei, a dentist. He complains that an *Omni* cartoon referring to a dentist as *Mr.* rather than *Dr.* is an insult that demands an apology. This is laughable and illustrates something I find very distasteful.

Of all the world's professionals, only the military, politicians, higher educators, judges, clergy and doctors insist upon a title. In the military there is an obvious chain-of-command function; in law and in academe, title indicates relative authority; if little else, in politics, authority and constituency are indicated.

But in medicine, the title is clearly a self-serving device (hugely successful) to place oneself in the public mind somehow above one's fellow citizens, solely on the basis of one's chosen work. Even lawyers, another preposterously self-important lot, don't call themselves Attorney Jones or whatever.

Mr. Massimei, you are indeed a doctor, and I applaud any expertise you may have, but you are no more important to society than an engineer, a scientist, a plumber, a grocer, a policeman, or a garbage collector—Messrs. (Mmes., etc.) one and all. *Mr.* is not an insult; it is a form of polite and proper address. If your ego prevents you from seeing this simple truth, it is too bad.

Robert C. Buckley
Daly City, Calif.

Illegal Listening

Regarding the column by Dr. Bernard Dixon entitled "Listening to Life" which appeared in your February 1980 issue and which detailed some of the latest scientific efforts in attempting to communicate with our flora friends: I feel it is important that Dr. Dixon know that listening to plants is illegal—it is l'eavesdropping.

Mark Shuler
Calgary, Alta.
Canada

On Record

I was pleased and proud to place James A. Michener's article "Looking Toward Space" [May 1980] in the *Congressional Record* on May 1, 1980.

As an enthusiastic proponent of our nation's space program, I was delighted to read Mr. Michener's sensitive and eloquent arguments for a healthy and aggressive U.S. space policy. Although I am not a scientist, I believe that America will benefit from dedication to a transcendent national goal. The space program is a thoroughly positive endeavor and not a reaction to the crises and dilemmas of our earthly condition.

Howell Heflin
United States Senate
Washington, D.C.

Last Men on the Moon

The romance of the manned space program always appealed to me. I remember watching, anxiously as Neil Armstrong slowly, slowly climbed down the ladder and I felt very privileged to see such a sight. I didn't realize how privileged I was until I read your description of Senator Harrison Schmitt in Omnibus [June 1980] as one of the last men to walk on the moon. It makes me sad to think that my children may never see a man's footprint on another world.

Margaret A. Hartzell
Seattle, Wash.

I was reassured to learn that Senator Harrison Schmitt, former astronaut in *Apollo 17*, has embarked on a legislative career [Interview, June 1980].

This country needs people of genuine accomplishment in public office, and I hope Senator Schmitt will not weary of the government's snail-paced bureaucracy. We need leadership based on logic and know-how, not on public relations and media hype.

R. Nester Ellis
New York, N.Y.

Gaia Abandoned

I must suggest a small correction to the Earth column by James E. Lovelock [July 1980]. Specifically, I am referring to the Greek goddess's name that was mentioned, which is correctly spelled as Gaea, *not* Gaia, as it appeared in the article. I found it hard to believe that such an error would be overlooked when the author was doing research of such magnitude.

Ben Geer
Hollywood, Fla.

*Both forms are in fact correct. Gaia is the original Greek spelling. Gaea is a Latinate version of the same. Lovelock preferred Gaia both in his article and in his book on which the article was based (*Gaia: A New Look at Life on Earth, *Oxford University Press, 1979).* —Ed.

Correction

Because of a typographical error, the name of Nobel laureate Sir Peter Medawar was misspelled [Life, July 1980]. We apologize for this oversight. ∞

GOSSAMER GIANT

EXPLORATIONS

By Ben Mayer

Earth had lost all communication with *Voyager 1*. The media carried the story of a probe cast adrift on its journey between Jupiter and Saturn, disoriented 990 million kilometers from Earth. Any number of circumstances could have confused the on-board computers, causing *Voyager* to lose its critical lock on the guide star Canopus. The hapless craft was moving uncontrollably outward at the dizzying velocity of 8,320 kilometers per hour.

"If we bombard it with commands, it may pick up our signal and reacquire its reference stars," the technician explains. "Then the main antenna will point in our direction again." We are standing in the operations room of the **Goldstone Deep Space and Satellite Tracking Facility**, next door to the famous radio telescope for which the station is named. The immense antenna structure—a prototype for identical installations—has fielded many of the splendid Martian and Jovian scenes portrayed in television space-shot specials. Situated near Barstow in southern California, the deep-space antenna is an essential link in a network of radio telescopes that reaches from Spain to Australia.

Weeks earlier I had been invited by Tom and Eva Kuiper, husband and wife astronomers, to visit the "big dish" during one of their observing periods. By a stroke of fate, my arrival would coincide with a day of excitement, even crisis, when research might have to defer to the urgent demands of the *Voyager* mission.

As one drives the lone access road toward the facility, scale plays tricks on the eye in the endless expanse of the Mojave Desert. The first antenna to come into view was not the famed one. A sign identified it as the Venus station—one of the many smaller dishes located throughout the vast space communication complex. The name commemorates the detection of Venus by radar in 1961, when a radio signal was first bounced off the planet.

