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OMNI

JUNE 1979 $2.00

NEUTRINOS:
COSMIC BULLETS THAT COULD REVOLUTIONIZE COMMUNICATIONS

WHO OWNS THE PLANETS?
SPACE LAW COMES OF AGE

ASTRONOMY AS ART:
SOME OBSERVATORIES WORTH OBSERVING

MIND VS. NATURE:
THE OUTER LIMITS OF HUMAN POTENTIAL

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OMNI

JUNE 1979

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Cover art for this month's Omni is space artist Don Dixon's vision of our largest planet, Jupiter Seen from Io. Dixon, who now lives in California, has just completed animation work on a film for NASA. This cover marks his third appearance in Omni.

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"The concern, of course, is that if the fear spreads, there may never be another nuclear-power plant licensed in the United States."

It was a close call. When the first reports came in of the now infamous "accident" that occurred in March at the Three Mile Island nuclear power plant near Middletown, Pennsylvania, it seemed like something out of a novel—a reactor gone mad, lethal radioactive dust and gas spewing out over the countryside, thousands of people evacuating the area in panic. One could envision the science-fiction scenario: complete with the "Harrisburg Crater" cordoned off, guarded, completely abandoned except for roving bands of mutants. (The first fictional account of this incident should appear any day now, if it hasn't already.)

Luckily, it appears now to have been only a close call. The resulting fallout was not so much radioactive as political, but, nevertheless, it may yet prove to be lethal.

The Three Mile Island incident galvanized both critics and proponents of nuclear energy into action. For the critics, the accident at Three Mile Island provided a distinct advantage in the nuclear debate—fear. As Henry Kendall, president of the Union of Concerned Scientists, put it, "There were a number of people who were terrified, and that's a new component in the nuclear debate." The repercussions of this element of fear were felt throughout the country. At Columbia University in New York City, some 100 students staged a sit-in in Seeley W. Mudd Hall, the engineering building, demanding that the university's small, soon-to-be-activated nuclear reactor be dismantled immediately. The school's engineering faculty responded by declaring "a moratorium . . . that would forestall either activation or dismantling of the reactor." The professors stressed that they were not concerned about questions of safety but rather were "very concerned about the growing apprehension on campus and that this stress has reached serious dimensions." Dr. William J. McGill, president of the university, capitulated even further. "I cannot and will not agree to activation of the reactor while I serve as president," he said.

Proponents of nuclear power have recognized this growing fear and are scrambling desperately to assuage it. President Carter himself, donning his hat as a nuclear engineer, went to Pennsylvania to pump up public confidence. The concern, of course, is that if the fear spreads, there may never be another nuclear-power plant licensed in the United States.

The pro-nuclear position was stated by Walter Creitz, president of Metropolitan Edison, which runs the Three Mile Island reactor. According to Creitz, the nuclear industry has operated for 30 years "without a single nuclear-related injury, let alone death, to any member of the public . . . an enviable record for any technological industry."

Both sides of the nuclear debate have approached the Three Mile Island incident as though it were the most crucial event in the history of nuclear power. The critics see it as the realization of the dangers of relying on nuclear fission and, perhaps more important, as a crucial setback to the nuclear-power industry. Interestingly, not only the avowed activists in the antinuclear movement but a host of congressmen and senators—obviously seeing votes clustering around this issue—have mounted the soapbox. The pro-nuclear forces, of course, are running scared, and in the wake of the Three Mile Island accident are stressing the impending energy crisis and the necessity of building more nuclear-power plants to prepare for the day when the oil pumps finally run dry. Both groups are desperately trying to capitalize on the emotion of the moment.

Thus the real fallout from the Three Mile Island affair has been fear, and with it an outpouring of rhetoric rather than reason from both sides of the nuclear debate. From one camp we hear that nuclear power is inherently evil (which it isn't), while from the other we learn that nuclear power will ultimately solve most of mankind's problems (which it won't). Once again we are faced with a serious technological issue that will be decided by emotion, not by logic. It is perhaps the curse of our species.

Whatever the outcome, it appears that Three Mile Island has forced the issue. Before we make a final decision, we would do well to look back on the Wisdom of Solomon found in the Apocrypha—"for fear is nothing but a surrender of the helps that come from reason."

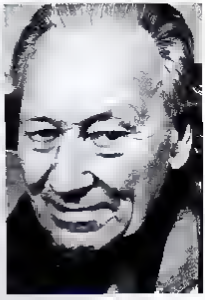
OMNIBUS


GRENIER


ANDERSON


ZELAZNY


ROB[illegible]


BATESON

We are at the Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois, where the world's largest particle accelerator is "making" neutrinos. What is a neutrino? Simply a mysterious subatomic particle that may reshape our total understanding of the universe, force a rewrite of all the textbooks on how the sun works, and perhaps provide a final explanation of the very nature of matter.

Producing neutrinos "in captivity" is a complicated and astronomically expensive business, but as *Hal Hellman*, author of more than 22 books on science, technology and physics, explains, it does have its practical advantages. "Someday neutrino radios, because of their superior penetrating power, may allow us to send messages straight through the center of Earth, or may provide a more rapid means of communication with inhabitants of other planets." The neutrino is the hottest story in physics to date. Catch "The Artful Dodger of the Physical World" on page 44.

Energy-intensive vs. energy-efficient. A heated debate has divided the agricultural community into two camps, each offering a conflicting view on the future of agriculture. *Alan Anderson*, a specialist in experimental agriculture, examines both sides in "Future Farming" (page 90). "There are two ways of thinking about the future," writes Anderson. "The high-technology bag—farming under bubbles and in skyscrapers, supertractors, vast soilless layouts, that sort of thing, and then there's the opposite view, low-technology—less meat, minimum tillage, and small machinery. Large vs. small. Whom are we supposed to believe?"

Space law to date has dealt primarily with earth-oriented legalities, ranging from communications satellites to product liability in the manufacture of space equipment. However, these issues pale when compared with the far more exotic legal principles and guidelines that will necessarily apply to long-duration manned missions, permanent space communities, and the environmental alteration of other planets, known as "terraforming."

Already a few pioneering attorneys have taken up the challenge of space law and are committed to the occupation of space as the next evolving phase in human destiny. *George S. Robinson*, the world's first attorney to receive a Ph.D. in space law, files a provocative report, "The Matter of Space Law," starting on page 76.

Philosopher-anthropologist-cybernetician *Gregory Bateson* offers some engaging thoughts in *Omni*'s excerpt of his latest work (see page 54), "Mind and Nature." Bateson challenges all of us to become more aware of the pattern that connects all living things, a subject he will discuss further in an exclusive upcoming *Omni* interview.

Considered one of the most respected science-fiction writers of the past 15 years, *Roger Zelazny* ("Halfjack," page 66) was born in Cleveland, Ohio, of Polish, Irish, American, and Dutch origins. Noted among other things for his sureness of style, Zelazny rose to prominence by winning two Nebula awards in the same year for his stories "He Who Shapes" and "The Doors of His Face, the Lamps of His Mouth."

In 1969 he wrote *Damnation Alley*, which was later released as a major motion picture by 20th Century-Fox. The cast was headed by Jan-Michael Vincent, George Peppard, and Dominique Sanda. Roger did want us to mention that the film bore little resemblance to the book. Other Zelazny novels under film option are *Lord of Light*, *The Dream Master*, *Sign of the Unicorn*, and *Courts of Chaos*.

George R. R. Martin ("The Way of Cross and Dragon," page 86) published his first science-fiction story in 1971. Martin has subsequently sold and published more than 40 pieces of short fiction, several articles, and two short-story collections. Winner of the Hugo Award in 1974 for his novella *A Song for Lya*, Martin was four times a finalist for the Nebula Award. He also won the Locus Award for *The Storms of Windhaven*, a novella published in 1975.

Finally, don't miss *Omni*'s exclusive pictorial on 20th Century-Fox's new science-fiction thriller *Alien*. Described as "the dark side of *Close Encounters*," *Alien* promises to be the smash hit of the year. Film correspondent *Cynthia Grenier*'s coverage begins on page 80. (Also see The Arts/Film, page 24.)

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U.K. & European Editions
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JUNE

LETTERS

COMMUNICATIONS

Science or God?

I would like to ask Saul Kent [Communications, February 1979] if he believes science is a subsfifute for God.

Mr. Kent's list of possible benefits resulting from a designed program of *in vitro* reproduction is quite horrifying to me. What makes him think that man has a right to "unlimited youth, intelligence, wealth, and access to the universe"?

Nature, God, or whatever one wishes to call that which controls us provides its own checks and balances and follows its own design. We, as humans, are not fully evolved, we are incapable of tapping our own total brain potential. To desire to control human evolution, using the limited human judgment of what is best for man, is nothing but folly.

Stacy Jannis
Providence, R.I.

UFO Challenge

How funny it is to read these endless literary debates concerning UFO research.

I have only two questions. If Ufology employs an indefinite number of experts, why hasn't over 30 years of investigation revealed a conclusive answer fo who, why, and what for?

Second, ever since 1948 investigators have been tiring hard photographic evidence toward the UFO skeptics, not fazing their stubbornness a fraction. I challenge you, Philip Klass, and you, James Oberg. What evidence do you possess that can convince me and the world that the UFO phenomenon is nothing but a case of swamp gas, weather balloons, or a wild human imagination?

Jeff Henry
Williamsport, Md.

Oberg replies: *Taking the second question first, it is a perversion of science to demand a skeptic to disprove anything, especially a topic so nebulous that you've got to ask that first question about it.*

Gale's Ark?

I don't mean to be pessimistic, but, as far as I can tell, civilization as we know it stands about a one-in-ten chance of surviving past the year 2000. So, while those of us who strive to ensure mankind's survival must by all means continue to do so, it perhaps behooves us to give serious consideration to the only other alternative should our efforts on this planet prove fruitless: exodus.

It seems unlikely that our governments will be of any assistance, preoccupied as they are with politics, finances, resources, and war. It is up to us.

Project Noah will certainly be vast, most likely expensive, but definitely not impossible. If you have anything fo contribute, from practical suggestions, through financial assistance, to your own person as a colonist, I urge you to contact me through this magazine. This appears to be a logical first step.

Tom Gale
Toronto, Ont., Canada

Impending Doom

In response to fiction editor Ben Bova's pitch for more money to NASA [March 1979], citing *Skylab*'s final failure, I would like to sfate that NASA was criminally negligent in sending up *Skylab* in the first place. If any space hardware cannot be made 1,000-plus-percent safe to all inhabitants of this earth, then it becomes outrageously irresponsible to launch it.

More money for NASA would not have changed this total lack of irresponsibility but probably would add more hardware with which to threaten mankind. NASA people responsible for this space bomb should stand in court for criminal negligence and crimes against mankind.

If conquest of space means possible disasters to mankind—anywhere, anytime—fhen let's not conquer space!

Howard Meyer
Little Neck, N.Y.

Behold the lowly turtle: he only makes progress by sticking his neck out! Seriously: Skylab's troubles come from totally unforeseen solar storms that heated the earth's atmosphere enough to reach Skylab in its "safe" orbit and drag it earthward. Nobody on Earth could have forecast that; the mission was completely

CONTINUED ON PAGE 133

DIALOGUE

FORUM

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

In Favor of the Hunt

I am disconcerted that your prestigious magazine appears to support the campaign against the seal hunt off the coast of Newfoundland [Continuum, February 1979]. This campaign is a classic example of good intentions run amok.

While it may be an overstatement to say that the federal government's regulation has completely eliminated the cruel practices of several years ago, they have certainly been drastically curtailed. To oppose the seal hunt per se is akin to opposing the "cattle slaughter" that provides us with our beef, or the "fish slaughter" off the east and west coasts of Canada and the United States.

The seal hunt is an important part of Newfoundland life. To terminate it would have serious social and economic effects. Not only does the seal hunt provide an important supplement to the meager incomes of many Newfoundlanders, but it also allows them to retain their independence and self-respect. Some people have proposed that a ban on the seal hunt should be accompanied by financial compensation to the hunters. This glorified form of welfare, where the men would be paid to sit around and do nothing, would open the door to the problems that emerge whenever welfare becomes a chronic part of life. Loss of self-esteem, alcoholism, and social instability are apt to be the "benefits" reaped from such a scheme.

I am concerned about the quality of our environment and the preservation of our wilderness areas. I believe that we need groups like Greenpeace to draw the public's attention to important issues and to apply political pressure for the changes and safeguards that are needed. However, in the case of the seal hunt, lack of consideration of all the factors involved has led to ridiculous protests, which undermine the credibility of such organizations as Greenpeace.

The campaign against the seal hunt reminds me of a sad chapter in Canadian history around the turn of the century. At that time the federal government had refused to sign treaties with Indians in northern Alberta. These Indians lived a traditional life-style of trapping, hunting, and fishing. Because treaties had not been signed, the Indians did not "qualify" for government aid in the form of medical care or emergency provisions when they were starving. Many died from starvation, and many more died from the diseases brought to this continent by the white immigrants (smallpox, tuberculosis, and measles).

At the same time that the Indians' pleas for help were ignored, the government decided that steps had to be taken to protect diminishing wildlife. A game reserve was created that took away the Indians' prime hunting grounds and an important source of food and clothing—the buffalo. Game laws were introduced regarding the hunting and trapping of other animals. All this was done without a care for the well-being of the Indians!

Now, I realize that opponents of the seal hunt do not desire such inhumane inconsideration for the Newfoundland sealers and their families. Nevertheless, the single-minded pursuit of the anti-seal-hunt campaign could very well have serious adverse repercussions on the quality of human life in Newfoundland.

There are many cases in the United States and Canada that need our attention, such as the hazards of nuclear waste disposal, the near-extinction of the peregrine falcon in the United States, and the chemical spraying of New Brunswick's forests for a quarter of a century to protect the trees (what about the people?). Let us not be sidetracked by a nonissue where more harm than good is apt to be the result of any further intervention.

Let the Newfoundlanders continue to eke out a living without unnecessary harassment from the world!

Daniel D. Horsman
Fredericton, N.B., Canada

Loves Free Enterprise

In the article "Planet Antarctica" [March 1979] Kenneth Brower states, "... it appears that our use of space will be pure exploitation. Mankind will not benefit from it, rich men will."

Under free enterprise, that's impossible. None will invest unless there will be a return, and there will be no return unless others find it beneficial.

We certainly cannot say that space programs to date have enriched the aerospace industry to the detriment of mankind.

Charles M. Hart
Cranford, N.J.

Specific Pain

Mr. J. B. Tucker's examination of the gains being made in the area of research on chronic pain in the February *Omni* [page 86] offers a vivid example of the most crucial problem facing modern medical science: a basic lack of lateral thinking. The current approach to control of chronic pain involves the attempts to block transmission of the signal by removing the factor responsible for its generation.

While information as to the psychological basis of pain has only recently come to light, we have long known that pain serves a specific purpose. Quite simply, pain informs us that a particular body system or tissue has been injured or has ceased to function in a proper fashion. Similarly, a smoke detector that sounds off during the night is informing us that a potentially dangerous fire has occurred. To remove the battery of the detector in an attempt to return to a pleasant dream would be illogical. It is just as illogical to interrupt any pain signal without correcting the situation that created the pain. To throw one's hands in the air in frustration and seek the comfort of painkillers is an injustice.

If we see pain as the major problem and

CONTINUED ON PAGE 134

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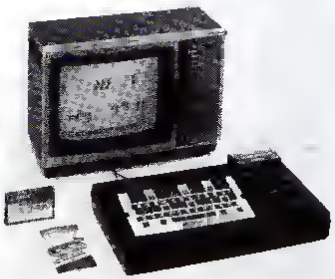

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PHOENIX OF CRESTED BUTTE

EARTH

By Kenneth Brower

In 1971 W Mitchell was driving to work—he was a gripman on the cable cars in San Francisco—when a truck hit his motorcycle The cap to his gas tank flew open, and the gas ignited Mitchell was, in his own words, "burnt up" For months his eyes were bandaged When the wrappings were removed, he found he could see Plastic surgeons rebuilt his face as best they could Mitchell taught the stubs of his hands first to hold cups and newspapers, then the controls of airplanes He learned to fly With the settlement money from the motorcycle crash he bought a Cessna 207 In 1975 taking off from the airfield at Gunnison, Colorado, Mitchell realized that his wings were icy He chopped power—he still had some runway left—but the plane came down too fast and crashed, breaking his back His legs paralyzed now he moved to Crested Butte, Colorado, a village of 1,000—few enough inhabitants that his face and wheelchair soon became familiar to everyone and ceased to draw stares

In 1977 a deposit of molybdenum valued at $7 billion was discovered under the mountain just west of his adopted home Later that year Mitchell rolled his wheelchair through the town's muddy streets campaigning for mayor with just one issue on his mind He spent $45 on advertising—a bold and unprecedented move in Crested Butte He won by 20 votes, a margin of victory greater, proportionately than Jimmy Carter's margin in 1976 In 1978 Mayor Mitchell, still a glutton for punishment, announced his intention to fight the giant mining corporation that wanted the molybdenum

Of his first accident the mayor of Crested Butte remembers nothing "The brain is too smart for that," he says He does recall his four months in the hospital, and the many months of helplessness afterward, and the slowly departing hypersensitivity of his hand stubs, and 20 sessions of plastic surgery (He could never grow accustomed to going under the knife) He does not remember being particularly depressed

Mitchell did a lot of walking An ex-Marine, on walks he wore his government-issue, wide-brimmed Smokey the Bear hat, in order to shield his skin grafts from the sun As he passed schoolyards, children ran to the fences shouting, "Monster! Monster!" Mitchell was not angry, his instinct was to explain "I wanted to go into the schoolyard and tell them about what had happened to me—that I had been in a bad fire, but that I could still do different things" Teachers ran up to hush the children Mitchell changed his mind and just walked on

He was born in Pennsylvania in 1943 His career before his accidents had been varied: the Marine Corps on turning seventeen, then selling insurance, substitute teaching, and taxi driving afterward He had worked in radio in Hawaii—sales, newscasting, disc jockeying (Today his voice still has a radio announcer's resonance—the fire may have charred him outside, but everything inside emerged intact) In Honolulu in 1964, on his discharge from service, he marched in protest against the Vietnam War He had liked the Marine Corps, the parades, the discipline, the shooting—he was an expert rifleman when he had hands—but he felt perfectly comfortable in this new kind of parade An affinity for liberal causes developed in him As a campaign worker for Senator Robert Kennedy he visited Colorado for the first time, and then California Kennedy's assassination temporarily soured, but failed to kill, his affection for political causes

He was never much concerned with the environment While he resided in California, he visited Yosemite National Park, read John Muir, and joined the Sierra Club, but he was not a great outdoorsman "I was the laziest bum in the whole world I wasn't even a hiker—I was a walker" When he first got to know Colorado well it was on the motorcycle with the faulty gas cap, the year before it failed him "I was playing *Easy Rider* I drove up through Mesa Verde, Durango, and Silverton It was so green that I thought I was in a beer commercial" (As an aesthete, he was still mostly the ex-Marine) He admits, a little embarrassedly, that he seldom strayed more than 100 feet from the motorcycle He first saw Crested Butte through the window of his Cessna, not long before it crashed

"It was just the perfect place I found a

CONTINUED ON PAGE 128

Mining "Red Lady" will collapse the entire mountain, much like Bartlett Mountain, shown here

EYE IN THE SKY

SPACE

By Mark R. Chartrand III

On a rainy afternoon ten years from now an astronomer walks into a basement observatory and sits at a televisionlike screen. An operator pushes buttons, checks dials, and makes adjustments. Stars appear on the screen—dozens of them, in the heart of a distant cluster. The astronomer steers the telescope to the single point of light he wants to observe, then commands the telescope to place the proper instrument—in this case a spectrograph—in the light path. Hours later he walks out, his data stored on reels of magnetic tape, while the operator goes on to another researcher's program.

A few weeks later two technicians prepare for some minor maintenance on the telescope, interrupting its usual round-the-clock operation. Carefully donning their space suits and picking up tools, they pass through the airlock of the space shuttle, drifting at a speed of 29 000 kilometers per hour above the blue-and-white globe of Earth 600 kilometers below. Slowly they float over to the space telescope and begin working.

This scenario should be a common occurrence by the end of the 1980s. The space telescope—once the Large Space Telescope but now shrunken by budget problems—is due to be launched in 1983, that date could change because of problems with the space shuttle's engines.

This new eye in space should help us answer many of the teasing problems of the universe. How old is it? How did it form and evolve? How fast is it expanding? Are there really black holes? Where do quasars get their energy?

Viewed from far above Earth's turbulent air, the stars will appear one tenth the size seen in ground-based instruments. Because the telescope puts the star's light into a smaller area on a photograph, it will be able to see fainter objects and scan a volume of space 350 times greater than that now open to us.

Unobstructed by the filtering atmosphere, it will peer far into the ultraviolet and infrared regions of the spectrum on either side of the part we see. These wavelengths carry important information about the hottest and coolest objects in space. Each part of the spectrum is a window onto the universe with a unique view. All the windows put together give a panorama not visible from Earth.

Far from replacing earthly observatories, the space telescope will complement them. These thousands of telescopes are still the most cost-effective way to make most astronomical observations. The new facility will be reserved for the crucial studies that peer at fainter objects or that pin down stellar positions more precisely.

The space telescope contains a 2.4-meter mirror with five major scientific instruments, their support devices, a power supply with solar panels, and a radio to relay the observations to Earth. Around all this is a shield to protect against stray light and micrometeoroids.

The space telescope will be carried into orbit by the space shuttle, the "space truck" of the 1980s. The telescope will just fit into the shuttle's cargo bay, which is about the size of a DC-9. During the telescope's 10- to 15-year lifetime, shuttle missions will stop by occasionally for minor maintenance and once or twice to bring the satellite to Earth for refurbishing.

On the ground the Goddard Space Flight Center at Greenbelt, Maryland, will supply facilities for astronomers using the telescope. Each investigator will have to ask for telescope time six months to a year in advance. A group of scientists will review the proposal's merits and, if they accept it, fit the project into an observing schedule. To make full use of the telescope, the work of many astronomers will be closely interleaved. All actual telescope operations will be handled by a specialist.

An entire book could be written about the problems to be tackled by this new astronomer's tool. We can say for certain that it will help us establish the distance scale of the universe and improve our knowledge of the evolution of stars and galaxies. It may even detect unseen planets circling nearby stars and confirm or disprove the existence of black holes. The most exciting prospect is that serendipitous discoveries unguessable now will add yet another piece to solving the puzzle of our fascinating universe.

Free of Earth's distorting air, the space telescope will open distant suns to astronomers' gaze

FAT FALLACIES

LIFE

By Dr. Bernard Dixon

Does any government have the right not simply to advise citizens about healthy diet habits but to ensure that they consume precisely what it considers good for them? Norway is the outstanding example of a country that has chosen this brand of nutritional totalitarianism. Since 1975 Norwegians have found themselves maneuvered by tax incentives and disincentives toward an officially endorsed diet. Farmers, importers, and the wholesale and retail trade have also been regimented into line under the government's "integrated nutrition, food, and agriculture policy."

The main aim of the policy is to curb people's consumption of saturated animal fats and to increase their appetite for the polyunsaturated vegetable variety. The payoff—Big Brother hopes—will be a dramatic fall in the incidence of coronary disease.

It is perhaps ironic that the four years that have seen the launching of the Norwegian program have also witnessed a damning scientific revolt against its principal tenets. Earlier this year one of the world's most distinguished experts on heart disease, Sir John McMichael, summarized the position in a major article in the *British Medical Journal* (1979, Vol. 1, p. 173). Pointing out that comparisons between different countries do not support the link between animal fats and coronary disease and that some vegetable fats are positively harmful, he concluded, "The time has come to reject advice to substitute polyunsaturated fats for animal and dairy fats in the nation's diet."

So much for a fashionable piece of health advice. And if the evidence is that controversial, how much less justified are government measures to dictate the gastronomic habits of an entire populace?

But where does the scientific debate leave those of us who worry about heart disease? Two points emerge very strongly. First, there is no serious disagreement with orthodox advice about taking exercise and avoiding tobacco. Obesity is always harmful, but diet is less important than exercise and abstinence from tobacco. Second, it's becoming abundantly clear that the saturated-versus-unsaturated-fat hypothesis is hopelessly vague. What seems to matter is not our consumption of either of these two broad categories of fat but our intake of specific fatty acids.

We cannot yet be certain, but the latest evidence (*British Medical Journal*, 1979, Vol. 1, p. 484) suggests that one polyunsaturated fatty acid in particular may be important in the prevention of coronary disease. Eicosapentenoic acid—remember the name—is common in fish oils. And Eskimos, whose diet is rich in this substance, are known for their freedom from coronary trouble.

Eicosapentenoic acid is certainly my candidate as a heart-attack preventer. Time will tell. Meanwhile, nutritional totalitarianism based on incomplete, controversial data seems unwise, to say the least.

Coincidentally, it was from Norway that a report came recently to threaten another fondly cherished myth about body fats. An important part of the ideology of exercise has been a belief that strenuous activity reduces the amount of fat and cholesterol circulating in the bloodstream. The evidence has always been inconclusive, so two experimenters at the University of Oslo, Dr. E. Rasmussen and Dr. A. Høstmark, set out to resolve the issue. They bred two distinct groups of rats: "energetic" animals, keen to exercise voluntarily on a treadmill, and "lethargic" ones, reluctant to take exercise. Next they divided each group into two subgroups. Half were allowed access to a wheel, and the others were denied that pleasure. The result was that the energetic rats given exercise facilities ran 12 to 15 kilometers a day while the others ran only 2 to 5 kilometers.

A fatty acid abundant in fish oil may be the Eskimos' secret for preventing heart disease

Rasmussen and Høstmark analyzed the animals' blood regularly and their findings were unambiguous. The amount of exercise taken on the wheel had no effect on circulating cholesterol and fats within either group supplied with a treadmill. But there *was* a difference between the two groups that were prevented from exercising. The energetic males had an increasing concentration of fats in the blood with age. At one year it was four times that in their lethargic brethren. The Oslo investigators conclude that the rats with an inherited desire to exercise had also inherited a tendency to develop high blood fats—and presumably cardiovascular disease (*Circulation Research*, Vol. 42, p. 598). It's likely, but not absolutely certain, that these results can be extrapolated to human beings—a conclusion that may once again put another piece of conventional wisdom in jeopardy.

If we are to accept that lesson, though, there is another implication of the Oslo work worthy of consideration. Among the energetic rats, the two sexes contrasted dramatically in their choice of exercise. The females were very keen and played on the wheel more as their life progressed. The males began less actively and took even less exercise as they grew older. Whether this "age-related tendency towards sloth" in males is typical of the human condition, I would not dare to guess.

A HIDDEN EARTH

STARS

By Patrick Moore

For several years now we have been hearing about "new planets." There are suggestions that our familiar companions—Mercury, Venus, Mars, and the rest—may not be all there is to the sun's family; that one member or more still await discovery. This idea is not new. A century ago it was widely thought that another planet could be found within the orbit of Mercury. It was even given a name: Vulcan.

While Vulcan does not exist, the case for a planet orbiting at the outer rim of the solar system is much stronger. This seems even more likely now that we have found remote Pluto to be more like a couple of ice balls than an Earth-style planet. I can give no proof, but in my view, Planet Ten is probably real. However, it is bound to be so faint that its discovery will be largely a matter of luck.

(*En passant*, we must stop referring to Pluto as the outermost planet. Since January it has been closer to the sun than Neptune is, and this will remain true until 1999. I hasten to add that Pluto's path is tilted so sharply that there is no reason to fear a head-on collision with Neptune when they cross in their orbits.)

But what about a planet much nearer to home, moving in a path similar to our own? This brings us to "Counter-Earth," a hypothetical planet that used to be taken very seriously and still crops up occasionally in the literature.

The theory is straightforward enough. Earth moves round the sun at a mean distance of slightly less than 148.8 million kilometers, taking 365.25 days to complete its circuit. The orbit is not perfectly circular. We are somewhat closer to the sun in December than in June, but the variation is not great. The other planetary orbits are also nearly circular, apart from that of the enigmatic Pluto. Moreover, Earth's orbit is stable. Our mean distance from the sun is unchanging, with no suggestion that it will vary in the foreseeable future.

Now consider a planet exactly on the far side of the sun, also moving at a distance of 148.8 million kilometers in a period of 365.25 days. Obviously, the earth, the sun, and the extra planet—the Counter-Earth—would be lined up. We earth-dwellers could not see Counter-Earth at all, because it would be drowned in the sun's glare. It was once said that conditions there might well be much the same as they are here, allowing for the existence of inteligent life. In fact, as recently as 15 years ago, a science-fiction film portrayed a Counter-Earth so like our own planet that an astronaut landing there found what seemed to be his own wife and colleagues waiting!

It is an intriguing theory and, of course, quite true that a planet exactly beyond the sun would be invisible. This applies to all the known planets. When a planet is directly beyond the sun, it is said to be at "superior conjunction." Mars passed through superior conjunction quite recently, which is why it has been absent from the night sky. We will not see it well again until later this year.

Unfortunately, science can be unromantic. Interesting as it would be to speculate about conditions on Counter-Earth, it would not be really profitable. There is an easy way to show that Counter-Earth does not exist.

All planets are perturbed—tugged aside in their orbits—by the gravity fields of other bodies. Because Earth and Counter-Earth would be separated by the whole diameter of their orbit, 297.6 million kilometers, the perturbing effects on them would differ. Result: Before long, the straight-line arrangement would be destroyed. Counter-Earth would swing out to the side of its arc, and we would see it. Moreover, Counter-Earth would produce its own perturbing effects upon Venus and the other planets, and these influences would have been detected long ago.

Nowadays, of course, there is direct proof that there is no massive, unknown body in our region of the solar system. Unmanned spacecraft have kept in touch with Earth even when almost on the far side of the sun, and their paths would have been violently twisted by the gravity of any lurking Counter-Earth. There could be some small asteroids moving more or less in our own orbit, but nothing more significant than that.

I have always thought that the Counter-Earth concept is one of the most fascinating in ancient lore. It is amusing to imagine a world perhaps identical to ours, with people of equal technological skill, less than 300 million kilometers away. And such a pity to realize that there is none!

The sun. Though Vulcan and Counter-Earth are ruled out, new planets may yet be found

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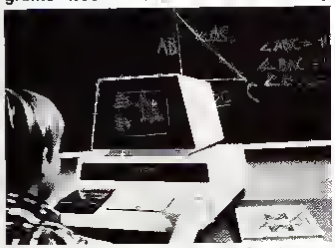

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THE ARTS

By James Delson

Star Trek—The Motion Picture, now in the works at Paramount, is one of the few real mysteries in a business where you can learn practically everything about any film by making a few phone calls. Though myriad rumors have claimed to detail the picture's plot line, props, sets and special effects, the studio has made an immense effort to keep the facts under tight security. Guards have been ordered to bar the stages to all visitors without proper identification.

After having several visits to the *Star Trek* sets canceled without explanation at the last minute, I finally managed to talk with producer-coscreenwriter Gene Roddenberry about his movie, now in its sixth month of filming. Roddenberry, a shaggy-haired ex-fighter pilot and perennial optimist, met me at Paramount's Building E, headquarters for his film. The creator-producer of the *Star Trek* TV series seems an unlikely choice for cult hero, much less guru to the millions of devoted "Trekkies" who made the show the most popular science-fiction program in history.

Roddenberry's office is crammed with memorabilia from the series, several real mementos of outer space, and stacks of material about the film. Production sketches litter the couch; several tentative advertisements cover a table, and some color paintings of the revamped starship *Enterprise* share a chair next to his desk. He is calmly philosophical about the film now three months over its original shooting schedule.

"We didn't have any crises that held us up," he reports. "It's just in the nature of science fiction that things tend to take longer." He's right. Of the half-dozen SF pictures shooting in Los Angeles, most have gone over budget or over schedule or have had to set back their announced premieres.

"We can storyboard every scene out," Roddenberry explains, "but that just doesn't work when there are so many variables. All you have to do is go out with your new space helmet and find that the glass reflects the camera, and suddenly you're dead for the day. In a regular picture everyone knows how to use the telephone, catch a taxi, or whatever. But we're dealing with space suits that don't fit, space gloves that won't close properly, and wires to simulate weightlessness that get all jiggled up. There's nothing we can do but wait around, at thousands of dollars an hour, and have them put right. We're learning so much that I feel like we've just finished a semester at college. Space Suit 101, Advanced EVA, and Special Effects Seminar. Everything in science fiction is new and different."

Except for the cast, Roddenberry has managed to reunite the entire crew of the TV show. Even Leonard Nimoy, as the elusive Vulcan with a human heart, can be found on the new *Enterprise* bridge. This means more to Roddenberry than a guaranteed box-office draw. What he wants is the depth of characterization an actor can create after he's had ten years to reflect on his role.

"The actors are older now," he says. "So they have a broader grip on life. They'll be playing the same characters as before, but you'll see more of their insides here. This is particularly true with [William] Shatner and Nimoy. We got into deep discussions in polishing the script, and their input meant a lot in making this story come alive again."

Re-creating *Star Trek* has been Roddenberry's dream for nearly a decade, but the first day of shooting was more like a day doing *The Twilight Zone* than his own show. "It was a feeling of total déjà vu," he recalls. "It took two or three days before we finally looked at each other and said, 'We're really doing this again, aren't we?' We thought there'd be exultation after the first day. I had planned a party, but none of it came off. It was just too big a shock after ten years.

"We're trying to remain true to the spirit of the show, yet still create a feature film that will please audiences who have never heard of Captain Kirk or Mr. Spock," Roddenberry comments. "Our constant worry is how much *Star Trek* must be kept in *Star Trek—The Motion Picture*.

"We would have had it much easier if we'd been able to design the film from scratch. It would have been a lot less trouble to work out the technical details. For example, everyone believed the old transporter on television, but after *Star Wars* it

CONTINUED ON PAGE 130

Spock and Captain Kirk are reunited on the screen in Star Trek—The Motion Picture, *now shooting*

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BOOKS

THE ARTS

By Robert Anton Wilson

Thirty years ago, old-timers may remember, conservative scientists solemnly proclaimed that we would never reach the moon. It is a measure of technology's acceleration that most will now admit that we can reach the closer stars "eventually." But they add that any thought of crossing the entire galaxy is mere science fiction. One wonders whether the same neophobic voices will be arguing in 2379 that, no matter how far we can travel in our galaxy, it is ridiculous to imagine flight to another galaxy.

What brings this to mind is the distinguished English science writer Adrian Berry, whose mind-boggling new book, *The Iron Sun* (Warner New York), persuasively outlines a way to make interstellar flights of any distance without violating Einstein's speed-of-light barrier.

I can already hear elderly voices muttering, "Mere science fiction." Not so fast, please. Berry is a thoughtful, well-informed, and very hardheaded chap whose first book, *The Next Ten Thousand Years*, is already a classic of futurist extrapolation. He is not assuming any such fanciful breakthroughs as the antigravity devices beloved of flying-saucer buffs. What he does assume—and makes a good case for—is that within 200 years or so we will be able to exploit the technological opportunities of black holes. This is hardly a fantasy when you consider that only four decades separated Einstein's $E=mc^2$ and the first atomic bomb.

Berry's plan for crossing space quickly calls on us to jump out of the Einsteinian space-time continuum via a black hole and to reenter it somewhere else. The largest part of *The Iron Sun* is devoted to showing that the scheme must work if you approach the black hole according to Berry's flight plan, you get sucked into it and crushed by gravity only if you approach the event horizon in a different way.

This is "speculative" in that it is based on the Kerr theory of the rotating black hole, and we have no way to test it. It would be a mistake, however, to dismiss it as being "only speculation." Radio was speculative in exactly this sense when J. C. Maxwell published his electromagnetic equations. An Adrian Berry then could only have argued that radio was possible. He could not have convinced the skeptics until Guglielmo Marconi built the first radio transmitter. In the same way, Berry can say that his Trans-Galactic Rapid Transit System is possible according to black-hole theory and that it is only a matter of time until some latter-day Marconi builds the first working model.

Berry's arguments are not in the whimsical "what if" style of science fantasy. They are strictly in the logical "if/then" style of inductive reasoning. He is careful to show that his system follows inevitably from the Schwarzschild equations that first predicted the existence of black holes. And the Schwarzschild model must be true if general relativity is true. To prove that Berry's plan can't work, we must refute Einstein's gravitational equations.

Berry says that failure to achieve interstellar travel "could bring about the stagnation and ruin of the human species. Yet if it can be solved, the prospect will instead be of the establishment of a galactic community, a society in which our descendants will be scattered through millions of worlds in orbit around countless stars. The race will be safe forever from the threat of extinction, and there will be no limit to the flowering of human culture which this diversity will produce."

This is, of course, the real motive behind the space program, even if the politicians are afraid to say it openly to terrestrial voters. It was this vision that motivated Goddard, Ley, and Von Braun when rocketry was considered science-fiction kid stuff.

Before 1914 the great Russian space pioneer Konstantin Tsiolkovskiy wrote: "The murky view which some scientists advocate as to the inevitable end of every living thing on Earth... should not be regarded as axiomatic. The finer part of humanity will, in all likelihood, never perish—they will migrate from sun to sun as the suns burn out. And so there is no end to life, to intelligence, and to the perfection of humanity. Its progress is everlasting."

It is salutary to have this cosmic vision restated. This is especially needed today when many antiscientific intellectuals are spreading a gospel of doom with what sometimes seems ghoulish joy. And it is a real pleasure to find it stated by a writer like Berry, whose logic is diamond-hard and whose style has the clarity of cut glass.

An artist's conception of a black hole, an area in space warped by powerful gravitational forces

THE ARTS

By Tricia Vita

In the shadow of the Capitol Building, what looked like a long, blue launching pad slept in the hours before dawn. As the sun inched over the horizon and climbed through a cloudless sky, a mirror-electronics system locked onto its path. Captured sunlight was beamed onto a row of glass plates mounted on the structure, and apparitions took shape a few meters in front of each glass. Spectrum-hued forks floated in midair, magic circles. Prongs jutted out, but try to karate-chop the dazzling tableware-weaponry and your fingers sliced thin air.

Scenario for a film about an alien takeover of Washington, D.C.? No, the unidentified objects are part of an environmental sculpture called *Centerbeam*, initially sighted at Documenta '77 in Germany and seen again in the summer of '78 outside the National Air and Space Museum. The phantom forks are Harriet Casdin-Silver's solar-tracked holograms for the collaborative project of artists from the Center for Advanced Visual Studies (CAVS) and scientists and engineers from MIT.

CAVS is a small, modernistic building that makes sharp-angled gestures toward the Cambridge sky. Inside may be the best of all possible atmospheres for the creation of the art of the future. "Every other art form is valid and will remain so. Painting will always be there, as will beautiful pencil drawings," artist-holographer Harriet Casdin-Silver told me. "Of course, we all feel that the statement of this era will come out of the laboratory." Casdin-Silver, a Fellow at CAVS since 1976, has been exploring the aesthetic possibilities of laser-light imagery for nearly a decade. Her innovative concept of displaying holograms outdoors, using the sun as a light source, adds to her impressive list of holographic firsts. The artist described the solar-trackers that the team of an astrophysicist, engineers, and graduate students designed and built. "Some trackers were operated electrically. Others were operated by the spectator. With cloudy days and nighttime viewing I did have a light. I liked to have the lights on at the same time the trackers were working with the sun because then I got many clusters of forks. Also, the sun itself, without the trackers, would sometimes hit the hologram, and there would be three images floating around each plate. The forks acted for me on *Centerbeam* almost like arms beckoning to the spectators, drawing them into the piece."

Around holograms, and holographers, these acts of technological magic are never unexpected. As I spoke with Harriet Casdin-Silver in her CAVS studio, sun streamed through the skylight reconstructing the reflection hologram she wore as a pendant. This third eye took in everything at once and then disappeared as often as Casdin-Silver moved to flick a cigarette ash. "I had complete artistic freedom," she said of her training in holography with Dr. Raoul van Ligten at American Optical Research Laboratories. "AO just wanted to see what would come from an artist working with the medium."

Centerbeam, *solar tracked holograms in action*

Although Dr. Dennis Gabor had invented holography in 1948, it was not until scientific applications were well under way in the late 1960s that an artist was let through the laboratory doors. In those pioneer days of 1969, Casdin-Silver remembers being called to work whenever lab space was free after completion of a scientific project. For one of these spur-of-the-moment holographic sessions, she glanced around the house for some object to take along. And that was how a dishwasher basket laden with silverware became her first hologram.

In a lab setup, a holographer bolts the objects down on the table because, as Casdin-Silver warns, "if anything moves, the imagery can disappear entirely." A laser beam is split in two. One beam hits the emulsion on the photographic plate; the other lights the object. As Casdin-Silver explains, "The reference beam meets the object beam at the plate, causing an interference pattern which in turn causes the recording of the light wave from the object in the emulsion."

Casdin-Silver's sculptures in light were displayed in "Aesthetic Holography," a one-person exhibition at the Polaroid Corporation in 1972. There she met Dr. Stephen Benton, inventor of white-light-transmission holography. The artist and the physicist collaborated on *Cobweb Space*, the first white-light-transmission artwork.

In 1977, Casdin-Silver was the first person to have a solo exhibition at the Museum of Holography in New York. This year, with the support of a Rockefeller Foundation grant, she is making holographic movies. On the subject of holography's future applications in art, Casdin-Silver has a multitude of visions. "I'd like to see environmental holography," she said longingly. "Holograms onstage — holographic imagery that real actors walk in and out of or real scenery that holographic actors walk in and out of. There's so much potential. And so much to happen." And so easy to venture a prediction that Harriet Casdin-Silver will make it happen *first*.

THE ARTS

By Tom Johnson

For some people learning to read music is a relatively simple matter. After a few lessons the lines and spaces take on significance, the sharps and flats make sense, and the fingers begin to respond appropriately. But many people are not so lucky. Western musical notation does not, after all, follow a particularly simple or direct logic. It arose largely through a complex series of historical accidents, and while it works quite well, it also forces the beginner to confront a number of tricky concepts. What does ¾ mean? Three fourths of what? Why the G clef, and why doesn't it look like a G? Why do dots sometimes mean one thing and sometimes another? And why in the world is the same note sometimes called G-sharp and sometimes A-flat?

For centuries adults as well as children have been getting lost in this maze, and none of the attempts to write music in clearer and more graphic ways have ever caught on. Sam Berd's new method may not catch on either, but it is achieving results for some hopeful beginners in New York, and, like Berd's new keyboard design, the Berdboard, the method has distinct advantages.

Digit music is still a very new system. In fact, it was only last fall that Berd opened his Digit Music Center on 57th Street in New York City, hired a small staff, outfitted several classrooms with small electronic keyboards, and began assembling a repertoire of three-color editions for students to play. Students began arriving at the center in December, and while a number of revisions and improvements in the materials are still being made, it already seems clear that the basic system works.

When I observed two small boys who had been grappling with digit music for only a few lessons, I was particularly struck by the accuracy with which they found the notes they were looking for. They had the same rhythmic problems that all children seem to have in their first weeks at the keyboard, and, somewhat to my surprise, they also managed to invent their own awkward fingerings, instead of using those that were so graphically illustrated in the written notation. But they never mixed up note 6 with note 7, the way students normally mix up F and F-sharp.

There is no doubt that digit music offers certain advantages. As Berd puts it, "One does not have to know a sharp or a flat or clefs or rest signs. Even the fingering is built in, faking guesswork off the mind. Modes are totally nonexistent. All it takes is reading numbers and colors." And the system seems clearly preferable to mechanical aids, such as the chord organ, since students of digit music must still physically play every note. The big question is how much trouble those students will have later on if, or when, they try to switch to conventional notation.

If Berd has his way, such a switch would never be necessary because in a matter of a few years all the music anyone will ever want to play will be available in digit-music notation. Berd is as ambitious as he is unconventional, and he is already making plans to form the publishing wing of the Digit Music Center, through which everything from orchestral scores and Beethoven sonatas to Cole Porter songs and kazoo books will be made available in his unique notation system. At the moment, however, he seems more occupied with his Berdboard.

Sam Berd and his Berdboard

The Berdboard is a new kind of piano keyboard, and, like digit-music notation, it stems from a basic contradiction that has concerned Berd for a long time. Berd, who has earned his income as a piano tuner for recording studios and rock groups, realized long ago that most of our music now involves the entire chromatic scale of 12 equal notes. Yet we are still working with keyboards and a notation system that came out of an era when the scale was seen to consist of seven important white notes and five less important black notes. Others have observed this contradiction too, but Berd decided to try to do something about it. Thus digit-music notation, which reduces the pitches to 12 equal numbers, and the Berdboard, which reduces the keyboard to 12 equal keys.

While ordinary keyboards combine short black keys with long white keys, the Berdboard makes all keys exactly the same size, retaining the colors simply as a convenient means of finding specific notes. Berd's arrangement brings the keys closer together than those on a standard keyboard, but on the demonstration model I tried the tops of the keys are rounded off slightly so that, even if you have large fingers, it is easy enough to play the note you want and not the ones next to it as well.

The Berdboard also has obvious advantages when it comes to transposing. On a standard keyboard, playing in the key of C is very different from playing in the key of D-flat, and many melodic and harmonic patterns that are easy in one of the keys are not possible at all in the others. On the Berdboard, however, all keys feel exactly the same. Thus there is only one major scale to learn instead of 12, chords have the same finger positions regardless of what key you are in, transposing is simply a matter of starting in a different place, and chromatic scales are duck soup.

