OMNI

COLLECTOR'S EDITION

FICTION:
ISAAC ASIMOV
THEODORE STURGEON
RON GOULART
JAMES B. HALL

EXCLUSIVE:
OMNI INTERVIEW WITH
FREEMAN DYSON

U.F.O. UPDATE:
THE SCIENCE CONFLICT

AGING:
SOME OF US MAY NEVER DIE

MICROWORLDS:
A ROMAN VISHNIAC PORTFOLIO

OMNI
October 1978

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Cover photo by © Pete Turner

This month's cover photo "Road Song," by Pete Turner, was shot at dusk along a deserted road. "A photographer's work is given shape by his personal vision," says Turner. "I have always been an avid science fiction reader and this comes through in my work."

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BOB GUCCIONE

"There is a universal architecture of infinite elegance and logic from which all things animate and inanimate seem to derive."

It was OMNI that I summoned up from the frost-cool morning of my youth. OMNI born in the breathless dreams of that long-ago child. It was much smaller then — a toy — the size of a matchbox, a flat, thumb-polished, silvery case bursting with exotic wires and tubes. When I held it to my forehead, I could see the future.

Time may have transformed my OMNI, but its properties remain the same. Its magic has become the alchemy of logic, the geometric progression of knowledge, science and ... ogy. OMNI will continue to see the future — a future of growing intellectual vitality, of expanding dreams and infinite hope.

"The human mind," Albert Einstein once said, "is not capable of grasping the universe. We are like a little child," he continued, "entering a huge library. The walls are covered to the ceiling with books in many different tongues. The child knows that someone must ... ten these books. It does not know who or how. It does not understand the ... guages in which they are written. But the child notes a definite plan ... the arrangement of the books—a mysterious order which it does not comprehend, but ... dimly suspects."

Like Einstein's hapless child of ... ity, I too am acutely aware ... identify the Promethean nature ... of these works. Their languages evade me, and I have little understanding ... their internal order. But I am fascinated to behold them if only to speculate ... content, knowing that, collectively, they explain the mysterious forces that shape our destiny.

There is a universal architecture of ... nite elegance and logic from ... all things animate and inanimate seem ... derive. There is continuity ... the ... of time and space ... a harmony ... lect and invention between ... and matter ... the world perceived ... the world per se.

All my life I have been fascinated ... the sublime structure of Einstein's ... and the variety and magnitude of its mysteries. I perceive a single key, however elusive, to its innumerable but interrelated disciplines—one key, a unique master file in which each book is ... roughly identified, explained, and related to the whole. And one day (... ral optimism tells me) that key ... be found. It already exists, in part ... scientific and philosophical probe ... undertaken. It exists in every work ... in every note of music, in the ... frightened bird, or in the odor of love.

My calling was art—the science of subjective vision. I was determined to reconstruct the world around me—to divine new disciplines ... new relationships. My interest in the natural world, therefore, was singularly without limitation. Unlike most, I found art and science to be compatible. We appear to pursue the same goals—the absolute knowledge of our own special sense of reality, the objective reality of the scientist and the subjective reality of the artist.

OMNI, then, is my compromise—my way of bridging both levels of interest and ... Like many of the more progressive ideas in our industry, OMNI evolved ... if not uneventfully, over a period of several years. I have created a few magazines in my time—conceptualizing and designing every aspect of each of them myself, but OMNI was different. It was a creation of pure joy—as if I were fulfilling ... the ... half of that boyhood dream.

The idea of a science-related publication was not in itself new: science fiction was ... a questionable art form struggling for status and recognition, and such matters as UFOs, ESP, and parapsychology ... received copious if not sensationalized coverage elsewhere in the media ... these ostensibly incompatible elements, however, had something crucial ... Each represented (and con... ... an ever-changing, sometimes ... but always compelling frontier ... and philosophical inquiry ... the editorial premise of ... original if not controversial ... science fact, fiction, fantasy, ... paranormal.

... unknown had become the subject of ... public interest. Institutional ... its implacable dogma ... to satisfy our spiritual ... every-day successes in science ... technology began to expand our ... the unknown faster than the ... rationalize. We rose from an ... position of simple, unquestioning faith to one of acute cultural ... and knowledge ... OMNI in the shadow of this ... storm—this inevitable and ... between science and religion, between knowledge and faith. Man ... one discipline without taking another's place. The frontiers of human knowledge and experience are forever ... forever expanding, and we are ... at the very dawn of ... make our common peace with ... if we are to survive the next ... years. ▯▯

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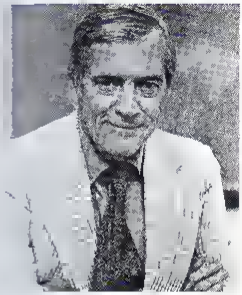
Photograph By Philippe Halsman

VISHNIAC

STUCKEY

ASIMOV



BLAKESLEE

When we called contributing editor *Bill Stuckey,* a Dallas Texonian who writes about science like Tom Wolff writes about culture, and asked if he'd like to do a story for us on the Nobel Prize, he said, "Now *that's* what I call good editorial direction!"

Such enthusiasm from Bill is as rare as mesquite-broiled porterhouse, so we knew we'd made the right decision.

"Texas is giving California a run for the best brains in the country," said Stuckey. "The cowboys are dark horses this year, but they may just walk away from that December ceremony in Oslo with a fistful of prizes . . . and cash. I feel very close to the action down here."

As well he should. Stuckey has been on the Nobel trail for years now, a pet project that burgeoned into hundreds of interviews with Laureates, Prize judges, and other insiders who gave him access to the mercurial, secret world of Nobel.

The Prize, of course, is well, *the* prize. Scientists can be annoyingly blasé about it, yet those persons adjudged Prize material get a kind of global *imprimatur* for their work. For astonishing predictions of who will win what, plus rare glimpses of the Nobel selection process, see page 84.

Turning from thoughts of this world to those of distant galaxies, we asked *Alton Blakeslee,* science writer and editor for the Associated Press from 1946 until his recent retirement, to tell us of astronomers' efforts to pick up intelligent signals from outer space. The result was "Listening for Life," page 62, a compelling report on the "electronic ears" that may eventually determine if we are alone in the universe.

Researching another story, we came across a color photo that so dramatically captured the lenticular effect of insect sight, we decided to contact the photographer right away. He turned out to be *Roman Vishniac,* who, at 81, is the established dean of photomicrography. Some days later we were treated to an exclusive showing of Vishniac's vast portfolio of photomicrography—dazzling images awash with every conceivable color, depicting fascinating processes of life that occur far below human perception. The Vishniac gallery on page 72 seemed a logical extension of our close encounter with genius.

Thomas Hoover's "Zen, Technology, and the Split Brain" (page 122) examines the curious behavioral phenomenon known as "computerthink," a syndrome that encourages human problem-solvers to mimic those computers with which we surround ourselves. Dr. Hoover is the author of *Zen Culture* (Random House, 1977).

One antidote to "computerthink," it seems, may be soon available in pill form, according to medical writer *Gene Bylinsky.* In "Future Drugs" (page 132), he suggests new ways to stimulate creativity through artificial means, the fruition of sophisticated pharmaceutical research that has its roots in the psychedelic 60s.

Omni is not only a magazine of science. It is also a magazine of science fiction. In this issue we present original stories by two of the genre's established masters, *Theodore Sturgeon* and *Isaac Asimov.* Sturgeon's "Time Warp" is a tale reminiscent of *Star Wars* complete with brave heroes and terrifying villains caught in a battle to save the Earth. After the story appears in *Omni* Sturgeon plans to produce a record album of "Time Warp" as well as a touring multimedia show. "Found!" (page 118) is vintage Asimov, a gripping story of mechanical madness in orbit.

On the more humorous side is "Invisible Stripes" (page 68), a sometimes hilarious, sometimes frightening offering by *Ron Goulart,* co-creator of *Star Hawks,* the most intelligent syndicated comic strip this side of "Doonesbury." And rounding out *Omni's* fiction package is "Valley of the Kilns" (page 58), by *James B. Hall.* Hall, while a much published novelist, short story writer, poet, and critic, is a newcomer to science fiction. He has recently stepped down as provost of College-5 at the University of California/Santa Cruz to devote more time to writing, a move we hope will make him a frequent contibutor to *Omni.*

Also in this issue—*Dr. Bernard Dixon,* distinguished editor of the British weekly *New Scientist* who, doubling as European editor of *Omni,* will regularly write our *Life* column, NASA scientist *James Oberg* with his *UFO Update, Mark R. Chartrand III* who takes time from his duties as director of New York's Hayden Planetarium to write our *Space* column and *Kenneth* and *David Brower,* the celebrated environmentalists who will report in *Earth.*

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OCTOBER

LETTERS

COMMUNICATIONS

Future Shock
This is the magazine I've been waiting for! Could you please run articles immediately on the future of: language, special effects in movies, cities, mass transportation, private air transportation, computer art, subliminal advertising, sex, sports, fashion, crime, animal behavior, parapsychology, underwater housing, racism, cosmetics, democracy, zero-gee weight reduction, gold, faster-than-light postal systems, pastries, childbirth, guitars, cats, sculpting materials, tropical diseases, tv commercials, and other forward-looking stones.

Jerry Edelman
Gretna, LA

Before the Flood
I realize that you have quite probably been the victims of a deluge of manuscripts since the announcement of Penthouse International's new venture into the science fiction field. However, there is not a merciful bone in my body. I add yet one more large manila envelope to the pile already threatening your sanity and disturbing your sleep.

Allen Curry
Cincinnati, OH

Do It Again
Great neutrinos, you've done it again! Just when all we Nobel Prize people were about to become vacuum cleaner salesmen, you bring us new hope with *Omni*. It's an exciting project, and I predict we'll work together even more harmoniously than we did on *Saturday Review* and *Science Digest*. As requested, I'm enclosing a mishmash of currently available Stuckey.

William K. Stuckey
Dallas, TX

Miniature UFOs
I would like to share my UFO experiences with some organization that will not laugh at me. For the last ten years I have seen landing on the rooftops of New York City skyscrapers infinitely delicate flying objects. I can't call them airplanes, and although they can land and take off vertically like helicopters, they have totally unique shapes. Sometimes the shapes cover the whole range of the geometric alphabet. And although the detailing on the "skin" is quite intricate, the actual size of the objects is generally small, about big enough to fit in an elevator shaft. They often have bright colors.

On the few buildings that have given me access to rooftops I found evidence of small triangular imprints. I have photographs. Would *Omni* be interested in printing them?

Melinda Moore
New York, NY

Congratulations: Birth of a Star
It was a pleasure learning about your new publication. *Omni* sounds as if it will become a long-lived phenomenon.

Richard Golob, Director
The Center for Short-Lived Phenomena
Cambridge, MA

I am looking forward to seeing the first copy of *Omni* out on the stands in October. Good luck with it.

Lyall Watson
Oxford, England

Our sincere hopes for success with *Omni*. A magazine of this scope and caliber is absolutely needed. If we can be of any assistance with regard to articles on solar energy, I hope your investigators will not hesitate to call on us.

J. Michael Levesque
Vulcan Solar Industries
Pawtucket, RI

Future Zoo
We would be pleased to cooperate with your company and are delighted to hear that the Metropolitan Toronto Zoo would be a model for the zoo of the future.

T.W. Thompson
General Director
Metropolitan Toronto Zoo

Sunburn Survey
We would like to locate individuals with very efficient molecular repair processes who are, as a result, highly resistant to sunlight, cancer, and aging processes. If you know of anyone who has (or had) a

very white skin color, never gets a suntan, and never gets sunburned regardless of how long he or she is exposed, please send us a brief note There will be no obligation All information will be confidential Please contact Sunburn Survey, Department of Chemistry Brooklyn College, Brooklyn, NY 11210.

Rolf Martin
Brooklyn, NY

S O S for Whales
I am writing to you today to ask for your immediate help in saving the whales from certain extinction It is within the power of such an influential new magazine like *Omni* to convince the world that the needless slaughter of the highly intelligent, warm-blooded beings is not only unnecessary but criminal

Cynthia Webern
Atlanta, GA

Copernicus Update
I am still overseas so I won't see the dummy for the new magazine until I return I look forward to seeing both the dummy and eventually the journal itself and would certainly consider writing something on Copernicus or Tycho at a later date

Owen Gingerich
Harvard College Observatory
Cambridge, MA

Bridging the Culture Gap
Omni is a most ambitious project, and I offer my warmest wishes for its success Such a magazine would make a huge contribution to American culture at one of the weakest points in its fabric—the "two culture" gap

Lawrence S Lerner
Professor of Physics and Astronomy
California State University
Long Beach, CA

Humble Dowser
Because of the nature of your new magazine I thought you might be interested in the subject of dowsing (otherwise referred to as water witchin divining etc) for some future issue The 1911 *Encyclopaedia Britannica* states that "the best dowsers are usually more or less illiterate men engaged in humble professions " And as a semiretired ad man, I think I qualify

Ted Kaufman
North River NY

Cosmic Line
I am an excellent photographer and a very good writer I'll be glad to present a few of my works and speak with you about ideas for a regular column in your new *Omni* For example, it would be interesting to launch a completely new fashion style "The Cosmic Line," which I shall be happy to prepare with the help of a French designer The new fashion line—if it is not simply a "masquerade line"—could do a great miraculous advertising job for *Omni*, because it would present you as an unending precursor of the NEW!

Alina Katathinna
New York, NY

Astral Preparations
My out-of-body experiences during the past 30 years have given me an endless source of ideas for science fiction with logical glimpses into the furture

Martha Fotinos
Napa, CA

Elementary Particles
I am writing to introduce myself as a possible contributor to *Omni*. I am a physicist by profession but have been doing a fair amount of science writing during the past few years For openers, let me sketch out a few ideas that might be interesting to *Omni*'s readers "What s New in Elementary Particles," "Is Anyone Listening Out There?" "Breaking the Light Barrier " and others

James Trefil
Charlottesville VA

SF Query
Attached is "Feed Me Flesh,' about a boy's struggle in a meatless society Thanks for giving us another market for our stuff and another SF magazine to read

Jay A Parry
Salt Lake City, UT

Soul Mates
I futzed around, indecisive about the proper market and deep into my third novel—until I saw the market notice for *Omni* and decided that [my] story and the magazine were perfect for each other

John Shirley
Portland, OR

Innovations
Omni sounds extremely interesting and I look forward to seeing the magazine's appearance this fall I will probably have contributions to make from time to time What I m thinking of is not conventional history of science, which is mainly concerned with the evolution and development of concepts and knowledge, but of innovation as such which has a special interest of its own and without which development would not occur Meanwhile all my best wishes

Stillman Drake
University of Toronto
Toronto, Canada

In Crowd
I'd like to be part of the magazine but let's face it who wouldn't?

Jefferson Scherr
Brooklyn, NY

Now that you have acquired the "power" my son, you must swear to me by the sacred sword of Jovan, that you will use the power only for good... never for evil.

Jovan Sex Appeal Aftershave/Cologne for Men.

At [illegible] stores everywhere.
[illegible] N. Michigan Ave., Chicago, [illegible]

MIRACLE EARTH

By Kenneth and David Brower

The harsh, demystifying light of science has left the modern biologist with one last miracle, a miracle of organization. Somehow, back in the planet's youth, molecules organized themselves into a structure that could reproduce itself. Dust quickened, and into an inanimate world came animation. All the rest has followed: the flight of the pelican, the fragrance of a baby's skin, the songs of wolf and whale. These latter developments are relatively recent, and we know in a general way how they came about. We can roughly trace their evolution backward. They are miracles several times removed.

But the original quickening was an entirely new principle. It was something like an idea . . . a beneficence. It was a miracle. That it happened here, on earth, is more than one small planet could ever hope for.

One of the wonders of the new principle is, having come into being it endured. There are potent forces of disorganization loose in the universe. Order is the exception here, increasing disorder is the rule. When a bullet strikes a rock—and time and the universe are full of this kind of violence—the energy of the bullet's motion is translated into random motions of the bullet's atoms and the atoms of the rock. The bullet and rock become hot. Heat is the scribbly signature of disordered energy. The event is irreversible. Disordered energy can't reassemble itself into the orderly kinetic energy of the moving bullet and fly backward down the barrel of the gun. It's a one-way street, an incline down which order slides. That's how the cosmic cookie crumbles.

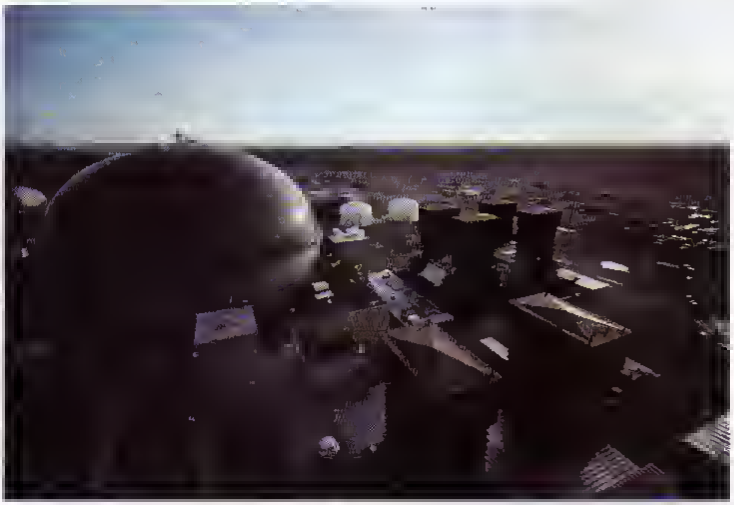
The beta particle—a high-speed electron emitted from the nucleus of a radioactive atom—is a bullet in the cosmic arsenal. When the particle strikes living tissue, it disorders the tissue. It rips negatively charged electrons from the tissue's atoms, leaving positively charged ions in its wake. (Alpha, gamma, and x-rays all have the same effect.) The liberated electrons in turn ionize other atoms until all the energy of the original particle is dissipated. Many beta particles travel at nearly the speed of light and strike with enough energy to break 100,000 of the chemical bonds joining atoms. The particle is a dumdum bullet, though enormously faster. Its entry hole is modest, its exit hole spectacular.

Living cells have an internal order that we recognize, through our electron microscopes, as architecture. They have a serendipitous beauty that the eye has only recently discovered. The radioactive particle mars the beauty. It tumbles the pillars and pediments of the unexpected architecture, and its passage leaves the city of the cell in ruins.

A cell can be so badly injured that it dies, or that its ability to divide into daughter cells is destroyed. But worse things happen. A cell that is injured less severely, in continuing to reproduce, can pass on the damage to its daughters. There occurs within animal cells a particular kind of radiation damage, a characteristic imbalance of chromosomes, that when multiplied by cell division grows into a leukemia or cancer. A single high-speed particle can disorder the chromosomes in this particular way. From this tiny event, a man or a mouse can die.

Life is adrift in a sea of radiation, as the makers of the artificial kind are apt to point out. The sea is full of eddies and countercurrents. Radiation seeps up from springs on earth and flows in rivers from space. The sun sends out a steady stream of particles freshened occasionally by solar storms. Yet on earth, life has found something like a backwater. Here life is protected from the full force of the cosmic stream by the planet's atmosphere; here life tolerates the weaker radiations from the planetary crust. Life on this planet has even made a sort of bargain with the disorganizing principle of the radioactive stream, tapping its mad energy for the occasional beneficial mutation that makes evolution possible, and suffering the bad mutations.

But the margin within which life operates is small, and the tolerances are fine. There is no question who the enemy is, our first and oldest. If the universe is hostile to life there is no better expression of that hostility than the radioactive particle. The Four



David Barnes, Photo Researchers, INC.

Test breeder reactor in Richland, Washington: key component for a Plutonium Economy

Horsemen are secondary enemies, at a less basic level of organization. The particle attacks us fundamentally by disordering the atoms of which we are made. It strikes at and scatters the miraculous principle that distinguishes us from dust.

Nearly 2000 genetically-determined human defects now have been mapped, and scientists agree that these are only a fraction of the total. Growing speculation suggests that most or all disease may have a genetic basis. There is further speculation that radiation, natural or otherwise, may be a primary cause of aging. If these speculations are correct, then the small particle takes on the largest significance. If they are correct, we move about like colossi under a submicroscopic bombardment that with time will bring us down. We scarcely feel the attack in our youth, usually, but we groan under it in our old age, and finally it topples us. Each of us in his own lifetime fights and loses life's war with disorder. There is no way to dodge an invisible particle traveling hundreds of millions of miles per hour. We sit and take it. Our bodies are composed mostly of wide open spaces, and some particles pass through without hitting anything, but others score, and with time enough they do the job. Disorder wins out in the end.

Advocates of the Atomic Age would have us tame the particle, slow it down, embrace it. It would light our streets and drive our flywheels; its three-rayed symbol would emblazon man's gray tunic of the future. Nuclear advocates would have us escalate our mining of radioactive metals, refine those metals into the most virulent of known poisons, and send that poison abroad on the surface of the planet. They would ring in a Plutonium Economy—in which hundreds of tons of plutonium travels from reactor to reprocessing plant and back again—safe, they guarantee from terrorists, psychotics, Mafia hijackers, sabotage, administrative incompetence, drunk drivers, floods, earthquakes and other acts of God.

Other proponents would escalate our export of reactors to the rest of the world, assuring us that plutonium from those reactors won't be diverted for bombs. We will solve the problem of thermal pollution, they say. The problem of disposal of nuclear wastes will be solved sometime in the future. We will successfully guard those wastes for all the tens of thousands of years they have to be isolated from the environment. We will not be haunted by groundwater leaks in our salt-mine repositories or ruptured casks in our deep-water dump sites.

But we *are* haunted by these leaks and ruptures—and we will continue to be, human fallibility being what it is. Minor world powers will explode their bombs made from reactor plutonium, just as India has, and with each new addition to the nuclear club we will subtract from our chances of avoiding the Final War. These things will follow, at any rate, if nuclear advocates continue their success in bending government's ear.

In his campaign and early days in office, President Carter made a strong commitment to new energy policy. He promised to minimize this nation's dependence on the atom, to strengthen nuclear safety standards, to cancel the Clinch River Breeder Reactor and shift research away from plutonium breeders, to take a strong stand against nuclear-arms proliferation, to give energy conservation and solar power top priorities, and to provide personally the leadership all these tasks require. The promised leadership has fallen to Energy Secretary James R. Schlesinger, former director of the Atomic Energy Commission

Bruce Roberts Photo Researchers, INC

Beta particles cause blue glow in pool reactor

and the Central Intelligence Agency.

Mr. Schlesinger has executed an about-face and is leading the country back to the old, radioactive Nixon and Ford energy policies which he helped formulate, and which President Carter has promised to end. For the canceled Clinch River reactor Schlesinger would substitute a new plutonium breeder two or three times larger. Instead of the promised strengthening of safety standards, the Secretary has sent Congress a nuclear-licensing bill that proposes not a single new provision to strengthen reactor safety and diminishes public participation in the licensing process. Instead of the promised redirection of our research energies to solar power, he has allotted nuclear power the lion's share of funds, leaving solar research with just 3 percent of his department's budget. Under President Carter, the State Department, instead of opposing nuclear proliferation as promised, has pushed for the sale of nuclear fuel to India, despite that nation's refusal to accept international safeguard requirements, and despite its detonation of a homemade nuclear bomb.

If the world is to step back from the nuclear brink, the United States, which led the way there, must lead the way back. Its President must reassert leadership.

The radioactive particle is too dangerous and implacable for fallible humans to fool with.

"Despite the best efforts and intentions of the people of the United Nations," said Jacques Yves Cousteau, addressing the U.N. in 1976, "human society is too diverse, national passion too strong, human aggressiveness too deep-seated for the peaceful and the warlike atom to stay divorced for long. We cannot embrace one while abhorring the other; we must learn, if we want to live at all, to live without both."

The strange thing is, we all know that and we always have. From time out of mind, our mythology has prepared us. The tales of Prometheus and Pandora, and of Faust, and the notion of *hubris* in Greek tragedy, are as apt now as when invented. More apt. How, in the Ages of Bronze or Iron, could those lessons have been so pertectly applicable, and so desperately important? It is almost as if the old storytellers had blinked, millenia in advance, at the white thermonuclear flash, and had begun preparing their admonitions.

Pandora opened her box, of course, and Prometheus stole the fire. Perhaps these things are inevitable, given the nature of man and matter.

It may be that any call to order in this disorderly universe is hopelessly quixotic. It may be that a nuclear advocate like Dr. Edward Teller, the putative father of the H-bomb, is, with his instinct for the cataclysmic, more truly in tune with the cosmos than men like George Wald and Linus Pauling. The big nuclear bangs with which Dr. Teller wishes to excavate harbors and canals have an impressive precedent—*the* precedent, if modern cosmologists are right. Things are done Dr. Teller's way in the universe—galaxies begin explosively.

Perhaps in all organization, in all organisms, there is a tension that longs for release. Time was in Creation when all entities banged around as happily as billiard balls. Perhaps a nostalgia for those days explains the moth-flame fascination that radium has held since it drew Madame Curie and killed her. Perhaps it explains the desperate brinksmanship of men like Mr. Schlesinger, who is doubtless a cautious fellow in smaller matters, like selecting the proper tie.

Then again, maybe human life will beat the odds and hang around for a while. Maybe our will to survive will outbalance our nostalgia for the void, and mankind will dodge through the gauntlet that lies ahead.

It will take a miracle, but miracles have happened before. ∞

COMET CHASING

SPACE

By Mark R Chartrand III

In July of 1985 NASA plans to launch a unique spacecraft Driven by a new solar-powered ion engine the spacecraft is scheduled to fly by Halley s Comet and then play tag with a second comet Tempel 2 If the mission flies we will get our first close-up view of these cosmic vagabonds and, in a few months discover more about comets than has been learned since the dawn of astronomy

In ages past a comet was believed to be a finger of a god pointing to earth bringing disaster to those below (dis-aster means bad star) Today we believe comets to be remnants of the redundant formation of the solar system some five billion years ago—primordial material stored in a leaky time capsule

Comets travel in orbits that are more elliptical (less circular) than planets, spending much of their time far from the sun The nucleus, or central part, of the comet was perhaps best described by Dr Fred Whipple, who called them "dirty snowballs " They are thought to be loose mixtures of water ice frozen methane ammonia carbon dioxide and other gases with bits of cosmic dust sand and rock stirred in Since comets have not been observed from closer than a few million kilometers astronomers don't know the exact size of the cometary nucleus but it is thought to be around ten kilometers across and probably lumpy

Surrounding the nucleus of the comet is a ball of gas and dust called the coma The nucleus and coma together make up the head of the comet which may be 20 000 to 200,000 kilometers across As the comet approaches the sun solar heat turns the outer layers of the frozen nucleus into vapor, liberating more dust and causing the coma to swell With each passage near the sun the comet loses some of its material until eventually it falls apart

All-pervading too, when a comet approaches the sun are the solar wind—a supersonic breeze of atomic particles blowing from the sun—and the pressure of sunlight, which retard the gas and dust from the coma with a force 50 times that of the local gravity of the sun This gas and dust lag behind and form the comet's tail a few cupfuls of diffuse material stretched out into a multimillion-kilometer streamer

Someone once described a comet s tail as something as close to nothing as anything can be and still be something The gas and dust in the tail are so dispersed that even the description "diaphanous' is extreme Stars can be seen undimmed through the tail In fact, our planet passed through the tail of Halley s Comet in 1910 with no ill effects Despite predictions of the end of the world the thin atmosphere of the earth was all the protection needed

Comet's tails always point almost exactly away from the sun because of the outward-streaming solar wind and light When the comet is inbound the tail is indeed trailing but when the comet is past its closest approach to the sun the tail actually leads the way The gas and dust may form separate tails, and the curvature of the tails of some comets gave the first clue that there was such a thing as the solar wind

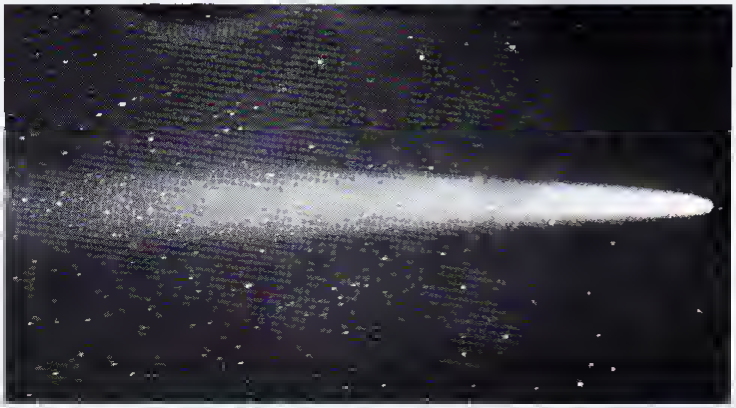
The Mission

NASA's plan is to launch the mission in July of 1985 A space shuttle will carry the craft into earth orbit, and then a dual-engine Inertial Upper Stage booster will propel the 1600-kilogram probe into an interplanetary orbit The solid fuel boosters will then drop off, and a solar-powered ion engine will take over the three-year three-billion-kilometer, low-thrust voyage to Comet Tempel 2 Along the way scientific instruments will monitor the conditions in the interplanetary environment

In November 1985 just four months after launch the spacecraft will release an unpowered probe that will be left behind as the main spacecraft accelerates outward from the sun The small probe about 200 kilograms, will drift into the path of the oncoming Halley s Comet about 73 days before that body rounds the sun The Halley probe will not carry cameras since at the 57 kilometer-per-second encounter velocity the two bodies will flash past each other with no time for even a brief glimpse However the probe will measure the comet and its surroundings and will radio the data to the main spacecraft for relay to earth

This will be a kamikaze mission for the Halley probe will likely not survive the close encounter What's left over after the cosmic juggernaut has passed will orbit the sun forever

Meanwhile, the Tempel 2 part of the mission moves out of the way of Halley s Comet and continues to accelerate outward until 1080 days after launch—July



Bright splendid head of Halley s Comet photographed on May 8 1910 during its last appearance

1988—it approaches Comet Tempel 2, then half again as far from the sun as is the earth. Radar and cameras will allow mission controllers to maneuver the probe within a few tens of kilometers of the head of the comet, all the while sending back high-resolution pictures of the nucleus. Wide-angle cameras will show more of the coma and tail, and spectrometers, magnetometers, and dust analyzers will study the local conditions in detail.

Radar will keep the craft alongside the comet head for six to twelve months—possibly in orbit about it—as the comet rounds the sun. More instruments will monitor the complex interactions between the comet and the interplanetary environment, while astronomers on earth compare their observations with those from space.

The cameras on board will be able to show us objects as small as a baseball on the surface of the nucleus. We may see volcano-like outbursts of gas as the sunlight heats the frozen vapors. Jets of gas may alter the orbit of the comet, ever so slightly. At the end of the mission we may try to bump the spacecraft against the nucleus to test its properties.

The possibility of making this voyage depends on the ability to get enough power for the engines, the instruments, the radio, and radar. This is where the ion propulsion system comes in. The spacecraft will carry a huge array of solar panels to gather the everpresent sunlight and convert it into electricity. Most of the power will go to the ion engines.

Ion propulsion is not new. It has been under development for 20 years, and about ten years ago an Agena rocket was launched carrying SERT, the Space Electric Rocket Test. Following that feasibility test, research continued in laboratories so that now ion rockets have operated under simulated-near-space conditions for 10,000 hours (about 14 months) continuously. There is $5 million in this year's

Comet probe is launched from Space Shuttle, boosters inject craft into interplanetary orbit, then drop off. Small probe is deployed at Halley's comet, main craft goes on to Tempel 2.

NASA budget for continuing development of the ion engine.

The ion rocket works by charging up a dense vapor and using an electric field to accelerate the gas out of the nozzle. That's the action. The reaction is the thrust given to the spacecraft. While the thrust is not high, a few hundredths of a pound, compared with thousands of pounds for medium-sized chemical rockets, the ion rocket has the great advantage of going for a long time on a little fuel. Rocket engineers call that "specific impulse," and for an ion engine it can be ten to a hundred times greater than for a chemical rocket. A further advantage, without which the mission would be impossible, is that the energy comes from the sun, rather than having to be carried along as fuel.

For the ion engine, the fuel is liquid mercury—860 kilograms of it for the three-year thrust. The mercury is fed into a chamber about the size of a cake tin and vaporized by heating. Electrons are squirted into it from an electron gun, similar to the one in a television tube. The electrons give the mercury atoms a charge, converting them into ions, and the ions are attracted toward two screens at one end of the chamber. One screen is grounded, the other charged up to 1000 volts, and this electric field accelerates the ions to speeds of 30 kilometers per second and throws them out the back. Six such engines would be clustered to power the comet mission.

Comets don't wait. The mission must be launched as scheduled or we will miss this opportunity to study two comets for the price of one.

NASA scientists will ask Congress for funds for the mission in the Fiscal Year (FY)1981 budget. The amount required will be one result of a current mission definition study. Ion engine development is already under way. But some researchers are worried that the project will get bumped by a domino effect from Proposition 13.

Each year, NASA asks for funds for "new starts" on projects that require many years lead time. In FY 1980, they will ask for funds for VOIR—Venus Orbiter Imaging Radar—scheduled for launch in 1983. They may get approval, but if they don't get it that year, an election year, the crunch will come when someone has to decide whether they will ask again for the Venus program the following year, FY 81, thereby bumping the comet mission, or whether they will let the Venus probe slip to FY 82, thereby bumping a planned Mars mission. If the comet mission start is delayed, we will not be able to rendezvous with Halley until its next pass in 2062.

Congress is likely to be in a money-saving mood in the near future, and politicians are wont to go after highly visible projects that affect (they think) the fewest voters. Public interest in the comet mission could help a great deal in seeing that this mission is not canceled.

It is an important mission, for several disparate reasons. It *is* time we looked closely at the smaller bodies of the solar system, those that preserve best a record of the early solar system and how we all got here. On a philosophical level, the degree to which a society supports basic research (as well as the arts and other "impractical" endeavors) is an indication of the maturity of that society. Since 1969, the will to explore the new frontier of space seems to have withered.

Halley's Comet is known to almost everyone, and though its 1986 appearance will not be spectacular, public interest will be high. We could use a resurgence of that feeling of exploration that accompanied the *Apollo* program. But we must get the comet mission launched on schedule.

Comets don't wait! ∞

LANDED ON EARTH.

IT CAME FROM ROCKWELL.

You remember the day that aerospace history was made On Friday, August 12, 1977, a NASA Space Shuttle orbiter, built by the Space Systems Group of Rockwell International, glided silently down to the Mojave Desert and completed the first flight of the world's first reusable space transportation system It's a story well worth telling, and remembering, with this T-shirt iron-on

The story is getting better all the time Next year an orbiter will actually lift off for Earth orbit And by the mid-1980s, a fleet of Rockwell-built reusable orbiters will be giving this country the world's only economical, efficient space transportation system, permitting brand-new uses of space and bringing the benefits of space down to Earth

The spaceship that lands on Earth is opening a whole new chapter in the space program

How To Iron On This Ad

Preheat iron (dry-wool setting) for 3 minutes Slip garment on ironing board over scrap material Remove wrinkles Position transfer face down and pin edges (outside design area) to ironing board cover Iron transfer slowly for 1 minute making sure to cover spaceship and large print (out to edges) equally as shown on T-shirt If paper browns iron is too hot Let transfer cool for 1 minute then unpin and slowly pull transfer straight up

Rockwell International

ENDANGERED SPECIES

LIFE

By Dr Bernard Dixon

A few decades from now, we may make a brutal, calculated decision to totally eradicate a particular form of life. We already are 99 percent of the way along that path.

Even conservationists, who publicly deplore the extinction of innumerable species of animals and plants through neglect, ignorance, or financial greed, have applauded this conscious, murderous act to be carried out by a UN agency.

I speak of smallpox virus. Since 1967, the World Health Organization (WHO) has been systematically obliterating this devastating parasite from vast tracts of the globe. The last case of smallpox in South America was recorded in 1971, the last in Indonesia in 1972, and in Pakistan 1974. Nine months ago, a triumphant WHO announced that the few remaining traces of infection in Ethiopia and Somalia have been stamped out. So ends the greatest public health crusade in history.

But WHO's field workers have not simply conquered one of the most vile maladies ever known to man. By vaccinating human populations, they made life impossible for a particular microorganism. As a result, smallpox virus is no longer at large among *Homo sapiens*. It is confined to glass phials in the deep-freezes of medical laboratories throughout the world. My question is: When we feel sure that smallpox is indeed extinct in nature, should those final stocks of virus be committed to flame? I guess they will be. Common sense supports the idea. But let's look at the implications.

All arguments deployed by wildlife enthusiasts in their efforts to protect endangered whales, turtles, and butterflies apply just as forcibly to smallpox virus. As a threatened species, it is absolutely unique. Once extinct, it can never be recreated by laboratory scientists. Smallpox virus has formed an 'ecosystem' with man in the past, and while we seem to have decimated it with impunity, there could be longterm ill consequences of which we are naively unaware. Finally, although an electron microscope is required to see it, smallpox virus is not an unattractive piece of life. Microbiologists gain aesthetic pleasure from peering at the most virulent of germs, this one included.

It is, of course, the nastiness of smallpox virus that makes talk of conservation seem laughable, if not lunatic. Its lethal power, rather than man's military might, explains why Hernando Cortez, with less than 600 men, was able to conquer the great Aztec empire in the early 16th century. The invisible germ spread like wildfire, reducing the population of central Mexico from some 30 million to three million. In modern times, before the WHO initiative got underway, no other virus was so feared as a cause of disfigurement and death.

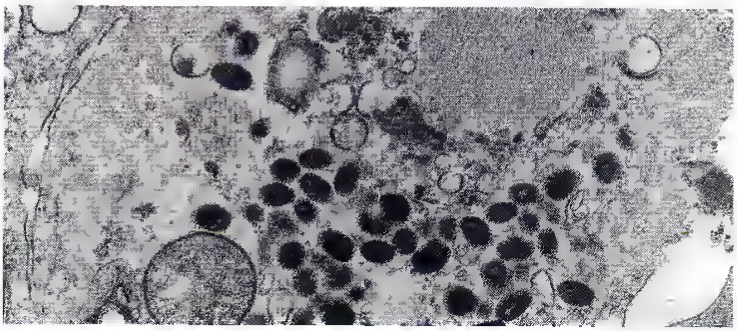
Putting aside conservation arguments (valid though they are), what possible reasons could there be for retaining such horrendous material? Just two. First, it's conceivable that smallpox will return and that the present-day virus could be useful in fighting the disease. The germ will not be required for vaccination, that is done with a related virus (vaccinia), which certainly will be maintained in laboratories for all time. But it might prove valuable as a tool for studying a resurgent form of smallpox. Once the WHO campaign has abolished the disease from nature, such a tool could come from only one source. A million-to-one chance exists that the virus is incarcerated in a desiccated burial vault or similar location, which has allowed it to survive without being transmitted from person to person. Unlikely, but possible.

Second, we could find numerous applications for smallpox virus in a totally different field. As the discipline of genetic manipulation forges ahead, hereditary material from diverse sources will be used to fabricate novel organisms valuable in medicine, agriculture and other fields. Every living creature, plant and animal on earth will become a vital genetic resource. In years to come, the irreplaceable DNA of smallpox virus may prove beneficial in areas that cannot be foreseen today.

These arguments will doubtless be eclipsed by the public's concern for maintaining a horrendous germ in national deep-freezes. WHO has said only that the number of laboratories holding smallpox virus will be reduced.

It seems certain to go further, however, making not just a dread disease but also a unique life-form totally extinct. That will be a spectacular historical decision. No other microorganism has been so methodically eradicated before. And the odds against it happening again (however mighty the WHO's battalions) are overwhelming.

In May of this year, the World Health Organization posted a reward of $1000 for anyone who first reports the finding of an active case of smallpox anywhere. Eradication of smallpox on a global scale cannot be officially announced until a two-year search fails to turn up evidence of the disease. —Ed.



Smallpox Virus/Center for Disease Control

UFO UPDATE

By James Oberg

Friction between science and flying saucers has generated a blizzard of sparks over the years. The sides are well defined. Establishment scientists traditionally dismiss UFO data as fanciful fiction, while UFO enthusiasts portray themselves as outcast Galileos, prophets of a new scientific revolution.

Advocates of Unidentified Flying Objects insist that they are onto some extraordinary phenomenon unaccountable by contemporary science. The favorite theory involves alien spacecraft, but growing splinter groups promote various psychic, interdimensional, cross-temporal, conspiratorial, or even more bizarre hypotheses. Whatever it is, UFO enthusiasts assert, the confirmation of extraterrestrial beings could be a key to the next great breakthrough in human knowledge.

Few could argue such a premise.

Early in 1977, the wire services reported that astronomers now favor scientific studies of UFOs. According to *The New York Times*, "unidentified flying objects should be investigated further, a majority of trained astronomical observers said in a survey disclosed recently."

Closer analysis showed that the private pro-UFO survey actually meant that only one-quarter of those polled responded that UFOs "certainly" or "probably" deserved study, with a few more agreeing that they "possibly" deserved study. More to the point, only one-quarter of 1 percent of the astronomers thought that UFOs were important enough to warrant their personal attention.

But the poll did nevertheless seem to bestow some measure of scientific respectability to this topic, previously ranked among the lunatic fringe. The poll was symptomatic of the changing image of UFOs, and the new status of UFO researchers.

After three decades of exuberant if amateurish fieldwork, furious propagandizing, and aimless theorizing, a number of UFO groups have finally begun to play the game using rules of science. Accepting the burden of proof, they have mounted an impressive scientific program designed to demonstrate, finally, that UFOs exist.

On a dark hillside in Texas, white-uniformed men monitor a battery of instruments, hoping to catch and record the subtle physical effects alleged to accompany UFO visitations. In photographic laboratories across the country, data processing specialists analyze computerized images of alleged UFO photographs, seeking evidence of forgery and potential proof of authenticity. A computerized data base in Chicago prints out pattern analyses of UFO sightings, seeking a signal behind the noise of thousands of annual reports. Pieces of metal picked up near alleged landing sites undergo spectroscopic examination in well-equipped laboratories.

These are the techniques of science, applied to a subject long regarded as beyond the fringes of science. But these are the techniques that will produce proof, *if proof is possible*.

Standards are now tighter and the experience of UFO investigators greater, so that many "unknowns" have diminished. More and more cases have been solved, but always a fraction remain unsolved, unexplained, unidentified. This residue of unknowns is the basis for UFO enthusiasts' hope. Skeptics disagree, saying that inherent limitations in human perception, memory, and knowledge will always introduce a small artificial residue of unknowns.

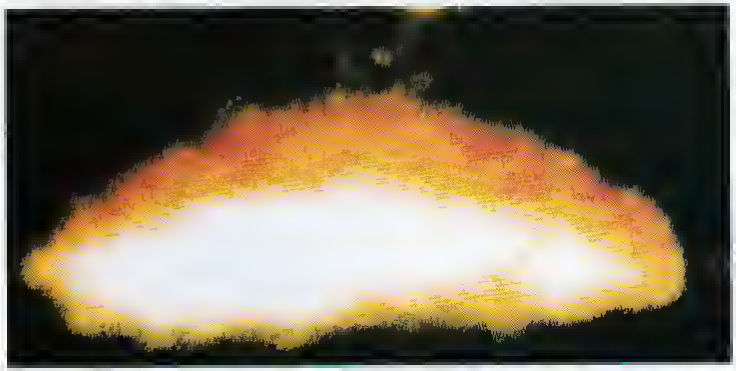
So what kind of data will stand up to scientific standards, not as a leftover residue of mysteries but as a definitive list of recorded events?

Laying aside the possibilities that alien ambassadors will land at the White House or that the fabled "secret captured flying saucer" will ever be rescued from alleged governmental oblivion, hard evidence for the reality and respectability of UFOs must come from laboratories now engaged in scientific research.

The "Project Starlight International" team, privately but generously funded by some Texas millionaires, has assembled an array of instruments that *could* produce incontrovertible evidence. They have cameras, radar, spectrometers, magnetometers, radiation sensors, gravitometers, and a small laser beam to communicate with extraterrestrials should they happen by.

The Starlight UFO trap has now been in full operation for nearly three years. New equipment continues to be added, including a radar set and computerized alert system that automatically telephones volunteer skywatchers in the vicinity of a computed UFO position. The system works well in drills—but nothing substantive has resulted.

The most exciting recent events have dealt with a fierce wood tick infestation on



Spectacular glowing UFO was photographed from a Concorde during 1973 solar eclipse

the hillside where the Starlight equipment is mounted. White-clad UFO watchers bend to their technical tasks amid the fumes of sulfur bombs. They watch a sky full of airplanes, meteors, satellites, kites, balloons, birds, ball lightning, migrating wind-blown spiders, and maybe, just maybe, something else. But, as Starlight project director Ray Stanford told colleagues at a 1976 UFO conference, "If we search for ten years with what we've got and we don't find anything, then we're going to have to admit that nothing is there."

One of the most visible aspects of the phenomenon is a growing collection of UFO photographs. While the vast majority of UFO sighting reports are made by honest, perplexed, often reluctant witnesses, most photographs are hoaxes. To separate out the possibly authentic photos, if any at all, experts use photoanalysis.

For example, Dr. Bruce Maccabee, a researcher for the National Investigations Committee on Aerial Phenomena (NICAP), has made densitometric scans of a famous 1950 photo from McMinnville, Oregon. The scans support the skeptical "Condon Committee" conclusion that the photo could in fact be of a large structured disk 50 feet or more in diameter. But another expert, computer specialist Robert Sheaffer, concluded that the photo was made with a smudged lens and that the object appears to be hanging from an overhead power line. Condon Committee investigators later changed their minds and agreed with Sheaffer.

Specialists at the "Ground Saucer Watch" (GSW) office in Phoenix also apply advanced data processing techniques to photographs. Their work has raised howls of protest from traditional UFO groups because many of the more famous photos have been denounced by GSW as frauds. However, GSW has compiled a small list of photos that they suggest could be genuine. Again, other researchers disagree, and scientific debate is raging on the validity of such processing techniques.

Computer scientists have a favorite proverb: "Garbage in, garbage out." It means that bad input data can be manipulated to produce nearly any output desired, but it will be useless. That, so far, seems to be the fate of UFO computerized data banks, since data processing specialists have criticized them for not having sufficient control over the validity of input data. UFO proponents, appealing to mathematical formulas from information theory, claim that a proper computer program can filter out the garbage and sift through to the authentic residue.

Nor have laboratories produced any specimen that could not have been obtained from ordinary sources on earth. Exotic space metals or artifacts continue to be reported, but none have passed the investigation of professional laboratories.

Yet these debates have changed markedly from the days when UFOs were the topic for screwball religious cults, nasty insinuations about witnesses' sanity and/or sobriety, and knee-jerk gullibility. Today's arguments must stand up to the time-tested standards of scientific research. Perhaps they will reveal something, perhaps not. But it's the only way to find out for sure.

• • •

In light of the need for better scientific research about UFOs, it is particularly frustrating to read published reports that "NASA has rejected a White House request to reopen the government-sponsored research program." But the real story is not so open-and-shut as these pessimistic accounts would indicate.

Actually the story began when President Carter promised to release all UFO data, if elected. Once elected, he discovered that the Air Force's "Blue Book" files were already being declassified, and everybody denied having any other files. Carter's science adviser, Dr. Frank Press, was assigned the task of answering UFO-related mail from the public. A flood of mail arrived, demanding that the "*real* secret files" be released.

Overwhelmed with queries, Press asked NASA director Dr. Robert Frosch if NASA might handle the mail. In the letter, one paragraph innocently asked if NASA would consider convening a panel to decide if a new official investigation was warranted.

Following several months of consideration, NASA said that it could see no reason to undertake a new investigation. However, Frosch offered to make NASA laboratories available to analyze any UFO "physical evidence" that might be submitted.

Six months later, nothing has been officially submitted.

• • •

If UFOs are alien spacecraft (and while this is the leading theory, many other schools of thought have come and gone), it's likely that earth's spaceships may have been able to encounter them in outer space. Stories have sprung up about how "our astronauts have seen them too!"

In fact, each story can be traced back to authors' misunderstandings, distortions, exaggerations, or just plain fabrications. There does not appear to be a single case on record of American or Soviet spacemen encountering anything extraordinary in terms of normal space occurrences.

The most famous case, however, continues to thrive. It deals with a UFO seen by astronaut James McDivitt on the Gemini 4 mission in June 1965. McDivitt insists that the beer-can shaped object was just another man-made satellite, but some observers have suggested that it was a glimpse of his own booster rocket in a nearby orbit.

A "tadpole" photograph was released by NASA soon after the flight, taken from a series of movie frames. McDivitt claims he shot a few exposures with two still cameras, but they did not turn out. He didn't touch the movie camera, and the blob of light released by an overeager photo technician shows only a window reflection, he insists.

APRO's Dr. Harder, however, insists that the "tadpole" really was the UFO, despite what McDivitt thinks, and that it was being propelled by a plasma jet. Dr. Harder chooses to disregard the astronaut's testimony and build his case on a few frames of reflections. UFO believers can only hope that most UFO evidence is not so insubstantial.

• • •

Positive proof of a genuine UFO encounter

Aerial Phenomenon Research Organization (APRO)

UFO experts give "the benefit of the doubt" to this Yungay, Peru photo and believe it genuine

could be extremely valuable for the entire human race. It could be financially rewarding for the owners of that proof. And it could spell financial ruin for one prominent UFO skeptic—unless, of course, he was the one delivering the proof.

The *National Enquirer*, a weekly tabloid newspaper with a circulation in the millions, has a standing offer of $1 million for "positive proof." The London-based whiskey bottler Cutty Sark, Ltd., recently unveiled an even bigger prize of one million pounds Sterling, or about $1,800,000 at the present exchange rate.

Lesser awards also are available in the absence of positive proof. The *Enquirer* annually grants up to $10,000 to witnesses of a UFO incident judged "most scientifically valuable" by an independent panel of UFO specialists (the "Blue-Ribbon Panel," see box). And Cutty Sark has announced plans to award £1000 to the best written essay on the UFO problem.

Moreover, a number of London betting houses have accepted various wagers on the imminent visitations of extraterrestrials. But the world's most famous "anti-UFO bet" has been set forth in the book *UFOs Explained*.

Author Philip J. Klass, a senior editor of *Aviation Week* magazine and the nation's leading UFO skeptic, claims he has challenged UFO believers "to put their money where their mouths are." Klass has offered to pay $10,000 to anyone who agrees to his bet if and when certain criteria are met establishing that a true UFO visitation has occurred. Every year until that happens, the wagerer must pay Klass the sum of $100 (up to a maximum of $1000, after which payments cease but the bet remains in force).

Less than a dozen UFO enthusiasts have signed up to date, usually on inside information that "*this* year the government is going to announce UFO contacts." Such predictions have appeared in print nearly every year for a quarter of a century, but people still seem to believe them. Klass has become a little richer because of them.

Only one UFO buff has maintained his bet in force, apparently more for publicity than persuasion. Stanton Friedman makes a living off his lecture tours proclaiming the reality of UFOs, and he responded to Klass's needling by formally agreeing to the bet a few years ago.

Additionally, Klass has offered to buy back all copies of his book *UFOs Explained* if events prove his assertions incorrect. But pro-UFO scientist Robert McCampbell has done Klass one better. He has offered to buy back copies of his book *UFOlogy* from anyone not satisfied with it, proof or no proof.

• • •

Actually, Philip J. Klass already had been setting off multimegaton detonations among the ranks of UFO believers. Miffed when UFO experts in 1968 ridiculed a serious (and still tenable) suggestion that many UFOs were actually ball lightning, the by-nature combative aviation reporter threw himself into serious investigations of what were regarded as the "best" classic UFO cases. He often dug up startling (and embarrassing) new evidence but has become a pariah in UFO circles. (Hynek refuses to appear together with him, and Hynek's 'UFO bibliography' handout pointedly ignores Klass's two books.)

With the death of astronomer Donald Menzel in 1976, Klass has emerged as the nation's leading UFO skeptic. He spurns the word "debunker," with its connotations of knee-jerk dismissals and unorthodox points of view. Instead, Klass attempts to investigate UFO cases more deeply than might other researchers who have subconscious desires to actually find proof of extraterrestrial visitors. Concentrating only on the generally acclaimed "best cases," Klass often has exposed the superficiality of work done by pro-UFO experts.

In 1977, he joined with other scientists and educators in forming the "Committee for the Scientific Investigation of Claims of the Paranormal," a group that has denounced easy acceptance by the public of allegedly baseless beliefs in astrology, the Bermuda Triangle, ESP, "ancient astronauts," and other so-called modern myths. Klass heads a small but potent band of skeptical investigators called the UFO Subcommittee. At the very least, this group demands the tightening of standards in so-called scientific UFOlogy. The level of carelessness of many pro-UFO experts has markedly declined, so progress is being made. ☒

THESE PEOPLE ARE WATCHING AND WAITING

Center for UFO Studies (CUFOS), 1909 Sherman Suite 207, Evanston, IL 60201. Self-styled pinnacle of UFO activities, this small group generally depends on other groups for data. Dr. Allen Hynek does the public appearances and fund raising while researcher Allan Hendry carries out actual coordination and in-depth investigation. Two publications: *CUFOS Quarterly Bulletin*, $15/yr., and *International UFO Reporter*, $12/yr.

Aerial Phenomenon Research Organization (APRO), 3910 E. Kleindale, Tucson, AZ 85712. Among the longest surviving UFO groups (represented in 50 countries). APRO is held together by the dedication of its cofounders Jim and Coral Lorenzen, who have recently led the group to specialize (critics say monopolize) in "UFO abduction cases." *APRO Bulletin*, $10/yr. for 12 issues.

National Investigations Committee on Aerial Phenomena (NICAP), Suite 23, 3535 University Blvd., Kensington MD 20795. Another old group, unfortunately in a downhill slide following a decade of organizational in-fighting. *NICAP Bulletin*, $10/yr.

Mutual UFO Network (MUFON), 103 Oldtowne Road, Seguin, TX 78155. A vigorous, expanding group acting in concert with CUFOS. *MUFON UFO Journal*, $8/yr.

Ground Saucer Watch (GSW), 13238 North 7th Drive, Phoenix, AZ 85029. Highly professional organization (membership by invitation only), which applies vigorous scientific standards to UFO investigations. Quarterly journal free with membership.

Project Starlight International (PSI), PO Box 5310, Austin TX 78763. Somewhat mysterious organization with the best array of gadgets yet assembled to measure UFOs—if only they could find one. Irregular bulletin sent in exchange for cash donations.

Committee Against UFO Secrecy (CAUS), 191 E. 161st St., Bronx NY 10451. New offshoot of GSW, this small group is using Freedom of Information suits to extract allegedly secret hypothetical government 'UFO files.' Newsletter $10/yr.

20th Century UFO Bureau, 756 Haddon Avenue, Collingswood, NJ 08108. This group, associated with Dr. Carl McIntyre's "20th Century Reformation Hour," believes that some UFOs are angels and signs of the imminent Second Coming. However, other UFOs are sent by Satan to confuse people lest they recognize the angels.

UFO Subcommittee of the "**Committee for the Scientific Investigation of Claims of the Paranormal**," 923 Kensington Avenue, Buffalo, NY 14215. The first formal organization of UFO skeptics who tackle the "best UFO cases" on record, often with spectacular success, much to the dismay of most UFO buffs. Reports of activities are included in the Committee publication *The Skeptical Inquirer* (formerly *Zetetic*), $12/yr.

The *National Enquirer*'s **Blue Ribbon Panel** of UFO experts (who review "best cases" for cash rewards). Two regular members (James Harder and Leo Sprinkle) are joined by a changing cadre of obscure 'UFO experts,' including this year's Willard Armstrong and John L. Warren. More respected UFOlogists have declined offers of membership. Send contest entries to UFO REWARD, National Enquirer, Lantana FL 33464. All entries will be evaluated.