Forty-eight kilometers farther north, we came to a gently undulating range of barren hills. In the distance, dwarfed by the emptiness all around, stood the celebrated dish. A protective slope sheltered its northeastern exposure and denied the approaching visitor a sky-silhouetted contour until almost the last moment.

As nonstation personnel, we first reported to the crew supervisor, in the mission-support building. After meeting with the Kuipers briefly, we set out on a tour of the two-story complex, beginning in a long corridor flanked by impressive computer consoles. Row upon row they stood, with names as mind-boggling as their functions. There was a Maximum Likelihood Convolutional Decoder and nearby a Polarization Track Receiver. One bank of equipment was performing critical timekeeping functions with a cesium-rubidium clock. Attached to it was a large decal that read MICKEY MOUSE TIME.

Amid this phalanx of machines, however, human hardware was conspicuously absent. I wondered where the technicians were whose job it was to put the disabled craft back on course.

"The entire worldwide operation of the antenna system is remote-controlled from the Jet Propulsion Laboratory, in Pasadena," I was told. "From there the scientists oversee all the activities on their data-system terminals."

That is why so many of the instrument panels had oscilloscopes or cathode-ray tubes displaying data that were, in turn, monitored by closed-circuit TV cameras. The talented men and women who were at this moment deciding the fate of a craft one light-hour away were themselves housed three hours to the southwest.

The tour continued. We set out to investigate the antenna itself. Its base consists of a round, four-story structure, on top of which the giant saucer revolves and tilts. Walking between the mission-support complex and the pedestal structure, we passed the plant where large generators are housed to provide power for all critical space missions. Reliance on long overland power lines is too risky when manned spacecraft are being tracked. Power failures can spell tragedy.

As one approaches the monumental edifice, one's eye is drawn upward to where the white structural beams are

Goldstone's "big dish": white metal filigree interspersed with the azure blue of the desert sky

interspersed amid the azure blue of the desert sky. Like spokes in a wheel, they converge on a huge elevation bearing. Its rugged sturdiness serves as a reminder of metal-straining wind loads and the 7.25-million-kilogram burden it must carry.

The entire revolving upper part of the radio telescope is suspended on a thin blanket of oil which is kept under pressure. The central instrument tower, around which all systems turn, is hollow and extends deep into the foundations of the pedestal. A subterranean tunnel leads back to the basement of the mission-support building. Cradled along the walls are shelves upon shelves of cables. Only an hour earlier they had conveyed signals commanding *Voyager 1* to fire a tiny stabilizing jet.

By the time we returned to the facilities building, *Voyager* had already been handed on to the next antenna, a third of a world away. With the craft out of Goldstone's reach and the great dish free, the original experiment for which I was to be an observer could begin. Besides the Kuipers, the astronomical team included Professor James Gunn, the well-known cosmologist, and Dr. Gillian (Jill) Knapp, both from the California Institute of Technology. Movement of the antenna is controlled by a servo mechanism operated by an employee of the Bendix Corporation, the subcontractor charged with the operation of the facility. "They won't let us touch the controls," somebody had said.

The purpose of the investigation was to establish a connection between traces of radiation left over from the big bang of creation and very hot gases suspected in certain clusters of galaxies. Since remnants of the primordial fireball pervade our entire universe, their effect on million-degree gases elsewhere in space can be studied.

To collect the tenuous electromagnetic radiation from objects thousands of light-years away, a scan is performed. While magnetic tapes electronically record the slightest fluctuations in radiation, a visual record is also kept in real time. An electrically charged stylus traces a series of squiggles on a moving roll of graph paper. "What we are looking for today," Dr. Tom Kuiper says, pointing to the paper, "will amount to no more than an eighth of a centimeter of constant change on this graph."

It is only then that the impact of the quest strikes you full force: a 42-meter-high instrument tower supporting a 64-meter-diameter dish, a full 3,374 square meters of antenna in search of traces of electromagnetic radiation, which—if they register at all—will reveal their presence through needle-thin deflections.

Much later in the day, while the astronomical experiment was nearing completion at Goldstone, word was received via the Australian antenna that at Greenwich Time day 350, hour 20:30, *Voyager 1* had once again locked onto Canopus and that all systems were working normally. It was on course to rendezvous with the planet Saturn on November 12, 1980. ∞

GALACTIC JETS

STARS

By Gregory Benford

How could a black hole be driven out of its home galaxy? The whole idea seems bizarre. Intuition suggests, for example, that if there is a black hole at the center of our own galaxy, gobbling up stars and spewing out clouds of gas, it should stay put. After all, what is so monstrously powerful that it could push a black hole out of the gravitational "well" at the galaxy's center? One rather convincing candidate is another black hole.

Bizarre or not, a clash between black holes may be the best explanation for one of the strangest astronomical discoveries made in recent years. A barred spiral galaxy, dubbed NGC 1097, seems to show several faint "jets" that all point back toward the exact center of the galaxy. Jean Lorre, of Pasadena's Jet Propulsion Laboratory, made a computer-enhanced photo that suppresses the image of the galaxy (the mottled blob) to bring out the blue spiral arms and the jets themselves.