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SAUCER-EYED SPIES

UFO UPDATE

By Art Gatti

The recent release of top-secret files by the CIA, Air Force DIA, and others has added the U S intelligence community to the throngs who are if not believers in UFOs at least ardent collectors of sighting reports and related data The inability of those files to explain the enigma can only bring us to a single albeit vague, conclusion Indeed, there's something there As far as our national security forces are concerned the UFOs are not the creation of individual or mass delusions

With all due respect to those servants of pure science determined to keep the statistical 10 percent of unexplainables at 10 percent and no higher, the time has come to give up those mindless rituals with which we face the Unknown It s time to stop clutching at those reassuring IFOs and to quit kidding ourselves that the 90-10 ratio of identifiables to unidentifiables can ever be reduced to the 100 ziich some debunkers want to believe is possible

If anything settles the irreversible acceptance of the phenomenon, it's that stack of UFO files declassified in the current Freedom of Information (FOI) suit brought against the CIA and USAF by the Citizens Against UFO Secrecy (CAUS)

The declassification of the Air Force Blue Book files a few years back, intended to underplay UFOs by depriving them of their priority status, only served to convince once uninterested citizens that there was something to UFOs Maybe it was only a few hundred out of several thousand cases, but they were on official record

That s stale information now however It's been a decade since the Air Force stopped investigating The current suit demands to know what is going on Not only did the judge rule in favor of CAUS's basic action but he attached a subsidiary ruling that forces the agency to research files in other departments where there was any interagency communication on UFOs Peter Gersten, CAUS's legal dynamo plans to continue the suit against every U S intelligence organization, including the 'untouchable' and very secretive National Security Agency

In a superficial way, the government has been following judicial directives and submitting to those demands, it has told CAUS essentially what CAUS already knows But like the ratio of knowns to unknowns in sightings, that's only 90-percent true—10 percent of the information *is* news and some of it may have been inadvertently disclosed

The thousands of unexplained sightings in the CIA files are but the raw material from which one would assume some evaluations must have been made yet most of the files are stamped THIS IS UNEVALUATED INFORMATION CAUS hopes further legal action will uncover evaluations of the rest of the material

What Ufologists have been referring to for years as "the 75 flap" has been verified by the documents that CAUS director Todd Zechel obtained in his separate FOI suit against the Air Force His files chronicle a near infestation by UFOs of sensitive military bases in the continental United States that year, including several pursuits by our planes and radar/ground observation returns They also show the frequent flyovers in areas where atomic materials were either manufactured or stored

Double disk over Huascaren Range, Yungay Peru

In sifting through more than 1,000 CIA documents I divided the material into two basic heaps UFO sightings, theories, etc and miscellany, including bureaucratic repetitions red tape, correspondence, and the occasional "revelatory document " It is this final minuscule collection that may prove to be of most practical use to Ufologists

If you get a large number of documents sent to you by the CIA you're likely to get one or two totally unintended enclosures The CIA sends off documents haphazardly? Definitely CAUS got a four-page report on the 1950 resolutions of the All-China Store Clerk Workers' Conference

Correspondence proves the agency lied as a matter of policy on UFOs Referring to one overly insistent citizen, the agency's most prolific letter writer, a memo concludes " the extraordinarily noncommittal and evasive answer we were instructed to give Davidson was perhaps the only one possible if we were to avoid crossing up previous statements of our own, and other involved agencies to this man " A draft of a letter sent to then-Senator Lyndon Johnson advises him precisely how to answer a constituent's queries about UFOs The letter outlines an uninformative 11-line reply telling Johnson to answer "along these lines" and "without direct reference to this agency"

There's evidence that the CIA regularly monitored private UFO groups while disclaiming any interest in them File references were found to such groups as the National Investigations Committee on Aerial Phenomena (NICAP) to which several pages were devoted, and the Aerial Phenomena Research Organization (APRO) to which one agency official refers as "some crackpot group in the Midwest "

A February 1953 memo outlines a CIA policy that was never changed in

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CONTINUUM

A PREVIEW OF COMING ATTRACTIONS

In the remote Yukon valley of Alaska, natives can now get medical care from a doctor. That's quite a feat, considering the nearest M.D. is hundreds of kilometers away.

Inpatients entering the cabinlike clinics at Galena and Fort Yukon find that the examination rooms have been converted to television studios. Video pictures of the patients are bounced off NASA's ATS-6 satellite to physicians at Tanana, Bethel, and Anchorage, Alaska. X rays, EKGs, and voices are relayed via RCA's Satcom I. Patients' records can be retrieved from a computer in Tucson, Arizona. As the data come in, doctors make their diagnoses and instruct health aides at the remote clinics in how to administer treatment.

This is the Indian Health Service's ASTRO Program—an experiment in telemedicine. It is not unique—there is another like it in the Southwest—STARPAHC—that uses microwave transmitters to relay television signals. And the Pacific Northwest States have put together their own medical education satellite network.

Doctors aren't the only people taking advantage of recent advances in television technology. Educators are taking a hard new look at it as a teaching tool. AT&T, RCA, and Western Union have plans to revive the old videophone and set up teleconferences for businessmen. Everyone, from advertisers to zealots, is benefiting from new video/satellite/computer applications.

With the proliferation of telecommunications, we're seeing a cultural revolution as vast as any since the invention of writing. And we're listening to a storm of protests. Writing, legend has it, inspired a similar storm because it was thought literate men would forget how to remember. Now television is turning us into a race of passive spectators. But is it really?

In the Appalachian Mountains, the Appalachian Educational Satellite Program (AESP) broadcasts televised graduate courses via ATS-6 to some 45 rural sites. Students talk with their professors over telephone lines. AESP classes aren't easy. "Ancillary materials" (translation: homework) average 50 pages per week. Far from being passive watchers, these students find it's all they can do to keep up with the work load.

This teleducation experiment has been so successful that the AESP has expanded to become the first nationwide public service network. Soon we may go to college in our living rooms. But we won't just lie back and soak up taped lectures. We'll question our teachers, carry on debates, and think up excuses for not doing our ancillary materials.

The AESP uses TV to *communicate*, an important point. True communication runs in two directions. Just how well we hold up our end of the teleconversation will determine whether television becomes our servant or our tyrant. Should we continue to let the tube babble at us, it could be our undoing. "If this is so," wrote Arthur C. Clarke in 1959, "then the epitaph of our race should read in flleeting ' fluorescent letters: *Whom the Gods would destroy, they first give TV.*"

There is evidence, however, that we may survive. Destruction has yet to rain down upon Columbus, Ohio, where the Warner Cable Company has hooked home TV sets to a computer in an experimental system called QUBE. QUBE viewers can order products, purchase movies, attend college courses, watch cultural and sporting events not offered on conventional television, and be polled. The experiment incorporates televoting, teleshopping, teleducation, and telentertainment. Add a few on-air doctors and a teleconferencing service, and QUBE might show us a preview of things to come: teleculture.

To some, QUBE is reminiscent of E. M. Forster's SF classic "The Machine Stops," in which he portrays our descendants as confined to tiny rooms, watching one another on the boob tube. But it was television, remember, that brought us the first steps on the moon, a sunset on Mars, and Jupiter's Red Spot. Soon we'll get a video look at the Rings of Saturn. There is nothing confining about a box that can bring the universe into our living rooms. And we can't really call it a boob tube anymore, not when we can obtain a graduate degree for watching it.

For those of us who view the coming tidal wave of video technology with fear and reluctance, let's think about this. If used for interactive communication, these electronic miracles may greatly enrich our lives, may even reinstate a few of those old traditions we now view with nostalgia. By touching a button on our TV console, we might vote on important national issues as if we were at a town meeting. We could shop in a leisurely fashion again, finding what we want as quickly as we can change channels, instead of searching like detectives in clerkless discount department stores. And through the magic of television our doctors may once again make house calls. —*NICK ENGLER*

CONTINUUM

PLAYER PIANO

Roll over Beethoven and tell orchestra musicians the news—they could be replaced by a portable keyboard synthesizer called the Synclavier

The Synclavier is capable of duplicating the sound of 25 musical instruments including the tuba, clarinet, drum and violin and the human voice And it can put them all together to create the sound of a full orchestra

Invented by Dartmouth College composer Jon Appleton and engineers Cameron Jones and Sidney Alonso, and manufactured by New England Digital Corp , the minicomputerized synthesizer is one of the most sophisticated digital instruments on the market (for $13 000) Bell Labs and Stanford have more complex polyphonic devices, but they cost around a quarter-million dollars and they're not for sale

In addition to simulating an orchestra, the Synclavier can transpose any piece of music from one key to another—instantly It can speed up or slow down a piece without distorting the pitch It can transpose a melody to a non Western or entirely new scale

According to its inventors, the Synclavier is important to composers as a means by which they can orchestrate their compositions immediately as they create them and it is being used that way at a number of colleges and conservatories And it can be used to create music never heard before

—Kathleen Stein

Science means simply the aggregate of the recipes that are always successful All the rest is literature "

—Paul Valery

Jon Appleton at his Synclavier The machine can duplicate the sounds of 25 musical instruments for a price of only $13,000

MOTHER'S MILK

Stepping gingerly between alarm and assurance federal officials this year are telephoning 1,400 women across the country to ask whether their breast-fed infants are healthy

The women, from 46 states, participated in a 1975 study that found cancer-causing pesticides such as dieldrin and DDT, in breast milk And in about 300 cases polychlorinated biphenyls (PCBs), widely used as an electrical insulating fluid, were found in levels that were higher than the standards proposed as safe by the Food and Drug Administration Elevated levels were found in all U S regions

'It was considered serious that the levels in mother's milk were not that much different from levels that caused problems in rats and primates,' says Jerome Blondell of the U S Environmental Protection Agency's human-effects monitoring branch

But the situation is complicated On the one hand, breast milk gives nursing infants valuable natural antibodies for which there is no substitute And the PCB amounts were a thousand times lower than levels that caused skin lesions and discoloration during a Japanese poisoning accident in 1968 On the other hand, officials consider any level of PCB in mother s milk to be unsafe

'There are no easy solutions,' says the Environmental Defense Fund, a Washington D C consumer group For one thing there are not enough chemists to test breast milk for the 4 million babies born in the United States each

Breast feeding Valuable antibodies but a hint of PCBs

year The group suggests that women who plan to breast-feed their babies not eat fatty fish and meat (in which the chemicals concentrate) and wash fruits and vegetables thoroughly to remove any traces of pesticides

—Stuart Diamond

Clarke's First Law '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 "

—Arthur C Clarke

A hen is only an egg's way of making another egg "

—Samuel Butler

THE ULTIMATE MAP

Amid the pomp surrounding the centennials of Albert Einstein's birth and Thomas Edison's invention of the light bulb a less publicized—but equally significant—centennial is also being marked this year that of the U S Geological Survey (USGS), whose 13,000 scientists, engineers, technicians, and general staff are still mapping and remapping the country

Since it began on March 3, 1879, the USGS has compiled millions of pages of data on surface and subsurface geology It has located mineral deposits, charted earthquakes and measured the flow of every major U S stream Its findings are used to drill wells, build cities and plan crops

To celebrate its centennial, the agency, headquartered in Reston Virginia, plans a year of exhibits lectures and publications And, in October, it will sponsor an international conference on global resource requirements predicted for the next century

Among its goals between now and 2079 predicting and controlling earthquakes, mapping the United States down to the contours on individual properties and finding, with greater accuracy offshore energy supplies and minerals —S D

"What counts however, in science is to be not so much the first as the last "
—Erwin Chargaff

JET CLOUDS

Are the thousands of vapor trails from high-flying jet planes affecting local weather and crops?

False clouds? can form from thousands of vapor trails

Illinois scientists are looking into the question with financial aid from the National Science Foundation Their research will cover a nine-state area 2,013 kilometers in diameter with Illinois-Indiana being the center of an air corridor used by some 2,000 jets daily around the compass

Sky photos show vapor trails from early-morning jet flights merging to form cirrus clouds, turning what may have begun as a sunny day into a cloudy day, says Dr Stanley A Changnon Jr head of the Atmospherics Sciences Section of the Illinois State Water Survey

Changnon says Water Survey weather records show marked changes in Midwest weather patterns He claims that lately there have been more cloudy and fewer sunny days and that the daily temperature range is smaller with warmer nights and cooler days There have also been fewer rain generating thunderstorms

—Alton Blakeslee

CAVITY FIGHTER

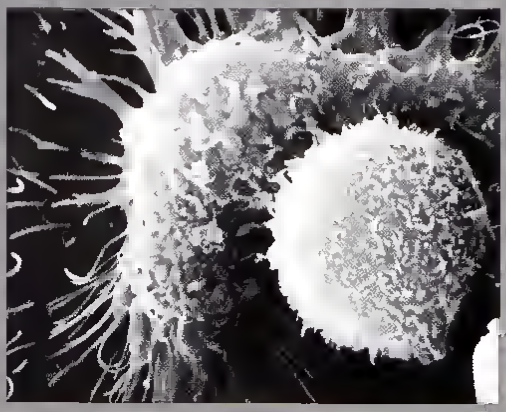
Cavity prone people may be able to eat candy and drink soda without fear of the dentist s drill if a recently isolated compound proves as effective in daily life as it has in a lab

A dental expert at the State University of New York at Stony Brook has discov ered a component of saliva—called sialin—that neutralizes tooth-decaying acids These acids form when bacteria in the mouth react to sugar He believes that cavity-resistant people have a lot of sialin and that cavity-prone people are deficient in sialin

The dental expert Dr Israel Kleinberg suggests that synthetic sialin could be added to toothpaste mouthwash, and even candy and soft drinks to offset the effects of sugar He isolated the substance in 1977 and the Warner-Lambert pharmaceutical company has given him a six-year, $960 000 grant to enable him to continue his research

Synthetic sialin can be made from almost any protein Kleinberg plans to find the appropriate dosage and check for any negative effects on his subjects before the substance is marketed

If the research is successful he says tooth decay may someday become a rare disease —S D



Tooth bacteria as portrayed by the scanning electron microscope A substance in saliva may be the key to eliminating decay

CONTINUUM

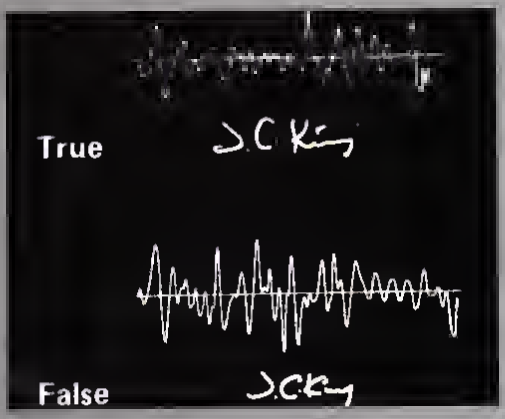
FORGERY DETECTOR

IBM scientists have invented a device that will make it almost impossible for someone to forge your signature and get away with it. Unlike the methods used by human handwriting examiners, the IBM system does its detective work while the signature is actually being written. Small acceleration meters that detect changes in speed and direction, along with a pressure sensor inside the pen—all connected to a computer—are used to spot differences between the signature and a reference signature as well as to reveal hesitations in the impostor's hand.

An individual's signature, it seems, is such a familiar pattern that even the timings of the hand muscles are virtually beyond conscious control. Because of this, Noel Herbst, one of the system's inventors, says that the chances of a forger imitating the dynamic characteristics of the real individual's signature are extremely unlikely.

Such a system will have enormous practical applications. Herbst thinks that it could be used to control access to credit information, Social Security records, and automatic teller machines at banks.

—Kenneth Jon Rose



While the signatures above are similar, IBM's computer detected the forgery through patterns of pen acceleration and pressure.

"Stand firm in your refusal to remain conscious during algebra. In real life, I assure you, there is no such thing as algebra."

—Fran Lebowitz, "Tips for Teens," Newsweek, January 1, 1979

All that glitters may not be gold, but at least it contains free electrons.

—John D. Bernal

FALLOUT

A shocking report from Utah indicates that atomic bomb testing may have resulted in a significant increase of leukemia deaths among children in that state.

From January 1951 to October 1958, 97 above-ground atomic tests were conducted in desert areas in southern Nevada, at Frenchman Flat and Yucca Flat. At least 26 of these blasts, according to records obtained from the Atomic Energy Commission, resulted in radioactive fallout over Utah, primarily in the southern half of the state. Now this fallout is being blamed for a 40-percent rise in leukemia deaths among Utah children born during the 1951–58 testing period.

Dr. Joseph L. Lyon, assistant professor of family and community medicine at the University of Utah and codirector of the Utah Cancer Registry, reported these findings in a recent issue of the *New England Journal of Medicine*.

"We can't say from this study that fallout causes cancer," Dr. Lyon noted, "but I think we can say without question there is an association between fallout and the increased incidence of childhood deaths in Utah."

Lyon's report reveals that in the period 1944 to 1950 southern Utah's normally low average yearly leukemia death rate was 2.12 per 100,000 people. But in the period 1959 to 1967 following the atomic testing, the rate climbed to a startling 6.02. From 1968 to the present the death rate dropped to preatomic testing levels, around 1.97. The increased death rates were most dramatic in southern Utah, the area most exposed to the fallout.

The study covered all childhood malignancies but specifically concentrated on leukemia, the type of cancer most easily attributable to radiation exposure.

Dr. Lyon cautioned against misinterpreting his findings. "No matter what some residents may believe, there is no 'cancer epidemic' in Utah now."

Public health records show that one other study investigating leukemia deaths in the fallout area was prepared in 1965. The report was never published or made public until a copy was accidentally found in the Utah Public Health files last December.

—Richard Levitt

Nevada nuclear test cloud. Utah children have felt the impact.

CHICKEN LITTLE

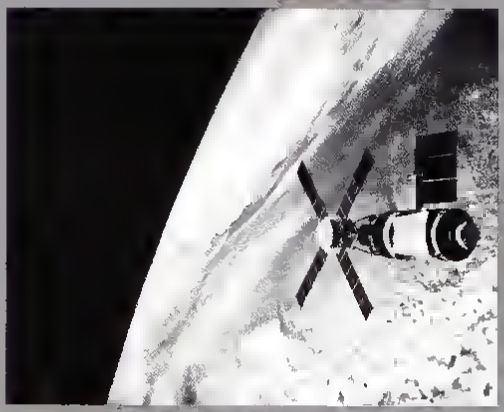
NASA's been remarkably sanguine about the whole thing. When they say that there is nothing to worry about, you have to ask, 'What don't they know?'

Alex Frazier, a member of Chicken Little Associates, thus describes his reasons for instituting a new watchdog group: one set up to do what NASA refuses to predict when and where *Skylab* will fall. The 84-ton space station has been slowly but surely deorbiting and soon is expected to reenter the atmosphere scattering wreckage in a 5,000-kilometer footprint across the surface of the earth.

For $100 a month Chicken Little will provide subscribers with computer information that gives up-to-date, localized sightings of *Skylab*, provided to it by the NORAD complex in Colorado. In addition, when the day finally arrives that *Skylab* actually starts its descent, C. L. will telephone its subscribers and warn them to take cover.

NASA spokesmen have pointed out that *Skylab*'s fall will be comparable to the total weight of meteorites that fall on the earth in a single year. What they neglect to mention, Frazier says, is that it will take only *15 minutes* for *Skylab* to come down.

—Eric Rosen



Skylab in earth orbit. NASA says not to worry about it falling on your head, but Chicken Little will tell you when to duck.

It is a profoundly erroneous truism . . . that we should cultivate the habit of thinking of what we are doing. The precise opposite is the case. Civilization advances by extending the number of important operations which we can perform without thinking about them.

—Alfred North Whitehead

PET PERKS

Having and caring for a pet can help you survive a heart attack. That's the conclusion of Dr. Erika Friedmann, a biologist at Chestnut Hill (Pennsylvania) College. She and her associates found that people with pets—dogs, cats, birds, gerbils, whatever—were more likely to survive the first year after being hospitalized for serious heart diseases than non-pet owners.

The correlation seems strong. Dr. Friedmann told the American Heart Association. It turned up as part of a larger study of social and psychological data on heart-disease patients. —A. B.

"What we need is not the will to believe, but the wish to find out."

—Bertrand Russell

WALLET PAIN

Not only does carrying a heavy wallet in your hip pocket provide pickpockets with a tempting target, but it may also give you a pain in the back.

Thanks to shrewd observations by Dr. Elmar G. Lutz of St. Mary's Hospital in Passaic, New Jersey, we now have credit card–wallet sciatica: a painful condition caused when an extra-thick wallet full of credit cards presses on your sciatic nerve as you sit at your desk or in your car.

This pressure can result in mild to moderate pain in the lower back and thigh. There is no need for sufferers to be unduly alarmed, however. Dr. Lutz, writing in the *Journal of the American Medical Association*, prescribes a simple remedy: a 'walletectomy."

—Erika Nargolwala

Man's (or woman's) best friend may indeed be a dog (or cat or bird), according to study linking heart-attack survival to pet ownership.

CONTINUUM

THE KILLING MECHANISM

If medical scientists could understand how the body s defense system recognizes and destroys foreign cells and tissues, they could manipulate the system to kill off cancer cells Now thanks to a new discovery that dream may be moving closer to reality

Gale Granger and his colleagues at the University of California at Irvine have recently unraveled parf of the mystery surrounding this process known as cell-mediated immunity

This refers to the way in which whife blood cells or lymphocytes, defend us against foreign cells It involves two steps recognition and killing

Once cells are recognized as foreign, populations of lymphocyfes are formed that possess surface receptors

Micrograph shows lymphocytcs (top left) attacking tumor

mafching those of the foreign cells In the reaction between their surfaces that ensues the foreign invaders are destroyed

Several years ago Granger and his associates discovered a group of molecules known as lymphotoxins which are released by the lymphocytes during the destruction process However the behavior of fhe lymphotoxins was puzzling because they seemed too weak to kill off cells by themselves and also had nonspecific killing properties despite the fact that only specific cells are destroyed in the process

A major breakthrough came when it was learned that lymphotoxin molecules form an association with both the lymphocytes and the foreign invaders, enabling the lymphocytes to organize into a high molecular-weight complex that is a very powerful killing system In the absence of this association, the complex breaks back into weak pieces—explaining why healthy cells in the same area are not destroyed

A full undersfanding of the killing mechanism may lie only a year or two away, in Granger s opinion And this opens up the possibility of controlling the assembly and disassembly of the killer molecules so thaf we could destroy a cancer cell or stop the killing process following organ transplants

—Sharon McAuliffe

Absolutum obsoletum—*If it works it's out of date*

—Stafford Beer

IGNORED PREDICTION

In a little-noticed article published in 1977 Gary Latham of the Geophysics Laboratory of the University of Texas at Galveston working with two Japanese scientists successfully predicted the major earthquake that struck the Oaxaca region of Mexico last November The quake s magnitude 7 9 on the Richter Scale was also very close to the strength expected

The scientists predictions were based on observafions of two distinct phases of seismic activity occurring prior to a quake In the first phase known as ' alpha " the small tremors that normally occur along a fault line ominously disappear in one region The second phase or "beta, is marked by the return of small tremors to the area—the telltale signs that a major quake will shortly follow

Apparently when giant landmasses along a fault push past one another some masses may slip rather smoothly in a series of minor tremors while others may "lock," causing tension to build up at that point until it is finally released in a major quake The absence of seismic activity observed during alpha is thus thought to be due to landmasses having become locked in this manner

At Oaxaca two major quakes had occurred separated by a 160-kilometer stretch of fault that had entered the alpha stage Latham and his colleagues recognized the immediate need to monitor the fault, because the two other quakes had occurred 1 5 to 2 years after entering the alpha stage However, a month before the quake

San Andreas Fault Funds for the monitoring of a similar fault in Mexico were suspended a month before a major earthquake struck

monitoring was stopped because the research team's application for a renewal of government funding was rejected at that time "I think they missed a good bet," said Latham

—Tony Fusco

THE 'DIVING REFLEX'

Research by a Michigan pulmonary expert is revolutionizing the treatment of drowning victims Dr Martin Nemiroff of the University of Michigan has discovered that people who are presumed drowned may actually be revived, without brain damage, up to more than half an hour after they submerge

For decades medical experts have presumed that after six minutes underwater a person is not revivable Pulled from the water, victims of drowning are cold, blue, not breathing In many cases resuscitation is not even tried Dr Nemiroff said

But he has found that in water below 20 C (68°F) drowning victims may undergo the 'diving reflex' during which the amount of oxygen normally sent to the skin and muscles is drastically reduced The oxygen is sent instead to the brain to protect it The reaction is named after a reflex found in whales, dolphins and other seagoing mammals that can swim underwater for half an hour before surfacing for air

Dr Nemiroff suggests that the diving reflex was responsible for the survival of an eighteen-year-old boy who was submerged for 38 minutes More than a dozen others who were underwater for more than 10 minutes have been successfully revived at his hospital The colder the water and the younger the victim, the better the chance for survival he said—although one survivor was forty-two years old

The findings are controversial particularly since they raise serious legal questions—such as the possibility that some people who were pronounced dead could have been revived But the Red Cross has asked Dr Nemiroff to suggest revisions to its drowning manual And his plea for attempted resuscitation of victims who've spent more than six minutes underwater is being heeded by an increasing number of localities throughout the world —S D

Drowning victim being pulled ashore If new research is right, people who could have been revived have been pronounced dead

MAGIC STONE

The mystery of the 'magic stone' has been solved Since ancient times members of royalty have dipped bezoar stones into their wine to protect themselves against being poisoned by arsenic (The word *bezoar* comes from two Persian words meaning 'protecting against" and 'poison ") England's Queen Elizabeth I wore the magic stones set in silver rings, which she dunked in her wine before drinking it

Bezoar stones are actually concretions that develop in the digestive tracts of goats and llamas and other ruminant animals Nobody knew why they worked but they did Queen Elizabeth never suffered arsenic poisoning

Now researchers at Scripps Institute of Oceanography in San Diego California have discovered by using radioactive tracers, that arsenite is removed by combining with sulfur in the partly digested animal hair

Queen Elizabeth I A good advertisement for bezoar stone

that is contained in the stones.

'The hair can actually act as a chemical sponge for the arsenite Scripps biologist Andrew A Benson explained

Somehow 'magic stone' sounded more romantic

—Don Fabun

Engineering is the art of doing that well with one dollar which any bungler can do with two after a fashion

—Arthur Mellen Wellington

There is a madman proposing to light the streets of London—with what do you suppose—with smoke!'

—Sir Walter Scott 1810 on the subject of gaslights

CONTINUUM

MEDICAL MILESTONES

This year has been one of strange medical breakthroughs Here are some of the strangest

Keith Richard's never once did I have a cold

• The Russian newspaper *Pravda* reports the discovery of a second or lymphatic heart—common to all human beings—by a team of Soviet radiologists headed by a Dr Tsyb of the USSR Research Institute of Radiology Detected by X ray techniques the lymphatic pump appears to the Russians to be a long tube separated by 20 valves into individual segments aligned along the spine This heart seems to serve the same functions for the lymph system that the blood pumping one does for the cardiovascular system

American doctors are skeptical You would have thought they'd have discovered it a long time ago if it s there remarked an American specialist

• New evidence indicates that mental illness and retardation lessen one s chances of getting cancer Jeanne Achterberg of the University of Texas studied the death records of 3 214 mentally disturbed and retarded patients in Texas and found a cancer rate of only 4 percent one-fourth the rate of the general population Of all the disturbed patients only paranoids had a high cancer rate

• Rolling Stone guitarist Keith Richards claims he has discovered a cure for the common cold an unexpected side effect of his years of heroin use 'I must admit in all fairness to the poppy he explained to the British music weekly *Melody Maker* that never once did I have a cold The cure to the cold is there but of course they daren t let anybody know because then we d have a nation of dope addicts" (See also 'Chicken Soup " above right)

• Extramarital sex might be dangerous for heart patients When Dr Gerald Fletcher of Georgia Baptist Medical Center in Atlanta Georgia monitored the heartbeat of a recent surgical patient he found that when the man had sex with his wife his heart beat no faster than 92 times a minute—within normal limits

But during a noontime tryst with his girl friend the man's pulse hit 150 and showed signs of arrhythmia a warning of impending heart attack —K S

CHICKEN SOUP

So what s new? Mama *told* you chicken soup helped cure colds But now there s scientific proof

A study at the Mt Sinai Medical Center in Miami Beach found that fresh chicken soup cleared mucus from nasal passages at the rate of 9 2 millimeters per minute compared with 8 4 for hot water and 4 5 for cold water Dr Marvin A Sackner measured the progress with X rays

Sackner's findings published in *Chest* a journal of pulmonary disease, were subject to peer review and pronounced 'statistically significant "

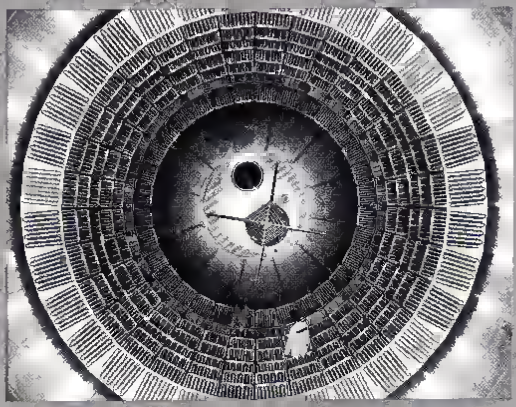
The doctor did not test chicken soup against other soups with his 15 subjects nor does he plan further research 'He didn't check matzo balls either said Susanna Barger a hospital representative But he did find that it was necessary to have chicken soup every half hour because its curative powers wear off quickly

Why did Dr Sackner decide to test chicken soup in the first place?

Answer Why not?'—S D

But to place a man in a multi stage rocket and project him into the controlling gravitational field of the moon where the passenger can make scientific observations perhaps land alive, and then return to earth --all that constitutes a wild dream worthy of Jules Verne

—Lee DeForest, the father of electronics quoted in the June 1957 Reader s Digest



This is what it looks like inside the gigantic 1 9-million-liter external fuel tank for the space shuttle At bottom Martin Marietta Aerospace engineers inspect the slosh baffles which prevent any disrupting movements of the liquid oxygen fuel during flight

The Cap Tree (above), a capacitor, reduces the load on the community's power lines when Fermilab turns on its accelerator. The Energy Fountain (right) absorbs any excess power

ARTFUL DODGER OF THE PHYSICAL WORLD

The neutrino may help us stop earthquakes and even talk to alien worlds

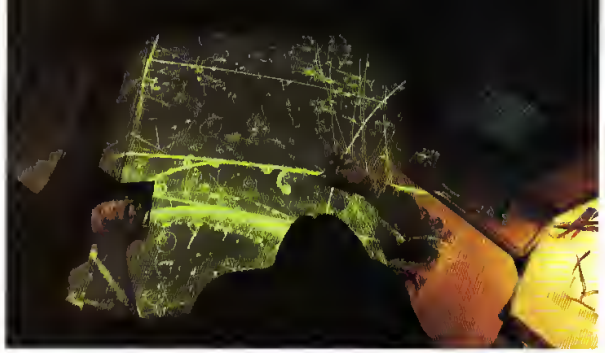
BY HAL HELLMAN

In 1962 the American physicist Philip Morrison predicted that the neutrino might well "turn out to be the major actor in an unseen drama of the physical world."

The neutrino is a subatomic, subnuclear particle, and, though most people have still not heard of it, Morrison may be right about its importance, considering the rapidly growing use of this particle in physics and astronomy. The neutrino may end up doing nothing less than furthering our understanding of the universe, forcing a rewrite of all our textbooks on how the sun works, and perhaps may even provide a final explanation of the nature of matter.

And, in a practical vein, "neutrino radios" may someday allow us to send messages straight through the center of the earth or to

PHOTOGRAPHS BY
DAN McCOY/RAINBOW



communicate more rapidly with inhabitants of other planets. Neutrinos may even be used to prevent earthquakes.

Like the Artful Dodger in *Oliver Twist*, the neutrino is elusive, speedy and penetrating. But while Dickens's Artful Dodger limited his incursions to gentlemen's pockets, billions of neutrinos are zinging through your body every second. You needn't worry, though. Thanks to their extraordinary properties, they pass through your body just as if it weren't there. To make sure that a neutrino will collide with something, we would have to put over 150 million kilometers of lead in its path.

You can't capture a neutrino. It's so small and elusive that only the results of its collisions with other matter have been recorded. Neutrinos are emitted wherever high-energy particle collisions take place, including the sun, other stars, supernovas, pulsars, quasars and neutron stars. You'll also find neutrinos being generated inside particle accelerators, such as those at Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois, and Brookhaven National Laboratory in Upton, Long Island, New York.

Brookhaven's Ray Davis, Jr., one of the leading actors in Philip Morrison's 'unseen drama,' was recently explaining to me that the neutrino's penetrating ability is attributable to the fact that it comes as close to being nothing as something can, for it has neither mass nor charge. Trying to show how smart I am, I added that it does carry spin and that it travels at the speed of light. "Actually," he whispered confidentially, "light travels at the speed of neutrinos."

As with many jokes, this one has some truth to it. After all, it is really somewhat a historic accident that light has taken on the basic aspect it possesses, inasmuch as we are biologically sensitive to it. But scientists have come to know that we can drag additional information out of the universe by turning our attention to other kinds of radiation, including infrared, microwaves, and X rays. Cosmic-particle radiation has also been useful.

The superior penetrating power of the neutrino, however, makes it a far better solar, galactic, and intergalactic messenger than any of these. Specifically, we're already using this messenger quality of neutrinos to find out what's going on inside the sun. And we're being hit with some surprises.

For example, every budding physicist and astronomer learns that a star's light and heat are produced in a nuclear-fusion "furnace" buried deep within its core. In this furnace hydrogen nuclei (protons) are fused into helium, liberating energy—in the form of light and heat—in the process. But something else is also released in this reaction: neutrinos.

This is a very neat theory, and for 40 years teachers have been teaching it and students have been learning it. But how do we know it's correct? What evidence do we have?

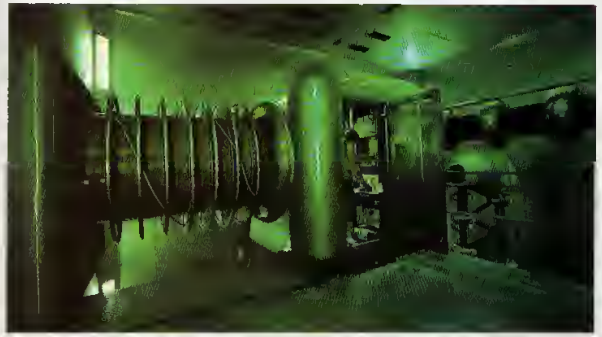
The evidence has come to us mostly in the form of light and other radiation emitted by the sun. Scientists have squeezed an amazing amount of information from that radiation. The problem is that the rays are coming to us from the *surface* of the sun, while the nuclear furnace lies deep, deep within its heart. It takes the radiation produced there a million years to stagger through the dense layers around it before emerging at the surface and making the quick (about eight minutes) trip to Earth to report to us. And what if the real message it got from the sun's interior is lost in the interval?

Remember that neutrinos are also produced in the furnace, and these zip right out in a couple of seconds. It was Ray Davis who suggested some 15 years ago that it might be a good idea to use these neutrinos as a direct check on our theories of what's going on inside the sun. Just as a description of a happening is usually best told by a personal witness, so is the neutrino likely to be a more accurate storyteller than the other forms of the sun's radiation.

Above: Fermilab employee scans particle tracks in film made in bubble chamber, a liquid-filled neutrino-detection device. Neutrinos themselves leave no tracks, but they produce other particles that do. Right: In this neutrino experiment, photomultiplier tubes (inside orange pipes) detect light created by lab's particles.

"To make a neutrino collide with something, we would have to put over 150 million kilometers of lead in its path."

"You needn't worry, but billions of neutrinos are zinging through your body every second."



In each fusion reaction, four atoms of hydrogen combine into one helium atom, and two neutrinos are set free. It was easy enough to calculate how many of these we should expect to receive on Earth. The figure comes out to a tidy 60 billion per square centimeter per second. Davis also came up with a method for detecting some of them. Not many, mind you, but enough to provide a check on the theory.

This is not easy to do, however. The neutrino's tremendous penetrating power, while sometimes useful, makes detecting even a few of them a gargantuan task. Davis's approach requires a huge 15-meter tank filled with 375,000 liters of perchloroethylene, a cleaning fluid. The trick is that when an atom of chlorine-37 in the fluid is struck by a neutrino, it is changed to radioactive argon-37. Every couple of months the argon is extracted and the number of atoms counted (yes, it can be done), each one being an indication of a single "hit" by a neutrino.

To be sure that the conversion process would not be fouled up by other incoming particles, such as cosmic-ray particles, the tank was buried 1.6 kilometers deep in a still-functioning gold mine, called the Homestake mine, located in Lead, South Dakota.

Davis told me the miners and the builders of the tank became interested in the experiment, with many of them working overtime to help get it finished in time. One day, while talking to them, he mentioned that it was a 24-hour-a-day experiment. "But," one of them protested, "the sun goes down at night." It took a bit of patient explaining to convey the idea that because of the particles' penetrating power the Earth was almost perfectly permeable to them, and as a result they were coming into the tank just about as often from the bottom as from the top. *That* really got to them.

The upshot of the experiment? Upsetting, to say the least. The number of neutrinos being received in Davis's tank is low by a factor of three. Being off by a few percentage points is one thing. Being off by two thirds is quite another. The astronomers say there's probably something wrong with the experiment. Davis and company shrug their shoulders and counter, "Maybe *you've* got it wrong. Maybe your model of how the sun produces its energy is incorrect."

The implications of a mistake in the solar model are staggering. The sun is just an ordinary star, but because it is the closest one to us, we feel we know it best, and we use information about it to construct theories about the more distant bodies—indeed about the whole universe.

Similarly, our approach to controlled nuclear fusion here on Earth—one of the main hopes for our energy future—may also be wrong, a terrifying idea to fusion experts.

It has even been suggested that the solar furnace may not be a nuclear-powered one at all. Perhaps at the heart of our star and others there is a black hole that is producing the energy. Though made of collapsed matter so dense that not even light can escape, it nevertheless may somehow be radiating energy gained from the accretion of surrounding gas.

Do the solar-neutrino physicists really believe this? No, but as John Bahcall, a Princeton-based colleague of Davis's told me, "To a physicist anything is possible until proved otherwise."

SAVING THE SOLAR MODEL?

Then again, maybe both sides are right. While it takes neutrinos only seconds to travel through the sun, it takes them more than eight minutes to conclude the trip to Earth. Maybe something happens to them on the way, or even during their trip through the sun.

Here we begin to see very clearly an intriguing phenomenon, how the physics of the macroworld—the world and universe around us—interacts with that of the microworld—atoms and subatomic particles.

Let's consider the microworld first. One of the major unsolved mysteries in physical science is the apparently simple question: What is matter made of? It was long thought that protons, neutrons, and electrons were the fundamental building blocks of nature and that there was nothing smaller. Further work with particle accelerators, such as the one at Fermilab, showed that these particles, particularly the protons and neutrons, can be blasted apart and that they are made up of yet more fundamental particles. Does this go on forever, with each particle being made up of yet smaller ones? Though many new particles have been discovered, this doesn't seem likely.

Currently there is some leaning toward the idea that there are two fundamental classes of particles, *leptons*, which include our own neutrinos, and another group called *quarks*. Quarks are, as neutrinos were at one time, a purely theoretical idea. If they exist, they are of several kinds and are subunits of the more familiar particles.

CONTINUED ON PAGE 108

Fermilab's particle beam begins in cube (above) of Cockroft-Walton Pre-Accelerator. Scientist inside replenishes hydrogen gas from which machine strips protons. These are fed into beam through column at left of cube. Pre-Accelerator sits on tall legs with doughnutlike rings (left) to avoid high-voltage sparking in the laboratory.

FICTION

THE MICKEY MOUSE OLYMPICS

Each athlete was developed to be perfect for each event--which was awful for the Olympics!

BY TOM SULLIVAN

A world apart two specially chartered airliners took to the sky within an hour of each other First there was the Aeroflot Soviet colossus lifting off the runway of the secret development base near Minsk Forty minutes later a Pan Am curl-winged behemoth left the maximum-security training complex at Provo, Utah Each flight maintained a fighter escort in international air space Each followed a path guaranteed free of man-made weather by its crisis-detection satellite overhead

To the personnel on board it was unbreached boredom Occasionally someone made a boast "We will *bury* them eh Nikita?" "Hey Shit when we start shootin', those suckers gonna bleed *red*!"

The landings were accomplished on isolated runways of Havana's José Martí Airport The triple-wire fences were two hundred meters away In each case a telephoto lens foreshortened the distance

"*Podyelka!*" screamed the Russian when he saw the films of the American disembarkment hours later

"Fraud!" echoed the American at his own private screening of the Russians' arrival

The next afternoon they stood side by side in the jammed Olympic stadium mouthing the oath of brotherhood and fair play A Babel One hundred sixteen countries Sixty-eight languages When it was done and the crowd's roar had chilled the platform Duncan Sherman poured a syrupy smile onto his Russian counterpart

"Mr Smerdyakov" he said with benign formality "I believe we can dispense with a translator"

Giorgi Smerdyakov allowed his own smile to fill out "Yes I speak a little English, Mr Shuer-mann"

Politely but boldly they took each other's measure The Russian saw a scruffy tweed-bearded man white and gray perhaps an ex-athlete atrophied now with an indoor skin—a below-ground skin The American observed a face like an omelette pan-

PAINTING BY RAY GOODBRED

shaped slightly askew the USSR executive chairman had never laced a sport shoe he felt sure already and he doubted that the cherubic Smerdyakov could even reach his socks without pulling a hamstring

"I trust you had a pleasant flight" said Sherman

"Very pleasant And you had a smooth landing, I hope"

"Didn't you see it?"

Smerdyakov was caught off guard momentarily but then Sherman's teeth flashed and they shared a treacherous laugh

"I hope the tog didn't spoil your pictures" the Russian said "We had to use a computer to sharpen ours"

"Ah Smerdyakov could a little fog keep us from seeing those weight lifters of yours—the ones that had to get off the plane sideways?"

The suitcases were bulky' Smerdyakov waved his hand fussily "We were concerned about that four-meter basketball player of yours yes? He didn't bump his head did he? Or was it a female high jumper? My trainer insists it was wearing lipstick!"

"You must have seen Stilt carrying his girl friend on his shoulders Our tallest is barely nine feet About three times the height of one of your dwarfs"

"Drawers ? Smerdyakov feigned a language gap

"Munchkins You know mice midgets Little folk?"

Our gymnastics team is young, Smerdyakov shrugged helplessly "But let me congratulate you on that odd bone structure so many of your athletes have For us to equal it we would have to violate every rule laid down at the second Olympic Convention on Genetic Manipulation"

Like all the Russian staff, Smerdyakov had a doctorate in genetic engineering Sherman resented that He couldn't afford to get into details So he straightened dutifully as the Olympic torch passed by Round the track it went an unruly presence in an otherwise respectful pavane Up the steps it went to the top of the stadium There it too straightened Flags fluttered The Olympic chain ascended hydraulically—a Walt Disney touch Who else could afford to build the facilities? After the Games the second and fourth rings in the chain would become mouse ears The flame now leaped to its dish and pillared upward Another roar avalanched onto the platform where Smerdyakov and Sherman stood Champagne was poured among the reps

"To my friend Shuer-mann " Smerdyakov addressed And delivered a toast in Russian that sent his vestigial translator into hysterics

Sherman nodded gratefully "To Smerdyakov" he said lifting his glass 'ay May ightning-lay ike-stray is-hay ass ay!

Sherman was at the track and field stadium before the events officially started the next morning watching the athletes arrive dictating notes to his Man Friday As the homogenized delegations cast off their sweat suits for warm-up he hit upon a scheme for identifying those without numbers Autograph? he would ask tapping pad and pencil in the face of a select athlete Auto-graph pl-lease?" The flattered participant would then sign while Man Friday snapped a picture This was necessary because no head-to-head international competition had taken place in fifteen months That was because of the mandatory chromosome tests And the chromosome tests were required because of genetic cheating No one wanted a ruling in an Olympic year

Sherman saw his first sideshow when the Russian women came out on the field He could tell they were women because the CCCP was on the left jacket breast as distinguished from the men's right-sided monogram When the jackets were off there was no distinction But what really jarred ol' Sherman—what really filled the mold cast of suspicion and shaped to nonhuman form—were the jumpers

"My Gawd-d " he drawled

"A flea circus," Man Friday acknowledged tersely

With piano-wire legs proportioned as uniformly as sausage links, the Russian bevy looked like the insect equivalent of mermaids In unison they began loosening up Their jack-in-the box knee bends, frenetic locomotive drill and gazellelike bounding erased any doubts

"Protest protest, protest" Sherman whispered, rapidly snapping his fingers

Man Friday grabbed a fistful of forms from his attache case But salt 'n' pepper whiskers were already flowing amid the low orbital ballet "Autograph—get the camera ready Felix—autograph please" Man Friday wrestled with attache protest forms and camera

Suddenly a basso profundo erupted and one of the females advanced on Sherman rubbing the air in front of her with bunched fingers as if wiping a splat from a windshield

"It's the coach sir" said Felix

Sherman held ground

"She says if you come near her girls again, she'll have Ludmilla kick you in the in the "

"Got it Felix" Sherman grinned falsely in retreat saluting with his pencil A few of the girls giggled Deeply

"See that? See that? Touchy No way Felix There's no way they can survive a protest" Sherman drew himself erect, slowed his voice 'Fill it out A blanket challenge We'll get the names later"

"What'll I charge sir?'

"Charge anything Say you saw them rubbing their hind legs together and chirping Say their calves are longer than their thighs We want a chromosome match-up with their parents damn it! And if necessary their great-great-grandparents—right back to the jackrabbits!"

"Yes sir" said Felix

The Russian translation of this scene concurrently took place in Gymnasium 1 of the Multi-Sports Hall, to which Smerdyakov had gone in response to a panic call from the Soviet wrestling coach

The American team lay basking like lizards at the side of a mat on which a freestyle paperweight match ensued between a thyroidal cretin from the Ukraine and a Yankee pyramidal hump The pyramidal hump sported its apex between its shoulder blades

"I could hang my hat on that!" the Russian coach pointed

Smerdyakov's eyes bugged his chin retracting into the folds of his neck

"We've won all our contests but the American ones.' the coach shrilled "They are impossible to pin Hunchbacks All of them We can't even win on points Pankin bruised his chest executing a hug "

"Protest the losses When does Korolenko wrestle the American?"