THE ARTS

Most readers of *Omni* presumably grew up like this reviewer, with the concept that the inevitable expansion of humanity would lead to the colonization of other planets. While this idea is hardly dead and buried—witness a recent journal article in which James Oberg offers some bold but plausible plans to transform our moon, Mars, Venus, and even Mercury into earthlike biospheres—the goal of planet colonization has been challenged by a radically different notion of the Final Frontier. Created by Princeton professor of physics Gerard K. O'Neill, this new concept is based on one of those revolutionary propositions that are so simple they seem self-evident. *The surface of a planet*, O'Neill asserts, *is not a very good place to house a postindustrial society*. Free space itself, he says, is the natural ecological habitat for a high-energy, high-growth technological species.

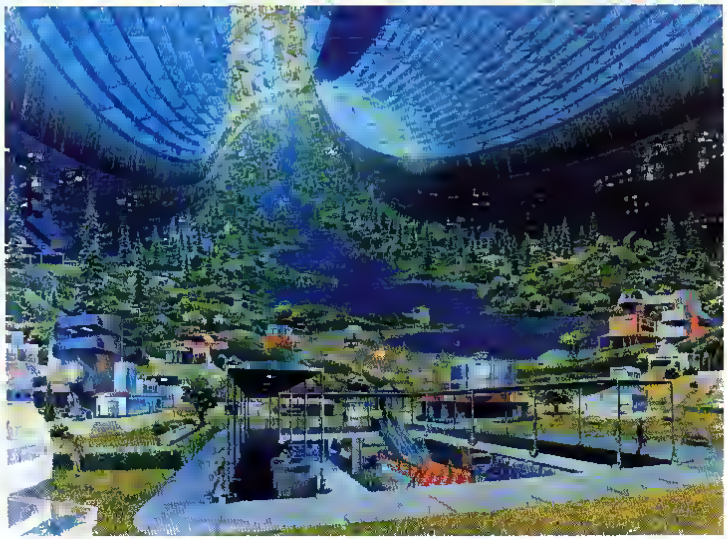
The best single presentation of O'Neill's ideas is found in his book *The High Frontier* (William Morrow, 1976). "On a planetary surface," he argues, "we are the 'gravitationally disadvantaged.' at the bottom of a deep hole in potential energy. To raise ourselves from earth into free space is equivalent in energy to climbing out of a hole 6461 kilometers deep, a distance more than 600 times the height of Mt. Everest. Does it make sense to climb with great energy out of one such hole, drift across a region rich in energy and materials, and then laboriously climb back down into another hole, where both energy and matter are more difficult to get and to use?" Answering with a resounding no, O'Neill explains how we could build a variety of space habitats, space towns, and eventually space cities, starting in the L-5 area (the most stable of the five Legrange points where the earth-moon gravitational fields balance out to zero).

Dr. O'Neill writes in an easy, nontechnical style and stresses, after demonstrating the engineering soundness of his designs, that the resources and enormous new energy such space habitats would capture would stave off the Doomsday and New Dark Ages predicted by the professional pessimists of the Club of Rome and the pop ecology movement.

Space Colonies, edited by Stewart Brand (Penguin, 1977), offers both emotional and intellectual debate on O'Neill's scenario and features what Hollywood might call an all-star cast—including Buckminster Fuller, Carl Sagan, Russell Schweickart, Lewis Mumford, Governor Jerry Brown, and dozens of others, pro and con. Unfortunately, the text seems to have been set by a disciple of the Marquis de Sade, in a typeface that should be called Old Eyesore, and the reader who tries to get through all of it will probably end up with a case of eyestrain.

A warning on semantics before we go farther. Professor Magorah Maruyama, an anthropologist who favors O'Neill's scenario, has been warning for about four years that "space colonies" is an unfortunate phrase, since the word *colonies* in any context provokes a negative reaction among Third World readers. The only ones who have assimilated Maruyama's perspective are the editors of *L-5 News*, a journal devoted to O'Neill's ideas, and they have switched to "space habitats." Dr. Timothy Leary with his usual Mad Avenue flair has offered H O M E s (High Orbital Mini-Earths) but was not particularly enchanted when this reviewer suggested he popularize his idea further by writing a song, "H O M E s on Legrange." *Space colonies* still haunts most of the books we are reviewing here.

T. A. Heppenheimer's *Colonies in Space* (Stackpole, 1977)—there it is again—is lively, lavishly illustrated, and a model of how to popularize science for a mass audience. If you want to know exactly why the L-5 area is stable, why space colonists (pardon, *dwellers*) will probably drink goat's milk instead of cow's, how to keep bees in high orbit, or dozens of nitty-gritty matters like that, Heppenheimer is the man who can lay it all out for you in a



Don Davis/NASA

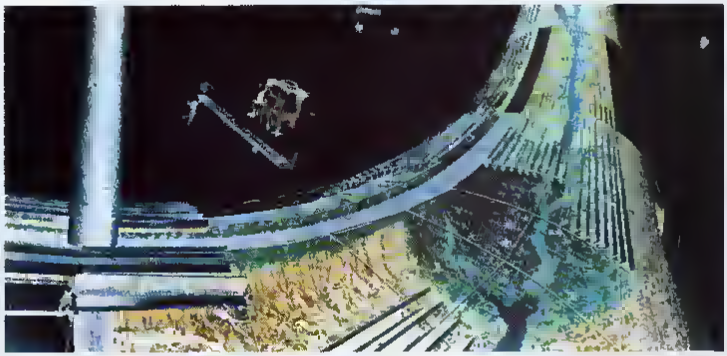
One of the most promising solutions for such earthbound problems as pollution, overpopulation, and energy is to build artificial environments that would sustain settlements in space

breezy, easy style. There are no oversimplifications, yet a bright high school student can understand every word, beginning with Ray Bradbury's lyrical introduction.

Staggering is the only word for G. Harry Stine's *The Third Industrial Revolution* (Putnam, 1975), a book as popularly written as Heppenheimer's but as mind-boggling as *2001*. Stine, an aeronautic engineer, is concerned only in part with O'Neill's space settlements; his vision encompasses *all* the industrial processes that can be accomplished more cheaply and efficiently in space. The First Industrial Revolution, in Stine's evolutionary perspective, was only a small step beyond agriculture and cottage economy; the Second Industrial Revolution (cybernation), only a slightly larger leap; but the Third Industrial Revolution (space technology) is a really big jump, offering us so much new energy and resources that all previous history becomes the Dark Ages by comparison. Written with the nuts-and-bolts, cost-and-profits orientation of an engineer who is accustomed to justifying every new idea to the financial/management department, *The Third Industrial Revolution* is totally Utopian but remorselessly pragmatic—"as revolutionary as science and as conservative as the multiplication table," to borrow a phrase from Calvin Coolidge.

The books of Iranian sociologist F. M. Esfandiary, now available in paperback (*Optimism One*, *Upwingers*, and *Telespheres*, Popular Library, 1977), insist polemically that the only real reason to reject the Utopian scenarios of O'Neill and Stine is a gut-level feeling that humanity doesn't *deserve* success and happiness. Castigating the "pessimism," "self-hatred," and "despair" of the antigrowth philosophy, Esfandiary writes like a jet-propelled Nietzsche, sometimes substituting invective for solid argument but certainly stunning and provoking the reader with a roller-coaster ride into a near-future. Esfandiary's vision is one in which space resources will abolish poverty, medical advances will achieve longevity (and the first steps toward immortality), both nations and the nuclear family will wither away, and humanity will be so transformed by the first decade of the next century that all present ideas of limitations on progress will be obsolete.

Every bit as sober as Esfandiary's book is visionary Gerald Feinberg's *Consequences of Growth* (Seabury, 1977), examines all the ecoconservative objections to space habitats, longevity, genetic engineering, and Futurist optimism. With consideration for the feelings of those who regard the future with anxiety, Feinberg examines the evidence dispassionately and votes, with reservations, for the optimists.



Don Davis/NASA

By the year 2000, space settlements at the Legrange points may be home for 10,000 workers

Barbara Marx Hubbard of the Committee for the Future offers her own scenario in *The Hunger of Eve* (Stackpole, 1976). Hubbard is as daringly original as Esfandiary but remains his opposite in all other ways: poetic where he is polemic, mystic where he is rationalistic, gently *yin* where he is ferociously *yang*. Still, the Hunger of Barbara is huge, aiming at indefinite expansion in both space and time (O'Neill habitats plus immortality); her book is also the best written of all those reviewed here, singing of space and human potential with the lyricism of a prose Whitman and the fire of a feminine Blake.

The ultimate (so far) in Futurism is Dr. Timothy Leary's *Exo-Psychology* (Starseed/Peace Press, 1977), which combines a joltingly electronic text with a superslick layout. Magazine-style headlines across the top of each page are matched by a reiterated slogan across the bottom that reads: SMPLE SMPLE SMPLE SPACE MIGRATION INTELLIGENCE INCREASE LIFE EXTENSION. Behind this tv commercial facade, Leary offers a whole new theory of evolution, dividing humanity's terrestrial history into 12 stages of increasing intelligence and projecting 12 quantum jumps of even higher intelligence after we migrate from earth. The message of the whole is given in a nutshell at the beginning: "Since no one can allow the game to become bigger than our concept of the Game (what is not imprinted is not real to the primate brain) therefore let us define the game as large-tast-intense precise as possible. Unlimited Space, Unlimited Time and Unlimited Intelligence to enjoy same. SMPLE." Only Esfandiary comes close to being as *futique* as that ideologically or typographically.

Ben Bova's *Colony* (Pocket Books, 1978) is the first science fiction novel on the O'Neill scenario. Looking both ways, Bova projects a Utopian future in space while allowing all the worst gloom-and-doom predictions to come true down on earth. The book's hero, David Adams, is a genetically engineered superman from an O'Neill spaceworld who takes pity on the suffering masses of ecologically ruined Terra and sets out to save them. To tell what happens would ruin the suspense of a very exciting yarn, but one can hint that tragedy and triumph are mixed in the manner of the epic futuristic visions of Olaf Stapledon. Don't be surprised if *Colony* wins the Hugo as best SF novel of the year.—*Robert Anton Wilson*

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There is nothing new, strictly speaking, in film and television translations of science and science fiction material. Every conceivable subject has been dealt with in books, magazines, and pamphlets in the past century. What *is* new, however, is the apparent growing interest in this genre by a sizable portion of the American and international audience.

Science fiction has been dealt with in movies since the silent days, notably in Georges Melies's comical extravaganza *A Trip to the Moon* in 1902. But there has never been enough audience interest to generate a flock of "serious" (i.e. big budget) science fiction films and television shows. Until now. With the enormous success of *Star Wars* and *Close Encounters of the Third Kind*, the powers that control the purse-strings of the entertainment industry have been convinced of the profits to be gained in this market.

Reluctantly at first, then with greater determination, every major film studio, backroom independent producer, television network, and even that bastion of good taste and educational fervor, the Public Broadcasting Service, has jumped on the *Star Wars* bandwagon. Financial gain is only part of the story. Many of the films and television programs now in various stages of production represent even more ambitious undertakings than *Star Wars* and *Close Encounters*.

If the current crop of television shows is successful, the next three years will see a

massive reorientation of audience viewing time toward science and science fiction and away from traditional westerns, medical programs, police dramas, or musical variety shows. Hybrids of tried and true TV fare will most likely emerge as well. Be prepared for *Medical Center 2000*, *Lasersmoke*, *Carol Burnett and Buzz Aldrin on the Moon*, or *Mars Squad*. On the positive side, the success of the PBS science shows, from Bronowski's *The Ascent of Man* to *The National Geographic Specials* and *The Cousteau Odyssey* will lead us into more serious examinations of our planet and its surrounding universe.

In the movies, the trend toward big-budget adventure melodramas ('space operas') has replaced the still-extant though now downplayed disaster cycle, of which hybrids have sprouted in all directions. What might have been just an earthquake, a tidal wave, or some other natural disaster is now a product of manipulation by forces from outer space, as evidenced in the upcoming *Meteor*, *Terror Beyond the Stars*, and other light entertainment.

Science fiction may not be here to stay, for the quality of many efforts will surely tax the patience and credulity of even the most devoted enthusiasts, but it is being given a fair chance. This fall we'll see the tip of the iceberg in the SF boom. Whether the remainder of the floe will ever see the light of day may depend on the ability of the upcoming sample to generate enthusiasm even marginally comparable to *Star Wars* and *Close Encounters*, which together are approaching the $400,000,000 mark in world box office receipts.

FALL TELEVISION FARE

There are well over a dozen science and science fiction programs being presented this fall on the tube. They range from 90 seconds in length to thirteen hours or more, cover a variety of subjects from serious documentary to wars in outer space, and include a healthy sample of shows being renewed by the all-powerful dollar-hungry networks. This season's programs fall into four areas: adventure, comedy, drama, and educational entertainment. The surprise of the year is that the educational shows are as numerous as adventures, quite unexpected for a medium in which viewers typically would rather watch an explosion than have it analyzed.

EDUCATION/DOCUMENTARY **The Cousteau Odyssey** (PBS, origin: KCET, Los Angeles) Returning with four new shows for the 78–79 season. The first new program, to air in December, will include a visit to and explanation of Easter Island. Later shows may include an examination of the Nile River. . . . **How About . . .** (syndicated) Don Herbert, who as "Mr. Wizard" was one of the groundbreakers in science education on television, returns with a series of 90-second and two- and four-minute spots covering a variety of contemporary subjects. . . . **Marie Curie** (PBS, origin: WCET, Cincinnati, a coproduction of the BBC and Time/Life Films) Five hour-long weekly dramas about the life and work of the two-time Nobel Prize-winning discoverer of radium. Produced by Peter Goodchild, who was responsible for the *Microbes and Men* series on PBS a couple of seasons past, in which Madame Curie was one of a number of great scientists portrayed.

© Copyright 1978 Universal Studios

The National Geographic Specials (PBS, origin: WQED, Pittsburgh) Returning with four new shows. *Gold*, an examination of its power over men, *Hong Kong*, a study in the lifestyle of a city, *Thor Heyerdahl and the Tigris*, the final journey of the extraordinary explorer across the Persian Gulf and the Indian Ocean on a Sumerian reed craft, *Kenya: Wildlife/Land Management*, problems of conservation in a developing nation. Their documentaries are totally objective, perhaps too objective for the late '70s. Efforts to thread the line between exploitation of their subject and examination of serious issues lack needed commentary. . . . **What Do We Know Now That We Didn't Know Then** (syndicated) A series of one-hour documentaries on diverse subjects. One program examines UFOs.

ADVENTURE **The Amazing Spiderman** (CBS) Series dramatizes the adventures of the Marvel Comics Group super-hero. . . . **Battle of the Planets** (syndicated) 85 half-hour animated science fiction episodes made in Japan in the tradition of round-eyed derivative children's tare. . . . **Battle Star Galactica** (ABC) One of the expensive (and probably well-produced) series to reach television. Special effects created by John Dykstra, who was largely responsible for the look and feel of *Star Wars*. A classic space opera with classy special effects, but will they work on the little screen?

COMEDY **Mork and Mindy** (ABC) Seemingly someone re-read *Visit to a Small Planet* and decided it might make a good series. Produced by the makers of *Happy Days* and *Laverne and Shirley*, this show presents us with the story of Mork from the planet Ork, and his American girlfriend Mindy, who's the only one to know his true identity. Mork from the planet Ork? . . . **The Muppet Show** (syndicated) The most entertaining, though hardly the classiest, space show since *Star Trek* is the regular segment of *Pigs in Space* seen on *The Muppet Show*. Commander Link Hogthrob, Doctor Strangepork, and that sexually smoldering mistress of outer space and America's hearts, Miss Piggy, on their never-ending mission to destroy all that is holy in the tradition of space adventure. Not to be missed.

© ITC Entertainment

Special effects from Battle Star Galactica *(above).* Pigs in Space *from* The Muppets

DRAMA **Fantasy Island** (ABC) Though not strictly science fiction, its resemblance to Michael Crichton's *Westworld* bears mentioning. Unfortunately, the series generally resembles *The Love Boat*, abandoning the potential excitement implied by its title. **Fire In the Sky** (NBC) Made-for-television film reminiscent of *When Worlds Collide*, an astronomer (Richard Crenna) tries to tell the world of its impending collision with a comet. **Project U.F.O.** (NBC) With special effects far better than those in most feature films this Jack Webb-produced series takes *Dragnet* to its ultimate spaced-out conclusion: government investigators look into reports of close encounters of the first, second, and third kind, with highly comic effect (though unintentionally so) as each sighting is explained away or left unanswered, in a straight-laced 1950s police manner.

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PROGRAMS IN PRODUCTION FOR SPRING. FALL 1979 **Brave New World** NBC 4-hour novel for tv. Big-budget adaptation of Aldous Huxley's futuristic novel. **Buck Rogers** NBC made-for-tv movie with possible sequels or series to follow. **Flash Gordon** NBC animated World Premiere Movie with series potential. **The Lathe of Heaven** Pilot for PBS series dramatizing works of speculative science fiction. **The Martian Chronicles** NBC six-part mini-series adaptation of Ray Bradbury's famous work. **The Unknown** Syndicated daily supernatural soap opera written by author of *Dark Shadows*.

FALL SCIENCE FICTION FILMS AWAITING RELEASE

Amid the 17 feature films in this field, several look interesting, a couple might have possibilities, and a great number appear to be low-budget ripoffs. The absence of "quality" studio films can be attributed to the great deal of time it takes to write, prepare, photograph, edit, and market a big budget movie. The list here, however, is almost entirely studio-oriented, each of the major film companies having chosen to produce between one and three science fiction films for release in 1979–80.

The films ready for the fall season are grouped according to their estimated budget and audience, rather than type, as expensive and inexpensive pictures overlap in storyline and degree of sophistication, but not in expected distribution patterns (the more important the film, the better its chances at the box office.)

The Cat From Outer Space (Buena Vista) Walt Disney Studios have adapted their earthbound type of fantasy film *(The Absentminded Professor, Pete's Dragon, Bedknobs and Broomsticks)* to space. A cat by the name of "Zunar J5/90 Doric Fourseven" (sounds more than coincidentally like C3PO and R2-D2) is helped out by several Disneyesque scientists, played by Ken Barry, Sandy Duncan, and McLean Stevenson.

Invasion of the Body Snatchers (United Artists) Donald Sutherland and Leonard Nimoy star in the updated version of Jack *(Little Big Man, Time and Again)* Finney's novel, first filmed in the '50s by Don Siegel. A long-awaited film with a top-secret lid on its content. United Artists is releasing this as its big Christmas picture. As always with remakes, the question remains: since the picture was so good the first time, can a remake possibly overcome the first version's reputation and stand on its own?

Photograph Courtesy United Artists

Painting By Ralph Bakshi

The classic science fiction/horror film Invasion of the Body Snatchers *has been remade (top); the animated* Lord of the Rings *(below)*

Jason and the Argonauts (Columbia) Since it would be prohibitively expensive to remake this 1962 film, it is being re-released instead. Although the cardboard plot and generally one-dimensional acting drag this picture down a few points, the beautiful color photography and brilliant special effects by Ray Harryhausen have made it a classic in the fantasy field. The highlight, a swordfight between four men and seven full-sized animated skeletons, is considered by connoisseurs to be among the greatest stop-motion animated sequences ever produced.

Lord of the Rings (United Artists) The long-awaited interpretation of J.R.R. Tolkien's trilogy by Ralph (*Fritz the Cat, Wizards*) Bakshi is being touted as a "painting in motion." Judging by previewed production illustrations, the film promises to be a faithful and loving rendition of the tale. **Superman** (Warner Brothers) Several years in the making and budgeted at $25,000,000, *Superman* is the most expensive science fiction film ever produced. A second part has already been partially filmed, but its completion will depend on how well the first version does at the box office. The production credits are a Who's Who of show business, but you'll be reading them all over billboards, magazines, newspapers, and television for the next four months. Suffice it to say that Marlon Brando plays the Supe's dad, and Gene Hackman his archrival, Lex Luthor. The rest will be history. **Warlords of Atlantis** (Columbia) The opposite of *Superman*, this low-budget action movie was produced by the same artists who gave us *The Land That Time Forgot* and *The People That Time Forgot*. It features the cast that time forgot: Doug McClure and Cyd Charisse, and special effects that should have been forgotten. The stills remind one that some things are best left unseen.

OTHER FILMS **Gizmo!** (New Line Cinema) Originally entitled *Eureka!*, this film was produced and directed by *Village Voice* "Scenes" writer Howard Smith, who co-directed *Marjoe* a few years ago. *Gizmo!* is a humorous compilation of people's most ridiculous inventions and attempts at immortality from wirewalking and homemade flying machines to walks in outer space and perfect dimplemaking machines. Medical scientists take note.

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FILMS IN PRODUCTION. Of particular interest is, of the 20 films listed below, a large number are adaptations, sequels, remakes, or otherwise not *original* material. One of the major reasons that *Star Wars* and *Close Encounters* were successful is that both had original screenplays. Despite their rush to duplicate the smashing success of these films, studios have overlooked this all important factor. As a result, the odds are

CONTINUED ON PAGE 140

CONTINUUM

THE IMPORTANCE OF BEING TENTATIVE

"Doubt is not a very agreeable status," wrote Voltaire, "but certainty is a ridiculous one." That statement would have made the 18th-century French philosopher a prime candidate for membership in a recently established organization called the American Tentative Society (ATS).

"It is the essence of science, and common sense, to regard our present knowledge as subject to growth, addition, or revision, and therefore—tentative," announced the ATS in its brochure. "Otherwise we become prisoners of our yesterdays, stuck with our dogmas, mired in our inability to learn and adapt. Current knowledge is, of course, the best we have with which to live and be guided. But the ATS concern is that outmoded information can limit thinking, actions, feelings."

To stress the importance of being tentative, the ATS, at a recent luncheon held at New York City's Waldorf-Astoria, presented the Rennie Taylor award (after the late founder of the ATS) and a check for $2500 to each of six scientists. According to ATS president Alton Blakeslee, the scientists were selected for their "intellectual flexibility."

The awardees were Frank D. Drake of Cornell University for his early and continuing interest in detecting signals from extraterrestrial intelligent life; J. Tuzo Wilson of the Ontario Science Center for championing the concept of continental drift against then-current dogma; S. Jocelyn Bell Burnell of the Mullard Space Laboratory in England, who "persevered despite discouraging advice" in the work that led to the discovery of pulsars; Norman E. Shumway of Stanford University for his pioneering work in the transplantation of human hearts; Rose Payne, also of Stanford, for her work in immunological research that contributed to the success of the heart transplants; and Edwin Land of Polaroid for answering his daughter's question, "Where is the picture?" after he had taken her photograph with a conventional camera.

The ATS is not an isolated phenomenon. Last year Pergamon Press published *The Encyclopaedia of Ignorance*, containing "papers on what we do not know, on matters which lie on the edge of knowledge." Fifteen years earlier I. J. Good edited an anthology of "partly baked ideas" called *The Scientist Speculates*. And just this year a new science journal called *Speculations in Science and Technology*, intended as a forum for ideas too tentative for established journals, began publication in Western Australia.

All of these efforts raise the nagging, disturbing question that lies at the root of all scientific investigation: How do we know?

How do we know our descriptions of the universe are accurate? How do we know what is true?

Well, there are tests. The most powerful is: Does it work? If a theory describes events or phenomena adequately and economically (or at least better than its competitors), if it doesn't contradict some other known physical law that seems sound, and if it's fruitful in suggesting other observations and predictions, then the theory is considered correct.

There are problems, however, with this utilitarian approach to truth. For example, in the context of the knowledge of the 15th century the Aristotelian-Ptolemaic idea that the sun is the center of the universe seemed true.

The danger, then, is what might be called "hardening of the categories." There are endless examples of this peculiar ailment, and perhaps the most illuminating is from the American astronomer Simon Newcomb, who said at the beginning of this century, "The demonstration that no possible combination of known forms of machinery, and known forms of force, can be united in a practical machine by which man shall fly long distances through the air, seems ... as complete as it is possible for the demonstration of any physical fact to be."

Newcomb, who died in 1909, six years after the Wrights took to the air, is best described by a statement sometimes known as "Clarke's Law," by author and scientist Arthur C. Clarke: "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."

If we fail to keep in mind the provisional nature of current knowledge, warns the ATS, "we can become arrogant in defense of some 'truth' learned long ago." For information on the ATS, write to Mrs. Ana Rose, Executive Secretary, American Tentative Society, P.O. Box 751, Ansonia Station, N.Y. 10023. Those interested in *Speculations in Science and Technology* can write to Western Australian Institute of Technology, Perth, South Bentley, 6102, Western Australia.—*TRUDY E. BELL*

CONTINUUM

LIFE IN VENTS

Early this year, oceanographers discovered a region of life-supporting vents more than 1600 kilometers north of the Galapagos Rift—an area 640 kilometers west of Ecuador where molten lava has caused the earth's crust to separate. This find was not unique.

In March 1977, in what was to be a routine mission to study several hot water vents in the ocean bottom, scientists from the Woods Hole Oceanographic Institution, the Massachusetts Institute of Technology and Oregon State University had descended three kilometers below the ocean's surface to the Galapagos Rift. Instead of finding an expected barren abyss, however, the geologists and chemists inside the submersible *Alvin* discovered a diversity of life centered around the vents.

By all reasoning, this was not supposed to happen. Animals living in total darkness do not survive unless they feed on organisms that use sunlight for energy. In the abyss, no light is available. However, scientists found hundreds of white clams and oversize brown mussels plus tubeworms, crabs, an octopus, and small cotton puff-like organisms never before seen.

The reason for the animals' large size and great number soon became apparent as the scientists found that along with the hot water, high levels of hydrogen sulfide were seeping from the vents. This chemical, used by the sulfur-oxidizing bacteria in the area, provided food.

The vents have led scientists to think that suboceanic life is not uncommon. But if you're wondering how the animals got to the vents in the first place, you're not alone. That is just one of the questions the Galapagos Rift group will try to answer when they go down again in January.

—Kenneth Jon Rose

Seaworms, limpets, crabs, and unknown fish at 2800 meters

LASER SCALPEL

A remarkable new surgical device, the laser scalpel, has recently been developed by the department of electrical engineering at the University of Washington.

Excessive blood loss has always been a serious problem in surgery, especially in burn case operations. The rupturing of surrounding blood vessels and the damage to skin tissue pose a constant threat. With the advent of the "laser blade," these obstacles may be virtually eliminated.

Incorporated in a sharp, transparent quartz knife, a 25-watt argon laser sends a beam through an optical fiber, instantaneously cauterizing the blood vessels adjacent to the incision. The laser blade will take no more time in the operating room than the currently used electric knife does and will be at least three times more efficient in reducing blood loss.

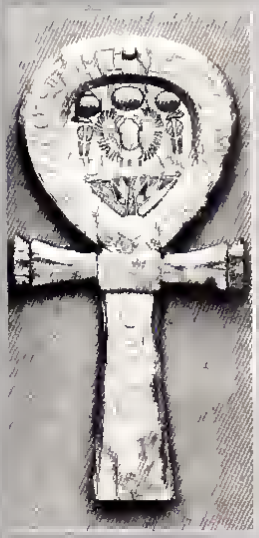
ANKH

Explorer and historian of ancient astronomy George Michanowsky recently shed new light on the origin and meaning of the fabled Egyptian *ankh*, or "looped cross" symbol, that is popular today as a good luck charm and erotic talisman. Once thought to be derived from the shape of a sandal strap, the origin of the symbol has long puzzled scholars.

According to Michanowsky, author of *The Once and Future Star* (Hawthorn Books), there is now compelling evidence that *ankh* is derived from the language of the ancient Sumerians of Mesopotamia, where the word was one of the names for a gigantic starburst, or supernova, that was seen in the southern sky some 6000 years ago.

Physical evidence of this momentous celestial event was discovered in the last decade by radio observations and optical probes conducted from Australia. As the closest known supernova to the earth, the stellar explosion would have appeared brighter than the full moon, poised above the southern horizon, and it is now understood to have figured prominently in the lives of the early Mesopotamians.

Michanowsky traced the origin of the Egyptian *ankh* to the Sumerian expression *an-ha*, meaning "Fish of Heaven." This was one of the epithets of



Harry Burton/Metropolitan Museum of Art

The mirror case for the tomb of Egyptian King Tut-ANKH-Amun

the god *E-A* who, as Michanowsky explains was the southern sea and sky god with whom the Sumerians identified the great supernova Michanowsky believes that the loop of the symbol stood for the great burning star while the horizontal stroke represented the watery horizon of what is today called the Persian Gulf over which the Sumerians observed the supernova

SUN RIGHTS

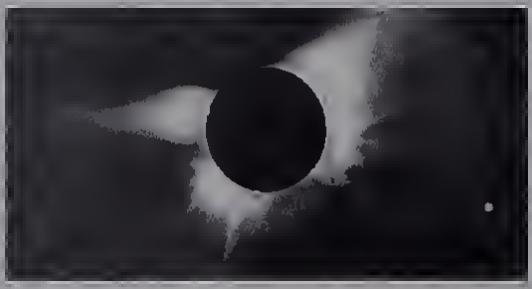
The Council on Environmental Quality projects that by the year 2000, 25 percent of our energy needs may well be met by solar energy Even now, sales for solar-energy collectors are booming, 500 000 square meters of solar panels were bought in 1977 alone

But for the unsuspecting new owner, trouble may loom right next door It could take the shape of a neighbor s second story addition or a venerable towering pine The current reality is Solar homeowners have no rights to unobstructed sunlight and no legal recourse if that light is blocked

The concept of sun rights has been rejected repeatedly by U S courts and, in the absence of clearly defined rights, the solar-collector owner is, at best in limbo

Recently, however a number of states have passed laws aimed at resolving the dilemma Several, including Minnesota, Connecticut and Oregon, have enacted legislation to encourage three-dimensional zoning which takes into account sunlight and shade, as well as overhead air space Shade-control ordinances devised so far regulate either the height of potential obstructions or their location, with outright bans on trees or new structures that would cast a shadow on a neighbor's equipment during midday (usually 9 30 A M to 2 30 P M)

—Katherine Horwitz



Rights to unobstructed sunlight do not exist for solar homes

FAMOUS RECORDED MESSAGES

*Hello, this is the answering machine of Marshall McLuhan At the sound of the beep, please leave a medium message

*Hello this is John Cage When you hear the beep, please don't say anything I'd much rather listen to the tape hiss and phone static

*Hello This is J Edgar Hoover It won t be necessary to state your name We already know who you are

*Hello this is Franz Mesmer You will take 500 francs and mail them to Dr Mesmer, 13 Rue le Graf, Paris Once this is done you will have absolutely no recollection of this message

*Hello, this is Dr Benjamin Spock At the sound of the tone please leave your name and number in a soft and loving voice Do not shout or curse for you will only alienate the machine

*Hello this is Socrates I am unable to take your call at the moment for I am out having a drink with my friends

BEE WARNINGS

Just as canaries once warned of lethal gases collecting in coal mines now, in a biological monitoring system in southeastern Montana honeybees are being used outdoors to provide early warning of environmental pollution

Bees forage widely picking up chemicals in air and water pollen and nectar, and from surfaces of flowers explains Jerry J Bromenshenk entomologist and ecologist of the University of Montana Missoula, in a recent issue of *The Sciences* They tend to accumulate harmful chemicals in their bodies at concentrations higher than those existing in the environment

Hives of commercial beekeepers offer a biological network to capture specimen bees freeze and chemically analyze them for any of some 40 trace or major elements In a current project funded by the Environmental Protection Agency, Bromenshenk finds that bees have shown an increase in fluorides since operation began of two new coal-fired power plants 15 kilometers away—Alton Blakeslee

CLONE KIT

Need some carbon copies of your spouse? Of someone else s spouse? Then you might investigate the Home Cloning Kit a perfect gift for the "Me Generation " Conceived and assembled by four Philadelphia journalists including Pulitzer Prize winning cartoonist Tony Auth the kit consists of a test tube, a culture medium, and a set of instructions that promises to grow something " Says Harry Jay Katz sales representative for the kit, 'People like you can now reproduce alone in the comfort of your own home The kit goes for $6 95 To order write Home Clone Corporation 1700 Walnut Street Philadelphia, PA 19103 It s better than a pet rock

...the Me generation

CONTINUUM

APHRODISIAC

Endocrinologists in Italy have found an experimental drug that has abolished impotence in some men and kindled sex drives in "women who never had an erotic feeling in their entire lives."

According to Andrea Genazzani of the University of Siena, the drug, bromocryptine, can induce menstruation in women whose cycle has ceased. Another clinical trial, described by Domenico Fonzi in *Chemical & Engineering News*, demonstrated the drug's ability to increase sexual libido and restore spermatogenesis in men.

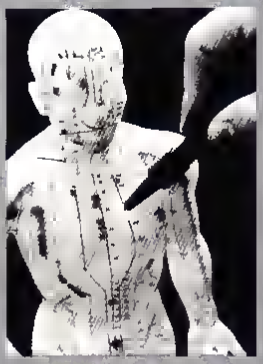
Bromocryptine acts by inhibiting secretion of the hormone prolactin in the pituitary, the drug's antidepressive effect may be due to its influence on the production of serotonin and dopamine, two major brain chemicals that partially regulate people's moods. Bromocryptine is now available in the U.S. on an experimental basis.

LASER ACUPUNCTURE

Those intrigued with the reported therapeutic advantages of acupuncture yet repelled by the thought of having their body pierced by hundreds of needles might consider trying laser acupuncture.

A German company (Messerschmidt-Boelkow-Blohm GmbH) has developed a laser-powered device that promises to make acupuncture both clean and painless.

Called "Akuplas," the device is based on the concept that red light easily passes through the skin and incorporates a low-powered helium-neon laser beam that can penetrate to a depth of between 3 and 10 millimeters, harmlessly and painlessly. By use of a glass optical fiber, the two milliwatt, rosy-colored beam is transmitted to a small pencil-like handpiece, where it can be directly applied to the patient's body. The focused beam can then be guided to the traditional 700 acupuncture points, from where, according to the ancient Yin/Yang principle, the various organs of the body are influenced.



Laser is directed at traditional acupuncture points on model

KIRLIAN PHOTOGRAPHY

If a flower, coin, or human finger is placed on an unexposed photographic plate and then subjected to a high-frequency, high-voltage capacity discharge, strange shapes and patterns known as coronas often appear around the object's image when the film is developed.

Since the discovery of this process by Soviet researcher Seymon Kirlian in 1939, there has been a growing interest in its possible medical application by Russian and other Eastern European scientists and governments. In the U.S., however, researchers interested in electrophotography have had trouble getting the scientific community to take their findings seriously. To scientists, Kirlian photography is a product of the occult whose adherents claim that the strange configurations are pictures of astral bodies, ectoplasm, and other far-out psychic phenomena.

If some of the findings at this year's second annual conference of the International Kirlian Research Association at Harriman College, Harriman, New York, can be duplicated in other laboratories, however, the use of electrophotographs for medical diagnosis may soon be commonplace.

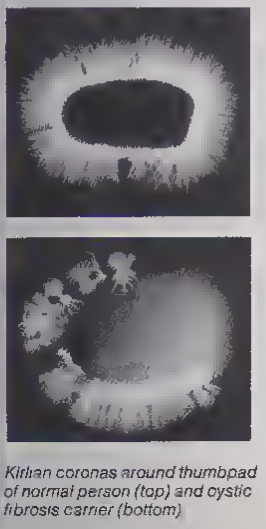
Three physicists at Drexel University have discovered that Kirlian photographs show marked changes in finger-pad coronas after hyperventilation, mental arithmetic, minor pain, and a 100-decibel burst of a 1000-hertz tone. They believe these changes result primarily from the amount of sweat being exuded from sweat ducts.

The Drexel work seems to be supported by the findings of Leonard W. Konikiewicz, director of medical photography at Polyclinic Medical Center in Harrisburg, Pennsylvania. He discovered that elevated levels of sodium and chlorine in the sweat generally signal the presence of cystic fibrosis, an inherited disease. Both sodium and chlorine are good electrical conductors. Konikiewicz's electrophotographs show how patients suffering from the disease have finger-pad coronas that differ substantially from those of normal subjects.

Kirlian photography may also have an application in cancer research. Dr. S. Mallikarjun, professor of physics at New Jersey's Monmouth College, claims that finger-pad coronas of healthy human subjects show time-related cyclic changes, while those of patients with cancer retain a highly intense luminosity unaffected by time. "In cancer patients successfully treated by surgery," Mallikarjun says, "the finger-pad image changes to the cyclic pattern."

Information on the latest developments in Kirlian research can be obtained from IKRA Communications, 411 East 7th Street, Brooklyn, NY 11218.

—Theodore Cogswell



Kirlian coronas around thumbpad of normal person (top) and cystic fibrosis carrier (bottom)

PACIFIC LOBSTERS

Lobsters, once found only in North Atlantic waters, have now been transplanted from their natural cold Atlantic habitat to the West Coast Not only do they survive in warm California waters, report San Diego State University aquacultural scientists Jon Van Olst Richard Ford and James Carlberg, but they grow nearly three times faster

"Because less time is necessary for lobsters to grow to full size when cultivated in warm water ' says Van Olst, "it will probably cost less to produce them—an estimated $2 24 to raise a 500-gram animal—if you can find an inexpensive source of heated seawater '

Doing just that they have taken advantage of the heated waste seawater from two power companies—San Diego Gas and Electric Company and Southern California Edison Company Directing the warm effluent into the breeding grounds they can maintain a temperature of 70°F to 75°F—possibly the ideal temperature for promoting lobster growth About 5000 lobsters, more than in any other culture program, are now being raised from the larval stage They are expected to reach the 500-gram market size in less than three years—a feat that takes seven to eight years in the cold waters of the Atlantic

The lobster transplant operation has not been without problems It has been difficult finding the right food mix the food some lobsters preferred turned them blue The color didn't affect their taste or edibility but might have startled the consumer Also, lobsters are cannibals, able to seriously deplete their own ranks However, Van Olst has already developed a revolving carousel contraption called ' care-o-cell ' which channels the lobsters into private quarters and curbs their cannibalism

Univ of Sty of California San Diego

Van Olst holding lobster specimens from aquaculture project

HOMEMADE SPACE TRIP

The man who designed and built the "Skycycle' for Evel Knievel s ill-fated Snake River Canyon jump three years ago now says that for one million dollars he will put any man or woman into space

Robert Truax of Project Private Enterprise has created a seven-meter-long single-stage reusable rocket in the backyard of his home in Saratoga, California Assembled from old surplus government equipment, the "Volksrocket X-3" will be capable of lifting an astronaut to an altitude of 80 kilometers (about 50 miles), to the edge of space

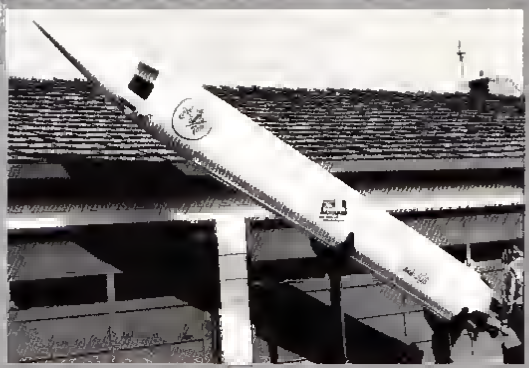
Formerly a research chief at the Aerojet General Corporation, Truax is said to be something of a pioneer in rocketry His past experiences include work with the Navy Air Force and Department of Defense He was also involved with the Mercury space project and Polaris missile

Truax already has found a customer " Thirty-one-year-old Martin Yahn of San Jose, married and with two children, was chosen from a list of 50 applicants Yahn, presently unemployed doesn't happen to have a million dollars to buy a ticket, but he is enthusiastic Truax plans to send him up for free

The Volksrocket has already undergone several successful ground tests, and if all continues to go according to schedule, it should be ready for take-off just 18 months from now—about the same time the Space Shuttle will blast off from Cape Canaveral

Several days before the launching, the Volksrocket will be set up next to a large body of water (probably the Pacific Ocean but any large lake will do) There he will have a recovery team standing by armed with a 34-meter cutter two helicopters and an airplane Yahn, enclosed in his air-tight compartment will be hoisted atop the seven-meter booster by a crane Moments after the engines fire the rocket will rise faster than 860 meters per second

Once the rocket has reached an altitude of 28 600 meters, the engines will burn out leaving Yahn to coast to a maximum height of 80 kilometers The rocket will then descend back to 28 600 meters where a small parachute will be automatically released Five minutes later, when the rocket has dropped to 6000 meters the main chute will be deployed reducing the rate of descent for a safe splashdown Total time of travel—about ten minutes If Yahn survives, he will have the singular honor of being the world s first private astronaut



Photograph by Val — Solar

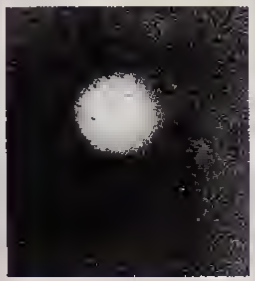
For one million dollars you too can journey to the edge of space in the Volksrocket X-3 shown before builder's garage

CONTINUUM

GRAVITATIONAL IMAGE

The Nye Optical Company of Spring Valley California has announced that it has successfully photographed the gravitational field around a 500-gram lead weight The photograph was obtained by placing the weight in a recently developed gravity chamber called GRIM 1 that is capable of forming an image of minute gravitational fields and then photographing the image with ordinary high-quality camera equipment

The photograph is what experimenters call a near-contact gravitational field image—analogous to the optical situation that occurs when a flashlight is placed in near contact with photographic film The validity of the process was confirmed in two ways Several images of the same object agreed fairly well and interactions between three objects produced gravitational barriers (points where the forces between the objects are in equilibrium) that roughly agreed with computed values



First gravitational image ever made a 500-gram lead weight

The Nye Optical photograph is believed to be the first image of a near-contact gravitational field ever obtained It is particularly significant because it is only one step removed from imaging gravity at a distance and it may serve as the basis for the future development of gravitational optics If gravity could be imaged at a distance, then the structure of the interior of the earth or even the interior of the sun could be mapped 'Beyond this, we look to the production of synthetic gravity and hopefully coherent synthetic gravity" says Richard Nye president of the Nye Optical Company "Then the crowning achievement will be gravitational or magnetic holography Some responsible people are even beginning to talk about the neutralization of gravitational fields

NO PEDICURE

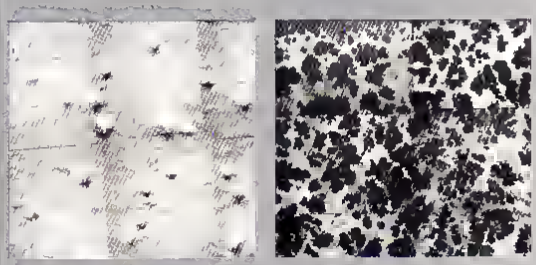
If you enjoy nibbling on your toenails be consoled Many others share your vice While researching a cure for finger nail biting psychologist Frederick Smith of Brigham Young University discovered a high incidence of foot-in-mouth syndrome During interviews with 75 fingernail munchers Smith discovered that two of his subjects also liked to chew on their lower digits Convinced that foenail biting was far more widespread than ever realized Smith pursued this line of research further He estimates that as many as 15 percent of all Americans engage in this unusual habit

Although that figure may seem high Smith points out that most people bite their toenails in secrecy because they feel it is a 'rare or abnormal practice that would invite scorn from others " But despite their fear of being ridiculed Smith has found only one subject able to break the habit—and that was because he became too overweight to get his foot into his mouth

THE ACOUSTIC MICROSCOPE

The acoustic microscope, which forms images by sound waves, will soon take a place beside the electron microscope and the light microscope as a valuable research tool in science and industry By next year, Calvin Quate and his research group at Stanford University hope to complete an acoustic microscope that can take pictures at sound frequencies of three billion cycles per second—equaling the resolution power of optical microscopes

The instrument which produces images of specimens by means of a scanning acoustic beam that reveals properties of matter that are not detectable by light or electron microscopes will open up new frontiers of research into the density elasticity and viscosity of materials In industry the acoustic microscope could be used for detecting flaws in crystals of gems and for locating faults in integrated circuits In addition, a number of medical diagnostic uses for the microscope already have become apparent Growing evidence indicates that cancerous tissue transmits sounds at a higher velocity than normal tissue This velocity differential could be utilized to detect malignant growth Sound waves may also be valuable in diagnosing certain forms of anemia and other blood disorders



Cobalt-titanium alloy optical image left, acoustic image right

ELECTRICITY & WEATHER

There are hundreds of statistical correlations between solar activity and the weather, but scientists are generally skeptical of their validity because the driving force for the earth's atmosphere—the sun's heat—is essentially constant In a recent issue of *Nature* however, Ralph Markson of the Massachusetts Institute of Technology speculates that the connection may not be thermal but electrical

The solar cycles to which weather cycles appear con-

Bruce Roberts © Photo Researchers Inc

Sun may affect thunderstorms

necfed—sunspots and solar flares—involve electrical and magnetic phenomena Markson hypofhesizes that thunderstorms on the earth form what is essentially a vast global electric generafor fhaf drives current through the atmosphere The current flows from the storm clouds up into fhe ionosphere (fhe charged layer in the upper atmosphere) and refurns to the ground in a diffuse form in fair areas outside the storms Thunderstorms release a lof of energy and at any one time there may be 1500 raging over fhe earth

Flares on the sun could change the resistance of the elecfrical circuit in two ways by shoofing out a greaf number of charged particles from the sun that the earth intercepts and by sending out magnetic fields that deflect fhe rays from reaching the earth

The solar flare particles would tend to lower the resistance of the atmosphere especially above thunderstorms enhancing their aclivity The effect would be greatest at higher latitudes, where fhe particles penetrate most deeply At lower lafitudes the lesser number of cosmic rays reaching the earth would increase the resistance of the atmosphere, suppressing thunderstorm activity there

"If atmospheric electrical variafions can influence weafher, this suggests another way that we might tamper with nature,' Markson points out Nuclear explosions in the atmosphere for example, could release charged particles that might alter fhe weafher Very-low-frequency radio waves senf ouf from the ground or from space could do the same

Speaking of modifying the weather by radio waves in a recenf issue of *Science* C G Park and R A Heillwell of Sfanford University present statistics showing that radiation from ordinary elecfric power lines leaks into the ionosphere and sfimulates strong, very-low frequency radio waves that can be detected bolh from space and from the ground

Observations from three stations in Antarctica show that fhe radio-wave acfivity induced by power lines tends to occur when power consumption is high in northeasfern North America They report. "Much more research is needed before we can estimate how much impacl this phenomenon has on the upper afmosphere and what ef fects, if any, filter down lo the lower atmosphere"

"The universe is not only queerer than we suppose, but queerer than we can suppose."

— J B S Haldane

MAGNETIC SENSE OF SHARKS

Not only do sharks possess an excellent sense of smell and a fine sensitivity to low-frequency vibrations it now seems they can find both their prey and their directions *electromagnetically*

The first evidence of fhis remarkable abilify was produced more than a decade ago when Adrianus Kalmijn of the Woods Hole Oceanographic Institution showed fhat sharks can detect electric fields as low as a hundred-millionth of a volt per centime fer Since all organisms in the sea produce small elecfrical fields, sharks can uncover from under the sand fish they cannot see Moreover fhey will also attack live electrodes buried there

Just this year however Kalmijn has found fhaf sharks also navigate using fhe earth's magnetic field as their guide By acfively swimming fhrough the ocean a shark cuts fhe magnefic field lines of the earth, inducing an electric current around itself which it detects by the same sensory organs it uses in detecting prey The direction in which it swims affects the direction of fhe current induced Thus, in a manner of speaking sharks have an internal compass that works electromagnetically

Sharks are not the only animals with an internal compass Early this year Kalmijn trained a small species of stingray which is also electrically sensifive to receive food in a section of a fank that was magnetically east or west depending on the trial From this and other information he has come to the conclusion that sharks and rays may not be nature's smartesl creatures—then again for 300 million years fhey have not gotten lost

—Kenneth Jon Rose

New York Zoological Society

Sharks use electromagnetic sensory organs not only to zero in on prey but also to navigate by the earth s magnetic field

CONTINUUM

HOME-BREWED TORNADOES

In the past 50 years tornadoes have killed some 9000 people in the U S and have destroyed up to 300 million dollars of property a year Yet these devastating twisters have remained bafflingly unpredictable

Recently, however Ernest M Agee, Christopher R Church, and John T Snow of Purdue University have constructed a huge tornado-making machine indoors, in their laboratory in West Lafayette, Indiana

The 6 5-meters high by 3 5-meters wide tornado-maker simulates on a small scale various sizes and strengths of a

Photo Researchers Inc

Predicting the unpredictable.

twister results can be readily related to the dynamics of an actual storm By engaging a powerful blower atop the machine 1140 cubic meters of air per minute is sucked into the giant cylinder creating home-brewed two-meter tornadoes By simulating the natural conditions that contribute to the development of a tornado the three meteorologists are certain they can eventually predict not only the storm's ferocity but also its elusive path of travel

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"We must welcome the future remembering that soon it will be the past, we must respect the past remembering that once it was all that was humanly possible"

—George Santayana

BIRDS

According to Cornell biologist Melvin Kreithen who has been working with homing pigeons for over ten years birds inhabit a sensory world that makes the human senses of sight and hearing seem truly earthbound

"Birds have a full panoramic view of the earth and sky," Kreithen says, "and for them the sky is ultraviolet and blue crossed by a series of grid lines in great circles The grid moves across the sky as the sun moves We know honeybees use the grid in getting back to the hive and birds can do the same trick, I suspect"

Whereas human ears quit at sound frequencies lower than ten to twenty cycles per second birds can hear infrasounds (ultralow frequencies with extremely long wavelengths) down to three cycles per minute Infrasounds are created by large-scale geophysical events says Kreithen "There are several acoustic beacons in the Western Hemisphere One is in the mountains in Argentina another in the Cascades of the Pacific Northwest When the wind blows through peaks it creates infrasound, which a bird can hear up to 5000 kilometers away This means that a bird flying over the geographical center of the United States could hear the wind in the Cascades and the infrasounds from winds blowing across the tops of waves on both the Atlantic and Pacific oceans simultaneously"

Birds can pick up the sounds of thunderstorms several thousand kilometers away and earthquakes farther away than that They can also hear the low frequency resonances of the up-and-down pulse of the ionosphere during magnetic storms and the rumbling of the aurora borealis

So strong is the navigational system of pigeons that they can fly home from up to 160 kilometers away *blind* Biologists have placed frosted lens caps over their eyes to blind them yet still allow light to enter their eyes (if totally blinded they go to sleep) "I've taken them 160 kilometers away in random directions and released them at breakfast time and then seen them come helicoptering out of the sky within 100 meters of their roost at dinner time," Kreithen says They also seem to have a good sense of barometric pressure and can orient to the earth's magnetism When we hang magnets on them, they fly differently"

—Jeff Cox

Photo Researchers Inc

Birds can sense infrasounds, magnetism, barometric pressure.

ELEMENTARY WISDOM

The following definitions come from students of elementary-school teacher Harold Dunn

"The way psychology is different from sociology is say that a man kills a neighbor Well, psychology blames the man and sociology blames the neighbor"

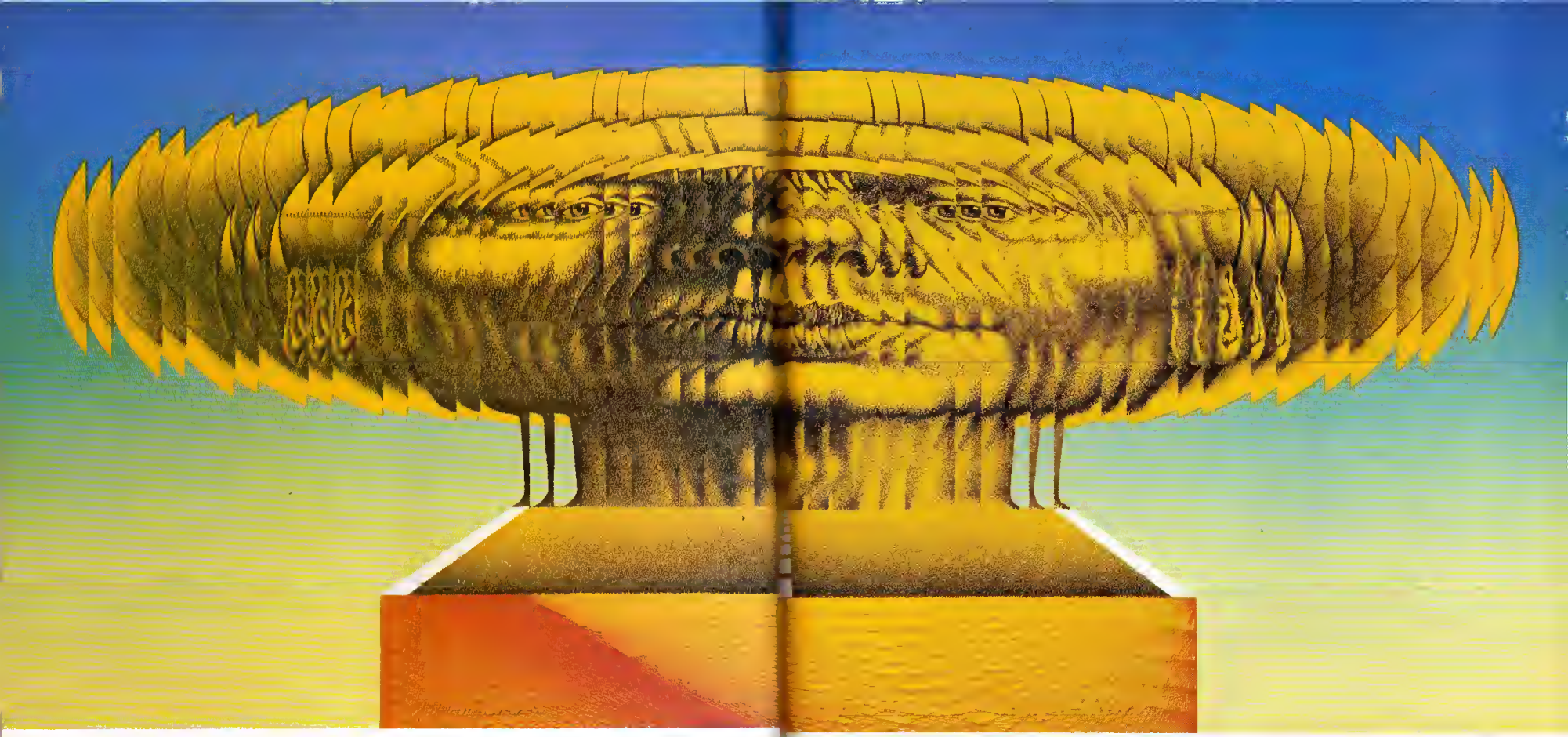
Biology is a spare word for when you cannot think how to say insides"

"Genetics explain why you look like your father and if you don't why you should"

"Meteorology is the study of how to get climate without weather"

Astronomy is the same as astrology except the opposite"

"Geologists are one of the chief by-products of geology"



SOME OF US MAY NEVER DIE

There may be no biological limit to the human lifespan. In the near future a healthy 21 year old might live 200 years or more.

BY KATHLEEN STEIN

In October 1976, Luna, the 16-year-old daughter of science writer Robert Anton Wilson, was brutally beaten and killed in a grocery store robbery. Helpless in the face of death, Wilson took the only action he could. He had the child's brain set immediately in cryonic suspension, frozen in liquid nitrogen at 320 degrees below zero (Fahrenheit). From this brain a part of Luna's identity may someday be reconstructed, or, from one of her stem cells, a new body cloned. Hers was the first brain to be frozen in this manner. Now, however, a special cryonic cylinder for the brain has been made available for the purpose of future cloning or identity reconstruction of some other kind.