Two blue jets stand out clearly from the random coloring of the background sky. The shorter one spreads as it moves away from the galaxy, then expands into a luminous, roughly circular patch. The other blue jet is longer and wider and makes a sudden right-angle turn.

There are also two red jets. The more obvious is exactly opposite the first blue jet. The other lies very nearly counter to the dogleg blue jet (only 11 degrees off).

Nothing like these jets has been seen in any other galaxy. They are all remarkably straight. Careful study of NGC 1097's spiral arm structure shows that the gas is disturbed near the jets. This means the jets must pass through the disk of the galaxy. Whatever made them was orbiting in the same plane as the bulk of the galaxy.

It seems likely that a single powerful event caused both jets. If the galaxy were steadily spewing out a beam of matter, for example, we would expect to see a curved jet, bent by the galaxy's motion, just as a moving firehose makes a curved spray of water. We can use this to estimate the age of the jets. The spiral galaxy rotates one full turn every 300 million years, so the size of the disturbed areas in the spiral arms indicates how long the jet has been stirring them up. This works out to be close to 10 million years.

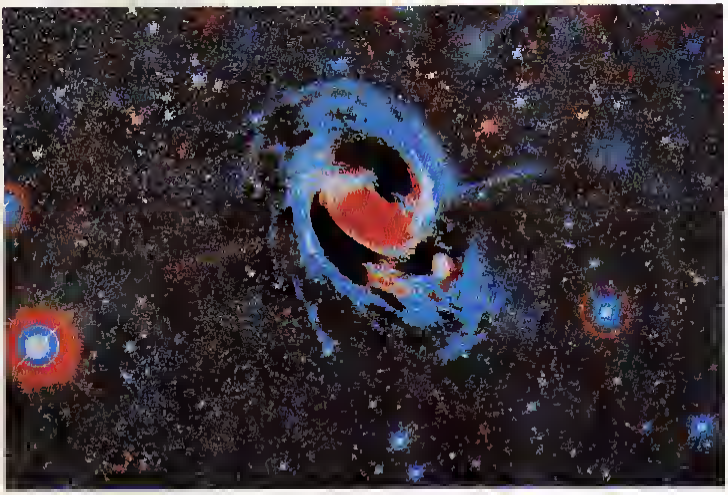
Imagine several black holes orbiting one another in a gravitational depression. Occasionally several holes undergo near-miss "collisions" and carom off one another like billiard balls. This can knock one hole out of the well entirely. In fact, calculations show that two or more holes can often be ejected in opposite directions, thus conserving angular momentum.

Some very energetic objects—perhaps black holes—were probably ejected from the galactic center at very high speed. They ionized the matter around them, swallowed some of it, and sprayed out debris. This left a straight path of luminous material, like picnickers dumping trash as they go. There are bright, diffuse patches of light near where the jets depart from the galaxy, and this suggests that the litter left behind was highly energetic.

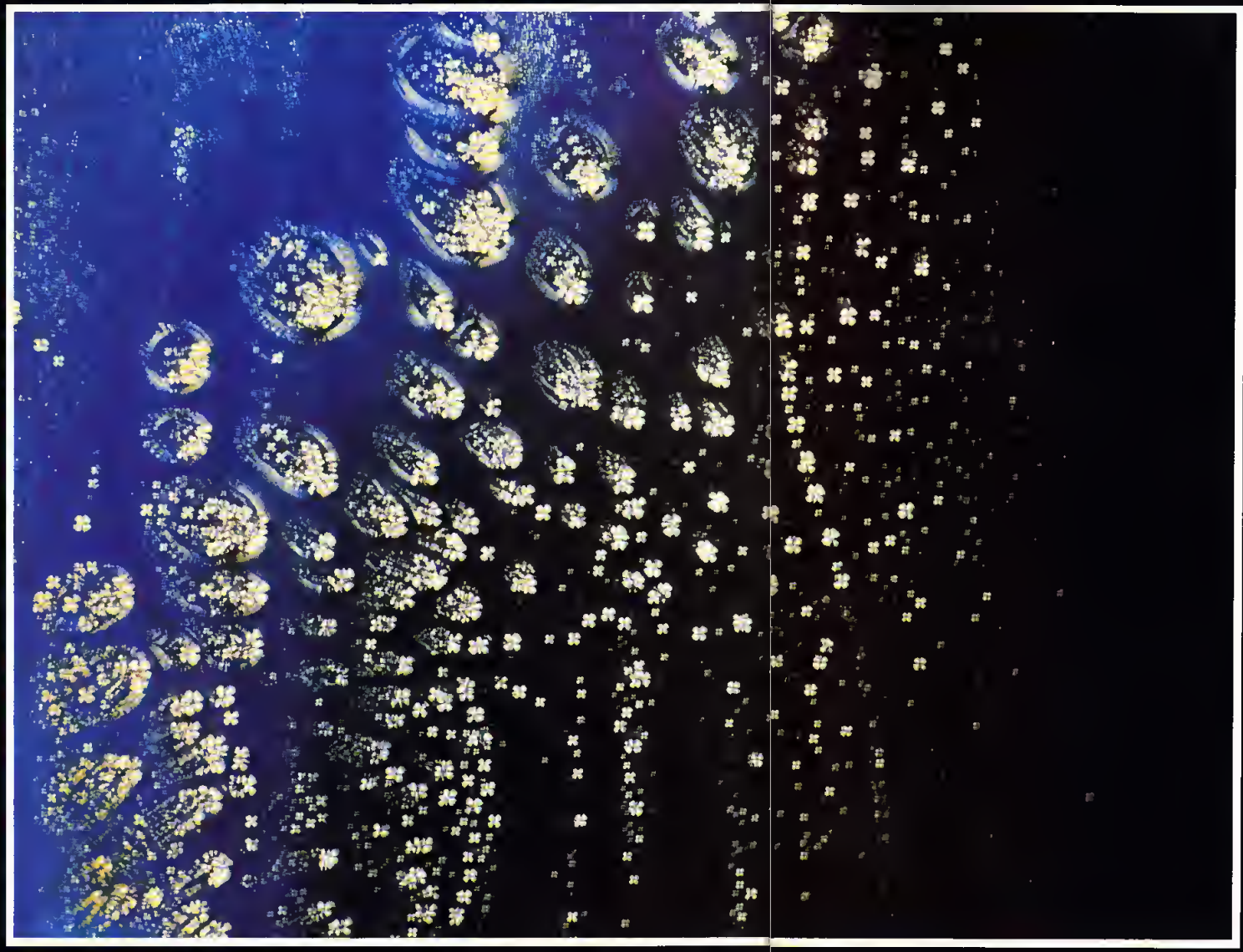
Many riddles remain. Why are the counter jets red? One explanation is that the blue jets come from more energetic black holes than the red ones do. These "holes" may in fact be groups of objects that were ejected as a body from the galaxy. Such orbiting families can be unstable, can even ricochet off each other, ejecting one of the black holes from the family.