"Next"

The Ukrainian cretin had the American by the legs and was wheeling him around the circle on his hump Smerdyakov dropped to all fours and beaf the mat The American promptly scissored his opponent down for the count

"Korolenko!" called the Russian coach

Up stood Korolenko stripping off his sweats His coach massaged him with a pair of gloves and the dry rasp was audible throughout the gym

"He's got scales!" came an incredulous whisper from the capitalist side

The Quasimodo of the moment balked at the edge of the circle no longer sure of his quarry "Is eczema contagious?" he was heard to quail The American trainer assured him that the scruffy corn husk from Siberia had merely peeled in the Cuban sun But at first touch the American wrung his hand and when the Russian clutched him with piggish grunts he screamed as if impaled

"That ain't skin!" he appealed with a forlorn look to the side "This guy's an alligator"

CONTINUED ON PAGE 122

> *"The American team lay basking like lizards at the side of a mat on which a freestyle paperweight match ensued between a thyroidal cretin from the Ukraine and a Yankee hump"*

MIND AND NATURE

In search of the mysterious link between mind and nature—the pattern which connects

Gregory Bateson is not an easy man to type. Best known as an anthropologist, he is the discoverer of the double bind theory of schizophrenia, one of the founders of the science of cybernetics, and one of the original researchers (with John Lilly) in the field of interspecies communication. He is the son of the celebrated geneticist William Bateson, ex-husband of the late Margaret Mead, a regent of the University of California, and consultant to Governor Jerry Brown. The following essay is excerpted from his new book, Mind and Nature, *in which he urges us to "think as nature thinks."*—Ed

In June 1977 I thought I had the beginnings of two books. One I called *The Evolutionary Idea* and the other *Every Schoolboy Knows*. The first was to be an attempt to reexamine the theories of biological evolution in the light of cybernetics and information theory. But as I began to write that book, I found it difficult to write with a real audience in mind who, I hoped, would understand the formal and therefore simple presuppositions of what I was saying. It became monstrously evident that schooling in this country and in England and, I suppose, in the entire Occident was so careful to avoid all crucial issues that I would have to write a second book to explain what seemed to me elementary ideas relevant to evolution and to almost any other biological or social thinking—to daily life and to the eating of breakfast. Official education was telling people almost nothing of the nature of all those things on the seashores and in the redwood forests, in the deserts and on the plains. Even grown-up persons with children of their own cannot give a reasonable account of concepts such as entropy, sacrament, syntax, number, quantity, pattern, linear relation, name, class, relevance, energy, redundancy, force, probability, parts, whole, information, tautology, homology, mass (either Newtonian or Christian), explanation, description, rule of dimensions, logical type, metaphor, topology, and so on. What are butterflies? What are starfish? What are beauty and ugliness?

It seemed to me that the writing out of some of these very elementary ideas could be entitled, with a little irony, *Every Schoolboy Knows*.

But as I sat in Lindisfarne, working on these two manuscripts, sometimes adding a piece to one and sometimes a piece to the other, the two gradually came together, and the product of that coming together was what I think is called a Platonic view. It seemed to me that in *Schoolboy* I was laying down very elementary ideas about epistemology, that is, about *how we can know anything*. In the pronoun *we*, I of course included the starfish and the redwood forest, the segmenting egg, and the Senate of the United States.

And in the *anything* which these creatures variously know, I included "how to grow into five-way symmetry," "how to survive a forest fire," "how to grow and still stay the same shape," "how to learn," "how to write a constitution," "how to invent and drive a car," "how to count to seven," and so on. Marvelous creatures with almost miraculous knowledges and skills.

Above all, I included "how to evolve," because it seemed to me that both evolution and learning must fit the same formal regularities or so-called laws. I was, you see, starting to use the ideas of *Schoolboy* to reflect not upon our own knowing but upon that *wider knowing* which is the glue holding together the starfishes and sea anemones and redwood forests and human committees.

My two manuscripts were becoming a single book because there is a single knowing which characterizes evolution, as well as which *aggregates* humans, even though committees and nations may seem stupid to two-legged geniuses like you and me.

I was transcending the line which is sometimes supposed to enclose the human being. In other words, as I was writing, mind became, for me, a reflection of many parts of the natural world outside the thinker.

On the whole, it was not the crudest, the simplest, the most animalistic and primitive aspects of the human species which were reflected in the natural phenomena. It was, rather, the more

BY GREGORY BATESON

PAINTING BY BILL MARTIN

complex the aesthetic, the intricate, and the elegant aspects of people that reflected nature If was not my greed my purposiveness my so-called animal so-called instincts which I was recognizing on the other side of that mirror over there in "nature" Rather, I was seeing there the roots of human symmetry beauty and ugliness, aesthetics, the human being's very aliveness and little bit of wisdom His wisdom his bodily grace, and even his habit of making beautiful objects are just as animal as his cruelty After all the very word *animal* means "endowed with mind or spirit (*animus*) "

Against this background, those theories of man that start from the most animalistic and maladapted psychology turn out to be improbable first premises from which to approach the psalmist's question, "Lord, what is man?"

I never could accept the first step of the Genesis story "In the beginning the earth was without form and void" That primary *tabula rasa* would have set a formidable problem in thermodynamics for the next billion years Perhaps the earth never was any more a *tabula rasa* than is a human zygote—a fertilized egg

It began to seem that the old-fashioned and still-established ideas about epistemology, especially human epistemology were a reflection of an obsolete physics and contrasted in a curious way with the little we seem to know about living things It was as if members of the species man were supposed to be totally unique and totally materialistic against the background of a living universe which was generalized (rather than unique) and spiritual (rather than materialistic)

There seems to be something like a Gresham's law of cultural evolution, according to which the oversimplified ideas will always displace the sophisticated and the vulgar and hateful will always displace the beautiful And yet the beautiful persists

It began to seem as if organized matter—and I know nothing about unorganized matter, if there is any—in even such a simple set of relations as exists in a steam engine with a governor was wise and sophisticated compared with the picture of human spirit that orthodox materialism and a large part of orthodox religion currently drew

The germ of these ideas had been in my mind since I was a boy But let me start from two contexts in which these thoughts began to insist on utterance In the 1950s I had two teaching tasks I was teaching psychiatric residents at a Veterans Administration mental hospital in Palo Alto and young beatniks in the California School of Fine Arts in San Francisco I want to tell you how those two courses commenced how I approached those two contrasting audiences If you put these two first lectures side by side you will see what it is I am trying to say

To the psychiatrists, I presented a challenge in the shape of a small exam paper telling them that by the end of the course they should understand the questions in it Question 1 asked for brief definitions of *sacrament* and *entropy*

The young psychiatrists in the 1950s were in general unable to answer *either* question Today a few more could begin to talk about entropy And I suppose there are still some Christians who could say what a sacrament is

I was offering my class the core notions of 2,500 years of thought about religion and science I felt that if they were going to be doctors (medical doctors) of the human soul they should at least have a foot on each side of the ancient arguments They should be familiar with the central ideas of both religion and science

For the art students, I was more direct It was a small group of about 10 to 15 students and I knew that I would be walking into an atmosphere of skepticism bordering on hostility When I entered it was clear that I was expected to be an incarnation of

> *"I was very lucky to be teaching people who were not scientists Untrained as they were, their bias was aesthetic By* aesthetic, *I mean responsive to* the pattern which connects *"*

the devil, who would argue for the common sense of atomic warfare and pesticides In those days (and even today?) science was believed to be "value-free" and not guided by "emotions"

I was prepared for that I had two paper bags and the first of these I opened, producing a freshly cooked crab which I placed on the table I then challenged the class somewhat as follows "I want you to produce arguments which will convince me that this object is the remains of a living thing You may imagine If you will that you are Martians and that on Mars you are familiar with living things being, indeed yourselves alive But of course you have never seen crabs or lobsters A number of objects like this, many of them fragmentary have arrived perhaps by meteor You are to inspect them and arrive at the conclusion that they are the remains of living things How would you arrive at that conclusion?"

Of course the question set for the psychiatrists was the *same question* as that which I set for the artists Is there a biological species of entropy?

Both questions concerned the underlying notion of a dividing line between the world of the living (where *distinctions* are drawn and *difference* can be a cause) and the world of nonliving billiard balls and galaxies (where *forces* and *impacts* are the causes of events) These are the two worlds that Jung (following the Gnostics) calls *creatura* (the living) and *pleroma* (the nonliving) I was asking, What is the difference between the physical world of the *pleroma* where forces and impacts provide sufficient bases of explanation and the *creatura*, where nothing can be understood until differences and distinctions are invoked?

In my life I have put the descriptions of sticks and stones and billiard balls and galaxies in one box the *pleroma* and have left them alone In the other box I put living things crabs people problems of beauty and problems of difference The contents of the second box are the subject of this [article]

I was griping recently about the shortcomings of Occidental education It was in a letter to my fellow regents of the University of California and the following phrase crept into my letter "Break the pattern which connects the items of learning and you necessarily destroy all quality"

I offer you the phrase *the pattern which connects* as a synonym another possible title for this [article]

What is the pattern which connects all the living creatures?

Let me go back to my crab and my class of beatniks I was very lucky to be teaching people who were not scientists and the bias of whose minds was even antiscientific All untrained as they were their bias was aesthetic By *aesthetic*, I mean responsive to *the pattern which connects* So you see I was lucky Perhaps by coincidence I faced them with what was (though I knew it not) an aesthetic question How are you related to this creature? What is the pattern which connects you to it?

By putting them on an imaginary planet Mars, I stripped them of all thought of lobsters amoebas cabbages and so on and forced the diagnosis of life back into identification with living self "*You* carry the bench marks the criteria with which you could look at the crab to find that it too carries the same marks" My question was much more sophisticated than I knew

So they looked at the crab And first of all they came up with the observation that it is *symmetrical*, that is, the right side resembles the left

Very good You mean it's *composed*, like a painting? (No response)

Then they observed that one claw was bigger than the other So the crab was *not* symmetrical

I suggested that if a number of these objects had come by meteor they would find that in almost all specimens it was the same side (right or left) that carried the bigger claw (No response *What's Bateson getting at?*)

Going back to symmetry somebody

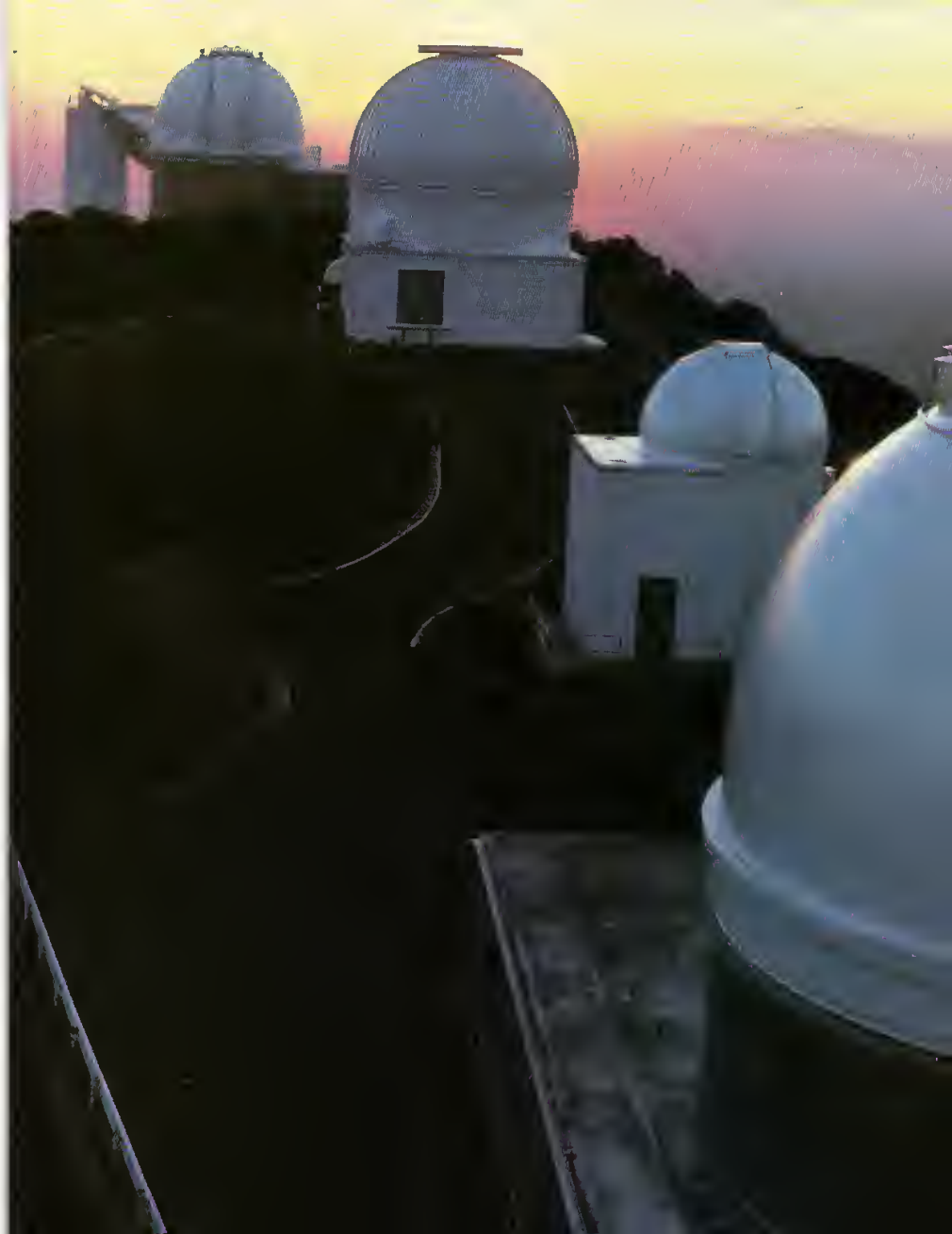
CONTINUED ON PAGE 106

Detail from painting *Au urm* by Bill Martin

EYES ON THE UNIVERSE

BY TRUDY E. BELL

Every nightfall at
hundreds of observatories
astronomers probe the
universe's frontiers
Observatories themselves
are sculptures of
science where astronomy and
architecture meet—
whether caught in
the crackling power
of a lightning storm (left)
or in sunny quietude (below).



The last copper rays of the setting sun glint off the rear wall of the silver and white observatory domes, whose open shutters face the darkening east. In an hour or so the temperature inside each dome will equalize with the night air outside, and overhead will arch the star-flung sky. This is the telescope's hour. Under the dome an astronomer uncaps the optics and slews the leviathan camera onto a distant galaxy or quasar, to gather light that may have begun its journey before the swirling primordial nebula condensed to form our sun and the earth.

In this photographic celebration of the astronomer's quest, it is evident that not all observatories are the same. Some domes are short and squat, others tower 19 stories high, and some aren't even domes at all. Yet all these designs have purpose. Indeed, observatories embody

Clockwise from left: silver dome of the Kiso Observatory, Tokyo, Japan; white dome of one of the 40-centimeter reflecting telescopes at Kitt Peak National Observatory, Arizona; panoramic view of four other Kitt Peak telescope domes.

"Nightfall is the telescope's hour—when it gathers faint light emitted before the earth was formed."

the architectural premise that grace of form follows function.

Observatories are found on remote mountaintops high above the dirty turbulence of lower air. From their lofty summits they unconsciously command the grand rugged beauty of mountain terrain. The hemispherical dome is a recurrent form because it effectively shields the telescope from wind and weather while permitting it to rotate freely in all directions. The structure housing the telescope is always painted white or silver, creating a daytime mood of shrinelike peace. These colors best reflect the sun's radiation and thus minimize stress on the telescope from the grueling daily cycle of heating and cooling.

The most arresting astronomical instrument shown here is the white slanting shaft of the McMath solar telescope at Kitt Peak National

Clockwise from left: six-meter reflecting telescope—world's largest—seen inside its dome in the Caucasus Mountains, dome of a 2.1-meter reflector Kitt Peak, corrugated building housing a 91-centimeter reflector at Kitt Peak

An observatory is a prime example of the premise that the grace of form follows function.

"Domed shapes shield the telescope from wind and weather, while permitting free rotation."

Observatory in Arizona (page 65). A clock-driven mirror at the top of the shaft tracks the sun across the sky and reflects its image down the shaft to an underground observing room 30 stories below. Since the telescope shaft points toward the north celestial pole, the angle it makes with the horizon is equal to the telescope's geographical latitude. If the telescope were farther north, the shaft would be more steeply inclined. Thus, once again, form follows function.

And yet the aesthetic attraction of observatories never seems to be sacrificed by stringent functional requirements. If anything, it seems to be enhanced. Perhaps the awesome beauty of the universe is likewise deeply rooted in its function—mystery that may someday be revealed to us through the eye of the telescope. ∞

Below: trails of stars rising over a 2.1-meter telescope dome at Kitt Peak, the time exposure blurring the bright image of Comet West in the morning sky, the distinctive slanting shaft and tower of the McMath solar telescope at Kitt Peak.

FICTION

HALFJACK

Half-man, half-machine,
he roamed among the stars, seeking fulfillment

BY ROGER ZELAZNY

He walked barefoot along the beach. Above the city several of the brighter stars held for a few final moments against the wash of light from the east. He fingered a stone, then hurled it in the direction from which the sun would come. He watched for a long while until it had vanished from sight. Eventually it would begin skipping. Before then, he had turned and was headed back to the city, the apartment, the girl.

Somewhere beyond the skyline a vehicle lifted, burning its way into the heavens. It took the remainder of the night with it as it faded. Walking on, he smelled the countryside as well as the ocean. It was a pleasant world, and this a pleasant city—spaceport as well as seaport—here in this backwater limb of the galaxy. A good place in which to rest and immerse the neglected portion of himself in the flow of humanity, the colors and sounds of the city, the constant tugging of gravity. But it had been three months now. He fingered the scar on his brow. He had let two offers pass him by, to linger. There was another pending his consideration.

As he walked up Kathi's street, he saw that her apartment was still dark. Good, she would not even have missed him, again. He pushed past the big front door, still not repaired since he had kicked it open the evening of the fire, two—no, three—nights ago. He used the stairs. He let himself in quietly.

He was in the kitchen preparing breakfast when he heard her stirring.

"Jack?"

"Yes. Good morning."

"Come back."

"All right."

He moved to the bedroom door and entered the room. She was lying there, smiling. She raised her arms slightly.

"I've thought of a wonderful way to begin the day."

He seated himself on the edge of the bed and embraced her. For a moment she was sleep-warm and sleep-soft against him, but only for a moment.

"You've got too much on," she said, unfastening his shirt.

He peeled it off and dropped it. He removed his trousers. Then he held her again.

"More," she said, tracing the long fine scar that ran down his forehead, alongside his nose, traversing his chin, his neck, the right side of his chest and abdomen, passing to one side of his groin, where it stopped.

"Come on."

"You didn't even know about it until a few nights ago."

She kissed him, brushing his cheek with her lips.

"It really does something for me."

"For almost three months—"

"Take it off. Please."

He sighed and gave a half-smile. He rose to his feet.

"All right."

He reached up and put a hand to his long, black hair. He

PAINTING BY MICHEL HENRICOT

took hold of it. He raised his other hand and spread his fingers along his scalp at the hairline. He pushed his fingers toward the back of his head and the entire hairpiece came free with a soft, crackling sound. He dropped the hairpiece atop his shirt on the floor.

The right side of his head was completely bald; the left had a beginning growth of dark hair. The two areas were precisely divided by a continuation of the faint scar on his forehead.

He placed his fingertips together on the crown of his head, then drew his right hand to the side and down. His face opened vertically, splitting apart along the scar, padded synthetic flesh tearing free from electrostatic bonds. He drew it down over his right shoulder and biceps, rolling it as far as his wrist. He played with the flesh of his hand as with a tight glove, finally withdrawing the hand with a soft, sucking sound. He drew it away from his side, hip and buttock, and separated it at his groin. Then, again seating himself on the edge of the bed, he rolled it down his leg, over the thigh, knee, calf, heel. He treated his foot as he had his hand, pinching each toe free separately before pulling off the bodyglove. He shook it out and placed it with his clothing.

Standing, he turned toward Kathi, whose eyes had not left him during all this time. Again, the half-smile. The uncovered portions of his face and body were dark metal and plastic, precision-machined, with various openings and protuberances, some gleaming, some dusky.

"Halfjack," she said as he came to her. "Now I know what that man in the cafe meant when he called you that."

"He was lucky you were with me. There are places where that's an unfriendly term."

"You're beautiful," she said.

"I once knew a girl whose body was almost entirely prosthetic. She wanted me to keep the glove on—at all times. It was the flesh and the semblance of flesh that she found attractive."

"What do you call that kind of operation?"

"Lateral hemicorporectomy."

After a time she said, "Could you be repaired? Can you replace it some way?"

He laughed.

"Either way," he said. "My genes could be fractioned, and the proper replacement parts could be grown. I could be made whole with grafts of my own flesh. Or I could have much of the rest removed and replaced with biomechanical analogues. But I need a stomach and balls and lungs because I have to eat and screw and breathe to feel human."

She ran her hands down his back, one on metal, one on flesh.

"I don't understand," she said when they finally drew apart. "What sort of accident was it?"

"Accident? There was no accident," he said. "I paid a lot of money for this work, so that I could pilot a special sort of ship. I am a cyborg. I hook myself directly into each of the ship's systems."

He rose from the bed, went to the closet, drew out a duffel bag, pulled down an armful of garments, and stuffed them into it. He crossed to the dresser, opened a drawer, and emptied its contents into the bag.

"You're leaving?"

"Yes."

He entered the bathroom, emerged with two fistfuls of personal items, and dropped them into the bag.

"Why?"

He rounded the bed, picked up his bodyglove and hairpiece, rolled them into a parcel, and put them inside the bag.

"It's not what you may think," he said then, "or even what I thought until just a few moments ago."

She sat up.

"You think less of me," she said, "because I seem to like you more now that I know your secret. You think there's something pathological about it—"

"No," he said, pulling on his shirt, "that's not it at all. Yesterday I would have said so and used that for an excuse to storm out of here and leave you feeling bad. But I want to be honest with myself this time, and fair to you. That's not it."

> *Standing, he turned toward Kathi, whose eyes had not left him. . . . Again, the half-smile. The uncovered portions of his face and body were dark metal and plastic . . . machined. . . .*

He drew on his trousers.

"What then?" she asked.

"It's just the wanderlust, or whatever you call it. I've stayed too long at the bottom of a gravity well. I'm restless. I've got to get going again. It's my nature, that's all. I realized this when I saw that I was looking to your feelings for an excuse to break us up and move on."

"You can wear the bodyglove. It's not that important. It's really *you* that I like."

"I believe you. I like you, too. Whether you believe me or not, your reactions to my better half don't matter. It's what I said, though. Nothing else. And now I've got this feeling I won't be much fun anymore. If you really like me, you'll let me go without a lot of fuss."

He finished dressing. She got out of the bed and faced him.

"If that's the way it has to be," she said. "Okay."

"I'd better just go, then. Now."

"Yes."

He turned and walked out of the room, left the apartment, used the stair again and departed from the building. Some passersby gave him more than a casual look; cyborg pilots not being all that common in this sector. This did not bother him. His step lightened. He stopped in a paybooth and called the shipping company to tell them that he would haul the load they had in orbit, the sooner it was connected with his vessel the better he said.

Loading the controller told him, would begin shortly and he could ship up that same afternoon from the local field. Jack said that he would be there and then broke the connection. He gave the world half a smile as he put the sea to his back and swung on through the city, westward.

Blue-and-pink world below him, black sky above, the stars a snapshot snowfall all about, he bade the shuttle pilot goodbye and keyed his airlock. Entering the *Morgana*, he sighed and set about stowing his gear. His cargo was already in place and the ground computers had transferred course information to the ship's brain. He hung his clothing in a locker and placed his bodyglove and hairpiece in compartments.

He hurried forward then and settled into the control web, which adjusted itself about him. A long, dark unit swung down from overhead and dropped into position at his right. It moved slowly, making contact with various points on that half of his body.

—Good to have you back. How was your vacation, Jack?

—Oh. Fine. Real fine.

—Meet any nice girls?

—A few.

—And here you are again. Did you miss things?

—You know it. How does this haul look to you?

—Easy for us. I've already reviewed the course programs.

—Let's run over the systems.

—Check. Care for some coffee?

—That'd be nice.

A small unit descended on his left, stopping within easy reach of his mortal hand. He opened its door. A bulb of dark liquid rested in a rack.

—Timed your arrival. Had it ready.

—Just the way I like it, too. I almost forgot. Thanks.

Several hours later, when they left orbit, he had already switched off a number of his left-side systems. He was merged even more closely with the vessel, absorbing data at a frantic rate. Their expanded perceptions took in the near-ship vicinity and moved out to encompass the extrasolar panorama with greater than human clarity and precision. They reacted almost instantaneously to decisions great and small.

—It is good to be back together again, Jack.

—I'd say.

Morgana held him tightly. Their velocity built ∞

Photograph by Pat Hill

Our one scientist
closest to the President
is anxious to
reverse the downward curve
of fiscal support
for scientific research

INTERVIEW

FRANK PRESS

Frank Press made his scientific reputation by researching the mechanism and prediction of earthquakes, a particularly appropriate background for the position he now holds: science adviser to the President of the United States and director of the White House Office of Science and Technology Policy. The position has had a tumultuous history. Established by President Dwight Eisenhower to help calm public fears after the Soviet Union orbited the first man-made satellite and elevated in the federal hierarchy by John F. Kennedy, the post was abused by Lyndon Johnson (who resented scientists' opposition to the Vietnam War), abolished by Richard Nixon, and finally revived by Gerald Ford.

When Jimmy Carter took office—determined to fulfill his campaign pledges and cut the federal payroll—the Office of Science and Technology Policy seemed a prime candidate for obliteration. After all, a President trained as an engineer didn't need a professor on board to counsel him on science and technology. Rumors of the new President's uncertain attitude were not happily received by the elders of American science, many of whom had lobbied Gerald Ford to undo Richard Nixon's axing of their principal contact point in Washington. From across the country leading researchers signaled their distress, and cautious Jimmy Carter, who tends to ask around before making a serious move, responded by appointing a science adviser. Frank Press, fifty-two, chairman of the department of earth and planetary sciences at MIT. His selection puzzled most observers because Press had not been connected with Carter's presidential campaign.

Born in New York City, Frank Press received his undergraduate degree from the College of the City of New York and a Ph.D. in geophysics from Columbia in 1949 and was off to a swiftly rising career. He has since authored 160 papers and, at the tender age of thirty-three, won election to the National Academy of Sciences. Press's pioneering work in seismology and deep-earth structures led to his appointment as a member of the U.S. delegation to

nuclear-fest ban negotiations in the late Fifties and early Sixties He subsequently became a member of the President's Science Advisory Committee, a now-defunct council of senior scientists attached to the office of the President s science adviser

After two years as President Carter's science adviser (since May 1977), Press holds an established position in Washington s scheme of things Neither a political operator nor a member of any particular faction in the administration, he is valued by the President as a reliable source of information and analysis on an ever-widening range of issues 'He's one of the people whose word we can trust at face value,' says a senior member of the Office of Management and Budget Press played a key part in the opening of relations with China, heading one of the first U S delegations formed to plan collaborative efforts with the Chinese As our government's top official in science, he has reversed the decline of financial support for research

If any criticism exists as to Press's performance, it might be for his passionless support of the President. The scientist s own views on research and development are impossible to distinguish from official administration positions Frank Press doesn't dispute the charge; he wears it like a badge of honor, stressing that he was hired to work for the President, not to serve as the scientific community s lobbyist in Washington

Dr Press recently had the following conversation with Daniel S Greenberg a frequent contributor to *Omni* and a longtime observer of the science and government scene in Washington

Omni: There have been many warnings recently that American science is facing a crisis, that our ability to develop new technology is falling apart, that federal funding is inadequate How do you assess the health of our science and technology? What's strong and what's weak?

Press: When you travel through other countries and ask them how we are doing, you find that they are in awe of us Look at the Nobel prizes, look at where some of the startling new ideas are coming from Our science and technology are strong in comparison with the rest of the world, and anybody who says that they are falling apart is crying wolf

I am concerned not about our present position but about trends which might cause us some problems if they continue Are our young scientists employed to the top of their abilities? Are those with the best ideas able to raise research funds fo prosecufe fhose ideas?

Omni: Is this a good time for a bright young person to go into science?

Press: We don't have an unemployment problem for young scientists and engineers In fact there's a huge unfilled demand for engineers Most of the basic research however is done at universities, and our universities have the problem of aging facufties The rigidity of fenure makes it difficult for universities to hire young people Some try to deal with the problem by bringing in young people for postdoctorate work or other nonfaculty positions That provides jobs which is good, but it also means that these young scientists lack independence They can't raise money for their own ideas from government research agencies when they are employed by senior people as helpers—highly professional helpers, but not always in a situation where the best use is being made of their talents

Omni: What about the procedures for obtaining government funding?

Press: Visit scientists and ask what their lives are like They're writing proposals all the time It s a frantic effort to get so many commitments of money from so many different sources just to keep up a common laboratory They're running on a treadmill to keep their teams together, rather than doing what they know best That's not an efficient way to do scientific research

Omni: Much of the red tape seems to originate in the executive branch of the government The Office of Management and Budget for example now has the universities up in arms about accounting methods for their research A great deal of time and effort is going into a bureaucratic fight on this mainly on the subject of indirect costs for research

Press: We're frying to find nonbudgetary ways to improve the research climate, such as encouraging shorter proposals and reducing reporting requirements We want to simplify the regulations on indirect costs while taking into account the different procedures of different universities—big and small private and state

Many congressmen believe—erroneously in my opinion—that universities are using indirect costs to enrich themselves There are some cases where their performance doesn't stand up when it comes to accountability and we have to show Congress that we are reviewing these cases and that the new regulations will work to correct the situation If we don't get regulations that are more efficient and consistent with modern accounting procedures Congress will do it, so we re taking the initiative

Omni: This is the first administration in a long time that has proposed no big new technology initiatives in space or elsewhere To the contrary, it has attempted to stop some existing projects such as the Clinch River breeder reactor Why doesn't President Carter have any grandiose plans for big technology as most of his predecessors did?

Press: First of all, he understands technology, so nobody is going fo sell him a bill of goods If you want a big technological effort in energy say or in space he's going to ask, Why are we doing it? How will it help? Is it cost-efficient? Is it environmentally sound? Is if consistent with other goals such as nonproliferation, for example? In the case of the Clinch River plant he was worried that a similar course if adopted by other nations would lead fo nuclear weapons proliferation

Omni: Why haven't we seen more progress in reducing our dependence on oil? What does R and D have to offer in thaf area?

Press: There's fusion, geothermal and ocean thermal power windmills waves and tides, there's fission, including breeders and advanced converters which use uranium more efficiently, there's solar power in all its forms from hydroelectric to biomass to photovoltaics to solar thermal We can't invest in all of these we have to make prudent judgments, and those judgments have to take into account the environment the competitive position of U S industry, the costs, and other factors, as well as the technology These questions are terribly complex, and yet we have to make decisions today We're spending more money on fusion than the rest of the world is, more money on breeder technology more money on synthetic fuels right on down the line—and we can't keep doing that

The President doesn t want to put federal money into demonstration plants where the product will be twice as expensive as alternative sources However when it comes to fusion or solar energy—the long-lead time but highly important research areas where industry can't afford to invest yet because the payback is too distant or the risks are too great—there we have an appropriate role And those are precisely the areas which are treated very well in the budgef

Omni: What about space?

Press: We have reached a transition point in our space program We now have the tools to use space in important ways for the good of mankind with all the things that remote sensing can do for us monitoring pollution and atmospheric changes mapping developing countries verifying arms-control agreements locating mineral resources That s where we want to put our money

We re not going to shortchange the space sciences which have a very high priority There's the big telescope, the *Pioneer* probes of Venus and the *Voyagers* fo Jupiter and beyond, the high-energy astronomy satellites, the solar-polar mission We protected all of these programs in the face of a very fight budget even with space-shuttle overruns which will require one hundred eighty million dollars that we were going to use for other things

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"Charles has one of the first pacemakers ever built."

The Moon stays constantly over a slice of Earth bounded by latitude twenty-nine north and the same distance south; if one man owned all that belt of Earth—it's roughly the tropic zone—then he'd own the Moon, too, wouldn't he? By all the theories of real-property ownership that our courts pay attention to."—D. D. Harriman, hero of Robert Heinlein's classic novel The Man Who Sold the Moon.

When we opened the American West, if you can believe Hollywood, the law trailed years behind the settlers, then had to be forced on unwilling cattle barons, rustlers, and thieves at six-gun point. We're doing things a little more neatly these days. Laws and treaties that will govern the first space settlers are already on the books.

Space law falls into two categories. Many legal issues deal with the impact of space exploitation on our home planet. The work that went into setting up the communications-satellite companies in the mid-Sixties is a good

THE MATTER OF SPACE LAW

BY GEORGE S. ROBINSON

"Legal engineers" work to keep the peace in the last frontier

PAINTING BY INGO SWANN

example In the long run though the second category may be more important How will we govern the space colonies themselves? All through space law there are far more questions than answers

However much respect we have for such concepts as 'human rights' and 'natural law' it is clear that we cannot hope to carry our legal traditions beyond Earth's atmosphere The laws that govern our colonists must grow naturally out of the demands that space itself makes on people who would live in it Obvious as this principle is there is little evidence that today's lawmakers understand it The international treaties on which space law is based all center on earthly concerns and approach them in traditional ways

At the root of all space law is the U N Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space Including the Moon and Other Celestial Bodies Known casually as the Outer Space Treaty, it provides that

- Space exploration shall be conducted for the benefit of all countries and shall be the province of all mankind
- Outer space and celestial bodies cannot be nationalized
- Space research must further the interests of international cooperation understanding, and peace not merely in space but particularly on Earth
- Nuclear weapons and other weapons of mass destruction military bases, installations or fortifications maneuvers and weapons testing are all banned from space
- Astronauts are envoys of mankind and must be given assistance and protection in their endeavors
- States, governments, and international organizations accept certain liabilities for activities and accidents arising from their space explorations
- Celestial bodies must not be contaminated with earthly life forms, nor may Earth be confaminated with extraterrestrial organisms
- Governments must consult one another when a planned experiment might interfere with the activities or interests of countries not involved in the projected undertaking

These are noble sentiments and it seems that the diplomats who dratted the treaty sincerely hoped to keep space free of the national bickering that sometimes threatens human survival here on Earth Yet since the treaty was opened for signing lawyers politicians and military planners have consistently tried to reinterpret it to their economic and military advantage

"Damnation nationalism should stop at the stratosphere —Harriman

For example though the treaty prohibits nationalization of space or celestial bodies one form of nationalization has already been attempted In December 1976 eight equatorial countries signed the Declaration of Bogota which claims that certain parts of space are not really 'space' at all at least as the Outer Space Treaty means it The regions in question are the highly desirable equatorial geostationary orbits positions 35 903 kilometers over the equator where a satellite will remain above the same point on the planet's surface at all times Unlike the rest of space the declaration would have us believe these orbits are rare and limited natural resources owned by the countries lying beneath them It is unlikely that other nations will accept this assertion

Then there is the question of what military activities can be allowed in space For that matter just what activities are military? And is there any effective way to prohibit the undesirable ones? These may be the most difficult questions in space law

The United States itself provides two good examples of the problem The Outer Space Treaty bars "weapons of mass destruction" from space and technically we have obeyed that edict But military navigation satellites are a key part of our ICBM guidance systems As military planners explain it only warheads are banned under the treaty not the means of delivering them

"The shuttle is a peaceful research vehicle, to hear us tell it, Yet the Soviet Union sees it as a manned satellite killer, a versatile space weapon, potentially the most deadly military tool ever devised"

And what about the space shuttle recipient of NASA's almost entire budget? As we tell it the shuttle is strictly a peaceful research vehicle But when Alexei Leonov head of the Soviet Union's cosmonaut corps visited this country several years ago and looked at a shuttle mock-up he couldn't understand why we objected to his nation's killer-satellite program The shuttle Leonov pointed out could be the most efficient satellite destroyer yet devised In fact it could carry out virtually any offensive chore a military tactician might want done Russia has yet to demand that we abandon the shuttle as a potentially offensive space weapon

One painful lesson becomes clear There is no practical way to ban from space any activity that a technologically able nation wants to put there The Outer Space Treaty will be effective only if nations obey it of their own will policed by an informed public opinion

Despite its limitations the treaty paved the way for several very practical agreements For example the International Convention on Registration of Objects Launched into Outer Space makes it mandatory to register launchings and report such data as the satellite's identifying features orbital data and general function Without such reports it is all too possible to mistake a new peaceable satellite for an orbital weapon or nuclear missile

The 1971 Convention on International Liability for Damage Caused by Space Objects was an equally useful accord—or so it seemed As larger satellites are built their chances of surviving reentry also increase escalating the risk that they will cause major damage when they crash back to Earth Under this convention spacefaring nations would pay for any destruction caused by their reentering space vehicles

Until last summer the convention seemed to guarantee that plummeting spacecraft would at least cause their unwitting recipients no permanent financial damage Then came the fall of *Cosmos 954* into the Canadian wilderness last summer Because the satellite was nuclear-powered and aimed at gathering military intelligence the Soviet Union was anything but helpful in tracking the object and locating its fragments Only months later did the USSR agree to pay some of the retrieval costs—a commitment the Russian government has since renounced The United States may well be tested on this point when *Skylab 4* fears back into our atmosphere

Then there is the 1968 Treaty on the Return of Astronauts and the Return of Objects Launched into Outer Space Under this agreement any country whose astronauts encounter any trouble must promptly notify the United Nations Other nations must give endangered astronauts all reasonable help and immediately return downed space crews to their homelands Unmanned spacecraft must also be returned to the country that launched them and the launching authority must pay recovery expenses

Again this is a truly humanitarian accord—on the surface Underneath however it is not hard to sense the space powers' fear that astronauts and spacecraft possessing valuable military and economic secrets could be lost with no legal way to retrieve them

There are any number of earth-oriented legal problems that no one has even begun to deal with How do the laws of product and contract liability apply to space efforts? How do insurance regulations negligence statutes labor laws and workmen's compensation translate into space? And how do domestic rules and standards apply? The Occupational Safety and Health Act alone has been a baffling legal tangle on Earth Adapting it for space industries will be even more chaotic

One thorny problem is how we regulate satellites that threaten national sovereignty in nonmilitary ways orbital transmitters that

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ALIEN

A close encounter of the most hideous kind. Obscene. Elegant. And horrifyingly lethal.

Out in deep space, a commercial starship is cruising toward home. Its crew of seven astronauts (five men, two women) is safely ensconced in suspended animation. The space freighter is ably controlled by its superintelligent computer named Mother. Suddenly an uncharted planet rouses the crew from its intergalactic slumber. The astronauts set out to explore the planet and find a huge abandoned spacecraft with the skeleton of the pilot—a 4.3-meter (14-foot) giant—still at the controls. What ended the giant's life is a mystery.

One of the astronauts then discovers hundreds of huge

BY CYNTHIA GRENIER

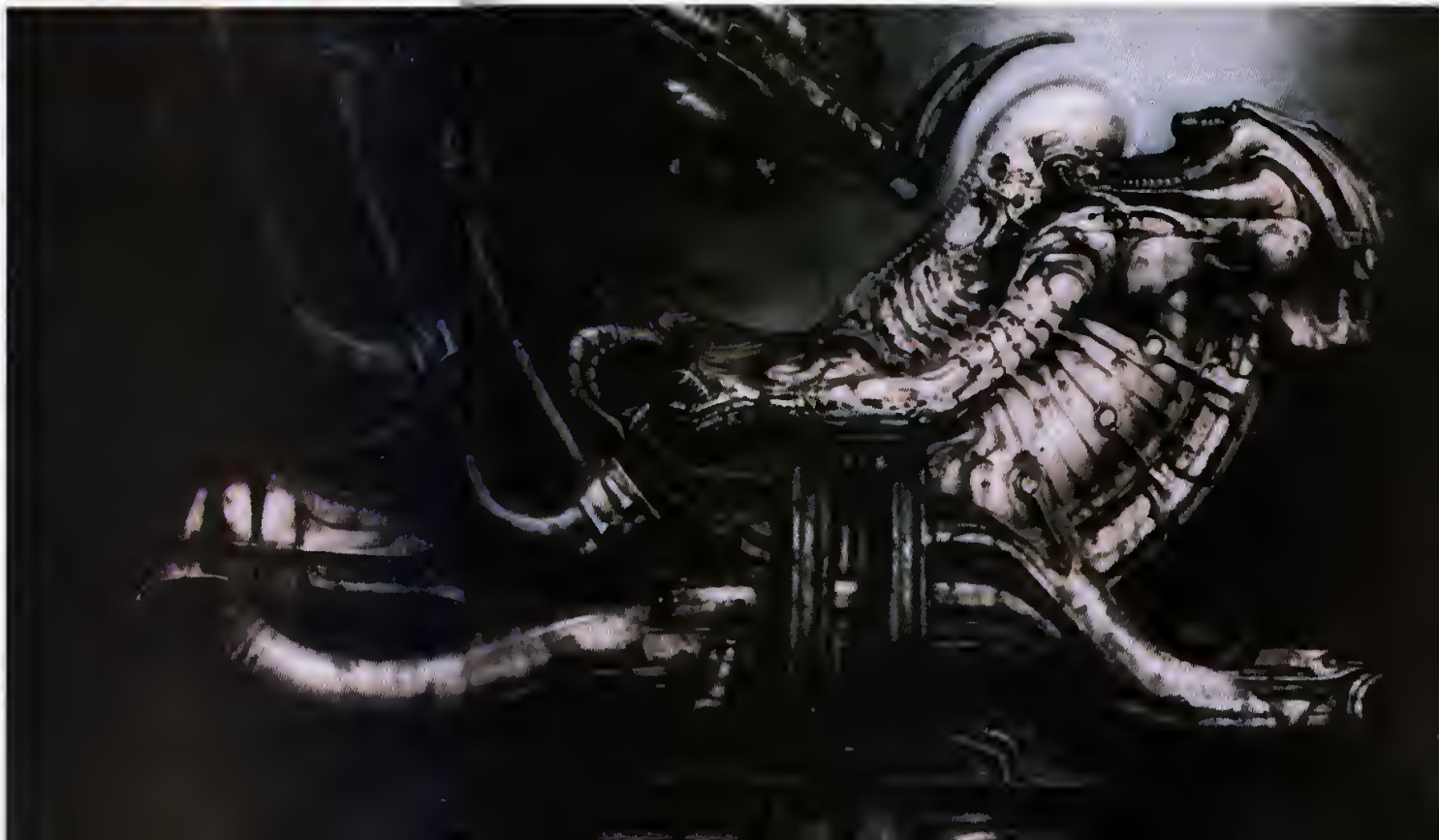
Clockwise from left: Crew explores uncharted planet; astronaut confronts the unspeakable; crew awakens in animation chambers; inside starship with Mother's console in background

"20th Century-Fox has taken extreme measures to keep the Alien's identity a secret"

seeds—egglike leather sacs. He sees something moving inside one of them and puts his face close to it to get a better look. And the terror begins. The seeds eventually confront the crew with something utterly unknown and horribly violently lethal. In fact, something alien.

Twentieth Century-Fox's new SF thriller, *Alien*, has been described as "the dark side of *Close Encounters*." And dark it is as the Alien grows into something more and more horrible and obscene as the motion picture progresses.

What does the Alien look like? We can't show you. Fox has taken extraordinary security measures to keep the Alien's visual identity a secret until the film is released. But we do know that the Alien, including all of his terrifying metamorphoses as he grows



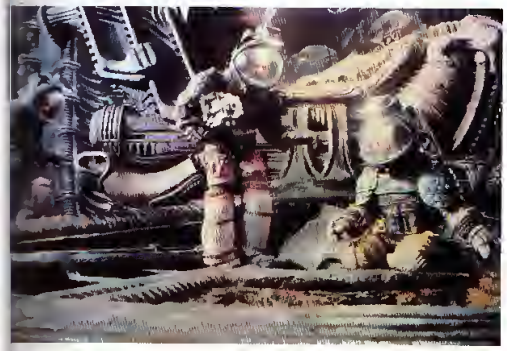
Counterclockwise from right: Giant pilot found dead at his controls, crew penetrates vaginalike entrance, gigantic equipment dominates this Giger set, astronaut peers at long-dead creature

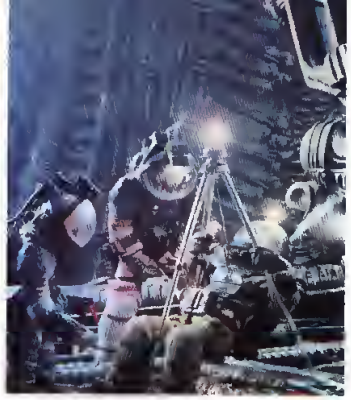
"The seeds eventually confront the crew with something utterly unknown and violently lethal."

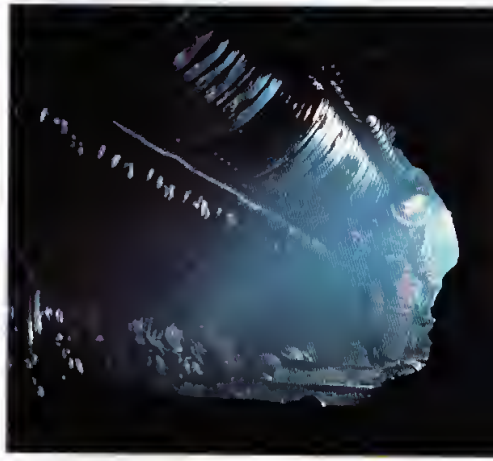
to maturity, has been designed by the Swiss artist H. R. Giger whose work has often been featured in *Omni*.