Cryonic preservation is undertaken on the premise that the infinitely more advanced medical scientists of the future might be able to revive the dead and repair whatever killed them. It's a long shot, to say the least, but the odds are still better with freezing than they are with cremation or burial. Some cryobiologists estimate that certain bodies could be preserved for

several hundred thousand years without any deterioration.

However desperate, bizarre, or macabre an effort it may seem, cryobiological interest is growing and profit-making organizations such as Trans Time in Berkeley, Bay Area Cryonics, and the Cryonics Society of Michigan are forming around the country. Adherents of the practice include people such as Woody Allen and Columbia University physicist Gerald Feinberg, who conceived the hypothetical faster-than-light particle, the tachyon. It is rumored, although without confirmation, that Walt Disney is among those whose animation is cooling off until a better day.

Unlike Luna Wilson's body, most of the souls resting in cryonic suspension are intact. Immediately after death each body is packed in dry ice, drained of blood and filled with glycerol and DMSO (dimethylsulfoxide) an antifreezing agent, to prevent ice crystals from forming in the living tissue. The frozen body is then wrapped in aluminum foil and stored in a thermos-like insulated double-walled polished steel "cryonic storage capsule" until the millennium. The body is "buried" in a cryonic cemetary which uses auxiliary power sources to keep it frozen even in the event of a power shortage.

To keep the immortal fire burning, however, is no minor financial undertaking. For most people, the initial cost of interment amounts to about $15,000 with a maintenance charge of $1800 a year. At Bay Area Cryonics a $50,000 insurance policy is said to cover the whole thing. And you have to plan ahead!

DEATH VS. THE PEOPLE

The obvious drawback to cryonic suspension is that you have to die in order to enjoy an extended life. But movements such as cryobiology point to the growing rebellion against aging and death. People simply want to live longer, better, and are less and less willing to "go gentle into that good night." And the cryonic refrigeration revolution with its "freeze . . . wait . . . reanimate" is not the only front on which death and aging are being attacked.

In Robert Anton Wilson's *Cosmic Trigger*, Paul Segall, Ph.D., a researcher in the department of physiology at the University of California, Berkeley, offers several approaches to longevity, which include:

- *Transplantation*, which might allow us to continue replacing organs "until the point where we are still there, but our entire bodies are new."
- *Prosthetics* and *cyborgs*, machine-human combinations of which the Bionic Woman is a none-too-fanciful projection.
- *Identity reconstruction* through cloning.
- *Regeneration*, a process by which repressed genes are switched back on to renew cell tissue.

And at the heart of the matter is *gerontology*. This science investigates not only the chemical and biological processes of aging, but also the possibilities for extended healthy life. If gerontology research proves as promising as it looks, drastic measures such as freezing, cloning, and mechanizing humans in order to preserve your vital personality may not be necessary. Most efforts in the gerontological field are concerned with postponing senescence.

As early as 1962, Dr. Bernard Strehler, professor of biology at the University of Southern California, and one of the indefatigable warriors of the seige on death, announced that before long science will have understood aging's sources and that "toothless, wrinkled, mindless incontinent wrecks with Dorian Gray-like [sic] bodies—they will not exist!" In the absence of aging, Strehler said, the longevity of a healthy 21-year-old could exceed 2000 years.

"If life extension becomes a national priority . . . if there were a $200 billion assault on aging and death . . . in five years we'd have a program that would put such a dent in death we might wipe it off the face of the earth."

Following the startling hypothesis that aging could be curable, gerontologists have been piecing the puzzle together, moving closer to pinpointing the causes of aging, the sources of longevity.

Right now it seems quite possible that the underlying cause of aging may not be impossibly complex, but singular, primary. It may be that senescence is not a natural phenomenon, but a byproduct of social conditions. There may be, in fact, no biological limit to a healthy, vigorous lifespan. To extend the accepted lifespan potential from 70—100 years to 120, 200, 400, 1000 and on up, may be part of *Homo sapiens* on-going evolutionary destiny.

With the tremendous explosion of knowledge of basic molecular biology and genetics, we are learning the secrets of life and in doing so, we're learning how to control aging, to extend life.

Data now are beginning to indicate that life extension is inevitable. We may have some way of lengthening our lives before the year 2000. Some of us may never die.

An array of potentially useful drugs are in various stages of testing, drugs which may not extend lifespan significantly, but which will stave off bodily wear and tear, perhaps rejuvenate the body and preserve energy and youthfulness past middle age. These drugs might contribute to a 'synergistic effect' whereby one advance buys a person enough time to live well until the subsequent discovery prolongs his health even more.

Anti-aging therapies are being tested that combat free radicals, for example, those fragments of molecules which break off, careen about the body tissue wreaking havoc and contributing to the build-up of cellular garbage such as lipotuscins. Dr. Denham Harman, an internist-chemist at the University of Nebraska school of medicine is working on a series of antioxidants, which react with free radicals and minimize their effects.

Dr. Harman developed a number of compounds that increase life expectancy as much as 50 percent in mice. These include Vitamin E, 2-MEA (mercaptoethylemine), a compound first used for radiation detection, BHT and Santoquin, commonly used as food preservatives, as well as sodium hypophosphite, an old drug used for the treatment of tuberculosis around 1900. These drugs all have extended life expectancy in mice, and Harman hopes this testing will now extend to larger mammals.

Another compound, DMAE (dimethylaminoethanol), is showing promising results, reports Albert Rosenfeld in his important book *Pro-Longevity*. DMAE is a lysosome membrane stabilizer, and as such it strengthens cells against damage caused by lipofuscin accumulations. When lysosome membranes are damaged, harmful substances leak out and may be responsible for aging symptoms.

Dr. Richard Hochschild of the Microwave Instrument Company of Del Mar, California, found that by adding DMAE to the water of mice he increased their lifespans significantly. Other investigators have successfully employed centrophenoxine, a synthetic compound derived in part from DMAE, to delay lipofuscion build-up in the brain of guinea pigs. Centrophenoxine, which has almost no toxic side effects, is already used experimentally with apparent success in France to improve the mental abilities of senile patients.

The first drug likely to pass through the FDA's interminable bureaucratic maze, however, is the well-publicized Gerovital, developed in 1945 by Dr. Ana Aslan of the Bucharest Geriatric Institute. In Romania it is possible to get "youth shots" of Gerovital's 2 percent procaine hydrochloride and haematoporphyrin solution from government doctors.

Over the last 25 years, Dr. Aslan has claimed to have cured people of everything from heart disease and athritis to impotence and gray hair. But few scientists are prepared to sing the drug's praises.

Says Dr. Ruth Weg, of Andrus Gerontology Center of the University of Southern California. "We just don't know."

The list of potentially effective drugs, then, is growing geometrically, and the catalogue of agents that offer some chance of alleviating or postponing some debilitating symptoms are imminently testable. In the future, moreover, enzyme cocktails and genetic manipulation in pill form might be as commonplace as valium and birth control pills.

EAT LESS, LIVE LONGER

Since the 1930s, classic laboratory studies show that restricting an animal's diet in the first half of its life can double its lifespan—to the point where a 1000-day-old rat can be compared to a 90-year-old human with the body of John Travolta. These experiments have been conducted on everything from one-celled *Tokophrya*, to rotifers, worms, insects, mice, hamsters, and rats with similar results. This is a key concept in the theory of life expansion. Restricting diet delays maturity and increases longevity.

Dr. Roy Walford, a pathologist at the UCLA school of medicine, a man with a reputation among his colleagues for meticulous research, recently has extended this nutritional study to include the testing of mental function. He will find out whether dietary restriction produces long-lived idiots or long-lived supermice. "It may well be the supermice," he says.

In a new development, Walford and his associate Dr. Richard Weindruck have discovered that when dietary restriction is begun in mid-life mice, the animals' immune systems seem to be rejuvenated. A chief researcher in immunological systems, and the author of the *The Immunologic Theory of Aging*, Walford has found that in aging not only do the immune cells lose their ability to fight off the body's enemies, but they actually go berserk and turn against the very tissue they are supposed to protect. There is increasing evidence that this autoimmune response is a fundamental symptom of aging, which involves certain self-destructive acts. "like an art performance," Walford laughs.

Two years ago, Walford traveled extensively throughout India to measure body temperature regulation among the yogis. He found that through their yogic practices some could lower their body temperature one-half to one degree Centigrade.

Why lower body temperature? Walford and others have found that reducing body temperature of humans a few degrees could greatly extend lifespan. "A very minor reduction, about three degrees Fahrenheit," says Bernard Strehler, "could well add as much as 30 years to human life."

Neither Walford nor anyone else, however, has succeeded in lowering temperature in "warm-blooded" (homeothermic) animals, although Walford has experiments with the diverse substances, including marijuana, to determine to what extent they could do the job. Marijuana is the best substance for lowering body temperature," he says. Yet his mice developed a tolerance to the drug, and, after a few weeks of injections it had no effect on their temperatures. "There might be an analogue or chemically similar substitute that could do it," he speculates.

Richard Cutler of the National Institute of Aging's Gerontology Research Center offers the bizarre, but workable, scheme of actually inserting a tiny ceramic device into the blood vessel preceding the hypothalamus (where temperature is controlled). A microwave unit also might be placed in the bedroom. At night during sleep, when the body's metabolic rate is slower, the microwave unit would beam on and the embedded device would, in turn, trick the hypothalamus into thinking the body was in a fever of one or two degrees. The hypothalamus consequently would lower the temperature a degree or so. In the early morning, before awaking, the microwave unit would switch off and the body temperature would be restored to 98.6°F. The user would not be bothered, but might live twice as long.

"Will extended lifespan create a massive population explosion? Not at all, if every person has just one child—a quota that should be observed anyway, if the world is to avoid procreating itself into oblivion."

DEATH CLOCK?

As more is known about the genetic structure of life, biologists are coming to the conclusion that aging is not the result of slow 'trashing' of all parts, but may be the result of a genetic program, coded along with the other instructions for the functioning of the cells in its DNA. The big question remains. Are we programmed to die? Is there a "death clock" that turns off the genes one by one? Or is nature simply indifferent to our fate after we've played our part in perpetuating the species? Or does the program for growth and sexual maturity contain within it what Dr. Richard Cutler of the National Institute on Aging calls 'pleiotropic processes"—necessary functions which have by-products which in the long run are harmful to your health?

Many investigators on the case are now "pro-clock." Opinions vary drastically and vehemently, however, as to where the timepiece is located. One group theorizes that the aging mechanism occurs at the cellular level. Molecular biologist Dr. Leonard Hayflick discovered evidence that there are only so many times (± 50) a cell can divide *in vitro* before its descendants age and die. Thus, Hayflick concluded, the cell has a built-in genetic limit. And ever since the revolutionary "Hayflick Limit" was announced, it has been the target of continuous speculation. Critics scour the territory for evidence to refute it.

Dr. V.J. Cristofalo of Philadelphia's Wistar Institute, for instance, has prolonged cellular life by adding the hormones cortisone and hydrocortisone to culture solutions, thus suggesting that it is hormonal balance that signals the termination of cell division, not tiny clocks.

Dr. David Harrison of Jackson Laboratory, Bar Harbor, Maine, believes certain cells may indeed be immortal (as they were thought to be prior to Hayflick's results). When he transplanted stem cells, which have a large prolificacy capacity, from old animals into young, the old cells functioned as well as the young cells did when both were transplanted into young recipients.

Walford's rejuvenation of middle aged mice's immunological response, as well as work he has done with congenic mice strains, leads him to believe that control of the entire immune system is located within a small region of genetic material—corresponding to the sixth chromosome in humans. He suspects that this control center is fundamentally involved in the aging process as a whole—that it may be "the man pulling the strings behind the scenes." These strings may involve only a few genes.

THE BRAIN, HORMONES & DECO

Many other scientists now think the program for aging is encoded in the hypothalamus-pituitary system. The hypothalamus, that tiny pea-sized node at the base of the brain, is the master regulator of hormone distribution, and, along with the pituitary and endocrine system, it comprises the regulation network affecting virtually all homeostatic systems as well as growth and sexual development.

The body flashes an uninterrupted series of response and feedback signals between the individual glands and the brain. Aging may disrupt the hypothalamus's ability to run the show. Years of evidence more than suggests that the hypothalamic control of hormonal release goes haywire with aging.

By stimulating the hypothalamus of aged female rats with electric impulses, Dr. Joseph Meites of Michigan State, has successfully reactivated their estrus.

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Painting By Bob Venosa

FICTION

VALLEY OF THE KILNS

In one voice they pledged fidelity to the brick fires, but one among them dared to violate the law of the clay.

BY JAMES B. HALL

In these mountains, our flight together now past, I understand more clearly a return to the valley of my youth and to its factories might signify reconciliation and might be even wise yet against that compromise. I face again the ultimate fact of my wife now dead, and also two children. A sentimental gesture of return to the quarries can only dishonor love's memory. In this cave, therefore, I shall remain and here I shall die.

Before the death by falling (boy), by deadfall (girl), or her death (broken heart), I understood only a little the price of our rebellion. What I had not fully understood until now is how little our crime changed even slightly the established quotas of work, or the products of clay which at this moment are being fired, tallied, and cooled each week and each quarter of every year. In the Valley of the Kilns our names are not recorded.

To the thousands of workers who remain, our flight so long ago signifies nothing. No person shall profit from either our hardships or from the example of our devotion to one another. Were I to return to the Valley for trial, would public confession of error perpetuate her memory? I doubt it.

Nevertheless, I shall make this chronicle of two lives accurate with neither apology nor self-delusion intended. And as I set down these words which never shall be read, farther back in this cave I hear the great clay heart of the world beating darkly among stalactites.

At dawn, when the snowfields above wink in the first light, I foresee clearly my own fate: extinction by wolves when I can no longer walk our cave-path to the grove of oaks for fuel. Until then I accept austerely the seasons remaining. Towards evening I watch deer walk from the forest near my deadfalls to drink; at times, when the rains of winter come my certain end may seem almost just. If by chance, in the future, someone reads these mere words on paper, no doubt they will make other judgements, each reader for himself alone.

Although in the Valley the routine of each morning is the same, I recollect vividly my first day of duty on the high escarpments.

Before the first rays of the sun illuminated the peaks, I was awake. In the farthest reaches of our barracks-caves, I heard hundreds of workers stirring, on their feet now, coming towards the light to work. Outside, the first "music" from the loudspeakers flooded our flat, wide, white assembly area.

Across the Plaza, on the front porches of their individual dwellings, precisely at the same moment, our foremen appeared. In a stately way, all in a line, they walked across the Plaza.

As the sun rose all crews stood precisely at attention.

Fascinated, we listened to the roll call of production units, then yesterday's work done, and this new day's communal goals. With great excitement each morning I heard the tonnage for Escarpment Six. With one voice we pledged Fidelity to the Kilns, our work to be pure, to uphold the customs of our craft, to sacrifice, etc., etc. My voice with a thousand other voices re-echoed our pledges upward into the sun's first rays. And I was young.

Therefore I accepted with pride the challenge of the high escarpment, where the clay was talcum white. From those heights our kilns seemed only row-upon-row of brown smoke hives no larger than a wineskin. We tamped black powder into holes drilled by hand. We blasted away great avalanches of rock which fell like a long white feather of rolling thunder towards the conveyor gangs three thousand feet below.

Our work was elite work. We knew the entire enterprise of the Valley rested upon us: without clay all kilns must cease production. The risk was great and only those with a nimble, extraordinary sense of possible catastrophe survived. On the high escarpments my character was formed, and I became a man.

Towards noon our Foreman signaled his drill crews strung out along the sheer, rising walls. Casually we came down to his assembly area to eat and to rest for the one hour allotted to us each day.

"So, my eagles come for food?" our Foreman always said, and each day smiled at his own joke. Yet it was true: we called one another "Eagle." Because of rains or wind erosion, if an apparently solid path gave way suddenly with a hollow rush of air beneath a man's feet, we believed that man flew through space for a long time before the rolling, white-feather avalanche took him.

I saw two hundred men "fly" briefly, then disappear into tons of rock and white clay at our escarpment's base, yet not one man cried out. Instead, backs arched, arms extended and in that classic position they fell—down, down, became smaller, smaller—and at last tumbled end over-end when the avalanche of rock took them.

Our bread, our white cheese, our customary wineskins passed from the eldest to the youngest man in our crew, vividly I remember the shapes of our brown, hairy legs as we rested beneath the shade of an overhang. Against the talcum dust our feet were sturdily splayed, for our ancestors for a thousand years had also worked these quarries, had climbed these escarpments of clay where dust and sky became one.

At those moments of rest even a piece of bread became alive in the callous grace of our hands. Against white clay our intricately woven, encoded loin cloths breathed in the light, into our loin cloths were woven our future assignments, our destiny in the enterprise of the kilns. Only foremen and upper-level management could read those secrets; all others obsessively stared without comprehension. Besides our identical matching headbands each man had a device implanted in the upper arm. At certain hours these devices made "music", at others, especially at night, they merely hummed and we knew happily that something was listening.

When the sun setting touched the first rim of the mountains, we re-formed on a lower terrace, by now our bodies had become liquid-ivory statues, breathing easily. Sometimes singing, incredibly white from the blown dust, we went at a half-trot to the valley floor.

At the assembly plaza, later, especially in the windless nights of Spring, the kilns seemed to become upright, mighty organ pipes, glowing in their own heat, turning orange, then red, and just before dawn,

"Into our loincloths was woven our future assignments, our destiny in the enterprise of the kilns. Only foremen and upper-level management could read those secrets. All others stared obsessively without comprehension."

pale blue. At those moments our singing became one voice rising from the dark, open throat of the Valley.

A feeling of right order came upon us. We were at one with an enterprise which signified purpose, something essential to our larger world.

One summer night exactly like that I lay half-asleep at the entrance of our barrack-cave. Above the escarpments I watched our constellation take more perfect shape: the Great Jug with three handles, to the West, The Brick, also mighty in orbit against the vast, ultimate furnace of our universe.

"Awake?" and it was my Foreman from the escarpment, his profile a blade of cast bronze against the light of our kilns.

"My Eaglet much awake?" his tone was ironical, the customary speech of all Foremen. In the mysterious way of management, he knew where to find me, and that I was awake, staring at our constellations.

Casually the Foreman picked up the end of my loin cloth. By holding it parallel, he shifted those patterns alongside the beads of my headband. When aligned, the two narrow sashes caught the light from the kilns, blinked, and for a moment seemed to join to become one larger pattern.

"What I see here . . . Eaglet—" My Foreman then held the bead patterns unnaturally close to his hooked nose. He said, "Yes, . . ." and again cleared his throat. "Is . . ."

For the first time, I realized the man who had first led me to the escarpments was near-sighted: worse, his hesitation conveyed absolutely that he did not clearly read—could only guess—what my loin cloth and headband patterns foretold. With more of a shock than I realized at the moment I understood the knowledge of all Foremen—and by extension all Management—was approximation, myth. Furthermore, in his moments of hesitation, my Foreman seemed incredibly old.

"Cert-ain-ly!" and I heard false enthusiasm. "She reads, 'new assignment.' Hah?"

Because I had grown to full manhood on the escarpments and had survived, I expected change, yes, and also reward and recognition. Yet because I had been taught so, at that moment I *felt* nothing at all. Thus my deeply protective reply was very much the tone of my Foreman.

"So, tomorrow is my time?"

Abruptly, he turned from me.

First he seemed an abnormally tall figure, his shadow massive, blue, then he was only a man growing smaller as he walked almost furtively back across the shimmering, absolute stones of the Plaza.

Because he had told me nothing, I called out.

He did not turn back.

Without thinking, I trotted across the Plaza, towards him and the first row of little houses where the Foremen lived with their "wives." I touched his shoulder.

Startled, he drew back. Fear was what I saw in his face, and in the gesture of his upraised arm. I had crossed their Plaza, had touched him. Because of my audacity, he drew back.

"Am I a Foreman?" I asked, "with house?"

He stepped back to the front steps of what might be his own "home." Because all windows in all the small houses were dark, I thought. *Why no one at all lives here. These are only house fronts. These doors lead only to other quarters, perhaps into barracks-caves.*

Far down the production lines an extraordinary flash of blue light illuminated his face, the house fronts, and his door.

"You . . . you have done well."

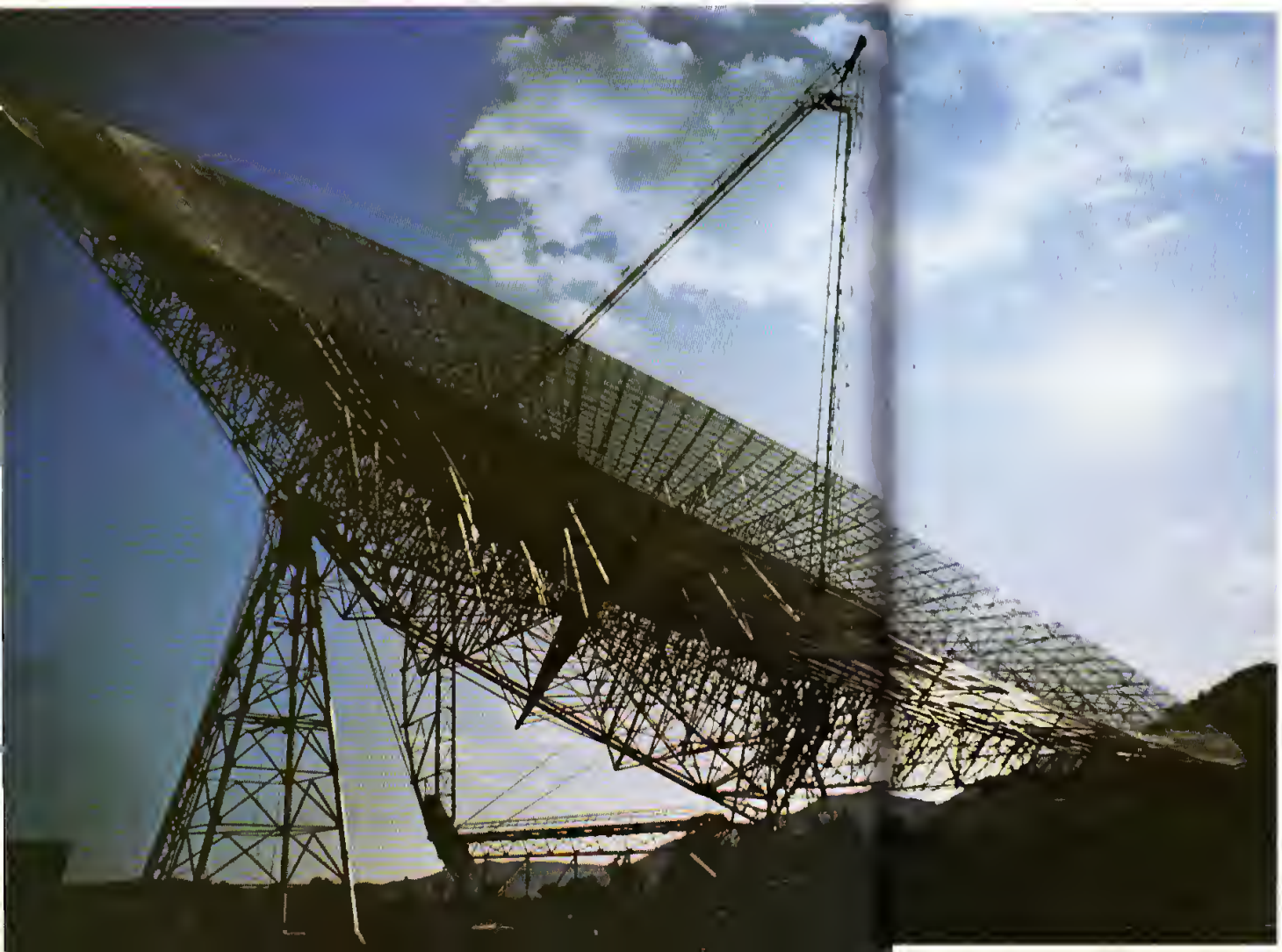
"Then a wife assigned?"

Harshly, in the dialect of all Management, he both spoke and turned from me.

With one futile disengaging motion of arm and shoulder, he disappeared through the door.

And of course I never saw him again.

Bent low, I trotted back across the Plaza.



Photograph by Fred Ward/Black Star

The 92-meter radio telescope in Green Bank, West Virginia

At this moment, astronomers over the world are eavesdropping on the starry cosmos

LISTENING FOR LIFE

BY ALTON BLAKESLEE

At any moment, radio signals beamed from some distant planet may be touching your body, unseen and unfelt of course, but bringing evidence that we earthlings are not alone in this vast universe.

Most astronomers now are convinced there is intelligent life, with some civilizations far more advanced than ours, on planets circling the billions upon billions of stars or suns in the cosmos. Further, some civilizations could well be broadcasting signals announcing their presence—telling us, if we could only hear, about their location, their knowledge of life and science, and of our own possible future.

Proven contact would profoundly affect human life, philosophically, spiritually, even materially. Some advanced civilization might instruct us on how to preserve life, how to avoid disasters and suicide by nuclear war, or by careless destruction of our own earthship's environment. They might even reveal how we could become immortal, like themselves.

It is such a tantalizing prospect that the National Aeronautics and Space Administration has now asked Congress for $19 million to fund an expanding five-year search with radio telescopes to listen for word from somewhere out there. Even now electronic "ears" in the United States, Russia, and Canada are listening closely for intelligent interstellar signals.

One proposal for the future is Cyclops: an array of some 1500 radio antennas, each 100 meters across, grouped in a circle 10 kilometers in diameter. To build Cyclops now would cost $10 billion, and there isn't yet the official sentiment to proceed with such a gamble. But Cyclops might be built in segments over many years to gradually extend our ability to intercept extraterrestrial messages.

Cyclops, says Frank Drake, director of the National Astron-

omy and Ionosphere Center at Cornell University would be so keen of hearing that it could likely eavesdrop upon, and then reproduce, a television program that originated on some planet more than 300 light-years away

Might we actually pick up programs that originated 300 years ago? Yes, Drake says, for it is a fact of physical law everywhere in the universe that radio and television and all other transmissions zip not only to receivers on the planet itself, but also radiate out in all directions into space Television signals are especially strong Like it or not, the earth has been announcing its presence for some 30 years through a cacophony of television and radio signals in a continuous outgoing wave of energy, traveling at the speed of light Drake estimates that our own "leakage" of signals has now gone out far enough to have impinged upon some 400 stars, their planets, and their intelligent inhabitants, if such exist

Might we similarly eavesdrop on television programs from planets 100 or even 1000 light-years away, bringing us their versions of Johnny Carson, the Spacemobile Runabout series, or toothpaste commercials—or television classroom courses revealing untold knowledge of health and biology, sources of energy, or even insights into unimagined areas of knowledge? The intelligent signals that we might detect from planets around other stars could reach us accidentally, or they could be directed deliberately at our general neighborhood in space Speculating about the abundance of such signals and whether they are impinging on us right now, Drake answers "I am sure they are We just don't know how strong they are, or what the frequencies are "

Drake is not alone in his optimism that intelligent life exists elsewhere in the universe He also is realistic about the difficulties of making contact with it

The universe is so vast that by one estimate there are 100 billion stars for each human now on the earth—and there are four-plus billion of us The Milky Way, the galaxy or family of stars to which our rather ordinary sun belongs, measures some 100,000 light-years across It alone contains 200 billion stars, or 50 stars per earthling And there are billions of galaxies in the universe

Within all these galaxies stars are forming, evolving, and dying So are their offspring planets Increasingly, the consensus among astronomers is that most stars have planets

"The birth of planets frequently if not inevitably accompanies the birth of stars," says Carl Sagan, director of Cornell University's Laboratory for Planetary Studies and winner of the Pulitzer Prize for his book *The Dragons of Eden* (Ballantine Books). Altogether, there may be 100 billion planets suitable for life within the Milky Way galaxy alone

Our sun is perent of nine planets, with only tha earth, to our knowledge, supporting intelligent life The two Viking spacecraft exploring Mars for life signs "gave discouraging but not conclusive negativa results." Dr Drake says The Vikings discovered that Mars has a peculiar surface chemistry but this was " not the result of organic chemistry either inside or outside of living things Alas, we found no dead bodies on Mars, no organic molecules that could be the past or present constituents of living things "

Stars, being nuclear furnaces, burn hydrogen to form helium and then in successive steps create heavier elements Exploding as supernovas, or expanding as red giants, they pour these elements out into space to become part of the dust clouds giving birth later to new stars and planets Stars, long dead, brewed all the atoms of your body

On the earth, atoms formed into the molecules of the primordial seas and atmosphere, which presumably consisted primarily of such substances as methane, ammonia, water, hydrogen, carbon monoxide, formaldehyde, and hydrogen cyanide Laboratory experiments in the 1950s by the biochemists Stanley Miller, Harold Urey, and Sidney Fox showed that organic molecules could be formed from those substances by heat or lightning or other natural events Chemical reactions synthesized amino acids (the building blocks of proteins), purines and pyrimidines (the units for genetic material), and also carbohydrates, hydrocarbons, fatty acids, and other organic compounds These could organize into more complex structures similar to those in living cells

Perhaps it all happened this way on earth Did it happen the same or similarly on millions of other planets? Drake thinks "there is almost nothing you can do to stop a primitive atmosphere from making the molecules of life The chemical processes that we have identified as being most important to formation of life on earth are in fact common results of the laws of chemistry We can expect that they have occurred in many places in the universe "

Space itself is a chemical factory for molecules basic to life In huge interstellar clouds of dust, radio astronomers have detected 40 or more molecules made in space, including ammonia, water vapor, formaldehyde, formic acid, methanol (wood alcohol), carbon monoxide, hydrogen cyanide, cyanoacetyline, and acetaldehyde Drake and others look upon carbon monoxide formaldehyde, and hydrogen cyanide as "the familiar triumvirate that probably dominated the production of the chemicals of terrestrial life "

The violent heating and collapse of a dust cloud to produce a new star and planets would destroy most of these organic materials, but not all Just as bits of wood, tar paper, cement, bricks, and the like are left over in building a house, so unused parts of the dust cloud would be left over in building a new solar system Comets are perhaps leftovers from the formation of our own solar system Drake thinks they may contain many cubic miles of the organic molecules, serving as deep freezes that carry the stuff for future life, which is released when they crash-land on newborn planets Large meteorites of the type known as carbonaceous chondrites might also be space freighters of organic chemicals The large Murchison meteorite that fell on Murchison, Australia in 1969 contained 18 amino acids including six that are found in living cells Another possibility is that a planet could pick up spece-made organic molecules when it drifts through a dust cloud in space

Drake estimates that a new system of intelligent beings is being created about once every year in the Milky Way Such beings could vary fantastically from us and from each other in their physical shape, appearance, mental set, motivations, morals, and knowledge Some might be a million years more advanced than us, others might just be beginning to reach our stage of technology Some galactic neighbors, curious to find other neighbors, may be sending beacon signals telling of their presence and skills On the other hand, they might be predators seeking promising new colonies

The first attempt to tune into radio communications from somewhere else began in 1960 with Project Ozma It started on a chilly April morning near Green Bank, West Virginia, a mountainous town of about 100 souls at the National Radio Astronomy Observatory (NRAO) The observatory's 26-meter-diameter antenna had its shiny cup-shaped ear pointed at two initial targets These were the stars Tau Ceti and Epsilon Eridani in the southern sky barely visible to the naked eye, both about 11 light-years away

Project Ozma was named after the fictional princess Ozma, in Frank Baum's book *The Wizard of Oz*, who ruled " a place very far away difficult to reach, and populated by strange and exotic beings " The project was largely the concept of Frank Drake then 29 with the enthusiastic support of the late Otto Struve director of the NRAO The time to begin the great search had arrived, with more sensitive antennas and radio amplifiers that had just then become available Special equipment for the initial listening cost about $2000 and was supplied by the National Science Foundation, which supports the observatory

For 200 hours over a period of three months, the radio ear was tuned to listen on a wavelength of 21 centimeters, the wavelength of radio waves emitted by hydrogen atoms when they become excited after colliding with other atoms in space That wavelength, it was reasoned, would

Photographs Courtesy Cornell University

Arecibo radio telescope, 310-meters across, rests in a circular valley in Puerto Rico Suspended high above it is the receiver which picks up the faint signals collected and focused by the dish In 1975, the telescope was used to beam a message from the earth to the Globular Cluster in Hercules some 25,000 light-years distant The message, shown to the left, broadcasted the binary numbers 1 to 10 the atomic numbers of elements of life the formula and structure of DNA a human figure a diagram of the solar system, and the telescope transmitting the message

be known to all physicists and astronomers in the galaxy since nature presumably plays the same rules all through the universe.

On this particular "telephone" line to Tau Ceti and Epsilon Eridani, Project Ozma sought for signals above the usual radio noise in the universe, something that would say, 'You are not alone, join the galactic club.' The coded signals might have been a mathematical formula, the atomic weight of some element such as uranium, or anything else recognizable as a planned artificial signal.

Once a signal was received, the plan was to broadcast it back. The reply would have taken another 11 years to reach Tau Ceti or Epsilon Eridani, and then another 11 years for us to learn they had heard us.

But no signal was detected.

Listening too late? Too soon? On the wrong frequency? No one knows for sure.

The concept of searching for extraterrestrial intelligence, however, has continued to intrigue astronomers. In 1968, under the direction of Vsevolod S. Troitsky at the Gorky Radio Astronomy Observatory, Soviet astronomers scanned 12 nearby stars similar to the sun in size. Two different series of observations were carried out from March, 1970 through November, 1970.

One problem that concerned the astronomers was how to determine that any signals received were actually from outer space and not the earth. It is possible for a radio-taxicab call in the streets of Bucharest to bounce off the moon of the ionosphere and be received back somewhere else on the earth! To eliminate that possibility, the Soviet astronomers employed two widely separated listening stations, first from Gorky and the Crimea and later from Murmansk and the Ussun region between Manchuria and the Sea of Japan. Since the antennas in each pair of stations were separated by thousands of miles, if all the stations received the same signal then it almost certainly had to be something different from a taxicab in Chicago or a radio talk show in Cleveland.

Once, Drake recalls, a Soviet scientist told him excitedly that they had picked up a suspected real space signal. Drake guessed, correctly as it turned out, that it was a signal from a newly launched American spy satellite. Nothing more was detected.

Soviet interest in searching for extraterrestrial intelligence continues high, with good possibilities of international cooperation in the cosmic search.

Troitsky, after his first attempts, renewed them in 1972 and has since continued. The U.S.S.R. now has a state commission devoted to organizing the quest, and its large RATAN 600-antenna radio telescope in the Caucasus is to be devoted to part-time listening duty. RATAN, which stands for (in Russian) Radio Astronomy Telescope of the Academy of Sciences, is 600 meters in diameter.

In 1966, British astronomers were briefly excited that they had received, in routine operations, what seemed to be an intelligent code. Further investigation revealed that they had detected a pulsar, a massive neutron star spinning rapidly and flashing radio signals like a lighthouse in space. Several hundred such objects are now known.

In 1972, Gerrit L. Verschurr, then at NRAO, also took a look at ten nearby stars, also without success. In Ozma II, between November, 1972 and August, 1975, Patrick F. Palmer and Ben M. Zuckerman used NRAO's then new 92-meter dish and its 140-foot dish to observe 659 nearby stars. Each antenna had a receiving system equivalent to 384 radio channels. The astronomers looked at each star for four minutes at a time, typically six or seven times during the program. The stars, 60 to 70 light-years distant, were similar to our sun in size and activity. Ozma II in five minutes repeated the original Ozma I, and cocked an ear at hundreds of additional stars. Again—no positive results.

Some believers in extraterrestrial intelligence are dauntless. In Canada, Alan H. Bridle and Paul A. Feldman are conducting a search of several nearby stars at the Algonquin Radio Observatory at Lake Traverse, north of Toronto in Ontario. At Ohio State University's Observatory in Delaware, Ohio, between five and 20 channels of its 2,460-square-meter radio telescope are devoted to listening for signals. Near Mt. Shasta, California at the Hat Creek Observatory of the University of California at Berkeley, specialists operate an 26-meter radio telescope to observe the motions masses, and temperatures of clouds of hydrogen gas in our own galaxy. But they also have mounted on it, piggy-back, a receiver that takes side looks for intelligent signals from space. Again, nothing of positive interest has yet been found.

Far southeast, in Puerto Rico, is the Arecibo Observatory, operated by the National Astronomy and Ionosphere Center of Cornell University. The Arecibo radio telescope, with its 310-meter-diameter antenna set into a circular valley, has 100 times the collecting area and six times the recording power of the NRAO dish that first looked out in Project Ozma for signals from space. In one-tenth of a second, the Arecibo telescope can duplicate what was done in 1960 in two months at Green Bank. It is able to detect signals that might be coming from civilizations hundreds to about 30 thousand light-years away.

Beginning in 1975, in programs initiated by Drake and Sagan, the sensitive Arecibo antenna was pointed at five galaxies. More recently, Paul Horowitz of Harvard University used the Arecibo telescope to search for intelligent signals from the 200 observable stars nearest the earth. In the most sensitive search for extraterrestrial signals undertaken so far, Horowitz simultaneously monitored more than 65,000 narrow radio channels.

All these eavesdropping attempts were carried out primarily on the 21-centimeter radio wavelength of hydrogen. The choice of the frequency illustrates a major difficulty in listening for extraterrestrial life. 'We are searching for a few needles in a fantastic haystack of inconceivable size," Drake points out. Even though the Arecibo radio telescope is the most powerful in the world, it "would have to point in 20 million

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Workmen walking on fine mesh surface of Arecibo dish must wear large "snow shoes" to distribute their weight evenly over large area. Flecks on photograph are debris trapped by mesh.

Photograph Courtesy Cornell University – (left) Photograph by Fred Ward/Black Star

FICTION

Even out of prison, he really wasn't free. A teleport implant had made his body the property of Lt. Denzlo.

INVISIBLE STRIPES

BY RON GOULART

He ran. So they shot him.
Five kilguns hit him almost simultaneously, slicing him into chunks.
Although everyone assumed his running was an admission of guilt, Andy Stoker wasn't guilty. Not this time.
But since the stranglings stopped when Andy died, the case was officially closed. Nobody, or hardly anyone rather, beside myself knows what was really going on. By the time I had everything figured out, Andy was dead and gone and I'm certain the Greater Los Angeles Police Department wouldn't believe me. Besides which, if I went near the GLAPD fortress out in the Pasadena Sector someone in the Murder Division would be sure to find out. Can't risk that.
So you're the only person I'm going to tell about Andy Stoker, about the stranglings and who really committed this particular batch of murders.
The first time I saw Andy in person was on a hot bleary afternoon in August of 2005. He was tugging off some of his clothes out in front of the main building of the Quakeproof Studios in the Burbank Sector of GLA.
Spotting him through the one-way window of the tiny office OS was loaning me, I jumped up and dived for the door.
"Musk," rumbled the dented robot secretary that went with the office.

Painting by Ernst Fuchs

"Beg pardon?" I hesitated, anxious on the threshold.

"Hair note save War musk."

"Oh, right." I dashed back to my floating metal desk, snatched up the breather and clapped it to my face.

"Half a hobby die," chuckled the old bot as I headed out again.

Back in the Connecticut Enclave where I live, the air is usually breathable, so I wasn't in the habit of wearing a protective mask. When I first hit the glaring afternoon outside, the tinted goggles seemed to go black for several seconds. By the time I could see again Andy had his tunic off and was slapping at his bare chest.

The android security guard, a baffled expression on his cream-color face, was holding his stungun at the ready.

"It's okay," I called, running in the direction of the security huts. "He's my guest."

"Just look at that, will you?" Andy ordered the guard, tracing a finger over the certificate tattooed on his flesh. "They did program you to read, didn't they? This states I graduated *with honors*, from the Pasadena Playhouse For The Criminally Insane. I'm absolutely clean now. No matter what the Murder Division may have told—"

"You got to have a pass," the humanoid guard insisted. "I'm not all that interested in your body, sir, nor in its decorations. Your criminal past is so much water over the dam so far as my duties—"

"Hey, he's alright!" I said. "He's here to see me." I had reached them.

The guard cupped his gunfree hand to his metal ear. "Eh?"

Andy reached over, gave my breather a thump with his fist. "You shouldn't wear an American brand mask," he advised. "Especially one of these clunky GEs. They garble your speech, let in enough airborne carcinogens to kill the average lab rat in about fifteen—"

"Ah. I recognize you, sir, by the New England cut of your two-piece daysuit," the guard said to me. "Very ivy league, now that I make it out through the haze. You're the gentleman from Oldies, Ltd."

"Exactly," I shouted through my mouthpiece. "This is Andy Stoker, came to work as a technical advisor on a nostalgia show we're doing entitled *Fabled Pattern Killers Of Yesteryear*."

"I happen to be a pattern killer myself," Andy told the guard, grinning. "Relatively famous, about five years ago, as Captain Midnight. So called because I always struck at exactly—"

"My memories only go back two years, sir," said the android. "In show business that's sufficient. Famous murderer were you?"

"I strangled nine people, made the covers of *Timelife* and *Mammon* in the same week." Andy stooped to grab up his discarded tunic.

I noticed a nasty reddish lump on his back, but didn't comment on it. "Come along, Andy," I said, catching hold of his arm. "I'll show you the sets they're building."

Andy continued to address the mechanical guard. "I was the best known video-induced criminal of the year, although I'm less famous these days. Except to the darn Murder Division of the Greater Los Angeles Pol—"

"You'll vouch for him, sir?" the guard asked me.

"He doesn't have to," answered Andy. "I'm *clean* now." He poked at the tattooed diploma. "I won't strangle anyone, ever again. *Unless* I happen to be goaded into it by a suggestively violent television show. Since, however, I'm forbidden by the terms of my parole to own, operate or even look at a tv set, a disksyst or a vidwall, there's very little—"

"The sets, Andy," I hurried him away across the bright, hazy grounds of the

"What is that thing?" I asked referring to an inflamed reddish lump. "That's my teleport box. They let me loose but they stuck me with this ... which means I'm wearing invisible stripes."

video studio. Ever since he'd criticized my breather I'd felt the thick air was sneaking in and seeking out of my lungs and doing them harm. "They're all indoors."

"I'm sorry I lost the pass you sent me," he said as we, rapidly, walked toward Studio C. "It fell out of my pocket while I was upside down over the Grand Canyon."

"Why were you in that position?"

Andy was a long, lanky young man of about 29 and, being several inches taller than me, leaned down now and lowered his voice. "It's got to do with romance," he confided through the mouthpiece of his Japanese-made breather.

"How does the Grand Canyon—"

"Don't you read *Fax-Variety*?"

"I have to."

"Then you ought to have noticed the item about Dynamite Dunn and myself being a new twosome."

"Dynamite Dunn, the lady daredevil?"

"There aren't that many Dynamite Dunns in the world. She's who I mean. Didn't you read the tremendous writeup they gave her in *WomenStunts* last week, or the rave notice in *Stunt Persons* a couple months ago? I suppose, being head over heels in love, I'm prejudiced about Dynamite's stunts, but to me she's the best-looking girl in the Suicidal Stunt field."

"In here." I pushed open the door of the sound stage and we entered.

Andy tugged off his mask. "You ought to get yourself one of these Nusubito Breathers, the Japanese really know how to make the things. Their air was unbreathable way before ours. Back when I was strangling fulltime I used an American make and found it to—"

"How did you happen to be over the Grand Canyon?"

"Oh, Dynamite's planning a stunt that involves her being seduced by three—this is London in the 19th century, right?"

We'd entered the dimlit set which represented a block of the East End of Victorian London. "Going to use it in our 'Jack The Ripper' sequence."

"Messy. Jack The Ripper was messy," observed Andy, slowing and gazing around. "Strangling is much neater. If I were, which I assure you I never will, going to kill anybody again, I'd sure use strangulation."

I took, even though he seemed pleasant and calm enough, a few steps back from him. "We don't have to talk about your crimes if it upsets—"

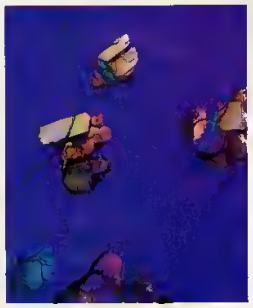
"They weren't crimes," Andy said, grinning. "Which is what made my case so famous. I was judged by both a six person human jury and a three member robot backup jury to be video susceptible. In fact I've got one of the worst and most severe kinds. I'd always been strongly goaded by what I saw on our TV wall as a kid. Broke a leg one summer trying to emulate Hunneker The Jungle Man, came very close to fracturing my head after viewing *The Girl With The Iron Skull*." Those little incidents were only preludes and then on that fateful night in 2000 I chanced to watch 'The Case of the Barchester Strangler' on *Bently of Scotland Yard* and off I went. Strangled nine helpless victims before the GLAPD ran me to ground. Always did it at midnight, like the killer on the show, hence my nickname of Captain Midnight. Coined by the media." He lifted up the front of his tunic, studied the tattooed diploma. "I'm cured now though, which is why I was let out on parole two years ago. I'm fine so long as I keep absolutely clear of tv. I haven't, give you my word, harmed a soul since I've been out. Too busy for crime anyhow, what with my consulting work and my courtship of Dynamite."

"I thought I saw in the *National Intruder* where Dynamite was sleeping with someone on the GLA police force."

"Oh, that item you noticed, huh?" Scowling, Andy shuffled along the shadowy London lane. "I honestly believe her affair with Lt. Denzlo is only another stunt. Nope, the one true love in Dynamite's life is me. Be-

CONTINUED ON PAGE 148

"Nature, God, or whatever you want to call the creator. . .comes through the microscope clearly and strongly. Everything made by human hands looks terrible at high magnification. Every bit of nature is lovely."



DNA (opp.) Pinecone Cluster

THE PHOTOMICROGRAPHIC WORLD OF

ROMAN VISHNIAC

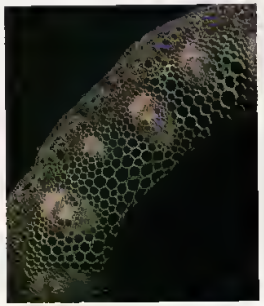
BY FRANCENE SABIN

Simply washing your hands can be an adventure in the New York apartment of photographer-scientist Roman Vishniac. I discovered this fact some years ago. "My God!" I screamed as I was about to turn on the faucet. "What's that in the washbasin?"

Dr. Vishniac responded calmly, "That is a crab. I brought him here to take his picture and he is waiting patiently until I take him home to Florida. You must not frighten him."

Most people would dispose of such creatures after using them. To Roman Vishniac that is an act of murder. "They are living beings with as much right to exist, and due the same respect, as human beings." It is a feeling he shares for *all* living things, down to the simplest one-celled animals.

This powerful reverence for life began when, as a child in Moscow, Roman's grandmother gave him a microscope. It was 1904; he had just turned seven. The microscope came with three prepared slides and magnified to 150x. Young Roman was instantly captivated by the fantastic world seen through the eyepiece. He soon prepared his own slides with bits of plants, fur from a family pet, insects



Buttercup Stem / (opp) Cross Section of a Young Root

"The higher the magnification we use, the more details are brought out, perfectly formed, like endless sets of boxes within boxes . . "Colorization" frees images obscured by the dazzle of ordinary light"

His room in the Moscow apartment became a laboratory

That was the birth of his photomicrography 'Nature, God, or whatever you want to call the creator of the universe,' says Vishniac "comes through the microscope clearly and strongly Everything made by human hands looks terrible under magnification—crude, rough, and unsymmetrical But in nature every bit of life is lovely And the higher the magnification we use, the more details are brought out, perfectly formed, like endless boxes within boxes '

When he was nine, Roman put some water from a goldfish bowl under his microscope lens and gazed in awe at the 'mysterious and beautiful" protozoa "To see them gliding and whirling," says Vishniac, "was a profoundly moving experience "

In 1914, Vishniac entered Moscow's Shanyavsky University Six years later he left with a Ph D in zoology and an M D Still in his teens, he was named an assistant professor of biology

During this period, he produced time-lapse films in cinemicroscopy—the first ones ever—and also did endocrinological research involving the thyroid and the metamorphosis of the axolotl a variety of salamander He wanted to publish his work, but the Russian political situation in 1920 made that impossible As a dissident in Soviet Russia, his career—indeed, his life—had a limited future Roman tied to Berlin

There, along with research in endocrinology Vishniac explored the complexities of optics and light He wanted everyone to see the glorious, splendid universe he saw through the microscope

To photograph a prepared slide of a flat, dead object was simple, but Vishniac refused to work with nonliving material Then, as now he was concerned with the three-dimensional living creatures that could not be seen with the naked eye These microorganisms swim through their aquatic world in an endless ballet while eating reproducing, surviving It was wrong, Vishniac felt, to kill them as if they did not have as much right as humans to live "It is also bad sci-

"All life is interrelated. To understand art, one must understand man. To understand man, one must understand all living things. There exists as much beauty in a grain of sand as in a Mozart symphony."

Part of a Computer I (opp.) Protein

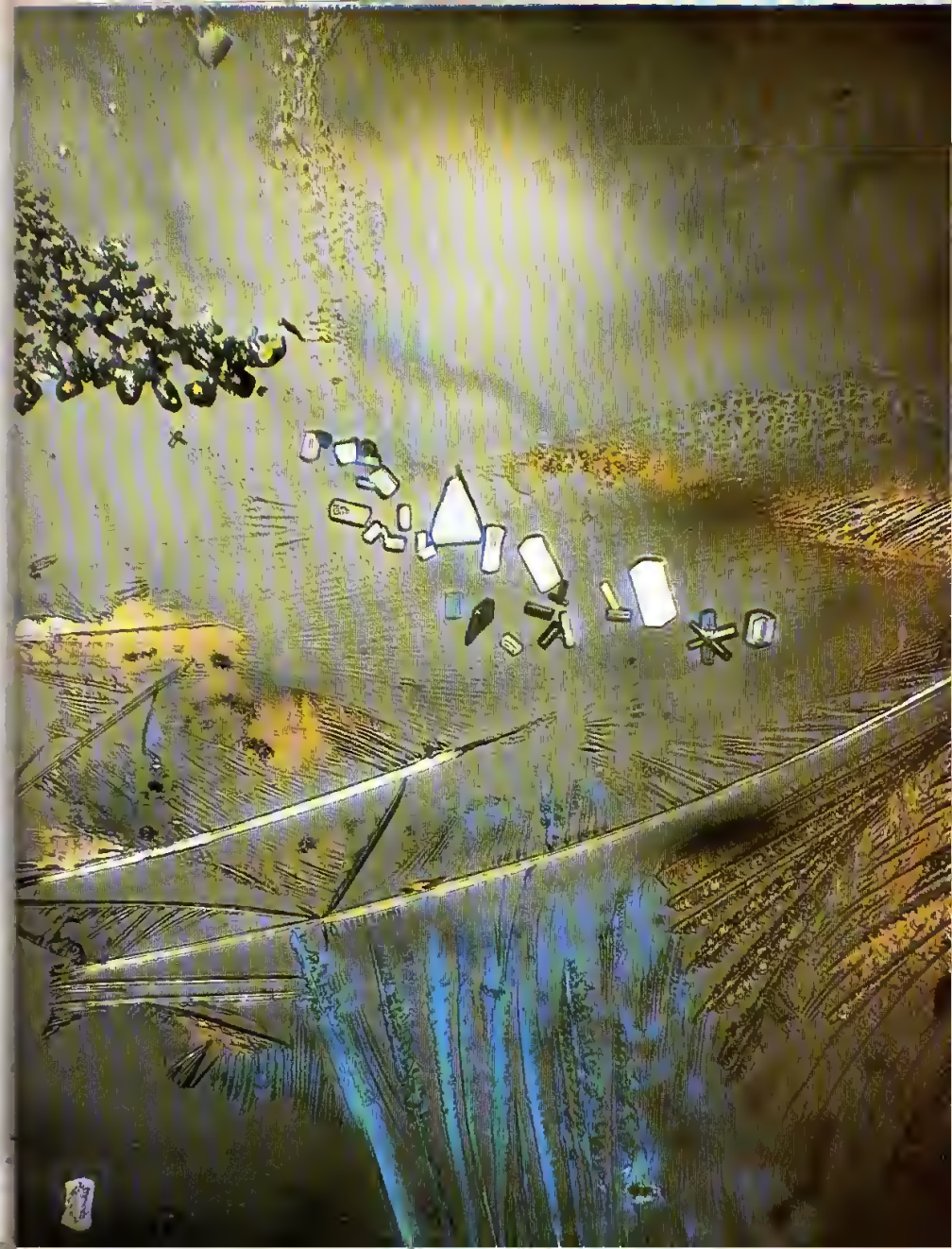
ance," he insisted, "because dead matter does not teach about life." So he searched for a new way to deal with light through the microscope, one that would show a viewer the functioning inner structure of living microorganisms.

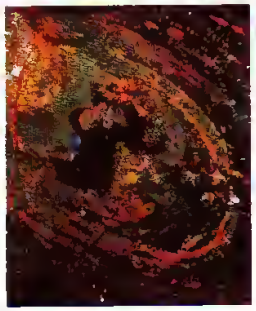
At the same time, Vishniac became deeply interested in Oriental art and entered a postgraduate program in the subject at the University of Berlin. He completed all the work required for a Ph.D. in Oriental art, but the Nazis, who had come into power, did not permit giving diplomas to Jews, so it was withheld.

While in Berlin Vishniac also invented a technique called "diffracted wave contrast" that greatly improved microscopic visibility. In 1932, he offered it to two large German optical companies but during the testing period the Nazis came to power. Both companies then asked Vishniac to provide proof, not of the efficiency of his new method, but of the Aryan descent of his grandmothers'. Since they were Jewish the optical companies pronounced the technique non-Aryan and turned it down. Some time later, the Dutch physicist Zernike developed a similar method called "phase-contrast" and for it won a Nobel Prize.

Vishniac emigrated to the United States on December 31, 1940, with $400 and no knowledge of English. Able to speak eight languages and read 13, holding two doctorates and the equivalent of a third, Vishniac still could not find work. Finally, he turned to freelance portrait photography by day and continued his scientific research by night. This brought in enough money to survive. At the same time, Vishniac went to magazine offices with his photographs of insect life and microorganisms, occasionally selling a few.

Since 1950, when Vishniac was able to give up portrait photography, he has devoted most of his time and genius to science. He has taught at universities, has made nature films for the National Science Foundation and other prestigious organizations, written a number of books and scholarly papers, and lectured on an incredible range of





Root of a Legume [(opp.) Vitamin

"To see the protozoa gliding and whirling was a profoundly moving experience. . . and the camera lens fit so snugly over the lens of my new microscope it almost seemed designed that way."

subjects. His photographs, both scientific and sociological, have been exhibited throughout the world.

"There are two subjects," Vishniac once told me, 'about which I do not know anything: sports and women's fashions. Everything else interests me, and I study. I want to learn, and everything teaches me something. All life is interrelated. To understand art, one must understand man. To understand man, one must understand all living things. There is as much beauty in a grain of sand as in a Mozart symphony, a Shakespeare play or a Japanese painting. It is all one."

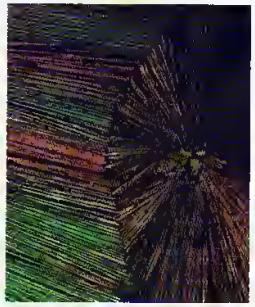
Among the many cameras Vishniac uses to photograph nature and microlife are Nikon, Leica, Hasselblad, and Olympus 2. Although they are excellent instruments, he maintains that it is not the camera that ultimately matters. "A box camera such as the one I used as a child can take good pictures, too,' he says. "It is in the brain and heart of the photographer that the real work is done."