This might also explain the astonishing right-angle turn the long blue jet makes. Perhaps at this point one large black hole was thrust to the side and several smaller holes went the opposite way. If the smaller holes were less active, we would not see them. This explanation implies that the galactic center held a swarm of black holes of varying sizes, with whole clumps being ejected. A similar breakup might have caused the round blotch where the other blue jet ends. It is very difficult to explain the right-angle turn by positing a steady flow of matter out of the galaxy.

NGC 1097 is about 60 million light-years away. So we are seeing a relatively recent event. Elliptical galaxies are usually noted for their violent activities, and spirals such as our own galaxy are thought of as pedestrian places. NGC 1097 shows that spirals are not always quiet. Their centers may resemble interstellar speedways. ∞



NGC 1097. If black holes did not create its strange jets, the truth may be even more bizarre.



PHENOMENA

Eerie orbs of liquid crystal are a midway point of matter: Not quite a liquid, not crystal, they display charactenstics of both. James Bell's photomicrograph captures the texture of these molecular anomalies. Their unique properties are being studied for uses ranging from watch crystals to temperature measurement.

The crystals shown here are cholesteric acid, a derivative of cholesterol. Structurally peculiar, cholesteric crystals form a series of molecular chains stacked upon one another like the pages of a book. Instead of lying flat, however, each layer is slightly offset from the one beneath it. This effect creates a molecular spiral that twists polarized light into the hues you see here.

Bell produced the photograph, using a light microscope built in 1915, together with a Leitz lens. A 35mm Asahiflex camera and Ektachrome 64 film completed the setup. DC

GAMES

ANSWERS TO GAMES (PAGE 129)

1 Life expectancies are greatest in Sweden—72 years for men, 77 for women. The United States, with expectancies of 68 and 75 respectively, does not even rank among the top ten nations on this measure.

2 Sponge. A black Seychelles tortoise (a species now extinct) was captured in the Seychelles Islands in 1776 and was housed in an artillery barracks on the island of Mauritius. There it lived until 1918 when, seemingly in excellent health, it fell through a gun emplacement and died—152 years after its capture. At capture, the tortoise was already an adult, making its final age at least 170, perhaps more. This is the longest documented life span of any vertebrate animal. Still, the invertebrate sponge lives much longer. Sponges have no known life-spans and, theoretically, could be immortal. A red sponge may be plucked, ground up, diluted, and forced through a handkerchief into a mist of tiny specks, clouding the water in its aquarium, but by the next day or so it will have reformed into a new sponge, shaped exactly as it was before.

3 Sperm. The Red Cross stores refrigerated blood only three weeks, after that it goes to laboratories for research. Sperm lasts much longer. Healthy, normal babies have resulted from artificial impregnations with sperm that had been stored frozen for as long as 13 years. The real storage limit is probably much higher. Bull sperm frozen as long as 25 years has produced healthy, normal calves.

4 Bat. Rats live only up to 6 years, but bats can live 20 years or longer.

5 Pekingese. It is a general rule in animals that larger species live longer than smaller ones, but this rule is reversed in dogs. A Pekingese has a potential life-span of 20 years; a fox terrier, 16 years; and a Saint Bernard, 14 years.