Director Ridley Scott claims the creature will grip audiences with terror. "Giger's work combines the organic and the technological in a disturbing, almost hideous manner. His paintings are both elegant and obscene." Twentieth Century-Fox is obviously high on the picture. The studio has given it a publicity budget to match its other space film *Star Wars*. (For more details see The Arts/Film, page 24.)

Below: An astronaut discovers hundreds of strange, phallic seeds. Bottom right: He moves in for a closer look, and the terror begins. Three other photos show Giger's "organic technology" approach to set design.







FICTION

THE WAY OF CROSS AND DRAGON

Across the stars he fought against heresy

BY GEORGE R. R. MARTIN

"Heresy," he told me. The brackish waters of his pool sloshed gently.

"Another one?" I said wearily. "There are so many these days."

My Lord Commander was displeased by that comment. He shifted position heavily, sending ripples up

PAINTING BY BOB VENOSA

and down the pool One broke over the side and a sheet of water slid across the tiles of the receiving chamber My boots were soaked yet again I accepted that philosophically I had worn my worst boots, well aware that wet feet are among the inescapable consequences of paying call on Torgathon Nine-Klariis Tûn, elder of the ka-Thane people, and also Archbishop of Vess Most Holy Father of the Four Vows, Grand Inquisitor of the Order Militant of the Knights of Jesus Christ, and counselor to His Holiness Pope Daryn XXI of New Rome

"Be there as many heresies as stars in the sky each single one is no less dangerous Father" the archbishop said solemnly "As Knights of Christ it is our ordained task to fight them one and all And I must add that this new heresy is particularly foul"

"Yes my Lord Commander" I replied "I did not intend to make light of it You have my apologies The mission to Finnegan was most taxing I had hoped to ask you for a leave of absence from my duties I need rest a time for thought and restoration"

"Rest?" The archbishop moved again in his pool, only a slight shift of his immense bulk but it was enough to send a fresh sheet of water across the floor His black pupilless eyes blinked at me "No, Father I am afraid that is out of the question Your skills and your experience are vital for this new mission" His bass tones seemed to soften somewhat then "I have not had time to go over your reports on Finnegan," he said "How did your work go?"

"Badly" I told him "though ultimately I think we will prevail The Church is strong on Finnegan When our attempts at reconciliation were rebuffed, I put some standards into the right hands and we were able to shut down the heretics' newspaper and broadcasting facilities Our friends also made certain that their legal actions came to nothing"

"That is not *badly*," the archbishop said "You won a considerable victory for the Lord and the Church"

"There were riots my Lord Commander" I said "More than a hundred of the heretics were killed and a dozen of our own people I fear there will be more violence before the matter is finished Our priests are attacked if they so much as enter the city where the heresy has taken root Their leaders risk their lives if they leave that city I had hoped to avoid such hatreds such bloodshed"

"Commendable but not realistic" said Archbishop Torgathon He blinked at me again and I remembered that among people of his race blinking is a sign of impatience "The blood of martyrs must sometimes be spilled and the blood of heretics as well What matters it if a being surrenders his life so long as his soul is saved?"

"Indeed" I agreed Despite his impatience Torgathon would lecture me for another hour if given a chance That prospect dismayed me The receiving chamber was not designed for human comfort and I did not wish to remain any longer than necessary The walls were damp and moldy the air hot and humid and thick with the rancid-butter smell characteristic of the ka-Thane My collar was chafing my neck raw I was sweating beneath my cassock my feet were thoroughly soaked and my stomach was beginning to churn

I pushed ahead to the business at hand "You say this new heresy is unusually foul my Lord Commander?"

"It is" he said

"Where has it started?"

"On Arion a world some three weeks' distance from Vess A human world entirely I cannot understand why you humans are so easily corrupted Once a ka-Thane has found the faith he would scarcely abandon it"

"That is well known" I replied politely I did not mention that the number of ka-Thane to find the faith was vanishingly small They were a slow ponderous people, and most of their vast millions showed no interest in learning any ways other than their own or following any creed but their own ancient religion Torgathon Nine-Klariis Tûn was an anomaly He had been among the first converts almost two centuries ago when Pope Vidas L had ruled that nonhumans might serve as clergy Given his great life span and the iron certainty of his belief it was no wonder that Torgathon had risen as far as he had despite the fact that fewer than a thousand of his race had followed him into the Church He had at least a century of life remaining to him No doubt he would someday be Torgathon Cardinal Tûn, should he squelch enough heresies The times are like that

"The very edict that had admitted Torgathon into the clergy had caused a half-dozen worlds to repudiate the Bishop of New Rome and find a particularly ugly heresy."

"We have little influence on Arion" the archbishop was saying His arms moved as he spoke four ponderous clubs of mottled green-gray flesh churning the water and the dirty white cilia around his breathing hole trembled with each word "A few priests a few churches some believers but no power to speak of The heretics already outnumber us on this world I rely on your intellect your shrewdness Turn this calamity into an opportunity This heresy is so palpable that you can easily disprove it Perhaps some of the deluded will turn to the true way"

"Certainly" I said "And the nature of this heresy? What must I disprove?" It is a sad indication of my own troubled faith to add that I did not really care I have dealt with too many heresies Their beliefs and their questionings echo in my head and trouble my dreams at night How can I be sure of my own faith? The very edict that had admitted Torgathon into the clergy had caused a half-dozen worlds to repudiate the Bishop of New Rome and those who had followed that path would find a particularly ugly heresy in the massive naked (save for a damp Roman collar) alien who floated before me and wielded the authority of the Church in four great webbed hands Christianity is the greatest single human religion but that means little The non-Christians outnumber us five to one and there are well over seven hundred Christian sects some almost as large as the One True Interstellar Catholic Church of Earth and the Thousand Worlds Even Daryn XXI, powerful as he is, is only one of seven to claim the title of Pope My own belief was strong once but I have moved too long among heretics and nonbelievers and even my prayers do not make the doubts go away now So it was that I felt no horror—only a sudden intellectual interest—when the archbishop told me the nature of the heresy on Arion

"They have made a saint" he said "out of Judas Iscariot"

As a senior in the Knights Inquisitor I command my own starship which it pleases me to call *Truth of Christ* Before the craft was assigned to me it was named the *St Thomas* after the apostle but I did not feel a saint notorious for doubting was an appropriate patron for a ship enlisted in the fight against heresy I have no duties aboard the *Truth* which is crewed by six brothers and sisters of the Order of St Christopher the Far-Traveling and captained by a young woman I hired away from a merchant trader

I was therefore able to devote the entire three-week voyage from Vess to Arion to a study of the heretical Bible a copy of which had been given to me by the archbishop's administrative assistant It was a thick heavy handsome book bound in dark leather its pages edged with gold leaf with many splendid interior illustrations in full color with holographic enhancement Remarkable work clearly done by someone who loved the all-but-forgotten art of bookmaking The paintings reproduced inside—the originals were to be found on the walls of the House of St Judas on Arion I gathered—were masterful if blasphemous as much high art as the Tammerwens and RoHalldays that adorn the Great Cathedral of St John on New Rome

Inside the book bore an imprimatur indicating that it had been approved by Lukyan Judasson First Scholar of the order of St Judas Iscariot

It was called *The Way of Cross and Dragon*

CONTINUED ON PAGE 115

FUTURE FARMING

The big issue in agriculture today is simply "Will Buck Rogers replace Farmer Brown?"

BY ALAN ANDERSON, JR.

Try to envision one huge machine running in a field of wheat, precision planting a second crop at the same time it is harvesting. The machine could be made of new supermetals and have a computer-controlled, automated operator's station with the precision of modern-day manufacturing machine tools in all its operations. It would have high productivity and would reduce unit production cost to a fraction of present expenses."
—Robert Tweedy, Allis-Chalmers Company

"For twenty years the world has pursued a dead-end path in agriculture. There is no way of avoiding some form of pervasive change in what we are doing. To meet new energy realities farmers must begin to supply large fractions of their own energy. . . . Such self-sufficient farms would tend to be smaller and to provide more employment than those that prevailed in the oil era."
—Denis Hayes, Worldwatch Institute

Large farms or small farms? Energy-intensive technologies or energy-efficient ones? These questions are at the core of a heated debate that has divided the agricultural community into two distinct camps, each of which offers a conflicting view of the future of farming. Whereas the opposing sides in this debate do not agree on solutions, they do concur on the problems.

- Food prices are steadily rising—10 percent in 1978, according to *Business Week*—and will probably continue to do so.
- The world's population may well double by the turn

"I think the whole idea of going back to old-time farming is a lot of baloney"

of the century, leaving the American agricultural industry with having to feed 3 to 4 *billion* more people

• The fossil fuels now used to run most farm machinery are getting both expensive and scarce

HIGH TECH

The futuristic scenario that Robert Tweedy envisions above should not come as a surprise to anyone who has followed the growth of twentieth-century farming. The trend toward mechanization began in the 1930s, when the tractor first reached the farm, and we are better than halfway toward complete mechanization today. Back in 1935 a headline in the *Illinois State Journal* bannered the pleasures of the machine: FARMING ONCE PRIMITIVE, EARLY ILLINOIS CROPS WERE PLANTED, HARVESTED BY TEDIOUS HAND METHODS—FARMERS HAPPY. The tune is much the same today. In 1976 an enthusiastic article in *Successful Farming* magazine began: "Brawny tractors and sleek implements have replaced tired horses and awkward tools."

Today we feel the effects of mechanization more than ever before. Little on the farm has been left to the human hand. No more weeding, for example, since a wide-tired truck can "dope" as much as 200 hectares per day with herbicide. Nine-ton combines can cut a 7.5-meter swath of grain, combining the reaping and threshing operations, and blow it all into grain carts. Mechanical cotton pickers can pluck 9,000 kilograms of cotton a day—it would take 100 humans to do that—and leave the unripe pods in the field to mature. A Rube Goldberg–like potato harvester can excavate five tons of dirt and potatoes a minute, shovel the cut roots and lift the potatoes, spit out the vines, and whisk the potatoes into sacks.

Haying, which used to help thousands of high-school football players get ready for fall, is automated now. One man and a machine can collect, stack, and haul some 3,100 bales—about 100 tons—of hay a day. Even the most tender crops are now harvested by machine. Ernest and Julio Gallo, who produce 35 percent of all California wine, approved the purchase of a new wine-grape harvester. Big tomato growers (is there any other kind?) are buying $200,000 infrared scanners to sort the fruit and complement their mechanical pickers.

Two examples of today's mechanized, energy-intensive farming. Above, a four-wheel-drive tractor pulls a 16-meter-wide cultivator; left, huge combines harvest wheat in Wyoming.

Nor is the farmer himself being neglected. He can now talk with his wife from distant fields via CB radio, hitch a motorbike to his tractor so he can scoot back to the house for lunch, and ride in a quiet, air-conditioned cab on a plush seat designed by orthopedic specialists. John Deere recently set up a Human Factors research section to study the farmer's "operator environment." The farmer's land is worth more than he ever dreamed possible, and his business is being courted by everyone from tape-deck salesmen to travel agents. And with specialization has come more leisure time. *Farm Journal*, one of the most widely read farm magazines, carries a regular feature called Travel News. The farmer keeps up on his own specialty by leafing through such journals as *Weeds Today*, *Wines & Vines*, *Pig International*, *Peanut Science*, and *Hoofs & Horns: The Magazine of the American Cowboy*.

What can we expect of the future? Everything will continue to grow as before, but the farmer will own nearly twice as much land as he does today—perhaps 400 hectares in the Corn Belt. His tractor will still be diesel-powered in the near future, but it will be bigger—around 500 horsepower—and designed to burn other, more exotic, fuels, if necessary (perhaps mixtures of ethyl alcohol and low-grade petroleum). The tractor will cost over a quarter of a million dollars, but for his money the farmer will get an array of on-board computer functions and electronic monitors that would do justice to the starship *Enterprise*. The farmer/operator will have digital displays for every tractor operation, from the rate of plow spin to actual seed-planting depth, and will be able to choose to make adjustments automatically if he feels like reading the morning newspaper. Indeed, the only reason for him to be aboard at all will be that he prefers driving the tractor to sitting at his desk.

To help monitor his farming operation, the farmer will use a home computer that has a direct link to a global satellite system. This system will help him estimate, by measuring reflected solar radiation, acreages to be planted, warn him of incipient diseases, predict harvest figures, and schedule his irrigation times. In addition, daily readouts on international market conditions (both financial and commodity) and new agricultural products will be available.

His computer will also help him decide what to grow each season. Several years ago the computer analyzed his operation and decided that the small amount of beef cattle that he was raising was actually hurting his profits. After getting rid of the cattle, his profits rose much as his neighbor's had when *his* computer recommended that he increase his small turkey operation. His neighbor now raises more than 80,000 birds per year and delivers them frozen, stuffed, and wrapped to the supermarket chain that bought his farm.

Indeed, electronics will change much of life on the farm. Computers will control feeding, slaughter, waste removal, and other "barnyard" chores with electronically powered gates, shockers, cutters, conveyor belts, washers, blowers, dumpers, and haulers. Cattle will wear "cowboots"—handmade leather booties with fancy buckles and electronic sensors that will transmit the weight and whereabouts of the cow

wearing them. Or the cattle will have radio transmitters in their stomachs that beep when radio-interrogated with special units that the farmers will carry. These beepers will enable individual cows to be separated and identified and will act as deterrents to cattle rustlers.

In light of all this, it seems reasonable to ask what the purpose of farming is. The conventional definition is "to produce food and fiber," but that definition is already partially out of date. More and more of our fiber comes not from sheep and cotton fields but from synthetics via our dwindling petroleum stocks. An updated definition is "to feed the world"—a purpose promoted throughout the network of manufacturers and marketers known as agribusiness. And at the heart of agribusiness is the farm-machinery business. Gordon Millar, a vice president for engineering at Deere and Company, the largest producer of farm machinery in the United States, makes the case for agribusiness.

"There is a whole set of historical facts, a whole set of reasonably quantifiable projections that all have to fit together," said Millar recently at Deere headquarters in Moline, Illinois. "In order to survive, people need a certain amount of food. It looks like we'll have between six and a half and eight billion people at the end of this century. That's about twice as many people as we have now. And this food has got to come from somewhere. Who should these farmers be? Now here's where the cheese gets hard. Should they be farmers who live on six to ten acres of land and practice low-productivity primary agriculture simply to feed themselves and their family? Or should we have intensive, high-energy farmers who can feed twenty, thirty, fifty people? Is farming a way of life, like a recreational activity, or is the primary purpose of farming the production of food, so that the billions of people who are not farmers can have plenty to eat? The position I've taken is that we can have both. The Small Is Beautiful people can have their farms, because there won't be very many of them. And others can, for economic or moral or whatever reasons, have high-energy agriculture."

Other officers at Deere are more adamant in their support of large-scale farming. "I think agriculture will continue to become more businesslike," said Fred Stickler, director of Deere's think-tank-like Technical Center. "We've never found a way to refute the economies of scale of larger farms. Farmers will be better managers and better businesspeople. I think the whole idea about going back to the old ways of agriculture is just a lot of baloney."

High-technology, energy-intensive agriculture, however, is not without problems. "I see no way for modern technology to meet the need for a doubling or quadrupling of the food supply of the earth over the next fifty years," says Congressman George Brown (D-Calif.), a senior member of the House Agriculture Committee. As farming has become industrialized it has acquired a vast superstructure of suppliers, researchers, and spokesmen. Fewer people work on farms (farm population shrank 4.8 percent a year throughout the 1960s), and farmers must depend more on outsiders for things they used to do for themselves. They depend on the petrochemical industry for billions of dollars' worth of ammonia, fertilizer, herbicides, insecticides, and fungicides each year. They depend on drug companies for the huge amounts of hormones and antibiotics now used in animal feed. They buy their planting seed from seed companies. Supermarkets supply their food. All of these suppliers—and the prices they charge—are beyond the control of the farmer.

With this dependence on outsiders have come both indebtedness and a consequent loss of freedom. The total farm debt rose last year by 16 percent above the previous year's total to $118.7 billion. A farmer who wants to buy more land or buy more machinery or refinance a loan must go to a banker who usually wants a guarantee that the farmer is going to follow accepted practices of plowing, planting, fertilizing, and spraying. This policy effectively discourages the testing of new (and old) ideas on the farm.

> *"I think agriculture will continue to become more businesslike. We've never found a way to refute the economies of scale of the larger farms. Farmers will just be better businesspeople."*

As farming has become more capital-intensive, it has also become harder to be a farmer. In some regions, in fact, becoming a farmer is all but impossible without inheriting land and/or machinery. A 120-hectare spread in central Illinois—smaller than the average—would cost about $900,000 at today's prices. The machinery to grow soybeans and corn on this ground would be at least $100,000 more. A down payment on all this would come to better than a quarter of a million dollars, and interest on a loan for the rest, assuming it could be found, would be about $60,000 a year.

In the midst of all these forces, the farmer has nowhere to turn but to farm magazines supported by the same people who sell him sprays and drugs and tractors and to government and university researchers who get much of their research monies from those same sellers.

But are we really as agribusiness claims, feeding the world?

Not really, it seems. We export huge amounts of grain, but most is bought for animal feed by wealthy countries like France, West Germany, Japan, and the Soviet Union—not as food for the poor. Could we feed the world even if we wanted to give away grain? "No way," answers Angus Hanson, director of the USDA's Beltsville Agricultural Research Station in Maryland. Even the most generous philanthropist will agree that mass giveaways would trap poor countries into a fatal dependency on food from abroad.

What really seems to be bothering agribusiness is the catastrophic balance-of-payments drain caused by our petro-gluttony—a habit for which there seems to be no cure. Grain exports go a long way toward offsetting this drain, and one can only guess what would happen to our economy if they stopped.

SOFT TECH

The late E. F. Schumacher (author of *Small Is Beautiful*) and other critics have seen dangers in the highly centralized way farming is coordinated today. In reducing the number of farmers, modern agriculture depopulates rural areas and moves the farmers into already-overcrowded cities. In even the richest farming areas of the Corn Belt, small towns are becoming poorer. As unprofitable farms are sold, banks and neighboring farmers buy them up and then rent them to other farmers. Such non-owning landholders give less attention to soil maintenance and fertility than do owners who live upon the land they work. Farmers are also encouraged to grow cash crops for export, diminishing their ability to support themselves and thus the ability to survive on anything less than a large scale.

Schumacher pleaded for what he called "appropriate technology"—methods that could be managed and fueled by the farmer, increasing his independence and self-reliance. Such methods might include solar heating to warm barns and houses, solar cells to power irrigation pumps, alcohol from crop residues to power tractors, methane from manure to dry grain, old-fashioned manure spreading to enrich soil, and rotating crops and using natural predators to control pests. As long as petrochemicals remain cheap, however, many of these techniques will not be cost competitive with modern farming.

The earliest coherent complaints about conventional agriculture came from the so-called organic movement, whose practitioners eschew petroleum-based fertilizers and pesticides in favor of renewable on-farm sources of energy and pest control. Robert Rodale, editor and publisher of *Organic Gardening*, *Prevention*, and *The New Farm*, is perhaps the senior spokesman for the movement today. Rodale is predicting a steady trend toward self-reliance—not a rapid reversal of conventional agripractices. "My guess is that large

CONTINUED ON PAGE 126

"Harold, the Sunday Times is here!"

FLIGHT OF THE ORAGON

A bold confirmation of bestial evolution

BY PETER DICKINSON

There are three possible views about winged, fire-breathing dragons: (1) They are completely legendary; (2) they are largely legendary but contain elements based on fantasized accounts of real animals; (3) they really existed.

I take the third view.

I don't intend to prove that 27-meter lizards once floated in the skies of Earth and scorched whole villages with plumes of flame, because I don't think that can be proved. And I don't think it possible that fossil remains of a true dragon will ever be found. Moreover, it is unlikely that cave paintings showing tribal heroes of the Stone Age battling this ferocious enemy will ever come to light. But I can present a coherent theory at least as probable as the theory that dragons are completely legendary.

One cannot infer a possible mechanism by which dragons could have breathed fire, another by which they could have flown, and another to account for the supposed magical nature of dragon's blood, without focusing on the principal dynamic of animal evolution. The life form a species

PAINTINGS BY WAYNE ANDERSON

"Piercing a dragon releases the hydrogen in his central cavity, rendering him unable to fly."

evolves, no matter how strange, centers upon a particular specialization. My theory is that the particular specialization of dragons evolved as a unique mode of flight. They grew to their enormous size because great size was necessary if they were to fly successfully. They breathed fire because they had to. Their "blood" had seemingly magical properties because a particular chemical reaction was necessary for their mode of flight. All of these traits connected.

As to the remoter fringes of the theory, I think I can demonstrate how the life form that evolved through this specialization came to prefer for its diet young ladies of noble breeding. For our immediate purposes, however, the problem can be put very simply. How did a creature of this size stay aloft and, indeed, hover?

The question of weight is crucial, so the next step is to attempt to estimate a dragon's weight. Only the roughest calculations are possible, but they will do. The record for lift in the animal kingdom is held by the Canada goose, which hefts 2 grams of body weight for every square centimeter of wing. The swallow, by comparison, lifts only 135 grams. Apart from birds, the record belongs to the bumblebee, which lifts 1,125 grams. The difference is accounted for by the peculiarity of feathers, which allow air to pass through them from above to below but not in the opposite direction, and so increase the pressure difference.

Some artists have drawn dragons with feathered wings, but they always look wrong, so it is fair to allow our dragon a lifting ability equivalent to that of the bumblebee. To lift 9,000 kilograms, a dragon would need 720 square meters of wing. Give it a relatively normal wing shape, and it would have to have a wing span of nigh on 150 meters. This is impossible.

And yet they did fly. They were no mere soarers, either, relying on cliffs, as the prehistoric Pteranodon did, or on wave effects, as the albatross does. They flew efficiently and quickly. The dragon Smaug made the flight from the Lonely Mountain to Laketown (a journey that had taken Bilbo and the dwarfs three days in the opposite direction) within the first half of one night—and there are no thermals to provide free lift at night, either. The dragon Kalessin took Ged and Arren from Selidor to Ravnor—half the width of Earth—in a few days. But even more noteworthy than their speed is their ability to hover. A bird the size of a pigeon can manage it for a few seconds. Anything larger cannot achieve the rapid wingbeat required.

Clearly there is something badly wrong with our assumptions, something that cannot simply be put down to an error in the original description. Reduce the length of a dragon to, say, 6 meters and give it a 12-meter wingspan and it still cannot be made to fly. Increase the efficiency of the wing beyond anything else known in the natural kingdom and the same is true. What does that leave?

It leaves weight.

In order to fly, dragons must have been almost weightless.

"These dragons grow exceedingly big, and from their mouths cast forth a most pestilential breath, like unto thick smoke rising from a fire. At their destined time they gather together, and developing wings they begin to raise themselves into the air. Then, by God's good judgment, being too heavy, they fall into a certain river which springs from Paradise, and therein they perish wholly. All those who dwell round about attend the season of the dragons, and when they see that one has fallen they wait yet seventy days. Then they go down and discover the bare bones of the dragon, that they may take the carbuncle that is rooted in the forehead thereof." —Jordanus, in The Wonders of the East

We have been asking the question the wrong way round. We should be asking not *How could an animal so big possibly fly?* but *Why should an animal that needed to fly evolve to such a size?* Jordanus talked of "destined time" and "falling" notable phrases.

The first thing that occurred to me when I read this passage was that it described a mating flight. The phrase *developing wings* supports this notion. I thought perhaps that dragons flew only for the mating flights (like some of the social insects) and that afterward the successful males died. I was still of this mind when one day I happened to see on television an old newsreel film of the wreck of the airship *Hindenburg*. In a flash all my ideas changed. As I watched the monstrous shape crumpling and tumbling in fiery fragments, with the smoke clouds swirling above, I said to myself, *It flamed and it fell*, and my mind made the leap to Jordanus. All the pieces I had been considering shook themselves into a different shape. I saw that the *Hindenburg* was not merely a very big machine that flew—it was a machine that could fly only because it was very big. Other answers slotted into place.

- A dragon could fly because most of its body was hollow and filled with a lighter-than-air gas.
- A dragon needed an enormous body to hold enough gas to provide lift for the total weight of the beast.
- A dragon breathed fire because it had to. It was a necessary part of its specialized mode of flight.

Jordanus says that the dragons began to raise themselves into the air, and then, be-

ing too heavy ' they fell It is immediately clear that he is describing something he doesn t understand No animal has gone to the lengths of evolving flight only to be too heavy to fly Suppose Jordanus was indeed describing a mating flight We can make sense of the scene by linking this sentence with the one in front of it, about the dragons breathing out their fiery breath

The flight would not have been like that of the males of a social-insect species competing in pursuit of their new-hatched queen it must have been something more comparable to the behavior of rutting deer in which males battle with one another for the right to fertilize females But whereas stags fight with their antlers the dragons fought with their flaming breath As in most mating contests, this would have been a highly ritualized form of battle, with little damage inflicted and most of the struggle consisting of pure display—vast plumes of noxious smoke, great blasts of flame—as impressive in its way as the tail feathers of the peacock or the song of the nightingale There was, however, a danger Should a dragon in an excess of sexual fervor flame off too much of its gas, it would lose buoyancy and plummet to the ground and die

The curious detail about the dragons' developing wings" now makes sense Dragon wings were comparatively small (though still far larger than the wings of any other flying creature) As they were not needed to support the weight of the dragon they were probably comparatively fragile and so would have been folded close along the body for protection until they were needed The original observer of the mating ritual would likely have been so impressed by the sheer size of the dragon's body that he might not even have noticed the wings until they were suddenly spread for flight (Anybody who has watched a small beetle produce, as if from nowhere, its filmy wings and float on the wind can perhaps imagine the effect)

There is one more link I must provide Why did the dragons burn their excess gas, instead of simply belching it out? The answer lies in another well-known custom of dragons They laired in caves and stayed there for long periods I imagine they must have had some control over their gas production and been able to manufacture more or less, according to need, but there would have had to be both upper and lower limits to this control—a major metabolic process cannot be completely shut down So even when they were at rest in their caves, there would have been a need to vent gas from time to time It, as I propose to show the gas was mainly hydrogen, an extremely explosive mixture would have been formed unless the hydrogen was burned in a controlled fashion as it left the dragon's body Where a major specialization requires some further adaptation to make it effective, that adaptation usually evolves If dragons needed to burn their breath in order to survive, nature would provide a means

What means? One is tempted by the idea of an electric spark, but existing animals such as the electric eel that are able to produce the necessary voltage for a spark are specialists in electricity I am extremely reluctant to propose any adaptation that does not arise from the original specialization so I think it more likely that the ignition system was chemical In order to produce the hydrogen the dragon's body must have already been a series of chemical retorts so the notion of some mixture's leading to spontaneous combustion on contact with air is much more plausible

Whatever the mechanism dragons learned to breathe flame because they had to For reasons I will describe later, the habit of lairing in safe caves was essential to their survival, and unless the explosive gases they produced were burned off, those caves would cease to be habitable The use of flaming breath as a weapon, and as a form of sexual display, evolved from something that already existed as part of

"Dragons learned to breathe flame because they had to. As a weapon and as a form of sexual display, this ability evolved because it existed as part of the mechanism of flight."

the mechanism of flight To the Stone Age hero confronting those pulses of fury at the mouth of the cave, fire must have seemed the primary aspect of the dragon, but like everything else in nature, however strange, it had evolved along a logical path

We have seen that the flight of dragons depended on their ability to make their body weightless or almost weightless in air To do this they needed to fill large cavities—cavities that composed the major part of their body structure—with a lighter-than-air gas Helium is light enough to do the job but is a most unlikely ingredient, being an inert gas found in minute quantities in the atmosphere but not known to play much part in the metabolism of any animal Hydrogen is far more plausible—a very light, abundant gas, violently inflammable when mixed with oxygen, and present in an accessible form in a substance already common in the digestive systems of all vertebrates—hydrochloric acid

Of course, biological chemistry is never as simple as that There would have to be all sorts of other substances to control and modify the reactions, as well as substances needed to ignite the gas when it was vented The innards of the dragon were a complex chemical factory with not only hydrogen as the end product but all sorts of other substances that had to be either used or excreted There have been accounts of the "pestilential" nature of dragon breath even when not ignited, and of the notorious trail of slime that dragons left behind them and that defiled the countryside anywhere near their lairs

Despite these chemical complexities the main body structure of the dragon consisted of a series of cavities, or vats, filled mostly with hydrogen Should one of these chambers be pierced from below—and remember that these cavities composed most of the dragon's body, so that a stroke from below would have every chance of piercing a cavity—two things would happen First, the acid would flow out and react with anything it touched—the blade that had made the wound, the arm that held the blade, even the dragon's own flesh Second, the cavity itself would become useless, and this in turn would have two results The dragon would no longer be able to fly, and it would no longer have excess gas to breathe out as flame

I shall return later to the essential vulnerability of dragons to cutting weapons For the moment, I must emphasize a different consequence of the violent chemistry of the dragon's metabolism Flight was achieved by a controlled digestion of parts of the bone structure When the dragon died, the control mechanism ceased to operate, and the whole structure corroded The natives in the passage from Jordanus who went to look for jewels in the body of a fallen dragon found only the skeleton If they had waited longer they would have found nothing at all This is why I consider it unlikely that my theory of dragon flight can ever be proved by the discovery of fossils As no fossils are likely to be found, any reconstruction of the dragon's actual body system is guesswork

Dragons clearly evolved from lizard-shaped dinosaurs I envisage cavities that were extreme modifications of the vertebrae of that long spine, each of the selected vertebrae becoming a large, thin-walled urn of bone closed at the top with a muscular membrane This membrane, and any other surface needing protection from the acid, would be coated with a resistant mucus, which is the normal way in which digestive systems are prevented from digesting the body they feed For maximum hydrogen production, the acid gland would open and the acid would flow down the walls of the cavity, reacting with the calcium deposited there from the bone structure The bone itself would be continually self-renewing

The various cavities would, of course, be interconnected by valves, and by adjustment of the tension of the upper membrane, transfer of gas throughout the body for balance and other purposes, could take place The membranes would serve a fur-

ther vital function. Normally the gas in the cavities would be under mild pressure and the dragon's weight in air would be positive. It would be light, but it would not actually keep floating upward. For flight the membranes would relax and the gas volume would expand. The volume of the dragon would increase, but its mass would remain the same, and it would become buoyant in air. On a smaller scale, a fish's swim bladder operates in the same way. In fact, when aloft, the dragon would be swimming in air, rather than flying.

When I say the volume of the dragon increased, this need not have been apparent to an observer, though records of Chinese dragons specifically remark on their ability to vary their size. Another possibility is that the membrane expanded into a space normally filled with air. This would have the same effect as an external increase in volume. A third idea, which I find attractive, is that the great row of spines down the dragon's back was not for menace or defense but was the protective cover for the expanded membranes. When the dragon was at minimum buoyancy, the spines would lie flat, but they were raised for flight.

A system like this would solve a problem that I have not so far mentioned, dealing with dragon flight. If the body were long and narrow but supported solely by the wings, it would need considerable muscular power to maintain itself rigid in the air. But if the body were self-supporting, the question would not even arise.

Owing to the absence of fossils, it is impossible to trace the stages by which dragons took to the air. (It is worth pointing out, though, that the same is almost true of birds—all we have are rare finds of two related species of Archaeopteryx and one disputed case of an unrelated species.) But we can produce a plausible set of steps.

At least we can begin with size—something that was already there. Many dinosaurs were very large for reasons still in dispute. Then there appears to have come a time when smaller, quicker creatures were at an advantage. One obvious solution was for the larger species to shrink; some achieved this, but most died out. Another possibility was the retention of size but a reduction in weight; this would make the animal speedier and at the same time reduce its energy needs. At first simple cavities developed and then, once the advantage of lightness had begun to tell, the production of hydrogen began. These early steps need not have been dramatic. Small improvements, taking place through many generations, would still have paid off.

In a period of evolutionary frenzy, such as the one that preceded the extinction of dinosaurs, any process that has begun tends to go to extremes. While its earthbound fellows were experimenting with horns and frills, the protodragon was becoming lighter and lighter. Bones became hollow and slight. The armorlike scales of the ancestral dinosaur were discarded, except from the head. We can assume that this ancestor was one of the kangaroolike big predators that already leaped after their prey, rather than ran. These leaps, as weight decreased, would become more and more dramatic until the kilometer-high bounds recorded in *The Dragon of the North* were not impossible. By this stage, some form of control of the path of the leap through the air would become essential. The rib cage would be modified into "wings," and imperceptibly, leaping became gliding and gliding became flight.

Dragons could never have been a dominant species. Their specialization carried with it too many disadvantages. But they seem to have achieved a balance, an ecological niche, and like the birds survived the extinction of the dinosaurs. They would never have been creatures of the forests, their bodies were too large and vulnerable, and above all they needed safe cave lairs. They were inevitably inhabitants of cliffs and crags, swooping out to scour the plains for prey among the vast herds of the grass eaters. The fact that suitable habitats were comparatively few reinforced a trait that was perhaps already there in the ancestral dinosaur—dragons became one of the most territory-possessive species on record. This is something on which all sources agree. ∞

FICTION

No deaths. No births. The whole world hung suspended, waiting. . . .

THE MADAGASCAR EVENT

BY ROBERT HAISTY

He sat very still and closed his eyes and tried to imagine being smaller—as if he could step into the large end of a telescope and recede through the eyepiece on and on until he was a speck a point gone

Mark Wynette was not a totally unseasoned reporter but now he had two fears in his belly sicknesses rolling against each other like the virulent clouds which had enveloped them through the day and on into the night One was the indescribable uneasiness about the thing itself The other was Thompson Thompson would be in no mood for it Never Sure he was afraid of Thompson City editors scream at their desks They shake your precious copy in your face "lousy chicken scratchings Je-eezus Christ! you call this reporting?" In less than a year at the *Morning News* Mark had seen three pretty capable guys thrown out and each time Thompson had said "The story is *always* out there If by some miracle there's not a story it's your job to find out by God, *why!*"

Mark stood up and shoved his chair back without even pulling from his typewriter the page on which he had written a single sentence Up and down the line of reporters desks the machines were rattling along frantically and the people pecking at them were stealing hurried bites of stale doughnuts and gulping cold coffee between phrases without ever looking up—as if everything were perfectly normal Mark shook his head sharply trying to clear it There could be no more delaying The midnight deadline was now exactly nine minutes away He should have acted before this Long before this

He made a right turn which brought Thompson's cubicle in view straight ahead of him Thompson hated the antiseptic new offices hated being removed from the traditional center of the newsroom Everybody knew what a fight he had put up before he was finally allowed to hold on to his battered old maple desk and his green eyeshade All the way down the hall you could still hear him yelling at someone usually several times a day This is supposed to be a newspaper office not a goddamn *circus schoolhouse insurance office* —or whatever else seemed to fit the misdemeanor at hand

An aura of Prohibition and crime reporters permeated the space within his half-walls evoked probably by the ancient hangings clippings and photographs and by Thompson's own skinny frame and balding head A slightly built man he more than made up for it by the power of his lungs and the sharpness of his words The queasiness in Mark's stomach reached a new

PAINTING BY GOTTFRIED HELNWEIN

height as he entered. Sure he should have done something about it hours ago. It was easy to see that now. But what actually? Call the *Herald*? Christ!

"Uhh... about the obits, Mr. Thompson—"

"Yeah. Where the hell are they?" Thompson was scribbling on his yellow pad and scarcely looked up when Mark came in. "You're an hour late with 'em, Wynette."

To Mark, it was entirely as if someone else's voice responded. He was numb and frozen. Even his cheeks were numb. He said, *"I'm afraid nobody died yesterday."*

MARK'S CHRONICLE

The First Day. It wasn't as bad as I had thought it would be. Thompson choked at first and grabbed at his chest. He told me to get the hell out, he didn't have time for any goddamn comedians.

Then Thompson called Herby Squires at the *Star*. And the hospitals. I was right. He was only mildly furious that I hadn't said anything earlier. He knows nobody ever starts on the obits before the last hour.

No time to do a story on it. We just ran the line "No deaths reported." The other morning papers did the same thing, even on the West Coast. Wire services started picking it up about 8 A.M.

The Second Day. It is worldwide! There've been no births reported, either.

The Third Day. Panic growing. Trading suspended on the major markets. DJI down over a hundred points. Most schools closed. Government offices ordered to stay open. President on TV twice a day. Says nothing to be frightened about. We don't understand it yet, but scientists have several possible explanations. May be the dawn of a new era. Fringe groups say forty days to the end of the world.

The Fourth Day. Not much else in the news. You get used to it. The creepy feeling can't go on forever. *Forever*—what's that?

Thompson is amazingly mild. Almost cherubic. We don't understand it. This thing has gotten to him. We never used to have staff meetings; now we have them all the time. He wants human interest. God, there's enough of that. He assigned me to cover Parkland Hospital. Then he decided Ann should work with me on it, because "... there may be some women-stuff." My heart almost red-lined. Me, a seasoned reporter. I gulped, and probably squeaked, when I said, "Yes, sir." I am so crazy about Ann's level blue eyes and perky hips. I would be happy doing a story with her in the depths of hell. Which may be where we are.

The Fifth Day. Thompson was right about the hospital. What they're mostly trying to figure out has to do with babies. There are no labor pains starting. No new pregnancies. We hear it from the nurses—there is already feverish debate in medical circles about doing cesareans. Some say it amounts to abortion. The baby remains in the fetal position, has a slow but steady heartbeat, does not respond to stimuli, seems to require no nourishment at all.

The other side says yes, but would you condemn the poor woman in the ninth month to go around like that forever? How do we know it is forever? the first school asks. "We must wait and see what happens." This argument seems reasonable to me. What can it hurt to wait? But Ann is strongly with the Cesareanists. "Who knows what it may ultimately do to the mother's health—and the baby's, for that matter? Who knows if it will end? How *long* should we wait?" I do not have the answers. I have only a vague thought that, given an infinite time, everything will happen. We have evidently entered a segment of infinity in which births and deaths are not allowed. It follows that this arrangement will also change. In a billion years? Perhaps even a trillion?

The Sixth Day. The burn victims and the drowned and the ones who have lost too much blood—they fill the hospitals, remaining in a state of hibernation, just like the cesarean babies, until they are revived with oxygen or plasma or medications. But the number of hiberoids, as doctors are calling them, is steadily increasing. There have been reports of several accidental decapitations being repaired, but in every case the victim has not come out of the hiber state. There are also bizarre rumors of unsuccessful experiments with fanks of hydrochloric acid.

> *"Panic growing. Trading suspended on the major markets.... President on TV twice a day. Says nothing to be frightened about.... Fringe groups say ... the end of the world."*

The Twenty-second Day. There has been no time for journal entries. Too much to cover, and we are too few. Ann is practically batty about this cesarean thing. I try to humor her, and she knows that's what I'm doing, and she hates it. The little bit of progress I had made foward sleeping with her is totally lost. She doesn't want to think about love now. A lot of women don't. Some men, too. We are doing stories on impotence. It hasn't affected me that way. Maybe it is the wailings of the fringe groups that bother them. They say we have only eighteen more days. Many have joined their movement.

The Thirty-fifth Day. The markets have opened again. Drug stocks crashed. Airlines and entertainment went up sharply. Then drugs recovered. The sale of painkillers and tranquilizers has skyrocketed. It is calmer around the hospital now. For a while there was a panic rush to have major operations done before this thing, whatever it is, came to an end. Then we saw it was not ending, and people began to fear they might come out of the operation as permanent hiberoids, though it has happened so far only in accidents involving severe burns or massive tissue destruction. Even so, the undertaking establishments—all of which rapidly converted their facilities into storage vaults for the hiberoids—are reaching capacity limits. Imagine! Only five days left, if you believe the fringies. I don't. But you can't help thinking about it. There is much talk about time warps, but no evidence. Atomic clocks, relative to mechanical movements or crystal oscillators or—for that matter—sundials have not shown the slightest deviation.

The Forty-first Day. Well... nothing happened. If we counted right, we should have had it by now. The fringe groups are refiguring. I noticed an item on the wire service today about something called the Mossbauer Effect. I don't think we put it in the paper.

The Forty-second Day. Who has ever heard of the Mössbauer Effect? The Nobel committee must have. They awarded the guy the prize in physics in 1958. Thompson directed me to find out about it.

The Forty-fourth Day. A graduate assistant in the physics laboratory at the university agrees to talk to me about the Mössbauer Effect. "It is based on the recoilless resonance fluorescence of gamma rays," he told me. I did not understand. He went through it again. "When a radioactive atom emits a gamma," he said more slowly, poking his finger at the desk pad with each word, "the energy of the gamma is that of the excited state of the emitting nucleus minus the recoil energy imparted to the nucleus itself." "Like when you shoot a gun," I said and nodded wisely. "Like when you shoot a gun," he agreed. "Now if the gamma passes through an absorber where it could give up its energy—conserve energy and momentum—by exciting an atom there to the same state, the probability of its being absorbed would be very high. That would be a resonance absorption. If wasn't observed originally because the recoil energies were too variable. Mössbauer showed that by embedding the source and absorber nuclei in a crystal lattice, he could make the recoil energy equal to zero in a large fraction of the transitions. Thus, he could observe greatly enhanced absorption.

"Now if he arranged for a Doppler shift by *moving* the source relative to the absorber, even by as little as a few millimeters per second, he could cause the absorption to be measurably decreased. From the way this reduction occurs, we can deduce a great many things about the structure of the material and the position of the active atoms."

"That is the Mössbauer Effect," I said, secretly hoping I could explain it to Thompson with some reasonable degree of lucidity.

That *was* the Mössbauer Effect," the assistant said dryly.

Was the Mössbauer Effect," I said, correcting myself.

We don't see it anymore. That can only mean *there is no Doppler shift.* The Mössbauer lines are so sharp we used to be able to see energy shifts so small they would correspond to a temperature of one ten-millionth of a degree. Now there is something funny with the Doppler shift. *Time is screwed up."*

The Seventy-third Day. Apparently the graduate assistant was right. Scientists all over the world seem to agree. We are at a nodal point in an extended geocentral time warp. Which is another way of saying we are an intermediate stop for some kind of space voyagers. It's not entirely as physicists used to think it would be, and there is no way of telling whether it is permanent or, if not, how long it will last. It could all end in the last minute.

The Two Hundred Sixty-first Day. Suddenly it's summer, and so beautiful again. I don't know how we got through the winter. Mostly with liquor, I guess. And that was only the first winter. The first of eight hundred million, perhaps, they say. The theories about the warp are beginning to congeal into something I can almost understand or at least believe. The Mössbauer measurements are hard to dispute.

Ann was right about the cesareans, of course, as the women everywhere have long realized. If I could find a pregnant woman today, I'd have quite a story for the front page.

The Three Hundredth Day. Something big has happened. We felt the vibrations here, hallway around the world. Communications are still sketchy. The first satellite photos show it as a white blob in the region where Madagascar should be. Pilots in the area reported a water funnel that opened the ocean five miles down, all the way to the bottom. One of them claimed to have seen a flash of greenish-yellow streamer curving in a parabolic arc as far as the eye could see.

There was an eternal instant of vacuum, then the horrible, grinding quake—and the tidal wave.

The Three Hundred First Day. It was nearly midnight when I got the call from Parkland Hospital. I sat there nodding, the instrument clamped tight against my ear upon my right shoulder as I mechanically took it all down on the yellow pad. I even managed to ask a couple of questions. 'Okay, thanks. Keep me posted,' I said, incredibly—as if there was nothing else to say. Then I hung up and sat there struggling with comprehension, staring unfocused at my notes. How is it possible that a thing like this can be reduced to a few scribbles on a piece of yellow paper? Roger Foreman was on his way back from the Coke machine, and he must have noticed something about the way I was looking. Roger is one of the old hands, and he can put a story together from a mosquito belch and a chigger egg, but I don't think it took that kind of ability for him to see there was something terribly wrong.

"Hey, Mark—" he said. I hadn't noticed he was behind me, and I jumped six inches.

"It's over, Roger. Like somebody pulled the stopper. Hundreds are dead. Thousands! And some of them are—"

"You better get this in to Thompson," Roger snapped.

I looked up at the clock and headed out in a run. The deadline! There was still time. "*We've got obituaries, Mr. Thompson,*" I shouted as I rounded the corner to his office. "*People are dying everywhere. But the weird thing is, it's like a lot of them have already been dead for a long ti—*"

I stopped, because Thompson was not there. Only a chalky skeleton in rotting, shredded garments was sprawled in his chair with the bony fingers still clutching at the rib cage, and the green eyeshade all askew.

Roger had come up beside me, and after a minute he said, "God, there's going to be a lot to sort out."

I didn't answer. I had the feeling it was his way of praying. ∞

NATURE

CONTINUED FROM PAGE 56

said, *"Yes, one claw is bigger than the other but both claws are made of the same parts."*

Ah, what a beautiful and noble statement that is. how the speaker politely flung into the trash can the idea that size could be of primary or profound importance and went after *the pattern which connects*! He discarded an asymmetry in size in favor of a deeper symmetry in formal relations.

Yes, indeed, the two claws are characterized (ugly word) by embodying *similar relations between parts*. Never quantities, always shapes, forms, and relations. This was, indeed, something that characterized the crab as a member of *creatura*, a living thing.

Later it appeared not only that the two claws are built on the same "ground plan" (i.e., upon corresponding sets of relations between corresponding parts) but that these relations between corresponding parts extend down the series of the walking legs. We could recognize in every leg pieces that corresponded to the pieces in the claw.

And in your own body, of course, the same sort of thing is true. Humerus in the upper arm corresponds to femur in the thigh, and radius-ulna corresponds to tibia-fibula, the carpals in the wrist correspond to tarsals in the foot, fingers correspond to toes.