He also utilizes various microscopes, from 60x to one with 1750x. His most complex piece of equipment is a Zeiss microscope with a special attachment called the Nomarski-Vishniac interference system. Dr. Vishniac never stains a specimen, never kills one, never uses artificial stimuli.

The key to his incomparable microphotographs is what he terms a "colorization" process. This involves the use of two prisms, with the optical system placed between them. "In trying to describe this process," he says, "one is bound to be guilty of oversimplification. Perhaps the best I can do is explain that ordinary light is made up of all the colors of the spectrum, and since they cancel out each other, the light appears colorless.

"Another thing about ordinary light is that it vibrates in all directions, or planes, at once. Under most circumstances this is a very fortunate thing, for it means that the rays of light are evenly diffused. But when ordinary light is used in sufficient quantity to penetrate the translucent interior of a microscopic organism, its dazzle obliterates

"An original piece of art is alive, a reproduction is dead. I bring the original to the student. . .and all the magic the artist put into it is seen and felt. So it is with nature. . . . I never stain a specimen, never kill one."



Hormones (above, opp.)

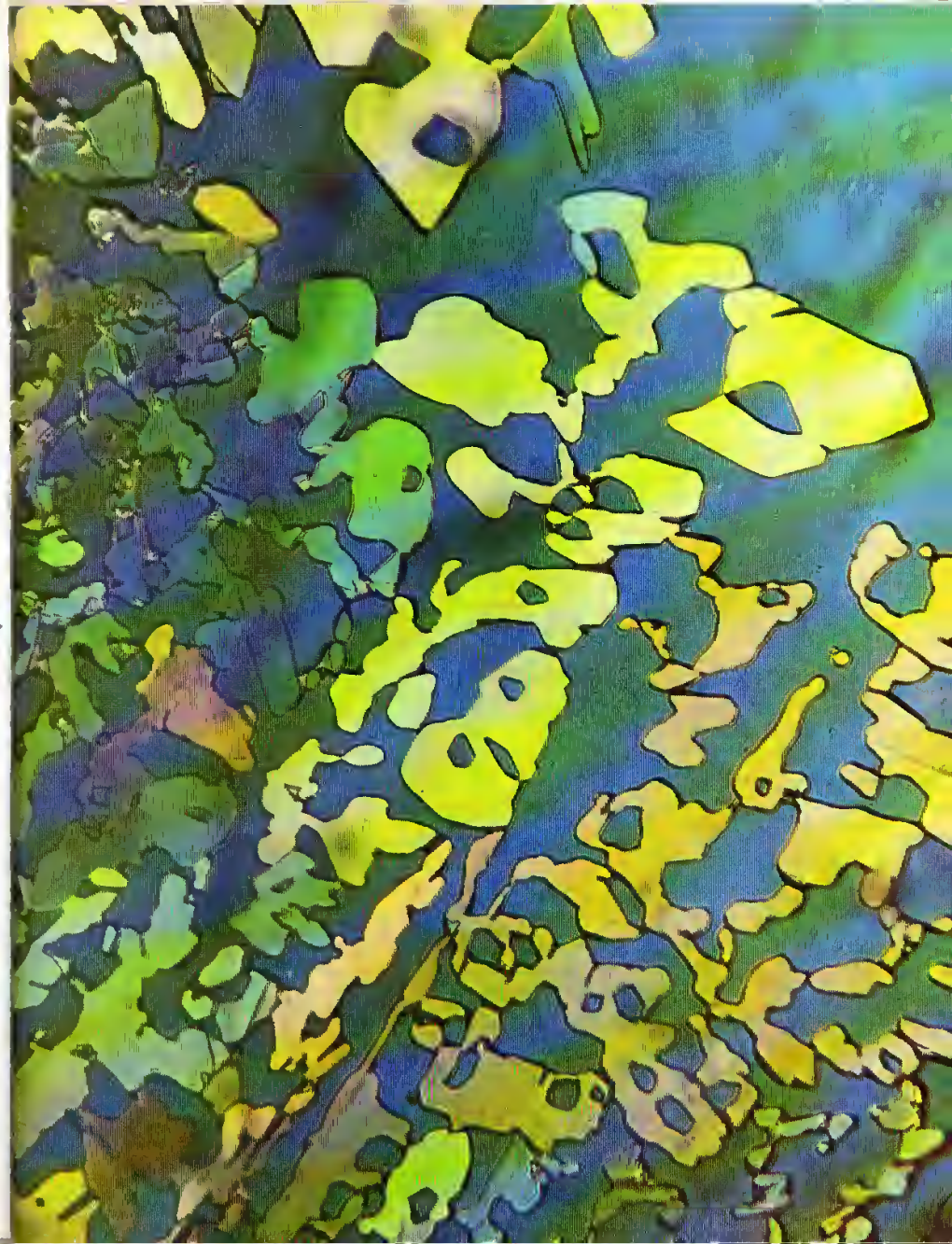
the details. Unrestrained light assassinates microscopic structures.

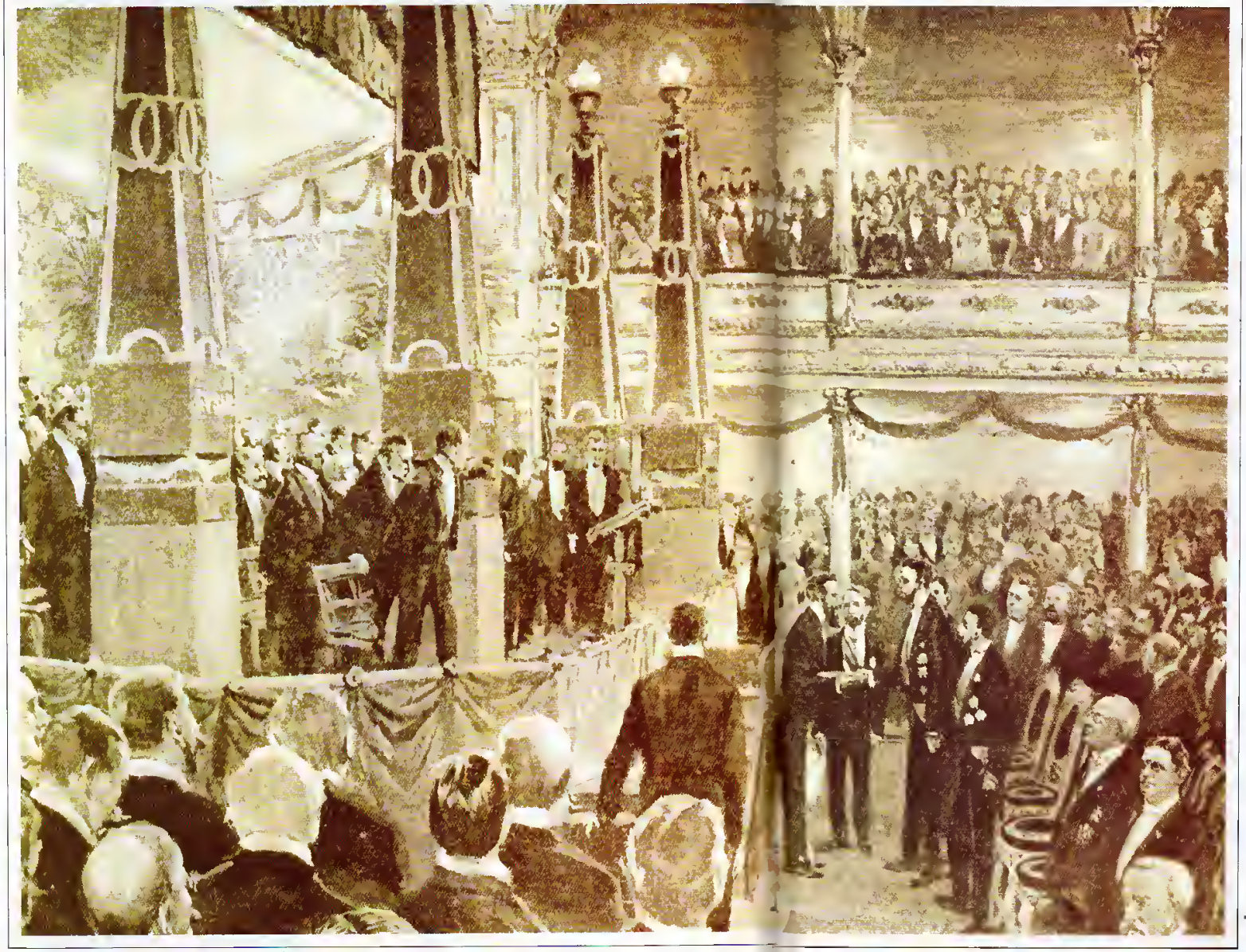
"So we turn to polarized light, which is ordinary light that has been passed through a calcite prism to make it vibrate on one plane only. It is still colorless, but what happens is that the detail and the color of the image that reaches the eye are greatly intensified, and the specimen's anatomy appears much as it would in a color x-ray."

Beyond the superlative technique and inventiveness Dr. Vishniac brings to his work, his success in photographing the microworld is a result of endless study and patience. Once, after being asked to photograph what is seen through the eye of an insect, he devoted weeks to reading everything available on insect vision, days collecting fireflies, and more weeks in the laboratory until he succeeded in removing, intact, the 4600 lenses of the insect's eye. Only then could he take the picture.

At 81, Vishniac's only concession to the calendar is that he now refuses to make commitments more than a year in advance. Otherwise, his pace could still exhaust a 30-year-old. Every summer, he and his beloved wife, Edith, climb the Swiss Alps. "We do not go swiftly," he says, "but it does not matter. We are not in a race."

His interests remain as diverse as ever. Lecturing at various colleges, Dr. Vishniac's aim is to awaken students to the beauty of their world. He wants them to understand the unity of creation in nature and in art. In addition to the slides with which he illustrates his lectures, Vishniac shows objects from his own collections of sculpture, paintings, coins, and rare books. "An original piece of art is alive," he explains. "A reproduction is dead. I bring the original to the students and, for the first time in the lives of some of them, there is an understanding of art. All the magic that the artist put into it is there to be seen and felt. So it is with nature. There are nice museums with everything in them dead—shells, stuffed animals. . . . But the colors fade, and there is no movement, no magic. How can we learn about nature from these things? We cannot.





The Nobel Foundation on Stockholm

NOBEL PRIZE

Science's ultimate award is a matter of politics, personalities, and being at the right place at the right time.

BY WILLIAM K. STUCKEY

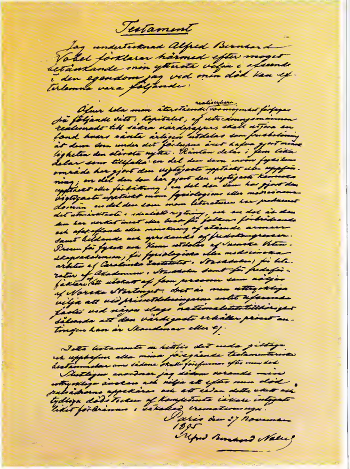
We can t measure science accurately It s not like a race where everyone is judged on the basis of time There are no generally accepted measures in science "—Erik Rudberg, former chairman Nobel Physics Prize Committee Stockholm, 1971

I have no doubt that Professor Rudberg believes this He was perhaps the most open and candid Nobel Prize judge I have interviewed But he was speaking on a rarefied level—the level of the judge who must decide whether the development of the integrated circuit is more significant than the discovery of the microwave radiation left over from the large wham-bam that created the universe It would take 20 mega-Solomons to resolve such matters What Rudberg did not say however is that there are certain scientific matters upon which fools like you, me, and the state legislatures can make judgments. One such matter is the Nobel Prize

This October, Stockholm will announce its selections for the "science prizes"—Physiology/Medicine, Chemistry and Physics In the spirit of a true itinerant gambler here are my picks

PHYSIOLOGY/MEDICINE Sweden's Sune Bergstrom and his life-preserving prostaglandins will capture the 1978 Nobel Prize in Physiology/Medicine Born in 1916, by Swedish Prize standards Bergstrom is still in his prime The mild-mannered truth-seeker will also carry to victory his longtime pal and understudy Bengt Samuelsson and—hold your hat—will bring an unprecedented second Nobel in Medicine to the grand wizard of the neurotransmitter Ulf von Euler Look for a Swedish three-way sweep

A hair behind the startling Swedes is Australia's master of the immunologi-



Testamente

Jag undertecknad Alfred Bernhard Nobel förklarar härmed efter moget betänkande min yttersta vilja i afseende å den egendom jag vid min död kan efterlemna vara följande:

Öfver hela min återstående realiserbara förmögenhet förfogas på följande sätt: Kapitalet, af utredningsmännen realiseradt till säkra värdepapper, skall utgöra en fond hvars ränta årligen utdelas som prisbelöning åt dem som under det förlupne året hafva gjort menskligheten den största nytta. Räntan delas i fem lika delar som tillfalla: en del den som inom fysikens område har gjort den vigtigaste upptäckt eller uppfinning; en del den som har gjort den vigtigaste kemiska upptäckt eller förbättring; en del den som har gjort den vigtigaste upptäckt inom fysiologiens eller medicinens domän; en del den som inom literaturen har producerat det utmärktaste i idealisk rigtning; och en del åt den som har verkat mest eller bäst för folkens förbrödrande och afskaffande eller minskning af stående armeer samt bildande och spridande af fredskongresser. Prisen för fysik och kemi utdelas af Svenska Vetenskapsakademien; för fysiologiska eller medicinska arbeten af Carolinska Institutet i Stockholm; för literatur af Akademien i Stockholm samt för fredsförfäktare af ett utskott af fem personer som väljas af Norska Stortinget. Det är min uttryckliga vilja att vid prisutdelningarne intet afseende fästes vid någon slags nationalitetstillhörighet sålunda att den värdigaste erhåller priset antingen han är Skandinav eller ej.

Detta testamente är hittills det enda giltiga och upphäfver alla mina föregående testamentariska bestämmelser om sådane skulle förefinnas efter min död.

Slutligen anordnar jag såsom varande min uttryckliga önskan och vilja att efter min död pulsådrorna uppskäras och att sedan detta skett och tydliga dödstecken af kompetente läkare intygats liket förbrännes i s.k. crematorium.

Paris den 27 November 1895

Alfred Bernhard Nobel

Nobel support of science is equivalent to the monarchial support of the arts that made the Netherlands a renaissance art center and Vienna a music center

cally amazing thymus, Jacques Miller—a top bet for the Nobel gold ($150,000 plus book contracts and other fringe benefits) by 1980. But the eagle may overtake the kangaroo with such contenders from the States as the princes of visual perception, the Hubel-Wiesel team; the mysterious mechanic of the cell membrane known only as E. Racker, and that veteran of the steroid wars who assisted in giving your daughter the pill, Carl Djerassi, who just might take the Prize in Chemistry instead. The dust hasn't settled yet, and it is hard to tell who and how many are in the running, but look for top performances from the leaders in endorphins, restriction enzymes, and the daredevil sequencers of DNA and RNA.

CHEMISTRY Even the Swedes say his work has a touch of art, and the Swedes should know, as they gave the 1965 Prize in Chemistry to Harvard's unbelievable Robert Woodward—my choice to *do it again*—who shared the glory with his favorite lab buddy, Roald Hoffman of Cornell. Both of them have put together the cleverest little reaction-prediction scheme to date. Woodward's only problem is that the Swedes have to think a long time before giving the same Prize twice, so don't count out the old long-distance synthesizer E.J. Corey or the man who did what they said couldn't be done—the wedding of two inert elements to produce never-before-seen compounds—Neil Bartlett. Also watch for Al Cotton, a dark horse from the unlikely brain farm of Texas A. & M., and Jerrold Meinwald, for his work with the fragrant pheromones, the talkative molecules of smell that act as communications satellites to bugs and other noncognitive earth creatures.

PHYSICS The shutdown in federal maintenance has slowed down the track in this stupendously abstract human calling, and many of the contenders are dispirited. Nevertheless, the sharpest eyes are again on astronomy—which the Stockholm referees recognized for the first time in 1974.

This year, my money rides on the space/time twins from Bell Labs, Arno Penzias and Robert W. Wilson, who should win for their near mystical detection of what is called three-degree radiation, the magical leftover whisper of the Big Bang that started it all. However, don't discount the Princeton-Chicago time-reversal duo of Fitch and Cronin or Steven Weinberg, the prodigy with perhaps the finest bloodlines in the queen of sciences (Niels Bohr Lab, Princeton, Berkeley, M.I.T., Harvard) who needs only a few more confirming experiments to pull off the biggest coup of all, the Unified Field Theory.

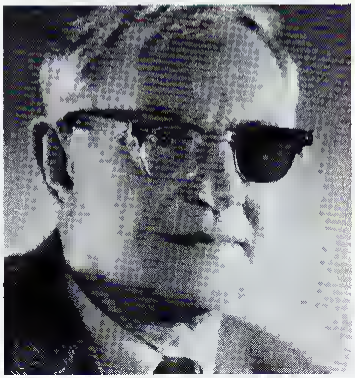
PICKING WINNERS In the 1960s, when I worked as a writer at Northwestern University and M.I.T., I was impressed by the epidemic of hypothalamic shudders that would grip the science faculties when a Laureate or Nobel-connected Swede materialized on campus. It was then believed that Laureate favor would bring honor, federal grants, and the brightest of students to the favored institution. Who picks the Laureates, I asked? Who picks the pickers? How do the pickers decide what is bingo, so-so, or thud in international science? Off and on, I spent the next eight years in Laureate-rich, Nobel-network centers of Sweden, Germany, France, England, and the U.S. asking such questions. I interviewed some 60 Laureates, a dozen Swedish judges, and various Networkers who are invited by Stockholm to nominate Prize candidates. A few of the interviews were revealing, others were nonsense because of the Swedish love of secrecy (they have kept Prize-selection records under lock since the Prizes were founded in 1901) and the European tradition of thinking it bad taste to tell a journalist anything but to go to hell.

In 1972, I put to the test what I had learned about Swedish Prize-selecting customs by attempting to predict future winners. An article of mine in the now-defunct *Saturday Review/Science* forecasted that two British quasar-pulsar hunters, radio astronomers Martin Ryle and Anthony Hewish, would win since in addition to displaying brilliance they were

Werner Heisenberg, Nobel Prize, Physics, 1932

At his death in 1896, Alfred Bernhard Nobel, the inventor of dynamite, left a fund of $9,200,000 "the interest on which shall be annually distributed in the form of prizes to those who, during the preceding year, shall have conferred the greatest benefit on mankind."
Nobel drew up his own will (opposite, in the original Swedish) and there were numerous loopholes, resulting in a five-year legal battle before the will was finally upheld. The 102nd element, nobelium, was named after him.

"My first reaction when I won the Prize was to turn to my boss and say, 'Now can I have a secretary?'"



Julius Axelrod, Nobel Prize, Physiology/ Medicine, 1970

doing everything else right as far as subtle Prize politics went. They won in 1974. In the same *Saturday Review* piece, I listed the names of some 20 others who were *doing it right* and would win. Five have since scored.

Now, six years later, I feel more confident about picking winners. I have since armed myself with a powerful tool: the 'Science Citation Index.'

THE INDEX The list was kept secret until last December. Then, Eugene Garfield, the cunning mogul of library science and president of the private Institute of Scientific Information in Philadelphia, dropped his bombshell. Without a backward glance, Garfield introduced a number system to the vaguely verbal Nobel world.

Science consists of doing experiments, cooking up theories, and publishing the results in scientific journals. Each paper traditionally carries an index listing other scientists' papers that bear on the topic reported upon. In 1961, Garfield launched a service called "Science Citation Index," which kept track of all these citations. Dull? Do not be misled. By 1968, the mustachioed, matrix-loving Garfield was telling the American Association for the Advancement of Science that "citation analysis" by computer may be a way to predict Nobel Prize winners. Keen-eyed Garfield had spotted a link between large numbers of citations and Nobel-level scientific quality. A heavy list of citations meant that a scientist was attracting the attention of his colleagues—perhaps, in Nobel terminology, "opening a door," "founding a field," going right to the "conceptual" and "fundamental" meanings behind the deceitful actions of Miss Nature. Citation ranking is like a best-seller list or a marketing survey.

Did Garfield sleep? Rest on laurels? No; he went on to list the 250 "most cited" scientists throughout the world over the 15-year period between 1961 and 1975. To make this list the researcher had to be cited at least 4,000 times by others over the decade and a half. The Garfield revolution upset the long-standing folk view that one's scientific quality could be judged by the number of papers *published*. The 250-citation study went much closer to the bone—how many people actually *read* your papers? There were a lot of complaints about the relevancy of the 250-citation study, and some were valid. But what caught my attention was how much more it told about the nature and quality of science than did 10[6] Nobel words. (Understand also that "250" represents a minuscule fraction of one percent of all the world's working scientists over the 15-year period.)

Consider Sigmund Freud. Although he was nominated for the Nobel Prize in Literature, Freud did not receive the coveted science prize. Garfield's top 250 list, however, ranks Freud near the top with some 8490 citations between 1961 and 1975. And Freud died in 1939. This last fact eliminated Freud from the running for prizes are only awarded to the living.

Further refining the citation index, sociologist Harriet Zuckerman noted in the 1960's that the average Nobel Prize winner received at least 200 citations in the year before he/she was awarded the Prize.

Garfield himself has stated that some high citation numbers are misleading due to citation customs in a particular science. Chemists appear to put every chemist who ever lived at the end of their papers, and so their numbers must be tempered. Life scientists seem to hold their citations to a reasonable number, and physicists tend to cite only their peers or above. As one observer put it, "Richard Feynman cites only Murray Gell-Mann, and Murray Gell-Mann cites only God."

I have mentioned that 4000 citations over the 15 years was enough to get on the 250-list (note that Garfield sometimes playfully calls it a 249-list and sometimes goes a few beyond 250 to reach the 4000 even number). The largest citation number referred to so far was Freud's 8490 listings. The top ten of the 250-list includes, at fifth from the top, double-Laureate Linus Pauling, with 15 662 citations over the 15-year period. Number two is the late Soviet physicist, also a

"There is no escaping the correlation between frequency of scientific citations and Nobel Prize nominations"

Laureate L D Landau drawing 18 888 gestures from his colleagues Number one with an astounding 58,304 citations—including 7565 for 1975 alone (not far from that of Freud s whole career)—is Oliver Lowry, of the Washington University medical school in St Louis

A respected scientist, Dr Lowry is nonetheless a lousy bet for a Nobel Prize He explains why

"Most of that enormous total of citations is for a single paper I wrote in 1951 It is a fluke All we did was to describe a cheap and sensitive method for measuring very small amounts of protein We didn't find any basic principles What we did was not even as original as inventing the monkey wrench Rather, we showed how to make a monkey wrench with a handle that wouldn't break off so easily It simply turned out to be very useful Almost everything that anyone has researched in the life sciences for decades has involved protein or something attached to protein That's the only reason my method has made a splash I'm not interested in methods per se I'm a neurochemist "

THE HIGH SWEDISH PROFILE To know you is to love you of course but the Swedes can't know you if they can't see you One must be in the right place for that since the Scandinavian vision is extremely narrow They can't see you unfortunately, if you've developed your antigravity device at North Dakota or your hyperspatial rejuvenator at Aleutian Polytech Instead one must be a part of that handful of great universities that are rich in members of the world's principal science academies, in Laureates, or in Prize nominators who are invited by the Swedes to serve as scouts for promising talent If you are a foreign member of the Royal Swedish Academy of Sciences (which in Swedish eyes means you are already good enough to be a Laureate) then you are in a strong position for a prize. Belonging to Britain's Royal Society (founded by gravity's own rainbow, Sir Isaac Newton, and literally swarming with nominator scouts) is a distinct advantage, considerably better than holding a seat in the U S National Academy of Sciences

My own code names for the most Swedishly visible regions in America are *New Harvington* (the golden preserve of Harvard-MIT, New York's Rockefeller and Columbia Universities, plus Princeton and the new center of Laureated gravity in Washington, the National Institutes of Health), *Midamerago* (four midwestern state universities that revolve around the University of Chicago) and *Los Berkliego* (the Jerry Brown-harrassed but still reigning University of California campuses in Berkeley, Los Angeles, and San Diego, plus Stanford and Cal Tech) Elsewhere we find *Royal Londoxbridge* (The Royal Society, Cambridge, Oxford, and London s Imperial College), and in Germany the multiple campuses once known as the Kaiser Wilhelm Institute but since the loss of all those wars Max Planck Institute (*Kaiser Planck*) Future centers should emerge in Japan (*Hai Technorogy san*) and Israel (*My-Son The*) But wait. Something is stirring in those long overlooked idea factories way down in Dallas, Houston, Austin, and College Station—the startling new contender from the Lone Star state—*Dalton Station*

In 1972 there were no Laureates working in the great state of Texas Now there are three, with others probably on the way In addition, there is John Wheeler the resident black hole king of the University of Texas who has made no "major discoveries" lately but who enjoys high Swedish regard for coauthoring *the* paper in the late 1930's on nuclear fission with Nobel saint Niels Bohr Also, the Garfield list, to general surprise, showed five Texas researchers in the top 250 of the world Chemist Al Cotton of Texas A &M not only held ninth place with 12 901 Garfields, but was one of only nine scientists on the list whose annual citation rate has actually increased since 1974 No other region east of L A , south of Chicago, and on the down side of Washington D C. enjoys such Swedish visibility

Not that this made any mark on the Texas Legislature

There is a small but important item in the Texas higher education budget called "organized research " Among other

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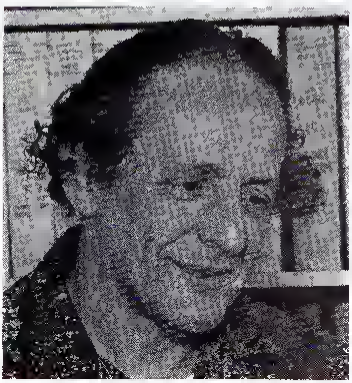

Eugene Garfield, President Institute of Scientific Information

THE TURIN SHROUD

BY BARBARA J. CULLITON

Computer analysis of a curious bolt of linen in which Jesus of Nazareth is believed to have been buried, may soon reveal the secret of Christendom's most baffling relic.

Perpetual Help Center

Consider the astonishing proposition that the Holy Shroud of Turin, which has been venerated by thousands of pilgrims during its rare public display in Italy this summer, is a *photograph* of Jesus Christ lying in His tomb—a photograph created nearly 2000 years ago by a "short, intense burst of light."

The idea confounds even the most devout, yet this supposed image of Christ crucified lies behind a scientific adventure that, if everything goes according to plan, will begin in October when a team of American scientists brings space age technology to bear on the central mystery of the ancient relic. What formed the image?

The Shroud of Turin, whose history accurately can be traced to the 1300s, is a piece of linen about 4.7 meters long and 9 meters wide. It shows in remarkable detail the image of a crucified man seen from the front and from the back. Skeptics, including bishops of the Roman Catholic Church, have dismissed the Shroud as a 14th-century forgery. However, recent scientific observation shows almost certainly that the image was not painted on the cloth. Given what is known about technology (or its absence) at the time, it is hard to accept simple forgery as an explanation.

How was the image formed? A team assembled by physicist John P. Jackson and aerodynamics expert Eric J. Jumper of the U.S. Air Force Academy in Colorado, intends to find out. The answer, they speculate, may be revealed by computer and molecular analysis.

"If Christ was resurrected from the dead, then the Gospels are truth, and eternal life—immortality—is offered to all of us," muses team member Ray N. Rogers, a thermal chemist at Los Alamos Scientific Laboratory in New Mexico.

"What better way, if you were a Deity, of regenerating faith in a skeptical age, than to leave evidence 2000 years ago that could be defined only by the technology available in that skeptical age?"

Evidence that the Shroud dates to the time of Christ is only circumstantial, as is proof that it comes from Jerusalem. But, scientists agree that it may never be possible to *prove* that the Shroud was worn by Christ even if further research, including carbon-14 dating, establishes that it did come from Jerusalem some 2000 years ago. Still, the evidence is enticing.

British historian and journalist Ian Wilson, author of *The Shroud of Turin* (Doubleday, 1978), has constructed a theory of the Shroud's history, tracing it from Jerusalem *circa* 30 A.D., through Edessa in Turkey, to Constantinople at the time of the Crusades, and on to Lirey, France, where, in the 1350s, it came into possession of a knight named Geoffrey de Charny.

From the de Charny family onward, the Shroud's location can be well documented, including its arrival in Turin 400 years ago this year. At present the Shroud is under the affective control of the archbishop of Turin, though its true owner is Umberto II, the deposed king of Italy who resides in Cela, Portugal.

From a scientific point of view, two pieces of evidance support the hypothesis that the Shroud's legacy begins in Jerusalem. In 1973, Dr. Max Frei, former head of the Zurich Police Scientific Laboratory, was given permission to study dust particles on the Shroud. Using adhesive tape to trap the tiny particles, Frei collected samples for microscopic examination back in his laboratory in Switzerland. He took particular notice of minute pollen grains, which he began cataloguing in detail. Because different plants produce distinct types of pollen indigenous to specific parts of the world, pollen provides clues to the Shroud's geographic history. Frei's painstaking work is yet to be completed, but already he has evidence that the Shroud has been in the area around Jerusalem, as well as Turkey and Western Europe. Another investigator, a Professor Raes of Ghent, Belgium, reported that bits of cotton woven in with the Shroud's linen fibers are characteristic of cotton used in the Middle East two millennia ago.

Although detailed scientific analysis of possible explanations of how the image was formed have had to wait until the late 1960's, medical studies of the portrait have been going on since the beginning of this century. Each one reaches the same conclusion: the image is anatomically correct in every detail. This observation is held to be another piece of the puzzle favoring the garment's authenticity.

Since death by crucifixion ended with the Romans, how, it is asked, could a 14th-century forger perfectly recreate the effects of that brutal form of execution? An important point lies in the placement of the nails in the wrists of the man whose image is on the Shroud. Paintings of the crucifixion typically show Christ with nails through His palms but anatomists experimenting with cadavers in Europe proved that palms could not possibly support the weight of a human body. The image on the Shroud more plausibly shows nail wounds through each wrist.

Additionally the image on the Shroud shows a number of wounds and areas of copious bleeding that conform both to what physicians say would occur in crucifixion *and* to what the Bible says happened to Christ. Dumbbell-shaped markings on the back of the man could be wounds from scourging; marks on the face could have come from a crown of thorns, and a wound mark on the right side corresponds to the Gospel's reference of Jesus being pierced with a lance.

Film negative of Enrie's 1931 photograph clearly depicts front and rear image of human figure.

Whether the Man of the Shroud really is Christ, or some other victim of crucifixion or the ingenious creation of some 14th-century forger, the central mystery remains. How did the image get on the cloth? The image is said to be extremely subtle, indeed barely distinguishable—a faint pattern of sepia color suggesting the body and slightly darker tones marking the areas presumed to be (or have been) blood. It is only when the relic is seen through the eye of a camera that the image takes on its stunning clarity. The man—tall, handsome, lying in repose with the hands crossed over the pelvis—is most clearly revealed in the negative. In a reversal of the usual rules of photography, contours of the face and body of the man appear most lifelike in photographic negative. The nose and the chin, for instance, are light and the eyes appear dark but the face looks entirely real having none of the masklike quality of a familiar negative. This surprising reversal suggests that the Shroud itself is a negative, that in the process of image formation the linen cloth acted as a piece of film on which the picture of the body was recorded.

Scientists conducting preliminary studies of the Shroud image have been working with a series of high quality black and white photographs taken by Giusappe Enrie in 1931. Although analysis to date has not answered the question of image formation, it has helped to eliminate some hypotheses, especially that the image was painted. Los Alamos chemist Ray Rogers notes that microscopic examination of the fibers reveals no evidence of any pigment. Furthermore, the image appears to be *only* on the surface of the linen, with no indication that any pigment had been absorbed through the fibers as would happen if the image were made of known paints or stains. To top it off, the Shroud was put to the test, so to speak, in 1532 by what Rogers calls "a perfect thermal experiment." It was in a fire.

The Shroud lay folded in a silver casket near Savoy when the Chambery Chapel caught fire in 1532. Rogers estimates that the temperature within the cask reached 200 to 300 degrees Celsius before the Shroud was doused with water and taken from the burning church. The Shroud escaped with minimal damage, but it was burned by drops of molten silver which appear as triangular markings along the length of the cloth on both right and left.

The importance of the "thermal experiment" is: if the image were composed of pigment, it would have been affected by the intense heat. Similarly, if the image were the result of some natural biologic process related to the decomposition of a body or to the aloes (oils) and spices with which a cadaver was annointed, those natural products too would have been attected by the heat. But as it is, nothing happened. Says Rogers, "If large, complicated, natural-product organic molecules were responsible for the image, they should have decomposed, changed color, or volatilized at different rates depanding on their distance from the high-temperature zone during the fire. [As a result, the image would have marked variations in color tone and density.] There is no evidence for any variations at all."

Looking at the Shroud from another perspective, scientists Jackson and Jumper, collaborating with researchers at the Sandia and Air Force Weapons Laboratories in New Mexico and the Jet Propulsion Lab in California, have approached the problem of image formation with the relatively new computer techniques of image enhancement and analysis. Just as computer enhancement was used to bring clarity to pictures of Mars taken during the unmanned Viking landing two years ago, digital processing can be employed to clarify the Shroud image by sharpening portions that scientists want to study while eliminating these distracting features of "noise," such as the herringbone weave of the cloth.

Based on the unusual clarity of Enrie's photographs, scientists have come up with two observations of particular importance. First, there appear to be button-like objects—possibly coins—over the eyes of the Man of the Shroud. Until new photographs are taken, Jackson and Jumper will not be able to confirm this observation but, if it turns out to be right, it could reveal both how and when the image was made. At the time of Christ, it was not uncommon in Jewish burials to cover the eyes of the dead with potsherds or coins. Inasmuch as Christ was buried by Joseph of Arimathea, an affluent man, it may be possible that the objects are coins. Jackson and Jumper are hopeful that computer enhancement of photographs of the eyes will prove that the objects *are* coins, and also show what kind of coins they are.

The second observation, according to Jackson and colleagues is, "computer research has shown that the Shroud image is three dimensional in that information defining the spatial contours of Jesus' body are encoded in the varying intensity levels of the image." Normal photographs do not contain three dimensional information, as the scientists showed in an experiment in which they created a computer generated three-dimensional relief of a normal photograph of Pope Pius XI. The resulting image is distorted, with the nose and mouth, for instance, pushed into the face.

By contrast, computer generated three-dimensional relief of the Shroud produces a distinct, correctly defined image. The

Two parallel lines of scorches, left by 16th-century fire dominate positive print of Shroud.

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FICTION/A ZADO MYTH

She was held by a force beam and bending over her was one of the members of the Mindpod

TIME WARP

BY THEODORE STURGEON

He was sleek and he was furry, he was totally amphibious, and Althair the Adventurer was what he really was. However, he was known, on his lovely planet Ceer, as Althair the Storyteller just because he did that better—better even than adventuring, at which he was a marvel.

His people called his planet "Ceer, the planet indetectable," and that it really was. It had no smoke or factories, machines or jails or presidents, just uncommanded beauty made of waves and wilderness. It had a kind of shrub-tree plant that would yield to mental pressure and produce the living living-shelters, cupping coolness by day and hoarding heat at night.

A heavy planet, Ceer, with strong inhabitants who had still stronger minds—so strong that with a ceremony they had linked their minds together and created an integument, a kind of shell, a shield around their worlds that bent all outside rays and gravities. Reflecting and occulting nothing, it concealed the planet's mass, and more, concealed its absence: yet the peopled plains and oceans could see the friendly stars unhampered. The peoples' name was Zado.

Story time! Story time! Slithering, litha, surfing, sliding, inchworming, crackly-whiskered, beady-bright, soft, smooth and shining, came the young, the pups and pemmies gathering round. Story time! Story time!

Altheir, a tower in a sea excited, waited out the shouldering, scrabbling, let-me-near silenting, until at last *they* did all the waiting.

"Today I will tell you (Althair began) of the planet Orel and the horror that happened there, but first I must tell you about a pup and pammie older than yourselves who were just about as big as me, and lived on a planet with the name Earth. Their names were Will Hawkline and Jonna Verret. . . ." (There was a clatter of chittering giggles as the little Zados tried to say the funny names and could not. Althair let them try, then raised his head. They shushed.)

"Will Hawkline and Jonna Verret lived on an island named Avalon, which they had made beautiful and kept beautiful, and saw hardly at all for their working. Will was very important being Coordinator of the Time Center, which means he said what to do and everybody did it.

From the painting by Cliff McReynolds © 1977 Pomegranate Publications

Jonna was the best test pilot he had, which means when Time Center built something, she tried it out. Way down deep Will was angry at Jonna, though he never said it and maybe didn't know it. He wished for a test pilot bigger and older than he was, so he could tell him what to do and see him do it. Jonna was younger and smaller and she was a pammie but good is good and there's no arguing that. So he was angry because she was a pammie and she was the best in the world at what she did. (Althair boomed along with the chittering chuckles. It certainly was funny.)

There were lots of other people on Avalon, of course, but they're not really in this story, except for Little Johns. Now the Little Johns were very special. You see, Earth people were slowpokes, so they built things called computers which could logic much faster than they could. The first Little John had the strange ability to think himself into a computer, or think the computer into himself. So he could then do create/computing almost as well as a Zado—as long as he was linked to a computer. Without a computer he was just another slowpoke. So they cloned him a dozen times, creating a dozen Little Johns.

That's what the Time Center was all about—to stop Earth from being a slowpoke. When they wanted to go to another star, they could get inside a big metal jug and fly it in real-time, which took so long they had to go to sleep until they got there a long time later. Then when they got back to Earth the same way, all their friends were long ago dead of old age. *Or*, they could get into a different kind of jug and fly to the star faster than light, and not have to go to sleep for hundreds of lifetimes, but when they got back, time had still passed on Earth and their friends had still died away. Earth time and jug time were just too different.

But Will Hawkline, with the help of his computers and his people and the Little Johns, Will Hawkline did it! He found a way to separate time from space-time, so his little jugs could go *back* a little way in time while they went forward a long way in space—all at once! That way space travelers could go away to a star and come back again, while the people they loved were still alive to welcome them and listen to their stories. I know that's a long funny way to solve a problem, but then they weren't Zados, and you have to admire them. Jonna Verret tested the new little jugs—*scouts* is the Earth name for them—and they worked, and because they worked, a terrible thing happened. And now I will tell you about Mindpod and Orel.

No one knows when or where it came from, but a great dark jug landed on the planet Orel, and in it were 26 *things*, alive and awful which together are called Mindpod. Zados are not the only ones in the universe who can link minds, but unlike us, the Mindpod used their linkage as a weapon.

Orel was a wild place where the biggest animal was a meercath, a lizard with thick quick hind legs and small deft hands, bigger than me, with a toothy mouth that could take off my head, and a mind just good enough to feed and be happy. In a *blip* the Mindpod had those meercaths' minds, and all they would do forever after was to make weapons and go off to other worlds to kill and destroy. Nothing could ever give them back their own minds. A meercath commanded by the Mindpod is a terrible thing. And there were enough worlds within reach of the Mindpod's big dark jug—the Earth word for it is "cruiser"—that the Mindpod itself could rest safely on Orel for a very long time, and take other worlds which take other worlds and Oh! (Oh! cried the young ones. Oh! they wept.)

The Mindpod cruiser had in it all sorts of structures and inventions that could do things that the Mindpod could not—they were rather like Earth people that way, but not at all funny. They had feeler things and listening things and find-out things so that they knew right away what had happened when Jonna tested the back-in-time jug, the little one she called a "scout." That made the Mindpod afraid. When the Mindpod was afraid it was immediately very, very angry. It knew how to travel in zero time but it didn't know how to travel *back* in time, so the Mindpod sent a cruiser toward Earth to steal and destroy.

> *"No one knows when or where it came from, but a great dark jug landed on the planet Orel, and in it were 26 things alive and awful which together are called the Mindpod. . . . It sent a cruiser toward Earth to steal and destroy."*

On Avalon, in Time Center Control, Jonna had just come in from the last of her flights. She stood proud and happy, happy because she had done everything right, happy for Will too, because it was truly a great thing he had done. Will Hawkline looked at her, how she stood smiling, her hair a bright tumble, her eyes pleased and giving. Just for a moment his regret that she was a pammie and not a bigger and older pup grew smaller and he smiled and took her hand.

At that moment the very walls boomed with a terrible voice:

"Attention Time Center. You have one complete revolution of your planet to prepare all records of your experiments and to have yourselves and the records ready for pickup. One hour later Planet Detonation will occur, whether or not you are planetside."

Will Hawkline, still holding Jonna's hand though he had quite forgotten it, bawled "Little John!"

Immediately Little John Five stepped up—a big Earth person, strong as a Zado, with close golden hair and eyes very wide apart. Will Hawkline cried: "I have done a terrible thing, but—how could I know? Who are they? What do they want? Can they do what they say?"

The large growing eyes closed, and now the Little John was one with the big computer and its instant logic and immense memory. He said: "Subspace wake trace indicates that they came in zero time from OREL—Orion Remote Earthtype Landbase. Who they are: No data, except that they are not indigenous to Orel. Can they do what they say: All revelant data indicate that they can, to a probability of 99 point eleven nines. Could you have known: You could not. What do they want: Clearly it is the back-in-time scout device. If they had it they would have used it, and would have struck before our tests."

"But if we don't give it to them, they'll blow us up anyway, and then they'll never have it."

"Which indicates they are afraid of it. If they can't have it, no one will have it."

"Then they've given us the answer!" When Will Hawkline made up his mind, he did it altogether. "If they're *afraid* of it, we'll use it. We'll arrive on Orel before they leave and stop them." He turned to Harper Townsend, his chief of operations. "Harper—are both scouts ready for launch?" At his nod: "Jonna—are you willing to take a Little John and go to Orel, while I take the other scout and rendezvous with you before they attack?"

Her face told him how ready and willing she was.

"Then let's go! Harper, put every computer on the problem of destroying that cruiser—but don't make a move until the last minute, or they'll strike before the deadline."

He sprinted toward the launch gate and only then realized he was still holding Jonna's hand—he almost pulled her off her feet. "Sorry. . . ." he said and was gone. She looked sadly at her hand. "Sorry?" she said, then turned and ran for her own scout, shouting for Little John Twelve.

And you know, by the time they were in their scouts, the Little Johns and the computers had worked out every single figuring they needed to make the trip back in time, forth in space, to Oret before the Mindpod cruiser left.

At that very moment on the place in the dark cruiser where the devices that made it go were—the Earth word is 'bridge'—a meercath left his lace of blinking lights and came to the commander. "There are stowaways, sir." (That's the way they talk in jugs. And a stowaway is a person who gets on a jug or whatever they call them, without anyone knowing.) "Stowaways, sir. I thought at first there were three, then it seemed like four. Anyway it's certainly two."

"Start a search then," the commander said. "Every compartment, room, pathway." The meercath went away, and another one called out. "Small craft leaving the planet, sir." But even as they fixed their look-at thing on it and spit fire, the scout slipped into faster than-light and was lost to them. Just then another appeared, and a great fan of flame swept out from the Orellian cruiser and sliced off a tail section just before this scout flung itself into faster-than-light and also escaped the attack.

None of us could possibly know what it's like to fly out in one of those little scouts. Acceleration squeezes you backward until you can't breathe any more and you can't see anything right or really think straight, and all of a sudden there's a great bloom of light, a spinning spiral, and you're in another universe full of grey shapes that make you dizzy when you look at them. In time—how much time depends how far in real-space you are going—you're back in this universe, blinking at a whole different set of stars, with a strange planet floating nearby. Terrifying.

But for Will Hawkline it was infinitely worse. Seconds before they slipped into faster-than-light, "We're hit!" Little John Five cried out, and Will Hawkline said, "Too bad, but we're counting down and we're going out anyway!" At that, the bloom of light spiraled around them and they were in the grey place, and—*crunch-ring-biang*—things broke in the scout's insides. Their lights went out and flared bright and dim again. "Damage report," Will Hawkline ordered, and the Little John told him a long list of awful things. "Can you get a fix on Jonna?" And that was worst of all.

"She's on Orel—on the surface!"

"Captured," Will Hawkline whispered, and oh, he had a feeling inside himself he didn't know he could feel. "She's alive though," he almost-said, almost asked.

"She's alive," said the Little John. "But they are doing something to her."

Oh yes they were doing something to her. She was flat out under a force-beam with a fearful light shining on and through her, and bending over her was one of the actual members of the Mindpod, and I can't tell you what it looked like because no one's told me, except that it was horrible beyond description so that even if I could I wouldn't. And it said:

"We have placed a substance in your bloodstream which will kill you in a very

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Photograph by Hal Hill

Planet farming, laser rockets, intelligent clouds, and asteroid colonization—are but a sampling of the visionary ideas of physicist Freeman J. Dyson.

INTERVIEW

FREEMAN DYSON

"One should expect that, within a few thousand years of its entering the stage of industrial development, any intelligent species should be found occupying an artificial biosphere which completely surrounds its parent star."

For 20 years now, Professor Freeman J. Dyson has been discussing mind-boggling prospects in just that calm, matter-of-fact, "one-should-expect" way. It is his hobby, he says disarmingly, something that grew up alongside his career as one of the finest mathematical physicists of our time. To his colleagues at Princeton's Institute for Advanced Studies, Dyson is known for his understanding of what goes on in the core of a star or in the interaction of high-energy beams of subnuclear particles—contributions that have earned him the American Institute of Physics' Heineman Prize, the Royal Society's Hughes Medal, among other honors.

To a wider circle, though, he is known for imagining an artificial biosphere—or environment in which life can exist—called the "Dyson shell." It is a vast structure built by dismantling a Jupiter-sized planet and using the raw material to provide living area millions of times greater than that of any planet. He further suggests that the powerful gravitational field of a white-dwarf binary star might serve as a super-slingshot to accelerate interstellar voyagers free of fuel costs ... and that an army of self-reproducing automatons could mine the ice of Saturn's moons and use it to make chili, and Mars a garden planet.

Freeman Dyson was born in Crowthorne, England, in 1923. He attended a public school in Winchester where his father was a teacher, entering Cambridge during World War II. After two years of service with the RAF's bomber command, he took a B.A. in mathematics (his specialty was number theory). Dyson came to the United States in 1947, after a few years at Cambridge and the University of Birmingham. At Cornell, he was drawn from mathematics into physics by the influence of Richard Feynman and Hans Bethe. In 1953, he moved to the Institute for Advanced Studies where he has worked since then.

Dyson's speculative side lay dormant, he says, until 1956 when he met physicist and bomb designer Ted Taylor at a series of conferences convened by the General Atomic Co. in San Diego. They worked together on the fail-safe design of the TRIGA research reactor, and on Project Orion—a plan to propel spacecraft far larger than Apollo (even the size of a city!) by detonating nuclear or thermonuclear bombs behind a "pusher plate." Since then, the two men have been close friends, stimulating each other in imaginative synergy. Dyson also has worked for the U.S. Disarmament Agency, served as consultant to NASA and the Department of Defense, and is a former chairman of the Federation of American Scientists.

Today, at 55, Dyson is more freewheeling than ever in his speculation. Conversing with him leaves one slightly breathless as he jumps from details of a rocket that might be launched tomorrow to the outlook for the next ten billion years of evolution. After a while one begins to sort out what he says by how he begins each sentence. "It's inevitable..." signifies his certainty about the next century or two; "It seems obvious..." enlarges the scope to the future of mankind on the earth; and "One should expect..." can reach from the Big Bang to the end of the cosmos.

Dyson is a small, compact man with sharp features ("I don't have much hope for your pictures," he warns; "my children always say my nose looks like the beak of a bird") frequently softened by a half-smile. When the smile breaks into laughter, which is often, the laugh is that of a hearty, delighted young man, and it seems almost too large for its owner. However much he may deprecate his "hobby," Dyson clearly enjoys it—as well as the reactions of his more staid colleagues.

In the last decade, Dyson has been watching and advising the growth of Princeton physics professor Gerard O'Neill's plans for self-sufficient colonies in space, supplied with raw material catapulted from the moon by an electromagnetic "mass driver." The interview began with that subject.

Dyson: I think O'Neill saw what I and others did not see—that the public was ready to get excited about space again. It seemed after Apollo that people were turned off, they'd seen too many moon rocks. I thought it would be hopeless to get people interested in space colonies for twenty years or so. But O'Neill showed that you *could* get them interested, especially young people. It showed great courage and insight on his part.

Omni: Is it because he's talking about colonization, rather than a there-and-back expedition like Apollo? Or because he's showing how the colonies could pay for themselves by building solar-power satellites to supply energy to earth?

Dyson: I doubt the economic aspect was that important. It came later, when O'Neill was trying to get the Establishment—NASA and the Congress—interested. He had to sell it on economics, but as far as the public is concerned, it isn't that.

Omni: How do you explain O'Neill's success in view of the current mistrust of "big technology," of big government projects, and so on?

Dyson: I don't really know. Perhaps I should say that while I have the greatest respect and admiration for O'Neill, space colonization on that scale isn't entirely to my taste. The big colonies he envisions are a little too hygienic for me. I've done some historical research on the costs of the *Mayflower*'s voyage, and on the Mormons' emigration to Utah, and I think it's possible to go into space on a much smaller scale. A cost on the order of $40,000 per person would be the target to shoot for, in terms of real wages, that would make it comparable to the colonization of America. Unless it's brought down to that level it's not really interesting to me, because otherwise it would be a luxury that only governments could afford.

Omni: Where would your *Mayflower*-style colonists go?

Dyson: I'd put my money on the asteroids. Dandridge Cole and others suggested using a solar mirror to melt and hollow out an iron asteroid, and in O'Neill's book his homesteaders build their own shells from the minerals available out there. I wouldn't accept either of those as the most sensible course. I think you should find an asteroid which is not iron or nickel, but some kind of soil that you could grow things in.

Omni: What do you mean by soil?

Dyson: Well, we have specimens of meteoritic material called carbonaceous chondrite, which *looks* like soil—it's black, crumbly stuff containing a good deal of water, it has enough carbon, nitrogen, oxygen so that there's some hope you could grow vegetables in it, and it's soft enough to dig without using dynamite.

Omni: So you think it would be worth looking for an asteroid like that rather than trying to transform a raw stone or metal asteroid?

Dyson: Yes, if it's to be done on a pioneer basis, you'd jolly well better find a place where you can grow things right away. Otherwise, it's inevitably a much slower and more expensive job.

Omni: Is the sunlight at that distance adequate to grow plants?

Dyson: I think so. Plants are very flexible in their requirements, you know, and they could be genetically altered if it's needed. After all, a lot of things grow very well even in England.

Omni: What about colonizing the moon? Too much gravity?

Dyson: That, and it's simply too close to home. Too easy for the tax man to find you. And choosing a place to go is not just a question of freight charges. There have always been minorities who valued their differences and their independence enough to make very great sacrifices, and it seems obvious to me that it's going to happen again.

Omni: So you think we may not go in for the big O'Neill-type colonies after all?

Dyson: We may not, but others may. I was in Russia two years ago for a conference on telescopes, and all that anyone there wanted to hear about was O'Neill's ideas. They knew that he and I were both at Princeton, and assumed I could tell them everything about space colonies. The point is that in Russia, they have very little of our current mistrust of technology on the grand scale—in fact, it fits in very well with their ideas about our relationship to nature. Thousands of engineers working on a giant framework floating in space, that's a picture that excites them very much. I wouldn't be surprised if they choose that.

If they do, the historical analogy becomes very strong: the Russians play the role of the Spanish colonists in the New World, and people like me are more like the English, with smaller, scattered, decentralized colonies. Of course, it took the English much longer to get going, but when we did go, we did a better job.

Omni: As for the "going"—how will that happen? In *The Curve of Binding Energy* [Ballantine Paperback, 1976] John McPhee quotes you as having hoped that Project Orion would put men on Mars by 1965, Saturn by 1970. Looking back on it today, do you think that "bomb" propulsion should have been followed up?

Dyson: First, you have to remember that the background against which we're judging Orion has changed dramatically since the nuclear test ban treaty of 1963. At the time we were working on it, we calculated that launching Orion would add no more than one percent to the radiation from atmospheric tests. But that amount would be quite unacceptable under the current ground rules, and rightly so. In some sense, I do regret that we didn't try it—but history simply passed it by.

Omni: What about using chemical rockets to put an Orion-type ship into orbit, then going from there on nuclear explosions?

Dyson: We did consider that in the later proposals. It would have been disappointing to sacrifice Orion's advantages for the first and most difficult stage, and in any case, although the radioactive debris using that approach would not have been nearly so great as that from a ground launch, much of it would still have made its way down into the atmosphere.

Omni: Are there any current propulsion ideas as promising as Orion was in its time?

Dyson: There are several that I think are just as good, if not better. First, there's the ground-based laser system that [physicist] Arthur Kantrowitz has advocated. The ship would simply carry reaction mass—it could be water—and the lasers would follow it upward, delivering energy to vaporize the reaction mass. What's nice about the idea is that it would permit you to get into orbit with one stage, costing perhaps $10,000 for a ton of payload. The launching facility could be a "public highway" into space for the kind of small-scale colonization we were talking about: you'd make your reservation and show up with the equipment you'd need wherever you were going—perhaps not an individual or a single family, but certainly a small group.

Omni: What would lasers putting out that kind of power do to the air as they passed? It sounds like there'd be a spectacular "Star Wars" beam snapping, crackling and so on.

Dyson: Actually, it wouldn't be like that at all. Remember, air is very transparent, especially at the ten-micron infrared wavelength involved in this scheme. There shouldn't be more than a ten or twenty percent energy loss along the way, and it would be spread over quite a large volume of air. The idea isn't without problems, of course: the air would be heated slightly, which would cause it to expand, so it would tend to defocus the beam. But the biggest problems are in the design of the motor, the structure that receives the laser energy and converts it into heat as efficiently as possible. Unfortunately, no one has built even a prototype yet.

Omni: Then you foresee no problem as far as the laser itself is concerned; does that mean work on very high powered lasers is progressing satisfactorily—for military applications, say?

Dyson: I couldn't say. But there's no reason to use a single giant laser. You could just as easily use a battery of smaller ones, each with a power level that's attainable today.

Another possibility is O'Neill's mass driver. It's an old idea as far as ground launching is concerned, but his proposal to adapt it for thrust in space is new. On the ground, of course, it shares the laser system's chief advantage: you needn't carry along your energy source. There are various ideas on what to use as reaction mass for applications in space. If you get into earth orbit via chemical rockets, for example, you could grind up the empty fuel tanks into powder and use that. Some of it would end up harmlessly in the atmosphere, and the rest would be no significant addition to the ambient dust in the solar system. A liquefied gas would be even better.

The third idea, which would be for travel within the solar system although hardly for launching anything, is our old friend the solar sail. That's a very old idea—it's in Tsander, writing in 1924, and I wouldn't be surprised if it could be found in Tsiolkovsky even earlier.

Omni: Has anyone worked that idea out in detail?

Dyson: Not too long ago, NASA invited proposals for a mission to rendezvous with Halley's Comet in 1986, and several groups did studies. It's a terribly hard mission, and chemical rockets can't even begin to get near. It means getting into an orbit going the other way around the sun, a huge velocity change, so the only possibility of doing it at all is with some low-thrust long-duration propulsion system. So a group of solar-sail enthusiasts at the [NASA] Jet Propulsion Laboratory did a summer study on the mission. They put together a very thorough and really promising proposal, in the "real world" with launch dates and everything. They were working with a Mr. McNeil, a private-enterprise type, who is the inventor of a solar sail he calls the Heliogyro, which is very clever from an engineering point of view and much easier to manage than just a big square piece of foil.