6 Housefly. The average life-span of houseflies runs between 20 and 30 days. There is record of an extremely sheltered fly that lived to be 70 days old. If you said the maytly lives longer, give yourself credit only if you meant to include its larval stage—in which it may live up to three years before it blossoms into full adulthood as a fly. But when the big day arrives, things happen fast. With no functional mouth or stomach, the adult mayfly has no time for eating. It has only seven or eight hours left in its life to mate, lay its eggs, and die.

7 Black hole. According to Stephen Hawking, the Cambridge University physicist, a black hole with the mass of our sun can be expected to be around for $10^{54} \times 20$ billion years, the present age of the universe. By contrast, our sun is a medium-sized star whose estimated life-span is 10 billion years. It is presently thought to be 4 billion to 5 billion years old.

8 The Venusian day is longer. It takes Venus 246 Earth days to rotate once on its axis. Jupiter, despite its massive size, is spinning like a top. It makes one complete rotation in just 0.41 Earth day—about ten Earth hours. Jupiter rotates faster than any other planet in our solar system.

9 Oak. The life-span of a red maple tree is a mere 110 years; a sugar maple rarely lives past 275 years. A white oak may live nearly twice as long. It has an expected life-span of 450 years.

10 Paper wrap. Meat kept unfrozen in the refrigerator should be loosely wrapped to allow it to "breathe." Kendig and Hutton say: Air circulation keeps the outside of the meat dry and inhibits bacterial growth. A snug plastic wrap or aluminum foil inhibits this partial surface drying, causing bacteria to multiply faster. There are some oxygen-impregnated wrapping papers that release their oxygen to the meat, increasing its life-span. Cooked meat should not be placed in the refrigerator until it has cooled to room temperature, since condensation will form inside the wrapping, spawning bacteria. Also, if the meat is still hot, it will raise the temperature of the refrigerator and everything in it, decreasing the life-span of other foods.

11 Bread. Lettuce lasts three to eight days in the refrigerator. Rinse, dry and store lettuce in a plastic bag. Head lettuce can be freshened by cutting a slice from the bottom and setting the head in cold water. Never store lettuce near pears, plums, apples, tomatoes, or avocados, for the fruits give off a gas that can cause the lettuce to develop brown spots. Bread may be kept up to five days at room temperature, two weeks in the refrigerator, and three to six months in the freezer. Thawed bread stales faster than fresh bread. Storing bread in the refrigerator may inhibit mold growth, but the cold makes bread dry out very quickly; put bread in the fridge only when hot weather demands it, and only for limited periods of time.

12 A carnation. It lasts up to two weeks. Fresh-cut roses stay fresh an average of seven to ten days. Flowers purchased from a florist last an average of two to three days less because it took that long for them to be shipped to the shop. Cut flowers kept out of water will die quickly, but if they are thoroughly watered and refrigerated just before being displayed, they will wilt more slowly. The reason: Flowers go into shock if they are accustomed to a plentiful supply of water which is then suddenly cut off. After refrigeration it takes a while before the process of degeneration catches up with the trauma of a waterless existence.

13 Pencil. A hard pencil can draw a line more than 30 miles long. The Jumbo refill for a ball-point pen may be rated up to 10,000 feet (less than two miles of writing).

14 Aluminum cans. As garbage, these containers last a long time, but not forever. Plastic bags will last 10 to 20 years; plastic jars and bottles, between 50 and 80 years. Those aluminum cans, however, won't deteriorate appreciably for nearly a century.

15 Footballs. Game balls in the National Football League have short life spans. Because the home team is required to provide 24 new balls for each game, and because 8 to 12 of these balls are actually used—and then discarded, given away or sent to the practice field—a ball could be said to last about six minutes of playing time. The life of a hockey puck is even shorter. The New York Rangers of the National Hockey League may use 40 pucks a game (an effective life-span of 1.5 minutes each). But in baseball it is not uncommon for 100 or more balls to be used in a single game.

16 Equal. Home plate in Yankee Stadium lasts just about as long as a basketball net in Madison Square Garden. Each is changed twice a year.

17 Copyrights. A U.S. patent gives an inventor exclusive rights to his invention in the United States for 17 years, a term that is not renewable. According to the revised copyright law, anything created or published after January 1, 1978, belongs to the author for the rest of his life plus 50 years after that unless he signs specific rights over to the publisher. Creations copyrighted before that date are protected for 28 years from the time of first publication with the possibility of renewal after that period for 47 years more, giving a total copyright life-span of 75 years.

18 Smokey the Bear. Oswald was twenty-four when he died in 1963. Smokey the Bear, symbol of the National Park Service, died on November 9, 1976, at age 26.