The anatomy of the crab is repetitive and rhythmical. It is like music: repetitive with modulation. Indeed, the direction from head toward tail corresponds to a sequence in time. In embryology, the head is older than the tail. A flow of information is possible, from front to rear.

Professional biologists talk about phylogenetic homology for that class of facts of which one example is the formal resemblance between my limb bones and those of a horse. Another example is the formal resemblance between the appendages of a crab and those of a lobster.

That is one class of facts. Another (somehow similar?) class of facts is what they call serial homology. One example is the rhythmic repetition of change from appendage to appendage down the length of the beast (crab or man), another (perhaps not quite comparable because of the difference in relation to time) would be the bilateral symmetry of the man or the crab.

Let me start again. The parts of a crab are connected by various patterns of bilateral symmetry, of serial homology, and so on. Let us call these patterns within the individual growing crab first-order connections. But now we look at crab and lobster and we again find connection by pattern. Call it second-order connection, or phylogenetic homology.

Now we look at man or horse and find that here again, we can see symmetries and serial homologies. When we look at the two together, we find the same cross-species sharing of pattern with a difference (phylogenetic homology). And, of course, we also find the same discarding of magnitudes in favor of shapes, patterns, and relations. In other words, as this distribution of formal resemblances is spelled out, it turns out that gross anatomy exhibits three levels or logical types of descriptive propositions.

1. The parts of any member of *creatura* are to be compared with other parts of the same individual to give first-order connections.
2. Crabs are to be compared with lobsters or men with horses to find similar relations between parts (i.e., to give second-order connections).
3. The *comparison* between crab and lobster is to be compared with the comparison between man and horse to provide third-order connections.

We have constructed a ladder of how to think about—about what? Oh, yes, the pattern which connects.

My central thesis can now be approached in words. The pattern which connects is a metapattern. It is a pattern of patterns. It is that metapattern which defines the vast generalization that, indeed, *it is patterns which connect*.

Let me go back to the classroom of young artists.

You will recall that I had *two* paper bags. In one of them was the crab. In the other I had a beautiful large conch shell. By what token, I asked them, could they know that the spiral shell had been part of a living thing?

When my daughter Cathy was about seven, somebody gave her a cat's-eye mounted as a ring. She was wearing it, and I asked her what it was. She said it was a cat's eye.

I said, "But what *is* it?"

"Well, I know it's not the eye of a cat. I guess it's some sort of stone."

I said, "Take it off and look at the back."

She did that and exclaimed, "Oh, it's got a spiral on it! It must have belonged to something alive."

Actually these greenish disks are the opercula (lids) of a species of tropical marine snail. Soldiers brought lots of them back from the Pacific at the end of World War II.

Cathy was right in her major premise that all spirals in this world, except whirlpools, galaxies, and spiral winds, are indeed made by living things. There is an extensive literature on this subject, which some readers may be interested in looking up (the key words are *Fibonacci series* and *golden section*).

What comes out of all this is that a spiral is a figure that *retains its shape* (*i.e., its proportions*) *as it grows* in one dimension by addition at the open end. You see, there are no truly static spirals.

But the class had difficulty. They looked for all the beautiful formal characteristics that they had joyfully found in the crab. They had the idea that formal symmetry, repetition of parts, modulated repetition, and so on were what teacher wanted. But the spiral was *not* bilaterally symmetrical; it was not segmented.

They had to discover (1) that all symmetry and segmentation were somehow a result of a payoff from, the fact of growth; (2) that growth makes its formal demands; and (3) that one of these is satisfied (in a mathematical, an ideal, sense) by spiral form.

So the conch shell carries the snail's *prochronism*—its record of how *in its own past* it successively solved a formal problem in pattern formation. It, too, proclaims its affiliation under that pattern of patterns which connects.

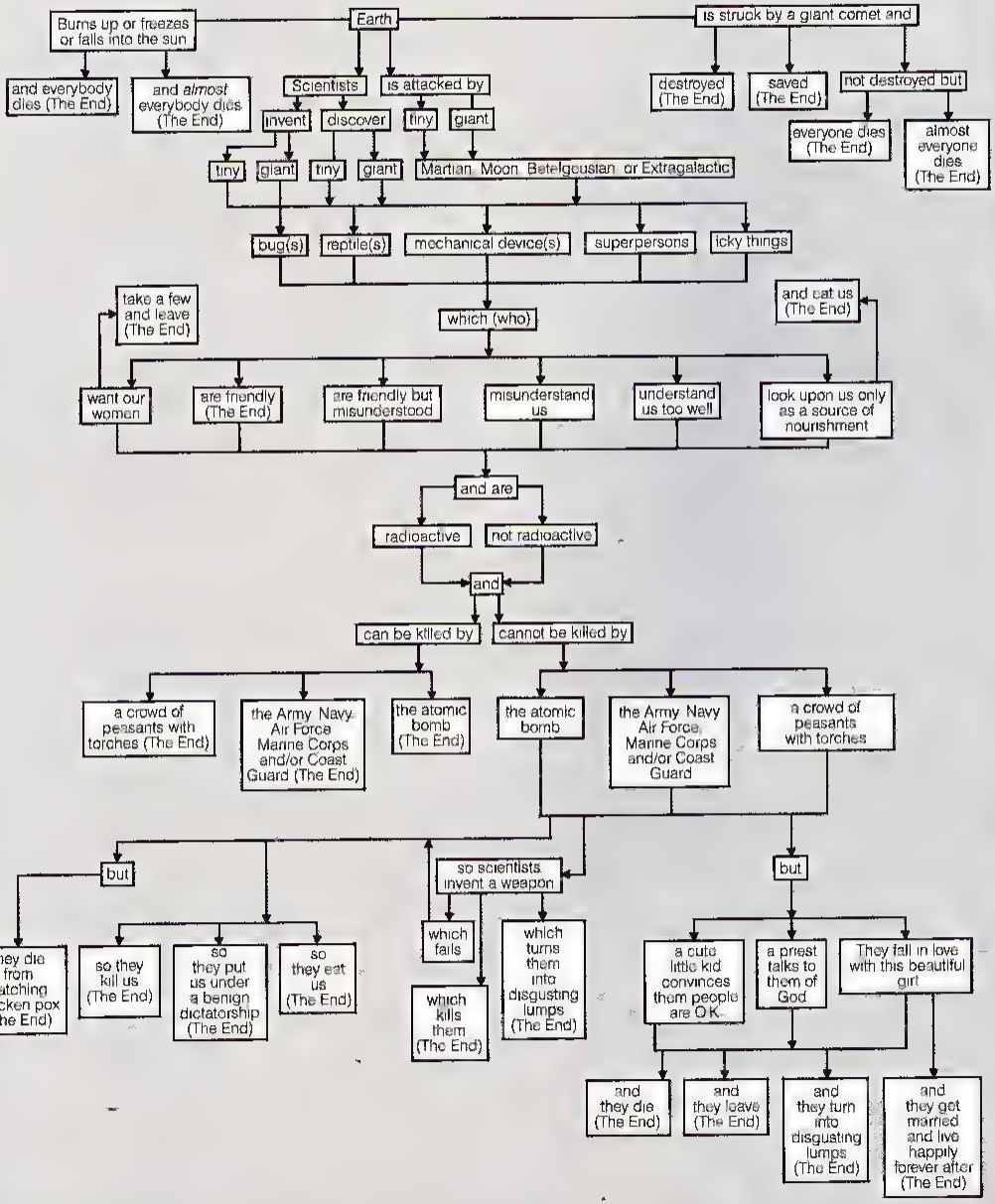
We have been trained to think of patterns, with the exception of those of music, as fixed affairs. It is easier and lazier that way but, of course, all nonsense. In truth, the right way to begin to think about the pattern which connects is to think of it as *primarily* (whatever that means) a dance of interacting parts and only secondarily pegged down by various sorts of physical limits and by those limits which organisms characteristically impose.

There is a story which I have used before and shall use again. A man wanted to know about mind, not in nature, but in his private large computer. He asked it (no doubt in his best FORTRAN), "Do you compute that you will ever think like a human being?" The machine then set to work to analyze its own computational habits. Finally the machine printed its answer on a piece of paper, as such machines do. The man ran to get the answer and found, neatly typed, the words:

THAT REMINDS ME OF A STORY

HOW TO WRITE A SCIENCE-FICTION NOVEL

For years the aerospace industry has used flowcharts to organize and simplify the task of developing complex Space Age hardware. Here is a flowchart that organizes and simplifies the task of writing a science-fiction novel. By using this chart *anyone* can write one! All you need is talent, imagination, and skill. Start at the top and go through to the end.



ARTFUL DODGER

CONTINUED FROM PAGE 49

Leading physicists including Leon Lederman the new director of Fermilab hold that there are six different quarks and six different leptons The quarks for reasons only theoretical physicists would appreciate have been named *up down charm strange top* and *bottom* The leptons are named *electron electron neutrino muon muon neutrino tau* and *tau neutrino*

As you can see this means there are three different kinds of neutrinos—electron muon and tau (this last neutrino being theoretical having yet to be discovered though its companion the tau particle was recently detected)

If this theory is correct the six leptons and six quarks *may be the fundamental particles from which all matter is built* Though this may not sound like a very simple model it is probably simpler than we have any real reason to hope for

Evidence? Not a great deal But William Fowler a theoretical physicist at the California Institute of Technology has suggested a more intriguing possibility And here finally we tie in with the solar-neutrino question—the macroworld Although only electron neutrinos are being ejected from the sun and detected in the Homestake mine by the time they arrive here some of them may have transformed into the two other types by a process called oscillation This phenomenon has been observed in something called the K particle though not yet in neutrinos

Do you see the implications? The two thirds of the neutrinos that appear to be missing may really be there but may have transformed into the two other types and are simply not being picked up in Davis's experiment

If this can be shown to be the case the solar-nuclear model will be saved the six-quark/six-lepton theory will get a strong shot in the arm and the oscillation theory will be able to include neutrinos in its cast of characters

A NEW ERA

So what the world needs is bigger and better neutrino catchers One of the problems with Davis's equipment at the Homestake mine is that being an early experiment it was designed to go after the easiest to detect of several possible types of nuclear reactions that take place in the sun Unfortunately that one happens to be a very rare type of reaction And while the numbers in this rare reaction should still come out right there is a greater likelihood of error

To help remedy the situation, Kenneth Lande and his coworkers at the University of Pennsylvania along with a group of colaborators from the University of Texas are beefing up the Homestake gold mine They have added a superstructure of pyramid-and-cube shaped neutrino detectors around Davis's tank of cleaning fluid This will theoretically turn the mine into a better neutrino telescope The group is making a similar effort in another mine in Ohio

And two new approaches to detecting neutrinos were described at a recent meeting of the American Physical Society one by I Dostrovsky of the Weizmann Institute of Science in Israel and the other by R S Raghavan of Bell Labs in New Jersey Dr Fowler commenting on the proposals went so far as to say that we have entered a new era in neutrino astronomy Afterward I asked him why it took so long for this to come about Weren't all these problems and questions about missing neutrinos evident say five years ago?

Man," he almost exploded "think of the equipment needed for these experiments Dostrovsky's calls for fifty tons of gallium Present world production is three or four tons a year And Raghavan's will use one hundred tons of plastic scintillating material divided into a thousand independent modules each with its own image read-out system (Davis describes the latter as a "gigantic super club-sandwich")

"Sure" Fowler went on "we've been asking the questions, but it's only in the last year that good equipment designs have been produced And until now Davis has been able to provide us only with limits within which we had to believe or disbelieve Last year relying on his ten years of data collecting he was able to provide a solid figure and it's held firm We kept thinking something would turn up but it hasn't So now it's time to do something else"

MANUFACTURING NEUTRINOS

All of these proposals for studying neutrinos concern themselves with particles that come from "out there" But some of the most important work being done concerns neutrinos that are produced in giant particle accelerators here on Earth

The largest accelerator in the world is the one at Fermilab in Batavia just a few dozen kilometers west of Chicago "Making" neutrinos in a particle accelerator is a complicated business At Fermilab protons are whirled round and round the 6 4-kilometer main ring until they reach an energy of 500 billion electron volts The protons are then guided down a 1,000-meter tube where they strike a thick metal target and produce a shower of particles There is one burst of these particles every eight seconds

Among these particles are pions and kaons which are led down another tube 400 meters long During this flight the pions and kaons decay into other particles including muons and neutrinos Now all four types of particles are speeding down the tube and the trick is to get rid of everything except the neutrinos

Some of the particles are stopped by an absorber at the end of the tube and the rest by a one-kilometer-long earth-fill shield

Only the neutrinos come through the shield and these then enter the detection devices. One of the most useful is the 4.5-meter bubble chamber. Though the neutrino leaves no tracks in this liquid-filled chamber it may produce particles that do. These tracks can be photographed and studied for further clues to the nature of the elusive neutrino.

Producing one's own neutrinos in captivity has certain advantages for theoretical physicists and, what's more, the ability to produce a neutrino beam may someday have important practical applications, a topic we'll get to later.

HIGH-ENERGY NEUTRINOS

Even so, the most adventuresome search involves neutrinos arriving from outer space. It also involves a billion tons of water around the Hawaiian Islands.

An international group of scientists intends to build the granddaddy of all neutrino telescopes. Called project DUMAND (for Deep Underwater Muon and Neutrino Detection), it will, if implemented, involve the instrumentation of a cubic kilometer of seawater—that's a cube with sides measuring more than half a mile each—five kilometers beneath the surface. Proposed by Frederick Reines of the University of California at Irvine and others, DUMAND will entail a bevy of photosensitive devices and perhaps even microphones spread about the ocean floor.

DUMAND will record the clicks and flashes that result from neutrino interactions with water particles. Reines, who participated in the world's first neutrino detection in 1953, says it will cost $35 million.

But if the cost is big, it's because DUMAND's backers are after big game: high-energy neutrinos. DUMAND will be set up to capture cosmic neutrinos, perhaps the most numerous particles in the universe. They will have energies beyond 10 trillion electron volts, far greater than that available from even the largest particle accelerators in existence or even planned. These high-powered neutrinos are messengers from the distant reaches of the universe and perhaps can tell us about neutron stars, quasars, black holes, active galaxies, and the like.

Where do high-energy neutrinos come from? Stars, like living things, have a life cycle. They are born, they live and grow, and they die. As sometimes happens in human life, their deaths may be far more spectacular than their lives. Neutrinos are intimately involved in these death throes.

Consider a star that is more than half again as massive as our sun. When the hydrogen fuel at its center is used up, the core collapses and the outer layers are blown off in a superspectacular explosion called a supernova. With no more heat being produced in the core by nuclear reactions, the enormous gravitation of the still remaining core material is unopposed; the electrons and protons are smashed together to become neutrons, and the whole thing shrinks down to a small, incredibly dense body. We have what is called a neutron star: an overgrown nucleus; a marble made of this matter would weigh a billion tons.

The neutron star is a fascinating concept, but how can we test it? As with the solar model, neutrinos provide a way. Thanks to the supernova explosion, we have a kind of radiation-matter shock wave speeding through space in all directions. Included in that shock wave are neutrinos that were produced when the protons became neutrons. In other words, the collapsing core of such a star is a prodigious source of neutrinos for something under a second. And when all the other material and energy have finally been lost or scattered in the depths of space (the Crab Nebula is a leftover from a supernova that flared in 1054), the neutrinos will continue on their merry way—forever? If we could but catch a bunch of them in our net, these theories would be strongly supported.

Several groups around the world are listening for such an event, including Ken Lande with his two installations and the Russians, who are now digging a four-kilometer tunnel into a mountain for their equipment. When and if built, DUMAND will become part of the network.

The chances of making such a catch *seem* fairly slim. Only four supernovas have been recorded in our galaxy in the past thousand years. These were detected by visible light, of course; they were seen as bright lights in the sky for a few months, after which they dimmed and finally disappeared. But when viewed by neutrino "light," supernovas should turn out to be more frequent occurrences. Estimates range as high as one every ten years—enough to keep investigators interested.

EXPENSIVE?

Now, does a nagging doubt creep into your mind? That enormous use of materials, for example? It's true that Davis's experiment required a dozen tank cars full of cleaning fluid. But the stuff is fairly common and, more important, it doesn't get used up. Over the course of a month about 15 *atoms* are destroyed. The rest is all still there and in good condition. Bahcall once pointed out that even if the whole idea proved a failure, the experimenters could still go into the cleaning business. Indeed, adds Fowler, the fluid is worth far more today than when it was bought. "It may well be," he chuckles, "the best investment the United States has made in a long time."

But the costs are still undoubtedly high. There's DUMAND's $35-million price tag, and the gallium for the Dostrovsky device is worth about $20 million at today's prices, though clearly the whole experiment is not going to go into operation at once.

Neutrino research is definitely expensive. Then again, no one expected the search for the secrets of the universe to be cheap. Unlocking such mysteries, however, will more than justify the cost.

Still, it would be convenient if there were some obvious practical use for these particles. But physicists tend to turn a bit resentful when asked about such things.

Leon Lederman, for example, replies, "If somebody had asked Fermi whether neutrons had a use when he first started playing with them in the 1930s, he would have said, 'I don't know.' But the neutron eventually taught us much about the nucleus and nuclear physics, and this eventually led to fission and fusion. Almost half our program at Fermilab involves studies of neutrinos."

As for high-energy neutrinos, as in cosmic studies, we have even less idea of how they'll prove useful. "If more neutrinos are found than expected, our whole picture of how the universe was formed will be wrong. We find that prospect very exciting. But high-energy neutrinos are also helping us develop an understanding of the next lower level of matter. We don't know what crises of the twenty-first century this information may get us out of."

Actually, there have already been suggestions for putting neutrinos to work. Lande suggests that if the oscillation phenomenon in neutrinos is real, it might be useful in studies of the earth's core. The way the neutrinos transform might give us a better idea of densities and composition in the still-strange inner space of Earth, which could lead to better understanding of earthquakes and how to predict, or even prevent, them.

But the neutrino's greatest promise may be in the area of communication. J. M. Pasachoff of Williams College and M. L. Kutner of Rensselaer Polytechnic Institute suggest that neutrinos are a more desirable medium than radio for interstellar communication, in which case current radio searches for extraterrestrial civilizations may be misguided. "The discovery of a regularly modulated neutrino beam would surely indicate the presence of an advanced civilization," they write. An additional advantage is that the neutrino receiver is omnidirectional, thus a signal coming from any direction will be detected.

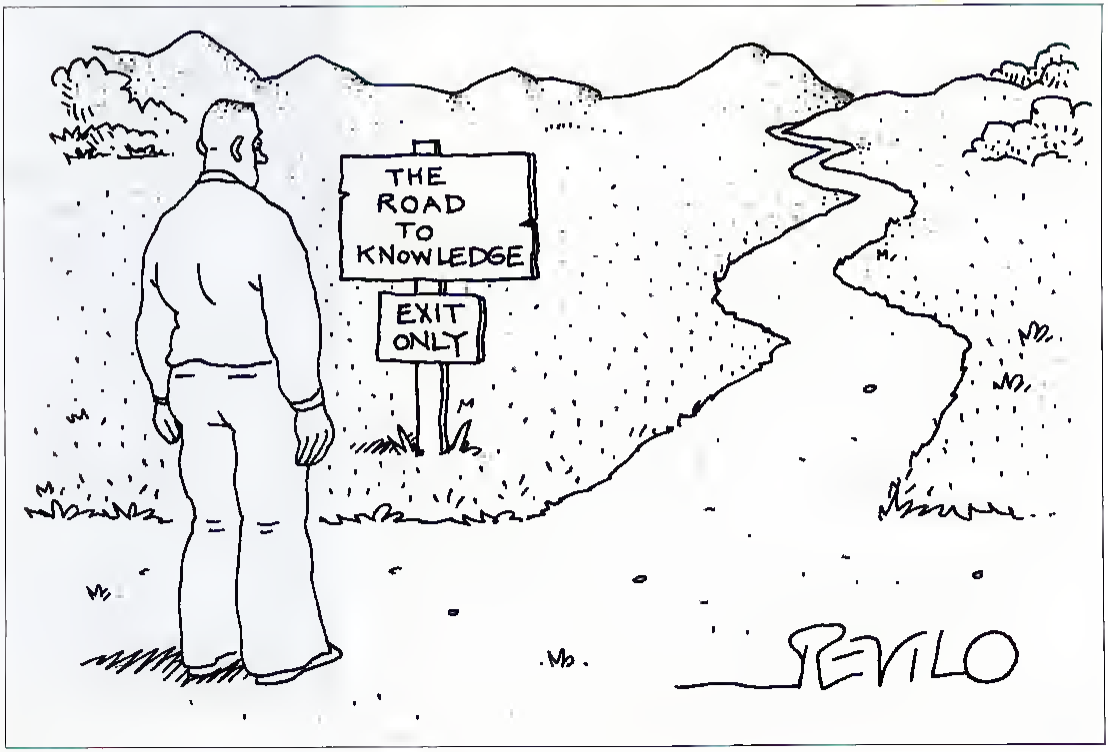
Earthbound communication by neutrino is similarly interesting. The main advantage, of course, is that the communication could take place in a straight line right through the earth—fast, direct, and without interference from weather, magnetic storms, or jamming.

The basic idea is simple. The transmitter would be a high-energy proton accelerator, similar to the present one at Fermilab, together with the equipment necessary to direct a narrow beam in the desired direction. While the neutrinos cannot be aimed, the protons can, because momentum must be conserved, the neutrinos produced by the protons will continue to travel in the same direction.

The receiver would be an array of detectors immersed in some sizable body of water—say, in the ocean or a deep lake. When a neutrino interacts with a nucleus, it will produce a shower of particles that, because of the great energy given to them, will emit tiny blue flashes in their passage through the water. These are detected electronically, and information can thereby be sent by Morse code. Distance is no problem, but bit rate—the amount of information sent per unit time—is. With current equipment probably no more than a word or two could be sent with each pulse of neutrinos every eight seconds. This will change as neutrino research becomes more sophisticated.

The only practical use right now is military, especially for submerged nuclear submarines. No good way has yet been found to communicate with them. The neutrino beam would act as a paging device, similar to those carried by many doctors. As Davis explains it, "The 'beep' would tell the submarine commander, 'Something important has happened, surface now and contact us.'" When I asked him whether he thought neutrinos might one day be useful as a communications pathway for purposes other than military, he answered, "It's very possible, particularly if an accelerator were designed for the purpose."

But, as Leon Lederman pointed out, neutrinos are already being used for personal communication. "Just let the particle beam at Fermilab stop for a minute. In no time at all the neutrino physicists are screaming, 'Goddamn it, where's the beam?!' Communication, right?" ∞



INTERVIEW

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Omni: Are we still committed to leadership in space?

Press: Yes, and the competition is increasing, so we are going to have to do a lot. We feel we can maintain the present level of space science—a handsome level—and develop the use of the shuttle for all sorts of things, and yet not say the nation needs a man on Mars or a return to the moon or a man in orbit for umpteen days, just to recapture the record from the Russians, when we don't see where that goes or its practical or scientific importance. The "new frontier" in space is not going to be one big glamorous expensive thing, it is going to be many many projects of moderate scale which together will do more for us and for the world.

Omni: What about R and D spending in the biggest category of all, national defense? Will there be major breakthroughs in the next generation of weapons or refinements of existing systems?

Press: I don't want to speculate about what the Russians are going to do, but they spend an enormous amount of money on R and D—more than we do, I believe, combining civil and military R and D. They are building forces of such strength, beyond their defensive needs, that we simply don't understand their purposes. I don't think they'll go to war with us, because they realize that a nuclear conflict would just kill everybody. But they *are* building very great forces, perhaps as a political threat. Western Europe is deeply concerned about the Russians' huge tank forces, their troop concentrations, their expanding navy, their large numbers of new missiles.

Omni: What is our response going to be?

Press: While we don't understand the Russians' aims, it would be a serious political blunder—and possibly also a serious military one—to do nothing. The administration feels that it is prudent to approach defense through high technology because we excel in that. Dollar for dollar, man for man, we are the best in the world at that. So we will take a high-technology approach to defense in the years ahead; that's why you see a major increase in defense R and D in the budget. When it comes to other things, connected with defense, our allies can contribute. The Germans have a very good tank, the British have very good things in several different areas. But the whole Western alliance looks to us for the high-technology R and D approach to defense.

Omni: What can you reliably tell the public about particle-beam weapons as missile destroyers?

Press: The Defense Department [DoD] people tell me, in a nutshell, that particle-beam weapons face such enormous difficulties that they are not weapons for the near future. They don't feel there could possibly be a Russian breakthrough that would threaten us. We are spending money to keep up to date, to ensure that the technology base is adequate for us to move ahead rapidly in case that situation changes. DoD has assembled the best high-energy and atmospheric physicists in the country to look at these questions, so I am confident that they are on top of the situation. The particle beam is a weapon for the distant future, if ever, and there are better ways of spending major-weapons money at present.

Omni: The latest rash of UFO sightings includes some from military bases, corroborated by radar. These reports are from trained, qualified observers and seem to have more solidity than many reports in the past. Is this anything that concerns the President? Has he asked you to look into it?

Press: No, he hasn't. As you know, the number of sightings is enormous, including many cases where such trained observers as airline and military pilots have seen UFOs. Jack Schmitt [ex-astronaut, jet pilot, and Republican senator from New Mexico] said the other day that one time he was sure he had a UFO trailing him on his wing—and it turned out to be Venus. There are atmospheric phenomena—density inversions, charged areas, ball lightning—which can be visible and reflect radar signals, there are weather balloons and images of planes distorted by atmospheric optical effects. These must account for a great many reports.

As for the sightings from military bases that you mention, I haven't looked into them. If there were concern within the Defense Department, I'm sure they would have told me or the President, that they haven't leads me to believe they're skeptical. The laws of physics impose such demands—in energy required, in time—on interstellar travel that it's enormously difficult, if not impossible. Since we have no direct manifestations other than sightings, no positive evidence of physical effects on, or harm to, people, it's really not a great cause for concern. I would say that in most of the scientific community and in the government there is a great deal of skepticism, not that they give it zero probability, but they are waiting for a demonstration that these things exist.

Omni: Since World War II there have been many technological innovations that have had decisive effects on society. Is anything like that coming along now?

Press: Yes. There is just as much excitement and potential now as there has ever been in the past, if not more. Take microprocessors. The increase in productivity they make possible is really fantastic. That microprocessors the size of your thumbnail can be inserted into every piece of complex machinery we have opens up tremendous potential. If that potential is capitalized on, we can produce a new generation of 'smart' machines that may do significant things for our exports. I'm talking about everything from automobiles—we almost have that already—to toasters, refrigerators, thermostats, drills, manufactur-

ing equipment—just about everything. Just about every machine will have a brain in it; no industry will be unaffected.

We need to reduce the size and increase the speed of these microprocessors, and this is where the research money is going. We have an initiative involving the Bureau of Standards, the Defense Department and the National Science Foundation to ensure that this research is undertaken for government projects, as well as to provide a research foundation for industry which is also investing large sums, as it should.

Omni: What about biology and medicine?

Press: We've already had the antibiotic revolution; now we're beginning to think about antiviral drugs—think of what they could do! Then there's parasitic disease, which afflicts two billion people throughout the world; the solution to that problem is perhaps the single most important contribution we could make to developing countries. The total world budget in this area is thirty million dollars. Compare that with the billion dollars we spend each year for cancer alone.

Omni: How responsive is the budget that the President has just submitted for these endeavors? For example, we're spending scarcely anything on tropical medicine.

Press: We have these goals in mind. We are increasing the tropical-medicine budget. Last year and this year we've tried to tilt HEW and NIH research toward a more conceptual understanding of disease, by reprogramming within a constant budget. The President aims to help developing countries through science and technology. In the overall scheme of things this kind of research is not that expensive; it makes good sense in terms of economics, health and national security.

Consider the long-term developments in agriculture. Some fifty years ago we began to reap huge returns from small investments in developing hybrid corn, and more recently we've seen the impact of the new strains of rice. Today four farmers feed one hundred Americans, our grain surpluses alone represent a major fraction of the USSR's total production. That's fine, but it's an energy-intensive, chemical-intensive technology. We are ready for the next stage of the agricultural revolution, when we can start creating crops that need little or no fertilizer, that can use not ten percent of incident solar energy but twenty percent or more, that have the ability to use irrigation water far more efficiently than today's crops. With genetic engineering we might do these things, the returns would be enormous.

Omni: Do you believe the public has turned against science and technology?

Press: No. That may have been the case for certain sectors of the public ten or twelve years ago. But four recent polls have asked, "What institutions do you expect will contribute most to the solution of the nation's serious problems?" Science and technology were at the top of the list of answers each time.

Omni: That must make being the President's science adviser a little more encouraging. On that subject, just what does the job entail? What do you do?

Press: I think you'd have to give a different job description for each president, because each one perceives it differently. I think I have the easiest job of any science adviser in the history of the office, because, as I said earlier, the President understands technology. He understands its role, its vocabulary, and he is not intimidated by scientists and engineers. He has worked with them in the past and doesn't find this area exotic or esoteric. So in a very few words you can explain to him why you're proposing certain things, and he understands it and can say yes or no immediately.

The President understands the importance of science and technology in maintaining our position in world affairs of all kinds, and he feels that support of research is a wise investment. He wants to make it a hallmark of his administration. He supports it not in a wild, uninhibited fashion—because there are bounds to what we can do—but in a sensible way. He challenges his administrators throughout the government to pay proper attention to how research can help their departments.

"The role of technology is understood by the President, and he is not intimidated by scientists. He doesn't find this area esoteric. . . . In a few words you can explain to him why you're proposing certain things."

Omni: What about the connections between technology and other activities of government such as international affairs?

Press: Well, take the question of technology transfer to other countries and its pluses and minuses. It earns good money for American industry, but we have to be concerned with what technology we make available to potential adversaries. There's a role for the science adviser among others in this question. And in our relations with developing countries we have to do things that will help them "get off the welfare roll", if we don't. It's going to be handouts, for humane purposes, forever. We can't turn our back on the terrible problems of disease and hunger that they face, but we have to do more than simply give them material to help them past this food shortage or that epidemic. We have to help them help themselves, and science and technology will be major tools in that.

Omni: Previous science advisers had a standing council of wise men called the President's Science Advisory Committee (PSAC). You don't have that committee. Would your standing in the White House be strengthened if you had those senior scientists and university presidents on call?

Press: I was on the PSAC during the Kennedy administration, so I know how it works. When I think of what it did, there is no question of its value and importance at that time. But that was almost twenty years ago. Today I don't need one PSAC, I need a number of them. In those days sixty to eighty percent of PSAC's concerns were in the aerospace and defense areas. Today however we need to look at questions of the environment, energy, health, foreign aid and our developing technological relationships with China, the Soviet Union and the Third World. I simply couldn't assemble a single panel to come in two days a month and advise me across the board; I'd need a specialist in all these areas, and it would be a Tower of Babel. Instead, I have groups coming in to consider each of these areas, each group with enough specialists to give me a "critical mass" of expertise.

Omni: Your initial involvement with the federal government was in connection with verification of the first nuclear-test ban. Have you stayed close to that issue? What's your view on a comprehensive test ban?

Press: You know, if we could have had a comprehensive test ban twenty years ago, the impact would have been much greater. The cat's out of the bag to a certain extent today. We still have a proliferation problem, though. We promised the other signatories to the nonproliferation treaty that the United States and the USSR would stop testing, and eventually we have to deliver on that promise. The symbolic significance of stopping nuclear testing still makes it worthwhile. There are near-nuclear nations which can still be convinced not to go the nuclear-weapons route if we set the example. They are now saying, "Come talk to us when you stop testing yourself. Don't ask us to stop unilaterally." If India goes to large-scale nuclear-weapons development, then Pakistan does, and so on. We could bring pressure to bear against proliferation to a degree that we cannot in the absence of a comprehensive test ban. We are so close to that, and we should pursue it.

Omni: What about the technology for detecting nuclear-bomb tests?

Press: Any country can, under certain circumstances, test at a very low level and possibly evade detection. But there are many ways secrecy can be broken. We have seismography and other techniques; there are people who detect and say they were witnesses to certain things, and so on. All that adds up to a powerful disincentive to testing at any level. Probably a nation could defy all these things and conduct a test at a fraction of a kiloton—but if it does that, would it develop any advantage that could threaten our security? I sincerely doubt it. And the possibility of being caught is far too great. ∞

Wild Should Wild Remain.

"Man always kills the thing he loves, and so we the pioneers have killed our wilderness. Some say we had to. Be that as it may, I am glad I shall never be young without wild country to be young in."

ALDO LEOPOLD

"Integrity is wholeness, the greatest beauty is organic wholeness, the wholeness of life and things, the divine beauty of the universe. Love that, not man apart from that . . ."

ROBINSON JEFFERS

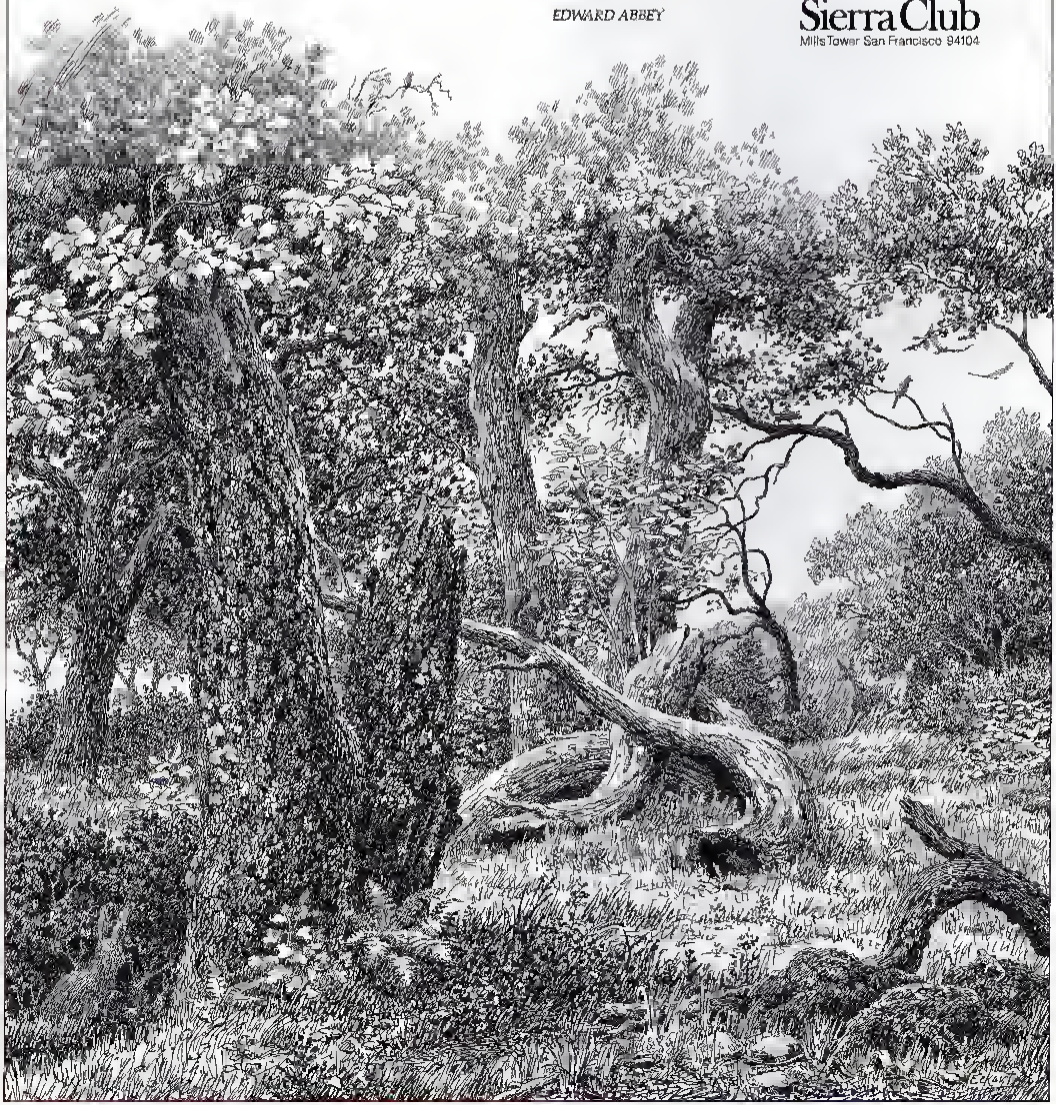
"The love of wilderness is more than a hunger for what is always beyond reach, it is also an expression of loyalty to the earth, (the earth which bore us and sustains us), the only home we shall ever know, the only paradise we ever need—if only we had the eyes to see."

EDWARD ABBEY

"We need wilderness preserved—as much of it as is still left, and as many kinds... It is important to us... simply because it is there—important, that is, simply as an idea."

WALLACE STEGNER

Sierra Club
Mills Tower San Francisco 94104



SPACE LAW

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can broadcast directly into home TV sets and earth-resources satellites whose sophisticated scanners can assess economic resources with unprecedented precision. No country wants its rivals beaming propaganda uncensored into its citizens' living rooms. And highly accurate mineral surveys and crop predictions could give technologically advanced countries a tremendous economic—and military—advantage over less advanced nations.

Whether countries can really limit the use of satellite technology depends on how effectively they can punish or defend against those who use it and on how well they argue their political and ideological cases. One approach is to sell satellite data openly to any buyer who can pay for it. In this way NASA has shared information about earth resources, weather patterns, natural disasters, and the like with Chile, Zaire, Italy, Brazil, Canada and many other nations. To date, remote sensing has forced international cooperation under the close scrutiny of a free public. Let us hope this continues.

"Do you know what we may find up there? People!" —Harriman

We have had trouble enough trying to deal with the mundane aspects of space exploration. The exotic problems of deeper space and permanent habitats will be even more challenging. A few serious attempts are already being made to prepare for contact with intelligent aliens. The late Andrew G. Haley, a Washington, D.C., attorney and counsel for the prestigious International Astronautical Federation, formulated what he called the Interstellar Golden Rule, which holds that sentient beings must "do unto others as they would have you do unto them." How well it will be followed remains to be seen.

Closer to home, the possibility of life existing on other planets already poses some grave legal problems. We have the technology to bring Martian soil samples back to Earth for analysis. Yet if an alien life form escaped from a space probe, it could cause anything from low-grade infections to a biological catastrophe. There is probably no legal way to prevent such an accident from occurring.

Quarantine laws have often been used to imprison people for their political, religious or social beliefs without their being given a public hearing. Modern statutes have been carefully drafted to prevent this sort of abuse. One provision stipulates that a contagious disease be known and identifiable before possible carriers are quarantined.

There are no laws dealing with unknown diseases. Federal or state agencies that were to quarantine a planetary surface sample would probably be violating the due process clauses of the U.S. Constitution. In fact, the NASA quarantine regulations for the *Apollo* lunar samples probably were unconstitutional.

"Outbound contamination," though not dangerous to man, is no less important under the law. Our own spacecraft have always been rigorously sterilized before launching, but the Soviet Union has not always been so conscientious. Sending bacteria-laden probes to other planets is a clear violation of the Outer Space Treaty, but there is no effective way to enforce this ban. NASA has recently confirmed that terraforming Mars would be entirely practical if we were willing to do it over hundreds of years. Whatever the benefits, such plans would be an even more flagrant violation of this clause.

"I'm going to set up a lunar colony and then nurse it along until it's big enough to stand on its own feet." —Harriman

For all the questions that remain unanswered in earth-oriented space law, the principles that will govern space dwellers are even less well developed. Permanent space habitats will raise a vast array of ethical and legal problems that must be solved within the next few decades. There will be many approaches to the social, political, ethical and legal theory of space exploitation. Until our second or third generation of space citizens, extraterrestrial cultures will be shaped purely by economics and by our technological and physiological capabilities.

> *Space colonists may need mind-altering drugs to control behavior, erase painful memories, and tailor sexual preferences to suit the population. Doctors may create them, but will such methods be ethically acceptable?*

Simply enabling men to live in space could raise some of the most difficult ethical questions man has ever faced. Long-term colonists may have to be genetically adapted to survive their synthetic alien environment. Fitting colonists for permanent life in space could require anything from eugenic counseling of their parents to outright genetic engineering. Will such methods be ethically acceptable? Will we be creating, in effect, a new species? Will our first contact with extraterrestrial intelligence come when we meet our own genetically refabricated children? No one has the answers.

Again, the high-pressure environment of a space colony may demand psychotropic drugs to control undesirable behavior, erase traumatic memories and even tailor sexual preferences to suit the colony's population balance. All such manipulative possibilities raise profound ethical and legal issues.

The classic ethical dilemma of space travel has already come perilously close to reality. The near deaths of our *Apollo 13* crew could easily have become the first case in which an astronaut was sacrificed to permit the survival of his fellow crewmen. You can be sure that, as fuel and oxygen slowly ran out on that aborted mission, each crew member did plenty of worrying about who was most expendable!

One possible approach is to write standards of behavior and performance into the contracts under which space colonists are hired. The legal principles under which these problems would then be handled are well established. But how willing would we be to write or sign a contract that, in dire straits, called for "survival homicide"?

We must also figure out how to govern space colonies as societies. Many practical legal problems have cropped up even in these early stages of space law. To date, spacecraft and their crews have been ruled by mission regulations dictated by NASA and by the Soviet space authority.

But how well can this principle be maintained? Research programs will eventually share space habitats with manufacturing facilities. Their practical needs will differ, and the personalities of scientists and business-oriented crewmen may clash. One of the most serious conflicts in the American space program developed when scientists in the astronaut corps suggested that the former test pilots among them were unneeded and possibly undesirable. No one knows how to resolve such problems.

Some space colonies will probably consist of clusters of interconnected modules, each sent into space by different nations, companies or launching authorities. During the *Apollo/Soyuz* flight, astronauts followed NASA regulations while in the American capsule, Soviet rules while in the Russian craft. It seems unlikely that such a system could work in a long-term habitat or one that answered to many different launching authorities. And then what principles would govern the relationships between the cluster as a whole and Earth's societies or other space stations? So far, no one can predict.

The diplomats who signed the 1967 Outer Space Treaty clearly meant for space colonies to benefit the common welfare of mankind. To ensure that their wish is carried out, we need yet another international convention. Space habitats will be places of unique social and political experimentation. We must first guarantee that space stations are governed as the cultural province of the colonists who live in them; then establish space as an economic resource for the common good of earth and space dwellers alike.

CROSS & DRAGON

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I read it as the *Truth of Christ* slid between the stars at first taking copious notes to better understand the heresy that I must fight, but later simply absorbed by the strange, convoluted, grotesque story it told. The words of the text had passion and power and poetry.

Thus it was that I first encountered the striking figure of St. Judas Iscariot, a complex, ambitious, contradictory, and altogether extraordinary human being.

He was born of a whore in the fabled ancient city-state of Babylon on the same day that the Savior was born in Bethlehem, and he spent his childhood in the alleys and gutters, selling his own body when he had to, pimping when he became older. As a youth, he began to experiment with the dark arts, and before the age of twenty he was a skilled necromancer. That was when he became Judas the Dragon-Tamer, the first and only man to bend to his will the most fearsome of God's creatures, the great winged fire lizards of Old Earth. The book held a marvelous painting of Judas in some great dank cavern, his eyes aflame as he wielded a glowing lash to keep at bay a mountainous green-gold dragon. Beneath his arm is a woven basket, its lid slightly ajar, and the tiny scaled heads of three dragon chicks are peering from within. A fourth infant dragon is crawling up his sleeve. That was in the first chapter of his life.

In the second, he was Judas the Conqueror, Judas the Dragon-King, Judas of Babylon, the Great Usurper. Astride the greatest of his dragons, with an iron crown on his head and a sword in his hand, he made Babylon the capital of the greatest empire Old Earth had ever known, a realm that stretched from Spain to India. He reigned from a dragon throne amid the Hanging Gardens he had caused to be constructed, and it was there he sat when he tried Jesus of Nazareth, the troublemaking prophet who had been dragged before him bound and bleeding. Judas was not a patient man, and he made Christ bleed still more before he was through with Him. And when Jesus would not answer his questions, Judas—contemptuous—had Him cast back out into the streets. But first Judas ordered his guards to cut off Christ's legs. "Healer," he said, "heal thyself."

Then came the Repentance, the vision in the night, and Judas Iscariot gave up his crown and his dark arts and his riches to follow the man he had crippled. Despised and taunted by those he had tyrannized, Judas became the Legs of the Lord, and for a year he carried Jesus on his back to the far corners of the realm he had once ruled. When Jesus did finally heal Himself, then Judas walked at His side, and from that time forth he was Jesus' trusted friend and counselor, the first and foremost of the Twelve. Finally, Jesus gave Judas the gift of tongues, recalled and sanctified the dragons that Judas had sent away, and sent his disciple forth on a solitary ministry across the oceans, "to spread My Word where I cannot go."

There came a day when the sun went dark at noon and the ground trembled, and Judas swung his dragon around on ponderous wings and flew back across the raging seas. But when he reached the city of Jerusalem, he found Christ dead on the cross.

In that moment his faith faltered, and for the next three days the Great Wrath of Judas was like a storm across the ancient world. His dragons razed the Temple in Jerusalem and drove the people from the city and struck as well at the great seats of power in Rome and Babylon. And when he found the others of the Twelve and questioned them and learned of how the one named Simon-called-Peter had three times betrayed the Lord, he strangled Peter with his own hands and fed the corpse to his dragons. Then he sent those dragons forth to start fires throughout the world, funeral pyres for Jesus of Nazareth.

> *"In that moment his faith faltered, and for the next three days the Great Wrath of Judas was like a storm across the ancient world. His dragons razed the Temple in Jerusalem..."*

And Jesus rose on the third day, and Judas wept, but his tears could not turn Christ's anger for in his wrath he had betrayed all of Christ's teachings.