So they put this document together, and when it was finished they went to the JPL management and asked them to recommend to NASA that it be tried. The outcome, and I quote: "The principal limitation preventing the sail from receiving a positive recommendation . . . was the high risk associated with asserting its near-term readiness in the face of absolutely no proof-of-concept tests."

Omni: Hmmmm . . . who else did they expect to test it?

Dyson: The problem is, of course, that they can't afford to fail. The rules of the game are that you don't take a chance, because if you fail, then probably your whole program gets wiped out.

Omni: Would a change at the top, say in NASA, open it up to ideas like the solar sail or laser launching?

Dyson: I don't think the problem is with NASA, but with the whole political system by which government projects are funded. You can't afford to fail if it's as simple as that. Congress just doesn't provide money for things unless they're sure to work. Of course the situation could change, but the change has to be primarily in Congress. I don't think any management at NASA could do very differently from what they're doing at the moment. The trouble is, the scientists aren't interested in new propulsion methods either. They just want the good old reliable rockets; they want to get their stuff into orbit and that's it. So scientists are not going to provide the kind of push that's needed.

Omni: So O'Neill's approach might be the only way to create a constituency for space colonization?

Dyson: That's not the way I want to go. You see, O'Neill also has this no-risk philosophy very strongly.

Omni: Then how do you reach Congress?

Dyson: Perhaps you can't. That's the whole question. I'd like to do it with private enterprise. There are people like Gary Hudson, who would like to go into business completely independent of NASA and put stuff into orbit commercially. He believes he can undersell NASA by a factor of ten. Maybe he's right; I wouldn't be surprised. It's just hard getting the customers. Well, as he says, he has lots of people lined up for his *second* launch.

Omni: Is it fair to say that for you, the most important aspect of space colonization is that it be cheap, flexible, small-scale?

Dyson: Yes. I'm not altogether fanatical about it, not really a follower of Schumacher. One needs the big enterprises too; there may be things that demand them, and I think it would be a great mistake to be too ideological and say "we must not do it because it's big," which some of my friends tend to do. I merely say that at the moment we're *only* doing the big expensive stuff, and that's stupid.

Omni: Short of orbiting enough solar power satellites to fill all our needs, what do you see as possible answers to our current energy dilemmas? What about fusion?

Dyson: I would have to say that at the moment fusion doesn't look good. Even the best fusion reactor would use ten times as many neutrons to produce a kilowatt of electricity as a fission reactor. Of course with fission you have a very different set of problems, and we may make the political decision to avoid those—but on technical and economic grounds alone, fission looks better. I'm very wary of any statement that something can't be done though—somebody may come up with a new approach to fusion power tomorrow, and I could be totally wrong.

Omni: And what about near-term uses of solar power?

Dyson: Right now I'm involved with a solar-energy scheme that Ted Taylor is promoting. I'm just as excited about it as I was about Orion. Ted's a man I'll always be willing to follow. He's always years ahead of

"Unless you enforce a total prohibition on genetic research, it's inevitable that people are going to make their children better than themselves. The techniques to do that will be available in the next century."

the rest of us, and he decided a few years ago that solar energy was the thing to work on. What we're aiming for is a trial here in Princeton of a system centered around a solar pond, a system that would provide heating, cooling, and electricity for a hundred homes, for a capital investment of half a million dollars.

It's a very earthbound, low-technology project—essentially village technology, something that the Indians, the Thais, the Nigerians could put to use at once. The basic requirement is a lot of plumbing, and you can find plumbers anywhere—in fact, you may find better plumbers in the 'underdeveloped' countries than here! And the only mass-produced component would be the heat engines, and those you can buy off the shelf right now, cheap and quite efficient.

I don't know if we can do it, but if we can, we'd turn the world upside down, it beats anything.

Omni: How far along is the project?

Dyson: Oh, it's nowhere yet—just Ted's enthusiasm and a few pieces of paper. We've had negotiations with the Department of Energy, but it's just laughable—you can't even get to the people who matter with anything this small.

Omni: Even you? Even Taylor?

Dyson: That's right. But the amusing thing is that it really doesn't matter whether we succeed or not, because there are hundreds of other little groups like us around the world. One or another is going to come up with the right idea, and it's no tragedy if ours fails. If it isn't solar ponds, it'll be something else along those lines. There are so many variables—it's like finding the best way to design a bicycle: lots of details that you only get right after a long time. The most difficult part will no doubt turn out to be figuring out how to dig the ponds cheaply, how to keep children from falling in, and so on.

This is a wild extrapolation, but I think it's worth saying. One of these solar pond systems takes just about the same amount of money and land, per capita, as a highway. If the U.S. were to derive all its energy from solar ponds, it would mean essentially making over again the same kind of investment we've made in our road system—one percent of the land area, and something like a thousand billion dollars.

Omni: Presumably a cleaner investment.

Dyson: Not all that clean—I'm sure there'd be a lot of people who'd object to having these ponds around, and it'd involve many of the same problems as roads. But at least ponds won't stop you from walking from one place to another! Oh, there'd be problems. Sunlight is so abundant, if you can just think up any sensible scheme that will make use of it at five-percent efficiency you're in. That doesn't mean we should drop fission or the research into fusion, of course.

Omni: OK, let's assume we get through the next few years, and find sources that will let us keep expanding our energy use. But will we? The thinking behind the Dyson shell, and some of the other 'cosmic engineering' projects, seems to be that any advanced civilization will keep doing more of the same thing we've been doing in the last few centuries. Is that a safe assumption?

Dyson: Oh no, that isn't my assumption at all. When I wrote about the possibility of detecting infrared emissions from a shell built around a star, the rules of my game were "What could we *detect*?" There may be many advanced civilizations that don't handle vast quantities of energy, or that do it in a way we can't imagine and can't detect. But if there are any which do try to make the most of the total output of their stars, we should be able to spot them.

Omni: As you know, a number of science fiction books and stories have made use of your speculations. Was there a reverse influence—did fiction influence you?

Dyson: Certainly. As a child I read through all the Jules Verne books I could find, I read Wells and enjoyed them very much. I read very little else, actually, because I was a poor reader. But the one who set my style of thinking, certainly the most influential, was Olaf Stapledon, with his *Star Maker* and *Last and First Men*. I remember they were in Pelican paperbacks, ninepence each, and one day I sat in Paddington Station for two or three hours, reading *Star Maker*. It seemed to me perfectly obvious that that was the way to think about space and about the future—that kind of broad scope, that kind of scale.

Omni: You must be aware that some of your colleagues take a jaundiced view of your ideas about giant trees growing on comets, taking Jupiter apart to build a Dyson shell, and so on. Does it bother you to know that they're out there muttering about 'Dyson's crazy ideas'?

Dyson: Not at all. Keep in mind, I'm also a perfectly respectable physicist, and the speculation is a hobby. It's become well known, but I've grown used to the idea that people very often become famous for accidental reasons. It's amusing to think that someday all my 'serious' work will probably be a footnote in a textbook, when everybody remembers what I did on the side. . . . Anyway, what do I have to lose? I have tenure here, and no one expects much from a theoretical physicist once he's past fifty anyway!

Omni: In an article some years ago, you pointed out that chemical energy—the kind in our bodies and brains, the kind we've built a technological civilization on—is very small, even trivial, compared to the major forms of energy in the universe: gravitational, kinetic, nuclear, and so on. Yet here we are. Is there something about chemical energy to account for that?

Dyson: It is very, very special. The beauty of chemical energy is that it's so enormously flexible, and it can serve so many different purposes at once. It's a good way of storing energy, a good way of releasing it in a controlled fashion, a good way of transferring it from one point to another. I think that's why life makes use of it. There have been ideas, people trying to imagine creatures living inside neutron stars and various other unlikely places. Olaf Stapledon, of course, wrote about living stars—

Omni: And there's Fred Hoyle's "Black Cloud," an intelligent nebula of gas and dust.

Dyson: All these things may be possible, but we've absolutely no reason to believe it at the moment. What chemical energy has that the other forms don't is versatility, the huge variety of structures, the variety of types of chemical bond. It's a very many-sided thing. But it's hard to know just what is responsible for its "specialness," because we've nothing else yet to compare it with.

Omni: What's your immediate reaction to, say, Hoyle's black cloud? Does it seem unlikely?

Dyson: I think it's very plausible. In fact, I was thinking about just that in another connection, another of the things I've been working on as a hobby. What is the ultimate fate of living creatures in the universe? There seem to be two possibilities, either we all get fried or we all get frozen. If we all get fried, it's not very interesting. The universe collapses into a big black hole, temperature goes to infinity—it's all over, nothing you can do. The alternative is much more interesting, that the universe is open and expands forever. The conventional view is that that is also a depressing prospect, because everything gets cold and just disperses. It's Stapledon's "nothing left in the whole cosmos but darkness and the dark whiffs of dust that once were galaxies." But I've been thinking lately—if the universe is open, could we survive? Could life and intelligence survive? I think probably we could, but it would have to be in the form of a black cloud—there'll be no possibility for chemical life to survive.

Omni: Do you mean that we would transform ourselves into such a form, or that we would evolve into it?

Dyson: It's ... it's hard for us to grasp the time scale involved, it's unimaginably long. As a rule of thumb, it takes a million years to evolve a new species, ten million for a new genus, one hundred million for a class, a billion for a phylum ... and that's about as far as your imagination can go. In five billion years or less, we've evolved from some sort of primordial slime into human beings ... what would happen in another ten billion years? It's just utterly impossible to conceive of ourselves changing as drastically as that over and over again, but ... I think all you can say is that the material form that life would take on that kind of time scale is completely open. To change from a human being to a black cloud may seem a big order, but it's the kind of change you'd expect anyway over billions of years. There's all the time in the world for evolution before the sun runs out of fuel.

What I envisage as the structural unit of such a creature is simply dust grains, probably made of iron or some convenient stuff, probably charged and working on each other with electric and magnetic forces. One can imagine enormously complex structures built out of these things. What would correspond to a muscle, or a nerve synapse? I haven't the faintest idea ... it's an open-ended system. In the same way as the organic fluids we're made of, and the electromagnetic forces would give you a means of tying it together, coordinating it. It could be just as complex, even more complex than what we see around us now.

"In five billion years or less, we've evolved from some sort of primordial slime into human beings. What would happen in another ten billion years? The material form that life would take on over that time scale is completely open."

Omni: Then how do we manage to understand the universe at all? Do you agree with Carl Sagan, for example, that we find the mathematics of gravitation so simple and elegant because natural selection eliminated the apes who couldn't understand?

Dyson: Not at all. For apes to come out of the trees, and change in the direction of being able to write down Maxwell's equations ... I don't think you can explain that by natural selection at all. It's just a miracle.

Omni: You have also written that "as we look out into the universe and identify the many accidents of physics and astronomy that have worked together to our benefit, it almost seems as if the universe must in some sense have known that we were coming." Is that a playful suggestion?

Dyson: It's not playful at all.

Omni: Then we seem to be talking about sentiments that most people would consider religious. Are they religious for you?

Dyson: Oh yes ... It's always difficult to mix science and religion without making a fool of oneself—in fact, it's probably impossible, and one is probably very unwise even to try ...

Omni: Well, let's say that the pressure of this interview is forcing you out on a limb. As we all know, the dominant tendency in modern science has been to assert that we occupy no privileged place, that the universe does not care, that science and religion don't mix. Where do you fit into those ideas?

Dyson: The tendency you're talking about is a modern one, not old. I think it became almost a dogma only with the fight for acceptance of Darwinism: Huxley versus Bishop Wilberforce, and so on. Before the nineteenth century, scientists were not ashamed of being religious, but since Darwin, it's been taboo. The biologists are *still* fighting Wilberforce. If you look now, the view that everything is due to chance and to little bits of molecular clockwork is mostly propounded by biologists, particularly people like Jacques Monod—whereas the physicists have become far more skeptical about that. If you actually look at the way modern physics is going, it's very far from that. Yes, it's the biologists who've made it so hard to talk about these things.

I was reading recently a magnificent book by Thomas Wright, written about 1750, when these inhibitions didn't exist at all. Wright was the discoverer of galaxies, you know. So I'd like to read from that—it's easier to say these things by quoting others. He's talking about how many inhabited worlds there are, and he writes:

"In this great celestial creation, the catastrophe of a world such as ours, or even the total dissolution of a system of worlds, may possibly be no more to the great Author of Nature than the most common accident of life with us. And in all probability such final and general doomsdays may be as frequent there as even Birthdays or Mortality with us upon the earth. This idea has something so Cheerful in it that I own I can never look upon the stars without wondering that the whole world does not become astronomers, and that men, endowed with sense and reason, should neglect a science that they are naturally so much interested in, and so capable of enlarging the understanding, as next to a Demonstration must convince them of their immortality, and reconcile them to all those little Difficulties incident to human nature without the least Anxiety."

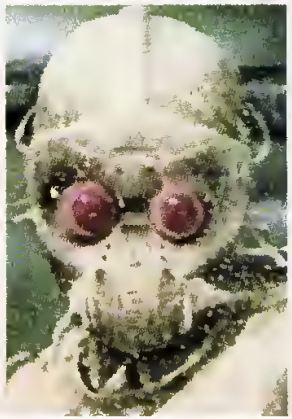
Omni: That's the long view indeed ... even at the Institute for Advanced Studies. How much do you discuss your hobby with your colleagues here?

Dyson: This place is a motel, and people change from year to year. That's what I like about being here, a fresh crowd every year. The number of permanent people is very small, so most of the time I'm talking to visiting members. In the School of Physics we are, generally speaking, very serious, the young people are highly specialized and want to talk about their professional work, so the people I talk to

CONTINUED ON PAGE 173

One danger that haunts science fiction is the looming form of threatening robots The earliest of these were constructed of flesh and bone and would now be called androids Frankenstein's monster (1817), and Capek s R U R (1923), Rossum's Universal Robots, the source of the term The idea that if you built it it couldn't be good carries on through C C Campbell's *The Avatar* (1935), in which the perfect artificial man becomes dictator of the world and has to be destroyed

It was only with the construction of metal robots—obedient machines—that mechanical men began operating on the side of justice In the early pulp magazine, Frank Reade's Steam Man fought the Indians for the good guys, and Eando Binder's robot, built for peace to prove its worth to mankind, was smart enough to choose sides against the Nazis in *Adam Link Fights a War* Edmond Hamilton's Captain Future could count upon the faithful robot Krag, as well as the faithful but not so nice



ROBOTS

BY HARRY HARRISON

A glittering gallery to celebrate those timeless workhorses of science fiction.

android Lothar to aid him at all times.

A later development is the part man, part metal (or plastic) creature. This theme and the psychological effects of bionic engineering have been explored successfully in Budry's *Who* (1958) and more recently in the preposterous bionic man, woman, dog, hamster, etc., tv series. The authors of these stories never seem to realize that all mechani-

cal substitutes for human parts are far weaker than the originals, the bionic man needs a wheelchair—not a springboard to leap over buildings. We must slip far into the future to rationalize a superior technology that makes the creature work well, as in Saul Dunn's Mandroid, who is only 10 percent human, the rest being manufactured parts.

A touch of order entered robotic cir-

cles in 1940 with Asimov s *Robby* and *Liar* The mechanical men now began to clank about radiating security, since they had the Laws of Robotics stamped into their positronic brains Asimov gets full credit for these laws: and countless are the writers who have utilized them

1 A robot may not injure a human being, or, through inaction, allow a human to come to harm

2 A robot must obey the orders given it by human beings except where such orders

would conflict with the First Law.

3 A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

Once the robotic threat had been removed, the infinitely varied relationships of robot with man could be explored. Clifford Simak, in his *City* series, shows mankind evolving and leaving the earth to the robots

and highly evolved dogs. Jack Williamson's *With Folded Hands* (1947) does discover a danger in robot control, but a benevolent one. To prevent men from being hurt, the robots are stunting all development of the human race. With all the robotic goodness around it was a pleasure to see Alfred Bester's *Fondly Fahrenheit*, about a slightly insane robot.

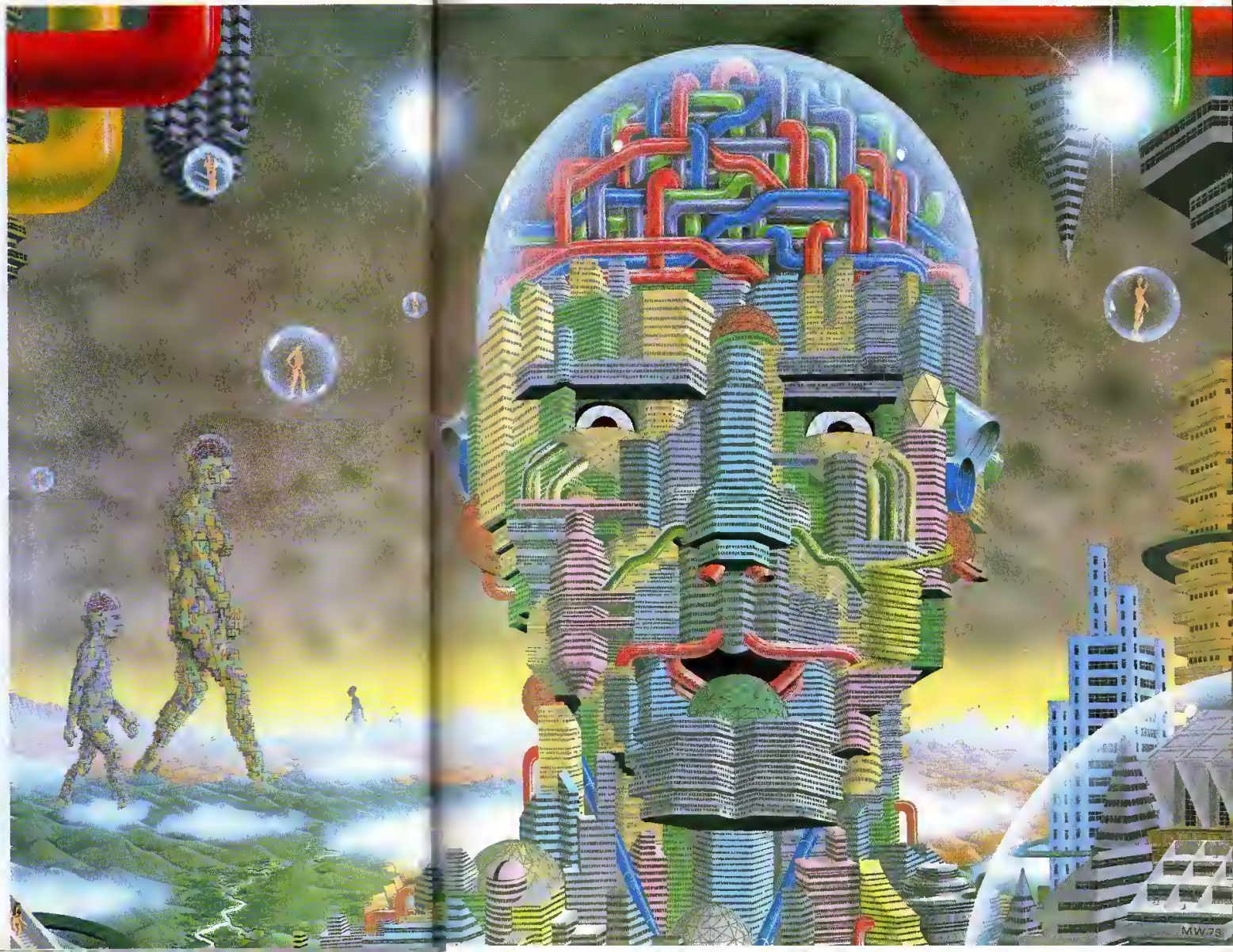
Having once as-

signed man's attribute to a machine, we must consider the relationship of this intelligent machine with man's mystical nature. Boucher's *The Quest for Saint Aquin* asked if it is possible to have a robot saint. Silverberg answered the question years later with *Good News from the Vatican*. If you can have a robot pope—then why not a saint?

Of course these are just the human-appearing robots, although there is no good reason at all to shape a robot in this manner, other than it looks nice and it is handy to have around the house. Real robots, the ones actually in use in industry today, look nothing at all like the classic clanker. The commonest are just collections of machine tools and mechanical manipulators.

SF also has nonhumanoid robots of this kind. The computer-controlled, fully automated spaceship has been with us for quite a while. Fully automated cities, usually so well designed that they keep operating after their inhabitants are gone, have had their day, and fully automated trains ran first in the pages of science fiction.

At sea we have Bass's Godwhale, a sentient giant robot designed for harvesting plankton for undersea food processing plants. In Space—and at war again—are Saberhagen's Berserkers, super war machines launched by alien nutters, whose job it is to zip about the galaxy destroying all forms of life. ∞



FICTION

FOUND!

Thousands of lives were jeopardized by Computer-Two's malfunction . . . so we had to go aloft and set things straight.

BY ISAAC ASIMOV

Computer - Two, like the other three that chased each other's tails in orbit round the Earth, was much larger than it had to be.

It might have been one-tenth its diameter and still contained all the volume it needed to store the accumulated and accumulating data to control all space flight.

They needed the extra space, however, so that Joe and I could get inside, if we had to. And we had to.

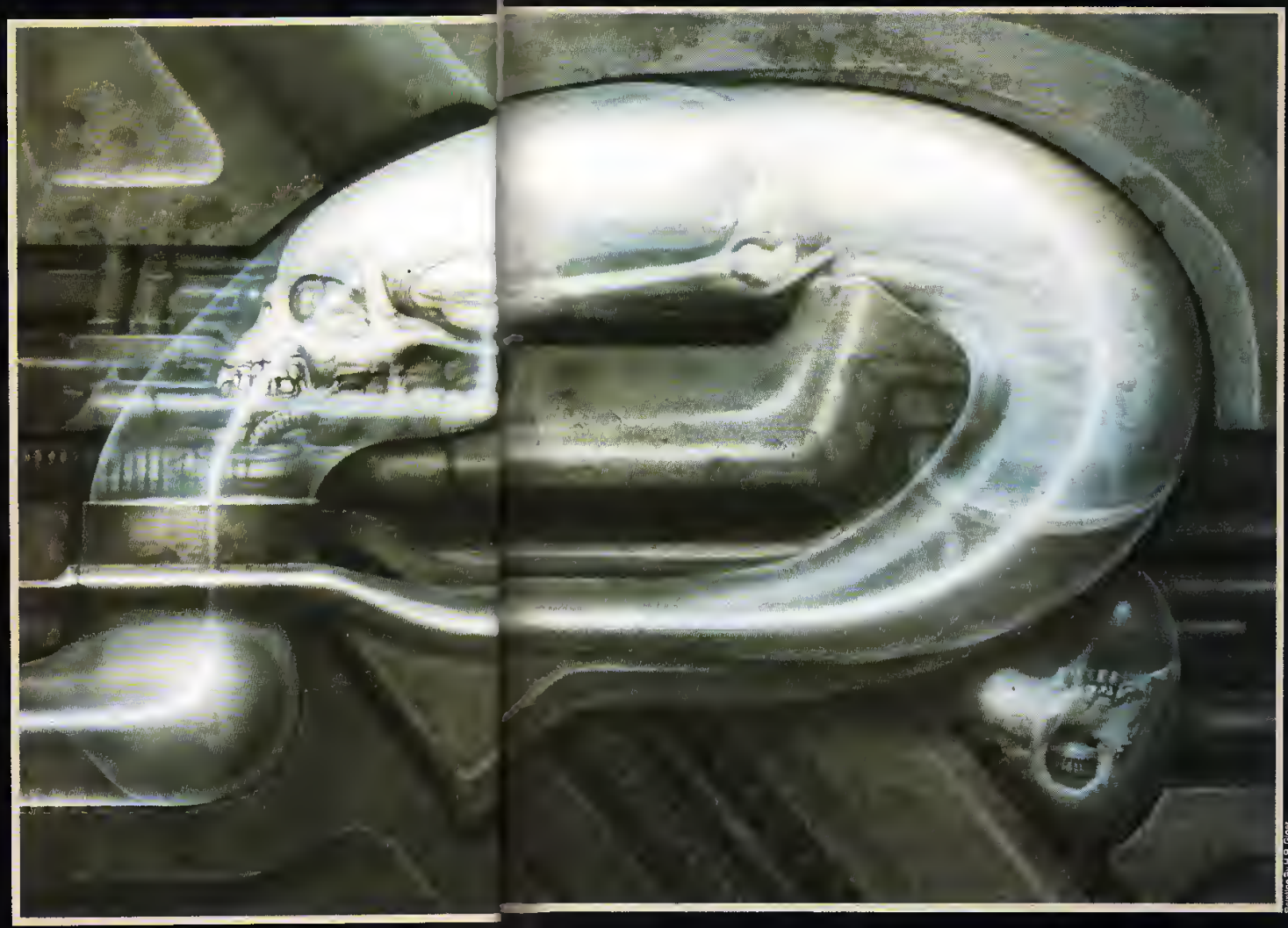
Computer-Two was perfectly capable of taking care of itself. Ordinarily, that is. It was redundant. It worked everything out three times in parallel and all three programs had to mesh perfectly; all three answers had to match. If they did not, the answer was delayed for nano-seconds while Computer-Two checked itself, found the malfunctioning part and replaced it.

There was no sure way in which ordinary people would know how many times it caught itself. Perhaps never. Perhaps twice a day. Only Computer-Central could measure the time-delay induced by error and only Computer-Central knew how many of the component spares had been used as replacements. And Computer-Central never talked about it. The only good public image is perfection.

And it's *been* perfection. Until now, there was never any call for Joe and me.

We're the troubleshooters. We go up there when something really goes wrong; when Computer-Two or one of the others can't correct itself. It's never happened in the five years we've been on the job. It did happen now and again in the early days, but that was before our time.

We keep in practice. Don't get me wrong. There isn't a computer made that Joe and I can't diagnose. Show us the error and we'll show you the malfunction. Or Joe will, anyway. I'm not the kind who sings one's own praises. The record speaks for itself.



Painting by H R Giger

Anyway, this time, neither of us could make the diagnosis.

The first thing that happened was that Computer-Two lost internal pressure. That's not unprecedented and it's certainly not fatal. Computer-Two can work in a vacuum after all. An internal atmosphere was established in the old days when it was expected there would be a steady flow of repairmen fiddling with it. And its been kept up out of tradition. Who told you scientists aren't chained by tradition? In their spare time from being scientists, they're human, too.

From the rate of pressure loss, it was deduced that a gravel-sized meteoroid had hit Computer-Two. Its exact radius, mass, and energy were reported by Computer-Two itself, using that rate of pressure loss, and a few other irregularities, as data.

The second thing that happened was the break was not sealed and the atmosphere was not regenerated. After that came errors and they called us in.

It made no sense. Joe let a look of pain cross his homely face and said, "There must be a dozen things out of whack."

Someone at Computer-Central said, "The hunk of gravel ricocheted very likely."

Joe said, "With that energy of entry, it would have passed right through the other side. No ricochets. Besides even with ricochets, I figure it would have had to take some very unlikely strikes."

"Well, then, what do we do?"

Joe looked uncomfortable. I think it was at this point he realized what was coming. He had made it sound peculiar enough to require the trouble-shooters on the spot—and Joe had never been up in space. If he had told me once that his chief reason for taking the job was because it meant he would never have to go up in space, he had told it to me 2^x times, with x a pretty high number.

So I said it for him. I said, "We'll have to go up there."

Joe's only way out would have been to say he didn't think he could handle the job, and I watched his pride slowly come out ahead of his cowardice. Not by much, you understand—by a nose, let's say.

To those of you who haven't been on a spaceship in the last 15 years—and I suppose Joe can't be the only one—let me emphasize that initial acceleration is the only troublesome thing. You can't get away from it, of course.

After that it's nothing, unless you want to count possible boredom. You're just a spectator. The whole thing is automated and computerized. The old romantic days of space pilots are gone totally. I imagine they'll return briefly when our space settlements make the shift to the asteroid belt as they constantly threaten to do—but then only until additional computers are placed in orbit to set up the necessary additional capacity.

Joe held his breath through acceleration, or at least he seemed to. (I must admit I wasn't very comfortable myself. It was only my third trip. I've taken a couple of vacations on Settlement-Rho with my husband, but I'm not exactly a seasoned hand.) After that, he was relieved for a while, but only for a while. He got despondent.

"I hope this thing knows where it's going," he said, pettishly.

I extended my arms forward, palms up, and felt the rest of me sway backward a bit in the zero-gravity field. "You," I said, "are a computer specialist. Don't you *know* it knows?"

"Sure, but Computer-Two is off."

"We're not hooked into Computer-Two," I said. "There are three others. And even if only one were left functional, it could handle all the space flights undertaken on an average day."

"All four might go off. If Computer-Two is wrong, what's to stop the rest."

"It was a small cylinder . . . clearly metal, but of an odd grainy texture . . . stuck to the outer wall. It left behind a perfectly round hole in the skin of Computer-Two. "There's the reason gas pressure declined to zero," I said."

"Then we'll run this thing manually."

"You'll do it, I suppose? You know how—I think not?"

"So they'll talk me in."

"For the love of Eniac," he groaned.

There was no problem, actually. We moved out to Computer-Two as smooth as vacuum and less than two days after takeoff, we were placed into a parking orbit not ten meters behind it.

What was not so smooth was that, about 20 hours out, we got the news from Earth that Computer-Three was losing internal pressure. Whatever had hit Computer-Two was going to get the rest, and when all four were out, space flight would grind to a halt. It could be reorganized on a manual basis, surely, but that would take months at a minimum, possibly years, and there would be serious economic dislocation on Earth. Worse yet, several thousand people now out in space would surely die.

It wouldn't bear thinking of and neither Joe nor I talked about it, but it didn't make Joe's disposition sweeter and, let's face it, it didn't make me any happier.

Earth hung over 200,000 kilometers below us, but Joe wasn't bothered by that. He was concentrating on his tether and checking the cartridge in his reaction-gun. He wanted to make sure he could get to Computer-Two and back again.

You'd been surprised—if you've never tried it—how you can get your space-legs if you absolutely have to. I wouldn't say there was nothing to it and we did waste half the fuel we used, but we finally reached Computer-Two. We hardly made any bump at all, when we struck Computer-Two. (You hear it, of course, even in vacuum, because the vibration travels through the metalloid fabric of your spacesuits—but there was hardly any bump, just a whisper.)

Of course, our contact and the addition of our momentum, altered the orbit of Computer-Two slightly, but tiny expenditures of fuel compensated for that and we didn't have to worry about it. Computer-Two took care of it, for nothing had gone wrong with it, as far as we could tell, that affected any of its external workings.

We went over the outside first, naturally. The chances were pretty overwhelming that a small piece of gravel had whizzed through Computer-Two and left an unmistakable hole. Two of them in all probability, one going in and one coming out.

The chances of that happening are one in two million on any given day—even money that it will happen at least once in six thousand years. It's not likely, but it can, you know. The chances are one in not more than ten billion that, on any one day, it will be struck by a meteoroid large enough to demolish it.

I didn't mention that because Joe might realize that we were exposed to similar odds ourselves. In fact, any given strike on us would do far more damage to our soft and tender bodies than to the stoical and much-enduring machinery of the computer, and I didn't want Joe more nervous than he was.

The thing is, though, it wasn't a meteoroid.

"What's this?" said Joe, finally.

It was a small cylinder stuck to the outer wall of Computer-Two, the first abnormality we had found in its outward appearance. It was about half a centimeter in diameter and perhaps six centimeters long. Just about cigarette-size for any of you who've been caught up in the antique fad of smoking.

We brought out our small flashlights.

I said, "That's not one of the external components."

"It sure isn't," muttered Joe.

There was a faint spiral marking running round the cylinder from one end to the other. Nothing else. For the rest, it was clearly metal, but of an odd, grainy texture—at least to the eye.

Joe said, "It's not tight."

He touched it gently with a fat and gauntleted finger and it gave. Where it had

CONTINUED ON PAGE 164

Painting By Dr Ez Schwertberger

ZEN

Technology and the Split Brain

BY THOMAS HOOVER

In a story told not long ago in a galaxy not far away, a young space pilot named Luke Skywalker guides a high technology fighter plane on a last chance mission to destroy the forces of evil. He must thread his rocket through a nearly invisible opening, while speeding at full power. A targeting computer, which updates the ship's firing controls on a microsecond basis, is Luke's only hope.

Suddenly, at the crucial moment, he hears a voice from the past saying, "Use the force, Luke. The force is an energy field created by all living things. Trust your feelings, not the computer." Coming up hard on the target he hesitates, switches off the electronics and —when it feels right —squeezes the trigger.

Below him the enemy explodes in a blinding nova, like a thousand suns.

That cliché-packed episode was, of course, from last year's movie blockbuster, *Star Wars*, acclaimed by many as the ultimate technology film. What did you feel when Luke switched off the computer and flew by intuition? A surge of pride—or perhaps relief—when he actually out-gunned the machine? Then you got the message. "Don't worry about all those intellectually threatening computers, a human being still can outperform a machine any day of the week." It's a reassuring tune—whistled in the dark.

In the real world, a computer's superior ability for split-second analysis is fact rather than futuristic fantasy. But the threat is not that the machine will outsmart us; it is that *the computer may actually be changing the way we use our own minds*. By provid-

ing an artificial "intelligence" that amplifies the brain's capacity for logical thought, these machines may be nudging us toward an increasing reliance on 'computerthink," a rigid, mechanical thought process devoid of intuition and creativity. We may be in danger of becoming no better thinkers than our machines.

TWO SIDES OF THE MIND

Perhaps the easiest way to understand this development is to recall some findings about the brain itself. In the late 1960s, an experimental treatment for patients suffering from severe *grand mal* epilepsy was conceived by neurosurgeon Joseph Bogen and psychologist Roger Sperry. They decided to try the radical step of severing the bundle of nerves connecting the two halves of the brain. The two scientists suspected that this connector, called the *corpus callosum*, was leaking electrical malfunctions in one half of the brain to the other. They hoped a radical separation would isolate the source, diminishing its impact. To their delight the operations succeeded admirably in reducing both the occurrence and extent of seizures.

Afterwards, Sperry subjected his patients to some standard tests of identification and verbal response. To his amazement he discovered that the hemispheres of our brain are specialized, with each side handling different cognitive functions, and when they are separated they seem to act as two independent, autonomous types of consciousness. For example, language ability in many people seems to reside in the left side of the brain, so that it was possible for a patient from a split-brain operation to hold an unseen object in the hand controlled by the right-brain (this being the left hand, since we're cross-wired) and be unable to name the object. However, when the right hemisphere was shown a picture of an object, such as a spoon, the subject could use his left hand to pick that object from an unseen assortment of items. *But the spoon could not be named.* In this experiment, with apologies to an ancient Taoist/Zen adage, "The hemisphere that speaks does not know, the hemisphere that knows does not speak."

The discovery that many people have verbal ability concentrated in the left side of their brain led experimenters to wonder exactly what the right side was thinking while the left was talking. Ever since the Greeks, who used the same term—*logos*—for both 'word' and 'reason,' we in the West have assumed that language and higher intelligence are synonymous. But further research found a number of differences in function. For example, the left hemisphere reads music from notes on a page, but the right remembers the music we hear; the left handles math, the right perceives poetry. Thus the brain seems divided by type of intellect. The language-using left side of the brain is process oriented and works through things sequentially (just like a computer), while the muta right hemisphere concerns itself with patterns, spatial relationships, concepts.

Sperry's finding that half our brain contains knowledge we can't verbalize sounds curiously like an insight spelled out over 2000 years ago by one of the Chinese forerunners of Zen, a Taoist named Chuang Tzu. This philosopher quoted a story told by a wheelmaker that could have come from a 1970s paper on split-brain research.

When I am carving a wheel, if my stroke is too slow, then it bites deep but is not steady; if my stroke is too fast, then it is steady, but does not go deep.

"The hemisphere that speaks does not know, the hemisphere that knows does not speak."

The right pace, neither slow nor fast,
cannot get into
the hand unless it comes from the
heart. It is a thing that cannot be put
into words, there is an art in it that I cannot explain to my son. That is why it is impossible for me to let him take over my work, and here I am at the age of seventy, still making wheels. In my opinion it must have been the same with the men of old. All that was worth handing on died with them, the rest, they put into their books.

The wheelmaker recognized that there was a nonverbal, intuitive kind of knowledge that had nothing to do with linear, structured analysis. There are some things that have to be worked out one step at a time (quick, divide 18 into 100!) and there are things you have to feel (at what point do you downshift your sports car for a curve?).

Sperry's experiments have been well popularized by Robert Ornstein of the Langley Porter Neuropsychiatric Institute in San Francisco, who has gone on to test the brain hemisphere activity of normal people as they carry out various tasks, with findings that generally support Sperry's split-brain theory. Thus modern brain research has finally verified a quality of the mind we've suspected for a long time. Look around and you find examples of the two ways of thought everywhere: objective/subjective, law/art, rational/mystical, yin/yang, digital/analog, sequential/holistic.

SCIENCE AND INTUITION

How important is our power of nonanalytical thought to the practice of science? It's the most important thing we have, declares the Princeton physicist-historian Thomas Kuhn who argues that major breakthroughs occur only after scientists finally concede that certain physical phenomena cannot be explained by extending the logic of old theories. Consider the belief that the sun and planets move around the earth, which reigned prior to 1500. This idea served nicely for a number of centuries, but then became too cumbersome to describe the motions of heavenly bodies. So the Polish astronomer Copernicus invented a new reality that was based on a totally different "paradigm" or model—that the earth and planets move around the sun.

When the paradigm being dissected by the logical, scientific method finally fails to explain observations, the creative portion of our intelligence must jump outside this failed "reality." Which is not to say that a new paradigm is any more true than the older idea; it merely explains observations a bit better for the time being. As did the ancient Zen teachers, Kuhn concludes that the real truth of our universe may be unknowable. But the important thing here is that the new reality doesn't come about by approaching a problem rationally, since rationality only can operate within the old rules. As does a computer, the human mind in its logical mode must follow the rules of logic. To go outside them would be "irrational."

There are many cases of scientists producing major breakthroughs by exploiting their mind's capacity for non-rational creativity. For example, the German chemist Kekulé in 1865 solved the mystery of benzene's molecular structure in a dream. (Most organic molecules are connected strings of carbon atoms; the benzene molecule is a hexagonal ring.) According to the traditional account, Kekulé nodded off one afternoon and dreamed of a snake writhing uncontrollably. It suddenly seized its own tail and slowly began to rotate, in a stable condition. When the scientist awoke, he knew he'd found the answer. Thus the cornerstone of organic chemistry came out of a dream, not a "logical" scientific experiment in the laboratory.

Similarly, the man who verified the existence of cosmic rays, Robert Millikan, in a burst of insight conceived an experiment that first measured the charge of the electron while riding on a train. There even is a story, considered apocryphal by some, that Nobel-prize physicist Donald Glaser (now at the University of California Berkeley) envisioned the bubble chamber, a critical invention in subatomic particle research, while meditating on the beads forming in his beer glass at an Ann Arbor, Michigan, saloon.

Albert Einstein, whose atomic-age "reality" that mass is convertible to energy replaced the earlier Newtonian cornerstone that mass is always conserved, was another non-verbal thinker. "The real thing is intuition," he said. "A thought comes, and I may try to express it in words afterwards." But perhaps the best-known example of nonanalytical creativity was Leonardo da Vinci, whose notebooks are crammed with mechanical technology centuries ahead of his time. His *circa* 1490 drawings include a spring-driven car, a spinning wheel, even a rudimentary helicopter. Yet it was all apparently done visually, intuitively.

ZEN AND CREATIVITY

The powers of intuition are nothing new to the thinkers of the Far East (the *force* in *Star Wars* is no more than a Broadway version of the 3000-year-old Chinese *tao*, that indescribable unity of all things). In fact, intuition was viewed in the Far East as the *only* adequate means of understanding the natural world. Many of the "realities" that arose from this non-logical intelligence were extremely perceptive, preceding similar realizations in the West by centuries.

But how can intuition be more correct than hard scientific data? It turns out that facts alone are only one part of scientific truth. As we learned from Copernicus, science also is ideas. Arthur Koestler comments in *The Sleepwalkers*: "Insofar as factual knowledge is concerned, Copernicus was no better off, and in some respects worse off, than the Greek astronomers of Alexandria who lived at the time of Jesus Christ. They had more precise instruments for observing stars than Copernicus had. Copernicus himself hardly bothered with star gazing; he relied on the observations of Hipparchus and Ptolemy (who) had the same observational data, the same instruments, the same know-how in geometry, as he did."

An Eastern paradigm derived from intuitive wisdom that turned out to be more correct than the longstanding position of Western philosophy is dramatized by Werner Heisenberg's 1920's Uncertainty Principle. This landmark rethinking of physics in effect states that both the position and movement of a subatomic particle cannot be known simultaneously since one is affected by the act of measuring the other. In short, object and observer interact, they are not separate. Although they never put it in mathematical terms (as did Heisenberg), the intuitive thinkers of China asserted for centuries that independence of object and observer is a questionable concept, that we are at all times participants in the world around us. Detached, objective observation is consequently absurd.

It cannot be entirely coincidence that many of the major scientists who ushered in the atomic age viewed Eastern philosophy as a system of thought more congenial to the new order. Physicist Neils Bohr declared that for a parallel to atomic theory it was necessary to turn "to those kinds of epistomological problems which thinkers like the Buddha and Lao Tzu (the father of Taoism) have already confronted."

"The force in Star Wars is only a Hollywood version of the 3000-year-old Chinese tao."

THE RISE OF "COMPUTERTHINK"

The computer does many things for us. It provides the high-speed trajectory computations that allow us to land on the moon. It operates a telephone system that some have estimated might otherwise require the services of almost a quarter of the U.S. population. It is, in fact, well on the way to becoming an alternative kind of "intelligence." The next two generations, riding on the miniaturization made possible by the silicon chip, will most likely bring this instrument within striking range of many logical functions of the human brain, among them language. It already can organize and process sequential information much faster than we can. Teach a computer the rules of logic, and it will out-analyze you every time, from calculus to tic-tac-toe. Even now the Cyber 176 computer is providing a serious challenge to human superiority in that ultimate logical pastime, the game of chess. *Those who believe that the capacity for logical decisions is all that separates man from inanimate matter had best start preparing to go down with the chip.*

One might suspect that this reproduction of left-brain (or logical) intelligence by a machine would make us want to use our *own* minds in a different mode, one that the machine can't replicate. However, just the opposite seems to be happening. We have become increasingly disposed to attack problems the logical, numerical, "computerthink" way since it's easier to give the work to a brute-force machine than to try to find an elegant solution. Worse still, the powerful logic now at our disposal tempts us to approach design problems in a way congenial to the computer rather than to our own instincts. For example, we now prefer to break a problem down into small parts and then handle the parts separately, rather than view it as a whole. If each element is "logical," then it frequently occurs to no one that the whole entity may make no sense.

The decline of nonverbal thought in technology was recently noted in the journal *Science* by University of Delaware professor of history and technology Eugene Ferguson, who related a disturbing fact. Current engineering graduates seem to have less and less capacity for visual, conceptual thought. One example Ferguson gave was the decline in students' ability to draw (remember Leonardo), which is so precipitous that "when the National Park Service's Historic American Engineering Record wishes to make drawings of machines and isometric views of industrial processes as part of its historical record of American engineering, the only students who have the requisite skills attend architectural schools." Drawing is a right-brain phenomenon, but as a result of the curricular emphasis on numerical analysis and computers as the basis of modern engineering design, we only are learning to do things like noncreative, left-brain way.

What Ferguson is describing is the impending triumph of "computerthink." In the long run, concludes Ferguson, "engineers in charge of projects will lose their flexibility of approach to solving problems as they adhere to the doctrine that every problem must be treated as an exercise in numerical systems analysis." These same designers, he notes, will be "unaware that their nonverbal imagination and sense of fitness have been atrophied by an intellectually impoverished engineering approach."

There are, of course, many scientists and scholars who do not accept this grim outlook. Buckminster Fuller, for example

views technology as a solution, not a problem, and Robert Pirsig, in *Zen and the Art of Motorcycle Maintenance*, advocates what he calls "spiritual rationality," a right-brain stroking of technology, in which we sort of meditate on its hard-edged metallic precision as a new form of aesthetics.

But there also are many who sense in technology a threat to our own human superiority. It is understandably distressing to have our analytical powers suddenly topped by a machine we can hold in our hands. A recent *Time* article noted that, "Some manufacturers of computer games have discovered that people are disconcerted when the computer responds instantly after the human has made his move. So the computers have been programmed to wait a little while before making counter moves, as if scratching their heads in contemplation."

Indeed, many of us now tend to delude ourselves about the impact of technology. A study of attitudes toward computers not too long ago revealed that all persons questioned, regardless of their station, predicted that thinking machines would eventually replace all jobs below their own. Top to bottom, everyone asked believed his own job was the last one above the water line. The left brain is looking over its shoulder and seeing the computer gaining fast.

But the real threat of the computer is not that it will outsmart us or replace our jobs. It is that we are relying more and more on this artificial "intelligence" rather than struggling to develop our own considerably more complex creativity.

HOLISTIC EDUCATION

A countermovement to the reign of sterile logic seems to be emerging, albeit confused and in disarray. Leslie Hart declares in *How the Brain Works*: "The great bulk of human brainpower suffers suppression and disparagement because of this witless, pompous, pretentious emphasis on largely nonproductive but respectable artificial modes of thought." Obviously we need to understand the potential of human intuition better if we are to reverse the trend.

For example: how can this nonverbal, nonanalytical strength of the mind be communicated from one to another? The scientist R. G. H. Siu declared in *The Tao of Science* that: "One of the chief obstacles hindering its transmission is its indefinable character. Although real, it is as imprecise as an exhilarating spring day. It defies articulate description. It is not dispensed in measured doses. It is absorbed slowly and subconsciously into the moral fiber and intimate intuition of the person over a long period of time."

There is, at the moment, much talk about holistic education, of developing "both sides of the brain." Recently author Paul Brandwein, director of research at Harcourt, Brace, Jovanovich, recommended: "First of all, teachers should recognize that all decisions need not be based on observable phenomena." He also suggested that the curriculum be liberalized and that students be taken to see things rather than just being told about them.

Interesting, but it sounds a bit like intuitive intelligence is somehow less demanding than rational intelligence. The opposite is closer to the truth. It requires more discipline to be meaningfully creative than to work by rote. Right-brain (or creative) functions aren't less demanding; they're just a bit bashful about making an appearance when the left-brain is awake and running the show. Consider how a logical chain of reasoning can so easily intimidate "better judgment," since intuition is hard to find and to defend. What is amazing about an intuitive thinker such as Albert Einstein

"What is amazing about an intuitive thinker like Albert Einstein (who, incidentally, didn't talk until he was three) is that he learned how to shut off and ignore the kind of thought that is merely internalized speech."

(who, incidentally, didn't talk until he was three) is that he learned how to shut off and ignore the kind of thought that is merely internalized speech.

Some interesting progress on the problem of suppressing left-brain functions and opening up spontaneous intelligence has recently been reported by a California art instructor, Dr. Betty Edwards, who discovered ways to enable students to see things without analysis. One technique is to force students to "scribble-draw," or draw so rapidly that there is no time to think about the process. Another approach is to make students focus on an object until they begin to see the space around it, rather than just the object itself. Still another method is to assign the drawing of a complex item such as the fine leaves on a tree, so that the attention can only be on the lines, not on an analysis of the object. The effect of all this is reported to be a release of the bashful right brain.

What seems not to be widely recognized is that *precisely* the same techniques were discovered around a thousand years ago by the Zen painters of China. Although they might study technique for decades, the actual process of painting was completely spontaneous. After meditating on a subject or a topic until both it and the space it inhabited were a part of his intuition, a painter would then fling down the ink drawing seemingly by impulse, without recourse to reflecting or rationale. The effect of stepping back to deliberate on a point was not in evidence. Meditation and the non-analytical technique had the effect of releasing the intuitive powers of the mind while simultaneously circumventing the left brain.

ZEN EDUCATION

The Zen masters of the eighth century onward began what we today might call a research project to find ways to defeat the left-brain and thus expand the right-brain's potential. After many years they eventually settled on two basic techniques for stifling the dominance of the left hemisphere: 1) meditation, and 2) a structured form of mental harassment.

Meditation, long the mainstay of Eastern practices, is now the subject of laboratory studies in the West. We have found that by sitting quietly in one place and suspending active thought processes, it is possible to significantly alter the measurable characteristics of the brain. But the objective of Zen meditation also was and is, among other things, to alter the way we relate to the world around us. Ideally, the sense of separation, the object-subject relationship to our environment that is so much a part of the analytical, rationalist tradition, gives way. Zen philosophy maintains that it is possible to "understand" our environment in a more meaningful way by seeing things without compartmentalization, analysis, or value judgments. To see a tree directly for itself rather than as an embodied scientific name is to participate in a kind of understanding that supersedes logic, analysis, or any of the other structured functions of the left brain. Meditation, in fact, apparently allows the mind to supersede these functions. It appears, however, to be more passive than active approach to exploring the mind.

As a result there were those who came to believe that the objectives of meditation could be realized by more dynamic means. After much trial and error Zen teachers developed a kind of deadly-serious zaniness, whose single-minded pursuit of the extrerational is reminiscent of our modern Theater of the Absurd. They developed a program of deliberate mental harassment designed to taunt the scholarly mind much the way the Marx brothers could taunt a straight-man. Take a typical Zen exchange and watch carefully as categories and logic are neatly exploded.

A monk once drew four lines in front of a famous Zen Master. The top line was long and the remaining three

were short. The monk then demanded, "Besides saying that one line is long and the other three are short, what else could you say?' The Master drew one line on the ground and said, "This could be called either long or short. That is my answer."

Or take another example:

A new arrival said apologetically to the Master, 'I have come here empty handed!" "Lay it down then!' said the Master. "Since I have brought nothing with me, what can I lay down?' asked the visitor. "Then go on carrying it!" said the Master.

Given enough of this never-getting-a-straight-answer, the logical mind seems to burn out its circuits. The conundrum or *koan* method of Zen is to pose a question that at first seems as though it ought to have a logical answer (What is the sound of one hand clapping?) but which in fact does not. The logical left hemisphere is thus placed in the position of a computer called upon to produce the square root of a negative number. It just slugs away until it finally throws in the towel. Then, as the Zen teachers say, the chain of causation snaps (i.e., sequential reasoning breaks down), and the mind is ready to explore its capacity for intuitive holistic wisdom. Zen teachers merely demonstrate that the "left-brain" isn't so all-powerful after all.

Out of this release of the latent capabilities of the right-brain there developed a novel culture, whose creations include arts that require complete spontaneity (impossible until the critical, nagging rational mind is discredited and silenced) and an aesthetic theory about materials and design that stressed the subtle manipulation of perception (which forces the observer to become involved in the creative process and to experience the work intuitively).

THE ZEN "UNCERTAINTY PRINCIPLE"

It may turn out that the most important insight awaiting us in the realm of Eastern thought concerns right-brain intelligence itself. The question of how to reach this intelligence already seems destined to become the fashionable education issue of the 1980s, as even now we are struggling to try to understand—in rational terms—how the right brain works. But the Zen teachers, who have been working with this part of the brain for many centuries, would tell us that the rational part of the mind by definition can never understand the workings of the intuitive part.

It is fundamental to Zen philosophy that self-conscious introspection is doomed to failure, since to understand your mind—using that very same mind—is like trying to grasp your own hand or see your own eye. And thinking about the intuitive mind logically is the one sure way never to understand its workings, since if you arrive at the understanding rationally or verbally guarantees the understanding is wrong.

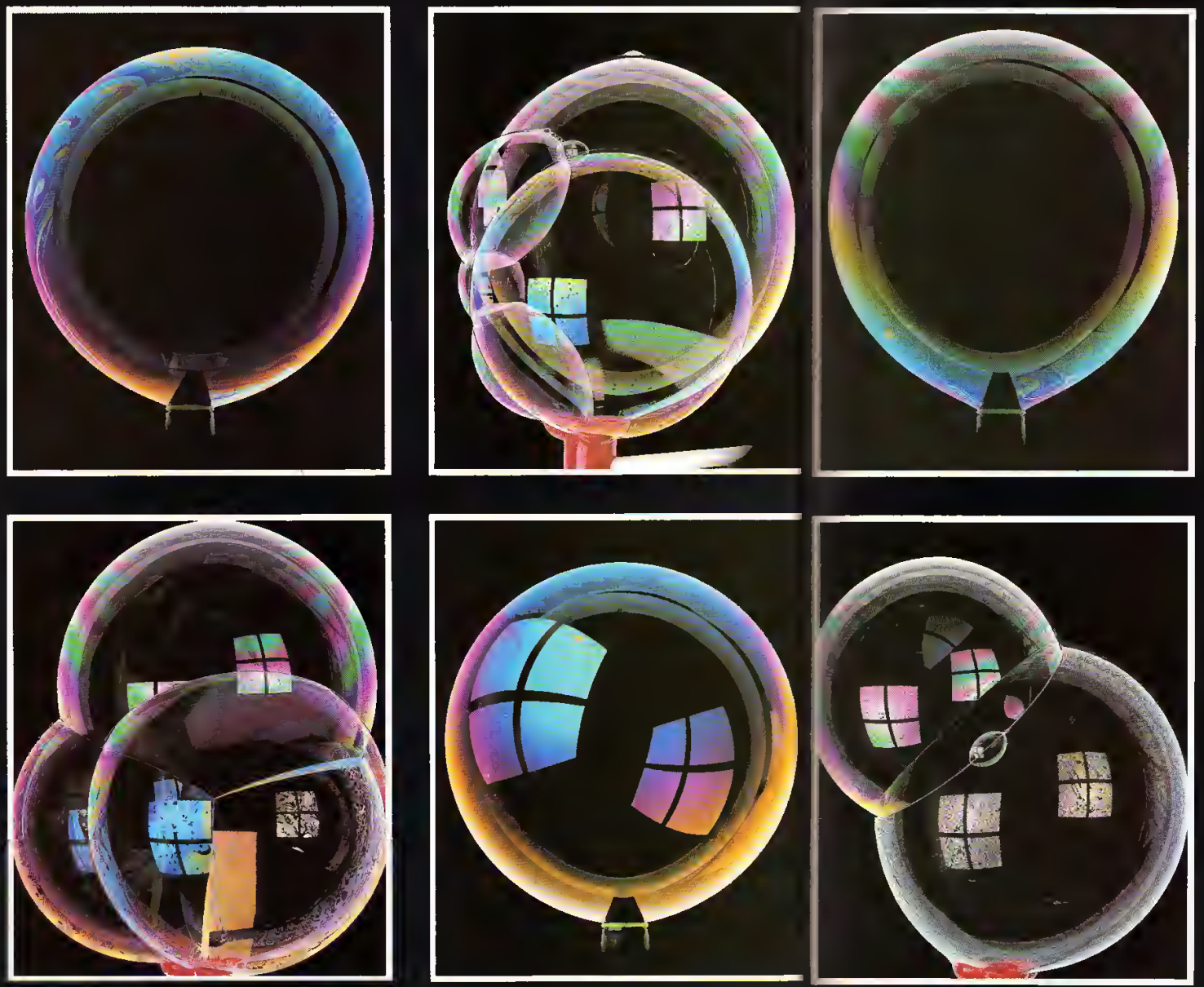
As a ninth-century Zen master put it: "Zen formulates the study of intuitive wisdom only to receive and guide beginners. In reality this intuitive insight cannot be learned, for the study of it actually screens it from our understanding." This might be called the Zen "Uncertainty Principle," the proposition that attempting to understand the workings of one's own intuition through rational processes is futile. If this sounds "illogical," it should.