Scoring: Which Lasts Longer

Based on 17 scorable items (#16 was a ringer)

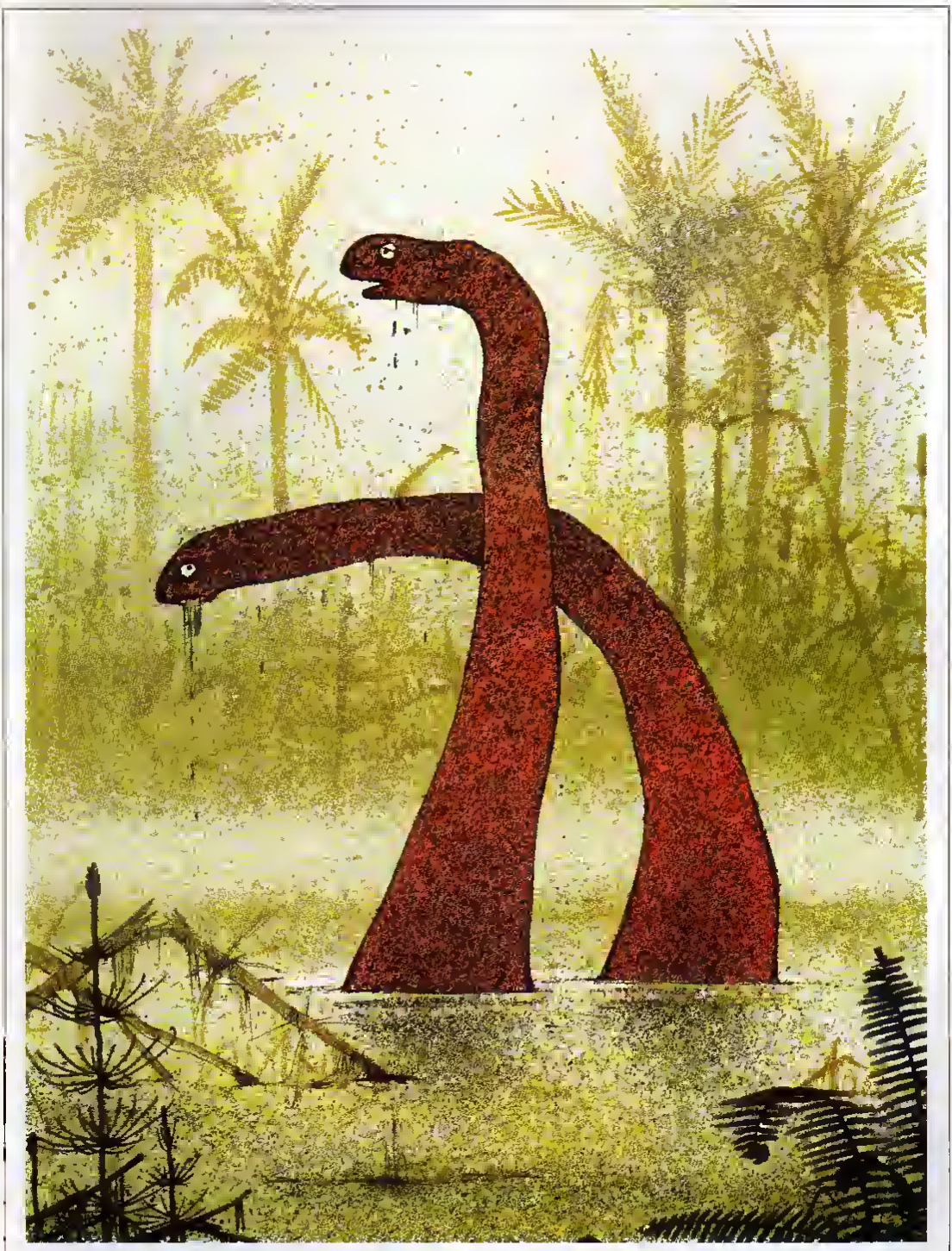
15–17 Excellent. *"Not marble, nor the gilded monuments of princes, shall outlive this powerful rhyme."*
—William Shakespeare

13–14 Very Good. *"The world's a bubble, and the life of man/Less than a span."*
—Sir Francis Bacon

10–12 Good. *"Life is an end in itself, and the only question as to whether it is worth living is whether you have enough of it."*
—Oliver Wendell Holmes, Jr.

8–9 Fair. *"Life isn't all beer and skittles."*
—Thomas Hughes, in *Tom Brown's School Days*

0–7 Poor. *"Life is short, live it up."*
—Nikita S. Khrushchev



"You know, for a minute there, I could have sworn I felt the earth's crust cooling."

A maddening toy and a new quiz It's about time

GAMES

By Scot Morris

People became infatuated with the puzzle and ludicrous tales are told of shopkeepers who neglected to open their stores Pilots are said to have wrecked their ships, engineers rush their trains past stations and business generally became demoralized

—Sam Loyd, describing the impact of his *15 Puzzle*, all the rage in 1873

ERNO RUBIK S MAGIC CUBE

A remarkable new mathematical toy has been driving people to distraction in recent months It promises to become more widespread than Instant Insanity, Master Mind, and Piet Hein s Soma Cube Perhaps even more popular than Sam Loyd's 15 Puzzle, introduced more than a century ago which is still in novelty stores today. The toy has been sold as the Magic Cube in Europe for almost two years Ideal Toys is marketing it in the United States as Rubik's Cube