So Jesus called back the dragons, and they came, and everywhere the fires went out. And from their bellies he called forth Peter and made him whole again, and gave him dominion over the Church.

Then the dragons died, and so, too, did all dragons everywhere, for they were the living sigil of the power and wisdom of Judas Iscariot, who had sinned greatly. And He took from Judas the gift of tongues and the power of healing. He had given, and even his eyesight, for Judas had acted as a man blind (there was a fine painting of the blinded Judas weeping over the bodies of his dragons). And He told Judas that for long ages he would be remembered only as Betrayer, and people would curse his name, and all that he had been and done would be forgotten.

But then, because Judas had loved Him so, Christ gave him a boon, an extended life, during which he might travel and think on his sins and finally come to forgiveness, and only then die.

And that was the beginning of the last chapter in the life of Judas Iscariot, but it was a very long chapter indeed. Once Dragon-King, once the friend of Christ, now he became only a blind traveler, outcast and friendless, wandering all the cold roads of the earth, living even when all the cities and people and things he had known were dead. And Peter, the first Pope and ever his enemy, spread far and wide the tale of how Judas had sold Christ for thirty pieces of silver, until Judas dared not even use his true name. For a time he called himself just Wandering Ju', and afterward many other names.

He lived more than a thousand years, and became a preacher and a healer and a lover of animals, and was hunted and persecuted when the Church that Peter had founded became bloated and corrupt. But he had a great deal of time, and at last he found wisdom and a sense of peace, and finally Jesus came to him on a long-postponed deathbed, and they were reconciled, and Judas wept once again. And before he died, Christ promised that He would permit a few to remember who and what Judas had been, and that with the passage of centuries the news would spread, until finally Peter's Lie was displaced and forgotten.

Such was the life of St. Judas Iscariot as related in *The Way of Cross and Dragon*. His teachings were there as well, and the apocryphal books that he had allegedly written.

When I had finished the volume, I lent it to Arla-k-Bau, the captain of the *Truth of Christ*. Arla was a gaunt, pragmatic woman of no particular faith, but I valued her opinion. The others of my crew, the good sisters and brothers of St. Christopher, would only have echoed the archbishop's religious horror.

"Interesting," Arla said when she returned the book to me.

I chuckled. "Is that all?"

She shrugged. "It makes a nice story. An easier read than your Bible, Damien, and more dramatic as well."

"True," I admitted. "But it's absurd. An unbelievable tangle of doctrine, apocrypha, mythology and superstition. Entertaining, yes, certainly imaginative, even daring. But ridiculous, don't you think? How can you credit dragons? A legless Christ? Peter being pieced together after being devoured by four monsters?"

Arla's grin was taunting. "Is that any sillier than water changing into wine, or Christ walking on the waves, or a man living in the belly of a fish?" Arla-k-Bau liked to jab at me. It had been a scandal when I selected a nonbeliever as my captain, but she was very good at her job, and I liked her around to keep me sharp. She had a good mind, Arla did, and I valued that more than blind obedience. Perhaps that was a sin in me.

"There is a difference," I said.

"Is there?" she snapped back. Her eyes saw through my masks. 'Ah, Damien, admit it. You rather liked this book."

I cleared my throat. "It piqued my interest," I acknowledged. I had to justify myself. "You know the kind of matter I deal with ordinarily. Dreary little doctrinal deviations, obscure quibblings on theology somehow blown all out of proportion, bald-faced political maneuverings designed to set some ambitious planetary bishop up as a new pope or to wring some concession or other from New Rome or Vess. The war is endless, but the battles are dull and dirty. They exhaust me, spiritually, emotionally, physically. Afterward I feel drained and guilty." I tapped the book's leather cover. "This is different. The heresy must be crushed, of course, but I admit that I am anxious to meet this Lukyan Judasson."

'The artwork is lovely as well," Arla said, flipping through the pages of *The Way of Cross and Dragon* and stopping to study one especially striking plate. Judas weeping over his dragons. I think I smiled to see that it had affected her as much as me. Then I frowned.

That was the first inkling I had of the difficulties ahead.

So it was that the *Truth of Christ* came to the porcelain city Ammadon on the world of Arion, where the Order of St. Judas Iscariot kept its House.

Arion was a pleasant, gentle world, inhabited for these past three centuries. Its population was under nine million; Ammadon, the only real city, was home to fwo of those millions. The technological level was medium high, but chiefly imported. Arion had little industry and was not an innovative world, except perhaps artistically. The arts were quite important here, flourishing and vital. Religious freedom was a basic tenet of the society, but Arion was not a religious world either, and the majority of the populace lived devoutly secular lives. The most popular religion was Aestheticism, which hardly counts as a religion at all. There were also Taoists, Erikaners, Old True Christers, and Children of the Dreamer, along with a dozen lesser sects.

And finally there were nine churches of the One True Interstellar Catholic faith. There had been twelve.

The three others were now houses of Arion's fastest-growing faith, the Order of St. Judas Iscariot, which also had a dozen newly built churches of its own.

The bishop of Arion was a dark, severe man with close-cropped black hair, who was not at all happy to see me. "Damien Har Veris!" he exclaimed in some wonder when I called on him at his residence. "We have heard of you, of course, but I never thought to meet or host you. Our numbers are small here—"

"And growing smaller," I said. "A matter of some concern to my Lord Commander, Archbishop Torgathon. Apparently you are less troubled. Excellency, since you did not see fit to report the activities of this sect of Judas worshipers."

He looked briefly angry at the rebuke, but quickly he swallowed his temper. Even a bishop can fear a Knight Inquisitor. "We are concerned, of course," he said. "We do all we can to combat the heresy. If you have advice that will help us, I will be more than glad to listen."

"I am an Inquisitor of the Order Militant of the Knights of Jesus Christ," I said bluntly. "I do not give advice, Excellency. I take action. To that end I was sent to Arion, and that is what I shall do. Now tell me what you know about this heresy and this First Scholar, this Lukyan Judasson."

"Of course, Father Damien," the bishop began. He signaled for a servant to bring us a tray of wine and cheese, and began to summarize the short, but explosive, history of the Judas cult. I listened, polishing my nails on the crimson lapel of my jacket, until the black paint gleamed brilliantly, interrupting from time to time with a question. Before he had half-finished, I was determined to visit Lukyan personally. It seemed the best course of action.

"He looked briefly angry at the rebuke, but quickly he swallowed his temper. Even a bishop can fear a Knight Inquisitor. "We are concerned, of course.... We.... combat the heresy."

And I had wanted to do it all along.

Appearances were important on Arion, I gathered, and I deemed it necessary to impress Lukyan with my self and my station. I wore my best boots, sleek dark handmade boots of Roman leather that had never seen the inside of Torgathon's receiving chamber, and a severe black suit with deep burgundy lapels and stiff collar. From around my neck hung a splendid crucifix of pure gold; my collar pin was a matching golden sword, the sigil of the Knights Inquisitor. Brother Denis painted my nails carefully, all black as ebony, and darkened my eyes as well, and used a fine white powder on my face. When I glanced in the mirror I frightened even myself. I smiled, but only briefly. It ruined the effect.

I walked to the House of St. Judas Iscariot. The streets of Ammadon were wide and spacious and golden, lined by scarlet trees called whisperwinds, whose long, drooping tendrils did indeed seem to whisper secrets to the gentle breeze. Sister Judith came with me. She is a small woman, slight of build even in the cowled coveralls of the Order of St. Christopher. Her face is meek and kind, her eyes wide and youthful and innocent. I find her useful. Four times now she has killed those who attempted to assault me.

The House itself was newly built. Rambling and stately, it rose from amid gardens of small bright flowers and seas of golden grass, and the gardens were surrounded by a high wall. Murals covered both the outer wall around the property and the exterior of the building itself. I recognized a few of them from *The Way of Cross and Dragon* and stopped briefly to admire them before walking on through the main gate. No one tried to stop us. There were no guards, not even a receptionist. Within the walls, men and women strolled languidly through the flowers, or sat on benches beneath silverwoods and whisperwinds.

Sister Judith and I paused, then made our way directly to the House itself.

We had just started up the steps when a man appeared from within; he stood waiting in the doorway. He was blond and fat, with a great wiry beard that framed a slow smile, and he wore a flimsy robe that fell to his sandaled feet, and on the robe were dragons bearing the silhouette of a man holding a cross.

When I reached the fop of the steps, the man bowed to me. "Father Damien Har Veris of the Knights Inquisitor," he said. His smile widened. "I greet you in the name ot Jesus and St. Judas. I am Lukyan."

I made a note to myself to find out which of the bishop's staff was feeding information to the Judas cult, but my composure did not break. I have been a Knight Inquisitor for a long, long time. "Father Lukyan Mo," I said, taking his hand. "I have questions to ask of you." I did not smile.

He did. "I thought you might," he said.

Lukyan's office was large but spartan. Heretics often have a simplicity that the officers of the true Church seem to have lost. He did have one indulgence, however.

Dominating the wall behind his desk/console was the painting I had already fallen in love with, the blinded Judas weeping over his dragons.

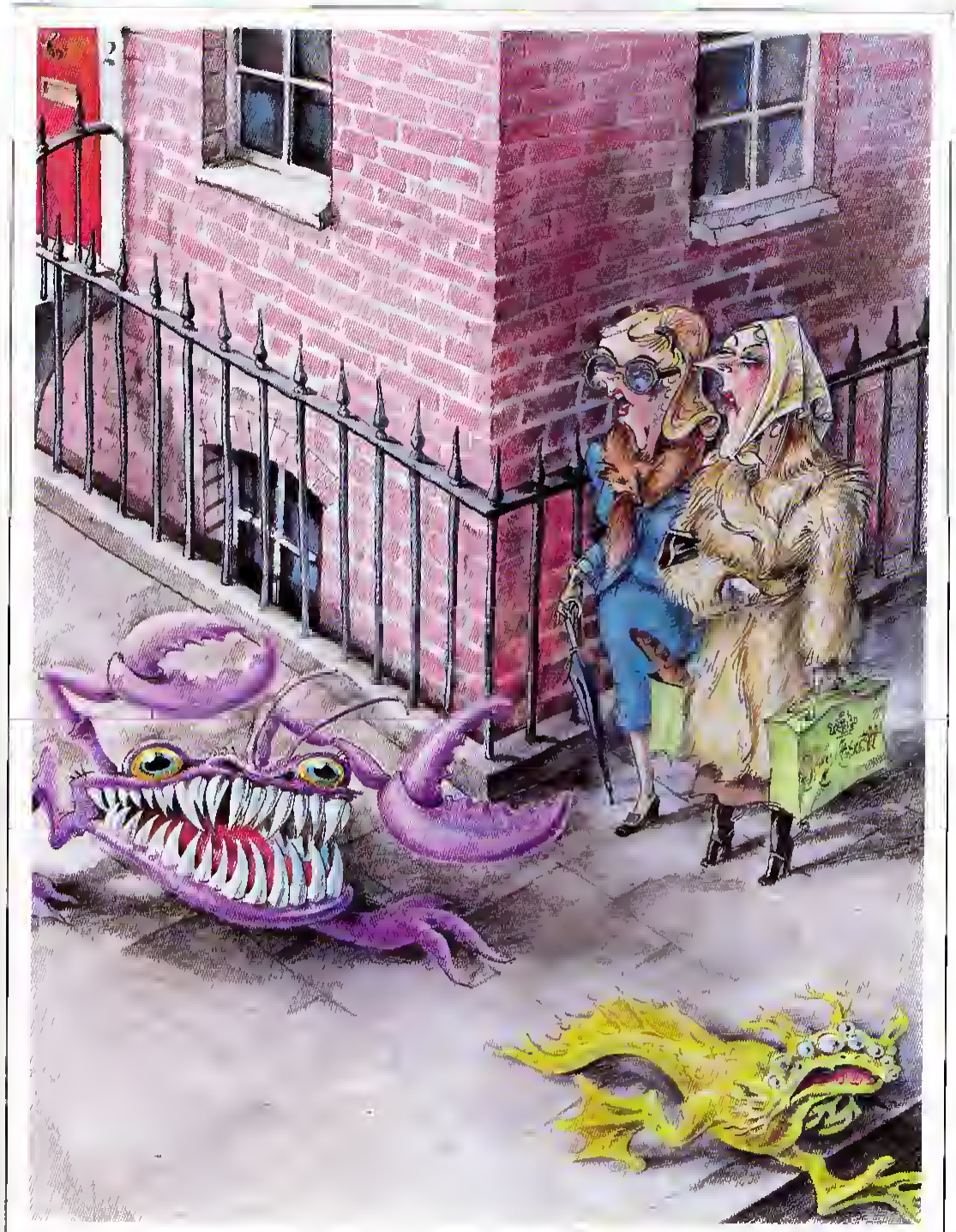
Lukyan sat down heavily and motioned me to a second chair. We had left Sister Judith outside, in the waiting chamber. "I prefer to stand, Father Lukyan," I said, knowing it gave me an advantage.

'Just Lukyan," he said. "Or Luke, if you prefer. We have little use for titles here."

"You are Father Lukyan Mo, born here on Arion, educated in the seminary on Cathaday, a former priest of the One True Interstellar Catholic Church of Earth and the Thousand Worlds," I said. "I will address you as befits your sfation, Father. I expect you to reciprocate. Is that undersfood?"

"Oh, yes," he said amiably.

'I am empowered to strip you of your right to administer the sacraments, to order you shunned and excommunicated for this heresy you have formulated. On certain



"It's one goddam thing after another"

worlds I could even order your death."

But not on Arion," Lukyan said quickly. "We're very tolerant here. Besides, we outnumber you." He smiled. "As for the rest, well, I don't perform those sacraments much anyway, you know. Not for years. I'm First Scholar now. A teacher, a thinker. I show others the way, help them find the faith. Excommunicate me if it will make you happy, Father Damien. Happiness is what all of us seek."

"You have given up the faith then, Father Lukyan?" I said. I deposited my copy of *The Way of Cross and Dragon* on his desk. "But I see you have found a new one. Now I did smile, but it was all ice, all menace, all mockery. A more ridiculous creed I have yet to encounter. I suppose you will tell me that you have spoken to God, that He trusted you with this new revelation, so that you might clear the good name, such that it is, of Holy Judas?"

Now Lukyan's smile was very broad, indeed. He picked up the book and beamed at me.

"Oh, no," he said. "No. I made it all up."

That stopped me. "What?"

"I made it all up," he repeated. He hefted the book fondly. "I drew on many sources, of course, especially the Bible, but I do think of *Cross and Dragon* mostly as my own work. It's rather good, don't you agree? Of course, I could hardly put my name on it, proud as I am of it, but I did include my imprimatur. Did you notice that? It was the closest I dared come to a by-line."

I was speechless only for a moment. Then I grimaced. "You startle me," I admitted. "I expected to find an inventive madman, some poor self-deluded foot firm in his belief that he had spoken to God. I've dealt with such fanatics before. Instead I find a cheerful cynic who has invented a religion for his own profit. I think I prefer the fanatics. You are beneath contempt, Father Lukyan. You will burn in hell for eternity."

"I doubt it," Lukyan said, "but you do mistake me, Father Damien. I am no cynic, nor do I profit from my dear St. Judas. Truthfully, I lived more comfortably as a priest of your own Church. I do this because it is my vocation."

I sat down. "You confuse me," I said. "Explain."

"Now I am going to tell you the truth," he said. He said it in an odd way, almost as a cant. "I am a liar," he added.

"You want to confuse me with child's paradoxes," I snapped.

"No, no," he smiled. "A *Liar*. With a capital. It is an organization, Father Damien. A religion, you might call it. A great and powerful faith. And I am the smallest part of it."

"I know of no such church," I said.

"Oh, no, you wouldn't. It's secret. It has to be. You can understand that, can't you? People don't like being lied to."

"I do not like being lied to," I said.

Lukyan looked wounded. "I told you this would be the truth, didn't I? When a Liar says that, you can believe him. How else could we trust each other?"

"There are many of you," I said. I was starting to think that Lukyan was a madman after all, as fanatic as any heretic, but in a more complex way. Here was a heresy within a heresy, but I recognized my duty—to find the truth of things, and set them right.

"Many of us," Lukyan said, smiling. "You would be surprised, Father Damien, really you would. But there are some things I dare not tell you."

"Tell me what you dare, then."

"Happily," said Lukyan Judasson. "We Liars, like all other religions, have several truths we take on faith. Faith is always required. There are some things that cannot be proved. We believe that life is worth living. That is an article of faith. The purpose of life is to live, to resist death, perhaps to defy entropy."

"Go on," I said, growing even more interested, despite myself.

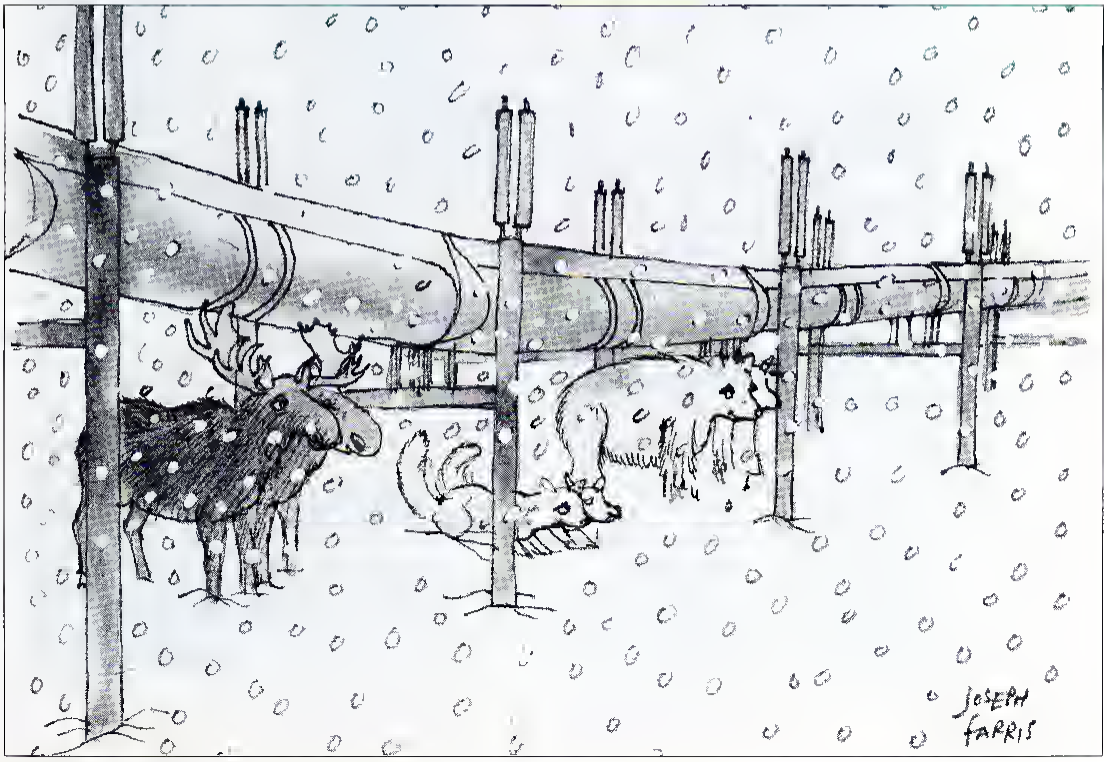
"We also believe that happiness is a good, something to be sought after."

"The Church does not oppose happiness," I said, dryly.

"I wonder," Lukyan said. "But let us not quibble. Whatever the Church's position on happiness, it does preach belief in an afterlife, in a supreme being, and a complex moral code."

"True."

"The Liars believe in no afterlife, no God,



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We see the universe as it *is*. Father Damien, and these naked truths are cruel ones. We who believe in life and treasure it will die. Afterward there will be nothing: eternal emptiness, blackness, nonexistence. In our living there has been no purpose, no poetry, no meaning. Nor do our deaths possess these qualities. When we are gone, the universe will not long remember us, and shortly it will be as if we had never lived at all. Our worlds and our universe will not long outlive us. Ultimately entropy will consume all, and our puny efforts cannot stay that awful end. It will be gone. It has never been. It has never mattered. The universe itself is doomed, transitory, and certainly it is uncaring."

I slid back in my chair and a shiver went through me as I listened to poor Lukyan's dark words. I found myself fingering my crucifix. "A bleak philosophy," I said, "as well as a false one. I have had that fearful vision myself. I think all of us do, at some point. But it is not so, Father. My faith sustains me against such nihilism. Faith is a shield against despair."

"Oh, I know that, my friend, my Knight Inquisitor," Lukyan said. "I'm glad to see you understand so well. You are almost one of us already."

I frowned.

"You've touched the heart of it," Lukyan continued. "The truths, the great truths—and most of the lesser ones as well—they are unbearable for most men. We find our shield in faith. Your faith, my faith, any faith. It doesn't matter, so long as we *believe*, really and truly believe, in whatever lie we cling to." He fingered the ragged edges of his great blond beard. "Our psychs have always told us that believers are the happy ones, you know. They may believe in Christ or Buddha or Erika Stormjones, in reincarnation or immortality or nature, in the power of love or the platform of a political faction, but it all comes to the same thing. They believe. They are happy. It is the ones who have seen truth who despair and kill themselves. The truths are so vast, the faiths so little, so poorly made, so riddled with errors and contradictions. We see around them and through them, and then we feel the weight of darkness on us, and we can no longer be happy."

I am not a slow man. I knew, by then, where Lukyan Judasson was going. "Your Liars invent faiths."

He smiled. "Of all sorts. Not only religious. Think of it. We know truth for the cruel instrument it is. Beauty is infinitely preferable to truth. We invent beauty. Faiths, political movements, high ideals, belief in love and fellowship. All of them are lies. We tell those lies, and others, endless others. We improve on history and myth and religion, make each more beautiful, better, easier to believe in. Our lies are not perfect, of course. The truths are too big. But perhaps someday we will find one great lie that all humanity can use. Until then, a thousand small lies will do."

"I think I do not care for you Liars very much," I said with a cold, even fervor. "My whole life has been a quest for truth."

Lukyan was indulgent. "Father Damien Har Veris, Knight Inquisitor, I know you better than that. You are a Liar yourself. You do good work. You ship from world to world, and on each you destroy the foolish, the rebels, the questioners who would bring down the edifice of the vast lie that you serve."

"If my lie is so admirable," I said, "then why have you abandoned it?"

"A religion must fit its culture and society, work with them, not against them. If there is conflict, confradiction, then the lie breaks down, and the faith falters. Your Church is good for many worlds, Father, but not for Arion. Life is too kind here, and your faith is stern. Here we love beauty, and your faith offers too little. So we have improved. We studied this world for a long time. We know its psychological profile. St. Judas will thrive here. He offers drama, and color, and much beauty—the aesthetics are admirable. His is a tragedy with a happy ending, and Arion dotes on such stories. And the dragons are a nice touch. I think your own Church ought to find a way to work in dragons. They are marvelous creatures."

> *"The Liars believe in no afterlife, no God. We see the universe as it* is, *Father Damien, and these naked truths are cruel ones. We who believe in life, and treasure it, will die."*

"Mythical," I said.

"Hardly," he replied. "Look it up." He grinned at me. "You see, really, it all comes back to faith. Can you really know what happened three thousand years ago? You have one Judas. I have another. Both of us have books. Is yours true? Can you really believe that? I have been admitted only to the first circle of the order of Liars. So I do not know all our secrets, but I know that we are very old. It would not surprise me to learn that the gospels were written by men very much like me. Perhaps there never was a Judas at all. Or a Jesus."

"I have faith that that is not so," I said.

"There are a hundred people in this building who have a deep and very real faith in St. Judas and the Way of Cross and Dragon," Lukyan said. "Faith is a very good thing. Do you know that the suicide rate on Arion has decreased by almost a third since the Order of St. Judas was founded?"

I remember rising slowly from my chair. "You are as fanatical as any heretic I have ever met, Lukyan Judasson," I told him. "I pity you the loss of your faith."

Lukyan rose with me. "Pity yourself, Damien Har Veris," he said. "I have found a new faith and a new cause, and I am a happy man. You, my dear friend, are tortured and miserable."

"That is a lie!" I am afraid I screamed.

"Come with me," Lukyan said. He touched a panel on his wall, and the great painting of Judas weeping over his dragons slid up out of sight, and there was a stairway leading down into the ground. "Follow me," he said.

In the cellar was a great glass vat full of pale green fluid, and in it a *thing* was floating—a thing very like an ancient embryo, aged and infantile at the same time, naked, with a huge head and a tiny atrophied body. Tubes ran from its arms and legs and genitals, connecting it to the machinery that kept it alive.

When Lukyan turned on the lights, it opened its eyes. They were large and dark, and they looked into my soul.

"This is my colleague," Lukyan said, patting the side of the vat. "Jon Azure Cross, a Liar of the fourth circle."

"And a telepath," I said with a sick certainty. I had led pogroms against other telepaths, children mostly, on other worlds. The Church teaches that the psionic powers are a trap of Satan's. They are not mentioned in the Bible. I have never felt good about those killings.

"Jon read you the moment you entered the compound," Lukyan said, "and notified me. Only a few of us know that he is here. He helps us lie most efficiently. He knows when faith is true and when it is feigned. I have an implant in my skull. Jon can talk to me at all times. It was he who initially recruited me into the Liars. He knew my faith was hollow. He felt the depth of my despair."

Then the thing in the tank spoke, its metallic voice coming from a speaker-grill in the base of the machine that nurtured it. *"And I feel yours, Damien Har Veris, empty priest. Inquisitor, you have asked too many questions. You are sick at heart, and tired, and you do not believe. Join us, Damien. You have been a Liar for a long, long time!"*

For a moment I hesitated, looking deep into myself, wondering what it was I did believe. I searched for my faith, the fire that had once sustained me, the certainty in the teachings of the Church, the presence of Christ within me. I found none of it, none. I was empty inside, burned out, full of questions and pain. But as I was about to answer Jon Azure Cross and the smiling Lukyan Judasson, I found something else, something I *did* believe in, something I had always believed in.

Truth.

I believed in truth, even when it hurt. *"He is lost to us,"* said the telepath with the mocking name of Cross.

Lukyan's smile faded. "Oh, really? I had hoped you would be one of us, Damien. You seemed ready."

I was suddenly afraid and I considered sprinting up the stairs to Sister Judith Lukyan had told me so very much, and now I had rejected them.

The telepath felt my fear. *"You cannot hurt us, Damien,"* it said. *"Go in peace. Lukyan told you nothing."*

Lukyan was frowning. "I told him a good deal, Jon," he said.

"Yes. *But can he trust the words of such a Liar as you?*" The small misshapen mouth of the thing in the vat twitched in a smile, and its great eyes closed, and Lukyan Judasson sighed and led me up the stairs.

It was not until some years later that I realized it was Jon Azure Cross who was lying, and the victim of his lie was Lukyan. I *could* hurt them. I did.

It was almost simple. The bishop had friends in government and the media. With some money in the right places, I made some friends of my own. Then I exposed Cross in his cellar, charging that he had used his psionic powers to tamper with the minds of Lukyan's followers. My friends were receptive to the charges. The guardians conducted a raid, took the telepath Cross into custody and later tried him.

He was innocent, of course. My charge was nonsense; human telepaths can read minds in close proximity but seldom anything more. But they are rare, and much teared and Cross was hideous enough so that it was easy to make him a victim of superstition. In the end, he was acquitted, and he left the city of Ammadon and perhaps Arion itself, bound for regions unknown.

But it had never been my intention to convict him. The charge was enough. The cracks began to show in the lie that he and Lukyan had built together. Faith is hard to come by and easy to lose, and the merest doubt can begin to erode even the strongest foundation of belief.

The bishop and I labored together to sow further doubts. It was not as easy as I might have thought. The Liars had done their work well. Ammadon, like most civilized cities, had a great pool of knowledge, a computer system that linked the schools and universities and libraries together, and made their combined wisdom available to any who needed it.

But, when I checked, I soon discovered that the histories of Rome and Babylon had been subtly reshaped, and there were three listings for Judas Iscariot—one for the betrayer, one for the saint, and one for the conqueror-king of Babylon. His name was also mentioned in connection with the Hanging Gardens, and there is an entry for a so-called Codex Judas.

And according to the Ammadon library, dragons became extinct on Old Earth around the time of Christ.

We purged all those lies, finally, wiped them from the memories of the computers, though we had to cite authorities on a half-dozen non-Christian worlds before the librarians and academics would credit that the differences were anything more than a question of religious preference.

By then the Order of St. Judas had withered in the glare of exposure. Lukyan Judasson had grown gaunt and angry and at least half of his churches had closed.

The heresy never died completely, of course. There are always those who believe, no matter what. And so to this day *The Way of Cross and Dragon* is read on Arion, in the porcelain city Ammadon, amid murmuring whisperwinds.

Arla-k-Bau and the *Truth of Christ* carried me back to Vess a year after my departure, and Archbishop Torgathon finally gave me the leave of absence I had asked for before sending me out to fight still other heresies. So I had my victory, and the Church continued on much as before, and the Order of St. Judas Iscariot was thoroughly crushed. The telepath Jon Azure Cross had been wrong. I thought then. He had sadly underestimated the power of a Knight Inquisitor.

Later, though, I remembered his words. *You cannot hurt us, Damien.*

Us?

The Order of St. Judas? Or the Liars?

He lied, I think, deliberately knowing I would go forth and destroy the Way of Cross and Dragon, knowing, too, that I could not touch the Liars, would not even dare mention them. How could I? Who would credit it? A grand star-spanning conspiracy as old as history? It reeks of paranoia, and I had no proof at all.

The telepath lied for Lukyan's benefit so he would let me go. I am certain of that now. Cross risked much to ensnare me. Failing, he was willing to sacrifice Lukyan Judasson and his lie, pawns in some greater game.

So I left, and I carried within me the knowledge that I was empty of faith, but for a blind faith in truth—truth I could no longer find in my Church.

I grew certain of that in my year of rest which I spent reading and studying on Vess and Cathaday and Celia's World. Finally I returned to the archbishop's receiving room, and stood again before Torgathon Nine-Klarus Tûn in my very worst pair of boots. "My Lord Commander," I said to him, "I can accept no further assignments. I ask that I be retired from active service."

"For what cause?" Torgathon rumbled, splashing feebly.

"I have lost the faith," I said to him, simply.

He regarded me for a long time, his pupilless eyes blinking. At last he said, "Your faith is a matter between you and your confessor. I care only about your results. You have done good work, Damien. You may not retire, and we will not allow you to resign."

The truth will set us free.

But freedom is cold and empty and frightening, and lies can often be warm and beautiful.

Last year the Church granted me a new ship. I named this one *Dragon*. ∞

MICKEY MOUSE

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The referee spoke mostly Japanese but understood screams. He motioned Korolenko close for examination.

"He's been fiberglassed," the American clamored, indicating the rows of abrasions on his torso. "I ain't wrestling no pineapple."

By this time both teams had edged forward in bilingual outrage. The official, who refrained from touching the specimen, suddenly straightened and announced in Oriental English, "No foe-lin sub-stints." He then chopped the air smartly with both hands, bidding the bout resume, and, when the American gingerly donned his jacket and savagely denounced his toe as a Communist cactus, the beleaguered ref declared a forfeit.

Smerdyakov shrugged and sat down opposite the American coach at the scorers' table to fill out another protest.

And so it went the first week until the Olympic Committee, as a sign of helplessness, convened a private meeting of the two antagonists at the Havana Libre Hotel.

Sherman, more tweed than ever, his skin a deeper-below-ground skin than before, and inhabiting a blue blazer he had not climbed out of for thirty-six hours, appeared first. Smerdyakov dallied psychologically long at a nearby coffee shop but showed up equally worn, his fat and flexible face delivered of cherubic charm, a post-pregnancy landscape, rilled, jellied. The two of them faced each other across the polished table, regarding each other's lapel pins.

"Gentlemen," began the wise old Olympic patriarch sitting peripherally to them, "we are all sorely tried."

Whatever else he said was inconsequential. Smerdyakov knew it. Sherman knew it. The two other Executive Committee members knew it. The grinning Cuban who seemed to have wandered in by mistake knew it. Each loathed the transcultural experience of an old man's speech. They had not come to be assuaged. They had come to cross swords, to bleed, and then—if enough blood of the right color was spilled—to bury.

"On behalf of the United Stafes," Sherman flickered to life at the proper moment, "and for the sake of the integrity of the Games, I demand gene scans of the following Soviet entries: Ivan Spadunka, center—"

"Spadunka!"

"—center forward, Soviet basketball team," Sherman overrode Smerdyakov's dismay.

"We'll trade you a gene scan of Spadunka for a gene scan of the humanoid you call Stilt!"

"—and of pole vaulters Olka K. and Mikhail C.," Sherman continued undaunted, "discus thrower Pyotr I.—"

"Inber or Izmaylov?"

"The one with the cast-iron forearms."

"All our field athletes have fine supinator and pronator development," declared Smerdyakov.

"Then I want scans of all of them."

"And what do you expect to find? Evidence of chemical synthesis?"

"You wouldn't be that clumsy."

Smerdyakov laughed smugly. A laugh deep inside the neck and shoulders. Internal peep show.

"We suspect they are *chimeras*," Sherman said slowly. "Reaggregated genes you've somehow controlled at the blastocyst stage—four parents, eight parents, whatever pick and choose."

"Ab-surd!" A touch too much anger. Smerdyakov attempted to cover it with reckless scorn. "Eight parents! Of course. Eight models of mediocrity instead of two. Makes sense. Something from nothing, yes, Shuer-mann? If you find the genetic model for this kind of development in anyone's ancestors, I'll be glad to call Inber and Izmaylov home myself. Why not? We can simply enter their parents!"

> *"He waved the paper loose from his jacket . . . "Fencers whose arms are longer than their legs, water polo players with dewclaws who secrete oil like seals, and this goalie of theirs!"*

"No, we won't find the right genetic model," Sherman agreed. "But we should be able to prove that their gene scans don't meet any possible permutations of the gene scans of any human parents you produce."

Smerdyakov began thumping the table. "Proof, proof, proof, Shuer-mann! None of this guilt by omission of evidence. Would your capitalist justice admit such foolishness? Where is the sire for this genetic circus you accuse us of?"

"Popeye!" Sherman blurted sarcastically.

"Pup-eye?" Smerdyakov blinked. "Who is Pup-eye?"

"We aren't dealing with legalities," said Sherman. "We're dealing with Olympic admissibility."

"Who is Pup-eye?" Smerdyakov asked the patriarch.

"*Pop*-eye," that august being informed him.

"Pope-eye," the Cuban was heard to repeat with inner amusement.

Smerdyakov looked concerned. The *Popeye*. Could it be the English equivalent of the actual sources they had used?

"—and unless convincing genealogies are forthcoming for all the entrants under question, they must be disqualified and stripped of their medals," Sherman was concluding.

"Genealogies?" Smerdyakov sopranoed. "The American neurotic wants us to have pedigrees! Incredible. First he invents an army of mutations, insulting the flower of Soviet youth, then he finds an ancestor for them—this, this mysterious Poop-eye, who probably exists only in imperialist folklore, and now—now he takes it upon himself to strip us of our medals! Curiously he makes no mention of Soviet protests. But I too have a list." He waved the paper loose from his jacket pocket. "Fencers whose arms are longer than their legs, water polo players with dewclaws who secrete oil like seals, and this goalie of theirs: they call Pon-toon! No need to go on. No need to tell you about the phone call to Spadunka at 3 AM announcing that his pregnant wife, Vera, had been arrested naked on a statue of Lenin in Novgorod. No need to mention the anonymous gifts our athletes receive—radios that don't turn off, an ant farm with a secret exit! No, I merely ask that the Americans on *my* list be suspended from further competition until their gene scans are also approved. We look for Poop-eyes too!"

Sherman snapped his fingers. "The medal count, Felix."

"Gold: twenty-eight/twenty-eight. Silver: sixteen/eleven, them. Bronze: twenty-three/twenty-two, us. That's without any protests upheld, of course."

"And without the fifteen hundred free, which is in the bag." Sherman stirred a lime rickey and eyed the swimming pool on TV. He had given up troubleshooting on the front line and turned his hotel suite into a nerve center with five phones and a television after finding out his blood was nectar to Cuban mosquitoes. "How does it figure if all the protests are upheld, Felix?"

Man Friday sighed like a steamed lobster. "Just about a dead heat in gold and silver. They might edge us in bronze."

"Nobody looks at bronze. The way I see it, when all the dust settles today, this fifteen hundred will be the difference. That's the way I see it. You see it that way, Felix?"

"I don't know, sir. The Russians haven't seen Thompson swim yet. They might protest. I—"

A long pause brought Sherman's glance. "What?"

"Isn't that Smerdyakov, sir?"

"Where?"

"There. Back of the starting blocks."

Sherman leaned close enough to count the electronic dots on the TV, several of which, it seemed to him, did approximate the silly-putty face of Giorgi Smerdyakov.

"That no-good-nik. That crummy Commie!" Sherman felt a transcendental tingle flowing down the back of his neck. Eupho-

ria before death Thompson was the last sure thing the United States had If they couldn't pull this out before tomorrow, it meant losing An eternity of losing for him He saw himself as the final contestant acknowledging defeat at cocktail parties vaguely introduced, shunned whispered about—"That's Sherman, he blew it in Havana"

Sherman arrived bloodless at the natatorium but managed to stroll casually through the press of dewed flesh and crisp white linen on the deck The pool was a caldron of warm-up, the officials were trying to organize back-up timers behind the automatic touch-pads Smerdyakov regarded his approach with cynicism

"Giorgi-li!" Sherman affected "I just had to see you to tell you I'm glad we got that awful protest meeting behind us It was a chance to get rid of our frustrations eh? And now it's the next-to-last day of competition and all is forgiven—the committee has forgotten us the athletes have done their thing the spirit of the Games has come through eh Giorgi?"

Smerdyakov sucked his lips into a thoughtful moue

"Oh, come now" Sherman laughed adolescently, "we've done *our* jobs We should just sit back and let things happen"

Smerdyakov continued to inhale his lips until one of the freestylers flip-turned and laid a wave at their feet

"Hey!" Sherman said as they backed away "Guess what I just came from the diving annex where I withdrew our protest against your diver, Baba Babalus the one that looks like a flying squirrel"

'The one that took fifth?' Giorgi smiled

'Fifth? Oh, did he? Fifth he took Well, he might move up If there are any other protests Anyway we thought it was time to—uh, in fact in fact, we've been thinking of withdrawing all our protests Of course, that could only be part of a *mutual* gesture'

Someone kicked into the wall Aquatic thunder A waiting teammate launched off the block Slap! The sound seemed to fit the sting on Smerdyakov's face "Eat spinach," he said

Sherman's eyelids fluttered "No need to get vulgar, Giorgi—"

"Eat spinach *Poop-eye* You see we have our sources The Soviet-American Cultural Society in Armenia traced down your imperialist mythology We are not stupid And we can keep medal counts as well as you I suppose you think we will just overlook this this amphibian Thompson of yours The one who doesn't warm up The one with the special shoes—he appears to have very few bones below the ankles, Shuer-mann"

'Thompson? Thompson The one with osteogenesis of the feet?'

'Quite select of the disease wouldn't you say? And another thing, we are told he doesn't breathe during the race Is that so, Shuer-mann? For fifteen hundred meters he doesn't breathe? Even amphibians breathe, though often through a blowhole in the top of the head

"He breathes very rapidly, Giorgi I swear it And his mouth is unusually elastic He can catch air with the slightest turn"

"How remarkable We will be filming the race to see"

They sat on deck chairs twenty feet apart behind the timers When the pool was cleared and the officials readied, the championship heat was marshaled to the blocks Thompson aided by teammates on either side, and wearing footgear resembling calf-length ski boots doddered to lane 4 The long, limp appendages that emerged from the boots could have been windsocks or as Smerdyakov said with a lustrous grin, albino galoshes Hardly less intriguing to the Russian was Thompson's topknot Except for a circular thicket at the crown of his head the swimmer was smoothly bald

'Amphibians!' Smerdyakov called sprightly, tapping the top of his head

Soviet cameras rolled

The Last Day

Thompson's world-record performance was under protest The Olympic Committee procrastinated Someone had sent Smerdyakov seven Popeye comics and a package of frozen spinach The mosquitoes around Sherman fed

Sherman was watching a replay of the final equestrian event grand prix jumping Uncle Sam had another gold—temporarily Fool's gold "It's down to the boxing Felix," he said 'Look at that nag She doesn't jump she hops Should've been destroyed Would you let a protest like that go by? It's down to the boxing Felix"

One of the phones rang Felix answered, "Smerdyakov" he said

Sherman took the phone and clamped it on his head like a hot compress "Hello, Popeye," he said wearily

'How dare you call that animal a horse!' screamed Smerdyakov

'It's got four legs and a tail doesn't it? That qualifies it in the Soviet stable'

'Shuer-mann We want that creature x-rayed!'

"Sorry The race was over two hours ago She's dead"

'Dead?" Smerdyakov's frayed voice cracked

"Broke a leg on the way back to the stable Had to shoot her

"Remarkable! An autopsy will do"

'Already buried"

"We will exhume the beast"

'Cremated We buried the urn"

'*Really*, Shuer-mann—"

"You can autopsy yours, though"

"Ours?"

"The thing that took the silver—a rump, a tail, sort of a head? The one we are protesting He's dead, right?"

"of course"

Thought so We figured one of your cos-

sacks spurred him to death"

"Very funny. He died of natural causes. We put him on a plane that crashed in your Bermuda Triangle."

"It's been nice talking to you."

"Nice talking to you, Shuer-mann. How are your mosquito bites?"

"Fine. How are your Popeye comics?"

"Excellent. This Bluto—ha, ha. Well, goodbye."

"Goodbye, Popeye."

Sherman handed the phone to Man Friday. "It's down to the boxing, Felix," he said.

He thought it was fitting that the final distillation of the brotherhood of nations in friendly competition should be two guys in the ring trying to beat each other's brains out. Even with headgear the heavyweights could deliver mickey finns. And the American boy had dynamite hands. So far as they could tell, the Soviet was a ballroom dancer. He glided, bowed, swept, dipped, and occasionally peppered his opponents with pretty but ineffectual volleys. His boxing was elegant, but no one had seen him take a punch in the qualifying matches. He had the brittle features of a ballerina. Well-scrubbed. Cleanly sculpted eyes. A porcelain jaw. Sherman got on the phone to the team manager at the arena. "The *head*, Bronson," he said. "Make sure he goes to the head. He can't outbox the man. He's got to put his lights out." Bronson let Sherman know how much he appreciated the interference, and the two men barked goodbye.

But he needn't have bothered to call. The kid chugged out of his corner at the bell like a wind-up toy. For the first round he pummeled, lambasted, and blasted. The Russian flitted and flicked. It couldn't last. Round 2 saw the American lash, beat, strike, cuff, and buffet. Solid hits. Crushing hits. The brittle nose became a Chuckle. But, except for that, the Soviet boxer seemed completely undaunted. He danced the same blithe dance, scored the same powdery tattoos, even stared the same serene stare. "He's been hypnotized," the Americans complained. A short but profound conversation with the Russian convinced the ref otherwise. Monotonously the American's assault continued. He smote. He thwacked. He Thumped, Thrashed, Drubbed, Pelted, and Trounced. Finally he FLOGGED and SCOURGED his sashaying enemy gloves whipping like windmills, then minnow tails, then dropping to his sides. In came the feminine taps. Down went the American, physically and emotionally exhausted, crying and clutching the great Isadora's knees.

"I don't believe it," Sherman murmured.

"I'll deliver the protest in person," Felix said, reaching for the attache case.

The phone calls came late in the day. One to Smerdyakov, one to Sherman, informing them that *all* protests had been upheld.

"All?" said Sherman. "But that's inconceivable!"

"What kind of Poop-eye Olympics is this?" choked Smerdyakov.

Stunned, they slumped in their separate chairs in separate suites.

"How could they uphold every protest?" Sherman said to himself. "I thought they might turn them all *down*, but uphold them? How could they uphold every protest? How could they?"

Felix dragged in twenty minutes later with a torn computer printout of the complete international protest results and medal redistribution. "Every major country with a genetic-development program..." he tried to begin, and then let the paper fall into Sherman's lap.

Sherman felt his hair going white as he read. He was looking into his grave. "Twenty-eighth?" he whispered hoarsely. "We finished twenty-eighth?"

"Tied with the Soviet Union," said Felix.

"*Sri Lanka*? Sri Lanka won?"

"Just ahead of Liechtenstein."

The phone rang.

"Shuer-mann," came soothingly over the line. "My dear Shuer-mann. We are ruined." Smerdyakov vented a few tight sobs. "Forgive me, Duncan. May I call you Duncan? I know your pain is great, too. What are we to do?"

Sherman choked, swallowed. "The first thing I'm going to do," he announced unsteadily, "is to open the windows of this room and let all the mosquitoes in. Then I'm going to take off my clothes and lie down on the bed."

"Ah, Duncan... no."

"... and if I'm still alive in the morning, I'm going to shave off my beard, buy a ticket for a public flight, and go back to my farm in Virginia."

"I wish it were so easy for me, Duncan. They will take away my car, my apartment, my free tickets to the Bolshoi... Do you think... do you think the American embassy in Havana might—uh, might...?"

"They would be very glad to see you, Giorgi. Very glad. Just don't mention my name, and they will be very glad to see you."

"Yes, yes, I understand. And do you think you might need a farmhand—that is, I'm very good at developing hybrids—"

"No question about it, Giorgi. No question... well, one question."

"Anything, comra—er, Duncan."

"How the hell did your boy take so much punishment in that fight today? He was like a thumb puppet in there. I thought he was getting his brains knocked out."

Giorgi sighed. "A thumb puppet. Not bad. A thumb puppet has no brains, yes? Not in his head, yes? Kuchka has no brains in his head, either."

"Giorgi. You didn't. But where...?"

"You didn't see him sit down, did you?"