SUMMA TECHNOLOGIA

The West's romance with rationalism now has evolved its final irony, the triumph of simplistic thought processes whereby we pay the machine our sincerest form of flattery—imitation. The longstanding belief that all problems can best be handled using logic and rationality—the more the better—has seduced us into easy dependence on synthetic machine logic. At the same time we have obligingly tailored our own thought process into the "computerthink" form, making it simplistic enough to be compatible with our machines. It seems almost a case of our being captivated by our own creation.

Yet few among us would disagree that most really good ideas arise from intuition and only afterwards are they tested by our logic. This logical apparatus, far from giving us new ideas, can sometimes squelch an innovative concept prematurely by exercising too heavily its critical function. The Zen teachers, while believing that the intuitive process is itself beyond rational comprehension, also knew that the repressive tyranny of rationality could be suppressed via various physical and psychological disciplines. And they found some very positive ways to explore, strengthen, and exploit this dormant creativity.

If we in the West are to make this nonlinear creativity work for us, we too must restore the delicate relationship between rational and intuitive thought. We may find in the Eastern experience clues to the release of our own latent creativity. If we succeed in discovering the process whereby our nonverbal, nonrational mind can be turned on, we finally will be able to call on our own creativity—that fickle "muse" who now appears at her own convenience—when and where we wish. And with this may come a quantum jump in the mind's potential for ideas and insights. The computer can then be put firmly in its place, as a servant for all the left-brain chores we can unload, much the way that physical work is being relegated to machines. We in turn, can then freely explore that extrarational realm called intuition, a potentially much higher intelligence with which we can create a new "reality." ∞



PHENOMENA

The ephemeral soap bubble is perhaps the most familiar of what are called "pneumatic structures"—structural forms that are primarily stabilized by differences in pressure. They are everywhere in nature. The peel of an orange is a pneumatic structure, for example, as are the human skin and blood vessels. The principles of pneumatic structures have been applied to such man-made devices as the sail, the hot-air balloon, the automobile tire, and the geodesic domes of Buckminster Fuller.

Soap bubbles are "minimum structures," enclosing the largest possible volume within the smallest possible surface area. When two bubbles join, their pressures immediately equalize and the common surface between them is always a plane. Soap bubbles are also forms of great beauty. The bubbles displayed here, blown from Pustefix, the ultimate in soap bubble solutions, photographed by Ken Kay. DO

Painting By Abdul Mati Klarwein

New chemicals to enhance your creativity and heighten your senses without confusion

FUTURE DRUGS

BY GENE BYLINSKY

I finally learned how to come into possession of an encyclopedia. I already own one now—the whole thing contained in three glass vials Bought them in a science psychedeli Books are no longer read but eaten, not made of paper but of some informational substance, fully digestible, sugar-coated

I also did a little browsing in a psychem supermarket Self-service. Arranged on the shelves are beautifully packaged low-calorie opinionates, gullibloons—credibility beans?—abstract extract in antique gallon jugs, and iffies, argumunchies, purtands, and dyecstasy chips

The imaginative Polish science fiction writer Stanislaw Lem wrote this passage in his book *The Futurological Congress*, just six years ago Lem's fictitious 'psychem" (psychiatric chemistry) society is a utopia based on a "chemocratic" system of government wherein whatever people want, they get—helped by strong doses of mood- and mind-influencing drugs

Vigilax disperses all states of somnolence trances, illusions, figments, and nightmares Obliterine and Amnesol purge the mind of unpleasant memories and Authentium creates synthetic recollections of things that never happened Children learn reading and writing from orthographic sodas Optimistizine and Seraphinol put people in the best possible humor Business letters with gentle reminders about accounts outstanding and amounts owed are saturated with a volatile substance that awakens the debtor's scruples and sense of responsibility

So fast is drug technology moving these days that the kind of chemical behavior modification envisioned by Lem is not that far from reality. "We are on the edge of a choose-your-mood society," says one scientist. "Those of us who work in this field see a developing potential for nearly total control of human emotional status, mental functioning, and will to act. These human phenomena can be started, stopped, or eliminated by the use of various types of chemical substances."

Scientists exploring the brain have begun to discover chemical signals of specific fractions of behavior. One such chemical enhances visual attention in the mentally retarded, also in normal people. Moreover, it promises to increase motivation and improve failing memory in the elderly. Another brain chemical makes people forget unpleasant experiences, just like Lem's science-fictional Obliterine. A third restores sexual potency in males and allows previously infertile women to have children.

Side by side with these discoveries, a separate area of research is beginning to produce results in the synthesis of new mind- and mood-influencing drugs, chemically akin to LSD, mescaline, and other mind-opening agents. In a radical departure from the usual approach to drug design, intended to help people who are identifiably sick, these new drugs promise to help *normal* people in many different ways, from improving their creative abilities, to easing the pain of divorce, to producing exhilarating effects similar to those of alcohol but without liquor's caloric content or damage to the liver.

These new drugs go beyond the familiar amphetamine pep pills and barbiturate thrill pills discovered long ago by users ranging from suburban housewives trying to cope and stay slim, to long-distance truck drivers on demanding schedules, to college students cramming for exams. The new drugs are much more specific in what they do. Where amphetamine pep pills encourage a person to do more of the same repetitive tasks (during World War II the Japanese gave amphetamine tablets to their war factory workers), the new drugs are capable of enhancing and suppressing specific moods and emotions such as attention, intention, anger, fear, and joy. In startling new research still unknown to the public, scientists are discovering that they can play the mood-and-emotion keyboard much as a pianist plays notes and chords.

This emerging ability to extend the range of behavior and emotions opens up a myriad of possibilities. In benign hands, it can improve man's creative and productive capacities and free him of unnecessary worries and anxieties. In sinister hands, it can be turned into a weapon as potent as, though much less conspicuous than the atom bomb.

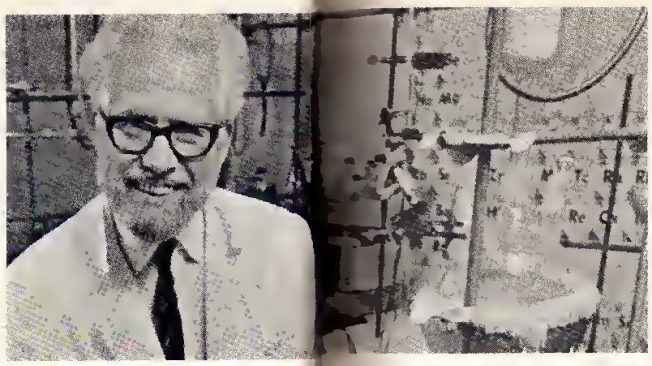
Since no mechanism exists today for legal introduction and controlled use of mind medications, they will be manufactured illegally and sold on the black market. The most sought-after will undoubtedly command very high prices. "The real problem in the field of psychopharmaceuticals," says Nathan S. Kline, a pioneer in the field, "is not so much the creation of new classes of drugs but determining who shall make the decisions as to when they should be used, on whom, and by whom."

These unresolved questions have taken on a certain urgency because, whether we like it or not, the capability of synthesizing highly specific mood- and mind-influencing drugs is already here.

Man has, of course, sought (and employed) mind-expanding drugs for thousands of years. Although Indians in the New World appear to have discovered most of the hallucinogenic drugs in plant sources, such as the various so-called sacred mushrooms, the denizens of the Old World and their descendants in America weren't that far behind. They too, employed "magic" plant extracts, such as the belladonna compounds used in witchcraft. Old World compounds are more properly termed *delusinogens* than hallucinogens, because they produce delusions rather than illusions, but they can be as potent as hallucinogens. Some researchers think, for instance, that the Salem witch trials were the result of a massive poisoning with rye bread contaminated with an ergot fungus containing a hallucinogen similar to LSD that caused bizarre, nightmarish visions in the normally placid Puritans.

Modern-day possibilities, however, didn't really hit drug designers until recent decades of deliberate, massive use of mind-influencing drugs that pointed to the possibilities of manipulating the nuances of human behavior.

Early hints of where mood control was going came from observation by psychiatrists treating patients suffering from mania, depression, and other mental problems with psychopharmacological agents. They noticed that the drugs had powerful effects on many aspects of their patients' personalities, far beyond the major symptoms that called for the drug treatment in the first place. They could see how previously quiet patients on antidepressants would suddenly become impersonally talkative. One psychiatrist recalled a mousy 47-year-old spinster suddenly telling him he was late for an appointment and demanding an explanation. They could see also how amphetamines organized the thinking of some people and how ruthless and aggressive men suddenly acquired a certain tenderness after exposure to small doses of hallucinogens. Bullies suddenly began thinking of children and baby animals frolicking in the grass.



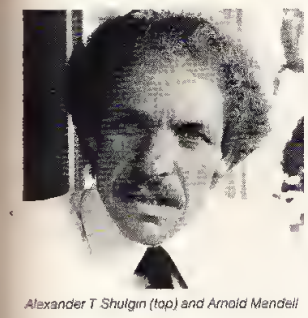
It was the exposure to hallucinogens such as LSD and mescaline that offered the most intriguing possibilities of all. A whole generation of youngsters whose often mindless use of psychadalic drugs sent them on mind-bending journeys into unreal worlds could now be observed. Eloquent pioneers such as Aldous Huxley had explored edges of those worlds earlier, but never had so many Westerners traveled so far with the help of drugs and brought back so many fantastic tales.

Psychedelic drugs, such as LSD, psilocybin, psilocin (from mushrooms such as *Psilocybe maxicana* and *Stropheria cubansis*), and mescaline, which comes from the peyote cactus, are in a class by themselves. They are unlike barbiturates, amphetamines, or tranquilizers such as Librium or Miltown. They are not like narcotic drugs such as the opiates, which are addictive. A percentage of amphetamine and barbiturate users become abusers. Psychedelic drugs are not physically addictive, and, of course, they produce psychological experiences spectacularly different from other mind-influencing drugs.

Among these experiences are fascinating changes in perception. Sounds are transformed into visual sensations, each tone or noise producing a kaleidoscopic color picture. Objects such as flowers or stones appear to pulsate and come to life. Incredible scenes are imagined with one's eyes closed. Incidents from the past are relived. Time and space are transcended. Many users claim that their artistic perceptions—appreciation of music and painting—are enhanced.

But no one has produced any artistic masterpieces under the influence of hallucinogens, and the drugs often have adverse side effects. A sense of unmanageability, even panic, on occasion grips LSD and mescaline users. In others anxiety or visual aberrations persist for days after use.

A healthy shift away from the often dangerous use of hallucinogenic drugs is now in the making as careful investigators pursue the question of how powerful mind-influencing drugs can be made to work for the benefit of humans without harmful hallucinogenic and other side effects. "There is a new realm," says Arnold J. Mandell, cochairman of the department of psychiatry at the University of California at San Diego. "I think the era of the new brain drugs will fractionate out aspects of behavior that we never paid any attention to before."



Alexander T. Shulgin (top) and Arnold Mandell

Mandell notes as an example that "attachment" as a human phenomenon is traceable to a brain system. One of the commonly used antidepressant drug families, the tricyclic antidepressants, in addition to removing depression also thins out the dependence patients have on their spouses and children. When a user of this drug anticipates the loss of a loved one—through divorce, for example—he doesn't experience the separation anxiety as painfully as he normally would.

We can also see that the function of attachment must be chemically modulated in the brain by observing animals. Cats, for instance, aren't as attached to man as dogs are, presumably because cats' brain chemistry is somewhat different. Scientists predict that when the biochemistry of behavior is deciphered it will be possible to assign specific emotions and actions to the presence or absence of specific chemicals in the brain—a dramatic shift from the environmental psychiatry that has ruled us for so long.

These advances stem from the often startling new knowledge about the brain. The old view presented the brain as a lightning-fast but rather rigid electrical switchboard. "an enchanted loom with millions of flashing shuttles," as one scientist described it.

In the new view, the brain is a more complex organ. It looks more like an enchanted forest than an enchanted loom. It's a place where dendrites, the antennas of the neurons, constantly grow out of neuronal bodies like interweaving branches of giant trees, where neighboring neurons whisper to each other at energy levels so low they are hardly measurable, and where cells called *glia*—in which the neurons are embedded—move about, influencing the activity of the neurons. The brain is changing, remodeling, and restructuring itself from instant to instant.

The great recent discovery has been that the biggest changes in the brain are directed by chemical substances acting in conjunction with electrical signals. Thus the brain was found to be not only an electrical computer but a computer submerged in a chemical cauldron where chemicals of different shades and hues can light up or darken the enchanted forest.

The brain responds instantaneously to millions of electrical impulses that constantly pour into it from sensory receptors. A thought can, of course, set off these impulses just as efficiently as sight can. The signals are processed with lightning speed and coded into computerlike yes or no commands. The impulses then speed along the remarkable network that consists of neurons.

A neuron is shaped somewhat like a tree, with the cell body at the top. From there branch out the dendrites, which receive messages from neighboring neurons. The tree's trunk is the axon, the neuron's transmission cable. Its length can be impressive. In man, for instance, axons that connect the big toe to the spinal cord can be three feet long. In a giraffe they may be 12 feet long.

Millions of axons run down the spinal column like coaxial cables. A signal transmitted down the axon is bioelectrical until it comes to a synapse, one of the hundreds of the axon's tiny junction points that connect with other neurons. The synapse is a slit less than a millionth-of-an-inch wide. The current in the axon is too weak to bridge this gap, so instead it activates transmitter chemicals located in storage granules at nerve endings.

When the signal reaches its destination, such as a muscle, the signal produces the desired action or movement. When the signal acts on neurons in a certain region of the brain—a pathway of a particular mood—it calls forth an emotion or a behavioral act.

These natural chemical messengers of behavior are known as neurotransmitters. In the mid-1950s, manipulation of neurotransmitter levels in the brain with psychotropic (mind-influencing) drugs that resembled neurotransmitters in structure—antidepressants, neuroleptics, stimulants—dramatically reduced the population of mental hospitals.

By using psychotropic drugs to illuminate the pathways of emotion and psychiatric disease, scientists have traced networks of neurons that respond to specific neurotransmitters. Of particular interest have been the so-called biogenic amines, derivatives of amino acids. Among the most important of these amines are dopamine, norepinephrine (or noradrenaline), and serotonin.

Loss of dopamine from the part of the brain called the basal ganglia is what causes the disorganized muscle activity of Parkinson's disease and possibly the disordered thought patterns of schizophrenia. Norepinephrine influences a wide range of functions through a diffuse network of neurons. Depression appears to be related to a deficiency of norepinephrine at certain synapses, and manic states to an excess of the same neurotransmitter.

Changes in serotonin levels in the brain alter an organism's ability to evaluate the contextual cues of its environment. The alterations influence many types of behavior. There are hints that some people who commit suicide are suffering from a serotonin deficit.

How can a subjective feeling be explained in terms of how neurons act? What is it that the biogenic amines do exactly to influence a person's mood?

Seymour Kety, who served as the first scientific director of the National Institute of Mental Health and now directs psychiatric research laboratories at the Massachusetts General Hospital in Boston, offers some intriguing thoughts on the biological underpinnings of moods.

"We haven't really appreciated the importance of the value system to the brain. Over a billion years of evolution, it is easy to conceive that the species would have learned and genetically endowed each individual with a means of evaluating results of behavior as good or bad. Animals would have learned through evolution that food is good because food leads to survival. That sexual activity is good because animals that didn't think so would die out

CONTINUED ON PAGE 168

THE LAST ECLIPSE

EXPLORATIONS

By Joseph Rao

Next February 26 North Americans will get an opportunity to observe nature's greatest sky show—a total eclipse of the sun This will be the first time since 1972 that such an event will be visible so close to home "Close," of course, is a relative term, but for those living in the northwestern U S and south-central Canada, this spectacular phenomenon will occur literally in their own backyards

Total solar eclipse is visible from some place on the earth about once every 16 months At such times, the moon casts its dark, slender cone of shadow (called the umbra) upon the earth's surface The track traced by this lunar shadow across the earth is very narrow, however, so that it may be hundreds of years between total eclipses at any one spot on earth

This will be the 11th time this century that a total solar eclipse crosses the contiguous United States Unfortunately, it will also be the last After next year most Americans either will be forced to do their eclipse viewing in foreign lands or wait until August 21, 2017 for another opportunity Curiously the last three eclipses in the continental U S have been primarily East Coast affairs On October 2, 1959 the moon's shadow touched Massachusetts at sunrise On July 20, 1963, the path of totality swept across Maine Most recently on March 7 1970, the path of totality tracked along most of the eastern seaboard

This winter, for the first time since 1945, the western U S will get its chance

At local sunrise on Monday morning, February 26, 1979, at a point in the North Pacific some 1100 kilometers due west of Gray's Harbor, Washington, the moon's umbral shadow will touch the earth's surface It will traverse empty ocean at 10,000 kilometers per hour for a few minutes as it heads almost straight eastward, then makes landfall on the Pacific northwest coast of the United States Slowing to 4000 kilometers per hour this great "wall of darkness" will rush from the Washington Oregon coast across northern Idaho, then cut northeastward through Montana into northwestern North Dakota Passing into Canada near the Saskatchewan Manitoba border the shadow will track through sparsely populated northwest Ontario into Hudson Bay cross the northernmost tip of Quebec Baffin Island, and will leave the earth at local sunset in northern Greenland (A small part of Western Europe will get a quick glimpse of the eclipse's opening stages just prior to local sunset.)

The shadow will be in contact with the earth for less than 90 minutes, the path of totality will run some 6700 kilometers in length and average 275 kilometers in width While moving through North Dakota however, the shadow's size will widen to a maximum of 315 kilometers

The duration of the total phase is always longest along the center line of the shadow's path Right at the Oregon coastline totality lasts two minutes 16 seconds Going eastward along the center line, the totality time slowly lengthens, reaching a maximum of two minutes 52 seconds just east of Lake Winnipeg Moving away from the center line totality time decreases, becoming zero at the path's edges

Surrounding the umbra is the penumbra, or partial shadow also conical but much larger (8000 kilometers) in diameter The penumbra is simply the half-shadow that lies outside every deep shadow whether it's cast by the moon or a house Wherever the penumbra falls, a partial eclipse will occur Practically all of North and Central America will be inside the penumbra next winter causing a rather large partial eclipse for much of the U S and Canada The closer you station yourself to the path of totality, the greater the magnitude of the eclipse Only inside the path itself, however, will you witness its full grandeur

When watching the partial phases, precautions must be taken in viewing the still blindingly bright sun Only when it's in total eclipse is the sun perfectly safe to look at

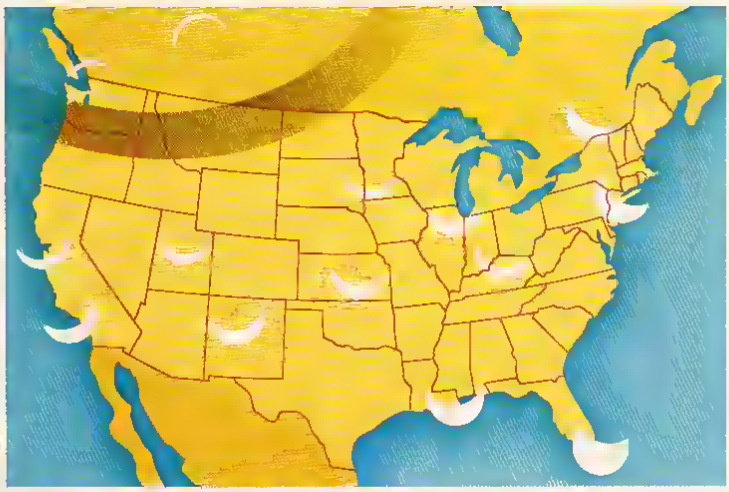


Illustration By George Kelvin

On the morning of Monday February 26, 1979, people in a large portion of the northwestern U S (marked by the shaded path) will witness one of nature's grandest spectacles a total eclipse of the sun Those outside the path will see a partial eclipse At its maximum phase the extent and orientation of the partial eclipse will, from different locations resemble the crescents displayed

WHAT TO EXPECT

A partial solar eclipse pales in comparison with a total one, even in those cases where the sun is reduced to a razor-thin crescent. The great show can begin only at the moment when the last speck of sunlight is extinguished. And what an astonishing experience it is! The sudden rush of darkness seems to suggest impending doom, and during the all-too-brief period of semi-darkness, nature takes on a most unfamiliar guise.

Scientists from all over the world as well as millions of amateur astronomers and sightseers will be drawn into the path of the moon's shadow next winter. Those who make the trip will be justly rewarded with a view of the greatest cosmic pageant that can be witnessed. It's almost impossible to adequately describe its beauty.

It starts quietly just over an hour before the total phase, with first contact: a small dent appears on the western limb of the sun, growing slowly larger each minute. The moon will continue to advance steadily, cutting the disk of the sun down to a crescent. In those last few minutes before totality, events pile in on each other. An eerie twilight begins to descend; the distant landscape becomes enveloped in a strange greenish-gray pallor; the temperature may suddenly dip several degrees.

Should the ground be covered with snow, or if you spread out a large white sheet, you may see shadow bands rippling, flickering, and scurrying about. These stripes of light and shade are believed to be caused by the last of the sun's rays being distorted by our turbulent atmosphere, just as a star's light is disturbed, making it appear to twinkle.

As the sun narrows to a thin filament, its much-enfeebled light will seem to rush out. If then suddenly disintegrates into irregular dots and points of light called "Baily's Beads," an effect caused by the last rays of sunlight streaming through the rugged mountain valleys on the lunar limb.

Then, the giant lunar shadow comes rushing in. Those watching for its approach should look to the west-southwest sky, where clouds will darken dramatically as if some great storm were brewing. At totality's onset, the shadow suddenly engulfs the viewer with the darkness of a moonlit night.

The moon now appears as a jet-black globe rimmed for several seconds by the vivid pastel-pink extension of the sun's atmospheric envelope: the chromosphere. If viewed through binoculars, you may see in several places around the moon's black disk solar prominences as tiny flames of pink, scarlet, reddish-violet, or magenta. In reality, these hot clouds of hydrogen gas are rushing out from the sun's surface for tens or even hundreds of thousands of kilometers into space.

The most spectacular view, however, is the pearly-white corona, which haloes the moon's disk, extending out into space for millions of miles. It differs in size, tints, and patterns from one eclipse to another. It is always faint and delicate, with a sheen like a pale aurora. Sometimes it has a soft continuous look, at other times long rays shoot out in three or four directions. It may stand out from the black disk in stiff streamers or end in brushlike tips.

As for the overall sky illumination, it will be unlike any dusk or dawn you've ever experienced. A weird saffron tint will form a bright border across the horizon, while clouds in the area may take on striking hues of sienna or salmon.

The brightest stars and planets will appear, brilliant Venus being the most conspicuous toward the south.

Just before the end of totality, the chromosphere will again reappear, followed suddenly by a brilliant solitaire of steely-white light set upon a thin luminous ring—the inner corona. The streamers vanish, the gem grows, the stars and planets fade away, the sky fills with light as the great "diamond ring" in the sky soon becomes too dazzling to look at.

All the phenomena seen prior to totality now reappear in reverse order as the moon moves off the sun's disk.

POINTS OF INTEREST

You may think it absurd to travel hundreds or thousands of miles for a sight that will last less than three minutes, but there are many other things to see and do in and around the path of totality. Here are a few suggestions.

WASHINGTON

Goldendale Observatory is a center for amateur astronomers from the Pacific Northwest. It boasts a 61.25 centimeter reflecting telescope, one of the largest in the world, that is available for use by the general public. The observatory is almost directly on the center line for the eclipse and has been chosen as the eclipse headquarters for the Astronomical League. The public is welcome to view through the telescope Wednesday through Sunday nights, from 7:00 to 11:00 P.M., at no charge.

Maryhill Stonehenge, 13 kilometers south of Goldendale on an isolated bluff above the Columbia River, is a replica of the ancient Stonehenge of England's Salisbury Plain. The replica was erected by industrialist Samuel Hill (1858–1931) in commemoration of World War I. It is located three kilometers northeast of Maryhill; you must look closely for it, as there are no markers to direct tourists and the monument is barely visible from the highway.

Grand Coulee Dam, one of the most massive concrete dams in the world, harnesses the Columbia River. It is 170 meters high and 1300 long.

OREGON

Crater Lake National Park centers around Mount Mazama, a 3700 meter volcano that exploded and fell in on itself, leaving a caldera that now holds the crystal-clear and intensely blue Crater Lake. Some 600 meters deep, it is the second deepest lake in North America.

Oregon Caves National Monument, near the California border, features an unusually beautiful series of cave passageways lined with limestone pillars, stalactites, vaulted domes, and galleries.

Portland, Oregon's largest city, is the home of one of the Northwest's great art museums: the Museum of Art, S.W. 9th at Park Avenue. Eclipse activities will probably center around the Oregon Museum of Science and Industry.

IDAHO

Hells Canyon, dividing Idaho from Oregon, is America's deepest canyon, rivaling even Arizona's Grand Canyon. At points along the border near Devil Mountain, the Snake River is 2400 meters below the lip of the Canyon.

Old Dependable is an impressive geyser that was capped by the townspeople of Soda Springs early in the century after they became annoyed with its constant eruption. It is set free to spout off only when tourists come to see it, or when the subterranean pressures become so great that it would otherwise explode.

Craters Of The Moon National Monument encompasses a weird moonlike landscape of more than 200 square kilometers stretched out in the southern Idaho desert. This unusual terrain is the result of volcanic eruptions that occured some 1600 years ago.

MONTANA

Yellowstone National Park is a world apart of natural wonders: colorful canyons, sparkling waters, spouting geysers and abundant wildlife. Winter activities run from December through March.

Glacier National Park provides some of the most spectacular scenery in the world. The park has numerous glaciers, unbroken forest, and such wildlife as moose, elk, mountain goat and sheep, black bear and grizzly bear. There are some 1000 miles of trails and nature hikes led by park rangers. Guided cross-country ski tours are available during the winter months.

NORTH DAKOTA

Bismarck offers eclipse visitors such attractions as the State Historical Museum, the Dakota Zoo, and the Camp Hancock Museum. The observation floor of the state Capitol building provides a panoramic view of Bismarck and the Missouri River Valley.

Amidon: In this little town (population 51) is a perpetual burning vein of coal, imparting a truly hellish appearance to the surrounding landscape, especially at night. You can see it 42 kilometers north of Bowman on U.S. Route 85.

CANADA

Winnipeg, the fourth largest city in Canada, contains one of Canada's largest medical teaching centers and numerous cultural facilities. Among these are the Winnipeg Art Museum, the Royal Ballet, Assiniboine Zoo, the Winnipeg Mint, the Manosphere exhibition, and the Museum of Man and Nature. In the museum is the Manitoba Planetarium with a heliostat that projects a bright 20-inch image of the sun.

HOW TO WATCH THE ECLIPSE SAFELY

Whenever an eclipse of the sun is due to occur, there are usually dire warnings broadcast over the airwaves and in newspapers telling people that there is no safe way to view an eclipse and that the best thing to do is watch it on television. Television, however, is a poor substitute for the real thing and should you choose to ignore the eclipse entirely, you'll only be cheating yourself out of seeing the grandest celestial spectacle visible from earth. This is not to say, however, that you should not take precautions. Staring at the sun with unprotected eyes or inadequate filters during the partial stages can cause blindness or severe retinal damage. DO NOT USE sunglasses, photographic filters, exposed color film, or—what was once considered the old standby—smoked glass, to watch the sun. You CAN, however, use two superimposed thicknesses of completely exposed and developed *black-and-white* film. Alternatively, you can use welders' safety plates, shades 12 to 14, which can be bought at a welder's supply shop in sizes that will cover both eyes.

The safest way to watch the eclipse is to turn your back on it—literally, not figuratively—by making a pinhole projector. Use two sheets of cardboard with a small hole in one. The perforated sheet is held up to the sun, projecting the light through it onto the other sheet, which is held beneath the "projector" in its shadow. A cardboard box can be used in much the same way. Make a hole in one side of the box and then point it toward the sun. The light will be strongly projected on the opposite side, inside the box.

You can also produce eclipse images by letting sunlight pass through the lattices of your fingers as well as any other small openings such as those in a straw hat or trees and bushes still in leaf. Even indoors, closed venetian blinds in a window facing south can produce row upon row of solar crescents on the wall or on the floor, so you may watch the eclipse indoors and stay warm.

One final note. If you are in the totality zone, don't fire your eyes on the partial stages. Save them for the total eclipse. You can better adapt to the sudden darkness by wearing a patch over one eye and removing it just as totality sets in. ◻◻

THE ARTS

CONTINUED FROM PAGE 40

against these new films because of a derivative overdose.

The Alien (20th Century-Fox) Directed by Ridley Scott (*The Duellists*), co-written and with special effects by Dan O'Bannon (*Dark Star*). **Flash Gordon** (Paramount Pictures) Produced by Dino De Laurentiis (*King Kong*) at a cost of $20,000,000, directed and co-written by Nicholas Roeg (*Don't Look Now, The Man Who Fell to Earth*). **The Fox and the Hounds** (Buena Vista) Full-animation feature. **The Humanoid** (no distributor set, A Merope Film Production) Starring Richard "Jaws" Kiel and Barbara Bach, both of whom were made popular by *The Spy Who Loved Me*.

Meteor (American International Pictures) The biggest production ever attempted by AIP, with a $16,000,000 budget, big name cast including Sean Connery and Henry Fonda. **Moonraker** (United Artists) The newest James Bond film, which will offer bigger and more expensive sets and effects than ever. **Nightwing** (Columbia Pictures) Based on the book by Martin Cruz Smith, in which the creatures of the night take over the night. **Overlords** (Avco Embassy) Beings from outer space fight out their interplanetary wars on earth. **Planet of the Dinosaurs** (No distributor set) Special animated effects by Jim Danforth. **The Primevals** (No distributor set) Multimillion-dollar stop-motion fantasy film epic. **Seven Warriors-Seven Worlds** (No distributor set, but Dino De Laurentiis anticipates a $4,000,000 involvement, which suggests Paramount Pictures). **The Shape of Things to Come** (Allied Artists) Remake of H.G. Wells's story. **The Shining** (Warner Brothers) Stanley Kubrick (*Dr. Strangelove, 2001, A Space Odyssey*) directs Jack Nicholson in this adaptation of Stephen King's story. **Space Probe** (Buena Vista) Disney's live action space opera.

Star Trek - The Motion Picture (Paramount Pictures) Long-awaited $15,000,000 voyage of the Enterprise, her original crew intact, promises to be one of the major motion picture events of the 1980s; directed by Robert Wise (*The Day the Earth Stood Still, The Sound of Music, The Andromeda Strain*). **Star Wars 2** (20th Century-Fox) Script completed, due to start shooting this fall for 1980 release. **Superman Part 2** (Warner Brothers) As mentioned above, already partially photographed; completion pending success of first installment. **Thongor in the Valley of the Demons** (No distributor set) The first in a series of sword and sorcery tales featuring Thongor. **Voices** (MGM) Starring Amy Irving (*The Fury*). —*James Delson* ◻◻

ANSWERS TO GAMES (page 174)

1. Most people come up with an answer of nine inches. This is incorrect. Imagine taking the books off the shelf—then where is the first page? The bookworm, of course, burrows only five inches.

2. The "Z" goes above the line. The pattern—straight letters on top, curved ones below.

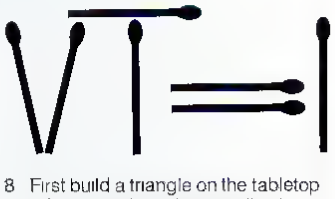
3. The blind man is wearing a red hat. The reasoning is as follows: The first man did not see two white hats for then he would have known that he wore a red. The second man, aware that the first did not see two white hats, needs only look at the blind man. If he saw a white hat on the blind man he would therefore know he wore a red. Since he did not know, the blind man must be wearing red.

4. The right side of each figure is a cardinal number (1,2,3,4, etc.) the left side its mirror image. Thus the next figure is **88**.

5. "Would a member of your tribe tell me that the left fork goes to Alphaville?" Both tribes must give the same answer to this question.

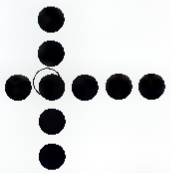
6.

7.



8. First build a triangle on the tabletop with three matches, then use this triangle as a base for the other three matches, propped against each other to form a pyramid.

9. Simply place one coin on top of another at the intersection of the two rows.



10. The missing number is 121. (The numbers are all representations of the number 16, expressed in different bases, moving from base 16 to base 1. Thus 121 is "16" expressed in base 3.)

THE ROOT OF ALL EVIL?

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LISTENING

CONTINUED FROM PAGE 67

different directions to examine the entire sky, and there are some ten million candidate channels upon which to search."

What is involved in being on the right frequency at the right time? Sheer luck. It is just possible that highly technological civilizations may turn themselves off as radio beacons. On the earth, our radio and television transmissions waste energy since so much is leaking out into space. It is cheaper to transmit information via cables or laser beams or fiber optics. But those transmission channels dim our radio visibility to other planets. Perhaps for only a few decades or a century do advancing civilizations inadvertently make themselves known by leakage.

Alternatively, a planet might fall silent because its civilization had blown itself up in a nuclear war, or it may be destroyed by an explosion of its own star. In a fit of paranoia a civilized world might decide it didn't want to make its presence known, for fear that predators might come to conquer and colonize it.

Very frustratingly, a civilization may beam a signal in our direction only a few hours a year, and we could be too early or too late in picking up the "telephone." We beam radar from Arecibo at Mars and Venus to map their surfaces and we also send signals to our space satellites. Some of those signals go roaming into space, perhaps to drive crazy some astronomer out there who hears them only once and not long enough to be sure they were from the earth. *We may be victims of the same kind of cosmic irony.*

Astronomers must guess which frequencies of the radio spectrum another world would choose to transmit signals. One likely candidate is the "waterhole," a tiny portion of the microwave window between the spectral lines of the two building blocks of water. One is hydrogen at 1420 million Hertz (cycles per second); the other is the hydroxyl radical (chemical formula OH) at 1662 million Hertz. Life based upon water, as it is on the earth, might select those frequencies as sensible. In addition, the waterhole really is a "hole" in the spectrum of radio noise from various sources in space.

Another guess involves whether the radio transmission from another planet would be coming on a narrow bandwidth or a broad bandwidth. The narrow bandwidth signal is one that is restricted to a narrow band of radio frequencies; such a signal travels farther more clearly and is easier to detect, but it carries little information. The broad bandwidth signal spreads out over many frequencies and can carry prodigious information—Drake says a broad bandwidth signal could transmit the entire contents of the *Encyclopaedia Britannica* in one minute. But the broad bandwidth signal is rapidly absorbed and attentuated during its trip through space. Intelligences out there might compromise sending a narrow bandwidth signal as a beacon to alert us and using it to tell us what frequencies to tune to for lots of broad-band knowledge.

Drake suggests that most of our searching or listening so far may have been ineffectual because we have searched for only broad bandwidth signals, sweeping a lot of the electromagnetic spectrum with low sensitivity. More progress could be made not by just using bigger radio dishes, but also by using more channels and more sensitive receivers. The technology for such sensitive instruments is increasing quite rapidly now. Each gain in sensitivity vastly increases the volume of space from which signals might be detected. And only some 1000 individual stars have been examined thus far on a few frequencies, most of them the nearest stars. We have barely made a beginning toward searching ten million stars on thousands of frequencies—a search that would statistically improve the chances of at last making contact.

If the Big Word comes, how do we recognize it? Astronomers believe it would be rather easy to recognize a signal as artificial because of its construction, or repetition, or other characteristics. It could be a statement of some well-known physical law, and it might well come in binary numbers (numbers written as combinations of the digits one and zero). Decoding the message might take a while, but experts in cryptography abound in most countries of the world, and the sender wouldn't be trying to code it as a secret.

Drake and the staff at Arecibo devised and shot out one token arrow of an earth message into space on November 16, 1974. It was directed at Messier 13, the Globular Star Cluster in the constellation Hercules, a family of stars some 25,000 light-years distant. Radio telescopes as sensitive as the one at Arecibo could pick up the message anywhere throughout the Milky Way, and then pose someone the dilemma of learning what it says.

Taking only three minutes to transmit—just for one time only—our brief message contained 1679 bits of information giving some knowledge of life on the earth. In binary numbers it gave a "lesson" on the numbering system being used, listed the atomic numbers of the elements hydrogen, carbon, nitrogen, oxygen, and phosphorus, and gave the chemical structure of the genetic material DNA. It also supplied a crude sketch of a human being, indicated its average height, said that there are four billion of us and that we inhabit the third planet from the sun. The message ended with an image of the telescope that

"I understand they passed a bill in Congress to get us to produce more oxygen."

sent the message.

At transmission, the effective power put into the beam was something like ten times the total electric power production on earth, Drake says. In the direction of the beam at the frequency of the transmitter, that power made the signal about ten million times brighter than the sun. 'For three minutes," Drake remarks, "we became the brightest star in our galaxy."

The Arecibo radio telescope always is busily scheduled for such work as radar mapping the planets and earth's upper atmosphere. Many programs employ it as a transmitter. During those programs, the telescope also could transmit messages out to space while being warmed up. "The cost would be only a couple of dollars, like sending a telegram here at home, to places as far as 25,000 light-years away," Drake calculated. "With present radio equipment, we could send a 60-word 'telegram' a distance of ten light years at a cost of about ten cents in electrical energy."

Radio broadcasts have not been our only attempt to contact extraterrestrial life. "Loafing' out into space beyond the solar system—meaning they are traveling only 16 kilometers per second—are the spacecraft *Pioneer 10* and *Pioneer 11*, bearing gold-anodized aluminum plaques designed by Sagan, Drake, and Linda Salzman Sagan (Carl's wife). After inspection of Jupiter the two spacecraft are going their lonely way to drift out of the solar system, perhaps someday to be found and their message deciphered. They tell the location of the earth and the sun with respect to 14 pulsars. They also show a diagram of the solar system and drawings of a man and a woman to scale with a diagram of the spacecraft. The plaques are designed, say the Cornell astronomers, "to be the longest-lived works of mankind," sure to survive unchanged for hundreds of millions or perhaps billions of years. And very probably, never to be found or read.

Also heading out toward the edges of the solar system are *Voyager 1* and *Voyager 2*. Next year the two *Voyagers* will fly past Jupiter, then swing on to Saturn and beyond. Each *Voyager* spacecraft carries a phonograph record with greetings in 50 languages, messages from Kurt Waldheim and President Carter, sounds from the earth (rain, people, cars, and so forth), 116 pictures of various scenes and things of earth, and an hour and a half of music: ethnic, classical, and pop—"Earth's greatest hits," Drake calls them.

Now, energizing the quest for contact, comes Project SETI (Search for Extraterrestrial Intelligence). Envisaging a $19 million program lasting five years, Project SETI is the proposal mainly of astronomers at NASA's Ames Research Center in Mountain View, California and the Jet Propulsion Laboratory (JPL) in Pasadena. It calls first for a huge one-million channel radio receiving system to increase the odds of picking up signals, and perhaps later for building the mammoth Cyclops system of 1500 great radio antennas in a 12- to 16-kilometer-wide array. The full system would be able to receive signals simultaneously on as many as one billion channels. In addition, existing radio telescopes at observatories around the world would be made far more sensitive by adding special equipment, allowing astronomers to monitor one million channels in the microwave region of the spectrum.

John Billingham, a former physician to U.S. astronauts, is chief of the SETI team at Ames, the team plans to begin the search with three big radio telescopes including the one at Arecibo, listening at the "waterhole" frequencies. The main targets will be sunlike stars within a few hundred light-years of earth, perhaps looking at each one sequentially for between 10 and 30 minutes each night.

The JPL group, headed by Robert Edelson, will use the 26-meter Goldstone radio telescope in the Mojave Desert to listen for narrow band signals in one quarter of the microwave window. This calls for searching most of the sky at less sensitivity than that of the Ames program, but with a broader frequency range.

From 1975 through 1977 Philip Morrison at the Massachusetts Institute of Technology, long keenly interested in the possibility of extraterrestrial life, chaired six science workshops of prominent scientists and others looking into the feasibility of searching for extraterrestrial intelligence. The group reached four main conclusions, published last year in their report, *SETI*.

"1. It is both timely and feasible to begin a serious search for extraterrestrial intelligence.

"2. A significant SETI program with substantial potential secondary benefits can be undertaken with only modest resources.

"3. Large systems of great capability can be built if needed.

"4. SETI is intrinsically an international endeavor in which the United States can take the lead."

SETI would not be a waste if no signals came. The technology learned and data gathered would be valuable in radio astronomy and deep-space communications.

Design studies for Cyclops were made by Billingham and Bernard M. Oliver in 1971. Information from all the 1500 antennas and on all frequencies would be fed to an enormous computer to sort the information. Costing about $10 billion if built now, Cyclops is more likely to be constructed in the 1990s and might cost $100 million a year to operate. But Cyclops could be built in sections starting with one or two big antennas centered around a power station and other facilities. There is debate over

"These continued rumors that I don't exist are making it very difficult for me to obtain credit!"

how soon and how hard the Cyclops project should be pushed. Drake is one who favors going ahead now.

An alternative to a ground-based Cyclops is a huge receiving dish, perhaps several kilometers across, orbiting in space and shielded from all the noise of the earth, collecting any space signals and relaying them to earth-based receivers. It could be built by ferrying up the materials on repeated trips of the shuttle.

While a search for extraterrestrial intelligence in any form seizes the imagination of many people, the quest for contact fills others with fear and doubt. Suppose, they say, the extraterrestrials want other planets on which to seed their form of life, or perhaps they regard other planetary life as food or slaves. Better that we keep our heads down and keep quiet, they advise.

Those enthralled with the prospect, however, view contact with extraterrestrials and the new knowledge that contact would bring as unifying forces among humans and nations, enriching our science and technology in ways that otherwise would take us great effort, time, and money to learn. We might catch glimpses of what our own future might be.

Says the *SETI* report of 1977: "Were we to locate but a single extraterrestrial signal, we would know immediately one great truth: that it is possible for a civilization to maintain an advanced technological state and *not* destroy itself. We might even learn that life and intelligence pervade the Universe."

The report continues: "Some have worried that a message from an advanced society might make us lose faith in our own, might deprive us of the initiative to make new discoveries if it seems that there are others who have made those discoveries already, or might have other negative consequences. But we point out that we are free to ignore an interstellar message if we find it offensive. Few of us have rejected schools because teachers and textbooks exhibit learning of which, so far, we were ignorant. If we receive a message, we are under no obligation to reply. If we do not choose to respond, there is no way for the transmitting civilization to determine that its message was received and understood on the tiny distant planet earth. (Even a sweet siren song would be little risk, for we are bound by bonds of distance and time much more securely than was Ulysses tied to the mast.) The receipt and translation of a radio message from the depths of space seems to pose few dangers to humankind. Instead it holds promise of philosophical and perhaps practical benefits for all."

"Other imaginative and enthusiastic speculators foresee big technological gains, hints, and leads of extraordinary value. They imagine too all sorts of scientific results, ranging from a valid picture of the past and the future of the Universe through theories of the fundamental particles to whole new biologies. Some conjecture that we might hear from near-immortals the views of distant and venerable thinkers on the deepest values of conscious beings and their societies! Perhaps we will forever become linked with a chain of rich cultures, a vast galactic network. Who can say?"

The Reverend Theodore M. Hesburgh, president of the University of Notre Dame, in the *SETI* report writes that "As a theologian, I would say that this proposed search for extraterrestrial intelligence also is a search of knowing and understanding God through His works—especially those works that most reflect Him. Finding others than ourselves would mean knowing Him better."

Probably, [illegible], a message may come from a civilization that has learned how to become immortal, and might share that knowledge with us. Dr. Drake thinks that immortal civilizations may be more numerous than mortal ones. Immortality he defines as indefinite preservation, in a living being, of a growing and continuous set of memories of the experiences of the individuals. The aging process may have been halted or techniques may have been found to repair indefinitely the damage done by the aging process. Or perhaps the inventory of memories of an old person's brain could be transferred into a young brain, even perhaps a clone. Immortal societies would have to limit their offspring very severely.

An immortal civilization might become timid about death by accident, become obsessed about safety, with that motivating them to tell other planets how to become immortal, so no one would be tempted to come seek out and conquer the immortal society. Immortals would like to make everyone else immortal and equal. So they might be sending out strong signals for easier detection, and they might be doing it fairly continuously and patiently.

If the instructions for immortality were received here, what then?

Would earthlings opt to become immortal, with a new set of problems, or would they elect to still accept the concept of death?

The time, to many astronomers, has come for serious search for intelligent life elsewhere.

"We may now be standing on a threshold, about to take a momentous step a planetary society takes but once: first contact with another civilization." Sagan and Drake write in *Scientific American*.

To them the question is not whether we mount the major efforts to make contact—but when. "If enough of the beings of the earth care, the threshold might be crossed within the lifetime of most of those alive today." DO

STRIPES

CONTINUED FROM PAGE 70

ing shot out of a solar cannon while a gorilla is ravaging you . . . stunts like that take a lot out of a person. Sometimes, I have to admit, Dynamite seeks relaxation in odd places. Nothing to worry about, though." He hoisted his tunic further, reached around and tapped at his back.

There was that slightly inflamed lump again, rectangular and about the size of a pocket computer. It was rimmed by reddish flesh, stuck up almost a half inch. "What is that thing?"

"Didn't you read the bio sheet I sent? That's my teleport box," he explained. "Ugly thing, and it itches like crazy most of the time. They let me loose, but they stuck me with this. So I'm, metaphorically, wearing invisible stripes."

"Who implanted that?"

"Talk about coincidence, it was Lt. Denzlo," Andy replied. "He ordered the job done, that is. Perfectly within his rights, since I am a paroled killer, under the Roaming Murderers Act of 2002. Yep, the great state of California South says it's okay to bury one of these teleport gadgets in any potentially dangerous killer. I've talked it over, you can bet, with my attorney many times. He's not a bad guy, a robot but built by the Japanese, loaded with legal lore and possessed of a really golden voice."

Nodding at his back, I asked, "They can summon you with that gadget?"

"Well, the law says only once in any given week unless there's an emergency situation." He chuckled, let his tunic fall and then scratched at the implanted teleporter. "Denzlo treats almost anything as an emergency. Oh, let me warn you now it's come up. What with these Media Killer slayings going on, the lieutenant's been yanking me into the Murder Division offices for questioning as often as twice a day. In case I should go whooshing away in the middle of our conversation, don't take it as an insult. See, I don't actually have any control over what he—"

"Who's the Media Killer?"

"They don't know. Lt. Denzlo'd like it to be me, so he'd have, in his cockeyed opinion, a clear field with Dynamite."

"I wasn't talking about identity, I'm just not familiar with the case at all."

"You really are steeped in the past. Working for Oldies, Ltd. has—"

Zimm!

A harsh tinny buzz was coming out of him, originating in his back.

Zimm!

"Again? They're really harrass—"

Then Andy wasn't there anymore. He vanished, as though he'd been sucked suddenly into another world. The air where he'd been standing gave off a faint popping sound after he'd gone teleporting away—to Lt. Denzlo and the GLAPD.

Andy didn't get back to me until two days later. Part of the time he was in the police fortress in the Pasadena Sector, the rest he spent with Dynamite Dunn. She'd given up her plans for the Grand Canyon and was contemplating a daredevil stunt involving the Nixon dam. Even though Andy was a certified video stimulation criminal who'd been cleared and pronounced socially acceptable by the Pasadena Playhouse for the Criminally Insane, the GLA had been able to have a teleport unit surgically implanted in him. This allowed them to whisk him in for questioning up to six times in any given month. Andy swore, which I'm inclined to believe, that once he quit watching tv he never strangled anyone else. Denzlo and his partner, Hart, didn't believe him apparently. They were working very hard to pin the Media Killer stranglings on him, which is why they'd teleported him off once again while he was visiting me at the studio.

They were very unconventional cops, Denzlo and Hart. In their early 30s, both lean and dark. They went in for conservative one-piece grey daysuits, close-cropped hair and no visible body decorations at all. Outside of a fondness for teleporting parolees and ex-cons into the Interrogation Pits, neither of them went in much for gadgets. They never used the Shockbox or the Fingerpopper, stayed away from Talkjuice and Brainprobing. Their approach was classic 20th century. Hart yelled and Denzlo was softspoken.

"We *know* you did it!" Hart shouted at Andy the instant he materialized in the sea-green Query Cell that afternoon.

Andy put out a hand to steady himself. As many times as he'd been yanked hither and yon by the teleport unit in his back, he still got a shade woozy. "Did what?"

"Don't scream at the guy," said Denzlo in his soft, droning voice. "He'll tell us without that."

"Oh, *will* he?"

"Sure he will." Denzlo circled the slightly swaying Andy.

"What about *Dr. Bubbles*?" cried Hart, hopping once.

"Who?" Andy reached a floating whale-black chair and sat, uninvited. "You're hauling me in too many times, by the way. I want to contact my robot attorney over in—"

"Only the *guilty* need robots!"

"Take it easy, Hart. Andy's going to confess any minute now."

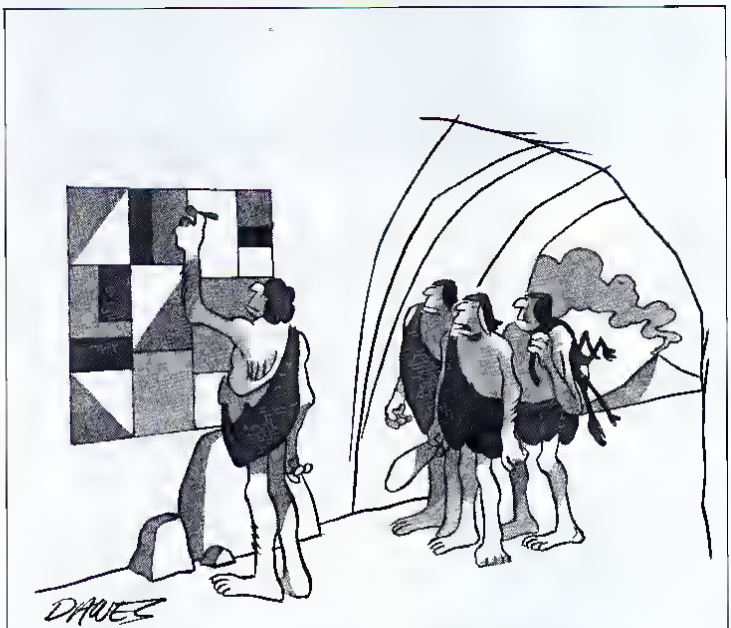
"Some things I don't mind your fudging about," Andy told them. "But I'm not going to let you teleport me more than the—"

"Look at *this*!" From behind his back Hart produced a small metal arm and thrust it at Andy.

He recoiled. "What the heck is that?"

"You *recoil* like a guilty man!"

"Thought you were going to poke me in the eye with those teenie metal fingers. Is



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that part of some toy?" He was bewildered.

"You do a very nice innocent act, Andy,' said Lt. Denzlo, smiling admiringly. "No wonder they call you the Media Killer, you're a real performer."

"Ah, so there's been another one of those." Andy nodded. "Well, I didn't do this one either."

"It's your M.O.!'

"Hundreds of people have my M.O. I mean, all I ever did back when I was a killer was put my hands on their neck and squeeze. Nothing fancy."

"Do you deny you used to watch *Dr. Bubbles* on tv? Do you deny that you *strangled* the poor old guy early this morning at the Hollywood Home For Washed Up Actors?"

"I don't watch any tv," said Andy patiently. "You guys know that. If I ever did again I'd do... Lord knows what."

'So you claim," said Denzlo in his calm voice. "We think you fooled the courts of California South five years ago, Andy."

"*But you won't fool us!*'

"Is that part of Dr. Bubbles?' Andy pointed to the little metal arm Hart was swinging in the air. "Must have been a small man with a—"

"*This* is a part of one of his pathetic little Knowbots!"

"Don't you recall watching the *Dr. Bubbles & His Knowbots Show* in your youth, Andy? It ran on the National Thoughtful Network for several seasons, taught a heck of a lot of kids how to... what's that on your tunic collar?"

"Is it *blood*?"

"Probably lipstick," answered Andy. "You ought to recognize the shade, Lt. Denzlo. Dynamite has it made up especially for her. Calls it Hazardous Crimson because—"

"You still claim to be seeing this Miss Dunn?'

"Claim? I'm head over heels in love with her. I worship every devil-may-care bone in her bod—"

"That'll be enough of that kind of talk."

"My partner *respects* Miss Dynamite Dunn! He intends to *wed* her, to sign a longterm marriage agreement. He doesn't care to hear cringing stranglers defile her repu—"

"The only time I've cringed today is when you poked that goofy arm in my eye. That'd make anybody—"

"You deny cringing, but not the strangler part?'

"I'm not a strangler either. We all know I used to be one, but with help I got over it."

"Where were you this morning?"

"At the Grand Canyon."

"An *odd* place to be." Hart made a few more hops. 'Did anyone see you there?"

"Certainly, Lt. Hart. Besides Dynamite, there was the crew from the ABCBS-TV network and a reporter from *WomanStunts* and a pudgy guy I think might have been the Vice President of the United States and... oh, lots of people. Whenever Dynamite practices one of her death-defying stunts, there's usually a crowd." Andy looked from one cop to the other. "Tell you something funny, too. By accident I happened to get just a tiny glance at a TV monitor screen and there was a picture of Dynamite doing a practice jump over a small ditch. First thing I knew, I was running and then making a jump myself. See, when I so much as look at anything on tv I—"

'Too bad you didn't jump in the canyon!"

"No, he wouldn't do that," said Denzlo. "He's a fake. He convinced a six person jury and an outmoded computer judge he's a severe victim case. I don't buy any of it."

"Do you think," suggested Andy, "it's because you're trying to steal Dynamite away from me that you—"

"We'll let you go for now, Andrew. I promise you I'll be checking out your alibi." Denzlo turned his back on him.

"You can go!" Hart strode to the teleport control board in the corner of the room. "Where to?"

"Since you've fouled up my job interview, you may as well send me home to my place."

Denzlo, very softly, said, "You're still very high on our suspect list."

'*Don't* strangle anyone else!"

"I don't strangle people any—"

Zimm!

He was in his cluster apartment in the Santa Monica Sector. He materialized five feet off the see-through floor. He fell now and banged his knee. That had probably been deliberate on Hart's part.

"He's trying to frame me,' insisted Andy when I met him for lunch a few days later at the Edge O' The Fault restaurant in the Altadena Sector.

Since there was something slightly wrong with the microwave unit on my side of the table, I was preoccupied with the way my knees were heating up. "Who?" I asked finally.

"Lt. Denzlo. Initially it was mainly harassment. Teleport me into the police fortress, question me, teleport me out. Now it's grown worse."

"How?' I found if I kept my knees tight together it was all right.

"You fidget a lot. I used to myself, back in the days when I watched TV. You ought to consider seriously dropping—"

"My knees were cooking, that's all. I can't stop watching television, since my work—"

"Well, about what Denzlo's up to. He's consumed with jealousy, as I believe I've mentioned. Dynamite informs me that when they're together he devotes much of his time to ranting over me. 'How's your killer friend?' or 'Does he like to put his

"Considering the heredity factor, it's not a bad report card, huh?"

hands on your throat when you're hugging?' And other snide stuff in that vein. I tell you, once you get labeled a strangler, it's—"

"Dynamite tells you what happens between her and this police officer?'

"Sure, why not? We're deeply in love."

"Not enough for her to drop Lt. Denzlo."

"She'd like to, believe me, except she's somewhat tearful," explained Andy, tapping the menu screen on his microwave unit. 'Is the frozen kelploaf any good here?'

'No."

"Look, if Denzlo isn't able to frame me, he may use his authority to make trouble for Dynamite. She has to keep dating the guy."

"Maybe the safest thing would be for you and this lady daredevil to part."