If ever there was a toy that deserves a by-line, this is it Erno Rubik is a sculptor architect, and design instructor at the Academy of Design in Budapest Hungary The thirty-six-year-old professor invented his cube about five years ago

The cube (below) appears to be made up of 27 smaller subcubes When you first receive it, each of its six faces (each consisting of nine subcube faces) is a single color Enjoy this pleasing symmetry while it lasts because you may never see it again once you start to play with the puzzle It is possible to twist each of the cube s six faces around its center The illustration at right shows the top face (consisting of nine subcubes colored red on their topmost sides) beginning to rotate From the starting position it would be possible to rotate the yellow face or the green face or any of the three unseen faces (colored blue, white or orange)

After four random twists the colors are so confused (as in the illustration on next page lower left) that it is very difficult to restore the cube to its original condition If you can manage to get even one face back to a single color in 20 minutes you are doing well Then it becomes more frustrating To get a second face back to a single color every twist seems to destroy irrevocably the first face

Ideal advertises Rubik's Cube as having Over 3 billion combinations—just one solution The slogan is a considerable understatement Actually, according to British mathematician David Singmaster, the number of different color patterns is in the quintillions It is precisely 43 252 003 274 489 856,000

Solving the puzzle requires developing a strategy, or algorithm, to restore any randomized cube Several methods have been devised Two years ago a few mathematicians specializing in group theory were able to restore a cube in less than five minutes with a maximum of between 150 and 200 moves By last fall a 110-move method had been discovered, and just recently a 41-move solution was announced Since the cube can be randomized in just four or five twists it would seem there is still room for improvement in the solutions

Those who are mechanically minded may be more puzzled by the internal mechanism of the cube than by restoring its color symmetry How does the thing work? As you twist the faces in every direction each tiny subcube becomes separated from its original neighbors, and yet the cube never falls apart How can such an object be made? I don't know anyone who after examining a cube has successfully 'reinvented the mechanism that is inside All who have seen the actual workings agree it is a truly brilliant piece of three-dimensional engineering

For many months I had one cube and wondered how it worked When I got a second cube, I decided to sacrifice the first to satisfy my curiosity With a butcher knife a screwdriver and a hammer I set to work, determined to chop it in half, if necessary, to get at the innards After discovering the cube s innermost secrets I was surprised to find that my anti-intellectual solution had not destroyed it at all and I was easily able to replace all the subcubes and restore the puzzle to working order

I'll leave the reader with the exercise of deriving a hypothetical mechanism, which could be inside Rubik s Cube that would allow it to behave as it does (Hint It isn't rubber bands.) Next month we'll show you what actually is inside, and we'll tell you how a cube can be opened easily without resorting to my Cro-Magnon tactics Be forewarned If you take one of these apart and then reassemble the pieces randomly you'll have exactly a one-in-twelve chance of doing it correctly That is, in 11 tries out of 12 you will put the pieces back in in an arrangement that has a different *parity* than the original START

position, and no amount of twisting will ever restore the cube. The possibilities for cheap practical jokery are obvious.

The property called parity (from permutation mathematics) played a big part in the promotion of Sam Loyd's original 15 Puzzle. Loyd offered $1,000 to anyone who could arrange the 15 sliding squares in serial order 1–15, as shown in the illustration at far right. In the marketed version all numbers were arranged correctly except the 14 and 15 in the bottom row were reversed. Loyd's money was safe. Of the more than 20 trillion conceivable arrangements of the 15 squares, it turns out that exactly half could be achieved from his starting position. The remaining half, including the one the prize was for, have an opposite parity and are impossible. If the 14 and 15 (or any other two squares) were lifted out of the box and exchanged by hand, however, all of the ten-trillion odd arrangements that had previously been possible would now be impossible, and vice versa. Loyd's $1,000 was never claimed. Loyd was never able to patent the puzzle because a "working model" of the solution had to be filed with the Patent Office. Since the puzzle was impossible, Loyd had no prototype.

Rubik holds a patent on his cube and is paid, through his Hungarian manufacturers, for every cube sold to Ideal. His cube may have as long a life as Loyd's 15 Puzzle. Those "ludicrous tales" of people being driven to insanity are beginning to come in. Business hasn't become "demoralized" as yet, but there are reports of cubists missing their subway stops and neglecting appointments, classes and jobs. We await the first divorce suit in which Rubik is named as corespondent.

For an exhaustive mathematical treatise, "Notes on the Magic Cube," send $3 to David Singmaster, Polytechnic of the South Bank, London, SE1 0AA, England.

THE WHICH-LASTS-LONGER QUIZ

"The depressing thing is that this loudmouth bird is going to outlive me."
— Owner of a white-naped South American parrot

What's the longest human life-span? There are frequent news stories about a one-hundred-thirty-year-old still as spry as a ninety-year-old, but most such claims cannot be substantiated by birth records. The record for the longest documented human life-span is currently held by Shigechiyo Izumi, who was still living in Japan at press time and who turned one hundred fifteen on June 29.