"Ah, Giorgi, Giorgi." Sherman chuckled. "See you in Virginia." ∞

Our next guest is a gentleman who claims to have actually been taken aboard a U.F.O.

FARMING

CONTINUED FROM PAGE 94

farms will get larger, says Rodale, and there will be more small farms. That is not as contradictory as it seems. Large farms will get larger because the deck is stacked in that direction. The new wave of small farms will fill in the chinks of land made available as some of the old-style farmers quit the business. Much land that could be used to grow vegetables, fruits, and specialty crops is lying idle. These acres growing up to weeds could be made into profitable farms if the proper plants and cropping systems for efficient small farms were developed.

Such systems have largely been ignored by government programmers and big ag-research firms, who have put their money on large tools for large farmers. So Rodale is trying to do it himself. His organization has evolved considerably over the past ten years, moving away from the "health nut" image it once had. Instead, it has emerged as a smoothly run business enterprise that supports a 120-hectare experimental farm, along with a staff of researchers trained in botany, plant breeding, nutrition, horticulture, and ecology. The primary goal of the program is to gather and test new ideas for inexpensive, appropriate technologies suited to the backyard or the homestead.

A typical "backyard" product of the Rodale farm in Maxatawny, Pennsylvania, is a 4.8-by-4.8-meter solar-heated greenhouse, which has produced vegetables year round for the past three years (including the two coldest winters on record). This building, along with a sister structure in Flagstaff, Arizona, was designed by physicist David McKinnon to cost the do-it-yourself farmer only $400 to $1,000, depending on location. The cost would be even less if the greenhouse were set against the south side of a house, where the existing structure would lend its insulating qualities to the greenhouse. And no backup heating is needed.

On a larger scale, David Mears of Rutgers University has been experimenting with solar-heated greenhouses for five years and is now building one that covers 4.8 hectares to grow such warm-weather crops as cucumbers, tomatoes, and ornamentals. Mears's group has managed to reduce the heat requirement by a factor of three by using better insulation and a movable plastic curtain. The Department of Energy and the Kube Pak Vegetable Company both are helping Mears with funding for good reason. Greenhouses can achieve about ten times the productivity per square foot of an outdoor field.

Other experimenters are broadening the concept of the greenhouse to achieve multiple chains of production. The goal is to maximize food production with minimal space and energy. In Norwich, Vermont, for example, Robert and Ellie Huke have enclosed a 5,600-liter fish tank in a geodesic greenhouse, where catfish are raised in the summer, trout in the winter, and vegetables during nine months of the year. The sun provides heat for the water, which in turn acts as an energy sink, releasing heat at night. The fish produce the fertilizer that nourishes the vegetables. And in even more elaborate multiculture experiments like those at the New Alchemy Institute in Massachusetts, the input-output cycle is tightened still further by raising chickens directly above the fish tanks. The manure drops into the water and fertilizes the algae, which in turn is eaten by the fish.

Efforts to minimize energy use are by no means confined to the backyard. More and more commercial farmers are trying to get by on less. Typical are three Missouri brothers who, when petroleum prices began to soar six years ago, quickly found themselves paying $45,000 to $60,000 a year for fertilizer and pesticides on their 1,400-hectare farm. They decided to go back to spreading manure, planting

> *"Although his tractor will cost over a quarter of a million dollars, the farmer of the future will have computer functions and electronic monitors that would do justice to the starship* Enterprise*."*

nitrogen-fixing legumes, rotating crops, and other "old-fashioned" measures. Today they pay $15,000 to $20,000 for a combination of organic fertilizers and natural pest controls. They report that their yields of milo, wheat, and hay are about the same; corn (the crop most responsive to powerful ammonia fertilizer) is "down a little," and soybeans are up. And their soil is improving in structure and fertility, instead of degrading.

Another experiment in self-sufficiency has been guided for more than 20 years by Michael Scully, a central Illinois farmer. Scully raises about 135 beef cattle and 350 pigs a year on 160 hectares. To feed his stock, he grows about 13,000 bushels of corn and 3,000 bushels of oats—all without commercial fertilizers or pesticides. Instead, he makes about 600 tons of compost a year from the manure of his own animals and relies upon natural predators to control pests. "Our corn yields are about fifteen to twenty percent below conventional yields in the area," says Scully, "but our fertilizing costs are about half. And our meat has better quality than regular commercial meat. So we still come out ahead."

Contrary to popular assumption, Scully's economic success is not unusual among full-size organic farms. A group of scientists at Washington University in St. Louis has found that modern farmers can indeed thrive without high-energy inputs. Since 1974, William Lockeretz and his coworkers have studied 14 crop/livestock organic farms (mean size, 170 hectares) and 14 conventional farms similar in size, location, and machinery. Although the per-hectare value of the crops has been about 11 percent lower on the organic farms, those yields have required some 60 percent less fossil energy to produce. So the net income per hectare has been about the same.

It is ironic that the price of fossil energy is making the difference between profit and loss to more and more farmers—despite the fact that farms are tremendous energy *producers*. Indeed, energy seems to be the key to the way that agriculture will go in the next 10, 20, or even 30 years. If abundant supplies of fossil fuels (or a suitable substitute) are available, farming will continue to follow current trends. But if we lose our sources of cheap energy, we will be forced to turn to the "alternative" methods. And whether these methods will be able to produce as much grain as current techniques do remains to be seen.

One small indication of the quandary facing agricultural planners is reflected at a tiny educational/research exhibit outside Des Moines, Iowa, called Living History Farms. The independent project (funding comes from such diverse sources as Pioneer Seed and John Deere) now has two farms operating—one in the year 1840, one in 1900. A third is planned to display possibilities for the year 2000.

"There are basically two ways of thinking about the future," says Jay Anderson, who joined the project last year to help plan the future farm. "There's the high-technology bag—*Star Wars*, closed confinement, farming under bubbles and in skyscrapers, vast soilless layouts, that sort of thing. Then there's the opposite—low technology, less meat, more grains, minimum tillage, crop rotation, small machinery.

"We're debating which way to go with our future farm. For some time people wanted a high-technology approach. When I came a year ago, I questioned that idea. I don't read the trends that way, and it's very, very expensive. We want to pay a lot of attention to energy and soil conservation. We might put the farmhouse underground, where the year-round temperature is fifty-five degrees. The prevailing winds here blow at twelve miles per hour, we'd want to use that. We're building a solar pond, domed; this gets very hot in the summer, and we'll use the heat. We'd like to make ethanol from cornstalks and use it as tractor fuel.

"We're toying around with all these things. We'll have the emphasis on what's simple, reparable. We're not in the business of advocating; we're a museum. But we want to show what's possible."

UFO

CONTINUED FROM PAGE 32

subsequent files. It emphasizes the dependence the agency was developing on information supplied by scientists who were members of UFO groups. As its example, the memo cites the findings submitted by Dr. Walter Riedel of the California Committee for Saucer Investigation.

In 1952 we were told that the Air Force had convened the Scientific Advisory Committee on Unidentified Flying Objects. We were given the names of five scientists who sat on the so-called Robertson Panel, named for its chairman, H. P. "Bob" Robertson. These names were put to the committee's final report—to this day rejected by most Ufologists as an outright deception of the American public. We were not told then that J. Allen Hynek had anything to do with the panel. People began much later to remember that he was an adviser to the panel.

But the files show that some people's recollections aren't quite so good. The panel officially consisted of Robertson, S. A. Goudsmit, Thornton Page, Louis Alvarez, and Lloyd Berkner. Yet, in a letter to agency assistant director Phil Strong, Goudsmit, now deceased, asks, "I wonder if my memory is failing. I do not remember at all that Lloyd Berkner was a member of our committee, but I do remember ... Hynek."

Has the Air Force's old Blue Book adviser always been the agency's scientist out in the Ufological cold? It is now acknowledged that it was the CIA, not the USAF, that set up the Robertson Panel. One of Hynek's right-hand investigators is Brad Ayers, a CIA hero of the early 1960s, and 1976 documents included in the batch, but heavily censored, suggest that Hynek's group, the Center for UFO Studies, includes someone who has been monitoring the group for the intelligence community. These revelations may do more than any others to shake up the UFO scene.

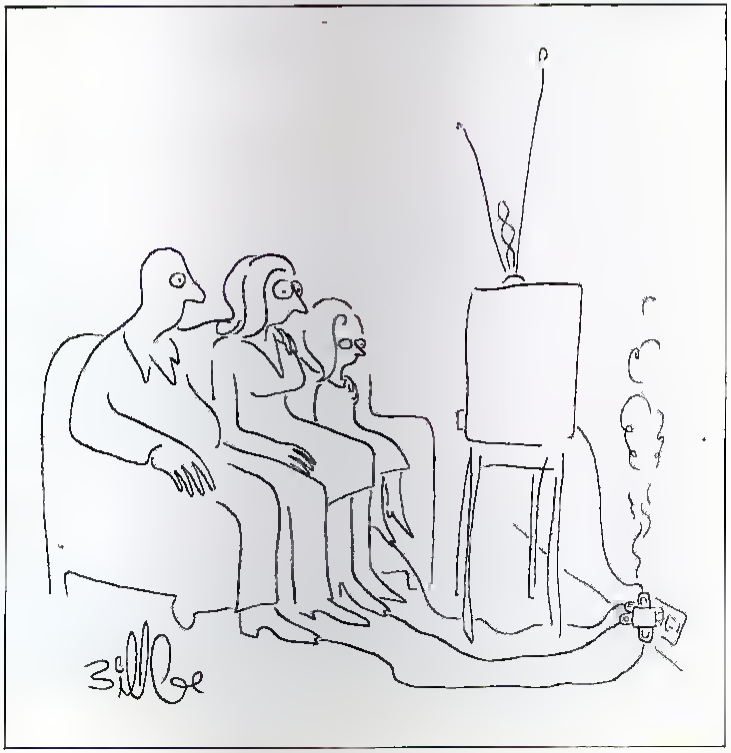
But, for the newly awakening, the files offer more worldwide, more officially monitored sightings than anything in recent times. I've characterized a few:

- A 1958 report of a sighting sent to the U.S. State Department by the British commissioner of the Cayman Islands.
- A sighting that same year by the Brazilian Navy that included photos not given to CAUS.
- Dozens of sightings along the Soviet border, from as far north as Finland to as far south as Afghanistan, during the 1950s.
- In 1959 the U.S. Navy intercepted two Soviet reports of UFO sightings over the Afghani-Soviet border. According to one, a UFO was seen exploding in midair. That incident was later connected to earth-tremor reports.
- A 1957 sighting report from the Finnish-Soviet border consisting of three long pages, and two similar reports from the U.S. Army near the Afghan border. Some years earlier, a 1955 sighting report from an Afghan army officer had been passed on through U.S. intelligence channels.
- Dozens of sightings in 1965 by an Argentinean weather team in the Antarctic.
- A two-page report, dated July 1960, on a sighting by a U.S. Army Geographical Specialist team in Northern Iran.
- A two-page report from Finland on four separate sightings of UFOs, one of which created a near-blinding light.
- An October 1962 report on a sighting from Czechoslovakia, six pages, five of which are blacked out, a report from within the USSR, three pages, with two blacked out, a summer of 1962 report on several sightings over Kamchatka in the eastern USSR, with sketches enclosed.
- Descriptions of color slides, also not included, taken by an Argentinean weatherman-astronomer, showing UFOs around an eclipse.
- A sighting by hundreds of witnesses in Czechoslovakia in 1965.
- A brilliant UFO over a Russian city in 1977 that shed light like rain on the town.
- The 1952 flap in North Africa, which elicited hundreds of reports.

And perhaps the most cryptic snatch of incomplete data comes to us from the files of the Defense Intelligence Agency. Dated November 1968, this dossier contains three heavily edited legal-size pages of a report on sightings over Laos and Thailand during the thick of our Southeast Asian adventure. "It is interesting to note that such unknown returns [armed-forces term for UFOs on radar] have been reported since 1965 and yet no unidentified aircraft has ever crashed or been physically observed so it can be identified. Friendly suppression forces have never shot down or hit those unknown intruders, whereas U.S. helicopters and aircraft in Vietnam and Laos have suffered many hits and losses."

The data are patchy because the CIA, responding to major flap-year public alarm, gathered information only during certain periods. For this reason, the early and late Fifties are disproportionately represented. The flap of 1975 is being analyzed by Zechel, who has the Air Force's records of those months. His book about those sightings will be published soon. Meanwhile, Gersten is trying to obtain the same information from the CIA.

But more "unevaluated information" is not enough. No one believes we scramble jets against things we never bother to evaluate. Are they, as the occasional Ufologist hints, afraid of panicking us with some terrifying analysis or revelation? Do they realize that they terrify some of us more by seeming not to know what to say? But that's probably it in a nutshell. They don't know what to make of the UFO thing. One thing they will have to accept: UFOs are real, and they won't go away. **OO**



EARTH

CONTINUED FROM PAGE 16

house there. I wouldn't be surprised if my being burned didn't have something to do with it. In a big city you spend a lot of time explaining what happened to you. You see a lot of eyes *asking* what happened. After I had been six months in Crested Butte, everybody knew me."

Crested Butte is a rustic mining town that has had a recent rebirth as a National Historic District. Some of its buildings are genuinely old structures that have been treated kindly by time and the elements. Others are new, but of a nineteenth-century design. When Mitchell bought his streetlamps and had them installed, replacing the mercury-vapor lamps that had illuminated Elk Avenue when he first arrived, his deed was part of a larger movement. In the past decade progress for Crested Butte has amounted to a gradual stepping backward in time. The town has become a monument to the old minerals of its birth: coal, lead, gold, silver, and zinc.

The metal of the future apparently is molybdenum. It is a rare, silver-gray element with a melting point of 2,606°C (4,730°F). Molybdenum was first used in the 1890s in cannons and armored plate. During World War II it was the most important strategic metal of the U.S. war machine; soldiers were assigned to Colorado to guard molybdenum lodes. Resistant to corrosion and ultrahigh temperatures, the metal hardens steel, yet at the same time lightens it. It is ever-present in technological society—in tools, jet engines, and nuclear reactors. The world demand for the metal doubles every 14 years. A 165-million-ton lode, the third-largest deposit in the world, lies 1,500 feet under the summit of Mount Emmons, or "Red Lady," the mountain west of town.

Mitchell is not alone in opposing the search for molybdenum in the core of the mountain. Most of the citizenry of Crested Butte are with him in his resistance to the mine. A few older townspeople are former miners who fondly remember the bustle of the old days; they favor a comeback for mining. (Several of these old-timers wish it could be a *coal* mine. Coal, unfortunately, is not the mineral buried beneath Red Lady.) Many of the newer residents are, like Mitchell, transplanted easterners. A disproportionate number of the transplants, including Myles Rademan, the town planner and a leader of the resistance to the molybdenum mine, are lawyers. There is more sophistication and political know-how in Crested Butte than any mining executive could have expected to discover in a small Colorado community.

Not all the molybdenophobes, however, are as confident as Mitchell is that the mine can be defeated. Seven billion dollars' worth of metal, after all, has a way of finding its way to light. AMAX, the mining company that plans to work the lode, is one of the biggest in the world. Under the U.S. Mining Law of 1872—a piece of rip-off legislation similar to laws that the railroads of that period arranged for themselves—AMAX has a *right* to mine the ore. Many of Mitchell's allies, including a group called High Country Citizens Alliance, are directing their energies toward muttling the *boom* in the boom-town syndrome, toward ensuring that the tailings from the mine will be disposed of in a way that makes some sort of environmental sense. This is, Mitchell believes, wishful thinking.

"We can beat it completely," he says. "Any kind of mine will be a disaster. It's not just visual. To grind up the mountain is bad enough, to fill up valleys with the tailings is equally bad. But to take a healthy community and destroy it, to give us crime, rape, unemployment, overcrowded schools, and snowmobiles and jeeps carving up the countryside is unconscionable. AMAX says they're 'environmentally aware.' [Here Mitchell makes rabbit ears, indicating quotation marks. He does so without benefit of fingers. He has made the sign just by a wiggling in what was left of his hands, but that does the job.] And they say they're the best. If that's the best, I'm worried about this country. It's a tremendous indictment of the system if a place like Crested Butte is devastated because of an old mining law. There is *nothing* that AMAX is going to do for Gunnison County. Nothing. Nothing that's going to benefit us. Crested Butte is the perfect cause. At least I think it is. If it's not, then I really fear in my heart for what this country considers valuable."

> *"Any kind of mine will be a disaster . . . to take a healthy community and destroy it; to give us crime, unemployment, overcrowded schools, and jeeps carving up the countryside is unconscionable."*

The mayor has become his town's principal weapon. "He's a one-man media event," Rademan, the town planner, has said. In the beginning Mitchell never guessed that this might happen.

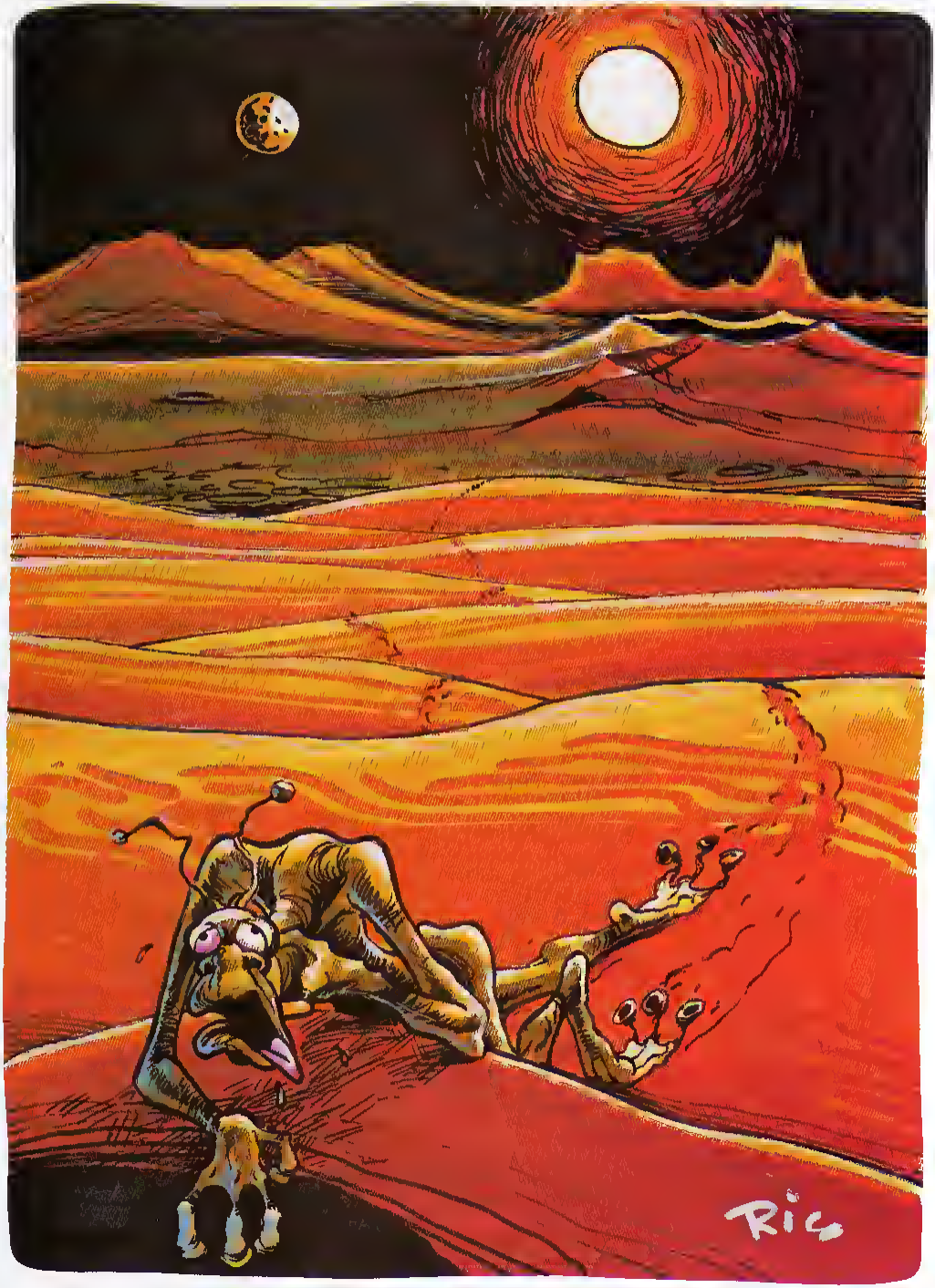
"After my motorcycle accident, I assumed I was pretty much unacceptable. Unphotographable, for sure. I certainly wasn't suitable for mass audiences. When I got in the wheelchair I was even more strange. I never liked being photographed even before I got burned. With the story in the *Rocky Mountain News*, I began to get used to it, but the idea of exposing my face to tens of thousands of people was still pretty strange. The *Washington Post* story really sensitized me to how I might be useful. By the time TV came, I realized I was acceptable. The more I concentrated on my unacceptability, the more I was acceptable."

Mitchell now spends 8 to 12 hours a day to combat the mine. He travels throughout the country bringing Crested Butte's dilemma to the attention of the nation. He has conferred with Senators Church, Kennedy, Hart, Talmadge, and Gravel. ("We'll help you on Crested Butte if you'll help us on Misty Fjords," said Senator Gravel. Both places were possible sites for molybdenum mines. "You mean you're against molybdenum in both places?" asked Mitchell. Gravel paused. "That's not quite what I meant," said the senator.) He has had meetings with Representatives Udall, Brown, and both the Burtons. He has met Vice-President Walter Mondale briefly, and he once bumped into President Carter in a hallway. ("I had the presence of mind, just as he was pulling away, to speak to him about Amy's skiing in Crested Butte. I kept him for fifteen minutes that way.") He has spoken with Cecil Andrus and Bob Herbst. And he has enlisted the support of John Denver and Robert Redford. Mitchell enjoys dropping names. He has lunched with Jack Anderson. ("He asked me why I wasn't running for Congress." Mitchell recalled. "I've been asked a thousand times why I don't run. Maybe I will. Someday four or six years from now why shouldn't I seek elective office? It's an important message I have to get out.") Stories about the mayor of Crested Butte have appeared in *Sports Illustrated* and *The New York Times Magazine*. He serves on the Presidential Committee for the Handicapped. He is Colorado's Handicapped Citizen of the Year. ("I don't want to be Colorado's Handicapped Citizen of the Year. Colorado's *citizen* of the year, maybe. I'm in a wheelchair and burnt up, but I'm not that different from other people walking around.")

To defeat the mine at Crested Butte will no longer satisfy Mitchell.

"I feel I'm on the track of something far beyond Crested Butte. If we are able to save Crested Butte, I'd say to AMAX, 'This is just a symbol.' I'd like to talk about the whole mining law. It's like the old Homestead Act. I'd like to demonstrate that by lining up a lot of Volkswagens at the edge of Yosemite and saying, 'Everybody gets an acre.' I'd like to speak on this whole issue of growth."

It is unlikely, of course, that any of this would have happened to the mayor had not fate burned him so badly. The defeat of the mine, if it comes to pass, may have had its origins in that brief inferno on a San Francisco street. Win or lose, the mayor has risen like a human phoenix from his own ashes. Time will tell. The flame that consumed him may prove too bright even for that heat-resistant metal molybdenum. ◻◻



"Methane... Methane!"

FILM

CONTINUED FROM PAGE 24

looks pretty primitive. Sound is something people remember very well. They may not be able to do a transporter sound, but they'll know if it's not the transporter sound we used to use. From the first day we had arguments over the Star Trek insignia. There was a faction who favored turning it on its side because it looked more streamlined. Eventually I said no.

There are a lot of improvements on the *Enterprise* itself, though. For instance, before we fire a photon torpedo, we'll have a shot down the hellfire interior of the photon-torpedo tube. Our old bridge was put together out of plasterboard, two-by-fours, and salvaged instrument faces. For the film we completely redesigned it. We wanted our actors to be able to push their own buttons and actually make their consoles respond. You get better acting when the performer wants a navigational readout and can punch it up himself. It just feels more honest than having a technician stand behind the fake set and start a piece of film on cue."

Technically *Star Trek—The Motion Picture* reflects the years between its TV demise and its cinematic rebirth. Following in the footsteps of *2001*, *Silent Running*, and *Star Wars*, the film will have a "hardware" look. Special effects, originally to be handled by Robert Abel and Associates, are now in limbo. Roddenberry and director Robert Wise are searching out a new team to produce the complex visuals the film demands. Front-runner is Douglas Trumbull, the man responsible for *Silent Running* and major portions of *2001* and *Close Encounters of the Third Kind*, who was brought in as an adviser early in production.

Roddenberry is facing stiff competition from other "hardware" films being released this year. Among them are Walt Disney's *The Black Hole*, 20th Century-Fox's *Alien* (see below), Columbia's reworked version of *Close Encounters*, Universal's *Buck Rogers*, American International's *Meteor*, and a horde of lesser rivals. As a result, *Star Trek*'s budget has almost doubled since the film went into production.

We looked out the window at the bright red bicycle on which Roddenberry commutes from office to sound stage. He shook his head and smiled. "Those guys never stop," he said. 'Someone came in here looking for something to use as a control handle in a shot of the bridge. I told him to look around for something else. Improvise. Those guys just stole one of the grips off my handlebar." No one can say that Gene Roddenberry doesn't give his all for *Star Trek—The Motion Picture*.

• • •

"*Alien* is my vision of *Jaws* in outer space," says Dan O'Bannon, the film's writer and special-visual-concepts consultant. 'Twentieth Century-Fox calls it *The Omen* in outer space, 'cause that was their picture and *Jaws* was released by a rival studio, but the monster we have here is a lot worse than anything you'd see in hell."

O'Bannon, a science-fiction fanatic since he learned to read, has a big stake in *Alien*. He wrote the original story with the film's executive producer, Ronald Shusett, then did the first draft screenplay. O'Bannon's work on *Alien* will be his third outing in the field of science-fiction adventure. Back in the early Seventies he cowrote, co-directed, designed, edited, created the effects for, and costarred in a brilliant little outer-space parody called *Dark Star*. Then he served for six months on an ill-fated production of Frank Herbert's *Dune*.

Though it was produced on the incredibly low budget of $50,000, *Dark Star* featured sophisticated model work, matte paintings, and other special-effects trappings of the post-*2001* period. Many of the picture's technicians have become leaders in the field, making contributions to such films as *Flesh Gordon*, *Close Encounters of the Third Kind*, *Star Wars*, and *Alien*. But when the technicians were working on *Dark Star*, they were all unknowns.

"When we started the film," O'Bannon recalled, "we were doing it primarily as a showcase of our talents. We wanted to prove that we could make a movie with the professional look of a big-budget production. Since we had only five or six thousand dollars for the first two years, we learned how to do everything economically."

Dark Star's other director, John Carpenter, has gone on to make *Halloween* and is well on his way toward becoming one of the leading filmmakers of the 1980s. But here he cowrote the script, scored the music for the picture, and also served as producer. Greg Jein, who would later build the 'mothership' in *Close Encounters of the Third Kind*, carved the model of the film's starship from a block of polyurethane foam, using a pocketknife. John Wash, who went on to do the graphic visual displays in *Star Wars*, hand-built an animation camera to create *Dark Star*'s computer printouts. Jim Davenforth, later responsible for work on Di Laurentiis's *King Kong*, did a number of paintings on ordinary window glass, showing planets in deep space. Lacking money to hire help, and wanting to ensure the proper feeling of a control-room set, O'Bannon built it alone, working 20-hour days for two weeks, driving himself to the point of exhaustion.

"By the time I finished that set, I was ready to collapse, but I still had other work to do. I was acting in the film, making all the props and costumes, and coordinating all the special effects as well. The costumes were incredibly difficult. The torso was taken from an asbestos fire suit, while the arms and legs were improvised from flexible air-conditioning tubing. Ordinary ski gloves, enormous overshoes, and a clear plastic bubble with vacuum hoses coming out of it completed the suit. The life-support system was made from an oven baking pan, a baby's bassinet, and a piece of-

molded Styrofoam from a typewriter packing carton. Each piece was kept in place with heavy-duty cloth tape wound around and around the costumes. Unfortunately this resulted in near-suffocation for the actors. O'Bannon solved this by giving them air through half-inch plastic tubing that ran from their mouths down under their costumes to their wrists. Sweating profusely, the actors would be cooled down between shots by having O'Bannon pour ice water down their backs.

Dark Star was released by a company that went into receivership shortly after the film was purchased. Though the movie has gained an enormous cult following as the best science-fiction spoof to date, relatively few people have seen it. "That's why I wrote *Alien*," O'Bannon explains. "Here I'd put three and a half years of my life into *Dark Star*, and nobody outside the business knew it existed.

"We'd tried to make it a spoof of the genre, but because we had so little money we had to cut too many corners. The Alien in that film was an orange beach ball with *Creature from the Black Lagoon* feet. When I went to work for George Lucas on *Star Wars*, he said, 'Dan, why didn't you put some of that plastic vomit on it? Would've made all the difference.' I said, 'George, why didn't you come over and help out instead of making *American Graffiti*?'

"We tried to make people laugh in *Dark Star*. That didn't work. So I decided to try to make people scream. *Alien* is as horrifying as possible, the exact opposite of *Dark Star*. It's essentially the same film, except for several plot twists here and there."

For those who have seen both *Dark Star* and *Alien*, O'Bannon's visual stamp and story style are obvious. Yet he readily owns up to the collaborative effort that went into the new picture. "We'd have been sunk without our director, Ridley Scott," he says. "He took our visual artists' ideas and brought them to life."

Nonetheless, it is O'Bannon's vision of outer space that colors the picture. His spaceship interiors in both *Dark Star* and *Alien* are darkly claustrophobic, almost submarinelike in their cramped control rooms, cabins, and passageways.

When O'Bannon wrote the original screenplay, he planned it as a vehicle he could direct. "It was written to be shot on a $500,000 budget, but Ronald Shusett co-owned the rights and wanted it to be a studio picture. It cost nine million dollars for 20th Century-Fox to make it, and I still feel I could have done as well for a twentieth of the budget. But I can't say I'd have done any better. Ridley just made himself a power in the film business with this picture.

"When I met Ridley, I kept bugging him to see a movie called *The Texas Chainsaw Massacre*, one of the crudest films ever made, but one of the scariest as well. I said, 'Look, you haven't made a horror movie before. You've got to see what the state of the art is.'

"He reluctantly agreed, and while he was in there watching it, I was sweating bullets. I thought, *Oh, he's European and has sensibilities. He'll hate it and think I'm a jerk.* When he came out, he couldn't stop raving about it. He thought it was great. He said, '*Alien*'s got to be like that but better!'

"I knew we'd be friends after that. All the drafts of the script after my first screenplay were ultimately cast aside, and the film he shot was basically the one I wrote.' As this goes to press, a Writers Guild arbitration committee is deciding whether to uphold an earlier ruling that O'Bannon should have solo screen credit as writer.

"We're trying to show how down-to-earth outer space can be," O'Bannon says. "Except for the Alien. That's what's going to make this picture go through the roof. After I did *Dark Star*, I was designer and special-effects director on a planned production of *Dune*, to be directed by Alexander Jodorowsky [*El Topo*, *The Holy Mountain*].

"When I went over to Paris to work on the film, I met [H. R.] Giger, a brilliant artist whose work was bizarre, frightening, gorgeous, sick, perverse, and wonderful. I'd found something I'd been looking for all of my filmmaking career. Here was someone who could create nightmares beyond what anyone else could visually imagine. He was the graphic equivalent of H. P. Lovecraft. Lovecraft on the page says, 'It was nightmarish beyond imagination.' But what does it look like? Giger whips out his airbrush, and there it is.

"I came back to the States and told friends about Giger, and they all went, 'Yeah, yeah, fat chance!' Even Ronnie Shusett. I wasn't able to bring back any of Giger's pictures with me, and so, while we were writing *Alien*, I'd keep telling him, 'Look, when you see these pictures, you'll believe me.'

"Finally, Giger sent me a couple of his art books, and I shoved them at Ronnie. When he opened them up, he said, 'Oh my God! Oh my God! It's more than you said!' I can't believe it!' Of course, Ridley said the same, which was great. Ridley didn't pick the exact creature I did, but that's minor. Audiences are going to just scream when they see it. Whatever you imagine, you can't imagine it.

"The guy who's reading this interview right now will say the same thing Ronnie did. He'll say, 'Listen to O'Bannon honk his horn.' The only reason he's pumping up Giger is because he found him and it's a reflection of his own age. Yeah, it'll probably look good. I go to the movies. I saw *Close Encounters*. I saw the little Pillsbury doughboy at the end. That was okay. I know what movie monsters look like.'

"Then you, dear reader, will go in and sit down, and you'll tap your toe and say, 'Okay, show me the monster, show me the monster.' And when we show you the monster, you will jump up and run out of the theater." (For more on the Alien, see pictorial beginning on page 80.)

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For practical reasons, the thirty nine-year-old inventor would like his keyboards to fit neatly over standard keyboards. That way one need not purchase a whole new instrument simply to have the new keyboard. In spite of the fact that piano actions are always rather delicate, and the leverage required to push down standard black keys is somewhat different from that required to push down standard white keys, the Berdboard does fit securely and is easily removable at the same time; the mechanical problems have thus far proved to be surmountable.

Even then, however, the Berdboard will have a long way to go in order to become generally accepted. Keyboardists who have already invested many years in learning the standard arrangement won't be anxious to start all over with a new arrangement despite certain advantages. It is questionable, too, whether music educators are flexible enough to adopt a radical new piano keyboard, even if it proves to be generally better than the current one. Berd's digit-music notation system is likely to run into similar resistance.

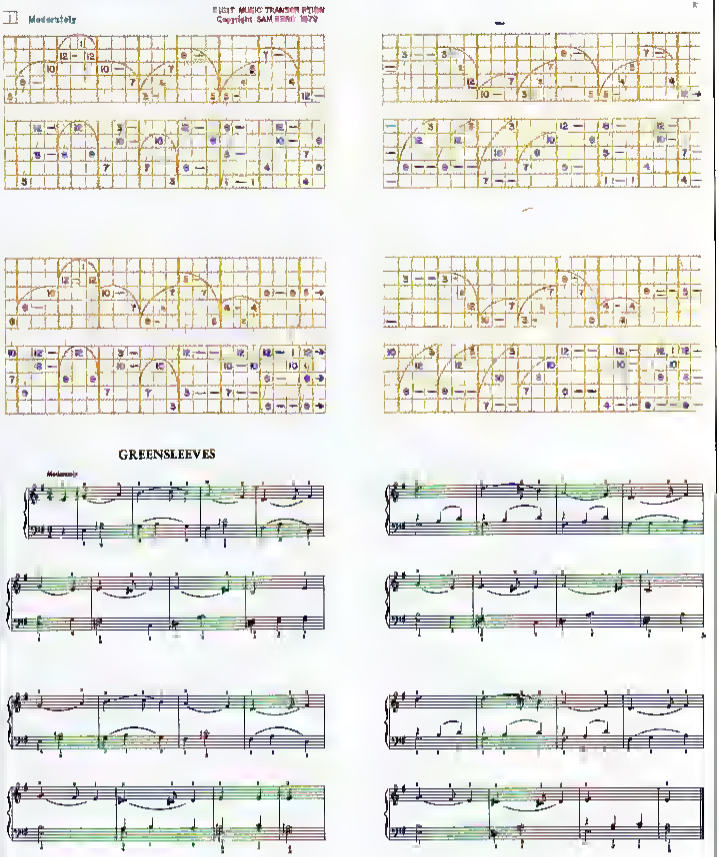
We don't like to change our ways, even when there may be good reasons why we should. Typewriters are another case in point. The standard typewriter arrangement, which is known as "qwerty" because of the arrangement of the letters on its top row, is now technologically obsolete. The qwerty arrangement was designed for mechanical reasons that are no longer relevant, and it has been proved that one can type faster on present-day typewriters if the letters are arranged in other ways. But we continue typing on qwerty keyboards, and we might continue playing the piano on our traditional seven-note keyboards.

Still, he does not strike me as a man who gives up easily. I like to think about Sam Berd, the pioneer, sitting in his office at the Digit Music Center, working on his Berdboard, making subtle improvements in his notation system, dreaming up new ideas, and trying, against sizable odds, to make us change.

The following are selections from the growing list of Digit Music transcriptions, ranging from the classics to show tunes and popular hits. Available from Digit Music Center, 157 W. 57th Street, New York, N.Y. 10019, are: Liszt's "Liebestraum"; Beethoven's "Für Elise" and "Moonlight Sonata"; Chopin's "Minute Waltz"; J. S. Bach's Minuet No. 1; Strauss's "Blue Danube"; the theme from *The Godfather*; "Send In the Clowns"; The Beatles' "Yesterday" and "Let It Be"; Joe Brook's "You Light Up My Life"; "When the Saints Go Marchin' In"; and selections from *Fiddler on the Roof*, *Jesus Christ Superstar*, and *West Side Story*.

The system should be computerized within six months, at which time longer pieces will be "digitized." ∞

DIGIT MUSIC



The accompanying example of "Greensleeves" written in Berd's digit-music system (above), may look complicated at first, but it is actually quite simple. The upper five boxes define the activity of the fingers on the right hand, and the five rows below tell you what to do with your left hand. The numbers 1 through 12 indicate specific pitches, with C corresponding to 1, C-sharp to 2, D to 3, and so on.

Thus the opening bars of the right hand would be interpreted as E with the thumb, G with the second finger, A with the third finger, E with the fourth finger, high C with the fifth finger, and so on.

Blue digits are played in the octave below middle C, red ones in the octave above that, and green digits in the octave above that. Additional colors would be used in more advanced pieces with wider ranges. The bar lines function as in ordinary music notation, and the subdivisions within the bars clarify quite graphically the exact duration of each note.

The little horizontal lines mean to sustain the previous note; the vertical dotted lines simply clarify when keys are to be struck simultaneously and that's about all you need to know in order to sit down at the piano and play this simple arrangement. You'll probably find that you can pick out the tune in a matter of minutes, although, if you already have some facility with standard notation, it may take you a few more minutes because you will find yourself trying to translate instead of fully trusting the new symbols.

Digit music offers certain advantages, compared with the standard notational system (below). With digit music the player does not have to know a sharp or a flat or a clef or rest signs. The fingering is built in, taking guesswork off the mind.

COMMUNICATIONS

CONTINUED FROM PAGE 12

safe when Skylab was launched. But if we restrict our activities—on Earth or in space—to only what is completely safe we'll never get out of bed in the morning. —Ed

A friend of mine came up with the best solution to the *Skylab* problem that I've heard. Why not let our fine armed forces with all our weapons capability just blow *Skylab* to smithereens when it starts to reenter the earth's atmosphere?

L. M. Yeutter
Tampa, Fla.

An excellent idea, except that it is illegal to deploy or use nuclear weapons in space. Both the United States and the Soviet Union signed an international treaty to that effect. And nothing less than a nuclear weapon would do the job with any certainty. —Ed

Aesthetic Space

"Space for Poets" [March 1979] is something that astronauts and cosmonauts alike have been waiting for almost since the beginning of manned space flight. "I know that the sea of space through which our world swims awaits not only scientists and technicians for testing and analyzing," said Gherman Titov, the second man in space, "but also the poets, the artists, and the composers."

Space has evoked a profound aesthetic response in many spacefarers. But few have found the words to describe what they have seen. Test pilots don't do so good when it comes to rich, lyrical prose," said Gus Grissom.

Some have lamented the absence of poets in space. The most poignant lament came from Mike Collins, as he recounted John Magee's classic "High Flight":

> while with the silent, lifting mind I've
> trod
> the high untrespassed sanctity of
> space,
> put out my hand and touched the face
> of God.

"All that from the cockpit of a Spitfire," said a sorrowful Collins. "What could he have said after one orbit? I cry that he was killed."

There are those who have tried. Edgar Mitchell put his feelings down in psychological terms as a "peak experience." Al Worden published poetry. Aleksei Leonov turned to painting. (One of his canvases hangs in the Smithsonian.) Still, no spaceman—or spacewoman—has been able to satisfy the imaginations of the earthbound millions.

Trudy E. Bell's article contains not just a fruitful suggestion but an imperative. The world anxiously awaits the articulate space voyager—someone who can let us share in the dream.

Nick Engler
Mountain Home, N.C.

French Volcano

While Dr. Eaton [Continuum, February 1979] may be an excellent volcanologist, his comments about the 1976 French evacuation of Guadeloupe earn low marks in psychology and political science. France, after all, is the only modern nation that has lost an entire colonial capital to a volcano. When Mount Pelée destroyed St. Pierre, Martinique, on May 8, 1902, a prudent evacuation had been opposed by local politicians.

One might reasonably predict that the French government learned a bitter lesson. Expert volcanologists notwithstanding, errors on the side of caution are likely to be repeated every time a volcano sneezes in the French West Indies.

Dean R. Lambe
Vincent, Ohio

Deep Doubt

I have read with interest the article "Deep Quest" by Stephen Schwartz in the March 1979 *Omni*.

I commend Mr. Schwartz's goal of trying to develop a practical test for psychic skills that would eliminate as many objections as possible. However, I must challenge the statement that "the area selected . . . could not have been found through old papers . . . and the conclusion that ". . . it rules out cheating."

It seems to me that since the sinking occurred in modern times, some form of influence on the test is not at all ruled out. How could such an event—explosion, fire, sinking, lives probably lost—have happened so close to shore and completely have escaped the papers? Not likely.

Raoul E. Drapeau
Vienna, Va.

An Opinion

I have always concerned myself with science from a layman's point of view. I had concluded that scientists considered accuracy to be crucial. Perhaps this analysis holds true only in the minds of the scientists and in their laboratories.

I became alarmed when I read the opening paragraphs of James Oberg's "Farming the Planets" [February 1979]. I am speaking of accuracy, therefore I state that Mr. Oberg would have been more precise by beginning, "In my opinion."

I am not saying that Mr. Oberg shouldn't write this material—it is his right—and I support his right. I am merely saying that the majority of material is accepted as fact because those three words are omitted.

I only want people to find their own answers from the research that the scientific community performs. This way learning goes on, and we don't suffer another Dark Age of education.

Gina Cohen
Rome, N.Y.

Medical Rivalry

The rivalry between Jonas Salk and Albert Sabin as described in "Irksome Vaccine" [Life, March 1979] reminds us of the battle between Andrew Victor Schally and Roger Guillemin, the Nobel Prize winners [January 1979].

Competition and attempts to find different solutions are obviously good. However, the personality conflicts and unnecessary waste of energy described in your articles clarify the distinction between technical power and scientific maturity.

Are these isolated cases? How are research funds being used? What can be done to increase efficiency?

Owen and Noreen Kerr
Buffalo, N.Y.

Small Power

In the February 1979 Continuum you have a short piece called "Let's Get Small." The column makes reference to Thomas Samara's article in *The Futurist* about the energy advantages of short people. Unfortunately, his numbers, which you quote, are incorrect. He made a fundamental error.

In his article entitled "Short Is Beautiful," Samara writes: "A modest increase of 5 percent in height raises the weight of a person by almost 16 percent, with the result that he (or she) requires significantly more food, oxygen, water, clothing, metal, paper, and other vital resources. Therefore, the benefits of population control can be cancelled by progressive growth in human stature."

This observation is basically correct, although the benefits of population control would not be canceled but only significantly reduced.

However, Samara then states: "People generally increase their weight as the cube of the increase in their height. Therefore, if human stature were to double in the future, people would weigh eight times as much and would require roughly eight times the food." This is not true.

Although weight does increase as the cube of height, food and energy consumption do not. If such were the case, a whale's or elephant's appetite would be enormous.

Since animals are essentially heat engines, heat loss is a vital aspect of energy (food) consumption. To stay alive, an animal must replace heat lost from its surface.

In Continuum, you say Ricardo Montalban is "more energy-intensive" than his pint-sized costar Herve Villechaize. Not so, even though taller Montalban uses more total energy. Villechaize is the one wasting more energy in heat loss, and he is thus more energy-intensive.

Mark Mills
Rome, N.Y.

Angular Errata

In the May *Omni* interview I quoted Richard P. Feynman on the Lamb-Retherford experiments measuring the "shifts in angular momentum of the electron in hydrogen atoms." The shifts were in energy, not angular momentum.

Monte Davis
New York, N.Y.