"I'm not a coward, like people in your line of work have to be. No man who can accompany Dynamite on many of her most dangerous feats, is a coward. I'm not about to let—"

"No one's ever called me a coward either, Andy. In fact, when I was visiting Burt Lancaster at the Old Aorobats Home in Taos to sign him up for—'

"Danzlo planted one of my watches at the scene."

"Scene of a crime?"

Slowly Andy nodded. "The last so-called Media Killer strangling, yes. Fellow named Mercenary Mazurky—maybe you've heard of him? Used to be a freelance soldier and was holding down the Invasion Desk on the Intensive News Hour on KLOB-TV.

"I think Mazurky pixphoned me a couple weeks ago, wanted me to enter this upcoming Clean Air Marathon to—"

"That's the guy. They're staging a ten-mile jog to raise money to clean up the air hereabouts. If you do enter, be sure you wear a better mask than the one you use or—"

"I'm not entering. I came out to GLA to produce the documentary on famous pattern killers of bygone days. Running isn't—"

"This Media Killer fellow apparently strangled poor Mazurky in the skycar lot behind KLOB over in the Westwood Sector late last night," Andy continued. "This time, didn't happen to be with anybody Dynamite was taping an interview with an Alistair Cooke clone for the National Thoughtful Network. I was home not watching tv. Heck, I don't even have a set, be a parole violation if I did. Thing is, Lt. Denzlo claims my watch was spotted in the shrubs near the murder site."

"How'd it get there?"

"Denzlo put it there, after swiping it out of my dwelling," answered Andy. 'The guy's intent on getting rid of me as a rival. He'll try anything."

"Mazurky was a freelance commando, wasn't he?"

"So they say."

'Big guy, very tough."

"Exactly." Leaning toward me, Andy lowered his voice. "You're wondering how the strangler snuck up on him."

"It occured to me, yeah."

"Killer had to be somebody Mazurky knew." Andy grinned. "I told Denzlo and Hart as much this morning when they teleported me in for grilling. Yanked me right out of a warm—"

"Why'd they let you go?"

"My robot attorney sprung me, but there's no telling how long before—"

Zimm!

"Damn, he's at it ag—"

Andy was teleported away.

I looked down at my warm lap, not exactly wanting to meet the glances of the other restaurant customers.

That lunch turned out to be the last time I personally encountered Andy Stoker.

Oldies, Ltd. got a tip that the last living Elvis Presley impersonator was living in a welfare commune in New Yazoo, Mississippi. They ordered me to teleport down there, see if I could locate the singer and sign him up for one of our nostalgia tours. We calculated he'd fit perfectly into a package we were putting together to star Conway Twitty and the very talented young girl who pushed his wheelchair. Accordingly, I turned over the pattern killer documentary to an assistant and went popping off to Mississippi. Teleporting, even when it isn't unexpected like Andy's and you use a conventional teleport depot pad, can do things to you. The side effects of that, plus two weeks of tracking the illusive Presley lookalike, landed me in a yogurt therapy spa in Free Europe 22.

By the time I emerged, nearly recovered, Andy was dead. The specifics of what happened I can only guess at. As I've told you before, though, I'm very good at making a complete projection from a minimum of data. Therefore, I'm willing to bet, the rest of this is fairly close to the truth. I did, when next I was in California South, attempt to compare some of my conclusions with Dynamite Dunn's. She was tied up in plans for her wedding to Lt. Denzlo, claimed no time to talk to me. You may have seen the subsequent wedding on tv, with the bride and groom consummating the marriage on a trampoline suspended over the Grand Canyon.

Andy's attorney, whom I did have a chance to interview just prior to his being scrapped, told me he'd been able to prove that the watch found at the scene of Mazurky's strangling was stolen from Andy's apartment three days prior to the crime. When the next victim, a salesman of electronic stimulation gear out in the San Fernando Sector, fellow named Paranoid Piet, was found strangled and clutching a lock of Andy's hair it looked bad. However, the robot lawyer established the fact that the hair came not directly off Andy's head but from the waste compartment of the

robot barber he visited.

At about the time of the Paranoid Piet strangling, Andy received some unsettling news from Dynamite. Unsettling hints actually.

Andy was visiting Dynamite in her home gym this particular afternoon. The redhaired girl, wearing an attractive one-piece stuntsuit, was swinging from a plyorope up near the domed see-through ceiling.

Jogging along beneath her, Andy was saying, "There's only one person who can be doing this to me. You realize that, don't you, Dyna?"

"You're letting your silly old jealousy feelings make you—"

"Come on. It's got to be Denzlo. He's got motive and opportunity. He's the one framing me."

"Andy, you—"

Thunk!

He dashed across the padded floor to the place where the fallen girl hit. "You usually don't fall off things, Dyna," he said as he knelt beside her. "Something's bothering you."

The pretty girl groaned some, shook her head and then sat up to hug him. "Andy, I suspect it's worse even than you imagine."

"Worse?" He stroked her fiery hair.

"Denzlo's been dropping hints lately," she said, sighing. "Wish he wouldn't, since it makes me gosh awful nervous. Not only have I been falling from some pretty high places lately, I've been screwing up other stunts, too. Last week when they shot me out of the neutron cannon to celebrate opening the new kelpfood plant out in the Oxnard Sector my trajectory was way off. I ended up landing smack dab in the middle of a pile of—"

"What about Denzlo? What's he been insinuating to you?"

"I honestly to gosh think he is trying to frame you for these Media Killer crimes, Andy."

"I been telling you that for weeks, Dyna."

"On top of which . . . Golly, I have the spookiest feeling he . . ." She let out a longer, sadder sigh.

Andy pushed her back from him. "I get what you mean," he said, eyes widening. "Denzlo is not only providing clues which point to me, he's providing the victims. Isn't that it?"

She nodded her lovely red-topped head. "Gosh, I'm afraid it is. What'll you do?"

"Stop him!"

"How? He's really smart, and powerful."

"Suppose," mused Andy, "I were, completely by unavoidable accident of course, to view this upcoming documentary on pattern killers that Oldies, Ltd put together? I'd be compelled to rush out and—"

"Andy, you're supposed to be cured."

"I am cured. You saw my diploma from—"

"Yes, don't bother showing me the darn thing again." She put her small warm hands on his. "What I mean is, golly, you shouldn't be having thoughts about running amok. Strangling a bunch of people like you—"

"Not people, Dyna, only Denzlo," he explained, grinning. "Actually, I won't watch the show. If I really watched it I might, as you put it, run amok, because I still am very susceptible to anything I see on television. I'll only *say*, when they come to arrest me for strangling Denzlo, that I was watching. Most I'll get is another few—"

"I don't like the drift of this darn old conversation," the lady daredevil told him. "Wow, do I pick 'em. A rogue cop and a dumbunny who tells me he's going to go out and commence choking innocent—"

"Didn't I promise you no innocent people this time? Only Lt. Denzlo, then I quit. Promise." He made a cross over his heart. "I really won't—"

Zimm!

"Again? Oh, Andy."

"We still have our dinner—"

Zimm!

She managed one quick kiss on his cheek before he went teleporting off.

Andy didn't land in the police fortress this time. Denzlo, probably with the cooperation of Hart, had teleported him elsewhere.

To the scene of the latest strangling.

They'd landed Andy there only minutes after the murder. No one was there as yet. Only the dead man and Andy.

"Talk about frameups," he said.

This was in the Pasadena Sector, the victim was a man named Reisberson. He was sprawled on the floor of his place of business, feet spread wide.

Reisberson ran a tv wall store and it was filled with sample walls. Each wall showed an ongoing television show.

Ten seconds after he saw the dead man, Andy looked up at the nearest of the huge tv pictures.

". . . an excitement in the air . . ." an unseen announcer was saying. "All for a very good cause, too, which must make all the folks who're about to participate in this Clear Air Marathon very happy."

The same picture was on all the giant wallsize screens which surrounded Andy. Hundreds of runners waiting for the signal to start.

A door behind him opened, feet came thumping in. "Stay right where you are, Media Killer!" ordered an official sounding voice. "We'll cut you in slices! Don't move!"

Andy, though, really was susceptible to what he saw on television. At that moment on all those enormous screens people began to run. There was nothing else Andy could do.

He ran. So they shot him. ∞

"It would look better over there."

NEXT OMNI

TOFFLER

COMPUTER

THE REAL BIONIC MAN—Steve Austin, move over—you've got real competition. At the University of Utah in Salt Lake City they are spending $8.4 million this year alone to build a real bionic man, if only a part at a time. So far they have developed an artificial arm that responds to thoughts—that's right, thoughts! The user simply *thinks* about moving his bionic arm and the arm, which senses the brain's electronic signals and decodes them with a tiny computer, moves. The Utah scientists have also pioneered artificial eyes, ears, blood vessels, hearts, and a tiny computerized implant that will provide instantaneous readouts of blood chemistry. The $6-million man will probably never exist, but the $8.4-million man is alive and well.

THE FUTURE OF FUTURE SHOCK—"When we set up a democracy, nobody ever thought science and technology would be political questions," said futurist writer Alvin Toffler in an exclusive interview with OMNI publisher Bob Guccione. "Nobody thought in terms of designing a technological policy for a nation. The United States doesn't even have such a policy today." A decade after the publication of *Future Shock*, author Toffler envisions both the near future and the long-range prospects for planet Earth. He examines the revolutions now occuring throughout the sciences and evaluates what effects these changes will have on the future of science, business, government . . . our whole way of thinking.

LANGUAGE, EMOTIONS, AND DISEASE—Does thinking promote disease? Are anger and depression as dangerous to us as cholesterol, smoking, even disease-related microorganisms? Surgeon-turned-psychiatrist Wallace Ellerbroek suspects so—and if he's right, correcting thought patterns could be a whole new area of research for disease prevention and control. Cancer, heart disease, and even acne may well be curable if we pay enough attention to *how* people get sick.

COMPUTER LIB—It is called the "home" or "personal" computer and it heralds the greatest technological revolution since the invention of the stirrup. Today these small computers (some are the size of a portable television set) can be purchased off the shelf for as little as $500 and are already in use in many homes—along with the microwave oven, the toaster, and the refrigerator. In the next OMNI, computer specialist Ted Nelson presents an insider's look at the new computer revolution and tells us how to come out on the winning side. According to Nelson, we are now in an age of "ham" computing but true "home" computing is almost upon us. It is an article you will not want to fold, bend, spindle, or mutilate.

BATTLE STAR-GALACTICA—Television's biggest hit this fall is the show that has brought *Star Wars*-like special effects into the living room. The next OMNI opens trade secrets and takes you behind the scenes of tv's most exciting new show.

KILNS

CONTINUED FROM PAGE 61

to the place where I belonged. If anything, I felt bereaved, desolate, as though suddenly on some high, rotting escarpment I had become afraid. As I reached the safety of our barrack-cave, the device in my arm began to play softly: music for marching, and also music for sleeping.

I awoke beside Kiln 82-B.

That is to say, I came to understanding through work on our production lines. My loin-cloth patterns took me not to a small, white Foreman's house but to three years and 40 days as lead-off man beside the fire doors.

Past daybreak one day in spring our crew of men entered the firing shed; at the same moment, the crew-women also arrived through their portal.

Our procedure was exact. Each man of our crew placed carefully one molded, white-square of clay on the firing rack. The women opposite scribed the day's pattern and "fed" the clay with a brush and red-vitreous glaze. Whereupon Caliper-men thoughtfully measured each brick and each row of bricks, trying without rancor to find their own quota of "Second-Forms." Nimbly, within the permitted time frame, tier-upon-tier the pallets rose as high as our tallest man could reach. For the firing run all pallets required perfect alignment.

The Talley-men, those roving jackals with clipboard and abacus, came and went; our Foreman with his symbolic, lashless whip of porcelain stood high above on his platform, never smiling.

Beyond my lead-off station, always, I was aware of the curved door of our furnace and of the fires within. At a signal from the platform above, I rolled back our furnace doors. One crew on either side, together, we pushed forward the wheeled truck of perfectly aligned, unfired bricks. When the heat caused the others to fall back, I, alone, pushed the load deeper into the furnace. Then I, too, was outside, and the door of the kiln slammed shut, then locked.

At once we walked all in a row to the rear of that somberly roaring kiln. We pulled forth an incandescent square honeycomb of new bricks which glowed among us like the sun.

To see an aligned, glowing dolly of bricks emerge triumphant from its week-long fire made us cry out in an almost indescribable joy. As we watched, still another crew pushed that truck—glowing, steadily turning red—towards cooling yards. Always we watched the square of light grow smaller until it was only a firefly disappearing. Outside everything was dark as pitch.

At such a moment we met.

To "meet," however, implies special circumstance. To be sure I had seen her each day for almost three years, but precisely because each worker inexorably was at one with our production, with the ideology of our Valley, the distinctions between men and women, while on the production lines, long ago had ceased to exist. With that distinction vanished, we spoke to one another only in quota-words or by communal song. Thus to see another person or to touch accidently across a pallet of clay was not at all to "meet."

As had happened before, exactly when the last pallet of the day emerged from our kiln, I had a terrible moment of vision. Three times before when I looked into the flames, unmistakably I saw my own face. That day, however, writhing, as though sculptured in flame, I saw the outline of my whole body, complete with loin-cloth patterns.

Blind, stricken, I fell down in the monstrous blue shadow of our Whip's platform. For one moment he too was blinded by the fiery sun of new bricks emerging.

"Three times before when I looked into the flames, unmistakably I saw my own face. That day, however, writhing as though sculptured in flame, I saw the outline of my whole body."

"You do . . . " was what she said very softly, her face partly averted, "More . . . "

What she said was illicit, and also not possible—that *anyone* could do "more", yet secretly I knew in my own heart what she dared say was true.

"More than anyone . . . "

The movements of my body had told her so: at the furnace door, then deeper into the flames than anyone else. I dared push our pallets, on the production line, at times, I was an Eagle still, high on the escarpment's most daring walls. And this, secretly, she had understood. As it had been so very long ago when I had seen a Foreman's profile against blue light, so was it with her at that moment: her profile against the kiln's subdued, overhead glow, her lips half-open.

We did not touch.

Instead, impulsively, she picked up the end of my loin cloth. Intently, her face without expression, she held the pattern of her loin cloth in parallel to mine. Never before had I seen a woman's hand do something so intensely feminine.

In the shadow of the platform above, at a moment when even the Talley-men were blinded, on shards of old brick, illicitly and contrary to Law and in the face of death by burning, she kissed me.

Terror was what I felt, and the Valley suddenly seemed to tremble because of our unplanned disobedience. Then as though we had passed only in those shadows, we stood apart, stepped back into our respective lines.

In the next weeks, two things happened.

At Kiln 82-B my personal effort—a concept not before known to me—redoubled. I sensed new, illicit purpose. I pushed our piled-high carts of unfired bricks almost into the very heart of the awful flames. Secondly, in ways I had not thought possible, she managed to put glaze on almost every brick which I placed on any pallet. No word was spoken, yet our work seemed to be for ourselves alone. And it was true: she managed to let others place her just beyond my touch, and yet I could observe her closely.

Of course we had no names, and outwardly she was precisely as all other women I had ever seen except in the center of her black, long hair was an enigmatic skein of ash-white. When the heat of the kiln blew her hair back across her shoulders, that line of color glowed and floated as I watched. Clearly that mark was her disqualification to bear children. Furthermore, I saw now a destructive, impulsive aspect of her work. She was wasteful of glaze, and at day's end impulsively threw down the honored tools of her craft. But would she ever see her own face in this consuming flame? I could not know the answer.

After six weeks we met again in the darkness beneath a Talley-man's decorated platform, our feet bare on shards of brick.

With absolute disdain for the symbolic porcelain whip above us, she said, "Tomorrow, I go down . . . to the cedar forests."

Terror was what I felt. Even with the Talley-man directly overhead I might have cried out but she touched me, placed her blunt, short fingers across my lips.

Far down the tracks towards the cooling sheds, we saw our last dolly of bricks glowing, becoming smaller in the exceptional, somehow comforting, darkness.

Without saying anything, she turned towards the receding light, and because of love for her I took the second step. We were two shadows running, following the narrow rails onward. Then we were going underneath vast, half submerged sheds, their roofs held up by massive columns of brick.

Suddenly ahead, the glowing, honeycomb of fired bricks flared, went out: the tracks had abruptly turned. Because it was totally dark, we walked more slowly. Underfoot were shards of pottery, of brick.

overhead we saw massive savagely decorated platforms where once Foremen and Talley-men austerely watched. These platforms from another age were now impotent, deserted, were falling down.

Beside a low, final tower we emerged beneath the sky and climbed the rough-hewn, primal steps to an upper platform. Stretched out ahead in the moonlight, humped like the back of some sleeping, vicious animal, I saw the roof of cooling sheds stretching away.

In full flight, with no guide save the escarpment to the East, gradually we went towards the docks, the shipping yards. On either side we passed between pallets of stacked-up bricks with three holes, then past canted stacks of jugs in a hundred sizes, all with three handles. Gradually these piles became smaller, the sheds more haphazard. After four miles, the shed roofs were rotted or blown away, the abandoned roof posts no taller than my waist. At last even the posts were only piles of rubble, covered by silt or by clay blown here by the winds.

On a rise of ground beyond the vast vestige of those mounds, at two o'clock in the morning, we stopped. For a moment we turned, looked back. Beneath the sky we saw blue and orange organ pipes of flame, a mosaic of streets and plazas, the row-upon-row of mighty kilns, the entire Valley a hearth glowing—the place where we were born. Ahead was only a canyon of stone, a prelude to the chaos of mountains.

Listening intently, we heard for the last time the far-off, sweet, industrial hum rising from the Valley of the Kilns. We felt bereft, but we did not turn back. What I saw next made all of the difference.

When we fled the kilns, I feared the areas of the Yards, and the River docks. Here the Talley-men roved with their giant, three-eyed dogs. These areas were central to our enterprise, to our dogma: our crews in the forest, on the escarpment, beside the kilns, or in the vast network of cooling sheds, yes, and our myriad of quotas, our athletic games when we ran long distances carrying heavy weights, and most especially the patterns programmed into our loin cloths.

This we believed: from our yards and docks—made Holy by Shardsmen—our life and our brick moved onward to construct walls and fantastic cities high on mountain tops we had never seen. These things known were the end, the justification of all our sacrifice.

Yet here, beyond the most savage, burnt-out cooling sheds, there were no railway yards. No docks. Where rail yards might have been, I saw only ancient, low ridges coming together. These ridges intersecting might once have been a primitive system of dikes, or canals, or possibly roadbeds—now abandoned, now overgrown.

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WARP

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a certain time it will become ineffective and you will stay locked in a world of visions so dreadful that you will die of your own free will to escape them. So quickly now, answer my questions. What was the mission? What kind of work was going on at your Time Center?

Who were you trying to contact when we captured your scout . . . ?"

— question, question, question.

Jonna lay there and spoke only once. "Little John Twelve was right." And then she wouldn't explain. For when the tractor beam from Orel took them, Little John Twelve said to her quietly, talking the way Little Johns do, "The probability of escape is negligible. My ability to refuse the information they will demand, not only of me, but of the entire contents of our computer banks, is equally negligible. There is therefore only one reasonable course. It has been nice knowing you, Jonna Verret," whereupon he smiled slightly and died.

She remembered wondering through her shock and fear what it must be like to be a clone among clones. He was as real as she was, yet dying could hardly be the same thing, for all the Little Johns had complete access to everything Twelve had ever done or thought or felt, so in a way he would live on in all of them, more than a memory.

Now, helpless under the light, his words rang in her mind. "There is therefore only one reasonable course . . . ," and she closed her eyes. But she didn't know how to die this way, and she did not know—yet—if she really wanted to.

And the light burned on, and the questions rained down, and it seemed that the podmember's face (if that could indeed *be* a face) grew larger and larger until it filled the room, the planet, and the endless space outside, and its wet pores grew into caves and from them came dripping horrors with pointed, poisoned teeth and sounds more ghastly than any sight, sounds rising growl/howl/scream/shriek, and loud and more and huge and new worse sights ashake, ashudder and tearing apart with the noise absolute, and all at once dead quiet so sudden it was agony, and in a dim radiance stood Will Hawkline smiling, smiling at last right at her, his eyes captured by hers, his hand out, *his arms out*, and, and, a spear of white metal striking up from somewhere, entering his breast and emerging scarlet from the top of his head, and oh, his look of complete astonishment as she screamed at last, then all was dark, then she was gone.

'Gone," said Little John Five in the scout with Will Hawkline. 'She's gone.'

Never knowing Jonna's last most terrible illusion, Will Hawkline asked, out of a dry throat, "What do you mean gone?" feeling again that which he had not known he could feel.

"No sign now from Orel, not from her. . . . Are you well? Your breathing stopped." It started again with a great shudder. The Little John said, 'And yet I have her life signals . . . no this can't be. This is not in my data banks."

"What? What?"

"The life signals come from another place . . . not Orel at all, but nowhere else either. No chart or survey or probe has ever reported anything but emptiness just there. And yet—I get her sign.'

"Pull out of this into real-space, and set a course, and go there, wherever she is," Will cried harshly.

"But Orel . . . the cruiser . . . the detonation of Earth—"

"Five, I order you.' And the Little John obeyed, saying only, "You know we're damaged," and did the things necessary to fling them into the real. A moment's observation and the Little John had set the new course and flung them spiraling into the grey. "You still get signs?"

"Naturally not."

'What do you mean naturally not?'

"Forward in space, backward in time," the Little John said. 'Have you forgotten? She will not have arrived there yet. Wherever 'there' is."

Off they went then, back in time, forward in space, until they emerged, and there, where all the data banks everywhere said there was nothing, was a planet in orbit around a distant star—distant enough and so erratically aflame that there had never been (would be) a reason to look for perturbations. They stared at the world in wonder until Will Hawkline said, "It's molten. The planet's molten!"

"Yes. It's newborn."

'We've come *that far back*?' And the Little John answered, "We're damaged."

"Orbit in close,' said Will Hawkline, "and speed up our time." Reluctantly the scout responded and they watched in fascination the agonies of a molten ball becoming a world, its heaving throes and spouts of lava, gouts of flame and writhes of color as the strata turned up edgewise and sank again, then a nearly endless time of clouds and fireflickers, and the emergence of land and oceans, land that stayed, land that sank, oceans roaring across land newly alive with grasses just invented.

And at last the beauty came, and calm—isthmus and estuary making firm agreements with the island dotted sea, and life flourishing at last, sure and powerfully evolving. And for Will, a growing sense of presence, of a newer kind of mind, strong and gentle and sane and fearless. "Do you feel it?"

"Feel what?" And by what, Will Hawkline knew that a Little John, for all his mental powers, could not feel certain things.

Then together, they gasped.

It was—*gone*. The planet vanished! All about them the stars shone, the distant sun flamed, but this world was *gone*.

Because he felt what he felt, Will Hawkline said, "Tighten your orbit. Move in closer."

"Orbit around what? Closer to *what*? There's nothing there anymore! I can't see it, my instruments can't see it . . . " Will Hawkline had never seen a Little John so upset. But he could feel the emanations of Mind close by, and he smiled and said, "Pretend it's still there, and go down."

Obediently the Little John did it. Nothing, and nothing, and *ah."*

And of course you know where they were, and when. They had witnessed the birth of our dear Ceer, and the beginnings of our shield, and had now passed inside it and were filled with wonder.

"Her signs! Her signs! She's alive here!' The Little John was really excited, amazing! And just then the scout gave a sickening lurch and Will himself overrode the computerized controls and summoned his old skill as a pilot—trained to manage these flying things with his own two hands. He righted it, but lost a great deal of altitude, and scout apparently disliked his firmness because it fought back and set up a great grinding clatter from somewhere inside it. "Where is she?" he shouted over the noise.

'Over there, right at the base of the peninsula! But there's a mountain . . . '

Will Hawkline saw it, then lost it in the rush of clouds and rain that swept down on it. He turned toward where he thought Jonna was.

"Climb! Climb!"

"Climb she won't." Will said grimly. "Anyway, I don't see any mountain now," which was perfectly true. As if insulted, the mountain reached up a high crag, or seemed to, and gouged out a slit a third of the way down the hull, throwing the nose of the scout almost straight up. Through the slit, which stopped just under his feet, he got a split-second glimpse of the peninsula and a wide flat meadow. As the nose came down he swung it that way. The scout tilted to the left and wouldn't correct, and they came in like that, skittered and slid, nose down, up and over, and it was all black everywhere and quiet.

The first thing Will Hawkline saw as he came out of the blackness was something he couldn't believe.

Me.

The next thing he knew was that the warm pillow under his head spoke to him. "Will . . . Oh Will—are you all right?" It had Jonna Verret's voice because the pillow was Jonna Verret's lap. He tipped his head back and looked at her and then again at me, and tried to sit up and scrabble backwards at once. I think he was afraid. Maybe my teeth. Jonna said, "It's all right, Will. That's Althair." He pulled you

out of the scout."

"What was left of it," said the Little John. Will saw him sitting on the floor nearby. He had a bump over one eye but seemed well otherwise. They were in what Will thought was a polished wooden cave. Well, what would *you* think if you'd never seen one of our living living-places before?

Anyway, you never heard such a flurry of questions in your life, and if it hadn't been for Little John Five sitting there nodding his big golden head every now and then, I don't think Will Hawkline would have believed a word of it. He had to know all about Ceer and we Zados, and the shield we thought up around our planet, and why we have no machines, and how we grow living-places and see-far and move to other worlds when we want to, without jugs.

"The Zados took me away from the Mindpod on Orel," Jonna told him. "Right out from under a force-beam. They brought me here and stopped the poison the Mindpod had put into my blood and made me well all over, even my head." And Will had to believe it, because she was here. But when I tried to explain *how* that making where she was, the only place in the universe she couldn't be (so she disappeared) and Ceer the only place in the universe she could be, he couldn't understand it. Slowpokes think *tools*, you see. When they want to do something, the first thing they look for is something outside of themselves to do it with, tools, machines, inventions. They can do a lot with tools, but that kind of thinking keeps them from doing things the simple way, which is why they are slowpokes. What makes them so funny is that they don't have to be slowpokes, and they just are.

Will Hawkline was very very bright, you have to understand that. He had to be, to have become Coordinator of his Time Center on Avalon while still so young. As I told you, that is a very high place to reach on Earth. But he was bright in a way that made things a lot more difficult than they had to be. He never stopped asking questions, which is a fine thing in itself, but when he couldn't understand the answers, he wanted to stop and work at it, and found it very hard just to accept and go on. We can do certain things, we Zados. We had proved it to him. But it was very up-hill for him to use what we could do without knowing how it worked, and without tools and inventions to test all the parts. *Acceptance* is the big word. Acceptance was very hard for Will Hawkline.

Little John Five was no problem. He could think like a living thinker, but he was conditioned by computers and computers can't think. Computers now—*they* know the meaning of acceptance. And Jonna—well, she was a pammie, and Earth Pammies are sort of special, and seem to be able to know a great many things without needing to be told. Acceptance is

easier for them.

By this time, of course, I knew all about the terrible things the Pod had done to Jonna on Orel (we had known about the Mindpod by our own mindnet from the moment they landed there, and had been watching) and also about the threat to Earth. And we had worked out a plan.

To do it, we would have to get into the caves under the big basket—cradle, the Little John called it—which held the Orellian cruiser on the surface of Orel. (Orel is mostly porous under the surface, great chains and tangles of holes and caves.) We could then try to get into the cruiser itself and see what we could do from there.

Getting to Orel was a lot harder than it had to be, mostly because of Will Hawkline's insistence on understanding everything we did. When I told him that the Zado High Council would convene for the ritual which would take us to Orel, he wanted to know where the council would meet, and I had to explain that it didn't actually meet at any certain place, the mindnet could be cast wherever the Council Zados happened to be. Then I had to tell him what to do with his own mind, which is just—*accept*. And at first he wouldn't and then he couldn't, and I had a time, I tell you, showing him how he could. I didn't want him to see me laughing, and really that was the hardest part.

I got them all comfortable and convened the High Council and we started to weave the Net that would send us to Orel. And wouldn't you know the moment the Ceer-reality began to fade around us, up pops Will Hawkline, bolt upright, demanding to know what's happening, and of course he broke the net and we had to start all over.

I was going to speak to him but Jonna said, "Let me," and went and sat down beside him. She took both his hands and looked into his eyes and said, "Will—just let it happen. Trust," she said. "Trust. Go with me." And while she held him with her hands and her eyes I quickly convened again. We got a good Net this time. The glowing sound-beds of shimmer lifted us and *blip*! we were in the caves on Orel.

Whatever Will Hawkline or any of them were going to say then, they didn't say it. Not so much because of the caves themselves, the crazy light (there are patches of luminescent rock, blue and green, and reddish moss and fungus that glows purple) and the odd smell of the air, none of this. It was the meercath standing there, scratching its stomach with one of its little hands. It was wearing a harness with a heat weapon stuck on it. It was the first meercath the Earth folk had ever seen and I guess I don't blame them for being upset. Jonna made a little scream and the Little John opened his big eyes wide, and Will Hawkline slapped a weapon out of his belt and *whsssht*! blew the meercath's big head right off.

I was not pleased about that. I had never thought to tell them, but I had a shield around us just like the one we put around Ceer, and the meercath never knew we were there. But now that Will Hawkline had used his weapon, the whole planet, or anyway the Mindpod, knew it and knew where we were. I didn't tell him this. Zados do not say things that make anyone unhappy. Will Hawkline was pleased and it was too late to correct what he had done. I took the heat weapon away from the dead meercath and gave it to Will Hawkline and showed him how to use it, and asked him for his; I told him the Mindpod could find us instantly if it was used again, but the meercath's weapon would be harder to trace.

Then we ran. Oh, we ran! I led them through the caves and into the labyrinth under the cradle, and you know I couldn't create the shield while we were moving that fast. Another meercath saw us and set up that horrible wailing cry, and in a moment it was coming from everywhere. We ran through the green and blue, through patches of purple, and soon there came the bright orange flare of the heat weapons.

> *"It was the first meercath that the Earth folk had seen and I don't blame them for being upset. Will Hawkline slapped a weapon out of his belt and* whsssht! *blew the meercath's head right off. I was not pleased about that."*

At last we were where I wanted us to be, right under the cradle, but it happened to be a blind corridor as well. If the meercaths found us here it would be a bad thing. As long as we were running they would try to bring us down with their heat-things, but if they had us trapped they would catch us and pull us apart and bite. That's the way the Mindpod trained them.

There was only one thing I could do—make a little mindnet and get us out of there. But I would need their help. Jonna and Little John Five seemed to understand right away what I needed—just to relax, give themselves to me and the net—and oh, how I wished Will Hawkline was a little less curious, a little less brave, and maybe a little more stupid! I will give him credit: he tried, but then he saw the meercaths, two, three, then seven, eight, nine of them. I instantly threw up the shield—I didn't need their help for that—and they could not see us, and in a moment they would have moved on to search somewhere else. But Will Hawkline could see them as clearly as we can see the stars here on Ceer, and he raised the meercath heat-thing I had given him and sent a great orange flash down the corridor. Two of the meercaths went down howling, and then they all knew for sure where we were.

Will Hawkline went down on one knee and steadied his weapon, and I thought, "That is the tool-craziest slowpoke in all the Known and Unknown!" I shouted in words and inside their heads to Jonna and the Little John: *give me you*! and they did, and while the meercaths were wading through the horrible mess Will had made in the corridor, I flung the energy they gave me, together with my own, against the soft rocks overhead and a huge section came crashing down, shutting it off.

In the sudden silence and swirling dust I said to Will Hawkline, "Now if you can't do what I ask, don't do *anything*!" as gently as I could. Maybe it was this or maybe the way Jonna and the Little John looked at him, but he became very quiet and almost helpful.

I called on the Ceer net with the precise locus, and as around us the cave faded away, metal walls, flat and dark, took their place. We were inside the Orellian cruiser, and almost before we could take a breath we had that crazy spinny inside-out feeling of space travel, zero time. The cruiser had lifted. It was a close thing.

It probably took us a little while to be able to think straight—you pups and pammies will never know what a wringing out you get from traveling that way. Once I got my wits back, I looked around. Flat metal walls. Dark. I made it a little lighter. Jonna and Will were stretched out. I guess still waiting for their minds to catch up with them. Little John Five was sitting up wagging his big head.

"Five," I said, "can you think-in to the computer on this cruiser?"

He looked at me. If he was surprised to see me shining in the dark he didn't say so. He closed his eyes and made some sort of effort. He opened his eyes and said, "It's different."

"You have to expect that. But isn't it the same in some ways?"

He closed his eyes again. After a while he nodded his head. "In a lot of ways."

"Can you learn it?"

"I think so."

"You do that. Five. Think-in all the way. Think-in so far that when they start looking for us with their tinder-thing, they will think you are another part of their own computer. Can you see out of their see-it thing? I want to know where we are," I said. "I'll help," I said.

He tried hard. I picked up what he mind-saw and made it shine on the dark wall. It was like a window. There was a planet...

"My God," I heard behind me, "that's Earth!"

"There's Avalon—see?"

"All right, that's where we are. I would like to know *when* we are," I said.

"I do not have the referents," the Little John said.

"I do. *Look!*" Will Hawkline cried out.

In the picture, from the curve of the planet's shoulder, came a tiny golden spark. "A scout," said Jonna Verret. "It's . . . could it be . . . ?"

Across the picture came a line of fire, at almost the exact moment the scout winked out in that special way a craft flares when it slips into faster-than-light. A moment later another spark appeared, the fire speared out and sliced into the tail section just before the ship disappeared. Somehow, the faster-than-light change came when it was strangely brighter than the first one.

"It—it's us. *Me*. They're going to do terrible things to—to her."

I decided to do a kind thing. I used a piece of the net and made it say to Jonna, deeply, "Sleep." And I said to Will Hawkline, "Sleep." They slept. They slept so deeply that even the Mindpod's probes and search-sees wouldn't know they were there. Then I said to the Little John, "Five, they are hidden in a special way, and I can put up my own shield. by now you know how they will search, can you make yourself seem like part of their computer? So much so they will not find you?" He said he could. Then I told him what to do.

When it was right, I got the net to bring Will Hawkline and Jonna up and up through their deeps until they were normally asleep, and then I woke them.

Immediately Little John Five said, "The computer reports stowaways. A meercath has told the commander."

I said, "That's all right."

The Little John said, "The commander has ordered a search."

I said, "That's all right too."

Jonna said, "Can we hide somewhere?"

I said I didn't think so—not for long.

Jonna said, "You can't mean for us just to sit here until they come for us!"

"They won't take us without a fight," Will Hawkline said, and he took the meercath beat-thing out of his belt, and wouldn't you know before I could say another word the door of the compartment crashed open and there stood a meercath guard. Will aimed his weapon and of course nothing happened because I had taken the charges out while he slept. I had neglected, however, to remove one patch of stupidity or his appalling bravery. As the giant meercath opened his mouth to squall, Will Hawkline flung himself across the compartment and shoved the weapon [illegible]en all those big teeth and into the [illegible]rcath's throat. And he didn't stop with [illegible]. With the momentum of his rush he [illegible]d a hand on the meercath's head and vaulted up and around, clamping his

legs above and below the meercath's long snout forcing its jaws closed. I remembered then that all big lizards, especially the one with long jaws might have, like a meercath, a bite powerful enough to nip someone my size in two, but the muscles that open the mouth are comparitively weak, and it's easy to hold the mouth closed. So the guard, scrabbling at Will Hawkline with its clever tiny hands, whimpered and died, and sounded no alarm.

Panting and exultant, Will Hawkline came back. "Help me drag this thing inside." Well, I helped him. And I thought, how can I tell him, without making him unhappy, that he had just done the worst possible thing he could do? Zados don't make people unhappy. How could I tell him that if he had let himself be captured, he would have been taken to the commander on the bridge, where we might be able to do something, but that now he has killed a guard, the other guards would bite his silly brave head off? How could I tell him that the most important thing of all was for the Little John not to be discovered, that he couldn't now be detected except if he were seen, and guards looking for their missing meercath would certainly see him? I couldn't say it. I couldn't say it. He was so smiling and proud.

"Will," I said, trying so hard to be gentle. "See Jonna there." And when he looked I threw the shield around her and she was gone. He gaped and took a step toward where she had been and I took the shield away. "See Little John Five." And I threw the shield around Five and then removed it and put it around Will Hawkline. "Will," I said, "you can see Jonna. You can see me. You can see Five. But they can't see you. Is that right, Jonna? Five?" They nodded their heads and I took down the shield.

"Why are you talking to me as if I were a child?' Will Hawkline asked, so maybe my gentling did not work as well as I thought it would.

I said, "We are going to use the shield. And I want you to understand that no matter how close you come to anyone, *they can't see you*. No matter how much you want to attack one of them, you must not. We are going out there and find a search party searching, and we are going to put Little John Five into some place they have just searched, because he has work to do and they can't detect him anymore. And then the three of us are going to the bridge where the commander is, and we are going to do it without getting our legs torn off and our heads bitten by them. Do you understand?"

'You're still talking to me as if I were a child,' said Will Hawkline.

"Well," I said, "I *love* children. Let's go."

I opened the door and put up a shield big enough for all of us. We could see no meercaths but we could hear sounds to the left, snuffling and stamping. I waved them to follow (we could see each other inside the shield) and we went that way. Sure enough there was a squad of meercaths right around the corner, opening and closing doors. We stayed close to the wall and moved right down on them, and I don't think the three Earthers really and truly believed in the shield until this moment. One by one the meercaths passed us as we stepped quietly out of their way, until they were gone.

I opened a door. "In you go, Five. Tell me when it's all done."

He smiled. This was the first time I ever saw a Little John smile. "I will," he said and closed the door.

The Little John had given me the cruiser's own computer picture of the big jug, and I had it well in my head. It was huge and a lot more complicated than it had to be, and it was full of machines and inventions and ups and throughs. And meercaths.

The bridge was way down in the middle of the cruiser with layers and layers of shells within shells all around it that could be sealed off, one from another, in case the big dark cruiser was damaged in space. The bridge was a sort of metal cave all studded with the pictures given it by the computer—pictures from the see-outs, the feel-outs, the how-fasts, how-soons, where-are-we's, and so on, and big ugly meercaths watching them. On a high place in the middle stood the commander, a special meercath, extra big.

Invisible under the shield, we stepped past the guard at the bottom of the ramp up to the high place, and went and stood behind the commander. We watched for a while, how he did the things a commander does to make a cruiser go. Mostly it was sticking out the tummy and looking fierce at one after the other meercaths who were actually doing something.

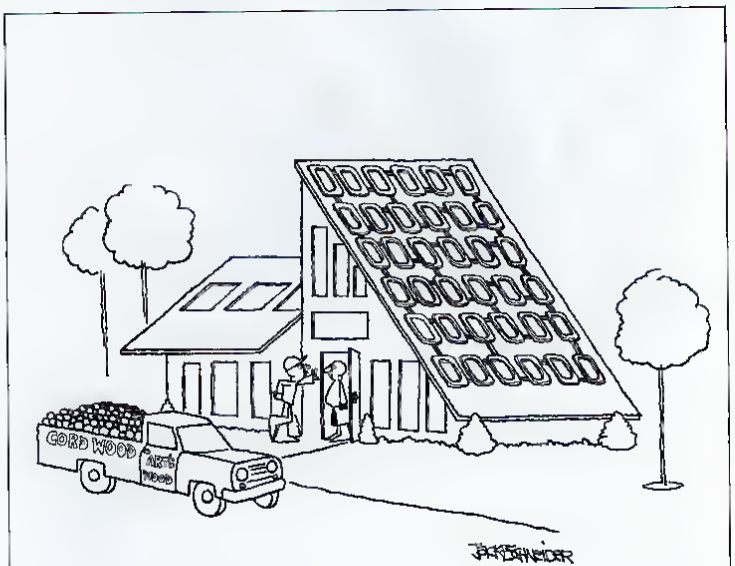
From the compartment deep inside the cruiser where we had hidden him, Little John Five mindspoke me. *'I'm all finished, Althair.'* It was a very weary mindspeak.

So I took the shield off Will Hawkline and Jonna Verret. But I kept mine.

You know, it seemed like forever that they stood there in plain sight, not knowing that they could be seen, while the commander strutted back and forth, not knowing they were there. Then one of the meercaths tending the little lights glanced up at the command post, froze for a second, and slowly stood up on his tail. (Meercaths sit on their tails.) Then another glanced, stared, and rose, and another. They began a funny little murmur among them, as if they were afraid to say anything to the commander.

And oh, it seemed like such a long while before the commander thought to look behind him, and there Will Hawkline and Jonna Verret looking him in the eye and smiling, quite used by now to being invisible, and not knowing they were not.

The commander's huge mouth slowly



"Care to lay in a cord or two for a rainy day?"

came open, and slowly he raised his little right hand, and he pointed a claw at Jonna. He said, in Earth talk, "You! You! You're the one who disappeared!" And only then did she realize she could be seen. 'Althair! Althair!" she cried, but I didn't say anything. Will Hawkline sidled in front of her, maybe thinking he was still invisible, maybe thinking he could protect her or attack the commander, maybe both, but the commander made it clear he could see him too. His pointing claw swung toward Will Hawkline. "You! I saw your picture from Earth. The Time Center . . . you're the Coordinator. You're Will Hawkline!" He whirled around and yelled, "This is what we want! He has the back-time invention in his head! Detonate the planet! Destroy Earth!'

"Oh . . . Althair!" Jonna's soft hurt cry was the last thing I heard as the cruiser hung over Earth and a meercath slammed his hand down on the planet smashing control.

There was a spiraling whirl and a blink of black, and a staggering, sickening feeling like traveling in zero time.

It was traveling in zero time.

And the terrible lightnings stroked out from the cruiser, red from this side, blue from that, green from below and a terrible yellow from above, and they met in a river of coruscating white as they plunged into the heart of the planet below, cracked it, kindled it, scorched and exploded it and turned it into a furious little star.

And the planet was Orel, and with it went the Mindpod, whoever they were, and never again would they move through the worlds, taking and killing.

But oh! my pups, my pammies. Oh! I stood with the Earth people and felt drowned in color and I couldn't breathe for shock and sorrow. Yes, the Mindpod was gone, and no, they would no longer menace us, or Earth, or any one else, but oh, Orel and its little animals, its brave grass and the swirls and swarms of life in its seas, any hope it might have to evolve and grow, gone, gone forever from the universe. Oh yes, there are lots more worlds and lots more life, but sometimes, when you have done a good thing, you have to look at all of the good thing, and wonder forever if there couldn't have been a better way, a way wherein nothing died.

We watched the death of Orel, all of Orel, layer after layer boiling and swirling, lava, explosions of gas, torn mountains, insane winds and oceans flowing into space. Never mind the Mindpod, never mind the meercaths. I cried for a world and all the life on that world, which can never be known again except in memory.

Meercaths . . . what of the meercaths? If I found myself heart-torn and shaking at the sight, what of the meercaths who had to watch their own home dying like that?

I looked around, and . . . and . . . and an incredible something else happened. With the death of the Mindpod, all of the meercaths in the cruiser disappeared. For each there was a little *pop!* of vacuum as they ceased to exist, and we understood at last that each was a projection, a solid projection, of a real meercath on the planet, and when they were gone, the projections were gone too.

I mindspoke. "Thank you, Little John Five." And the answer came back, "Can I sleep now?"

"Sleep my friend."

I dropped the shield. They looked at me, Jonna and Will, as if they did not know what to say to me.

I said, "I know I gave you a bad time for a while. I needed to get you to the bridge without your getting killed on the way. I needed to have the commander see you and think he had you captured: it was the one thing which would make him smash the planet, and do it before he could find out what Little John Five had done."

"Five! Where is Five? What did he do?"

"Something neither you nor I could have done. All the orders on a big jug like this come through the computer. The commander's orders were meant to be: *Detonate the planet. Return to Orel.* Little John Five thought himself into the computer and made the orders go: *Return to Orel. Detonate the planet.* . . . He's asleep, down there where we left him. Let him sleep. He's already set your course for Earth. Just touch that little light over there—yes, the green one—and off you'll go. But don't forget to message ahead. Earth may smash this cruiser the moment they detect it."

"Will you come with us?"

"Oh my no," I said. "I have something to do at home." 'Will," I said suddenly, because I couldn't help myself, "You learned acceptance almost . . . try learning it the rest of the way. Take your time. The little green light will wait."

They stood looking into each other's eyes for a long while, and I could see it happening, first his acceptance of what she felt, and the beginnings of his acceptance of what he felt. I called on the mindnet and went home. I had a story to tell.

• • •

He was sleek and he was furry, he was totally amphibious, and Althair the Adventurer was what he really was. However, he was known on his lovely planet Ceer, as Althair the Storyteller just because he did that better—better even than adventuring.

Story time was over. Slithering lithe, surfing, sliding, inchworming, crackly-whiskered, beady-bright, soft and smooth and shining, went the young, back to the ocean, back to sleepy-couches in the living-living-places. "I'll be Althair! they would play tomorrow. "I'll be Jonna, I'll be Will. This is myth aborning, this, what myth is for. ◻◻

FOUND!

CONTINUED FROM PAGE 120

made contact with the surface of Computer-Two. It lifted and our flashes shone down on a visible gap.

"There's the reason gas pressure inside declined to zero," I said.

Joe grunted. He pushed a little harder and the cylinder popped away and began to drift. We managed to snare it after a little trouble. Left behind was a perfectly round hole in the skin of Computer-Two, half a centimeter across.

Joe said, "This thing, whatever it is, isn't much more than foil."

It gave easily under his fingers: thin but springy. A little extra pressure and it dented. He put it inside his pouch, which he snapped shut and said, "Go over the outside and see if there are any other items like that on it. I'll go inside."

It didn't take me very long. Then I went in. "It's clean," I said. "That's the only thing there is. The only hole."

"One is enough," said Joe, gloomily. He looked at the smooth aluminum of the wall and, in the light of the flash, the perfect circle of black was beautifully evident.

It wasn't difficult to place a seal over the hole. It was a little more difficult to reconstitute the atmosphere. Computer-Two's reserve gas-forming supplies were low and the controls required manual adjustment. The solar generator was limping but we managed to get the lights on.

Eventually, we removed our gauntlets and helmet, but Joe carefully placed the gauntlets inside his helmet and secured them both to one of his suit-loops.

"I want these handy if the air-pressure begins to drop," he said, sourly.

So I did the same.

There was a mark on the wall just next to the hole. I had noted it in the light of my flash when I was adjusting the seal. When the lights came on, it was obvious.

"You notice that, Joe?" I said.

"I notice."

There was a slight, narrow depression in the wall: not very noticeable at all, but there beyond a doubt if you ran your finger over it. It could be noticed for nearly a meter. It was as though someone had scooped out a very shallow sampling of the metal so that the surface was distinctly less smooth than elsewhere.

I said, "We'd better call Computer-Central downstairs."

"If you mean back on Earth, say so," said Joe. "I hate the phony space-talk. In fact, I hate everything about space. That's why I took an Earth-side job—I mean a job on Earth—or what was supposed to be one."

I said patiently, "We'd better call Computer-Central back on Earth."

"What for?"

"To tell them we've found the trouble."

"Oh? What did we find?"

"The hole. Remember?"

"Oddly enough, I do. And what caused the hole? It wasn't a meteoroid. I never saw one that would leave a perfectly circular hole with no signs of buckling or melting. And I never saw one that left a cylinder behind." He took the cylinder out of his suit pocket and smoothed the dent out of its thin metal, thoughtfully. "Well, what caused the hole?"

I didn't hesitate. I said, "I don't know."

"If we report to Computer-Central, they'll ask the question and we'll say we don't know and what will we have gained? Except hassle?"

"They'll call us, Joe, if we don't call them."

"Sure. And we won't answer, will we?"

"They'll assume something killed us, Joe, and they'll send up a relief party."

"You know Computer-Central. It will take them two days to decide on that. We'll have something before then and once we have something, we'll call them."

"What if these life forms communicate somehow, and, across the vastness of space, others are now converging on us for the picking . . . Some, for the sake of Univac, may be able to invade the Earth for the metal of its cities"

The internal structure of Computer-Two was not *really* designed for human occupancy. What was foreseen was the occasional and temporary presence of trouble-shooters. That meant there needed to be room for maneuvering, and there were tools and supplies.

There weren't any armchairs, though. For that matter, there was no gravitational field, either, or any centrifugal imitation of one.

We both floated in mid-air, drifting slowly this way or that. Occasionally, one of us touched the wall and gently rebounded. Or else part of one of us overlapped part of the other.

"Keep your foot out of my mouth," said Joe, and pushed it away violently. It was a mistake because we both began to turn. Of course, that's not how it looked to us. To us, it was the interior of Computer-Two that was turning, which was most unpleasant, and it took us a while to get relatively motionless again.

We had the theory perfectly worked out in our planetside training, but we were short on practice. A lot short.

By the time we had steadied ourselves, I felt unpleasantly nauseated. You can call it nausea, or astronausea, or space-sickness, but whatever you call it, it's the heaves and it's worse in space than anywhere else, because there's nothing to pull the stuff down. It floats around in a cloud of globules and you don't want to be floating around with it. So I held it back; so did Joe.

I said, "Joe, it's clearly the computer that's at fault. Let's get at its insides." Anything to get my mind off *my* insides and let them quiet down. Besides, things weren't moving fast enough. I kept thinking of Computer-Three on its way down the tube, maybe Computer-One and Four by now, too, and thousands of people in space with their lives hanging on what we did.

Joe looked a little greenish, too, but he said, "First I've got to think. Something got in. It wasn't a meteoroid, because whatever it was chewed a neat hole out of the hull. It wasn't cut out because I didn't find a circle of metal anywhere inside. Did you?"

"No. But I hadn't thought to look."

"I looked, and it's nowhere in here."

"It may have fallen outside."

"With the cylinder covering the hole till I pulled it away? A likely thing. Did you see anything come flying out?"

"No."

Joe said, "We may still find it in here, of course, but I doubt it. It was somehow dissolved and something got in."

"What something? Whose is it?"

Joe's grin was remarkably ill-natured. "Why do you bother asking questions to which there are no answers? If this was last century, I'd say the Russians had somehow stuck that device onto the outside of Computer-Two—no offense. If it was last century, you'd say it was the Americans."

I decided to be offended. I said, coldly, "We're trying to say something that makes sense *this* century, Iosif," giving it an exaggerated Russian pronunciation.

"We'll have to assume some dissident group."

"If so," I said, "we'll have to assume one with a capacity for space flight and with the ability to come up with an unusual device."

Joe said, "Space-flight presents no difficulties, if you can tap into the orbiting Computers illegally—which has been done. As for the cylinder, that may make more sense when it is analyzed back on Earth—downstairs, as you space-buffs would say."

"It doesn't make sense," I said. "Where's the point in trying to disable Computer-Two?"

"As part of a program to cripple space-flight."

"Then everyone suffers. The dissidents, too."

"But it get's everyone's attention, doesn't it, and suddenly the cause of whatever it-is makes news. Or the plan is to just knock out Computer-Two and then threaten to knock out the other three. No real damage but lots of potential, and lots of publicity."

He was studying all parts of the interior closely, edging over it square centimeter by square centimeter. "I *might* suppose the thing was of nonhuman origin."

"Don't be silly."

"You want me to make the case? The cylinder made contact, after which something inside the cylinder drilled a circle of metal and entered Computer-Two. It crawled over the inside wall eating away a thin layer of metal for some reason. Does that sound like anything of human construction."

"Not that I know of, but I don't know everything. Even you don't know everything."

Joe ignored that. "So the question is, how did it—whatever it is—get into the computer, which is, after all, reasonably well sealed. It did so quickly, since it knocked out the resealing and air-regeneration capacities almost at once."

"Is *that* what you're looking for?" I said, pointing.

He tried to stop too quickly and somersaulted backward, crying, "That's it!"

In his excitement, he was thrashing his arms and legs which got him nowhere, of course. I grabbed him and, for a while, we were both trying to exert pushes in uncoordinated directions, which got us nowhere either. Joe called me a few names, but I called him some back and there I had the advantage. I understand English perfectly, better than he does in fact, but his knowledge of Russian is—well, fragmentary would be a kind way of putting it. Bad language in an ununderstood language always sounds very dramatic.

"Here it is," he said, when we finally had sorted ourselves out.

Where the computer-shielding met the wall, a small circular hole appeared when Joe brushed aside a small cylinder. It was just like the one on the outer hull, but it seemed even thinner. In fact, it seemed to disintegrate when Joe touched it.

"We'd better get into the computer," said Joe.

The computer was a shambles.

Not obviously. I don't mean to say it was like a beam of wood that had been riddled by termites.

In fact, if you looked at the computer casually, you might swear it was intact.

Look closely, though, and some of the chips would be gone. The more closely you looked, the more you realized were gone. Worse, the stores that Computer-Two used in self-repair had dwindled to almost nothing. We kept looking and would discover something else missing.

Joe took the cylinder out of his pouch again and turned it end for end. He said, "I suspect it's after high-grade silicon in particular. I can't say for sure, of course,

STARS

By Patrick Moore, O.B.E.

Last night I went into my observatory, uncapped my telescope, and pointed it in the direction of the planet Pluto. There was the tiny, remote world—looking like a dim star, and yet so profoundly unstarlike. Generally it is regarded as the outermost planet—but this is not always true—and many astronomers feel that Pluto shouldn't be there at all!

Pluto was tracked down in 1930 as the result of calculations by the American astronomer Percival Lowell, best remembered today for his fascinating (and, alas, completely erroneous) ideas about the canals of Mars. Lowell based his calculations on the disturbing effects of a then unknown source upon the giant worlds Neptune and Uranus, and had, so to speak, carried out a detective's investigation in reverse. He was right. Pluto proved to be just where he had plotted it.

Yet—something was wrong. Pluto was found to be very small, with a diameter less than that of the earth or even of Mars. How could such a midget planet possibly drag Uranus or Neptune out of position by any measurable amount? Yet it was by these very perturbations that Pluto had been discovered. It was all very odd, and to make matters worse, Pluto has an orbit that periodically brings it closer to the sun than Neptune (although there is no chance of collision). From January 1979 to the year 1999, Neptune, not Pluto, will be the outermost planet of our solar system!

What is the nature of the peculiar Pluto discovery? No one yet knows.

In the meantime there has been an exciting development with Pluto. Studies carried out at the Flagstaff, Arizona, station of the U.S. Naval Observatory and at Cerro Tololo Observatory in South America indicate that Pluto may have a satellite, or moon, with a diameter larger than half the diameter of Pluto itself! The moon seems to circle Pluto once each Plutonian day (about 6¼ earth days), and is about 20,000 kilometers away. It is still too early to be sure, but the satellite may well be there—in which case, it would make Pluto a double, or binary, planet.

Might there be another planet far beyond either Neptune or Pluto? If so, what are the chances of finding it? It must be cold, lonely, and remote beyond all understanding: from it, the sun would only be as brilliant as the full moon condensed to the size of a brilliant star. Tracking down such a world would be a Herculean task. But Planet Ten is a good possibility, and its discovery might help explain the history of the outer reaches of the solar system.

* * *

Speaking of satellites, another recent report is of real interest, this time concerning the asteroids or minor planets—dwarf worlds orbiting the sun in the gap in the solar system between the orbits of Mars and Jupiter. One of them, a very faint body 240 kilometers across, is named Herculina. On June 7 Herculina passed in front of a somewhat brighter star and occulted (hid) it for a few seconds. Remarkably that star winked not once but twice—from this startled observers in California inferred that the asteroid Herculina may not be a solitary wanderer. According to calculations by David W. Dunham of the International Occultations Timing Association, Herculina may have a satellite of its own, some 50 kilometers across and 1000 kilometers away.

Herculina may not be the only asteroid so honored. The idea that minor planets could have satellites was first conjectured as long ago as 1901. Several astronomers in the 1920's and 1930's made observations that seemed to indicate that the large minor planets Eros and Pallas have companions. In recent years those reports have been confirmed by other observers watching those asteroids occult stars.