Questions about how long people and animals live are often answered by wild guesses based on unreliable data and a dash of folklore. Finally, there is a book that sets the record straight on the longevity of everything—from tortoises to hockey pucks, from black holes to bologna to dreams. Frank Kendig, former executive editor of *Omni*, and Richard Hutton, a free-lance writer, have published a compilation of answers in *Life spans—Or How Long Things Last* (Holt, Rinehart and Winston, Copyright 1980 by Frank Kendig and Richard Hutton).

This quiz is based on the book. For each pair of items, underline the one that lasts longer. Answering and scoring, page 126.

1. Human life-spans in Sweden or in the United States?
2. A tortoise or a sponge?

3. Human blood or human sperm (in preservation out of the body)?
4. A bat or a rat?
5. A Pekingese or a Saint Bernard?
6. A housefly or a maytly?
7. A black hole or our sun?
8. A day on Venus or a day on Jupiter?
9. A maple tree or an oak tree?
10. Beefsteak wrapped snugly in foil (or plastic) or beefsteak wrapped loosely in paper?
11. Lettuce or bread?
12. A rose or a carnation?
13. A pencil or a ball-point pen? (Which can write the longest line?)
14. Aluminum cans or plastic bottles (time to deteriorate as garbage)?
15. A hockey puck or a football (consider their effective life-spans in professional sports)?
16. Home plate in Yankee Stadium or a basketball net in Madison Square Garden?
17. A patent or a copyright?
18. Lee Harvey Oswald or the original Smokey the Bear?

Answers on page 126

LAST WORD

By David E H Jones

'Here is an excellent example of how not to say something in an important journal'

Scientific knowledge depends crucially on clear, effective communication. Here is 'Fifty Centuries of Right-Handedness: The Historical Record', a research report written in a normal scientific manner by Stanley Coren and Clare Porac, published in *Science*, 198, 631 (1977), and — in italic type — a translation into clear, effective English by David E H Jones.

Original: It is common knowledge that contemporary man prefers to use his right hand when performing unimanual tasks; however, little evidence exists as to whether this has always been so.

Translation: Most people nowadays are right-handed.

To embark on such an investigation is theoretically important because it could possibly elucidate the adequacy of competing explanations of the etiology of hand preference.

If we knew whether this has always been so, it would help us to understand why.

Basically, there are two types of theories that attempt to explain the development of handedness in man. The first maintains that there are physiological predispositions, probably heritable in nature, which lead to the favoring of one hand over the other.

One theory is that handedness is innate and probably inherited.

This position is supported by reports of familial similarities in handedness patterns.

This is supported by its tendency to run in families.

The second type of theory suggests that social or environmental pressures (or both) lead to the high incidence of dextrality in man. This position is supported by human and animal work that has attempted to alter limb preferences through behavioral manipulations.

Another theory, supported by experiments in which people and animals have been coerced into changing their handedness, is that it arises from social or environmental pressures.

The social pressure position is summarized by Wile, who stated, 'There arose not so much a decline in the hereditary presence of left-handedness but rather a suppression of it under the demand for adaptation to changing principles of social organization, preservation and advancement.'

Wile supposes that inherited left-handedness was suppressed by the forces of social conformity.

Given these different viewpoints, one might be led to different predictions about the distribution of handedness if it were measured at different points along the historical continuum. The social pressure theory would predict an increase in the percentage of human dextrality with the development of more formalized societies with more complex patterns of tool use.

Thus, one might expect right-handedness to have increased over the centuries with the standardization of manual techniques.

In contrast, the physiological theory, which views handedness as being independent of these influences, should presume a relatively constant distribution of manual preference regardless of historical period measured.

But if it is innate and inherited, the proportions of right- and left-handers should have been constant throughout history.

Unfortunately, these predictions are difficult to test since written references to the distribution of lateral preferences are rare.

Unhappily, written historical references to handedness are rare.

Perhaps the earliest quantitative account of handedness appears in the Bible, Judges 20: 15-16, where 700 left-handed or ambidextrous men were counted against 26 000 right-handed individuals. Thus, this biblical population was 97 percent dextral.

The earliest account seems to be in the Bible (Judges 20: 15-16) where 700 left-handed or ambidextrous men were found among 26,000 right handers. Thus, this biblical population was 97 percent right-handed.

However, unhappily, such written reports are too rare to be useful in systematic investigations of the history of handedness.

Such direct reports are too rare to provide much useful evidence.

There are, however, other archival sources which can be used to assess historical trends in the distribution of manual preference. Nearly all cultures have art forms that depict human beings engaged in various activities.

More common are works of art showing people using their hands.

To the extent that such artistic efforts are an attempt to describe reality, one might expect that such drawings and paintings would mimic the distribution of hand use which the artist actually observed. If so, then manifestations of lateral preference in works of art could serve as a record of the handedness within the culture which produced them.

If the artists were trying to be realistic, their works should reveal to us the pattern of handedness in their society.

Although this has been suggested before, no systematic studies of handedness over the broad range of eras and cultures using this data base have as yet been attempted.

This idea has been suggested before but has not hitherto been used to study handedness over many eras and cultures. ∞

(Dr Jones is available to undertake further translations of this type, but does not guarantee the compression ratio of 2:2:1 obtained in this excerpt.)