FORUM

CONTINUED FROM PAGE 14

not as a symptom of another problem it is unlikely that excess energy will be expanded to alleviate the causative problem

I do not deny that any endeavor that provides information about the function of the body is valuable but the true value of that research lies in the use made of the information obtained Optimum use of any information requires a lateral approach

David J Leprich DC
Ontario Canada

Nonverbal Dolphins

I read with interest John Lilly's article on communicating with dolphins in your November issue

After many years of failure success in communicating with chimpanzees was finally achieved through the use of nonverbal human language American Sign Language which utilized the chimpanzees' natural abilities A nonverbal human language exists that could possibly utilize dolphins' ability to communicate with one another using a series of clicks This language is the International Morse Code

I propose the following experiment for any of your readers engaged in dolphin research

A ball should be thrown into the water where the dolphin is swimming, then the word *ball* should be spelled out in Morse Code using a variable oscillator and an underwater speaker This should be repeated using various amplitudes pitches and speeds of transmission to assist the dolphin in understanding that the intelligence is carried on the "dots and dashes" rather than on one of the other variables

David Edelschick
Woodbridge Va

Sex and Mouths

Referring to the article "Future Mouth" [Continuum February 1979], it is perhaps only reasonable that folks with little scientific bent should confound and confuse adaptation with accommodation The former operates through mutation and natural selection while the latter operates through environmental stresses Milford Wolpoff should be given a knock on the noggin with a piece of the Piltdown Man and then should review general biology with special emphasis on three men Lamarck who was wrong Mendel who was right and Darwin who was very observant

It has often been observed that high-fiber diets not unlike the postulated diet of primitive man would and do bring about muscular hypertrophy and an enlargement of the skeletal attachment Chronic jaw clenching may in some cases do the same thing But this is not to say that these acquired characteristics will be transmitted to the offspring of the eaters of primitive diets or clenchers of primitive teeth

The current understanding of genetics and inheritance dictates that no trace or predisposition can be passed on to succeeding generations unless it can be coded and incorporated by DNA and for most species transmitted during sexual union

Our present-day jaw size and tooth morphology are determined not so much by what we eat as they are by whom we meet

L S Davis DDS
Monticello Minn

Cargo Cult

I must take issue with Mr Alan Vaughn's statement in his letter in the March *Omni* as to the "coinage" of the term *Cargo Cult* by Richard Feynman True Dr Feynman may have used that term, but it actually originated in New Guinea shortly after the end of the Second World War and was coined in fact by anthropologists studying some of the effects of the impact of the American war machine upon certain hill tribesmen there

The New Guinea tribesmen, seeing aircraft for the first time unloading war and other materials at landing bases and apparently being tremendously impressed by this heavenly manna delivered gift-like from gigantic birds sought the return of such manna after the war's end and the disappearance of the U S forces

Their method one of faith was to clear a miniature landing area on a mountaintop build a "replica" of the C-47 out of straw place it on the landing strip with fires burning day and night for attention and ever watching prayed to entice the "magic birds" to return with more heavenly manna and material Being a behavior built upon faith and "primitive" interpretation the name given them by anthropologists was the "Cargo Cult" The cultists believed so firmly in their straw C-47 as a method of return of rich cargoes that they abandoned their prior hunting and gathering economy except in extremes Unfortunately, the "magic birds" never returned, and the Cargo Cult slowly died away

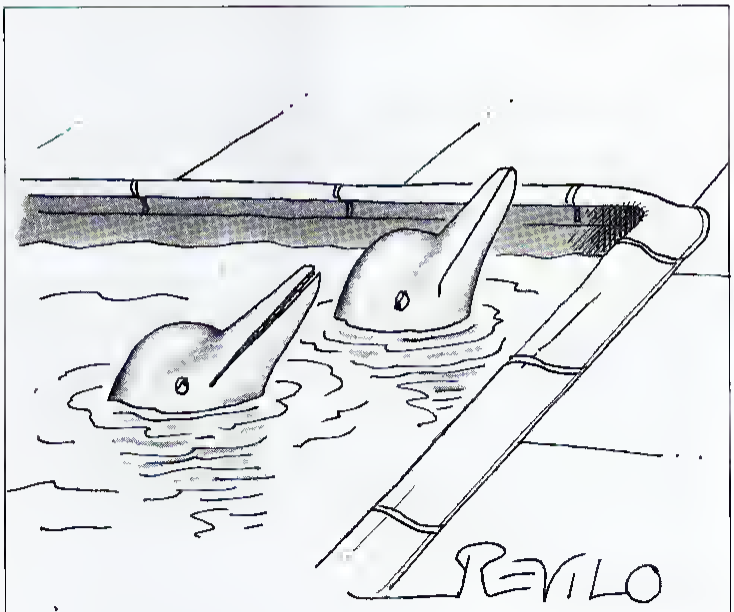
Tully Scott
West Palm Beach Fla

E O Wilson's Dilemma

The points of similarity between human and chimpanzee social behavior, when joined with the compelling anatomical and biochemical traces of relatively recent genetic divergence form a body of evidence too strong to be dismissed as coincidence I now believe that they are based at least in part on the possession of identical genes

E O Wilson
"On Human Nature"

Apparent contradictions paradoxes and dilemmas often prove to be the scientist's most valuable challenge A synthesis that reconciles seemingly contradictory facts and combines them into a general theory or model is an exceedingly valuable one



"Gosh, they're doing so well on the fish trick Do you think we might try them on something more advanced?"

Thus to cite an example from an earlier century "adaptive radiation" and "convergent evolution" have proved to be two sides of one coin the ecological niche Two niches differ if there are features of each that are not shared by the other Adaptive radiation merely reflects adaptations to the dissimilar features of several ecological niches while convergent evolution involves adaptations to those features that are common to the several niches

A more modern contradiction one that has not yet been neatly resolved is to be found in molecular genetics Two great principles have emerged during the past two or three decades of genetic study One is the *unity* of genetic mechanisms in all forms of life Not only are the nucleic acids the genetic material of all organisms, not only is the machinery by which genetic information is retrieved and acted upon within cells the same, but also the language of genetics—the genetic code—is the same in all organisms The contradiction is the *variety* of gene forms found in virtually all populations of all species that have been studied Despite a unity that blankets the genetic mechanisms of all living things, an infinite variety of details exists both within individuals and among individuals of every known species

At times dilemmas are self-generated J B S Haldane once concluded that one gene could be substituted for another only every 300 generations Unfortunately as some mammalogists and others quickly pointed out, elephants and other large long-lived mammals are among the most rapidly evolving organisms This contradiction is known as Haldane's dilemma

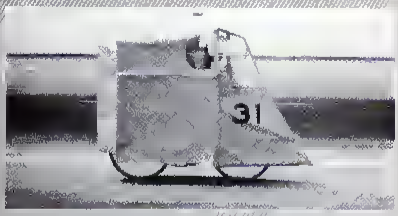
Wilson has I believe, also generated a dilemma I shall call it E O Wilson's dilemma It can be identified within the quotation cited above and can be summarized as follows Evidence ostensibly supporting the claim that social behavior has a genetic basis does not do so, and evidence that could do so cannot long exist in populations *What is seen is no proof what would be proof cannot be seen* This dilemma, I might add, is quite apart from any quibble that might arise over the words *identical genes*

The argument can be illustrated by an attempt to detect cheaters among students who have taken an examination Cheating concerns the independence or nonindependence of answers submitted in response to test questions In cheating, information generated by one student is copied by a second, the answers are not independent in origin Otherwise the answers are honest—that is, independently arrived at

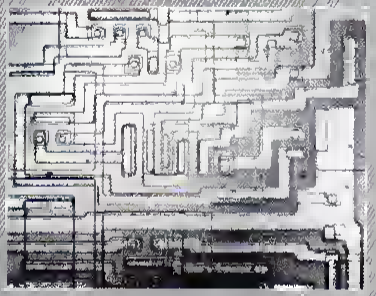
Suppose that a class is tested on elementary arithmetic by means of such questions as $12 + 37 = ?$ or $18 \times 39 = ?$ The possibility of detecting cheaters is limited to those students who answer questions *incorrectly*, cheaters among those answering correctly cannot be identified Because there is a correct answer to each of these

NEXT OMNI

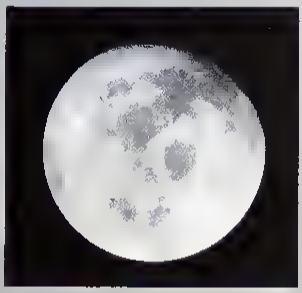
O'NEILL



BIKES



MIND MACHINE



MOON

THE ONCE AND FUTURE MOON—Next month will mark the tenth anniversary of Neil Armstrong's "giant leap for mankind." To help commemorate the occasion NASA scientist Bevan French looks at what we've learned from the seismic data, photographic maps, and more than 2,000 rock samples collected by the Apollo missions, then he peers into man's future on the moon You'll also find a spectacular gallery of photos of our moon and the satellites of distant planets

FUTURE BIKES—When walking at a five-mile-per-hour clip, your body is producing .25 horsepower With that same power output you could be pedaling a conventional bicycle 19 miles per hour But, says Chester R Kyle, a professor of mechanical engineering at California State University, given a properly streamlined bicycle, you could be zipping off to work at 30 miles per hour using that same measly quarter horsepower In the July *Omni* Kyle, a founder of the International Human-Powered Speed Championships, tells how bicycles now hit speeds over 50 mph and how your "commuter car" of the future may be a supersophisticated tricycle

THE MIND MACHINE—Will the electronic computer eventually replace man? Not according to G Harry Stine, who believes that we will shortly be putting the computer to work as a very fast supplement to the human brain In the next *Omni* Stine explores the intriguing possibility of vastly expanding our thinking, memory, and computational powers through the direct linkage of the brain to a computer

INTERVIEW/GERARD O'NEILL—"A great many things we do as a technological society can be better and more easily done in space with little or no pollution." So says Princeton physicist Gerard O'Neill, in an exclusive *Omni* interview as he continues his planning for space settlements and industry O'Neill discusses automated mining of the moon, creating new environments in space, and the building of space colonies on a less grandiose scale some to have as few as a dozen people Journey to the stars and beyond through the mind of Professor Gerard O Neill

INTERFERON—A new picture is emerging of that unique intercellular messenger interferon, the hormone that triggers the protective substances cells use to destroy invading viruses. Now comes the discovery that interferon can also retard the growth of malignant cells. The substance neutralizes certain cancer cells as if they had been infected by a virus, a fact that wasn't widely recognized until last year Today a growing number of experiments are confirming the hormone's effectiveness as a cancer killer In the July *Omni*, read why the American Cancer Society has just bequeathed its largest grant ever to the tantalizing promise of interferon

questions correct answers of nonindependent origin cannot be identified The situation is quite different, however if two students sitting side by side respond that 13 + 11 = 47 two identical incorrect responses are good evidence that these responses were not independently arrived at

In examinations where logic does not predominate but where lengthy descriptive passages are required the opportunity to identify those who have shared answers is exceptionally high As in the case with incorrect answers to mathematical questions the sheer improbability that two answers in response to a nonlogical question should be identical is low this low probability is in turn the basis for concluding that such answers could not have been generated independently

Living organisms have over the past several billion years developed two systems that are capable of arriving at logical solutions to various problems The one system is based on the genetic material, DNA, itself The second, a characteristic of animals is the nervous system

Plants with no nervous system solve an enormous number of problems solely by genetic means (not necessarily by *single* genes however) Winter with its sub-zero weather presents a problem that some plants have solved by means of an annual habit plus dormant, cold-resistant seeds and that others (perennials) have solved by a dormancy of the plant itself—retreat to the roots deep beneath the ground in some instances, simple dormancy of the above-ground structures in others

The nervous system of animals is a device built under the control of genes that is designed to provide logical solutions to pressing problems of short duration A brain even an insect's brain may analyze a problem and cause the body in which it is housed to react accordingly within a fraction of a second, direct gene-controlled responses in contrast may take minutes, hours or days to run their course A shot of estrogen will evoke the production of one protein in three hours A handful of grain tossed in front of a hungry chicken however is identified almost at once and the chicken immediately begins to feed

Here then is the basis of E O Wilson's dilemma Having seen that individuals of both species A and B behave in similar ways Wilson would like to conclude that the basis for this behavior in the two species is genetic, furthermore he would like to say that the behavior resides in identical genes Referring once more to the classroom analogy, if species A and B are closely related (as chimpanzees and human beings are) the situation does resemble that in which two students submitting identical answers sat side by side The *opportunity* for nonindependent responses is enhanced by both evolutionary and classroom proximity, opportunity however is not *proof* that two responses are in fact nonindependent

Because the solutions arrived at by plants and animals are logical solutions to the problems posed by their environments these solutions *should be* similar whether arrived at genetically or intellectually (via the nervous system) Consequently as was the case in the arithmetic class, similar answers provide no evidence as to whether origins are independent or nonindependent

Conversely two species that exhibited identical *illogical* solutions to a common problem would provide excellent evidence for a common genetic basis (just as one or the other of two students, both of whom claimed that 2 × 4 = 17, could be accused of cheating) Organisms that arrive at illogical solutions to environmental problems (such as maple trees that flower and develop leaves in midwinter in upstate New York) though do not survive and reproduce Illogical solutions of both the genetic and intellectual sort lower the fitnesses of their perpetrators and cause their own elimination from populations That is why I have said in regard to social behavior "What is seen is no proof, what would be proof cannot be seen" This is the dilemma that E O Wilson has created

The above account in no way weakens the argument of Wilson and others that the nervous systems of man and other organisms are genetically determined There is reason to believe that the construction of an elaborate, properly functioning nervous system is a most difficult genetic feat Normal brains, I believe, are under genetic control, not only in their general development but also (as in the case of the two hemispheres of each person's brain) in the nature of their intellectual functioning What I have called E O Wilson's dilemma does not concern this problem

Bruce Wallace
Ithaca, NY

Static

If all the problems of our times can be blamed on "staticon projectors" let us also blame them for the Crucifixion, the War of 1812 Lincoln's assassination the Fall of Rome, and the Great Flood

Anthony D Blokzyl
Minneapolis Minn

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EXPLORATIONS

By Roy A. Gallant

The time: June 30, 1908. The place: central Siberia, Imperial Russia. A giant meteorite, blindingly incandescent, streaked across the sky and smashed to Earth near the Tunguska River, devastating a roughly circular region nearly 150 kilometers in diameter. Forests were flattened and several herds of reindeer killed. The earth was pitted by cone-shaped craters up to 50 meters across. Ground vibrations from the impact shattered windows scores of kilometers away. Heat seared the bark from trees, and smoke billowed many kilometers into the atmosphere. Shock waves from the blast were "heard" around the world by delicate microbarographs, instruments that measure pulsations in atmospheric pressure set up by very long sound waves.

Had the Tunguska meteorite fallen on New York City, the destruction would have extended east to the tip of Long Island, north to New Haven, Connecticut, west to Wilkes-Barre, Pennsylvania, and south to Atlantic City, New Jersey.

In 1947 another giant fell from space, its brilliance rivaling that of the sun. Known as Sikhote-Alin, this fireball strewed several tons of iron over eastern Siberia near Vladivostok, peppering an area about 5 kilometers long by 1.5 kilometers wide with more than 100 impact craters. Some were nearly 30 meters across by 9 meters deep.

Astronomers estimate that these monsters weighed 100 tons or more before partially vaporizing when they entered the earth's atmosphere.

Because several popular disaster films are provoking interest in an end-of-the-world scenario involving giant meteorites, it seems timely to point out that anyone can visit the sites of such catastrophes. Before we take you to the craters themselves, however, a look at their origins will make it clearer just how spectacular these now quiet landscapes really are.

Just after the solar system formed about four billion years ago, the new planets swept millions of rocks and metal fragments from their paths. At that time craters were gouged on the moon, Earth, Mars, and Venus a thousand times more often than they are today. Missiles 1,000 kilometers across plunged into the earth, rupturing newly solidified crustal rock.

The moon, Mercury and Mars still have thousands of craters. Earth must surely have had as many in its youth. Over billions of years, however, the forces of geology and weather eroded many of them beyond recognition. Even so, geoscientists discover more giant meteorite craters each year. In Canada some of the oldest known craters on our planet have survived because they were long protected under sheets of glacial ice. The Canadian Shield region around Hudson Bay boasts many well-preserved craters. The most ancient of these are 6 billion years old.

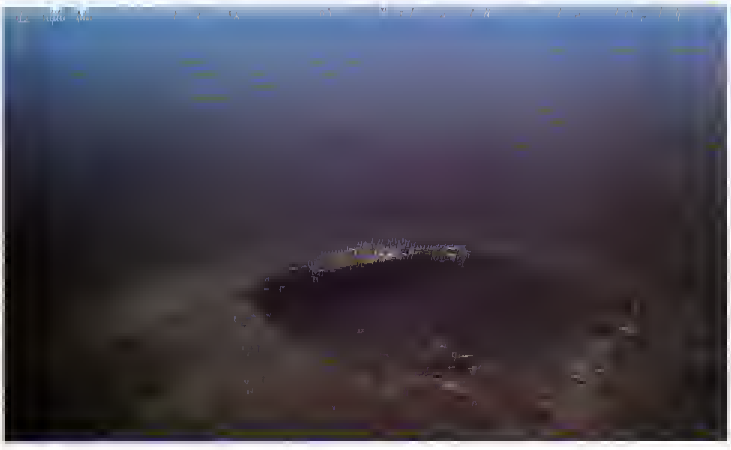
Astronomers have long suspected that many meteorites originate in the rubble of the asteroid belt between Mars and Jupiter. More than 2,000 "midget planets" have been observed in this region. Comets have also been implicated as a source of meteorites, both large and small. Some 30 asteroidlike bodies called Apollo objects or "earthgrazers" swoop close to our planet periodically. Many astronomers presume they may be remnants of old comets rather than asteroids. (For a more detailed account of the origins, composition, and structure of meteorites, see the Space column in our February issue.)

One Apollo object, named Adonis, comes within 2.5 million kilometers of Earth. Another, Hermes, approaches to 780,000 kilometers, only twice the distance of the moon from the earth. Others have come even closer.

Astronomers don't become nervous when earthgrazers sweep in close to Earth. The probability that one will plunge into our planet is very small. A direct hit occurs every 250,000 years. But if one should strike a bull's-eye, watch out. It could produce the impact of 100,000 ten-megaton hydrogen bombs and blast a crater 20 kilometers in diameter.

If you happen to be touring the United States or Canada, there are numerous giant meteorite craters you can visit. It will take some hiking or, better yet, a light plane to get to some of them, but they are well worth the effort.

The best-known impact site is the Arizona Crater, located in the desert just south of Highway 40, about 48 kilometers west of Winslow, Arizona. It is also known as the Barringer Crater, after D. M.



The spectacular Arizona Crater, near Winslow, is one of the most accessible in the United States

Barringer, who stoutly defended its meteoric origin against a host of geological doubting Thomases around the turn of the century.

The Arizona Crater is a model meteorite crater, closely resembling those on the moon. It is nearly circular, about 1,200 meters across and 200 meters deep. The upturned lip of its rim rises some 30 meters above the surrounding desert. Rock and metal fragments have been found scattered several kilometers from the impact site. Deep drilling in the crater has produced materials rich in nickel-iron, but no massive meteorite has ever been discovered. Astronomer E. J. Opik estimates that the Arizona meteorite weighed 2.6 million tons before it entered the atmosphere—a lump of iron the size of 200 ranch-style houses. It may have measured 100 meters in diameter.

Another spectacular meteorite crater in New Quebec, Canada, is a colossal water-filled bowl 3.2 kilometers across. It was discovered in 1950. The highest point of its crater wall rises 410 meters above the lake bottom. While the Arizona Crater is about 50,000 years old, the New Quebec Crater is roughly five million years old. Unlike the Arizona Crater, the New Quebec Crater is not accessible by road.

All known meteorite craters have several features in common. They look like bowl-shaped excavations surrounded by uplifted rims. The outer crater slopes are gentle, but the inner walls are steep. The rim may be blanketed by rubble, ranging from fine dust to large boulders, also found in the bowl itself. Older craters tend to fill up with sediment, and the rim and outer debris erode away. The outer slopes and the surrounding plain of young and small craters, such as the Arizona site, are sprinkled with meteorite fragments—sand and jagged rock.

While the remains of an iron meteorite are easily identified lumps of metal, fragments of a stony meteorite may be impossible to distinguish from local rock. Near a relatively young crater the rock may be fused into glass or slag similar to volcanic cinders.

Meteorites striking at the rate of more than four kilometers per second produce geological features that may elude the untrained eye. Something called shock metamorphism creates igneous rock recrystallized after being melted by the heat of impact. Also found are rocks containing high-density forms of quartz called coesite and stishovite, which are produced only by the combination of intense heat and pressure. You may also see shatter cones—large structures of quartzite that flare outward and down—produced by the meteorite's high velocity.

Several sources of information that may help you enjoy your hunt include:

"Fossil Meteorite Craters," by C. S. Beals, in the *Scientific American* of June 1958, contains pictures of geological features around ancient craters on the Canadian Shield.

"Apollo Objects," by George W. Wetherill, in the *Scientific American* of March 1979, describes these earthgrazing juggernauts in more detail.

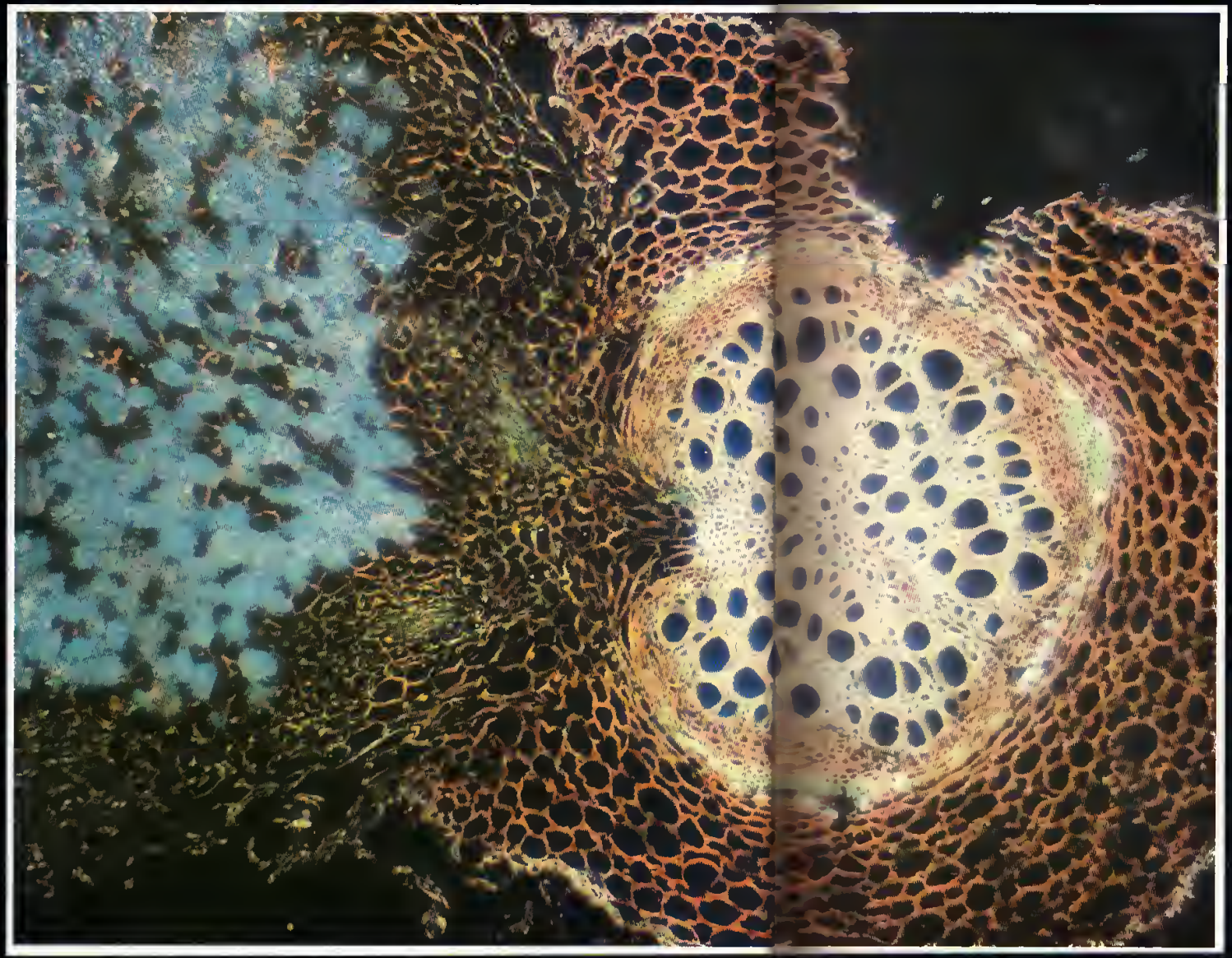
The *Observer's Handbook* for 1979 by the Royal Astronomical Society of Canada contains a more extensive list of craters in the United States and Canada. ∞

Obviously the work of Neanderthal man

THE BEST CRATERS

Name	Diameter (km)	Surface Features
Brent, Ont.	3.8	Sediment-filled depression
Crooked Creek, Mo.	5.6	Oval area of disturbed rocks, shallow depression
Decaturville, Mo.	6.0	Slight oval depression
Flynn Creek, Tenn.	3.8	Sediment-filled shallow depression with slight central elevation
Haviland, Kans.	0.011	Excavated depression
Holleford, Ont.	2.0	Sediment-filled shallow depression
Kentland, Ind.	13.0	Central uplift exposed in quarries, rest buried
Lake Wanapitei, Ont.	8.5	Lake-filled, partly circular
Middlesboro, Ky.	6.0	Circular depression
Odessa, Tex.	0.17	Sediment-filled shallow depression with very slight rim
Serpent Mound, Ohio	6.4	Circular area of disturbed rock, slight central elevation and surrounding depression
Sierra Madera, Tex.	13.0	Central hills, depression, outer rim of hills
Wells Creek, Tenn.	14.0	Basin with central hill and inner and outer rings of valleys and ridges
West Hawk Lake, Man.	2.7	Circular lake
Winslow, Ariz.	1.2	(See text for description)

(Data from *Observer's Handbook* 1979, Royal Astronomical Society of Canada)



PHENOMENA

A vital link in our food supply—that between alfalfa (right) and its symbiotic bacteria (left)—is brought forth in this remarkable new photograph by Roman Vishniac

These bacteria (known as *Pseudomonas radicicola*) invade the root hairs of the alfalfa, extract atmospheric nitrogen from the air spaces surrounding the roots, and convert it into a form that can be used by the plant. This provides the alfalfa with "free" fertilizer, since nitrogen is essential to its growth. Scientists are currently hard at work trying to introduce these and related types of bacteria to other plants (most notably corn) in the hope that they, too, can develop this relationship and thus lessen their dependence on artificial fertilizers.

Vishniac took this photograph, using Kodachrome film, through a special Zeiss microscope with a Lebedev- Nomarski-Vishniac Interference System. ☐☐

Fret no longer. Here are the answers to May Games

ANSWERS

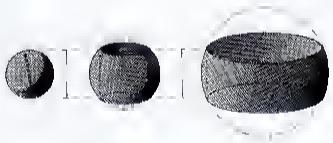
By Scot Morris

1 *Flip-Off.* You flip two coins, and your opponent flips one, you win only if you have more heads than he. It's an even bet. On those occasions when you flip both coins heads, you will win automatically, no matter what your opponent flips. This will happen on one fourth of the trials. (On another one fourth of the trials you will flip two tails and you will lose automatically.) But if your coins are head and tail (which will happen 50 percent of the time), you will win half the bets—only when your opponent throws a tail. These two probabilities, the only ways you can win, add up to 50 percent.

2 *Solve It Before They Crash.* The two cars are 50 kilometers apart and traveling toward each other at a combined speed of 50 kilometers per hour, so they will meet in one hour. In that hour, a fly that goes 100 kilometers per hour will travel 100 kilometers.

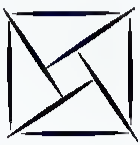
3 *No Hole in This Logic.* There's a hole ten centimeters long drilled through the center of a sphere. What's the volume of the remaining mutilated sphere? Your clue to solving this problem lay in its title and in our assurance that it was solvable. From that, you should have deduced that no matter how wide a hole through a sphere is, and no matter what the size of the original sphere is, if the hole is a given length, the volume of what's left must be constant. Otherwise, the problem wouldn't be solvable.

The simplest case would be a wire-thin hole that removed nothing at all from a sphere. Its length would be the sphere's own diameter. The formula for a sphere's volume is $\frac{4}{3}\pi r^3$, which for a sphere 10 centimeters in diameter works out to 523.6 cubic centimeters. We didn't expect you to calculate the whole answer but only to realize that you could and that it would be the volume of a sphere ten centimeters in diameter. If a hole ten centimeters long were cut through a larger sphere, it would be a huge, gaping space leaving only a thin ring of the original sphere, which would have the same volume as a ten-centimeter-diameter sphere. You didn't know that, you say? Oh, but you did. We told you in the last sentence of the puzzle that it was solvable.

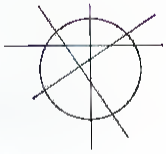


4 *Odd Coins.* Three coins in a bag: one double-headed, one double-tailed, and one a normal coin. Draw one at random. If the upface is heads, what's the chance that the downface is tails? One third. Each coin has a one-third chance of being drawn. Once drawn, a coin can be displayed in either of two ways, with one side up or the other side up. This fact remains true even if a coin has the same face on both sides. If a head is up, there are three possibilities: (1) that it is side A of the two-headed coin, (2) that it is side B of the two-headed coin, or (3) that it is side A of the normal head-tail coin. Each occurrence is equally likely, but in only one third of them is the downface a tail.

5 *Toothpick Puzzle.* There are several ways to make two squares and four triangles out of eight toothpicks, but the neatest, we think, is this:



6 *Cutting Up the Circle.* With four straight lines, you can cut a circle into at most *11* sections. Each successive line must divide as many sections as possible.

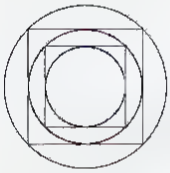


7 *Ten Coins in Three Glasses.* The only way to distribute ten coins into three glasses so that there is an odd number of coins in each glass is to nest one glass inside another. For example:

8 *Is Every Checkered Card an Ace?* How many cards must you turn over to answer the question? Two: cards 1 and 4. You needn't turn over card 2, of course, since the question asks only about checkered cards. But you needn't turn over card 3, either. Why? Because, if card 1 is a deuce *or* if card 4 is checkered, you may answer the question no immediately, without looking at any more cards. If card 1 is an ace *and* card 4 is striped, you may answer the question yes, without peeking at card 3. Nothing is changed if card 3's downside is striped, for the question asks only about checkered cards.

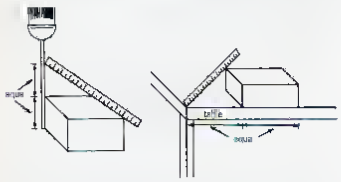
9 *Circles in the Squares.* If the outside circle has a diameter of ten centimeters, what's the diameter of the inside circle? Five centimeters. You can obtain the answer without complex figuring if you know only two facts: (1) that a square's side is the diameter of an inscribed circle,

while its diagonal is the diameter of a circumscribed circle, and (2) a square's side may be found by dividing its diameter by the square root of 2. If you attack the problem as a whole, you don't have to know what the square root of 2 is. The diameter of the middle circle is 10 cm/$\sqrt{2}$. The diameter of the small circle is (10 cm/$\sqrt{2}$)/$\sqrt{2}$, or 10 cm/2, or 5 cm.

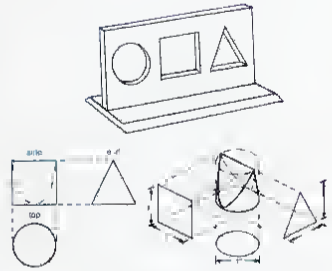


10 *Coin Triangle* Shift three coins to reverse the triangle.

11 *Inside Straight* Measure the long diagonal of a box by constructing a phantom box that you can get your ruler "inside." Examples, using a broom handle and a table corner, are illustrated below.



12 *Square Pegs* To carve a plug that will fit all three holes, start with a cylinder five centimeters in diameter and five centimeters tall. Viewed from one side, it has a square cross section. Slice two pieces from the cylinder so that a third cross section is an isosceles triangle. A picture is worth a thousand words.



13 *The Smartest Applicant* Three job applicants try to figure out what color spot is on their foreheads. They think a spot could be red or black, but in fact all are black. Each raises a hand to indicate that he or she sees a black spot on at least one of the other foreheads. From this information none of the applicants can deduce the color of his own spot. Applicant A knew that the others were also finalists for the job of assistant to the Games editor and that either of them would be capable of solving the problem if it was solvable. Applicant A reasoned: "If either of them saw a red spot on me, they would know their own spot was black, by noticing that the third applicant has a hand raised. Neither of them is speaking out, so I must have a black spot." The fact that all three applicants had the same information to start with made this a fair test to find the best Games assistant.

14 *Money* There's nothing wrong with the opening lines of "The Gift of the Magi": "One dollar and eighty-seven cents. That was all. And sixty cents of it was in pennies." When O. Henry wrote this story, the United States still had two- and three-cent pieces in circulation. One two-cent piece or four three-cent pieces would explain the statement.

15 *Word Associations*
BAG STORM BANK BAR
MOON FLOOR STORE DUNE
Which word from the bottom group belongs with those at the top? There are undoubtedly many possible answers, but the one we had in mind was DUNE, since all the words may be preceded by *sand*.

16 *For Catholics Only* This question and the next were left over from our April Fools' file. The Catholic Church does not allow a man to marry his widow's sister. How can a dead man marry anyone?

17 *Which Is Correct?* Is it correct to say that the yolk of an egg *is* white or that the yolk of an egg *are* white? Neither, of course. The yolk is yellow.

18 *Launch Pads* The reason space centers like Cape Canaveral are usually located in tropical climates is that rockets are launched in the direction of the earth's rotation, from west to east. To take advantage of the maximum "push" from the earth, launch sites are located as close to the equator as possible.

THE OMNI CRYPTOGRAM The uncoded message, including all punctuation, is: "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." Freeman Dyson. (From his *Omni* interview, October 1978.)

SPELLING TEST
Asinine, braggadocio, rarefy, liquefy, pavilion, vermilion, impostor, moccasin, accommodate, consensus, rococo, titillate, sacrilegious, mayonnaise, impresario, inoculate, supersede, obbligato, desiccate, resuscitate.

These are the words most commonly misspelled. Reasons for common errors may often lie in mistaken notions about a word's root forms. Word 10 (*consensus*) has nothing to do with the census. Word 13 (*sacrilegious*) has nothing to do with religion. Words with the least chance of being spelled correctly are *impostor* and *accommodate*, and the latter is misspelled in more different ways than any other.

GAMES

By Scot Morris

THE WORLD'S HARDEST SPELLING TEST

Eight hundred college graduates—including a large proportion of teachers editors journalists and advertising people—were given a test of 60 difficult words Not *one* of them got a perfect score The 20 words missed by the most persons are listed below phonetically, if grotesquely misspelled How do *you* spell these words?

1 ass-uh-9 _____
2 brag-uh-doe-c o _____
3 rare-uff eye _____
4 lick-wiff-eye _____
5 puh-vill-yun _____
6 ver-mill yun _____
7 im pah-ster _____
8 mock-uh-sun _____
9 uh-kahm-uh-date _____
10 kon-sen-sus _____
11 roe ko-ko _____
12 tittle-8 _____
13 sack-ruh-lijus _____
14 may-uh-naze _____
15 im-pray-sorry-o _____
16 in-ock-u-late _____
17 sooper seed _____
18 obly-gahto _____
19 dessuh-kate _____
20 re-sussah-tate _____

Scoring 6 correct=average
12 correct=excellent (better than 90 percent of college graduates)
18 correct=comparable to English professors

Answers, including last month's pages 142–43

THE OMNI FINAL EXAM RESULTS OF COMPETITION #3

In our third competition (January *Omni*), we asked for questions, the kind that lead to head-scratching eyebrow-raising all-night rap sessions or nervous breakdowns, the simple childish questions for which the only safe answer is, 'Go ask your mother'

If everything is made of molecules, why can we see through glass molecules but not through wood molecules?

If God is omnipotent can He build a stone so big He can't lift it?

Why does a mirror reverse left and right but not up and down?

If an airplane gets its lift from the curved upper part of its wing how can an airplane fly upside down?

The queries were mostly serious scientific sincere (Don't bother to send me the prize money I'd rather have the answer to my question") Questions about traveling faster than light or backward in time about black holes pre-big bang scenery and God's creator were omnipresent Some old standby puzzlers were revived—the zebra's stripes, the chicken and the egg, the irresistible force and the immovable object and the tree falling in the forest (One reader had the nerve to submit a question once censored from *Saturday Night Live* "If Helen Keller fell over in the forest when there was no one around to hear, would she make a sound?")

Some questions were too big, so overwhelming in scope that they lost their special wonderment How did life begin? Is there life on other worlds? Why is light the universal speed limit?

We looked for simpler paradoxical questions When ideas overlapped we gave preference to the clearest, shortest version or the earliest postmark Some questions below have been paraphrased for brevity The winning entries and honorable mentions make up an *Omni* final exam that would curl even the hardiest toes

THE WINNERS

1 Why can't you tickle yourself?
—Darlush Saghafi, University Heights Ohio ($100)

2 A spring is compressed and tied then dropped into acid Where does the potential energy go?
—Barry Ratlhn, Aloha Oreg ($25)

3 Why are so many more people right-handed than left handed?
—David Dinsfriend, Irvington N J ($25)

4 When shaved why will hair on a person's forearm grow back just to its original length and no longer?
—Ralph Page Urbana Ill ($25)

5 A compass rests on a tabletop A magnetized ball rolls around it the compass's needle pointing to the ball at all times When the ball has gone completely around the compass, has it gone around the needle?
—P Kaszyk Alexandria Va ($25)

6 Light travels at different speeds in different media It slows down when it leaves air and goes into water It speeds up when it leaves water and goes back to air But where does the energy come from to speed it back up? (When a hockey puck enters rough ice, it slows but does not speed back up when it gets to a smooth region)
—David C Moore, Cleveland, Ohio ($25)

7 If the tides are caused by the moon's gravitational pull why are there two high tides in 24 hours?
—E Marquis, New Brunswick, Canada ($25)

8 Why does the shower curtain insist on blowing in and up against the force of the water shooting down and out?
—John Wolf, Rochester Minn ($25)

9 Where does the light go in a sealed, mirror lined room when the light is turned off?
—David Kolodny Columbia Md ($25)
(Special mention Craig Hamer, St Louis, Mo , Angie McGehee Orlando Fla.)

10 What color does a chameleon turn when placed on a mirror?
—Paul Folk, APO N Y ($25)

HONORABLE MENTION

Did Adam have a belly button?
—Dale Park, Sunnyvale, Calif

Why do solid particles in a swirling liquid have a tendency to move to the center seemingly contrary to centrifugal force?
—Glenn G Mazzei Uncasville Conn

Which way do whirlpools rotate at the equator?
—Thomas Hughes, San Diego, Calif

If water can be pumped only to a height of 32 feet under normal atmospheric pressure how does water get to the top of an 80-foot tree?
—David DeKoeyer, South Haven, Mich

Can you convict an atheist of perjury if he lies in court under an oath to God?
—Keith Wolf Lake Ozark Mo

What is it in water that puts out a fire?
—Charles Van Dorn, Greenfield Ctr, N Y

Define the universe Give *three* examples
—Richard K Tangard Norwalk, Conn

Sound travels faster in warm air than in cold, dense air Why, then, does sound travel faster in dense materials, such as wood and metal? You d think that as air became more dense, sound should travel faster it doesn't Why not?
—Donn Brazier St Louis Mo

December 20 is the shortest day But it is not the day that the sun rises latest or sets earliest—these events occur in early January and early December respectively Why the asymmetry?
—N Chris Paulhus, Harvard Mass

If fibrinogen, the clotting substance in blood, is insolubte, then why does water dissolve a blood clot on the skin?
—Mike Jesse, Bradenton Fla

Why does room-temperature water feel cold to the touch while room-temperature air doesn't?
—Joe Heifman, Portage, Mich

Where has all the rubber that wore off all the automobile tires gone?
—Robert E Marganski Ansonia, Conn
Sean Murphy Wahiawa Hawaii

Evidence shows that the distant stars are moving outward with acceleration If everything started with one big bang, where is the force for this acceleration?
—Jim Walker Miami Fla

If life is a continuous cycle of reincarnation how is it that the population increases?
—Carole Sterne Long Beach Calif

Why does a full moon look so much larger on the horizon than it does overhead?
—Paul Parker Las Vegas Nev

Since nitrogen gas is lighter than oxygen, why isn t all the N_2 above the O_2 in the atmosphere?
—Steve Hudson Carrollton, Ga

In a steep rain, do you get wetter (i e encounter more drops per minute) if you run or walk?
—Ned Cotter, New York N Y

Why does high humidity make hot weather feel hotter but make cold weather feel colder?
—Lois Sharpless Brooks New York N Y

An ice cube stirred in a cup of cold water stops its rotation quickly while one in hot water will rotate until it dissolves Why?
—P Kaszyk, Alexandria Va

If people's knees bent the other way what shape would our chairs take?
—Steven Julian, Bloomington Ind

Why do boys have nipples?
—Romanas Buskus Chicago Ill

Why does hot water sound different when poured than cold water does?
—Judy Wright Climax Mich

Where do babies *really* come from?
—Gene Zwadski Solana Beach Calif

How would Adam and Eve ever have had grandchildren without incest?
—Robert B Agran Baltimore Md

What would be the proper thing to say to the Pope if he sneezed?
—Walt Buckley Grand Rapids Mich

OMNI COMPETITION #7 GRAFFITI

Graffiti the inscriptions scratched on walls etc constitute one of mankind s oldest forms of communication From 'Serena hates Isadore' a message preserved on the walls of Pompeii when Mount Vesuvius erupted there in the first century C E to the ubiquitous 'Kilroy was here" of World War II public scribblings are a universal reflection of folk culture They are usually associated with bathrooms, but their information packed eloquence and public ownership are comparable to the public-domain slogans we see all around us

This competition is for future or science oriented graffiti What sentiments might be expressed on the stalls of ivy at Harvard or MIT? What slogans might be tacked to the bulletin board at NASA? What sayings will be scribbled in the men s room of the *Enterprise*? What will appear on the twenty first-century equivalent of lapel pins, T-shirts and bumber stickers?

HEISENBERG MIGHT HAVE BEEN HERE
NIELS IS BOHRING
BLACK HOLES ARE OUT OF SIGHT!
GRAVITY DOESN T EXIST—
THE EARTH SUCKS
WARNING I BRAKE FOR ALIENS

The competition Submit one gratfito with an *Omni* flavor—a slogan pun or catchphrase along the lines of the above examples Postcards only, please, with one entry per card All entries must be postmarked by July 15 1979 First-prize winner will receive $100 Runners-up (2 through 10) will receive $25 each

All entries become the property of *Omni* and will not be returned Send entries to OMNI Competition #7 909 Third Avenue, New York N Y 10022 ∞

VAMPIRES REVAMPED

LAST WORD

By Bruce Wallace

Bram Stoker through his novel *Dracula*, and the motion-picture industry through its many portrayals, have led us to consider Count Dracula a fifteenth-century Romanian nobleman, as *the* vampire. The count, who was known as Vlad the Impaler, was a seemingly unpleasant person who was known to lunch in the presence of scores of impaled enemies. Once, during such a lunch, an ambassadorial guest complained that the sights and sounds interfered with his appetite. Count Dracula ordered one more stake (pun intended) on which he had his guest impaled. He then continued dining, alone.

Count Dracula makes a splendid vampire, but I wish to push the vampire legend beyond fifteenth-century Transylvania, back thousands of years to the prehistoric cave dwellers of Europe. The account I am about to relate was told to me by my elder brother, whose birth occurred only a few years closer to those ancient times than mine. Many of the aspects of his story are so attractive that I wish to place them on record.

To appreciate the elegant simplicity of the story I am about to propose, a number of biological and anthropological facts must be listed.

• Throughout the glacial periods, primitive human beings sought shelter in caves. Archaeological finds from these caves include paintings, stone and metal implements, shallow graves, ashes, and other debris of cave life.

• Bats normally inhabit caves. The Carlsbad Caverns of New Mexico, for example, were discovered because of a plume of bats issuing from a small hole in the ground at eventide.

• Bat populations are natural reservoirs of the rabies virus, and bats are important vectors of that disease. The drive to eliminate the vampire bat from tropical America is aimed as much at eradicating rabies as it is at the prevention of involuntary bovine anemia.

• General symptoms of rabies among mammals of all sorts are a (terminal) feverish alertness, aggression, and an urge to bite—this urge extends to rabies-infected horses and cows, which, despite being herbivorous, attack and bite nearby animals. Because the rabies virus is concentrated in saliva, the biting reaction can be viewed as an adaptive neurological disorder induced in the now-dying host by the virus.

• Another general symptom of rabies exhibited by recently infected animals is a preference for solitude, perhaps accompanied by discomfort when one is exposed to light. Thus, while the disease is developing, dogs seek out cool, shaded shelters and foxes retire to their dens.

• A final, simple, and well-known point: Rabies is typically transmitted from one animal to another by the bite of an infected individual. The mad dog is but one example: terminally ill foxes attack both human beings and dogs. Since 1972, 600 Europeans have died of rabies. The ultimate source of the virus in Europe today is the population of wild foxes.

All that now remains is to assemble my brother's story. In prehistoric times, when human beings were primarily cave dwellers, they clustered near the opening of the cave, where they were warmed and protected by a fire. The bats lived in the rear of the cave, where the ceiling approached the floor, and in the more remote and inaccessible caverns. Many of these bats were infected with rabies, and, occasionally, a rabid bat, driven to aberrant behavior by the virus, would deliberately attack and bite a human being. Such odd behavior on the part of a bat would have been noted by those present, just as farmers in Austria note the attack on a person by a crazed fox.

Bela Lugosi in 1931 film version of Dracula

In due time the bat's victim would develop rabies. During the early stages of the disease, the victim would seek solitude in the rear of the cave, away from daylight and the heat and light of the fire. Friends and family members bringing food and water to the ill one would note that his newly exhibited preference placed him in the company of the bats, not with his own kind.

Finally, in the course of his disease, the victim would become feverishly alert and aggressive—perhaps shrewdly rather than blindly so. He would be driven to bite those who came near him, driven by the same terminal neurological control the rabies virus exerts over all its victims.

The unlucky Samaritan, bitten by the now-rabid victim, would inexorably pass through the same stages as the original victim who was bitten by the bat: retirement into the dark recesses of the cave in a seeming preference for the company of bats over humans and the eventual alertness and craze to bite. Thus, the victim of a bat's bite would have taken on, in the eyes of his contemporaries, the habits of a bat—even the urge to bite that was observed in the original bat's behavior. Furthermore, the strange ability to cause another person to take on the behavior of a bat would confirm that the first victim had indeed become batlike.

That is my brother's story. Because of a nineteenth-century novel, most people associate vampirism with a fifteenth-century count. I suspect, however, that the truth lies more as my brother sees it. The vampire legend has been handed down for thousands of years, starting with the observations of cave dwellers on the effects of rabies and ending with the transmission of this disease from bats to humans and from one human being to another. ∞