Asteroids could be troublesome little bodies. When the first two *Pioneer* space craft went out toward mighty Jupiter, they had to pass right through the asteroid belt, and there was serious fear that they might be destroyed colliding with a chunk of cosmic debris. Luckily that did not happen—there may be fewer very small asteroids than we once thought—but a hit from a sizable piece of rock would destroy any probe in a fraction of a second. We can only hope a means of protection more reliable than luck will be devised before human beings start to invade those perilous regions.

We will, of course, go there someday. ☐

but my guess is that the sides are mostly aluminum and the flat end is mostly silicon.'

I said, "Do you mean the thing is a solar battery?"

"Part of it is. That's how it gets its energy in space, energy to get to Computer-Two, energy to eat a hole into it, energy to—to—I don't know how else to put it. Energy to stay alive."

"You call it alive?'

"Why not? Look, Computer-Two can repair itself. It can reject faulty bits of equipment and replace it with working ones, but it needs a supply of spares to work with. Given enough spares of all kinds, it could build a Computer just like itself, when properly programmed—but it needs the supply, so we don't think of it as alive. This object that entered Computer-Two is apparently collecting its own supplies. That's suspiciously lifelike."

"What you're saying," I said, "is that we have here a micro-computer advanced enough to be considered alive."

"I don't honestly know what I'm saying."

"Who on Earth could make such a thing?"

"Who *on Earth*?'

I made the next discovery. It looked like a stubby pen drifting through the air. I just caught it out of the corner of my eye and it registered as a pen.

In zero-gravity things will drift out of pockets and float off. There's no way of keeping anything in place unless it is physically confined. You expect pens and coins and anything else that finds an opening to drift wherever the air currents and inertia lead it.

So my mind registered "Pen" and I groped for it absently and, of course, my fingers didn't close on it. Just reaching for something sets up an air current that pushes it away. You have to reach over and sneak behind it with one hand, and then reach for it with the other. Picking up any small object in mid-air is a two-hand operation.

I turned to look at the object and pay a little more attention to retrieval, then realized that my pen was safely in its pouch. I felt for it and it was there.

"Did you lose a pen, Joe?' I called out.

"No."

"Anything like that? Key? Cigarette?"

"I don't smoke. You know that."

A stupid answer. 'Anything?" I said in exasperation. "I'm seeing things here.'

"No one ever said you were stable."

"Look, Joe. Over there. Over there."

He lunged for it. I could have told him it would do no good.

By now, though, our poking around in the computer seemed to have stirred things up. We were seeing them wherever we looked. They were floating in the air-currents.

I stopped one at last. Or, rather, it stopped itself for it was on the elbow of Joe's suit. I snatched it off and shouted. Joe jumped in terror and nearly knocked it out of my hand.

I said "Look!"

There was a shiny circle on Joe's suit where I had taken the thing off. It had begun to eat its way through.

"Give it to me,' said Joe. He took it gingerly and put it against the wall to hold it steady. Then he shelled it, gently lifting the paper-thin metal.

There was something inside that looked like a line of cigarette ash. It caught the light and glinted, though, like lightly woven metal.

There was a moistness about it, too. It wriggled slowly, one end seeming to seek blindly.

The end made contact with the wall and stuck. Joe's finger pushed it away. It seemed to require a small effort to do so. Joe rubbed his finger and thumb and said, "Feels oily."

"Fortunately these things are easy to kill now while they're forming. Later on they will grow, thicken their shells, and as spores, prepare to drift for a million years. They might not be easy to kill then."

The metal worm—I don't know what else to call it—seemed limp now after Joe had touched it. It didn't move again.

I was twisting and turning, trying to look at myself.

"Joe," I said, "for Heaven's sake, have I got one of them on me anywhere?'

"I don't see one," he said.

"Well, *look* at me. You've got to watch me, Joe, and I'll watch you. If our suits are wrecked we might not be able to get back to the ship."

Joe said, 'Keep moving, then."

It was a grisly feeling, being surrounded by things hungry to dissolve your suit wherever they could touch it. When any showed up, we tried to catch them and stay out of their way at the same time, which made things almost impossible. A rather long one drifted close to my leg and I kicked at it, which was stupid, for if I had hit it, it might have stuck. As it was, the air-current I set up brought it against the wall, where it stayed.

Joe reached hastily for it—too hastily. The rest of his body rebounded as he somersaulted, one booted foot struck the wall near the cylinder lightly. When he finally righted himself, it was still there.

"I didn't smash it, did I?"

"No, you didn't," I said. "You missed it by a decimeter. It won't get away.'

I had a hand on either side of it. It was twice as long as the other cylinder had been. In fact, it was like two cylinders stuck together long-ways, with a constriction at the point of joining.

"Act of reproducing,' said Joe as he peeled away the metal. This time what was inside was a line of dust. Two lines. One on either side of the constriction.

"It doesn't take much to kill them,' said Joe. He relaxed visibly. "I think we're safe."

'They do seem alive,' I said reluctantly.

"I think they seem more than that. They're viruses—or the equivalent."

"What are you talking about?'

Joe said, "Granted I'm a computer-technologist and not a virologist—but it's my understanding that viruses on Earth, or "downstairs" as you would say, consist of a nucleic acid molecule coated in a protein shell.

"When a virus invades a cell, it manages to dissolve a hole in the cell wall or membrane by the use of some appropriate enzyme and the nucleic acid slips inside, leaving the protein coat outside. Inside the cell it finds the material to make a new protein coat for itself. In fact, it manages to form replicas of itself and produces a new protein coat for each replica. Once it has stripped the cell of all it has, the cell dissolves and in place of the one invading virus there are several hundred daughter-viruses. Sound familiar?"

'Yes. Very familiar. It's what's happening here. But where did it come from, Joe?"

'Not from Earth, obviously, or any Earth settlement. From somewhere else, I suppose. They drift through space till they find something appropriate in which they can multiply. They look for sizable objects ready-made of metal. I don't imagine they can smelt ores."

"But large metal objects with pure silicon components and a few other succulent matters like that are the products of intelligent life only," I said.

"Right,' said Joe, "which means we have the best evidence yet that intelligent life is common in the universe, since objects like the one we're on must be quite common or it couldn't support these viruses. And it means that intelligent life is old, too, perhaps ten billion years old—long enough for a kind of metal evolution, forming a metal/silicon/oil life as we have formed a nucleic/protein/water life. Time to evolve a parasite on space-age artifacts.'

I said, 'You make it sound that every time some intelligent life-form develops a space-culture, it is subjected before long to parasitic infestation."

"Right. And it must be controlled. Fortunately, these things are easy to kill, espe-

cially now when they're forming. Later on, when ready to burrow out of Computer-Two, I suppose they will grow, thicken their shells, stabilize their interior and prepare, as the equivalent of spores, to drift a million years before they find another home. They might not be so easy to kill then."

"How are you going to kill them?"

"I already have. I just touched that first one when it instinctively sought out metal to begin manufacturing a new shell after I had broken open the first one—and that touch finished it. I didn't touch the second, but I kicked the wall near it and the sound vibration in the metal shook its interior apart into metal dust. So they can't get us—or any more of the computer—if we just shake them apart, now!"

He didn't have to explain further—or as much. He put on his gauntlets slowly, and banged at the wall with one. It pushed him away and he kicked at the wall where he next approached it.

"You do the same," he shouted.

I tried to, and for a while we both kept at it. You don't know how hard it is to hit a wall at zero-gravity, at least on purpose, and do it hard enough to make it clang. We missed as often as not or just struck a glancing blow that sent us whirling but made virtually no sound. We were panting with effort and aggravation in no time.

But we had acclimated ourselves. We kept it up and eventually gathered up more of the viruses. There was nothing inside but dust in every case. They were clearly adapted to empty, automated space objects which, like modern computers, were vibration-free. That's what made it possible, I suppose, to build up the exceedingly rickety-complex metallic structures that possessed sufficient instability to produce the properties of simple life.

I said, "Do you think we got them all?"

"How can I say? If there's one left, it will cannibalize the others for metal supplies and start all over. Let's bang around some more."

We did until we were sufficiently worn out not to care whether one was still left alive.

"Of course," I said, panting, "the Planetary Association for the Advancement of Science isn't going to be pleased with our killing them all."

Joe's suggestion as to what the P.A.A.S. could do with itself was forceful, but impractical. He said, "Look, our mission is to save Computer-Two, a few thousand lives and, as it turned out, our own lives, too. Now they can decide whether to renovate this computer or rebuild it from scratch. It's their baby."

"The P.A.A.S. can get what they can out of these dead objects and that should be something. If they want live ones, I suspect they'll find them floating about in these regions."

I said, "All right. My suggestion is we tell Computer Central we're going to jerry-rig this Computer and get it doing some work anyway, and we'll stay till a relief is up for main repairs or whatever in order to prevent any reinfestation. Meanwhile, they'd better get to each of the other Computers and set up a system that can set it to vibrating strongly as soon as the internal atmosphere shows a pressure drop."

"Simple enough," said Joe, sardonically. "It's lucky we found them when we did."

"Wait a while," said Joe, and the look in his eye was one of deep trouble. We didn't find them. *They* found *us*. If metal-life has developed, do you suppose it's likely that this is the only form it takes?

"What if such life-forms communicate somehow and, across the vastness of space, others are now converging on us for the picking. Other species, too, all of them after the lush new fodder of an as-yet untouched space culture. *Other* species! Some that are sturdy enough to withstand vibration. Some that are large enough to be more versatile in their reactions to danger. Some that are equipped to invade our settlements in orbit. Some, for the sake of Univac, that may be able to invade the Earth for the metals of its cities.

"What I'm going to report, what I must report, is that we've been *found*!" ∞

FUTURE DRUGS

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Organisms are born with such notions.

"On the other hand, destruction of tissue would be bad. Hunger would be bad. These are values in terms of survival of the species, and species that didn't incorporate these values would die out. Now the problem is, how do these values get translated into everyday experience?

"I like to think that the biogenic amines are the systems that mediate between these values, and that moods are the subjective counterparts of the biological processes by which various new experiences are evaluated, coded, and stored with an appropriate value—good or bad.

"It is not by accident that with the things that are good for the species, we have pleasure, and with things that are bad for the species we have pain. It's conceivable that with pleasure you have one kind of profile of chemical substances released in the brain, and with pain you have another kind of profile in a kind of color coding."

In his inimitable fashion, Stanislaw Lem presents this same idea: "All perception is but a change in the concentration of hydrogen ions on the surface of the brain cells. Seeing me, you actually experience a disturbance in the sodium-potassium equilibrium across your neuron membranes. So all we have to do is to send a few well-chosen molecules down into those cortical mitochondria, activate the right neurohumoral-synaptic transmission sites, and your fondest dreams come true."

Lem's fantasy comes pretty close to reality for psychedelic drugs resemble natural neurotransmitters and can be used to manipulate moods and emotions. LSD and a number of similar drugs all have an indole ring, a basic structural unit that also appears in serotonin.

Mescaline is closely related to the natural catecholamines norepinephrine and epinephrine (adrenalin). The drugs interact with their analogous neurotransmitters, stimulating or inhibiting their activity at the synapses. For example, LSD and related drugs, chemical cousins of serotonin, appear to inhibit the utilization of serotonin in certain areas of the brain, releasing it from serotonin-imposed inhibitions.

Arnold Mandell, a pioneer tester of the new drugs and a brilliant biochemical psychiatrist to whom we owe many of our new insights into the mind, believes that the new emotion-enhancing and behavior-improving agents act by holding down man's ancient and primitive "reptilian" brain while bringing out the best in the new cortex. A crocodile's or a frog's mere knob of a brain typifies the reptilian brain's limitations. This brain, the antecedents of which go back perhaps 200 million years, is located mainly in the brain stem and controls such basic instinctual mechanisms as courting, mating, and selecting homesites. It also controls such reflex activities of the body as muscular motion and glandular function, the flow of blood and the beat of the heart.

Mammals developed an increasingly more elaborate mesolimbic, or middle brain that encloses the old reptile within us. The middle brain controls the senses of smell and taste, supervises activities inside the body, and directs emotions.

On top of the middle brain is man's upper brain, the neocortex, which makes man unique. It allows abstract thinking, anticipation, problem solving, writing, and speech.

Mandell vividly describes the haunting contrast between these different levels of the human mind:

"The reptilian brain, when aroused, when allowed to express itself, is aggressive, competitive, suspicious, angry, bound by territorial limits, and insensitive to new input. It's the brain of the groin psychologists—Freud, Darwin, and Marx—tablishing dominance over that country. It's the cultural deification of the Marines, of macho and of pro football. It's the killer brain whose ecstasy is winning—a triumph that may involve the humiliation of others.

"The other, newer system in the brain we visualize more in terms of perceptual arousal. It is not bound by territory but is free to float. It is sensitive to new input. It is much more interested in beauty than triumph. The ecstasy of that system is insight or discovery."

Mandell, with an independent California drug designer, Alexander T. Shulgin, has been investigating whether creativity can be enhanced with derivatives of the hallucinogenic drugs. In his drugs, Shulgin combines some of the chemical features of mescaline with a side chain of amphetamine. A highly intuitive man, Shulgin has come up with some psychopharmacological bombshells.

"A number of materials I have been working on," he says, "are amplifiers of specific senses that will enhance the visual, the interpretive color sense, or the auditory acuity without blanketing the entire body with intoxication and confusion."

Whereas amphetamine typically strengthens the fixed patterns of response that characterize the reptilian brain—a student on amphetamine once happily counted cornflakes all night in a lab—Shulgin's drugs release the creative part of the brain from serotonin-imposed inhibition. The new drugs are effective in much lower doses than hallucinogens such as LSD and mescaline, and they can be administered in a wide range of doses without inducing hallucinations and the frightening dissolution of individuality that LSD can cause.

LSD doses are measured in millionths of a gram. An amount of LSD equal to an aspirin tablet is enough to produce effects in three thousand people.

An intense man with a leonine mane of prematurely gray hair, Shulgin began to design his remarkable drugs more than a decade ago. He is a Ph.D. pharmacologist who had worked for a big chemical company. On his own, he soon began to devise drugs with such specific action that his skills amazed psychiatrists.

His early drugs had to be tested behind the scenes. Testing such experimental drugs on human volunteers is easier abroad than in this country, so Shulgin supplied some of his early drugs to Claudio Naranjo, a psychiatrist at the University of Chile. Testing one early Shulgin drug on student volunteers, Naranjo found that the students' thinking and emotions were enhanced, without the perceptual distortions of hallucinogens. Hallucinogens depersonalize a drug taker (he often feels a sense of oneness with the universe), but Shulgin's drugs intensify a person's awareness of self without loss of contact with the environment or distortions in thinking.

Enhancement of creativity with the new drugs is one of the exciting areas being explored by Shulgin and Mandell. On the face of it, creativity would appear to be one of the most complex human functions, but it turns out that it is one of the most easily stimulated. Shulgin's compounds produce a feeling of newness or novelty in an old situation. Rats tested for habituation (in this instance their ability to get used to air puffs blown at them by a special device) react to each puff as if it were the first.

Tested on students, one Shulgin drug produced a striking improvement in their writing ability. Although amphetamine increases the amount of writing, it usually becomes vacuous and repetitious. "When you give a Shulgin compound," says Man-

"A number of materials I have been working on," says Shulgin, "are amplifiers of specific senses that enhance the visual, the interpretive color sense, or auditory acuity . . . without intoxification."

dell, "the writing will be long but it will have beauty and detail."

Shulgin is working with the part of the mescaline molecule that produces inhibition of habituation, or stops a person from getting used to familiar things. A Shulgin drug called DOET makes the subjects relaxed and receptive to new ideas without hallucinogenic effects. Recalled a student volunteer who took a series of tests after ingesting a small dose of DOET: "I was quite aware that I was being impatient with the tests, but I still wanted to do well. I was consciously trying not to rush through just to get it done, whereas if I had taken LSD, I would have just said to hell with every thing."

A number of sophisticated social scientists, including anthropologists and psychiatrists, have taken Shulgin compounds and described several kinds of enhancement they experienced: new insights, attention to previously unnoticed aspects of a situation, perception of new problem-solving possibilities, and a marked gain in creative capacity. People *have* tried to solve problems under the influence of LSD and other hallucinogens, of course, but those drugs are such commanding mistresses that their users soon get distracted by the drugs' effects.

Interestingly, Shulgin himself has gained new insights into drug design by taking his own creativity drugs.

"When you address yourself to a problem under the influence of a drug, you take hold of the problem by the lower-left-hand corner, so to speak—where you have never taken hold of it before. You find it's not a direct approach to a problem. It's almost like a derivative approach *to* the approach of solving the problem.

"You begin to analyze the reasons why you have a hangup. Rather than approach the problem in the classic way you already had, you find that your reasons for approaching the problem are often more important than the reasons for solving it.

"It's as though you had a neurological capability wired into the brain—something that Ma Bell had tucked away in her computer, and you just have no way of dialing in because the neurotransmitters are not at hand, they are not mobilized, they are suppressed, or something is amiss. The drug catalyzes it."

Of course, these drugs don't make a clod suddenly creative. Shulgin tried them on a small group of not particularly creative people and failed to get any response. "You are not seeing the emergence of creativity *de novo*," he says, "but you are allowing its organization in a person who should and could have it organized but does not because of a blockage or intuitive blindness. You can't design a pill that will write a play in a man's head." Adds Mandell, "When you re-create the first-time freshness in an old, experienced hand, then you've got creativity."

The finding that dullards cannot be made creative with drugs is in keeping with the discoveries of modern neuroanatomy that the brain is tied together as a network and that a person uses all of his brain. "The old mythology that human beings are using only some percentage of the brain is nonsense," says Gary Lynch, a young neurophysiologist at the University of California's Irvine campus. "A chimpanzee—whose brain most closely resembles man's—is not going to learn to read, and there is no drug on earth, I think, that will do that."

But *there* are distinct chemistries underlying attention and intention, separation and loss, mastery and coping, and such components of behavior can be influenced with drugs. Moving in this direction, Shulgin synthesized a new kind of antidepressant. Unlike commonly used antidepressants, Shulgin's compound, a variant of mescaline, is not a stimulant to normal people.

"But in a person who is demotivated, acting below his usual capacity," Shulgin says, "the drug brings that person back to his normal motivation." The compound is in the final stages of testing by a big drug company and has a good chance of becoming a commercial antidepressant.

Shulgin calls another of his drugs a low-calorie martini. In designing it he tried to duplicate the exhilarating effects of the first or second drink—and stop there. He thinks he has succeeded with a drug that acts in about 15 minutes and whose relaxing effects last an hour or two. The drug has no caloric value and none of alcohol's damaging effect on the liver.

In designing such specificity into drugs, Shulgin takes advantage of emerging skills in extra-fine modification of molecular structures. It has become clear that extremely small changes in molecular structure can cause dramatically wide shifts in biological action.

Drug designers are beginning to tailor drugs to the tiny receptors on the surfaces of cells. A receptor accepts specific substances that fit a receptor's particular shape. These substances cause the receptor to transmit an appropriate signal into the interior of the cell. A search is on for receptors for all sorts of feelings, emotions, and aspects of behavior. Drugs can then be designed to fit the particular receptors, either to evoke the desired behavior or to block undesirable behavior. Says Shulgin, "The time will come when we'll separate all our senses and capabilities—the visual from the auditory, the tactile from the sense of smell as well as wit, intellectual capability, creativity—and enhance them with drugs."

Application of the new mind drugs so far is just a small beginning. Dr. Mandell and others see a legitimate use for the new drugs to ease the pain of separation or divorce, to allow people dying prematurely

from incurable diseases to face death with equanimity, even to eliminate an employee's fear of the boss. "Objections to such boosts in emotion or behavior," says Mandell, "could only come from people who feel that medicine must taste bad to do good."

To this list of applications Nathan Kline, a pioneering psychopharmacologist and director of the Rockland, New York, State Hospital, adds other intriguing possibilities: prolonging childhood so as to increase acquisition of knowledge and skills, reducing or even circumventing the need for sleep, provoking or relieving guilt to treat criminals, among others; shortening or extending experienced time to enhance appreciation of music, for instance, and, conversely, to speed up the passage of undesirable events.

How soon such drugs will be made available legally is another question. "There is no social, scientific, or medical apparatus for optimizing normal human behavior," says Dr. Mandell. "I think it will take decades because there is no aegis in our society for introduction of performance or life-improving drugs. Under whose aegis could we administer a creativity drug, for instance? It isn't that you're sick, so no doctor can give it you. There is a wall against all this work."

A strange dichotomy that exists in social customs could be a serious barrier to the introduction of mood-control medications. There is a widespread belief, for instance, that use of drugs in a social setting is bad. On the other hand, use of alcohol in such a setting is considered proper. In drug use a lone-wolf user is tolerated for his idiosyncrasies, but a lone-wolf alcoholic is frowned upon.

It's not that scientists such as Mandell and Shulgin advocate a Brave New World society *à la* Huxley or Lem. (Huxley's drug in *Brave New World* was soma: "One cubic centimeter cures ten gloomy sentiments.")

In contrast, Mandell and Shulgin see use of the new mind drugs as being only episodic, say, by busy people who don't have time to exercise or run, those forms of exercise can automatically induce some of the euphoric effects produced by drugs. They argue, though, that research should be pursued if for no other reason than to head off the appearance of illicit drugs in this field, which may have dangerous side effects.

To find ways to minimize or eliminate the hazards, and to identify and develop the constructive potential of these powerful agents, would be a worthwhile task. The alternatives are not attractive. Sooner than anyone suspects, the lack of a mechanism to introduce such drugs might create difficulties for society whose dimensions will make the mind drug revolution we've already gone through seem like a minor conflagration by comparison. ☒

THE PRIZE

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things, this provides research funds for special University of Texas research centers such as the one on Astrophysics headed by John Wheeler and another one directed since the late 1960's by one Ilya Prigogine. In 1977, the Legislature sliced the "organized research" item exactly in half.

Prigogine is your average Texan who was born in Russia before the Revolution and who gained his credentials in physical science in Belgium. Since the late 1960's, he has split his time between research posts in Austin and Brussels. By 1977, however, he was worried. His funds were vanishing in both spots. No one cared that his thermodynamical theories were filling links in evolution that Darwin missed—explanations as to how inert chemicals in the earth's primordial atmosphere might combine into complex structures, and into life forms.

What saved Prigogine's research money was winning the Nobel Prize in Chemistry in 1977.

If the good old boys in the Legislature had known of the High Swedish Profile, they might have put all their leftover campaign funds on Prigogine's steel gray head. Seldom has there been such an obvious winner. Prigogine is on Garfield's top 250-list, is a member of the Swedish Royal Academy, and has received awards from Britain's Royal Society.

THE SWEDISH WONDER No Prize candidate anywhere is as Swedishly visible as Sune Bergstrom. The lanky paragon of Scandinavian biological wisdom was once dean of Stockholm's Karolinska Institute, the country's leading medical school, and at the same time chairman of the Nobel Physiology/Medicine Prize Committee. After retirement several years ago, he was named chairman of none other than the umbrella institution that administers and finances the Prize, the Nobel Foundation. Indeed, that might have blown his chances for a win—he was too close to the Nobel machinery to receive the Prize and still preserve the cherished Swedish reputation for objectivity—but that situation has changed.

The Bergstrom specialty is an extremely potent class of hormones called prostaglandins, first detected in the genital tissue of sheep. His mentor, Professor Ulf von Euler—who won the Prize for his work on neurotransmitters in 1970 (41 years after *his* father won it)—was apparently the first to note its biological activity. Von Euler applied it to strips of smooth muscle (uterine tissue) and noticed it caused them to contract. He urged Bergstrom to study it further, isolate the essence of the contractile factor from its surroundings, determine its chemical structure and the way it works.

Hot field? As Bergstrom told me in 1971, "This is the biggest thing in years."

If you are a right-to-liter, you won't like the first major clinical use that prostaglandins were put to—inducing contractions in the human uterus, producing abortion. However, you should go for prostaglandins' biggest potential—expanding arteries and blood vessels to relieve high blood pressure and all manner of cardiac ailments. Anything that promises the taming of the nation's leading killer has to be "the biggest thing in years."

THE SWEDISH NOISE FACTOR One way to eliminate yourself from the Nobel Prize running is to become involved in scandal or simply appear as though you are trying for the Prize. The austere Swedish message is to shut up, do your science, and keep your nose clean. The best shut-up example in recent years was the late Georg von Bekesy, a Harvard expert in the mechanics of hearing. As Harvard's Konrad Bloch (who won the Prize in Physiology/Medicine in 1964) recalled: "Von Bekesy had no professional appointment here. His psycho-acoustics lab was hidden away in the basement of Memorial Hall. No one here knew of his existence until he won the Prize."

No one but the Swedes. Von Bekesy, it seems, had been a researcher at Sweden's prestigious Karolinska Institute.

I once thought that Swedish Prize-selection knowledge and records might make up Western culture's most complete archive of value judgments in esoteric but infinitely important knowledge. I believed Swedish wisdom might make science education more pertinent.

"Ha!" commented Arne Karsberg, science writer for the leading Stockholm daily *Dagens Nyheter*. "I've seen their records and they don't amount to much more than the average newspaper morgue. You want to learn how to judge science? Go to your own National Institutes of Health or the National Science Foundation or the (then) Atomic Energy Commission."

As time went on, more and more Laureates—even judges—told me I was trying to snare the wrong owl. Institutional factors, set down in Nobel's will and in the Nobel Foundation's statutes, saw 'science' as composed of nothing more than classical chemistry, physics, and physiology/medicine. (Forget mathematics, much of astronomy, computers, plate tectonics, social sciences, etc., as well as any discovery achieved by more than three researchers.)

Perhaps the most telling comment on the condition of the Prize comes from Sten Lindroth, vice-president of the Royal Swedish Academy of Sciences: "Sweden's major exports are the Nobel Prize and nude women," he said. "Both are good propaganda for Sweden." ☒

KILNS

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What might have been rails, or steel shining, was only dew on ground-running tendrils reflecting the light of the moon, or reflecting the kiln-flames from the Valley itself. Beneath vines, beneath wind-blown gorse, I sensed there were only incredibly ancient rows of crude bricks which of their own weight and a thousand years of rain, were sinking inexorably into the earth from whence they came.

Stupefied, unable to speak, I set down on a low turtle-shaped mound of pottery shards—said nothing at all. As in a moment of vision, all the things heretofore not known or taken on faith in all my life seemed suddenly to become clear. In that terrible moment, I came truly to light. I understood. After this knowledge there was no forgiveness.

I looked up. I intended to share with her my revelation.

In her face I saw something both significant and terrible. She was sitting erect, smiling. Her face in the moonlight was full of another kind of wonder, an expression I knew too well. Although she saw what I saw, her mind, her imagination, was different. She had never been on the high escarpments. Therefore I understood she did in fact see "railroad yards." She saw what she had to see: docks, barges, and long lines of freight cars rolling. Her faith was absolute; she had never seen her own face burning like a rose inside a kiln. Only because of me she had come here, because of love—and that was enough.

Perhaps we might have returned the way we came. With good fortune, I might have lived out life in the kilns, silent, an outcast because of my fetal knowledge, awaiting my final years as a toothless, muttering grader of shards. Perhaps her spirit really was the spirit of the cedar forests, perhaps there was Justice after all, in the pattern of our loin cloths.

But we did not turn back.

I pointed ahead to a low notch in a wall, and to the dark canyon of stone beyond.

With impulsive, almost childish glee, with her long, black hair blowing in the first wind of morning, she took my hand. She raised me to my feet. She laughed and I laughed and as we ran the longest journey of our life began.

The sun rose. As we paused for the last time to look back, far away and far below, I saw the high escarpments turn for one moment into the flame.

The path leading always upward took us between flowers and across the first high-mountain meadow. There in a grove of sweet, low-growing pines for the first time, we made love and then slept in each other's arms until the sun was overhead. OO

SHROUD

CONTINUED FROM PAGE 95

team's conclusion is that whatever process formed the image acted in varying degrees of intensity depending on how far the cloth was from the body. For example, they note that "the hair on the front of the image stands out in natural relief but on the back image appears compressed against the head, as it would for a reclining body on a hard surface." The image intensity on the Shroud is the same for the front and back—another unusual feature that argues against an information process that depended upon contact between cloth and body. Taken altogether, Jackson and Jumper report that "... three dimensionality implies that the image-forming process acted uniformly through space over the body, front and back, and even seemed to act independently of the type of surface, organic and inorganic, from which the image was generated."

At this point, all scientists involved agree that more information is desperately needed. Enne's photographs, though high quality, were obviously not taken with computer analysis in mind. When the American team goes to Turin, its first order of business will be to take a series of pictures using a variety of film and filters, including infrared, which will be particularly suitable for analysis. X-ray fluorescence also is high on the list of Turin experiments. Because all elements produce a characteristic emission line in the x-ray region of the spectrum, the team predicts that x-ray fluorescence will help to establish the chemical composition of the image, and whether the composition of the body is different from that of the presumed blood spots.

The diversity of experiments planned for Turin is limited on the one hand because all tests must be nondestructive (for obvious reasons, the Church will not permit scientists to take pieces of the cloth, though they may be able to gather surface particles in a microvacuum cleaner); furthermore, as of this writing, they will be allowed only 24 hours to conduct their tests and take their pictures, though they would like to have as much as two weeks. Still, the team is optimistic about collecting enough data for later analysis.

Many members of the American team seem content to wait for the date to come in, but others cannot resist predicting what the outcome will be. Ray Rogers believes the image is a "scorch," (like a scorch should, it fluoresces under UV light) and says that it may have been produced by "flash photolysis," an intense burst of light. Jackson and Jumper put it differently, but it amounts to the same thing: radiation. An intense burst of light. But where it came from, they can't say. OO

NEVER DIE

CONTINUED FROM PAGE 56

cycles—put them back in heat. He also has reactivated the ovarian cycles of the old females by feeding them L-Dopa (a dopamine stimulator also used in the treatment of Parkinson's disease), and hormones such as progesterone, epinephrine, and iproniazid.

The exciting thing about this evidence is that the old ovaries still work and can be started up again when the "clock" in the hypothalamus is turned back. The implications for women past the menopause are astounding.

Dr. W. Donner Denckla, Associate Professor of Medicine at Harvard's Thorndike Laboratories, thinks he's close enough to hear the death clock ticking. An intense youngish man with collegiate horn rims and a wry sense of humor, Denckla explained recently to the large audience at a life-extension conference in St. Paul sponsored by the University of Minnesota, that he has "one very strong candidate for the demise of mammals."

Denckla's rather spectacular theory is based on the idea that humans have a built-in mechanism, not for aging, but for death itself. He believes the process of dying is built into our childhood; it starts around age ten.

Denckla proposes that at puberty the pituitary starts releasing an exceedingly powerful hormone, which he calls by the artful acronym DECO (for decreasing O_2 consumption). 'This lovely little molecule,' he says, "wanders out and progressively throws a block between the body's cells and its circulating thyroxin," the thyroid hormone vital to normal metabolism. Death comes as it does to the Pacific Salmon—by flooding the body with the "death hormone"—only more slowly, so insidiously as to seem not the cause.

In his super-realistic laboratories, Denckla removes the pituitaries (from whence, presumably, issues the DECO) of older rats. And, after adding hormone supplements to their diets, in a matter of months the old animals regain much of their pubescent glory.

One big hitch in the Denckla plan is that, although the pituitary-less rats are rejuvenated to adolescent physiological status, their lifespan does not seem to be prolonged. They die on schedule. It is possible, then, that DECO may serve an important life function.

THE LONGEVITY CLOCK

Richard Cutler is a man with a big plan which, if it does not embrace all of the manifold theories of aging, is at least compatible with most of them. Cutler is looking, not so much for the causes of aging, as for reasons for the evolution of longevity. There is no genetic program for death, he thinks, but an open-ended potential for unlimited lifespan.

In charge of the Program on Comparative Biochemistry of Mammalian Aging, Cutler constructs his architectonic ideas from sources as eclectic as his background. Cutler personally evolved from a Colorado farmboy into a helicopter designer to a copter company owner at age 18. He discovered college a few years later and proceeded to get degrees in aeronautical and electrical engineering, in physics, and biophysics.

According to Cutler, the rate of aging might very well be regulated by relatively few genes, which we can discover and eventually control. He has reached this conclusion after carefully studying the evolution of long lifespan in humans. It seems that our lifespan increased so rapidly compared to our apelike ancestors that no more than a few genes could have changed during such a brief evolutionary period. Hence, Cutler concludes that only a few genes may control the rate of aging.

Slowing down the aging process doesn't have to be a formidable task. We already know much about what genetic controls are involved. The deceleration is likely to be achieved first by biochemical manipulation of the neuroendocrine system via the hypothalamus-pituitary controls and, later, when more is known, by genetic engineering. "The scenario," as they say,' remarked Cutler, "is that you'd take a child when he's young, administer hormones to slow down his development and give him an analogue in his food to stimulate anti-aging processes." A person might become sexually mature by 28, full grown at 45, and middle aged by 120.

"I think within ten years, depending on how much we concentrate on learning to manipulate the controls of development, the slowdown might be accomplished,' he predicts.

A trickier problem than slowing growth is maintaining the body's level of intrinsic wear and tear fighters, what Cutler calls "continuously acting antibiosenescent processes." These include free-radical scavengers, antioxidants, DNA repair and so forth. Genetic engineering of the regulatory genes is too complex at the present time, so Cutler found a short cut: trick the cells with something like an anti-aging vaccine. One could inject a bit of "fake aging" and the body would alter its level of protective enzymes to combat this fake aging antibody. It works on a similar principle as the smallpox vaccine.

One could pop a pill that would diffuse into the cells and fool them into thinking "Hey, we've got a lot of DNA damage." The cells, consequently, might raise the level of DNA repair enzyme to match the needs of a longer-lived organism. "We might be able to stimulate a whole battery of repair processes," Cutler speculates, "by inserting a highly damaged piece of DNA, with everything imaginable wrong with it. And all the repair mechanisms would be stimulated by the artifact. You don't even have to know how it works to use it."

LOOK OF THE FUTURE

Cutler, unlike many gerontologists, has been willing to speculate a bit on the nature of *Homo longevus*. He says: "My guess is that it would be best, not only to double man's maximum lifespan potential, but also to double his brain size. Although doubling size is not likely to improve the quality of the brain, it might provide a greater redundant capacity for neurons and their supporting cells, thereby, perhaps, delaying the onset of senility even further."

By reducing a person's growth rate by one-half and doubling the time for the brain's development and maturation (it's growth rate would remain the same as now, and only one extra division of cells is needed to double its size), one might grow up to be an adult who looked much like a 12-year-old of today in terms of body and brain-size proportion.

When will it happen? Science writer and author of the soon to be published *Life-Extension Handbook*, Saul Kent believes predictions are irrelevant. "It's inevitable, but the timing depends completely on the effort. I could give you a sliding scale in years before the breakthrough, depending on the effort put into it."

"If life-extension becomes a national priority like the space program," says Paul Segall, "if the Americans, the Russians, and the Japanese join hands, if there were a $200 billion assault on aging and death, this could produce dramatic results in five years. Just $200 billion, involving tens of hundreds of scientists, hundreds of thousands of technicians—in five years we'd have a program that would put such a dent in death we might wipe it off the face of the earth. And a program such as this would cost no more than these countries are now spending on the maintenance of old age homes."

At present, however, there is no clear cut directive for life-extension research. The House Select Committee on Aging is holding hearings on the advisability of funding life-extension research. But as one committee member admitted privately, 'we really don't know what we're doing. We don't know who to listen to.'

Although NIA Director, Dr. Robert Butler, has officially stated that life-extension research is a "priority of the NIA," this priority is not reflected in the Gerontology Research Center's $7-million share of the total 1978 NIA budget of $37.3 million. And the entire NIA budget, moreover, pales beside the National Institute on Cancer's $872 million for 1978. The irony is profound, especially as evidence mounts that

cancer is predominately an age-related disease. There may be no way to cure cancer without curing aging.

"A lot of resistance to life-extension comes in the form of questions about overcrowding the planet, population explosions, social security, jobs, etc.," explains F.M. Esfandiary, a normative philosopher who teaches courses at New York's New School For Social Research. "At its base the question is pathological. After eons of programming to accept death, we suddenly find we can conquer death. As we're getting closer to vanquishing it, people are getting up-tight—Elizabeth Kübler-Ross is a case in point. They are afraid to face the idea they can beat death. They are afraid to be disappointed. We still don't have the infrastructure for life, but in the demise of religion, guilt-orientation, and orthodoxy, we're moving toward a life-orientation."

So prolonged lifespan is inevitable. But is it advisable? "It is impossible to foresee what it will do to society," says Roy Walford. "I think it will be highly destabilizing, and I'm in favor of that."

Lots of senile tricentenarians? Not so, says Rolf Martin, biochemist from the City University of New York. Martin designed a "survival curve" projecting that the proportion of nonproductive oldsters actually will be reduced by two-thirds if lifespan is doubled. People would die of other things before they got senile.

The biggest argument for life-extension, in some minds, is that the actual "advancement of civilization"—that sacred cow of the Western world—is imperiled by the exponential rise in knowledge.

The solution so far has been specialization. But as we become more and more specialized, our ability to communicate to people outside our field diminishes. Our awareness narrows. Fewer people are gifted with the ability to put it all together. We may simply require more time to learn.

"We need to investigate why man's lifespan evolved in the first place," Cutler says. "Because that is what made man what he is today. A longer lifespan allowed man to make use of a larger brain, become more self-conscious, see the world and learn. It is difficult for me to see why a continuation along the same lines wouldn't result in more of the benefits that accrued in the first place.

"In reality, the slowing down and cessation of the evolution of a longer lifespan might have been an artifact, a negative by-product of increasing civilization, and was, in a sense, *abnormal*. Continued self-evolution of extended lifespan and intelligence is getting back to the biological norm—getting back on the road again."

Says Cutler: "If you ask me about the ethics of extending our lifespan along evolutionary lines, I must say that, if we do not evolve a longer lifespan—that is unethical." DO

DYSON
CONTINUED FROM PAGE 106

about speculative things are usually historians and sociologists and anthropologists and such people. One of the most interesting was a Brandeis professor named Frank Manuel, who's interested in the concept of Utopia and its history, and how it has been transformed through the centuries. Actually, he was studying *me* as an example of the modern utopian, so we had long sessions in which I would talk about space colonies and so on, and he would say Ah yes, that came out of such-and-such a German writer of the seventeenth century that I'd never heard of.

Omni. Do you think that 'a modern utopian' is a good description of you?

Dyson. Yes, in the sense of someone who imagines ideal societies. I certainly am.

Omni. And the colonization of space will open up chances for new Utopias, many different societies in the asteroids.

Dyson. Even many different kinds of humanity. I don't think humanity is going to be a single species much longer—maybe because of divergent evolution as we expand into space, and maybe sooner than that via genetic manipulation. Unless you enforce a total prohibition on genetic research—unless you effectively outlaw the study of biology—I think it's inevitable that people are going to want to make their children better than themselves, and the techniques to do that will be available in the next century.

I've recently been on a local committee formed to consider Princeton University's plans for recombinant-DNA research. Our official responsibility was just to assess the potential danger from a laboratory accident that might release dangerous organisms, but I found that everyone on the committee was more concerned about the steps beyond that. They were concerned with what are they going to do to *us*? It surprised me, because I had thought that only I worried about these things. And I think their concern is much more realistic than some of the comforting reassurances about how far away human genetic engineering is. It's nearer than we imagine.

And beyond that, there's a continuing social strain that can only increase. It's a tension between the idea that all men are brothers and the idea that every individual or group should be free to do its own thing. You see it in racial problems, in national and ideological conflicts. Conceivably, if you give people the choice of being brothers or going out into space, that could provide the impetus for colonization. It's very striking how often in the past a journey that looked like exile from one point of view has turned out to be an opportunity from another. DO

A fresh approach, a leap, of logic . . . an "Aha! experience."

GAMES

BY SCOT MORRIS

Games and puzzles have universal appeal. It seems that everyone is addicted to one kind of game or another, though which particular type will catch people's fancy is anyone's guess. Some folks can't wait to attack the daily crossword puzzle. Others have a private passion for mazes or anagrams. If you pose the question, "Mary is now twice as old as Ann was when Mary . . ." and before you finish, some people have pencil and paper at the ready. Say, "Train A leaves Philadelphia at 60 miles per hour . . ." and a few closet puzzle fanatics will whip out their pocket calculators and start punching in numbers.

These kinds of problems have never appealed to me. The drudgery and humility of 8th grade algebra class still haunt me: the memories are too fresh.

The puzzles I like can be solved without extensive computation. What they require is a fresh approach, a leap of logic, a sudden jump out of the usual linear problem-solving strategy into a new realm of insight. The best problems have a taste of the unexpected, a spare elegance, a pleasing symmetry. At first glance they appear impossible to solve. There just isn't enough information, it seems, or finding a solution will take hours of trial and error fiddling. You try all the "intelligent" approaches and nothing seems to work. You can't move forward so you move sideways. Then suddenly the answer comes. It hits you like a pie in the face. It's so simple, so elegant, that you wonder how you could have been so stupid to have missed it. This flash of insight is what psychologists call an "Aha! experience."

Below are ten of the best of these "breakout" puzzles. Each in its own way is a classic of its type. There are no trick answers. The solutions are all rigidly logical, but finding them requires the type of approach that Edward deBono has called lateral thinking. The way some people attack these problems is reminiscent of the way they go through life—always following the familiar path, accepting unspoken assumptions that restrict their freedom of movement and blind them to new, creative options. I'd like to say that if you can solve these breakout problems you can tackle anything that life might place in your path, but that, surely, would be overstating the case. After all, this is only a game.

1. Four volumes of *Shakespeare's Collected Works* sit on the shelf.

The pages of each book are exactly 2" thick, and the covers are each 1/8" thick.

A bookworm starts eating at page 1 of Volume I and eats through to the last page of Volume IV. What is the distance the bookworm covers?

2. Where does the "Z" go, above the line or below, and why?

A E F H I K L M N T V W X Y
B C D G J O P Q R S U

3. A wicked king amuses himself by putting three prisoners to a test. From a box containing five hats—*three red* hats and *two white* hats—he puts one hat on each prisoner, leaving the remaining two hats in the box. He informs the men of the total number of hats of each color. If any man can tell the color of the hat he is wearing, he will be set free, but if he answers incorrectly, he will be executed on the spot. (In other words, no guessing!)

The first man looks at the other two, scratches his chin and says, "I don't know."

The second man looks at the hats on the first and third man, furrows his brow, and finally says, "I don't know the color of my hat, either."

The third man is at something of a disadvantage—he is blind. But he is also clever. He thinks for a few seconds and then announces, correctly, the color of his hat.

What color hat is the blind man wearing? How did he know?

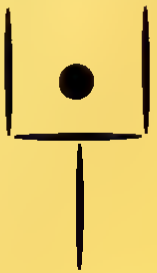
4. There is a definite pattern to this arrangement of designs. What's the next figure in the sequence?

5. On your journey to Alphaville, you come to a fork in the road. One road leads to Alphaville, the other to Betabury, but which is which? Seated by the intersection is an Indian dressed in traditional clothing that identifies him as a member of one of two tribes that dress alike. However, those in one tribe *always tell the truth* and those in the other tribe *always lie*. You may ask the Indian *one* question to determine which road to take to Alphaville. *What question do you ask?*

With two questions there would be no problem. You could ask, "Is this way up?" while pointing to the sky. The truth-teller would say yes, the Liar would say no. You then could ask, "Does the left road go to Alphaville?" and know whether to follow the man's answer literally or not. But you are only allowed one question. *What is it?*

Hint: After you are finally on your way to Alphaville, you still won't know which tribe the Indian belongs to.

6. Four toothpicks and a penny are arranged as shown, to schematically represent an olive in a martini glass. By moving only two toothpicks (and not the coin), can you create a new martini glass similar to the one you started with, but with the olive on the *outside*?



7 Can you move one match to produce a valid equation? (VI ≠ I—not allowed)

8 Can you arrange these *six* kitchen matches to form *four* equilateral triangles?

If you're like most people, you will start by arranging three matches in a triangle and then try in vain to get three more triangles out of the remaining matches. In this problem, as with previous ones, proper solution requires you to rise above the ordinary level-headed approach and seek its solution in a new dimension of thought.

9 Ten coins are arranged like this

Can you move just one coin to another position so that when added up either horizontally or vertically two rows of six coins each will be formed? (The problem is best solved with actual coins on a table.)

10 A curious sequence. What's the missing number here?
10, 11, 12, 13, 14, 15, 16, 17, 20, 22, 24, 31, 100, ____, 10000, and the curious final number 1111111111111111
Answers, page

SIGNS OF THE TIMES/A COMPETITION
In Europe, where language barriers often separate countries more sharply than political ones, wordless traffic signs have been commonplace for decades. "SCHOOL CROSSING." "NO U-TURN." "SLIPPERY WHEN WET." "NO LEFT TURN"—these and other messages have been reduced to simple, eloquently language-free international signs. Last year, in fact, France began erecting extraordinarily graphic signs depicting what it is that dogs—or at least Airedales, for that is what the silhouetted canine appears to be—may not do on the sidewalks.

The shrinking earth will require more and more language-free messages in the future. For example, how could one convey in symbols:
—Caution: Loud Noises
—Caution: Polluted Air (or Water)
—Marijuana Smoking Area (or No Marijuana Smoking)
—Caution: Laser Crossing
—Swimsuits Optional (or, Nudity Forbidden)
—Archaeological Dig in Progress
—Danger: Ultraviolet

The competition: Submit one design to convey any of the above messages, or any other communication that will be important in the future. Use the standard format of a generalized figure inside a circle, with a diagonal stripe to indicate any forbidden activity.

Draw your design at least two inches in diameter in black ink on white paper. Entries must be postmarked by Dec. 1, 1978. Neatness counts.
First-prize winner will receive $100.00.
Runners-up (2-10) will receive $25.00.

All entries become the property of *Omni* and will not be returned. Send entries to *Omni* Competition–1, 909 Third Ave., New York, N.Y. 10022. DO

THE OELPHIC POLL

Invented by the RAND Corporation, the Delphic Poll can help OMNI readers to predict the future, now.

BY DR. CHRISTOPHER EVANS

The future, lament its forecasters, is not what it used to be. Not too long ago, an intrepid visionary could safely venture predictions on, say sending men to the moon without fear of being proven right or wrong in his lifetime. But in this age of moon walkers and test-tube babies, little is beyond the realm of the possible. The future now becomes history in just a matter of moments—"Don't blink," as the big-city wag in the back seat used to warn before approaching Podunk (population 562), Iowa, "or you'll miss it."

But if the future is not what it used to be, neither are the men and women who earn their living predicting it. Throughout most of history, future predicting was confined to priests, astrologers, necromancers, conjurers, and other charlatans. There were no weather bureaus or stock exchanges; the only institutions devoted to studying the future were such divine sanctuaries as the Temple to Apollo at Delphi, considered by ancient Greeks to be the navel of the universe. There, the famous oracle was consulted not just by private citizens seeking power, wealth, or a better love life but also by kings and ministers on urgent affairs of state. In its heyday the Delphic oracle was always consulted, usually heeded, and sometimes even accurate. Among its most memorable prophecies was the prediction (2000 years before Freud invented the Oedipus complex) that King Oedipus of Thebes would murder his father and marry his mother.

Needless to say, all this has changed. Today's oracles are faceless think tanks, their priests the mathematicians and computer experts who man them. Predicting the future has been elevated (some might say "debased") to a science, so much so that its practitioners now debate what to call it—proposals range from *prognostics* (from the Greek for "foreknowledge") to *mellontology* (from the Greek for "future events") to *futures analysis*. But as these prognosticators or mellontologists debate their name they are also refining ever more accurate techniques for prediction. Technology *is* paring down the unknown.

Today's forecasts, like the cryptic messages of ancient oracles, are couched in ambiguous terms. Now, however, the ambiguities are mathematical; predictions are given as statistical probabilities. One of the most popular of these new techniques clearly acknowledges its debt (and similarity) to its mystical predecessors by naming itself after the oracle of Delphi. This Delphi method, or Delphic poll, was invented in the early years of the cold war by researchers at the Rand Corporation and was initially developed with defense funds to predict the probable effects of a massive atomic bombing attack. The researchers felt the need for a mathematical model, they later reported somewhat abashedly, because the subject did not readily lend itself to field experiments.

The Delphi method is a way of determining the consensus of experts in any given field. Generals are asked about military developments, engineers are asked about technological developments, and even narcotics agents are asked about crackdown results in some of the thousand-plus Delphic polls that have been conducted up until now. The experts' answers are usually interpreted by computer, carefully plotted on a graph as a neat statistical curve.

This method obviously has its strengths and weaknesses. One of the most glaring drawbacks is that it merely assembles the collective biases of a statistical mainstream—leaving little room for intuition, insight, or genius. But in practice its early predictions have enjoyed considerable success. Its estimates of nuclear damage, thank God, have never been put to the acid test. But Delphic polls have correctly predicted the year of the first heart transplant and foreseen that the population explosion would make the earth's underwater resources so valuable that nations would begin to stake territorial claims on them—a prediction given dramatic validity in the circus of rapacity that was last year's U.N.-sponsored International Conference of the Sea.

But despite the best efforts of mankind's assembled gray matter, the future remains essentially unknowable. The accelerating pace of change affecting every aspect of our daily existence has made "future shock" a permanent reality in our lives. Economist Kenneth Boulding put it in these striking terms: "I was born in the middle of human history to date, roughly. Almost as much has happened since I was born as happened before. The world of today is as different from the world in which I was born as that world is from Julius Caesar's."

Next year, next month, next week, tomorrow. Two hours from the moment you read these words. All these concepts remain in the realm of the unknown. The future that keeps bearing down on us—ever faster and more voluminously—remains an utter mystery. Can you really say what it holds in store for you? Be careful; the way you anticipate the future affects your every action in the here and now.

The crisis of an accelerating future has restored oracles to their former respectability. Economic indicators, military scenarios, weather reports, and pollsters govern our lives. As in ancient times, public prognosticators are always consulted and often heeded. But are they any more accurate than the oracles of ancient Greece?

In the spirit of healthy cynicism, *Omni* wants to find out if the so-called experts know any more about the future than you do. We want to disprove the old axiom about the world's most unpopular futurists: that everybody talks about the future but nobody ever does anything about it. We are asking you to fill out and mail to us the following Delphic questionnaire. You will be asked to make some predictions on scientific subjects, others on social trends, and still more on personal matters—you, after all, are the best expert on your own life.

At the same time, an independent panel of futurists (or prognosticators, mellonfologists, futurologists, futuristicists, futures analysts, or whatever they choose to call themselves) will be asked the same questions. The two sets of answers will be compiled and compared in a later issue. The answers, we amateurs can safely predict, should prove to be most revealing.

BEFORE TAKING PART IN POLL
PLEASE READ INSTRUCTIONS

Here is a list of possible events having far-reaching global consequences that many people believe could take place at any time within the next quarter of a century. Read each item carefully and decide if you believe it will ever take place. If you think it *will not*, then place a mark in the "Never" box. If you think it *will* take place, decide when it will most likely occur and put a mark in the appropriate box. Try to complete every item on the list. Remember that there are no "right" or "wrong" answers.

QUESTIONS	BEFORE 1980 (1)	1981-1984 (2)	1985-1989 (3)	1990-1994 (4)	1995-1999 (5)	2000 + (6)	NEVER (7)	
(1) First woman elected President of the USA	☐	☐	☐	☐	☐	☐	☐	(6-)
(2) Nuclear war breaks out between USA and USSR	☐	☐	☐	☐	☐	☐	☐	(7)
(3) US commits troops to Africa to counter Communist incursions	☐	☐	☐	☐	☐	☐	☐	(8-)
(4) Gasoline reaches 25 cents per liter	☐	☐	☐	☐	☐	☐	☐	(9-)
(5) First terrorist use of nuclear weapons	☐	☐	☐	☐	☐	☐	☐	(10)
(6) Return to pre-Sixties standards of morality and end of "Permissive Society"	☐	☐	☐	☐	☐	☐	☐	(11-)
(7) Manned landing on Mars	☐	☐	☐	☐	☐	☐	☐	(12-)
(8) First public "paying passengers" on orbital spaceflight	☐	☐	☐	☐	☐	☐	☐	(13-)
(9) Industrialization of space becomes important source of income	☐	☐	☐	☐	☐	☐	☐	(14-)
(10) Computer beats world (human) chess champion	☐	☐	☐	☐	☐	☐	☐	(15-)
(11) World shortage of animal protein makes meat too expensive for average American household to serve	☐	☐	☐	☐	☐	☐	☐	(16-)
(12) Contact made with intelligent extraterrestrial life	☐	☐	☐	☐	☐	☐	☐	(17-)

QUESTIONS	BEFORE 1980 (1)	1981-1984 (2)	1985-1989 (3)	1990-1994 (4)	1995-1999 (5)	2000 + (6)	NEVER (7)	
(13) A human being is successfully cloned	☐	☐	☐	☐	☐	☐	☐	(18)
(14) Extrasensory perception is accepted as fact by the majority of scientists	☐	☐	☐	☐	☐	☐	☐	(19)
(15) Average expectation of life is 100 years or more	☐	☐	☐	☐	☐	☐	☐	(20)
(16) Computers have 'self-awareness' and intelligence greater than humans	☐	☐	☐	☐	☐	☐	☐	(21)
(17) The majority of South American governments become Communist or Ultra-Left	☐	☐	☐	☐	☐	☐	☐	(22)
(18) Economic collapse of the West as predicted by Marxist commentators	☐	☐	☐	☐	☐	☐	☐	(23)
(19) Revolution in USSR leads to overthrow of existing regime and replacement by liberal "pro-West" government	☐	☐	☐	☐	☐	☐	☐	(24)
(20) Marriage as institution virtually disappears in USA with over 75 percent of babies born "out of wedlock"	☐	☐	☐	☐	☐	☐	☐	(25)

Finally, would you please complete the following questions about yourself. Please be assured that these responses are completely confidential and are used only for classification purposes.

1 In which age group are you?

Under 18	☐ (26-1)	35-44	☐ (5)
18-24	☐ (2)	45-49	☐ (6)
25-29	☐ (3)	50-64	☐ (7)
30-34	☐ (4)	65+	☐ (8)

2 At the present time are you employed?

Full-time (30 hours a week or more)	☐ (27-1)
Part-time (less than 30 hours a week)	☐ (2)
Not employed (indicate status)	☐ (3)
Student	☐ (4)
Housewife	☐ (5)
Other	☐ (6)

3 If employed, what is your job title or position (please be specific)

_____ (28)(29-)

4 What is the nature of your firm's business? If self-employed please give your professional or occupational status. (Please be specific, e.g., engineering firm, law firm, insurance firm, etc.)

_____ (30-)(31)

5 Please check the last level of school you completed

Some high school or less	☐ (32-1)
Graduated high school	☐ (2)
1-3 years of college	☐ (3)
Graduated College	☐ (4)
Graduate or professional training after college	☐ (5)
Educational degrees if any _____	☐ (33-6)

6 Please indicate your total household income. This should include income from all sources for yourself as well as other members of your household with whom you are living.

Under $8,000	☐ (34-1)
$ 8,000–$ 9,999	☐ (2)
$10,000–$14,999	☐ (3)
$15,000–$24,999	☐ (4)
$25,000–$34,999	☐ (5)
$35,000–$39,999	☐ (6)
$40,000 or over	☐ (7)

7 Are you

Male	☐ (35-1)
Female	☐ (2)

Your completed Omni Delphic Poll should be sent to:

Department CR
OMNI Magazine
909 Third Avenue
New York, N.Y. 10022